World Armaments and Disarmament

SIPRI yearbook 1972

Stockholm International Peace Research Institute

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SIPRI

Stockholm International Peace Research Institute

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PREFACE

The third issue of the SIPRI Yearbook continues our analysis of the world's arms races, and the attempts to stop them, up to 31 December 1971. As in all SIPRI publications, information has been obtained from open sources only.

All members of the staff had some hand in the preparation of the Yearbook and there was a considerable interchange of material and comments.

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March 1972

Frank Barnaby

Director of SIPRI

CONTENTS

Abbreviations, conventions, country terminology, conversions XVII
Introduction XIX

PART I. STRATEGIC NUCLEAR FORCES AND SALT

Chapter 1. Advances in strategic nuclear forces by the USA and the USSR during the Strategic Arms Limitation Talks (SALT) 1

I. Introduction 1
II. Land- and sea-based strategic forces 3
III. Improved accuracy and reliability of missiles 9
IV. Strategic bombers 10
V. Defence systems 11
VI. Summary 13

Chapter 2. The Strategic Arms Limitation Talks, November 1969–December 1971 23

I. Introduction 23
II. Attitudes toward SALT 24
III. Reported topics of discussion 27
The early rounds – The "agreement-to-agree" – The fifth and sixth rounds of SALT
IV. MIRV. 34
V. The secondary nuclear powers 35
VI. Substantative agreements concluded at SALT during 1971. 36

Chapter 3. The implications of SALT for the arms race 40

I. SALT objectives 40
II. SALT agreements. 44
III. Summary and conclusions 48

PART II. THE DEVELOPMENT AND SPREAD OF ARMS RACES

Chapter 4. World military expenditure, 1970–1971 51

I. Introduction 51
II. Military expenditure, by region 56
The United States – US military research and development expenditure – European NATO – Warsaw Pact military expenditure – Other developed countries – Underdeveloped countries

Appendix 4A. Sources and methods 74

I. Definitions. 74
II. Methods. 75
III. Sources 79
IV. Conventions 81

Chapter 5. The trade in major weapons with the third world, 1970–1971 100

I. Introduction 100
II. The main suppliers and recipients 101
The United States – The Soviet Union – The United Kingdom – France – Small suppliers

Appendix 5A. Sources and methods 111

I. Introduction 111
II. Sources of information 111
III. Coverage 111
IV. The tables 113
V. Joint and licensed production 117
VI. The register 118

Appendix 5B. Arms trade register: register of major weapon transfers to third world countries, 1970–1971 124

Chapter 6. Resources devoted to military research and development 149

I. Introduction 149
II. The pattern of military R & D spending in 22 countries 151
The level of current military R & D expenditures – The correlation between the level of total military spending, and the share of this total devoted to R & D – Long-term trends in military R & D expenditure
III. The size of worldwide military R & D efforts 182
Worldwide weapons development projects under way, 1960–1968 – The military R & D effort of the Soviet Union
IV. Conclusions 207

Appendix 6A. Statistical tables, sources and methods 211

I. Definition of military R & D 211
II. Sources of military R & D expenditure estimates 214
III. The reliability of the estimates 215
IV. The international comparability of the estimates 217

Appendix 6B. US estimates of Soviet expenditure on military research: an analysis of data published in 1971 and early 1972 232

I. US estimates published in 1971 232
II. The 1972 US assessment of the Soviet effort 235

Chapter 7. Foreign military presence, 1971: armed forces and major bases . . . 240

I. Introduction 240
II. Foreign military presence 241
Deploying countries – Host countries
III. Restrictions 243
Use of public sources – Peacetime patterns – Specific restrictions
IV. Tables 248

Chapter 8. The economic and social consequences of military expenditure: comments on the UN report 276

I. The facts 276
The national consequences – The international consequences
II. Comments on the report 280

PART III. THE PROBLEM OF THE PROLIFERATION OF NUCLEAR WEAPONS

Chapter 9. The near-nuclear countries and the Non-Proliferation Treaty 283

I. General background 283
The proliferation issue – The Non-Proliferation Treaty – The spread of nuclear technology – The Nth country problem – The main questions – The key countries

II. Country studies 298
India 298
Development of nuclear technology in India – The Indian attitude to the NPT – India and "the bomb"
Pakistan 307
Nuclear technology in Pakistan – Pakistan's position on the Non-Proliferation Treaty
Israel 309
The Israeli nuclear programme – Israel and the NPT – Israel and "the bomb"
The Arab Republic of Egypt 313
The Egyptian nuclear programme – Egypt and the NPT
South Africa 314
South Africa's nuclear programme – South Africa and the NPT
Japan 317
The development of nuclear technology in Japan – Japan and the NPT – Japan and nuclear weapons
Australia 324
Development of nuclear technology in Australia – The Australian attitude to the NPT
Spain 328
Spain's nuclear programme – The Spanish attitude to the NPT
Brazil 329
Brazil's nuclear programme – Brazil and the NPT
Argentina 332
Argentina's nuclear programme – Argentina and the NPT
Euratom and the NPT 333
The Federal Republic of Germany 337
The West German nuclear energy programme – West Germany and the NPT
Italy 345
The Italian nuclear programme – Italy and the NPT
The Netherlands 349
The Dutch nuclear programme – The Netherlands and the NPT
Belgium 351
Switzerland 352
The Swiss nuclear programme – The Swiss attitude to the NPT – The issue of Swiss nuclear weapons

III. Conclusions 355

Appendix 9A. Nuclear power reactors as a source of plutonium 366

I. The production of plutonium 367
II. Fast-breeder reactors 369
III. Summary 370

Appendix 9B. Enriched uranium technology 371
I. Gas diffusion 371
II. Gas centrifuge 372
III. The need for enriched uranium 373

Chapter 10. Nuclear safeguards 375
I. Introduction 375
II. Essential provisions of the safeguards system 377
Control of nuclear material – The functioning of the system – Financing – Non-compliance – Settlement of disputes – Entry into force
III. Significance of the agreement 385

Chapter 11. The test ban 389
I. Introduction 389
II. History 390
US policy – Soviet policy – The positions of other countries
III. The frequency of testing 405
IV. Verification 408
Seismic verification – Concealment – Non-seismic monitoring – Assessment
V. The military significance of tests 417
The United States and the Soviet Union – Other countries
VI. Nuclear explosions for peaceful purposes 424
VII. Compromise treaties 426
VIII. The political significance of a comprehensive test ban 426
The United States and the Soviet Union – Secondary nuclear-weapon powers – Near-nuclear-weapon nations – Other countries
IX. Conclusions 432

Appendix 11A. Evidence on understatement of numbers of nuclear tests and its significance 433

Chapter 12. Non-seismic detection of underground nuclear tests 437
I. Introduction 437
II. Statements implying a present role of satellites or of electronic intelligence in underground nuclear test detection and identification 441
III. Possible satellite detection of underground nuclear testing 444
IV. The capabilities of the Vela satellite system 448
V. Ground-based methods for detecting atmospheric and very high-altitude nuclear tests 453

Chapter 13. Nuclear weapon testing programmes, 1945–1970 461
I. Nuclear tests conducted during 1970 461
II. The Soviet nuclear testing programme for civil purposes 464

Chapter 14. World uranium supplies 470
I. Introduction 470
II. Background and demand 470
III. Military demand 472
IV. Civil demand 473

V. Supplies 478
Reserves – Stockpiles – Exploration – Production and production capacity
VI. Modes of international trade in uranium 481
VII. Conclusions 482

Chapter 15. China and disarmament 483
I. Introduction 483
II. China and nuclear arms 485
III. China's disarmament policy 489
China's opposition to US–Soviet disarmament policy – Chinese proposals for nuclear disarmament
IV. Summary and conclusions 499

PART IV. DEVELOPMENTS IN ARMS CONTROL AND DISARMAMENT, 1970–1971

Chapter 16. Chemical and biological disarmament 501
I. Introduction 501
II. Essential provisions of the biological disarmament convention 502
Scope of the obligations – Verification and enforcement – Relationship to the Geneva Protocol – Peaceful uses of biological agents – Link with chemical disarmament – Entry into force and withdrawal
III. Significance of the biological disarmament convention 512
IV. Prospects for chemical disarmament 513
V. Reinforcement of the constraints on CW 515

Appendix 16A. Convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction 517

Chapter 17. The nuclear test ban debate 523
I. Introduction 523
II. Interim measures 524
III. Partial measures 524
IV. Verification 525
V. Peaceful applications of nuclear explosions 527
VI. Legal form of the ban 529
VII. Draft treaty 530
VIII. Memorandum of the non-aligned powers 531
IX. Conclusions 532

Chapter 18. Preventing an arms race on the sea-bed 533

Appendix 18A. Treaty on the prohibition of the emplacement of nuclear weapons and other weapons of mass destruction on the sea-bed and the ocean floor and in the subsoil thereof 537

Chapter 19. The treaty for the prohibition of nuclear weapons in Latin America (Treaty of Tlatelolco) 542

Chapter 20. Declaration of the Indian Ocean as a zone of peace 550

Chapter 21. The Disarmament Decade 556

A DISARMAMENT RECORD, 1970–1971

Chapter 22. UN General Assembly resolutions on disarmament and related matters, 1970–1971 561

Chapter 23. List of states which have signed, ratified, acceded or succeeded to the treaties related to disarmament 574

Chapter 24. Chronology of major events related to disarmament issues, September 1970 to December 1971 594

TABLES, CHARTS AND MAPS

TABLES

Chapter 1. Advances in strategic nuclear forces by the USA and the USSR during the Strategic Arms Limitation Talks (SALT)

1.1. Western estimates of delivery vehicles for nuclear weapons, 1 January 1972 2
1.2. US and Soviet intercontinental ballistic missiles (ICBMs) 4
1.3. US and Soviet submarine-launched ballistic missiles (SLBMs) 7
1.4. Estimates of numbers of Soviet submarines, other than "Y"-class submarines, with ballistic missiles 15
1.5. Estimates of numbers of Soviet submarines carrying cruise missiles . . . 15
1.6. Deployment of US Minuteman ICBMs 15
1.7. Past and predicted changes in US megatonnage in high-yield delivery systems from 1965 until 1975, when MIRV and SRAM procurement are scheduled to be completed 16
1.8 US and Soviet medium- and long-range bombers 18
1.9. US and Soviet air-to-surface missiles for medium- and long-range bombers 19
1.10. US anti-ballistic missiles to be deployed 21
1.11. US and Soviet shorter-range European-based ballistic missiles 22

Chapter 2. Strategic Arms Limitation Talks, November 1969–December 1971

2.1. SALT sessions 24

Chapter 4. World military expenditure, 1970–1971

4.1. Long- and short-term trends in the volume of world military expenditure 53
4.2. The Viet-Nam War and US military expenditure 55
4.3. Trends in the volume of US Department of Defense Total Obligational Authority (TOA) 58
4.4. NATO: long- and short-term trends in the volume of military expenditure 60
4.5. Price changes in the USSR since 1965 62
4.6. Other Europe: long- and short-term trends in the volume of military expenditure 63
4.7. Warsaw Pact: long- and short-term trends in the volume of military expenditure 69
4.8. Middle East: long- and short-term trends in the volume of military expenditure 70
4.9. South Asia, the Far East and Oceania: long- and short-term trends in the volume of military expenditure 71
4.10. Africa: long- and short-term trends in the volume of military expenditure 72
4.11. Latin America: long- and short-term trends in the volume of military expenditure 73

A. Official and Benoit-Lubell exchange rates for Warsaw Pact countries . . 78
4A.1. World summary: constant price figures 82
4A.2. NATO: constant price figures 82
4A.3. NATO: current price figures 84
4A.4. Warsaw Pact: current price figures 84
4A.5. Warsaw Pact: current price figures 84
4A.6. Other Europe: constant price figures 86
4A.7. Other Europe: current price figures 86
4A.8. Middle East: constant price figures 86
4A.9. Middle East: current price figures 88
4A.10. South Asia: constant price figures 88
4A.11. South Asia: current price figures 88
4A.12. Far East: constant price figures 90
4A.13. Far East: current price figures 90
4A.14. Oceania: constant price figures 90
4A.15. Oceania: current price figures 92
4A.16. Africa: constant price figures 92
4A.17. Africa: current price figures 94
4A.18. Central America: constant price figures 96
4A.19. Central America: current price figures 96
4A.20. South America: constant price figures 96
4A.21. South America: current price figures 98

Chapter 5. The trade in major weapons with the third world, 1970–1971

5A.1. Values of imports of major weapons by third world countries: by region, 1950–1971 120
5A.2. Values of exports of major weapons to regions listed in table 5A.1.: by supplier, 1950–1971 122

Chapter 6. Resources devoted to military research and development

6.1. The level of current military research and development expenditures in 22 countries 153
6.2. Military R & D expenditures as a share of gross national product, total military expenditure and total government R & D expenditure, 1967 . . 156
6.3. The pattern of correlation between (a) the level of total military expenditure and (b) the share of the total devoted to military R & D, 1960–1969 158
6.4. Summary of military R & D expenditure, 1955–1971, at constant prices 165
6.5. The proportion of total military expenditure devoted to military R & D, 1955–1971 166
6.6. The proportion of government R & D funds devoted to military R & D, 1955–1971 178
6.7. The proportion of total national R & D funds devoted to military R & D, 1955–1970 181
6.8. Preliminary survey of government-financed weapons development projects under way 1960–1968 184
A. Illustrative calculation of potential level of Soviet military R & D expenditures 200
6A.1. General description of the sources and composition of the military R & D expenditure estimates 220
6A.2. Military R & D expenditure, 1952–1971 222
6A.3. Military R & D expenditure, 1952–1971 224
6A.4. Military R & D expenditure, 1952–1971 224

6A.5. Military R & D expenditure as a percentage of total military expenditure, 1952–1971 . . . 226
6A.6. Military R & D expenditure as a percentage of gross national product (GNP), 1952–1970 . . . 226
6A.7. Military R & D expenditure as a percentage of total central government-financed R & D, 1952–1970 . . . 228
6A.8. Military R & D expenditure as a percentage of total national R & D, 1955–1970 . . . 228
6A.9. US federal government military and civil R & D expenditure, by source of finance, 1939–1971 . . . 230

Chapter 7. Foreign military presence, 1971: armed forces and major bases

7.1. Foreign military presence in four areas: the United States . . . 250
7.2. Foreign military presence in four areas: the Soviet Union . . . 259
7.3. Foreign military presence: the United Kingdom . . . 262
7.4. Foreign military presence: France . . . 265
7.5. Foreign military presence: other countries . . . 267
7.6. Numbers of US armed forces deployed abroad, general . . . 268
7.7. Numbers of US armed forces deployed in Europe and South East Asia (excluding South Viet-Nam) . . . 269
7.8. Numbers of US armed forces deployed in South Viet-Nam . . . 269
7.9. Numbers of British armed forces abroad (including non-British personnel locally enlisted) . . . 270
7.10. Typical strengths (approximate figures) of foreign fleets in three areas: USA, USSR, UK and France . . . 271

Chapter 9. The near-nuclear countries and the Non-Proliferation Treaty

9.1. Nuclear capabilities of fifteen near-nuclear countries . . . 296

Chapter 11. The test ban

11.1. Yield distribution of US, Soviet and UK nuclear weapons tests, until January 1971 . . . 409

Chapter 12. Non-seismic nuclear test detection

12.1 Bomb radiations and outputs important to nuclear test detection . . . 438
12.2. Techniques and characteristics of ground-based systems used to detect nuclear explosions in the atmosphere and in space . . . 439
12.3. Project Vela funding . . . 452
12.4. Cost of research, development, testing and evaluation for the Vela satellite programme, 1965–1970 . . . 453

Chapter 13. Nuclear weapon testing programmes, 1945–1970

13.1. Reported nuclear test explosions, 1945–1970 . . . 462
13.2. US underground nuclear tests reported as venting, 1970 . . . 463
13.3. Reported nuclear test explosions, by environment, 1945–1970 . . . 464
13.4. Cost of the US nuclear testing programme, 1962–1972 . . . 465
13.5. US and Soviet nuclear explosive civil-application projects . . . 467

Chapter 14. World uranium supplies

14.1. Assumed growth of nuclear generating capacity used to calculate uranium demand . . . 474

14.2. Estimates of demand for uranium (U_3O_8), 1971–1980 476
14.3. Estimated world demand for uranium (U_3O_8) 477
14.4. World uranium production and reserves (U_3O_8 below $ 10 per pound) . 479

CHARTS

Chapter 1. Advances in strategic nuclear forces by the USA and the USSR during the Strategic Arms Limitation Talks (SALT)

1.1. USA and USSR: numbers of intercontinental ballistic missiles and launchers 6
1.2. USA and USSR: Polaris-type submarine-launched ballistic missiles . . 20

Chapter 4. World military expenditure, 1970–1971

4.1. World military expenditure, 1950–1972 52
4.2. Military expenditure in developed and underdeveloped countries compared, 1960–1971 54
4.3. The Viet-Nam War and US military expenditure 56
4.4. Alternative estimates of Warsaw Pact military expenditure figures . . . 61
4.5. Military expenditure in the underdeveloped countries (excluding South Africa and Japan) 66
4.5A. Relative size, 1950–1970, US $ bn, at constant 1960 dollars and 1960 exchange rates 66
4.5B. Growth rate, 1960–1970: index numbers, 1960=100 67
4.6. Military expenditure in Israel and Egypt, 1950–1971 68
4.7. Military expenditure in South Africa and Sub-Saharan Africa, 1960–1971 68
4.8. Military expenditure in India and Pakistan, 1950–1971 69

Chapter 5. The trade in major weapons with the third world, 1970–1971

5.1. Total exports of major weapons to third world countries 102
5.2. The main suppliers of major arms to third world countries, excluding Viet-Nam 103

Chapter 6. Resources devoted to military research and development

6.1. The level of military R & D expenditure in 22 countries 154
6.2. Military R & D expenditure compared with other economic indicators, 1967 157
6.3. The pattern of correlation between (a) the level of total military expenditure and (b) the share of the total devoted to military R & D, 1960–1969 159
6.4. Long-term trends in military R & D expenditure, 1955–1971 167
6.5. Long-term trends in the proportion of total military expenditure devoted to R & D, 1955–1971 168
6.6. Trends in US government military and civil R & D expenditures, 1939–1971 176
6.7. Long-term trends in the proportion of government R & D funds devoted to military R & D, 1955–1970 179
6.8. Long-term trends in the proportion of national R & D funds devoted to military R & D, 1955–1970 182

Chapter 11. The test ban

11.1 Nuclear tests conducted by the USA and the USSR, 1946–1970 405
11.2 Nuclear tests conducted by the USA and the USSR during the negotiating period for the test ban treaty, 1 January 1956 – 31 December 1963 . . 407
11.3. Nuclear tests conducted by the USA, the USSR, the UK, France and China, 1951–1970 408

Chapter 14. World uranium supplies

14.1. Estimate of annual demand for uranium 475

MAPS

Map 1. World map: deployment of foreign military bases and fleets by the United States, the Soviet Union, the United Kingdom and France . . . . inside back cover
Map 2. Deployment of NATO and Warsaw Pact combat aircraft and armoured and infantry division equivalents in Europe (Insert: deployment of US, Soviet, British and French troops in Central Europe) 272
Map 3. Soviet naval visits, 1962–1964 273
Map 4. Soviet naval visits, 1965–1967 274
Map 5. Soviet naval visits, 1968–1970 275
Map 6. World map: the spread of nuclear power. 292
Map 7. The zone of application of the Treaty of Tlatelolco, as of 1 January 1972 . 548

ABBREVIATIONS, CONVENTIONS AND CONVERSIONS

Abbreviations

mg.	milligram
lb.	pound
kt.	kiloton
mt.	megaton
m	metre
km.	kilometre
n.mi.	nautical mile
mi.	mile
in.	inch
ft	foot
yd	yard
mn	million
bn	billion
MWe	megawatts of electricity
GWe	gigawatts of electricity
FY	fiscal year

Conventions

Some conventions used with particular tables only are given together with those tables.

. . .	Data not available
—	Nil or less than half the final digit shown; negligible; not applicable
( )	Estimate or greater degree of uncertainty
[ ]	Estimate
▌	Date of independence

Country terminology

For the convenience of the reader, we have tended to use the geographical rather than the formal official name of certain countries. In addition, several states have recently changed their official names. Examples are given here.

East Germany	German Democratic Republic (GDR)
West Germany	Federal Republic of Germany (FRG)
North Viet-Nam	Democratic Republic of Viet-Nam (DRV)
South Viet-Nam	Republic of Viet-Nam
North Korea	Democratic People's Republic of Korea
South Korea	Republic of Korea
China	People's Republic of China
Taiwan	Republic of China
Congo (Brazzaville)	People's Republic of the Congo
Zaïre	former Democratic Republic of the Congo (Congo, Kinshasa)
Egypt	Arab Republic of Egypt (former United Arab Republic)
Bangladesh	former East Pakistan
Khmer Republic	former Cambodia

Conversions

Units of length

1 millimetre = 0.039 inch
1 inch = 25.4 millimetres
1 metre = 1.1 yard = 3.28 feet
1 foot = 30.480 centimetres
1 yard = 3 feet = 36 inches = 0.91 metre
1 kilometre = 0.62 statute mile = 1 094 yards
1 statute mile = 1.61 kilometres = 1 760 yards
1 nautical mile = 6 076 feet = 1 852 metres

Units of mass

1 ton = 1 000 kilograms (tonne) = 2 205 pounds, avoirdupois = 0.98 long ton = 1.1 short ton
1 short ton = 2 000 pounds = 0.91 ton = 0.89 long ton
1 long ton = 2 240 pounds = 1.1 ton = 1.12 short ton
1 kiloton = 1 000 tons
1 megaton = 1 000 000 tons
1 kilogram = 2.2 pounds
1 pound = 0.45 kilograms

Introduction

The SIPRI Yearbooks are about world armaments and disarmament. The aim is to describe, as factually as possible, the major quantitative and qualitative changes that are taking place in the world's arsenals, and to analyse the efforts made to control these arsenals. The first two Yearbooks made depressing reading—each was a record of vast increases in weaponry of all kinds, a process virtually unhampered by arms control or disarmament agreements. This Yearbook is, it is sad to relate, no exception.

The subjects of this Yearbook fall neatly into four parts, centred respectively on: the main nuclear arms race between the United States and the Soviet Union; the spread of arms and the consequences of this spread; the possible military and strategic implications of the widespread use of nuclear technology; and the efforts made to control and reduce armaments.

The first part of the Yearbook examines the advances made in strategic nuclear weapon systems, and describes the bilateral attempt to control the nuclear arms race, namely the Strategic Arms Limitation Talks (SALT) between the USA and the USSR. The second part deals with world military expenditures, the arms trade with the third world, the resources devoted to military research and development, and the deployment of military forces and bases maintained abroad. Thus, these two parts describe the armaments situation as it exists today.

The third part looks ahead to tomorrow—at the possibility of the proliferation of nuclear weapons, the prospects for a comprehensive ban on nuclear weapon tests and the attempts to be made to safeguard nuclear materials. The final part of the Yearbook analyses the multilateral arms control and disarmament efforts made during 1971.

SALT and the nuclear arms race

Because of the overwhelming importance of SALT, probably the last foreseeable chance to reverse the main nuclear arms race, it is natural that these talks should be described and analysed early in the Yearbook. SALT—repeatedly acclaimed as the most important series of negotiations held in the twentieth century—has continued over the past year in a desultory fashion. Euphoric statements made from time to time by the two political leaderships have raised unfulfilled expectations of progress at the talks while, in fact, no significant agreement is yet on the horizon.

While SALT has continued in low key, both the USA and the USSR have energetically continued to expand and improve their nuclear arsenals. This arm-while-you-talk policy inevitably arouses the suspicion that SALT has been used, either consciously or unconsciously, as a cover for continued armament rather than a means to disarmament.

The main stated objectives of the USA and the USSR at SALT are: to prevent a further erosion in the "strategic balance" between their nuclear forces, to avoid further large escalations in the costs of the nuclear arms race, and to strengthen the Non-Proliferation Treaty.

These objectives could best be achieved by agreement on a total ban on anti-ballistic missiles, a ceiling on offensive strategic missiles at a number significantly less than the numbers now deployed, a ban on multiple independently-targetable re-entry vehicles, a restriction of anti-submarine systems, and a ban on military research and development relating to those weapon systems mentioned above. An agreement, or series of agreements, falling far short of such a comprehensive one would not prevent a further erosion of the "strategic balance", would not curtail the enormous costs of the nuclear arms race, and would further weaken the Non-Proliferation Treaty. In spite of these consequences, the most likely SALT agreement that can be envisaged at present will in no way fulfil these requirements.

Pressures are increasingly formidable in both the USA and the USSR for decisions to be taken on the development and deployment of new nuclear weapon systems. The development of these weapons would inevitably move the main nuclear arms race to even greater and more dangerous dimensions. And there could soon be more nuclear-weapon powers. The danger of general nuclear war breaking out by design, miscalculation, accident or madness would then be much increased. But so far the SALT negotiations have not reflected the urgency which this situation warrants.

The spread of arms races

Although the nuclear arms race between the USA and the USSR is undoubtedly the greatest single threat to man's survival, the arms races now taking place elsewhere in the world are also extremely dangerous. A future conflict in one of these areas could escalate into a general nuclear war—possibly the most likely way in which such a war would come about.

Enormous sums of money are being spent on armaments. The proportion of the world's resources devoted to military expenditure is now about 6 per cent. In 1971 more than $180 billion went to military expenditure; this is roughly equal to the total amount spent by the governments of the world on health and education combined. The build-up of stocks of weapons in third world countries continues to be one of the disturbing features of the world: along with other factors, it often links arms races in the third world to the major East-West confrontation by the entrammelment of supplying countries in wars in the third world.

Six nations (the USA, the USSR, China, West Germany, France and the UK) account for the bulk—80 per cent—of world military spending. The third world countries (excluding China) account for only 8 per cent of the world total. Their expenditure, however, has been rising faster than in the developed countries in the past decade. This rise, in absolute terms, is largely accounted for by the countries in the conflict areas of the Middle East and Far East.

The greatest single source of advances in weapons technology, both nuclear and conventional, is military research and development. Technological arms races will not be curtailed until this activity is controlled.

During the last decade, the world has probably spent over $15 billion annually on military research and development. In this area of technological investment, it is estimated that the USA, the USSR, China, West Germany, France and the UK account for about 95 per cent of all expenditures. At the same time, however, the capacity for domestic development and production of sophisticated conventional weapons is beginning to spread to more and more countries.

Military research and development is not only the main stimulus to a continuous increase in the funds devoted to armaments, but also a very important source of diversion of educated manpower from constructive civil activities. A substantial proportion of all the qualified manpower in the world currently engaged in research and development is involved in weapons research and development. The attempts to improve weaponry constitute, furthermore, the single largest effort ever made in any area of applied science and technology.

The nuclear future

Mankind stands on the threshold of the nuclear age—an age in which nuclear energy will be utilized in a host of different ways, perhaps most dramatically in helping to satisfy the world's rapidly growing demands for electricity. The benefits to be gained from the use of nuclear energy are, in fact, such that its widespread use is inevitable. So far nuclear technology has been mainly concentrated in the industrialized countries, but it will soon spread to the underdeveloped regions. By the end of the 1970s about one-third of the countries in the world will have significant nuclear programmes which will produce large amounts of plutonium, some suitable for the production of nuclear weapons. This could lead to a totally new situation in military and strategic affairs. It is, therefore, appropriate that the third part of the Yearbook consists of a number of nuclear topics. The issue of the proliferation of nuclear weapons is, of course, central to the discussion.

Whether or not more countries acquire nuclear weapons probably depends on the future attitudes of the near-nuclear-weapon countries to their local security problems. They will acquire nuclear weapons if they come to regard them as necessary to maintain their security. Some countries may also be influenced by the perception that ownership of nuclear weapons somehow increases status in international affairs. Lack of technological know-how and cost are no longer serious constraints.

Arms control and disarmament

SALT is part of a process which has already been going on for over two and a half decades. Soviet and US negotiators have, since 1945, met officially on nearly 6 000 occasions to discuss arms limitations. The Conference of the Committee on Disarmament in Geneva held its 500th meeting during 1971. The results of this immense number of talks have, however, been very poor. The partial measures achieved so far have not brought us much closer to the most important goal—nuclear disarmament leading to general and complete disarmament.

In 1971 an important document was adopted by the International Atomic Energy Agency (IAEA) on the contents of the agreements to be concluded between the IAEA and states to verify compliance with the obligations of states under the Non-Proliferation Treaty. The fact that the majority of states appear to find this international verification system politically acceptable is a considerable step forward in the very difficult process of establishing a workable international mechanism for verifying arms control and disarmament measures. In the short term, the safeguards agreement will improve the prospects for a wider acceptance of the Non-Proliferation Treaty.

Negotiations on chemical and biological disarmament, which have been going on for a considerable time, have yielded the first, though only partial, result in the form of a prohibition of the production and possession of biological weapons and toxins. The biological convention, which is now open for signature and ratification, is the first real multilateral disarmament measure achieved during the whole post-war period. But the decision to treat chemical and biological weapons separately was very unfortunate.

There is general agreement that biological weapons have little military use. But chemical weapons, including herbicides, have been recently used extensively in warfare, with disastrous consequences. There is a grave danger that a separate ban on biological weapons will delay indefinitely the abolition of chemical weapons. Until a chemical disarmament convention is concluded, a series of measures could and should be taken to reinforce existing constraints on the use of chemical warfare agents.

No progress has been made on negotiating the cessation of nuclear weapon tests. Recent advances in the science of seismology have virtually removed the major technical obstacle to the negotiation of such a treaty. Verification without on-site inspection should no longer be considered a serious problem. All that remains is the political will to negotiate a ban.

The treaty prohibiting the emplacement of nuclear and other weapons of mass destruction on the sea-bed, signed early in 1971, had not entered into force by 1 January 1972, despite the relatively low number of ratifications required. There have been no negotiations on further measures for the prevention of an arms race on the sea-bed, even though the Sea-Bed Treaty contains an obligation to pursue such negotiations. The main arms race is shifting rapidly from the land to the ocean environment and, consequently, there is little likelihood of progress in this area in the foreseeable future. History has shown that arms control measures are limited to environments in which there is little or no military interest.

The zone of application of the Tlatelolco Treaty prohibiting nuclear weapons in Latin America has been widened. But the two largest countries in Latin America—Argentina and Brazil—are still not bound by its provisions, and Additional Protocol II of the treaty, under which nuclear-weapon states would undertake to respect the denuclearized status of Latin America, has still not been signed by China, France or the Soviet Union. Thus, the main purpose of the treaty has not yet been fulfilled.

Another proposal for regional disarmament, even more comprehensive than the Latin American treaty, was discussed in the United Nations. The aim of this proposal was the total demilitarization and neutralization of the Indian Ocean, but this goal seems far away. The military activity of the big powers in the Indian Ocean has so far not assumed really significant proportions as compared with that in the Atlantic and Pacific Oceans (in spite of popular views to the contrary) and, precisely for this reason, steps preventing the expansion of naval movements of the big powers in the Indian Ocean should be taken urgently.

The UN resolution proclaiming the 1970s a Disarmament Decade asked that a programme for general and complete disarmament be drawn up. But no such programme has been forthcoming. Instead, the United States and the Soviet Union have shown that they are unwilling to tie themselves to a precise pattern of negotiations and prefer to keep strictly to themselves the judgement of which measures should be dealt with and when. Considering the rapid acceleration of advances in military technology in the meantime, the situation appears almost hopeless.

The entry of China into the United Nations may have far-reaching, though unpredictable, consequences for future disarmament negotiations. China is unlikely to commit itself to partial arms control and disarmament measures of the type concluded so far, because these are considered detrimental to it strategically and politically *vis-à-vis* the United States and the Soviet Union. For instance, a nuclear test ban has been dismissed by China as implying a threat to its security. There is, however, reason to assume that China is willing to discuss measures of actual nuclear disarmament, given a reorganization of present negotiating forums.

A world disarmament conference, recently suggested by many nations, could put new life into disarmament discussions. But in itself it will not solve the present problems. The basic requirement is that the nuclear-weapon powers genuinely decide to abolish all weapons of mass destruction as a first step towards general disarmament. Once the political will exists, the forum for negotiation is irrelevant. Today's policy of preventing the less armed from becoming more armed and of readjusting nuclear arsenals without actually making them less effective will simply not suffice.

Part I. Strategic nuclear forces and SALT

Chapter 1. Advances in strategic nuclear forces by the USA and the USSR during the Strategic Arms Limitation Talks (SALT)

Introduction   Land- and sea-based strategic forces   Improved accuracy and reliability of missiles   Strategic bombers   Defence systems   Summary

Chapter 2. The Strategic Arms Limitation Talks, November 1969 – December 1971

Introduction   Attitudes toward SALT   Reported topics of discussion   MIRV   The secondary nuclear powers   Substantive agreements concluded at SALT during 1971

Chapter 3. The implications of SALT for the arms race

SALT objectives   SALT agreements   Summary and conclusions

1. Advances in strategic nuclear forces by the USA and the USSR during the Strategic Arms Limitation Talks (SALT)

I. *Introduction*

Because the United States and the Soviet Union have for the past two and a half years been engaged in efforts to agree on the mutual limitation of their strategic nuclear forces, it might be thought that during this time these two countries would have exercised some measure of restraint in the further development of their strategic forces. There is, however, no evidence of any such restraint; on the contrary, both the USA and the USSR have actively continued to improve, both quantitatively and qualitatively, their strategic nuclear forces. The main nuclear arms race has continued unabated; advances in military technology have significantly increased their already formidable momentum. In both the United States and the Soviet Union, significant advances have been made across the board in each of the three strategic offensive systems—land-based intercontinental ballistic missiles (ICBMs), sea-launched ballistic missiles (SLBMs) and strategic bombers —and in strategic defence forces. So many of the myriad components of the weapon systems have been involved in this ever-dynamic process that in this section it is possible to describe briefly only the most important changes that have been made.

Available information on the characteristics of US and Soviet strategic weapon systems leads to the conclusion that, from a purely technological point of view, the strategic nuclear weapons of the United States are superior in almost all aspects of performance to those of the Soviet Union. The major exception is the maximum size of the warheads which may be carried by ballistic missiles. But it should be emphasized that the differences in performance are totally unimportant if the policy which these weapons are supposed to serve is based on deterrence, at least so far as this concept is used in strategic nuclear strategy. The "hostages" of this deterrence are the cities and industries of the adversary. Both the United States and the Soviet Union have many times more nuclear weapons, and in both countries these weapons are of higher quality, than is necessary to provide a threat to these hostages of sufficient magnitude to maintain deter-

Table 1.1. Western estimates of delivery vehicles for nuclear weapons, 1 January 1972

Nation and weapon	Number	Capable of hitting: all or most of USSR	limited parts of USSR	other Warsaw Pact countries
USA				
ICBM – with MIRVs	150	×		×
ICBM – without MIRVs	904	×		×
(ICBM total)	1 054			
Polaris SLBM (MRVs)	544	×		×
Poseidon SLBM (MIRVs)	112	×		×
Long-range bombers	531	×		×
Carrier-based aircraft[a]	low hundreds/ 1 thousand[f]		×	×
Short-range missiles[a]	1 thousand or more		some	×
Medium and short-range aircraft[a]	low hundreds/ 1–2 thousand[f]		×	×
ABM	0			
United Kingdom				
Polaris SLBM[b]	64	×		×
Longish-range V-bombers[c]	56	×		×
Medium and short-range aircraft[c]	150–180		×	×
France				
IRBM	9[d]		×	×
Medium-range Mirage bombers[d]	36–60[d]		×	×
Carrier-based and other aircraft[d]	less than 50		×	×

		Capable of hitting: all or most of USA	limited parts of USA	other NATO countries
USSR				
ICBM[k]	1520[i]	×		×
Long-range bombers	140	×		×
"Y-class" SLBM	400	×		×
Earlier SLBM[a, g]	100		×	×
Cruise missiles on submarines[a, g, h]	270		*h*	×
Cruise missile launchers on ships[a, h]	about 60		*h*	×
Medium-range missiles	700			×
Short-range missiles	unknown			×
Medium-range aircraft	250–500			×
Short-range aircraft	unknown[j]			×
ABM	64			
China				
MRBM[e]	less than 20			
IRBM[e]	several			
Medium-range bombers (Tu-16)	30			

Sources: Fiscal Year 1971 Defense Program and Budget, Statement by Secretary of Defense Melvin R. Laird before a Joint Session of the Senate Armed Services and Appropriations Committees, 20 February 1970; Statement of Secretary of Defense Melvin R. Laird before the Senate rence. Therefore, it is unnecessary for either power to improve the performance of its offensive strategic weapons, or the number of weapons deployed, if it is serious about the stated desire to maintain only the existing deterrence posture. And this has been true for many years now. Moreover, some qualitative improvements are positively dangerous, as will be shown below, because they threaten to erode the strategic balance upon which deterrence is, unfortunately, perceived to depend and to increase the probability of general nuclear war breaking out by design, accident or miscalculation. Even if a power were not serious about maintaining only a deterrent and were, instead, actually striving for superiority, its efforts to improve weapons would be wasted because past experience has shown that superiority is an elusive goal.

II. *Land- and sea-based strategic forces*

The most dramatic *quantitative* change during the period of SALT (i.e., since 1969) has been in the total number of offensive strategic missiles

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Armed Services Committee on the FY 1973 Defense Budget and FY 1973–1977 Program, 15 February 1972; *Washington Post*, 25 September 1971; *Aviation Week and Space Technology*, 95 (9), 30 August 1971.

[a] SIPRI worksheets.

[b] *Jane's Fighting Ships, 1969–70* (London: Sampson Low, Marsten, 1970), p. 316; *Daily Telegraph*, 8 May 1970.

[c] *International Air Forces and Military Aircraft Directory*, Aviation Advisory Services, May 1969, p. 60; *Flight International*, 99 (3250), 24 June 1971, pp. 929–38; *The Military Balance* (London: International Institute for Strategic Studies, 1971–72), p. 56.

[d] *International Air Forces and Military Aircraft Directory*, Aviation Advisory Services, January 1969, pp. 40–43; February 1969, pp. 44–46; *Aviation Week and Space Technology*, 80 (1), 16 March 1964; *Flight International*, 100 (3257). Nine more French IRBMs are due to become operational in early 1972. Varying references give 36, 45 and 60 as the number of Mirage IV-As.

[e] *Washington Post*, 6 August 1971; *New York Times*, 2 February 1972; *Bulletin of the Atomic Scientists*, 28 (1), January 1972, pp. 28–35.

[f] The high figure is the number in different parts of the world that are physically capable of delivering nuclear weapons; the low figure is the estimated number that may be assigned to this role. The United States has announced that some 500 land-based and carrier-based aircraft in the European area are assigned to a nuclear weapon delivery role.

[g] See the *SIPRI Yearbook 1969–70*, pp. 368–70.

[h] It is not in fact clear whether the cruise missiles on Soviet submarines and surface vessels carry nuclear warheads.

[i] This figure requires an important caveat. It is usually given by US officials as "Soviet ICBMs in operation or under construction". Under construction refers to the fact that US reconnaissance satellites have observed the digging or emplacement of new silos. However, silo hardening programmes also exist in the USA. Significantly, new "holes" are not added to the total number of US missiles, and in fact should not be for the USSR until it is observed that a "hole" is filled with a new missile, or that another missile is not simply shifted from a less hardened silo to a more hardened one. Empty silos should not be counted.

[j] The Soviet Union and its Warsaw Pact allies are believed to have more than a thousand light bombers and ground attack aircraft, but there is no evidence that these carry nuclear weapons. In 1971 the IISS *Military Balance* for the first time included the Soviet Yak-28, SU-7, Il-28, MiG-21 J and MiG-23 as nuclear strike aircraft. Many of these Soviet aircraft had been in service through the 1960s and the IISS omitted these aircraft from its listing of nuclear strike aircraft in the previous 10 years.

[k] On 6 March 1962, the US Secretary of Defense announced that the USSR was beginning to install MRVs on some of its ICBMs. (*International Herald Tribune*, 7 March 1972.)

Table 1.2. US and Soviet intercontinental ballistic missiles (ICBMs)[a]

	USA			
Name[b]	Titan II	Minuteman I	Minuteman II	Minuteman III
Number	54	350	500	150
Designation[c]	LGM-25 C	LGM-30 B	LGM-30 F	LGM-30 G
Maximum range (nautical miles)	6 300+	6 300+	7 000+	8 000+
Warhead	5–10 mt.	1 mt.	1–2 mt.	MIRV 3 × 200kt.
First in service	1962	1962	1966	1962
Maximum length (ft)	103	56	60	31
Body diameter	10	6.2	6.2	4.5
Launch weight (lb.)	350 000	70 000	73 000	30 000
Number of stages	2	3	3	2
Type of engine	Liquid propellant rocket	Solid propellant rocket	Solid propellant rocket	Solid propellant rocket
Speed and burn-out (Mach number)	...	23	23	..
Remarks	Retained because of large warhead. Phase-out scheduled for 1973	To be replaced by Minuteman II and III by 1976	50 to be replaced by Minuteman III. Has penetration aids	Super-hardened silos being developed

[a] All of these missiles have inertial guidance systems.
[b] These are the NATO code names for the missiles. The Soviet names were unavailable.
[c] These are the US designations. The Soviet designations were unavailable.
[d] These estimates are highly uncertain; they are derived from estimates of the missiles' size and from that to formulae relating to the amount of fuel carried, thrust produced and warhead yield. It is probable that no Western sources know the actual warhead yields.

Sources: Jane's Fighting Aircraft 1970/71 (London, annual); *Aviation Week and Space Technology* (weekly).

deployed by the Soviet Union. Since SALT began, the Soviet Union has, in fact, increased its number of deployed intercontinental land-based ballistic missiles by about 10 per cent. There is, at present, a Soviet land-based ICBM force deployed or under construction of 1 520 launchers (which is five times the number deployed in 1966). The US land-based ICBM forces, on the other hand, have remained constant at 1 054 launchers, the number reached in 1967. The rate of Soviet ICBM deployment slowed down during 1970, and this may indicate a planned plateau near the present level. (See table 1.2 and chart 1.1.)

The United States has retained its advantage over the Soviet Union in numbers of sea-launched ballistic missiles—656 missiles as against about 400, respectively. But the gap is rapidly closing as the Soviet Union constructs more of the "Yankee"-class nuclear-powered ballistic-missile sub-

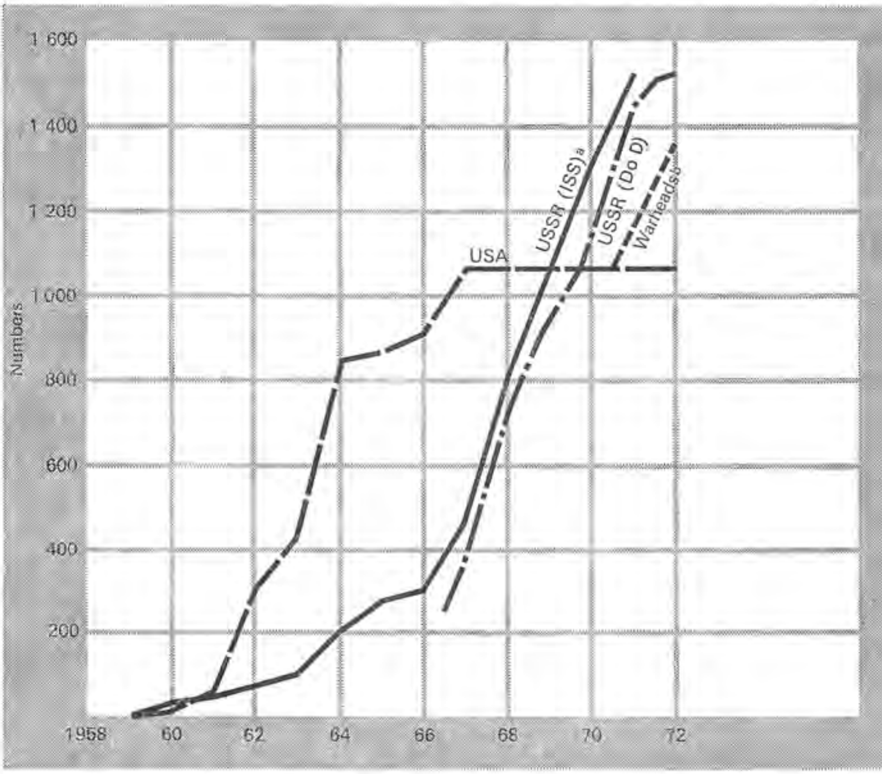
USSR				
Saddler	Sasin	Scarp	—	Savage
—About 200—		About 300	About 950	60
SS-7	SS-8	SS-9	SS-11	SS-13
5 700	5 700	7 000–9 000	5 500	4 500
(5 mt.)[d]	(5 mt.)[d]	(25 mt.)[d]	(1–2 mt.)[d]	(1 mt.)[d]
1961	1963	1965	1966	1968
..	80	114	..	66
..	9	10	..	65
..	..	..	..	..
2	2	..	3	3
Storable liquid propellant rocket	Storable liquid propellant rocket	Liquid propellant rocket	Storable liquid propellant rocket	Solid propellant rocket
..	..	..	..	..
Some are not deployed in underground silos	Some are not deployed in underground silos	Largest ICBM in existence. These missiles may carry MRV. Also used as FOBS launch vehicle	These missiles may carry MRV. About 100 targeted at Western Europe (and China) in 2-stage version	Deployed near Archangelsk in Soviet Arctic

marines. These submarines, similar to the US Polaris, carry 16 missiles each. The USA reports that about 25 of the "Y"-class submarines are operational (although only a small fraction are as yet on station at any one time) and about 17 are being constructed (but these will take some time to commission). The construction rate is probably about 8–10 a year. The Soviet Union could, therefore, numerically equal the US Polaris fleet of 41 submarines within the next few years. However, the range of the Soviet missiles carried on the "Y"-class submarines is about half that of Polaris A-3 missiles and generally the performance of the Soviet nuclear submarines is less good than that of their US counterparts. (See tables 1.3, 1.4 and 1.5 and chart 1.2, pages 7, 15 and 20.)

The most significant *qualitative* advance has been in US strategic nuclear forces, namely, the deployment of MIRVs on both land-based ICBMs and sea-based ballistic missiles (table 1.7). The replacement of Minuteman I missiles with Minuteman III missiles began in June 1970. Minuteman III, with three (MIRV) thermonuclear warheads, each of approximately 200 kt., has improved survivability and penetrability, greater range (over 8 000

Chart 1.1. USA and USSR: numbers of intercontinental ballistic missiles and launchers[c,d]

Numbers



[a] Including those designated as IRBM, MRBM (100 launchers).
[b] Due to MIRV, the number of US warheads on 1 January 1972 was 1354.
[c] The figure 1520 for the number of Soviet ICBMs requires an important caveat. It is usually given by US officials as "Soviet ICBMs in operation or under construction". Under construction refers to the fact that US reconnaissance satellites have observed the digging or emplacement of new silos. However, silo hardening programmes also exist in the USA. Significantly, new "holes" are not added onto the total number of US missiles, and in fact should not be for the USSR, until it is observed that a "hole" is filled with a new missile, or that another missile is not simply shifted from a less hardened silo to a more hardened one. Empty silos should not be counted.
[d] On 6 March 1972, the US Secretary of Defense announced that the USSR was beginning to install MIRVs on some of its ICBMs. (*International Herald Tribune*, 7 March 1972.)

Sources:
The Military Balance, 1969–1970 (London: International Institute for Strategic Studies), p. 55. Fiscal year 1971 Defense Program and Budget, A Statement by Secretary of Defense Melvin R. Laird, 25 February 1970, pp. 102–03; Statement of Secretary of Defense Melvin R. Laird before the Senate Armed Services Committee on the FY 1973 Defense Budget and FY 1973–1977 Program, 15 February 1972; *The Military Balance 1971–1972* (London: IISS), p. 56; *Washington Post*, 25 September 1971; Statement by Admiral Thomas H. Moorer, USN, Chairman, Joint Chiefs of Staff, in *Arms Control Implications of Current Defense Budget*, hearings before the Subcommittee on Arms Control, International Law and Organization of the Committee on Foreign Relations, US Senate, 92nd Congress, 1st session (Washington, June, July 1971).

miles)[1] and higher accuracy and is installed in super-hardened silos. The number deployed is planned to reach 550 by 1976, replacing all 500 Minuteman I missiles at the rate of about 100 per year, and 50 of the 500 Minute-

[1] A conversion table for the measurements used here is given on page XVIII.

Table 1.3. US and Soviet submarine-launched ballistic missiles (SLBMs)

	USA			USSR	
Name[a]	Polaris A-2	Polaris A-3	Poseidon C-3	Sark[c]	—
Number	160	384	112	42	400
Designation[b]	UGM-27 B	UGM-27 C	UGM-73 A	SS-N-4	SS-N-6
Maximum range (nautical miles)	1 500	2 500	2 500	300	1 500
Warhead	800 kt.	MRV 3 × 200 kt.	MIRV 10 × 50 kt.	(1 mt.)[d]	(1 mt.)[d]
First in service	1962	1964	1971	1961	1969
Maximum length (ft)	31	31	34	45	40
Body diameter	4.5	4.5	6	6	6
Launch weight (lb.)	30 000	35 000	60 000	..	..
Number of stages	2	2	2	2	2
Type of engine	Solid propellant rocket	Solid propellant rocket	Solid propellant rocket	Storable liguid rocket	Solid propellant rocket
Speed at burn-out (Mach number)	10	10	..	..	..
Remarks	Five "608"-class submarines now carrying A-2 will be converted to A-3	Will be retained on five "608"-class submarines and five "598-" class submarines	Have double Polaris A-3 payload. Will be carried on all 31 of the "616"-class submarine (Poseidon)	Launched only from surface from diesel "G"-class submarines	Deployed on "Y"-class nuclear submarines

[a] These are the NATO code names. The Soviet names were unavailable.
[b] These are the US designations. The Soviet designations were unavailable.
[c] A longer-range version, of 600 km., (Serb) was developed and tested in the mid-1960s; evidence is equivocal as to whether and when it was deployed and in which classes of Soviet submarines. However, from 1969 on, most sources assume "Serb" to have been in service.
[d] These estimates are highly uncertain; they are derived from estimates of the missiles' size and from that to formulae relating to the amount of fuel carried, thrust produced and warhead yield. It is probable that no Western sources know the actual warhead yields.

Sources: Jane's Fighting Aircraft 1970/71 (London, annual); *Aviation Week and Space Technology* (weekly).

man II missiles. The installation of 150 Minuteman III missiles at Minot Air Force Base, North Dakota was completed in December 1971 and the installation of a further 150 at Grand Forks Air Force Base, North Dakota is under way (table 1.6).

An advanced ICBM, capable of being launched from a super-hardened silo deep underground, is in the research stage. This missile will have improved all-round characteristics—lighter launch weight, improved mid-range accuracy, better penetration aids and a multiple warhead, and it is probable that each warhead will be manoeuvrable and be individually targeted.[2]

The first deployment of Poseidon missiles, with MIRVs, was announced in April 1971. By 1976 these missiles will replace the Polaris A-3 missiles on all 31 of the "616"-class nuclear-powered submarines. Poseidon carries about double the payload of the Polaris A-3 missile, with improved accuracy. Since each Poseidon missile carries, on average, ten nuclear warheads, each of approximately 50 kt. size, and each submarine carries 16 missiles, the planned deployment totals 4 960 warheads.

Development work has continued on an Undersea Long-Range Missile System (ULMS), built around missiles with ICBM capabilities and new large "quiet" submarines. The US Navy has recently requested an additional budget appropriation for ULMS which should advance deployment of the first system to about 1977. ULMS is designed eventually to replace the Poseidon system.[3] The ULMS missile, which will use advanced high-energy propellants, may have a range up to 6 000 miles, which is approximately twice that of the Poseidon missiles. If the longer-range missile achieves the higher range, this will give about a fifteen-fold increase in the sea area in which the ULMS submarines can hide (55 million square miles of ocean) and the missiles still reach their targets. The missiles will be able to cover their targets as soon as the submarines leave their home bases so that the submarines can operate from the coastal (or even inland) waters of the United States. This capability will further increase the invulnerability of the system.[4]

The Soviet Union has reportedly started to deploy multiple re-entry vehicles (MRV) containing three warheads: there is no evidence that it has so far tested an actual MIRV.[5] It is believed that these MRV warheads will be used on the Soviet SS-11 and SS-9 ICBMs—about 950 SS-11s and about 300 SS-9s are deployed—but there is no evidence that Soviet submarine-launched missiles are being fitted with multiple warheads. The SS-9 also serves as the booster for a Fractional Orbital Bombardment System (FOBS) designed to dispatch warheads against the United States on a South Polar orbit[6] to complicate detection by defence systems. The development of FOBS continues and tests of the system occur at a rate of about one or two

[2] F. Barnaby, "The March to Oblivion", *New Scientist*, 49 (738): 290–93, February 1971.

[3] M. Getler, "Fund Requests Seen Likely", *International Herald Tribune*, 13 January 1972.

[4] See the *SIPRI Yearbook 1969/70*, pp. 131–33.

[5] The difference between multiple re-entry vehicles (MRV) and multiple independently targetable re-entry vehicles (MIRV) is discussed on page 9.

[6] The altitude of the orbit would probably be about 100 miles compared to the maximum height of about 700 miles reached by an ICBM in its ballistic trajectory.

per year. And a new Soviet land-based ICBM, probably with a mobile capability to increase invulnerability, is under development. The Soviet Union is also developing a new naval missile with a range of about 3 000 miles (comparable to that of the US Poseidon and Polaris A-3 missiles) to replace the 1 500 mile range SS-N-6 fleet ballistic missile.

III. *Improved accuracy and reliability of missiles*

The guidance and control systems for ballistic missiles are being continuously developed by both the United States and the Soviet Union so that the accuracy of warhead delivery is improving. A manoeuvring, independently-targetable re-entry vehicle has been developed and tested in the United States.[7] Such a warhead would be able to take evasive action against missile defences. Terminal guidance[8] for individual warheads will be greatly assisted by the miniaturization of gyroscopes and accelorometers, already in an advanced stage of development. In the United States, these developments are included in the Advanced Ballistic Re-entry Systems (ABRES) programme. This 10-year old programme is aimed at generally increasing the survivability of warheads and enhancing their ability to penetrate enemy air defences. An individual warhead will carry a guidance mechanism augmented by a terminal seeker. The warhead will be provided with a map-watcher enabling it to home on a specific geographical point located by pre-programmed information. More sophisticated terminal guidance systems are also being investigated, using a combination of lasers and microwave radar. The broad-beam radar will direct the laser to the general target area so that the laser can lock into a specific point at the target (such as a high building).

The successful use of tactical laser-guided bombs ("smart-bombs") by the United States in Viet-Nam has, in fact, stimulated an interest in the pos-

[7] *Aviation Week and Space Technology,* 95 (17): 61, 25 October 1971.

[8] In the simplest multiple warhead system—the multiple re-entry vehicle (MRV)—as soon as the warheads are released from the platform carrying them, rails, springs, or small, fixed, solid-propellant rockets provide small velocity increments to the warheads in various directions, causing them to land in a fixed pattern around the aim point. In the Soviet MRV system each warhead is probably ejected along a rail. But a MIRV contains a more sophisticated arrangement to adjust the individual velocity increments so that each re-entry vehicle is caused to follow a trajectory, after release from the platform, to individually selected targets. Alternatively, MIRVs are carried on a low-thrust final stage, called a bus, which has a single guidance system. The bus is guided through a series of pre-determined velocity changes and, after each one, a warhead is released from the bus towards a target defined by the velocity change achieved at that time. The targets may be separated by over 100 miles. The present US MIRV uses such a bus arrangement. But the preferred method of directing MIRVs to their targets is by providing actual terminal guidance for each warhead.

sibility of laser-guided missiles, of countermeasures that could be used against enemy laser-guided weapons and of techniques to make the weapons less vulnerable to countermeasures. This is an area of military technology which is developing rapidly.

Existing missiles have "circular error probables" (CEPs) of between 1 500 and 4 500 feet. At present, the accuracy of the most accurate US missile is at the lower end of this range whereas the accuracy of the most accurate Soviet missile is at the higher end of the range. The CEP is the radius of the circle centred on the target in which half of a large number of ICBM warheads fired at the target would fall. Recent developments allow considerable improvement in this accuracy to be foreseen. With a few years, at the current rate of progress, CEPs may have decreased to 600 feet and, by the early 1980s, to 90 feet.[9]

The development of warheads combining high reliability with high accuracy will have grave consequences. MIRVed warheads of very high accuracy would be effective counter-force, or first-strike, weapons against fixed land-based forces. If one side perceives that the other is developing a first-strike capability, this might stimulate it to consider a "launch-on-warning" system in which land-based missiles will be fired by computer command as soon as a force of enemy missiles crosses the horizon. The transference of the final decision to initiate the nuclear holocaust from men to machines is regarded by many to be the most serious of the foreseeable developments in the arms race.[10]

IV. *Strategic bombers*

The effectiveness of US strategic bomber forces has been significantly enhanced by the introduction of the new Short-Range Attack Missile (SRAM) which entered production in mid-1970. This 100-mile range, supersonic, air-to-surface nuclear missile, capable of penetrating advanced enemy defence systems, can be carried by B-52 and FB-111 strategic bombers (the Strategic Air Command has about 450 B-52[11] and 72 FB-111 bombers. See table 1.8 on page 18.) A B-52 will carry 20 SRAMs together with up to four thermonuclear weapons. A FB-111 will carry six SRAMs. The number of nuclear weapons deliverable by the US Strategic Air Command will, therefore, in-

[9] D. G. Hoag, "Ballistic-Missile Guidance", in *Impact of New Technologies on the Arms Race*, B. T. Feld, *et al.*, eds. (Cambridge, Mass.: MIT Press, 1971), pp. 19–108.
[10] H. York, *Race to Oblivion* (New York, 1970).
[11] Of these, 255 are B-52G-H aircraft and it is these that are being modified to carry SRAMs. At present, they are armed with Hound Dog air-to-surface nuclear missiles and Quail decoy missiles, in addition to up to 4 thermonuclear free-fall bombs. The other B-52s are older, C-F types.

crease very sharply over the next few years. The B-52 could also carry the Subsonic Cruise Armed Decoys (SCAD), a nuclear-armed electronic countermeasure system, which is in an early stage of development. (See table 1.9.)

The proposed supersonic (up to Mach 2.2)[12] B-1 advanced, manned intercontinental strategic aircraft is under full-scale development to replace the B-52s and FB-111s. The swing-wing design of this aircraft will give it a capability for low-altitude, high-subsonic speeds for penetrating enemy defences and high-altitude supersonic speeds to be used when inside hostile territory. It will carry very advanced electronic and electro-optical systems for low-level navigation without visual cues, electronic countermeasures, infra-red surveillance and so on. The B-1 will be armed with about 30 SRAM missiles, SCAD missiles and thermonuclear bombs; the payload will be equal to about that of six FB-111s. If decided upon, production is expected to commence in about 1977, probably at a rate of about 3 to 4 per month, and a fleet of about 250 aircraft is envisaged.

In the Soviet Union, a new variable-geometry bomber (NATO code-name, "Backfire"), with supersonic speeds at low altitudes, has been developed and flown in prototype. The range of this bomber is about the same as the FB-111, and with refuelling it could have an intercontinental capability. There is no known Soviet air-to-surface missile comparable to SRAM.

V. *Defence systems*

Programmes to develop survivable satellite communications systems for the command and control of strategic forces following a surprise attack are under way. In a US system, for example, direct satellite-to-satellite links will permit global communications between airborne and earth terminals without relying on ground relay. This would eliminate the need for vulnerable overseas earth-relay terminals in the control of strategic nuclear forces. Ultra-high frequencies will be used for earth-to-satellite and satellite-to-earth communications so that airborne and submarine command posts can communicate with the satellites.

The development of new early-warning satellite systems, designed to detect ICBM attack, is continuing. Such systems are already deployed. In particular, new types of infra-red sensors are being evaluated to track ICBM warheads, after the booster phase is cut off, and to feed the information to anti-ballistic missile (ABM) systems. The present early-warning satellites detect the launch of an ICBM from the infra-red radiation emitted from

[12] The Mach number gives speed relative to that of sound. The Mach 2 is a speed equal to twice the speed of sound.

its rocket as the missile rises above the earth's atmosphere. It is believed that if enemy ICBMs would be intercepted in mid-trajectory, before they can release decoys and other penetration aids, it would increase the probability of a successful defence.

Both the USA and the USSR are improving their strategic defensive systems against bombers and missiles. (See table 1.10 on page 21.) In the United States, the modernized bomber defence system proposed will involve several new developments: an Airborne Warning and Control System (AWACS); the Continental US Over-The-Horizon back-scatter radar (Conus OTH-B) and satellite reconnaissance systems; a new nuclear surface-to-air missile[13] (SAM-D); and an improved all-weather "air superiority" interceptor aircraft (the F-15). The OTH-B radar is designed to detect enemy aircraft at great range to give maximum possible warning time, and AWACS is designed to track aircraft flying beneath the cover of other radars. With AWACS, command and control of interceptors is put in the air. It is claimed that Conus OTH radar will locate and track enemy aircraft sufficiently accurately to allow AWACS aircraft to be dispatched to the general area in which their conventional long-range airborne radars will take over. The US SAM-D, now in the advanced development stage, is a potential replacement for Bomarc, Hawk and Nike Hercules surface-to-air missiles. The multi-function phased-array radar associated with the system will detect targets, track them, and track and guide the surface-to-air missiles in flight—functions which require several radars in other systems.

The F-15 will be a single-seat fixed-wing fighter in the 40 000 lb. class, the airframe of which will utilize more advanced light-weight materials, like titanium and boron alloys, than any existing aircraft. It is designed to maintain "air superiority", with the ability to seek and destroy enemy aircraft in all weathers. It will deploy a variety of short- and medium-range air-to-air missiles and will have a maximum speed greater than Mach 2. The aircraft will be equipped with extremely complex electronic systems, possibly including a capability against ground targets using laser-guided bombs. The most advanced engine, weapon and electronic technologies, aerodynamics and light-weight material technology will go into the manufacture of this aircraft. The first flight is planned for 1972 and, if procured, it should enter into service in the mid-1970s.

Both the United States and the Soviet Union have continued to develop means of defence against ballistic missiles. Extremely sophisticated high-powered solid-state, phased-array radars and very large-capability highly

[13] Both the USA and the USSR have deployed very large numbers of surface-to-air missiles. The Soviet Union, for example, is thought to have about 10 000 in both fixed and mobile configurations. The US deployment is about one-tenth of this number.

complex data-handling equipment for ABM systems are under continuous development.

The Soviet Union has been testing an improved ABM missile which can loiter—that is, once fired, it can coast out to a general intercept area, select its target, restart its engine and manoeuvre to destroy the enemy warhead. In the United States, planning has continued on Hardsite—an alternative ABM system to Safeguard which would replace the Safeguard missile-site radars with a large number of smaller radars and use a variant of the Sprint missile (anti-ballistic missiles of very high acceleration—about 100 g—designed to intercept incoming ICBM warheads at low altitude) for the terminal defence of Minuteman silos. In addition, Project Upstage, a new anti-ballistic missile with loitering capability and using an advanced propulsion system to give it sufficient manoeuvrability to intercept a manoeuvring re-entry vehicle after its motor has burned out, is under development. Although this ABM can carry a nuclear warhead, it is claimed that it would be able to destroy a non-manoeuvring re-entry vehicle with a high-explosive warhead. The first test of an Upstage missile occurred in November 1971.[14]

Further developments have occurred in anti-satellite warfare. The Soviet Union has recently achieved the first two-altitude satellite interception involving a target at an altitude of less than 160 miles. The Soviet Union now appears to be able to destroy low-altitude reconnaissance satellites, as well as higher-altitude communications satellites.[15]

VI. *Summary*

In summary, while the SALT talks have been proceeding, extensive quantitative and qualitative advances have been made in offensive and defensive strategic forces by the United States and the Soviet Union. Both countries have developed multiple warheads for their ballistic missiles. In addition, the United States has developed and recently deployed MIRVs. The state of the Soviet MRV-MIRV programme is not known. If planned programmes are carried through, the number of strategic missile warheads deliverable by the United States, for example, will increase from just over 2 000 to nearly 8 000 by 1975. At present, US strategic bombers can deliver an additional 2 000 thermonuclear warheads, but by 1975 this number will increase by at least an order of magnitude (a ten-fold increase) with use of advanced air-to-surface missiles. Warhead reliability, retargetability and accuracy are steadily increasing. The inherent ambiguity of the intentions of a country with a potential counter-force (first-strike) capability, towards

[14] *Aviation Week and Space Technology*, 95 (23): 23, 6 December 1971.
[15] *Aviation Week and Space Technology*, 95 (24): 20, 13 December 1971.

which both countries could be perceived to be tending, could lead the adversary to adopt a "launch-on-warning" policy.

Developments continue to improve air and missile defence, and anti-submarine warfare.[16] Warning and interceptor control radars span the entire usable frequency spectrum and utilize the latest advances in electronic counter-countermeasures technology. Forward-scatter and back-scatter over-the-horizon radars and reconnaissance satellites are in use and under development to detect enemy strategic forces regardless of their launch-direction or trajectory. Land-, sea- and air-based radars are being developed and deployed to improve the ability to detect low-flying aircraft and incoming missiles. Highly sophisticated interceptor aircraft and new anti-ballistic missiles are under development.

Several elements of the arms race have not been included above because the weapons concerned are most often referred to as "tactical". As we have noted elsewhere, it is difficult to make a firm distinction between tactical and strategic weapons.[17] Aircraft of the US Tactical Air Command maintained in Europe and the Mediterranean could, for example, rapidly deliver nuclear weapons against the Soviet Union; about 500 aircraft have been officially stated to have this role. Then there are the Soviet medium- and intermediate-range ballistic missiles (MRBM and IRBM) targeted on Western Europe. Short-range ballistic missiles, aircraft carried on aircraft carriers and so on could also play a strategic nuclear role. All in all, an enormous number of nuclear weapons is involved in these weapon systems—certainly totalling tens of thousands.

[16] A comprehensive account of anti-submarine warfare (ASW) technology was given in the *SIPRI Yearbook 1969/70*, pages 106–22, and so it will not be dealt with in detail here. Because both the USA and the USSR now regard the problem of detecting and destroying enemy submarines to be a most urgent one, great efforts have been made to improve ASW methods. In the United States, for example, at least six different ASW weapon systems are deployed or being developed. These are based on land-based (P-C3) and sea-based (S-3A) ASW patrol aircraft, the anti-submarine guided-missile frigate (the DLGN-38) programme, the DD-963 destroyer anti-submarine programme, the hunter-killer (SSN-688) submarine and the Mark-48 torpedo. Continuous refinements have been, and are being, made in the equipment for these programmes and in the communications systems associated with them. The Soviet ASW programme is at a much earlier stage of evolution and is focussed mainly on naval helicopter carriers and long-range, land-based aircraft. The helicopters utilize very sophisticated electronic equipment for the detection and tracking of enemy submarines and rely on armed helicopters to destroy them. Two helicopter carriers are in service and are used for fleet defence. These have conducted extensive ASW exercises in the Mediterranean. Several types of long-range land-based aircraft, equipped with high resolution radar and magnetic anomaly detection equipment are designed to provide defence against Polaris submarines. A major distinction between the Soviet and US ASW programmes is that the former is to a much greater extent confined to an area close to Soviet territory and to fleets. The US system, on the other hand, is designed to provide a much longer-range capability.

[17] See the *SIPRI Yearbook 1969/70*, pp. 36–37.

Table 1.4. Estimates of numbers of Soviet submarines, other than "Y"-class submarines, with ballistic missiles

	Diesel-powered submarines		Nuclear-powered submarines		Total	
	Jane's	IISS	Jane's	IISS	Jane's	IISS
1966–67	40	25	13	15	53	40
1967–68	35	30	13	10	48	40
1968–69	35	30	15	13	50	43
1969–70	31	35	15	15[a]	46	50
1970–71	30	25	10	15	40	40
1971–72	26	31	9	10	35	41
Average	*33*	*29*	*12*	*13*	*45*	*42*

[a] *The Military Balance 1969–1970* gives the figure 18, but this appears to include an estimate of a few "Y"-class submarines. *The Strategic Survey 1969* (page 27) implies that there are 15 submarines other than "Y"-class submarines.

Sources: *Jane's Fighting Ships* (London, annual volumes for 1966–1972); *The Military Balance* (London: International Institute for Strategic Studies), annual volumes for 1966–1972; *The Strategic Survey 1969* (London: International Institute for Strategic Studies, 1970).

Table 1.5. Estimates of numbers of Soviet submarines carrying cruise missiles

	Diesel-powered submarines		Nuclear-powered submarines		Total	
	Jane's	IISS	Jane's	IISS	Jane's	IISS
1966–67	14	28	15	12	29	40
1967–68	22	24	25	20	49	44
1968–69	22	20	25	25	47	45
1969–70	22	22	30	25	52	47
1970–71	27	15	35	33	62	49
1971–72	28	25	36	35	64	60
Average	*22*	*22*	*29*	*23*	*49*	*45*

Sources: *Jane's Fighting Ships* (London, annual volumes for 1966–1972); *The Military Balance* (London: International Institute for Strategic Studies), annual volumes for 1966–1972.

Table 1.6. Deployment of US Minuteman ICBMs[a]

Place	Number	Missile
Malmstrom AFB, Montana	200	Minuteman II
Ellsworth AFB, South Dakota	150	Minuteman I
Minot AFB, North Dakota	150	Minuteman III[b]
Whiteman AFB, Missouri	150	Minuteman II
Warren AFB, Wyoming	200	Minuteman I
Grand Forks AFB, North Dakota	150	Minuteman II, replacement with III under way[b]

[a] As of 31 December 1971.
[b] Minuteman III is MIRVed with 3 warheads.

Table 1.7. Past and predicted changes in US megatonnage in high-yield delivery systems from 1965 until 1975, when MIRV and SRAM procure ment are scheduled to be completed

System	Yield per vehicle, recently or at present	To become	Number of the type of delivery vehicle deployed or to be deployed	Change in force yield	Difference in megatonnage for the system	Difference; missiles, bombers, and total
Missiles						
Minuteman I	1 mt.	3 × 200 kt. (MIRV)	550 of 800 now	From 800 to 580	−220 mt.	
Minuteman II	1–2 mt.	Same	200	0	0	
Total Minuteman	—	—	**1 000**	—	**−220 out of 1 000 to 1 200 mt.**	
Titan II	5–10 mt.	Same	54	0	0 out of 270 to 540 mt.	
Polaris A-2	800 kt.	3 × 200 kt.	160 launchers	From 128 mt. to 96 mt.	−32 out of 128 mt.	
Polaris A-3	1 mt. (single warhead) 3 × 200 kt. (MRV)	10 × 50 kt. (MIRV; average)[a]	496 launchers	From 298 to 496 mt. to 248 mt.	−50 (to 248) out of probable 298 mt.	*Missiles:* −662 mt. out of 2 186 to 2 854 mt.; a decrease of 23 to 30%
Total Polaris	—	—	**656 launchers**	—	**−82 out of 426 to 624 mt.**	
Mace	1 or 5 mt., varying reports	6 squadrons in Germany assumed to have been phased out in 1967–69, and 2 squadrons in Okinawa on 31 December 1969	Around 360; (however 1 000 Mace were reportedly procured)	Using 1 mt. as yield, from 360 mt to zero	−360 out of 360 mt.	
Pershing	400 kt. (up to 1 mt.)	Same	325	0	0 out of 130 mt.	
Aircraft						
B-52 C/F[a]	4–6 H-bombs, free-fall bombs are assumed to be 1 mt.,[a] while Hound Dog air-to-surface missiles are reported as 4 mt.	To be phased out by 1975?	375 (444 produced)	375 × (4–6 × 1 mt.) + 375 × (1 × 4 mt.)[a] to zero	−3 175 mt.	
B-52 G/H[a]	4–6 H-bombs;[a] same yields as for B-52 C/F above	20 SRAMs? 200 kt. each	255 (295 produced)	255 × (4–6 × 1 mt.) + 255 × (2 × 4 mt.)[a] to (255 × 20 × 200 kt.)	3 315 mt. to 1 020 mt.; or −2 295 mt.	
FB-111	Introduced in 1970; 6 weapons with total yield of 5 mt.	6 SRAMs, (6 × 200 kt.)	72 at present; expected procurement reduced 263 to 210 aircraft. Possible that no more than 76 will be	+360 mt. now; (72 FB-111 aircraft with SRAM will carry 91 mt.)	+360 mt. (if no further procurement)	*Aircraft:* −7 250 mt. out of 8 650 mt.; a decrease of 84 %

B-58	2 10-mt. bombs	Phased out in 1970–71	90 (of 96)	– 1 800 mt.	1 800 mt.	
B-1	—	24 SRAM and/or SCAD; 200 kt. each	240	+ (240 × 24 × 200 kt.) = 1 152 mt.	Increase of 1 152 mt. if the B-1 system is procured. If procured, it would not be expected to be deployed until 1977 or 1978, and is thus omitted from the total calculation here	*Missiles and aircraft combined:* total decrease of 71 % in megatonnage

[a] The most important qualification to this table is that it omits yet another decrease in US bomber-carried megatonnage which occurred in the 1960s and is even greater in magnitude than that shown here. In the early 1960s, US B-52s carried a high-yield thermonuclear bomb of 20 to 24 megatons. Most reports indicate that a B-52 bomber carried an average of 50 megatons in this period. However, it could carry four weapons. *If* each weapon were of such high yield, and 630 B-52 aircraft were in service at a peak period of several years, this represents a potential of perhaps 50 000 megatons. It is not known exactly how much of this was actually ever carried; apparently about half. (See Hadley, A. T., *The Nation's Safety and Arms Control* (Viking Press, 1961), pp. 3, 4, 33. The alteration to bombs in the range of 1 megaton carried by B-52s thus represented a very large decrease. In 1967 an Administration spokesman indicated that the decrease was about 10 thousand megatons. (See Deputy Secretary of Defense, P. H. Nitze, in *Scope, Magnitude and Implications of the United States Antiballistic Missile Program*, hearings before the Joint Committee on Atomic Energy, November 1967, p. 48.) It is not publicly known, however, in what years during the period 1960 to 1970 the conversion took place, whether slowly or rapidly, and whether the conversion is now complete and total.

In addition, the B-47, the last 225 of which were phased out in 1965, carried 20 megatons per aircraft. At their peak, over a thousand B-47s were in service. The phasing out of the last 225 B-47 aircraft in 1965 alone is a decrease of yet another 4 500 megatons.

After the indication of some of this data in the *SIPRI Yearbook 1969/70* (p. 379), some other authors arbitrarily assigned the same payloads in megatonnage to Soviet bombers in attempting to devise megatonnage "balance" tables for the USA and the USSR, and gave the SIPRI reference as the source. (See Slocombe, W., *The Political Implications of Strategic Parity*, Adelphi Paper no. 77, International Institute for Strategic Studies, 1971, p. 26.) Aside from the numerous indications that Soviet long-range bombers have been assigned other functions during most of the 1960s, there is no known justification for assigning the yields carried by US aircraft, now or in the past, to Soviet aircraft. The payload in megatonnage for Soviet bombers is not known.

Two further short comments can be made. A warhead "in widespread use" with F-104 "strike" aircraft based in Europe was reported as being 1 megaton. (Brown, N., "Advanced Military Technology", in *Royal United Service Institution Journal*, 113 (652), November 1968, p. 338.) Since there is no data indicating how many F-104 aircraft in which years had this capacity or this mission, the capability is not represented in the table. Megatonnage deliverable by carrier-borne aircraft is not indicated in the table either. It is also not clear if the remaining 255 B-52s programmed to receive SRAM and SCAD air-to-surface missiles in the coming years will also carry free-fall bombs. If they did, it would probably double their payload in megatonnage.

Finally, one last comment is in order. The United States has not felt that it has lost any advantage in what it describes as "target kill capability" through these moves, and that it will retain an advantage over the Soviet Union in this measure through the early 1970s, despite a reduction of perhaps 20 000 megatons in deliverable weapons since 1960. (Because of the omission of "tactical aircraft", this table gives no estimate of total megatonnage in residual total US air delivered weapons.) This is because it calculates that number of warheads, reliability, accuracy and survivability are more significant factors than total megatonnage. It also relates to the decreasing radius of damage produced by higher-yield weapons. Thus Deputy Secretary Nitze presented the following table to indicate the comparative effectiveness of two missile payloads, one with a single 10 megaton warhead, and the other with ten 50 kiloton warheads, totalling half a megaton, or only one-tenth the larger yield:

Comparative effectiveness of 2 hypothetical missile payloads (Number of targets destroyed)

Type of target destroyed	10 50-kt. warheads	1 10-mt. warhead
Airfields	10	1.0
Hard missile silos	1.2 to 1.7	1.0
Cities of 100 000 population	3.5	1.0
Cities of 500 000 population	0.7	1.0
Cities of 2 000 000 population	0.5	6
Total megatonnage	(*0.5*)	(*10.0*)

Table 1.8. US and Soviet medium- and long-range bombers[a]

	USA		USSR		USA	USSR
Type	B-52 C-F	B-52 G/H	Tu-20	Mya-4	FB-111[b]	Tu-16[b]
Number	195	255	100	40	72	500
Maximum range[c] (miles)	11 500	12 500	8 000	6 000	3 800	4 000
Maximum speed (Mach number)	0.95	0.95	0.78	0.87	2.2	0.8
Weapons (typical)	(4–6 H-bombs), 60 000 lb. bomb load, Hound Dog ASM	(4–6 H-bombs), 75 000 lb. bomb load, 2 × Hound Dog and Quail	40 000 lb. bomb load, Kangaroo	20 000 lb. bomb load	37 000 lb. bomb load, SRAM	20 000 lb. bomb load, 1 × Kipper and 2 × Kelt
First in service	1955	1958	1956	1956	1970	1955
Wingspan (ft)	185	185	165	160	70	105
Maximum length (ft)	156	156	150	150	74	115
Maximum height (ft)	48	41	..	..	17	..
Gross weight (lb.)	450 000	488 000	330 000	25 000	80 000	150 000
Number of engines	8	8	4	4	2	2
Crew	6	6	..	..	2	..
Remarks		To be modified to carry SRAM	Assigned mission is naval reconnaissance (50 aircraft) and aerial refueling (50 aircraft)	Naval reconnaissance and maritime strike aircraft	Variable Sweepwing (Swingwing). Assigned a defined intercontinental role	Was never assumed to have intercontinental role

[a] The long-range strategic bomber role of these US aircraft is not in doubt. At least since 1962 the Soviet long-range aircraft have primarily served for maritime reconnaissance, and as aerial refuelling tankers and anti-carrier bombers.
[b] These aircraft have a medium-range capability.
[c] Maximum range without refueling and without bomb load.

Sources: Jane's Fighting Aircraft 1970/71 (London, annual); *Aviation Week and Space Technology* (weekly).

Table 1.9. US and Soviet air-to-surface missiles for medium- and long-range bombers

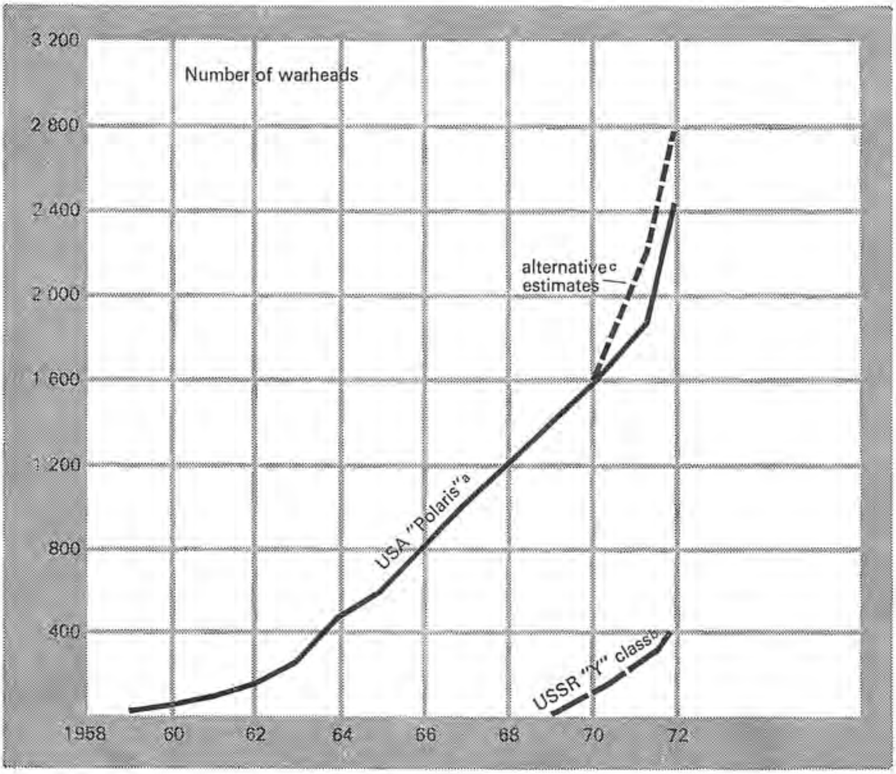
	USA		USSR				USA	
Type[a]	Hound Dog	Quail	Kangaroo	Kelt	Kennel	Kipper	SRAM[b]	SCAD[b]
Designation[a]	AGM-28 B	ADM-20 C	AS-3	AS-5	AS-1	AS-2	AGM-69 A	..
Maximum range (nautical miles)	680	350	300	100	45	100	120	..
Maximum finspan (ft)	9.4	5.4	..	..	..	..	..	..
Maximum length (ft)	43	13	50	30	28	30	14	..
Maximum body diameter (ft)	2.4	2.5	30 (wingspan)	15 (wingspan)	16 (wingspan)	16 (wingspan)	1.5	..
Launch weight (lb.)	10 150	1 230	..	..	..	..	2 240	..
Guidance	Inertial	Autopilot	Radar-guided turbojet	Radar-guided turbojet	Radar-guided turbojet	Radar-guided turbojet	Inertial	Inertial with terminal assistance
Remarks	Launched from B-52 G/H. Thermonuclear warhead of 1–4 mt., according to various references	Launched from B-52 as a decoy. Has electronic countermeasures; nuclear warhead (4 mt.)	Swept-wing missile for TU-20 bomber	Anti-shipping missile for TU-16 bomber	Anti-shipping missile for TU-16 bomber	Swept-wing anti-shipping missile for Tu-16 bomber	Short-range attack missile for B-1, FB-111 and B-52 G/H. Nuclear warhead.	Cruise armed decoy. In early development. Unarmed version called SCUD. SCAD will replace Hound Dog on B-52 and B-1

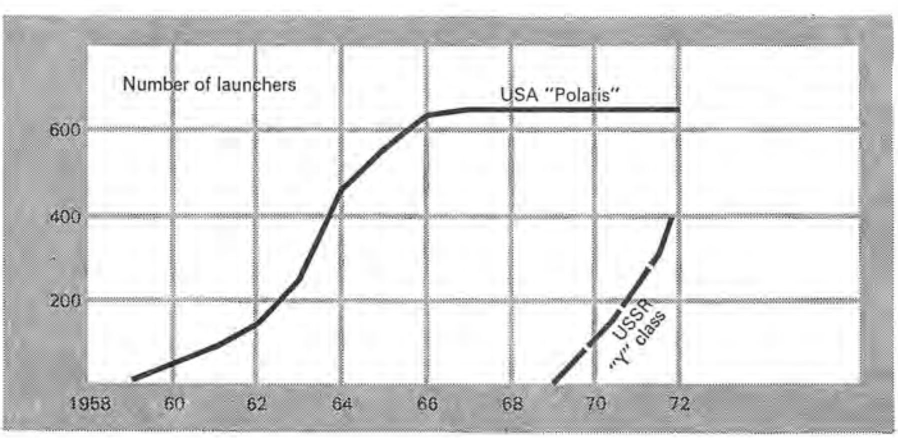
[a] These are the NATO code names and designations. The Soviet names were unavailable.
[b] These new US missiles are just being procured (SRAM) or are still being developed (SCAD).

Sources: Jane's Fighting Aircraft 1970/71 (London, annual); *Aviation Week and Space Technology* (weekly).

Chart 1.2. USA and USSR: Polaris-type submarine-launched ballistic missiles

Numbers; dotted lines indicate estimates





Notes a, b, c: see page 21.

Table 1.10. US anti-ballistic missiles to be deployed[a]

Name	Spartan	Sprint[b]
Maximum range (miles)	100	26
Warhead	4 mt.	Several tens of kt.
Maximum length (ft)	55	27
Body diameter (ft)	4	4.5
Number of stages	3	2
Type of engine	Solid propellant rocket	Solid propellant rocket
Guidance	Radar command	Radar command
Remarks	High-altitude ICBM interceptor. A warhead of about 4 mt. for this missile was tested at Amchitka on 6 November 1971	Will be used to intercept at low altitudes any ICBM warheads which escape the Spartan ABMs

[a] No details are available about the Soviet ABM, the "Galosh", except that the container in which it is transported is about 67 ft long and it has an internal diameter of 9 ft. There are 64 "Galosh" missiles in the Moscow system.
[b] By the time the facilities to accept these missiles are ready, around 1974, an improved version of Sprint may be the missile actually deployed in the new "Hardpoint" ABM system which the USA is now planning.

Sources: *Jane's Fighting Aircraft 1970/71* (London, annual); *Aviation Week and Space Technology* (weekly).

Notes to chart 1.2:

[a] The numbers for USA since 1965 are approximate estimates since the actual rate of conversion of Polaris A-3 warheads to ones with MRVs was never reported. See *SIPRI Yearbook 1969/70*, pp. 42–43.
[b] The numbers of Soviet "Y" class submarines reportedly operational derive from the US Department of Defense.
[c] These estimates are based on the total conversion of A-2 to A-3, and are thus the higher estimate:

Polaris–Poseidon

41 submarines, total

without all A-2 to A-3 conversion:

10 A-2 (1 warhead)	= 10 × 16 × 1 =	160
24 A-3 (3 MRV)	= 24 × 16 × 3 =	1 152
7 Poseidon (10 MIRV)	= 7 × 16 × 10 =	1 120
		2 432

with all A-2 to A-3 conversion:

34 A-3 (3 MRV)	= 34 × 16 × 2 =	1 632
7 Poseidon (10 MIRV)	= 7 × 16 × 10 =	1 120
		2 752

(Ten Poseidon warheads is an average number of MIRVs that Poseidon missiles will reportedly carry.)

Table 1.11. US and Soviet shorter-range European-based ballistic missiles[a]

	USA	USSR		
Name[b]	Pershing	Sandal	Skean	Scale board
Type[c]	SRBM	MRBM[a]	IRBM	SRBM
Number	325	600	100	..
Designation[b]	MGM-13 A	SS-4	SS-5	SS-12
Maximum range (nautical miles)	400	1 000	2 000	450
Warhead	400 kt. range	1 mt.	1 mt.	1 mt.
First in service	1962	1959	1961	1969
Maximum length (ft)	35	73	80	38
Body diameter (ft)	3	5	8	3
Number of stages	2	1	1	1
Type of engine	Solid propellant rocket	Liquid propellant rocket	Storable liquid propellant rocket	Storable liquid propellant rocket
Remarks	Launch weight 10 000 lb.	Launch weight 60 000 lb.	May be replaced by new, mobile 2-stage solid fuelled missile (SS-14 Scamp) on heavy-tracked transport	

[a] There are 100 SS-11s targeted at Western Europe; see table 1.2, page 5.
[b] These are the NATO code names and designations. Those of the USSR were unavailable.
[c] These are short-range ballistic missiles (SRBMs), medium-range ballistic missiles (MRBMs) and intermediate-range ballistic missiles (IRBMs).

Sources: *Jane's Fighting Aircraft 1970/71* (London, annual); *Aviation Week and Space Technology* (weekly).

2. The Strategic Arms Limitation Talks, November 1969–December 1971

Square-bracketed references, thus [1], *refer to the references on page 38.*

I. *Introduction*

The Strategic Arms Limitation Talks between the governments of the Soviet Union and the United States, which have been under way since the winter of 1969, are being conducted in strict secrecy. Both sides have formally pledged not to reveal the contents of the talks, and the joint communiqués issued at the conclusion of each "round" of talks are usually bland and non-committal. Speeches and interviews by government officials in both countries on the topic of SALT are usually of a similar nature. "Leaks" to the press, "informed sources", educated guesses and, in the United States, Congressional hearings provide some information about the SALT negotiations. However, the reliability and the completeness of such information must always be questioned as it is common practice among governments to "leak" certain facts and withhold others for their own purposes.

The following is an attempt to piece together as complete and clear a picture of the progress of SALT as possible, up to February 1972. It should be borne in mind that, due to the sources on which it is based, this picture, at least in part, may well be the one which the governments of the United States and the Soviet Union wish the public to have, rather than a true picture of what is happening at SALT.

The origins of the Strategic Arms Limitation Talks have been described in two previous SIPRI yearbooks.[1] Since the talks began in Helsinki on 17 November 1969, six rounds or a total of more than 100 reported sessions have been held, with the rounds taking place alternately in Helsinki and Vienna. These are supplemented by unreported, informal discussions. The sixth round began in Vienna on 15 November 1971, and ended on 4 February 1972. Normally the two sides meet two to three times a week in the official working sessions. The sessions usually last about an hour and a half but with the talks apparently moving into a stage of intensive negotiation, the final sessions in the sixth round often lasted as long as 3 hours.

[1] See the *SIPRI Yearbook 1968/69*, pp. 182–92, and the *SIPRI Yearbook 1969/70*, pp. 58–64.

Table 2.1. SALT sessions

Round	Opened	Closed	Approximate duration (days)	Intervals between rounds (days)
I (H)	17 November 1969	22 December 1969	35	116
II (V)	16 April 1970	14 August 1970	120	80
III (H)	2 November 1970	18 December 1970	46	87
IV (V)	15 March 1971	28 May 1971	74	41
V (H)	8 July 1971	24 September 1971	78	52
VI (V)	15 November 1971	4 February 1972	81	53
VII (H)	28 March 1972			

H = Helsinki, V = Vienna

Both governments have stressed the businesslike nature of the SALT negotiations and have praised the absence of polemics in the discussions [1]. Though some officials may have been disappointed by the slow progress of the talks, both sides emphasize that, given the complexity of the issues, immediate agreement was not to be expected [2].

II. *Attitudes toward SALT*

Both Soviet and US officials have given considerable verbal importance to SALT. It has been a constant theme in Soviet speeches and in the Soviet press that success at SALT would benefit not only the participants but the world in general [3]. Premier Kosygin has said that "effective measures in the field of restraining the strategic arms race and limiting strategic arms would meet the vital interests not only of the Soviet and American peoples, but also of the peoples of the whole world" [4]. Of course, this does not "abolish the struggle between the two systems itself but moves it into channels in which this struggle does not lead to military conflict" [5]. President Nixon has called SALT "one of the most momentous negotiations ever entrusted to an American delegation" [6].

Apart from the fact that the Soviet Union and the United States are obligated under Article VI of the Non-Proliferation Treaty to pursue negotiations "relating to cessation of the nuclear arms race at an early date", there seems to be a feeling on both sides that conditions are now more favourable for reaching an arms limitation agreement than they have been at perhaps any time since World War II. Several factors may have contributed to these generally favourable conditions, of which the most important are the improving political climate between the Soviet Union and the United States, certain developments in the arms race, and the economic burden of a continuing arms race.

The general political climate between the USSR and the USA has been improving steadily since the early 1960s, and even such events as the Czechoslovak crisis of 1968, the war in Indo-China, and the fact that the Soviet Union and the United States support opposite sides in the Middle East conflict, have only temporarily hampered this process. While the USA did, in the early stages of the SALT process, attempt to link the talks with other events such as the Middle East conflict, SALT has generally been "de-coupled" from other aspects of Soviet–US relations.

Certain developments in the arms race have also contributed to this favourable situation. Probably most important is the fact that the strategic military standing between the two countries is no longer characterized by massive US superiority. The Soviet Union has now reached approximate numerical parity with the United States in land-based ICBMs.[2] This means, as President Nixon pointed out in his 1971 Foreign Policy Report to Congress, that "perhaps for the first time, the evolving strategic balance allows a Soviet-American agreement which yields no unilateral advantages" [7]. Moreover, there is an awareness that developments in weapons technology pose a potential threat to the present situation in which both sides possess an assured second-strike capability.[3] President Nixon noted two

> critical areas of prospective strategic instability: Offensive systems have clearly developed to a point where certain further improvements as well as increased launcher deployments could pose a threat to land-based missile retaliatory forces and thus threaten stability. Instability also could develop through the unchecked extension of defensive capabilities. One side might believe that its defenses could clearly limit the damage it might suffer from retaliation, and therefore that it was in a position to strike first. [7]

Finally, the economic factor, while not a direct military strategic concern, certainly plays an important role in determining the political weight which both sides give to a successful conclusion of SALT. In the United States much of the public and Congressional pressure for a cut-back in weapons programmes and an increased effort in arms control and disarmament negotiations stems from concern over the enormous costs of continuing the arms race. One may reasonably assume that similar factors operate in the Soviet Union. Indeed, at the 24th Congress of the Communist Party of the Soviet Union, Party Secretary-General Brezhnev referred to SALT specifically in the context of freeing "substantial resources for constructive purposes" [8]. At a news conference on 10 December 1970,

[2] The USA is generally considered to be ahead in missile accuracy while Soviet missile forces are generally assumed to carry a greater total megatonnage.

[3] A "second-strike capability" is defined as the ability to retaliate and destroy a large portion of an adversary's industry and population, after the adversary has launched a nuclear attack.

US President Nixon declared that the "vital interests" of both countries require that they obtain "some limitation on arms, both because of the cost and because of the danger of a nuclear confrontation" [9].

While both the USSR and the USA express desires for a successful outcome of SALT, each government has warned the other against using SALT as a cover for advancing its strategic position. (However, as discussed on pages 1–22, both countries are in fact pushing ahead their strategic weapons development probably as fast and as far as funds and technology permit.)

In March 1971, the US Secretary of Defense stated before the House Armed Services Committee that the "new strategy emphasizes measured, meaningful involvement in vigorous negotiation from a position of strength" [10]. Even earlier, in November 1970, he had said that the US position in SALT is designed to "preserve US strategic sufficiency[4] through negotiations", and that he would "not hesitate to recommend additional [defence] effort should the threat or developments in SALT warrant" [10]. President Nixon has also warned that

> the decision to pursue a policy of strategic sufficiency rather than strategic superiority does not represent any lessening of our resolve not to permit our interests to be infringed.... It [the USSR] should be under no illusion that we will not respond to major quantitative and qualitative improvements which threaten to upset the strategic balance [7].

The Soviet government claims that its negotiating position at SALT is based on the dual principles of equal security and no unilateral military advantages: "It stands to reason that the success of these and other disarmament negotiations presupposes stringent observance of the equal security principle and renunciation of any attempts to acquire unilateral advantages" [12]. The Soviet Union appears to be just as determined as the USA to match any significant arms build-up on the other side with an equal strengthening of its own forces:

> The Soviet Union would welcome a reasonable agreement in this field. We have created strategic forces that are a reliable means of deterring any aggressor. We will respond to any attempts by anyone to gain military superiority over the USSR with the requisite increase in military might, thereby guaranteeing our defence. [13]

[4] It is no longer the *officially stated* policy of the United States to maintain "superiority" over the strategic forces of the Soviet Union. The new policy, alternately called "strategic sufficiency" or "realistic deterrence", is defined as meaning "enough force to inflict a level of damage on a potential aggressor sufficient to deter him from attacking, [and] ... the maintenance of forces adequate to prevent the US and its allies from being coerced". [11] In fact, there seems to be little or no difference between the two policies as far as development and procurement of weapons is concerned.

III. *Reported topics of discussion*

The early rounds

As the talks moved from the general exploratory stage to a discussion of specific proposals during the spring and summer of 1970, two main areas of disagreement between the two sides emerged. The first concerned the desirability of a separate agreement on ABM, the second a definition of the term "strategic".

On the first issue, the United States took the position that any agreement limiting strategic nuclear weapons should be what it views as comprehensive, covering both offensive and defensive systems. It therefore opposed a separate ABM agreement. On the second question, the USA roughly defined "strategic" weapons as those weapons which have an intercontinental range and held that at SALT "priority should go to those [offensive systems] that form the core of offensive threats, ICBMs, SLBMs, and heavy strategic bombers". [7]

Early US proposals presented at the talks reflected both these positions. When the second round of talks opened, the US delegation reportedly presented a proposal dealing with "all" offensive and defensive strategic weapon systems including ABM and MIRVs and involving both numerical and qualitative limitations [7].[5] An alternative approach presented at about the same time (the exact time is unclear) would not limit MIRVs [7].

On 24 July, the United States suggested a modified proposal establishing an overall numerical quota for offensive weapons [15], i.e., ICBMs, SLBMs and strategic bombers (one bomber = one missile). The overall figure would not be greater than the total of existing US systems in these categories, and preferably less. The mix of systems could be varied at will, with one important exception—there would be a specific limitation on the quantity of large missiles such as the Soviet SS-9. (US defence officials were at this time expressing great concern over the rapid deployment of the SS-9 missile under way in the Soviet Union.[6] The SS-9 is considered to have the potential future capability, if MIRVed, of destroying Minuteman missiles in their silos [10] and the existence of such a missile is one of the official rationales given for deploying Safeguard ABM systems around Minuteman complexes.) The proposal did not mention nuclear weapons deployed by the United States in so-called forward positions in Europe. Combined with the ceiling on offensive weapons would be a limitation on ABM deploy-

[5] "All" at this time did not include bombers [14].

[6] See the *SIPRI Yearbook 1969/70*, pp. 358–78.

ment to no more than 100 launchers each or, alternatively, a total ban on ABMs.[7] It is not known if the location of these ABMs was specified.[8]

Although less is known about the Soviet Union's early SALT proposals, what is known about its proposals and its response to US proposals indicates the Soviet position on the various issues. Apparently the Soviet Union also began by proposing agreements including both offensive and defensive weapons [16], but gradually came to favour agreements dealing with the two types of weapon systems separately, starting with an agreement on ABM.

On the offensive weapons side, Soviet officials reportedly accepted in principle the concept of an aggregate ceiling on strategic weapons, but did not respond in specific terms to the proposed sub-ceiling for large missiles. They apparently rejected a US proposal for a limitation on MIRV (see page 27). They reportedly showed interest in an agreement on zero ABM or a low level of deployment apparently around the National Command Authorities (NCA) of both nations. [17] However, even then they expressed a desire to deal with ABMs as a separate issue.

The sharpest Soviet objections to this US proposal of July 1970 were raised over the omission of nuclear weapons deployed by the USA under the auspices of NATO in Western Europe and targeted on the Soviet Union [18].[9] The purpose of SALT is to discuss limiting strategic arms. Whereas the United States calls only weapons with an intercontinental range "strategic", the Soviet Union includes in its definition of "strategic" those offensive weapons which can reach the territory of the other side, and therefore includes US nuclear forces based in Europe as well as nuclear-armed bombers on US aircraft carriers. Hence, in the Soviet view, these forces must be discussed at SALT and must be included in the overall ceiling on offensive weapons. Its own IRBMs and MRBMs would not be

[7] This was apparently a response to Soviet objections to the ABM provisions of the previous US proposal, the details of which are not known: "When it proved difficult to make progress on the basis of the initial approaches and proposals, our preparatory work enabled us to move rapidly to a modified approach taking account of Soviet objections. Our approach incorporated alternative provisions for either limitation or a total ban of ABM." [7]

[8] As of January 1972, the Soviet Union has an ABM complex of 64 launchers around Moscow; this number has not changed since 1967, but construction has recently been resumed. The United States is constructing two complexes to defend its Minuteman missiles, one at Grand Forks AFB, North Dakota, and the other at Malmstrom AFB, Montana. (See table 1.6 in chapter 1.)

[9] The United States is said to have approximately 7 200 nuclear weapons in Europe. The delivery vehicles include: (*a*) IRBMs and MRBMs, (*b*) about 500 fighter-bombers, stationed in West Germany, and capable of delivering nuclear weapons on the Soviet Union, and (*c*) nuclear-armed carrier aircraft in the Mediterranean Sea. [11] (The Soviet Union also included in its definition of "strategic" carrier aircraft located elsewhere within range of the USSR, e.g., in the Pacific Ocean.) (See table 1.11, page 22.)

included since they cannot reach the USA. Soviet officials charge that to exclude US nuclear weapons based on the Eurasian rimland from the discussions would violate the principle of mutual security by providing a one-sided military advantage to the United States [19].

The USA replied that only weapons with an intercontinental range should be included, and that this does not apply to its forces in Europe. In any case, as these forces are "essential components of integrated theater defenses created under alliance commitments" they are not a proper subject for the bilateral SALT negotiations. [7] Instead they should be discussed in the context of mutual and balanced force reductions of all Warsaw Pact and NATO forces. US officials also drew attention to Soviet MRBMs and IRBMs targeted on Western Europe, to which the Soviet Union replied that they in turn had to take French and British nuclear capabilities into consideration [20].

Disagreement over what to include in the talks, and the order of discussion seemed to be leading to a complete impasse. At the third SALT round, in late 1970, positions hardened and the talks became deadlocked. The Soviet Union continued to press for a separate ABM agreement (NCA), but without specifying the number, character or location of the radar systems which are crucial to the operation of an ABM system [21]. The United States still insisted that offensive and defensive weapon systems must be dealt with together:

> The US believes that to be stable and satisfactory, an agreement should include limitations on both offensive and defensive systems. . . .
>
> The strategic balance would be endangered if we limited defensive forces alone and left the offensive threat to our strategic forces unconstrained. It would also be dangerous, however, if only offensive forces were restrained while defensive forces were allowed to become so strong that one side might no longer be deterred from striking first. [7]

US officials further argued that the Soviet SS-9 missile poses a potential threat to the USA's deterrent forces and that, without some guarantee of a limitation on these missiles, the USA could hardly accept a limitation on its main defence against them, the Safeguard ABM. A third reason given by the USA for opposing an initial separate agreement on ABM was that,

> . . . it seems likely that if we were to agree to limit defensive systems only . . . there would be less incentive for the Soviet Union to come to an agreement on offensive systems and thus curb the potential threat to our land based forces. [22]

According to reports about SALT the situation by the end of 1970 was as follows:

The United States had offered two alternative proposals for discussion:

1. Numerical and qualitative controls of unspecified nature on all offensive

and defensive weapon systems including ABM and MIRV, with controls on the latter to be verified by on-site inspection;
2. A ceiling on the total number of offensive delivery vehicles (ICBMs, SLBMs and bombers) with an intercontinental range, including a sub-ceiling on large missiles, coupled with a total or partial ban on ABM.
The Soviet Union:
1. Had accepted the concept of an overall ceiling, but only if it included nuclear weapons deployed by the United States in Europe;
2. Did not respond to the proposed sub-ceiling on large missiles;
3. Had rejected the limitation on MIRV reportedly proposed by the USA;
4. Suggested a separate agreement limiting ABMs to NCA defence.

The "agreement-to-agree"

Although the third round of talks was reportedly deadlocked, there were some signs that the two parties might be prepared to compromise on the two issues in dispute. The USA was willing to reconsider its original demand for a "comprehensive" agreement. President Nixon stated in a television interview on 4 January:

> I am optimistic that we will reach an agreement eventually. I do not suggest now that we are going to have a comprehensive agreement, because there is a basic disagreement with regard to ... strategic weapons ... what that definition is. But we are now willing to move to a non-comprehensive agreement. [23]

This meant that the SALT negotiators could use a system-by-system approach, and that it might be possible to reach at least an initial agreement involving ABM plus some offensive weapon systems without having to settle the issue of whether or not US nuclear weapons in Europe should be considered "strategic".

Moreover, progress on a number of questions relating to the area of general European security, which is outside the specific framework of SALT but politically related to the talks, made it possible for the Soviet Union to compromise on its demand that US nuclear forces in Europe be included in SALT. On 31 March 1971, in a major policy speech before the 24th Party Congress, Party Secretary-General Brezhnev presented a five-point plan for peaceful coexistence. Among other things, the plan called for improved relations with the United States, a Soviet-German treaty leading to a general settlement of the European question, and a five-power nuclear disarmament conference. Secretary-General Brezhnev also called for a ban on all types of weapons of mass destruction, a cut in military budgets and a complete ban on nuclear weapons. [8] By May, Soviet officials had agreed to guarantee West German access to West Berlin, thus removing one of the main obstacles to settlement of the whole Berlin question. Progress on the Berlin question had in turn been one of the conditions given by the West for participation in a general conference on European security.

At various times in the last two decades, the Warsaw Pact countries have suggested the convening of a conference on European security. In the fifties and early sixties, they also repeatedly proposed talks on force reductions and disarmament, but this received a cool response from the West. In the last few years, there have been Warsaw Pact references to a European security conference, but no mention of force reductions. Instead, demands for Warsaw Pact–NATO discussions on mutual and balanced force reductions in Europe became the West's counterproposal to the East European suggestions for a general European security conference dealing with renunciation of the use of force and general economic, cultural, technical and political cooperation in Europe.[10] By the summer of 1970, the positions of the two sides were moving closer to each other. The West was gradually accepting the idea of a European security conference of the type proposed by the East. And in May 1971, Secretary-General Brezhnev announced in Moscow that the Soviet Union was now prepared to consider opening negotiations between NATO and the Warsaw Pact on mutual force reductions in Europe. [24] Although "mutual force reductions" are generally taken to mean troop reductions, it is conceivable that nuclear weapons deployed by both sides in Europe could also be taken up in these inter-bloc discussions.

These developments made it possible for a compromise to be reached on the issues which had delayed progress at SALT. This compromise was formally announced in a joint statement by the governments of the Soviet Union and the United States, released simultaneously in Washington and Moscow on 20 May 1971:

> The Government of the United States, and the Soviet Union, after reviewing the course of their talks on the limitation of strategic armaments, have agreed to concentrate this year on working out an agreement for the limitation of the deployment of antiballistic missile systems (ABMs). They have also agreed that, together with concluding an agreement to limit ABMs, they will agree on certain measures with respect to the limitation of offensive strategic weapons.
>
> The two sides are taking this course in the conviction that it will create more favourable conditions for further negotiations to limit all strategic arms. These negotiations will be actively pursued. [25]

Though *Pravda* gave only a small notice to the announcement, in Washington, President Nixon made a personal appearance on television to read the

[10] For a more detailed discussion of these developments, see the *SIPRI Yearbook 1969/70*, pp. 64–68.

statement, calling it a "significant development in breaking the deadlock of the talks". [25] While this may have been an over-statement, the announcement did signal the working out of a compromise between the two sides which may have settled both of the issues which until then had blocked progress in the talks.

The USA apparently was now prepared to accept an initial agreement on ABMs. However, there seems to be some internal disagreement in the US Administration about the exact interpretation of the provision for "certain measures" to limit offensive weapons. For example, chief US SALT negotiator Gerard Smith apparently feels "that the negotiations could proceed in parallel. We could make an ABM agreement and at the same time, be discussing an offensive agreement" [11]. On the other hand, Dr John Foster, Chief of Defense Research and Engineering, states categorically that "whatever elements of both defensive and offensive systems are to be limited in this initial agreement, both should go into effect concurrently." [11] There has so far been no official clarification on this point.

At the very beginning of the fourth round, in April, the Soviet negotiators had specified that they would like an ABM agreement with an initial 5-year duration and limiting each side to 100 ABMs around the national capitals [26]. There have also been reports that the Soviet Union has indicated a willingness to consider limitations on ABM radar installations which the United States has been requesting [27]. And following the May agreement, Soviet officials have reportedly also dropped the demand that US nuclear weapons deployed in Europe be taken up in these bilateral talks [28].

The fifth and sixth rounds of SALT

The fifth round of talks thus began with the understanding that the negotiations would concentrate on reaching a limitation on ABMs and, on the offensive side, would deal only with intercontinental land-based missiles, nuclear-armed bombers based on the territory of the two countries and submarine-launched missiles.

US negotiators reportedly opened the fifth round, which began on 8 July 1971, with a proposal that both sides halt construction of both land-based missiles and ballistic-missile submarines [29]. A cut-off date—preferably 1971—would be established, after which no new silos or submarines could be built and after which on-going construction would be halted. This interim arrangement would remain in effect for two years while a more comprehensive agreement was being negotiated. Neither side would be barred from modernizing, improving or MIRVing existing forces. Hardening of existing silos would be allowed during the proposed "freeze", but *not* enlarging to permit emplacement of a larger type of missile. [43]. A "supreme national interest" clause, similar to the one in the Test Ban Treaty, would permit either party to abrogate the agreement, under certain conditions. An accompanying proposal would permit each nation to choose between no more than 100 ABMs to defend the National Command Authority (NCA) or up to 300 ABMs to protect offensive missile sites. It is reported that, when the compromise approach was announced in May 1971, US officials had been planning to propose limits only on land-based missiles and a ceiling of 100 ABMs for NCA defence, but that they reconsidered this when some advisers argued that this would allow the Soviet Union too much time to build up its submarine forces while the agreement on land-based missiles was being negotiated. [29] The proposal for 300 ABMs around offensive missile sites may have been added partly because the Nixon Administration feared that the installation of an ABM system only around Washington, D.C. would be politically unacceptable to Congress [30].

Soviet officials objected to including submarine-based missiles in the proposed freeze on offensive weapons as this would leave them permanently in an inferior position *vis-à-vis* the USA in strategic submarine forces [31]. To meet this objection, US negotiators then apparently revived their previous proposals for an overall ceiling on offensive weapons. The overall ceiling would permit any mix of weapons, thus giving the Soviet Union the option of continuing to build up its submarine fleet at the expense of cutting back or halting expansion of some other offensive weapon system. The ceiling would include strategic bombers based in the USA and the USSR, while the freeze proposal only covered land-based and submarine-based missiles. Soviet negotiators in turn demanded that nuclear-armed carrier aircraft be included if they are based close enough to strike the Soviet Union. [31]

The Soviet delegation had originally seemed to favour a zero ABM agreement, but by the end of the fifth round of talks in September 1971 the Soviet Union was willing to accept a low-level ABM deployment rather than zero ABM. Both sides agreed that the type of deployment would be optional: the United States chose to continue deployment around its Minuteman missile sites and the Soviet Union opted for an NCA defence. [32] However, Soviet officials were not willing to accept inequality in the number of ABM complexes *or* the number of missiles deployed by each side which the United States insisted would be necessary if one side chose an NCA system while the other chose to defend its offensive missile sites. US officials argue that 300 ABMs of the Safeguard type are less destabilizing than 100 ABMs deployed around the NCA, as the former does not enhance a country's first-strike capability whereas the latter presumably does. There were unofficial indications that the United States would in fact be willing to accept a 2:1 ratio, leaving the United States with only the two ABM complexes of 100 missiles each which are already under construction [33].

The resumption of talks in November 1971 brought some reversals of the compromises relating to ABM tentatively worked out two months earlier. The Soviet Union continued to insist on absolute equality in the number of ABMs deployed by each side and also reverted back to its old proposal that only NCA deployment be permitted [34]. Later reports are that the Soviet Union has proposed a compromise that it deploy 100 ABMs to defend one of its offensive missile sites. This, together with an expanded Galosh of 100 missiles around Moscow, would then match the 200 ABMs which the USA insists on deploying around two Minuteman sites [44]. There was also disagreement over a Soviet suggestion that an ABM treaty should include a ban on the development and testing of ABM warheads as well as actual deployment. The USA is said to oppose this on the grounds that verification of such a ban would be virtually impossible and development is in any case not so destabilizing as actual launcher deployment [34].

Discussions of the "certain measures" to be taken in offensive limitations continued, and there was reportedly broad agreement that there should be a temporary freeze on offensive missile-launcher deployment while more final agreements are being negotiated [34].

When the talks adjourned for Christmas 1971, the situation was reportedly as follows:

1. There was general agreement between the two sides on the desirability of at least a temporary freeze on offensive weapons. It is not known if the Soviet Union would be willing to include ballistic-missile submarines as proposed by the United States.
2. Agreement seemed imminent on a low-level ABM deployment around Moscow and around some US Minuteman missile sites, the number of the latter being still in dispute.

IV. *MIRV*

MIRVs are considered by many strategic analysts to be one of the potentially most destabilizing developments in recent offensive weapons technology. Both sides have been pressing ahead in the area of multiple warheads. The United States has carried on extensive testing and began actual deployment of MIRV in April 1970, just as round two of SALT was getting under way. The first MIRVed Minuteman III squadron became operational on 8 January 1971. MIRV has also been installed in the first 7 of 31 projected Poseidon submarines [35]. Although the Soviet Union has tested MRVs there is no evidence that it has tested MIRVs. But the SS-9 launcher, which is the most likely Soviet missile to be MIRVed, can carry a bigger payload than existing US missiles.

Despite the obvious importance of MIRV to both sides—or perhaps because of it—MIRV has so far apparently been given only cursory treatment at SALT. [36][11] It appears that the USA did propose discussion of MIRV [39], in the form of a ban on testing coupled with on-site inspection, at an early stage of the talks, but has apparently now dropped this proposal. Given that such a ban presumably would have left the Soviet Union behind the USA in MIRV development, and given that it has often opposed foreign on-site inspection in the context of arms limitations, the Soviet rejection of this proposal was hardly surprising. The Soviet delegation has suggested that what is needed is a ban on deployment, but the two sides cannot for the present agree on the means of inspection for this [39]. It therefore seems highly unlikely that MIRVs will be included in the certain measures on offensive weapons to be taken as a result of the May 1971 agreement.

V. *The secondary nuclear powers*[12]

Although the other three nuclear powers are not directly involved in SALT, their existence plays a certain role in the negotiating proceedings. While the debate was continuing about the definition of "strategic", one of the reasons advanced by the Soviet delegation why its own MRBMs and IRBMs targeted on Europe should not be included in the talks, even if US European-based nuclear weapons were, was that the Soviet weapons were a counter to French and British nuclear forces. One can also contend that the potential threat of a growing Chinese nuclear capability may have spurred the Soviet Union to greater efforts in trying to achieve détente with the West, particularly following President Nixon's campaign of reconciliation with the Chinese government in Peking. And both govern-

[11] In US Senate hearings considering the consequences of ABM and MIRV deployment on arms control, Subcommittee Chairman Muskie stated: "There is every indication that neither side is pressing seriously, if at all, for control of MIRV" [37]. In an interview with *US News and World Report,* US Secretary of Defense Laird responded to the question: "Do you mean you can foresee an international agreement without a ban on multiple warheads?" with the answer, "That is correct" [38].

[12] For a discussion of the positions of the secondary nuclear powers regarding SALT, see the *SIPRI Yearbook 1969/70,* pages 61–64. For a discussion of the Chinese position on disarmament issues, see chapter 15, pages 483–500.

ments have used the projected future Chinese nuclear threat as a reason for deploying ABMs.

Nevertheless, both sides seem content to keep SALT strictly bilateral, and to deal with the other nuclear powers in separate discussions. NATO nuclear forces could presumably be taken up in discussions on force reductions between NATO and Warsaw Pact countries, or in the framework of a European security conference. During 1971, Party Secretary-General Brezhnev proposed—perhaps with an eye to Chinese participation—both a five-power disarmament conference including all nuclear powers and, later, a world disarmament conference, though not as a substitute for SALT, but in addition to it. [42] Neither the Soviet Union nor the USA has shown any desire to bring the Chinese into the SALT negotiations. Apparently, the Chinese threat seems too remote to be of immediate concern. When US Secretary of State Rogers was asked in 1969 how China's capability fits into the upcoming SALT, he replied that, "They haven't progressed far enough, and I think if we can work out something that is constructive from the standpoint of the two superpowers that we can deal with China's problem later on." [40]

VI. *Substantive agreements concluded at SALT during 1971*

Two years of SALT have so far resulted in only two substantive agreements, both of which are of little or no importance to halting the arms race.[13] The Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War Between the United States of America and the Union of Soviet Socialist Republics, and the Agreement Between the USA and the USSR on Measures to Improve the USA–USSR Direct Communications Link were signed simultaneously by representatives of the two governments on 30 September 1971.

Discussions about nuclear accidents began at round two of the talks but were accelerated and expanded in round four to encompass improved communications links as well, following Secretary-General Brezhnev's foreign policy speech of 31 March 1971, in which he urged the working out of "measures to reduce the possibility of the accidental occurrence or premeditated fabrication of military incidents and their development into in-

[13] This is not to say that these agreements may not be useful in preventing the outbreak of nuclear war. If one regards an accidental outbreak of nuclear war as more likely to occur than an intentional nuclear attack, then these accident-preventing measures are important.

ternational crises and war" [41]. Following this speech, two sub-groups were created at SALT, one to deal with procedures for consultation, the other with the establishment of a satellite "hot-line" to supplement the conventional cable "hot-line" which has linked Washington and Moscow since 1963.

The Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War is intended to improve safeguards against the accidental detonation of nuclear weapons and to minimize the risk that such an accident could lead to nuclear war between the two countries. Among other things, the agreement enjoins both countries to maintain and improve existing safeguards against the accidental or unauthorized use of nuclear weapons under its control; and "to notify each other immediately in the event of an accidental, unauthorized or any other unexplained incident involving a possible detonation of a nuclear weapon which could create a risk of outbreak of nuclear war". They are also to notify each other "in the event of detection by missile warning systems of unidentified objects", if it could "create a risk of outbreak of nuclear war between the two countries". In other words, if one party suddenly believes itself to be under surprise missile attack, it should contact the other party before launching a counter-attack. Each promises to notify the other in advance of any planned missile launches extending outside its own territory in the direction of the other party. In general, both sides will, in situations involving unexplained nuclear accidents, try to act in a manner which will not be misinterpreted by the other side.

The second agreement is complementary to the first in the sense that it enhances the ability of the two countries to communicate with each other rapidly and efficiently in times of emergency. The agreement on Measures to Improve the USA–USSR Direct Communications Link will create two satellite communications circuits between the countries, and a system of terminals—more than one—in the territory of each party. Each country also undertakes to ensure continuous and reliable operation of the system. A unique feature of the agreement is that the United States will build and operate a ground station in the USA for the Soviet Molniya II satellite system while the Soviet Union will build a station to work with the Intelsat system. The present cable "hot-line" between Washington and Moscow has in recent years been plagued by technical difficulties and was overdue for improvement or replacement. There seems to be little reason for this matter having been taken up at SALT, except to give the impression that significant progress is being made.

References

1. Statement by chief US negotiator Gerard C. Smith on arriving in Vienna on 12 March 1971, in *Statements on US–Soviet Strategic Arms Limitation Talks, March 1, 1971 – June 20, 1971* (United States Arms Control and Disarmament Agency), p. 21; and Statement by Soviet Foreign Minister Semenov, August, 1970, *Department of State Bulletin,* 31 August 1970, p. 246.
2. US Secretary of State William Rogers, statement in press conference, 23 December 1970, in *Chronology for Strategic Missile Talks (Part IV),* and USSR Premier Alexei Kosygin interviewed in *Asahi Shimbun,* 1 January 1971, in *Chronology for Strategic Missile Talks (Part IV)* (United States Arms Control and Disarmament Agency), p. 5.
3. Gerasimov, G., "Strategic Arms and Speculations", *Literaturnaya Gazeta,* no. 7, 1971; and Shestov, V., "What is Behind the Propaganda Screen?", *Pravda,* 3 February 1971.
4. Givertzman, B., *International Herald Tribune,* 4 January 1971.
5. *Pravda,* 4 May 1971.
6. United States Arms Control and Disarmament Agency, *10th Annual Report to Congress,* 1 January 1970 – 31 December 1970, p. 9.
7. *US Foreign Policy for the 1970s,* A Report to the Congress by Richard Nixon, President of the United States, 25 February 1971, pp. 58, 63–66.
8. *Verksamhetsberättelse av Sovjetunionens kommunistiska partis centralkommitté, SUKPs 24:e Kongress,* Speech by Leonid Brezhnev, p. 25.
9. United States Arms Control and Disarmament Agency, *Statements on US–Soviet Strategic Arms Limitation Talks, October 21, 1970 – February 26, 1971,* p. 13.
10. *Statement of Secretary of Defense Melvin Laird on the Fiscal Year 1972–76 Defense Program and the 1972 Defense Budget,* before the House Armed Services Committee, US House of Representatives, 92nd Congress, 1st session, 9 March 1971, pp. 2, 15, 46.
11. *Arms Control Implications of Current Defense Budget,* hearings before the Subcommittee on Arms Control, International Law and Organization of the Committee on Foreign Relations, US Senate, 92nd Congress, 1st session (Washington, June and July 1971), pp. 19, 37.
12. Arkadyev, N., "The Soviet Union and Disarmament", *New Times,* no. 26, June 1971.
13. *Krasnaya Zvezda,* 14 April 1971.
14. *International Herald Tribune,* 19 October 1970.
15. *New York Times,* 1, 17, 25 and 27 July 1970.
16. Statement by Secretary of State William Rogers to the House Foreign Affairs Committee, 9 June 1970, in *Department of State Bulletin,* 6 July 1970, pp. 2–3.
17. Tatu, M., "SALT: Hints of an Agreement", *Le Monde Weekly,* 1 July 1970; and Roberts, C., "Limited Accord in SALT Talks is Sought by Nixon", *International Herald Tribune,* 9 July 1970; and *International Herald Tribune,* 28 July 1970.
18. Toth, R., *International Herald Tribune,* 27 November 1970.

19. Shestov, V., "What is Behind the Propaganda Screen?", *Pravda,* 3 February 1971.
20. Tatu, M., *Le Monde Weekly,* 1 July 1971.
21. Beecher, W., *International Herald Tribune,* 29 April 1971.
22. Statement by Director of Defense Research and Engineering, Dr John Foster, on the Safeguard Defense System, before the US Senate Committee on Armed Services, 92nd Congress, 1st session, 19 April 1971, in *Statement on US–Soviet Strategic Arms Limitation Talks, March 1, 1971 – June 20, 1971, op. cit.,* p. 26.
23. Remarks by President Nixon during a televised interview with network commentators, 4 January 1971, in *Statements on US–Soviet Strategic Arms Limitation Talks, October 21, 1970 – February 26, 1971, op. cit.,* p. 20.
24. *Die Zeit,* 28 May 1971; and *Times,* 15 May 1971.
25. Text given in full in *Statement on US–Soviet Strategic Arms Limitation Talks, March 1, 1971 – June 20, 1971, op. cit.,* pp. 50–51.
26. Beecher, W., "US Reveals 5-Year Soviet ABM Plan", *International Herald Tribune,* 29 April 1971.
27. *New York Times,* 24 May 1971.
28. *New York Times,* 21 May 1971; and Hamilton, T., *New York Times,* 29 May 1971.
29. Beecher, W., *New York Times,* 23 July 1971.
30. Roberts, C., *International Herald Tribune,* 6 October 1971.
31. *International Herald Tribune,* 25 September 1971, and 27 October 1971.
32. Hamilton, T., *International Herald Tribune,* 25 September 1971.
33. *Washington Post,* 24 July 1971.
34. *International Herald Tribune,* 4–5 December 1971.
35. *International Herald Tribune,* 27 October 1971; and Office of the Assistant Secretary of Defense (Public Affairs), Press Release, 8 January 1971.
36. *International Herald Tribune,* 2 May 1971.
37. Statement by US Senator Edmund Muskie in *Arms Control Implications of Current Defense Budget,* hearings before the Subcommittee on Arms Control, International Law and Organization of the Committee on Foreign Relations, US Senate, 92nd Congress, 1st session (Washington, June and July 1971), p. 109.
38. *US News and World Report,* 11 May 1970.
39. Roberts, C., *International Herald Tribune,* 19 October 1970.
40. News conference remarks by Secretary of State Rogers on 15 October 1969, in *Statements on US–Soviet Strategic Arms Limitation Talks, July 24, 1969 – October 11, 1970, op. cit.,* p. 19.
41. Szulc, T., *International Herald Tribune,* 15 September 1971.
42. Demin, V., "A Step Towards Nuclear Disarmament", *Pravda,* 30 July 1971 (Novosti translation).
43. Beecher, W., *New York Times,* 12 June 1970.
44. Kleiman, R., "Nixon's Bargaining Chips", *International Herald Tribune,* 25 January 1972.

3. The implications of SALT for the arms race

I. *SALT objectives*

The present strategic relationship between the United States and the Soviet Union is in many respects more conducive to control of nuclear weapons than it has been at any other time during the nuclear age. Militarily, the USA and the USSR are approaching parity, at least so far as numbers of their nuclear weapons are concerned. Parity of any sort has not occurred during the nuclear arms race. And in arms control discussions no country is willing to negotiate from a position of inferiority. Moreover, in the recent past, the extreme folly of maintaining such large nuclear arsenals has become widely recognized. Former US Secretary of Defense Robert McNamara, for example, stated that about 400 thermonuclear warheads delivered on the Soviet Union would destroy 76 per cent of the industry and kill 30 per cent of the population.[1] The latter figure is a low estimate since it is based only on immediate fatalities and ignores those that are delayed, particularly those caused by exposure to high radiation levels. The arsenals of both countries contain many times this number—the US nuclear arsenal, for example, contains in its "alert force" alone ten times this number. And both the USA and the USSR are in the process of increasing their numbers of nuclear weapons and nuclear weapon systems, as has been discussed in chapter 1. If the United States, for example, continues to replace large fractions of its Minuteman and Polaris forces with new missiles carrying several warheads each and to provide a large fraction of its strategic bombers with air-to-surface missiles, then the number of nuclear weapons deliverable on the Soviet Union will increase to well over 10 thousand—more than 90 per cent "overkill", using the figures given by Secretary of Defense McNamara as a definition of minimum deterrence (above).

The main objectives of the USA and the USSR at SALT have been stated

[1] Increasing the number of warheads to 800 would increase the amount of industry destroyed to 77 per cent and the number killed to 39 per cent—an insufficient increase to justify the added cost. (*Authorization for Military Procurement, Research and Development, Fiscal Year 1969, and Reserve Strength,* hearings before the Committee on Armed Services, US Senate, 90th Congress, 2nd session (Washington, February and March 1968), p. 118.)

to be: prevention of a further erosion in the "strategic balance",[2] avoiding further large escalation in the costs of the arms race, and strengthening the Non-Proliferation Treaty by attempting to convince other powers of their determination to move towards significant nuclear disarmament.

Both the United States and the Soviet Union assert that it is essential to prevent an "erosion" of the strategic balance, the theory being that only the existence of some sort of "balance" between the nuclear forces of the two—i.e., "mutual deterrence"—has prevented the outbreak of a nuclear war. Qualitative improvements in weapon systems now under way, in particular deployment of MIRVs and ABMs, are said to threaten this "mutual deterrence". That is, accurate MIRVs could produce the perception that a "first strike"[3] was feasible; and new, very effective ABM systems might eventually reduce to "acceptable levels" the damage produced by a retaliatory strike launched by the opponent after he has suffered a first surprise attack. Thus, the US Administration claims that it greatly fears the potential threat posed to its ICBMs by the powerful Soviet SS-9 missile, and an overriding US aim since SALT began has been to limit the deployment of this weapon to about 300. The Soviet Union, on the other hand, was reportedly very alarmed at the Nixon Administration's stated intention in 1969 and 1970 to proceed with an extensive area missile defence. This may be the reason the Soviet Union has pressed so hard for an agreement limiting ABMs as the first order of business at SALT.

However, from a technical point of view, the likelihood of either the United States or the Soviet Union actually acquiring a first-strike capability in the foreseeable future is extremely remote. Neither country would be likely to consider a pre-emptive attack unless it was very confident that it could destroy the vast majority (over 95 per cent) of the attacked country's nuclear forces. This implies the ability to destroy virtually simultaneously most of the land-based and sea-based strategic missiles and long-range bombers of the adversary. This would require very large numbers of accurate missiles and a highly effective anti-submarine warfare (ASW) capability. But the development of a highly effective ASW capability is not feasible in the foreseeable future. In addition, a very effective air defence, including the capability of coping with sophisticated air-to-surface missiles, would be required because some aircraft would be airborne at the time of attack. If

[2] The term "strategic balance" is generally used in two ways. Most frequently it is used to mean the relative size of the nuclear forces of the Soviet Union and the United States. A second use is related to the concept of so-called "minimum deterrence" and means roughly a balance of opposing nuclear forces sufficient to deter each side from attacking first. In the present study the term is used with the second meaning.

[3] A "first-strike capability" is defined as the ability to destroy sufficient of the opponent's offensive weapons to prevent a successful counter-attack.

the attack were timed to strike ICBMs and bomber bases simultaneously, early warning of the attack would permit a large fraction of the bomber force to be launched. Moreover, the attacker could never be sure that the enemy's ICBM force would not be launched before his weapons detonated. If an attempt were made to strike the bomber bases by surprise using SLBMs or FOBS, then there would be a warning time of at least 20 minutes, after the destruction of the bombers, in which to launch the ICBM force.

It is not the erosion of deterrence—in the sense that either country might be able to achieve a first-strike capability in the foreseeable future—that appears likely. Rather it is the *perception* of some erosion of balance which either might attach to any single significant quantitative or qualitative gain which appears likely. And in international politics, particularly where nuclear strategy is concerned, perceptions often function as if they were facts. Hence, despite technical arguments to the effect that the deterrence forces of both sides are quite secure and will remain so for the foreseeable future, the perception of an eroding balance may be leading to another spiral of the arms race. Although both governments profess, on the one hand, to fear an erosion of deterrent capabilities and, on the other, to believe that improvements in weapons may not make a significant difference militarily, both are pushing ahead with MIRVs and ABMs, and even ASW which could be the most "destabilizing" development of all.

Even if politicians were convinced that an increment to either side's nuclear forces would make no difference *militarily*, they would still worry about an erosion of the "strategic balance" because of the *political* implications. Although difficult to measure, the political influence of a nation is said to be related, at least in part, to the size of its nuclear force. In any case, this is the claim of those who argue that any country which gains a qualitative or quantitative advantage in strategic forces—i.e., has some sort of nuclear "superiority"—would be in an advantageous bargaining position internationally, especially during periods of crisis. Thus some US officials have stated that for this reason they cannot permit the Soviet Union to gain strategic superiority, even if it would make no difference in an actual nuclear exchange.[4] And political considerations must also be part of what has motivated the Soviet Union to strive so determinedly to gain nuclear parity with, if not superiority over, the United States.

Uncertainties in the number of strategic nuclear weapons deployed by the opponent (the number of warheads in each missile cannot be deter-

[4] *Report, United States Military Posture for FY 1972, by Chairman of the Joint Chiefs of Staff, Admiral Thomas H. Moorer, USN,* pp. 6–18, in *Statements on US–Soviet Strategic Arms Limitation Talks, March 1, 1971 – June 20, 1971* (US Arms Control and Disarmament Agency), p. 18.

mined without on-site inspection) and in the effectiveness of these weapons also add to the feeling of an unstable situation. The development and deployment of new weapons by one side is often the rationale used by the other to follow suit—an action-reaction phenomenon that actively stimulates the arms race to higher dimensions. The fact that each country overestimates the effectiveness of the other side's weapons while under-estimating the effectiveness of its own weapons worsens this situation.

Other considerations are helping to keep the governments of the Soviet Union and the United States at the SALT bargaining table. In both countries there are increasing pressures for a redistribution of public spending. In order to satisfy an increasing demand for consumer goods, the Soviet Union may have to increase investment in consumer production and cut back investment in, e.g., heavy industry and armaments programmes. In the United States, increased reaction against the war in Indo-China has spilled over into a widespread antipathy to high military expenditure. At the same time, demand for more government spending in the public civil sector is growing. And although it is true that nuclear forces take a relatively small portion of the total military expenditure of either country, the "visibility" of this expenditure—i.e., the fact that, for example, a single missile costs many times more than a conventional weapon such as a tank—enhances the political desirability of cutting back expenditure in this area. This is particularly true at a time when more people are becoming convinced that continued spending on nuclear weapons will not contribute to a country's security but will rather reduce it.

Finally, the United States and the Soviet Union are very anxious to prevent the proliferation of nuclear weapons to states other than the five existing nuclear-weapon states. Both are aware that, unless SALT produces successful results soon, they will be criticized for not fulfilling their NPT obligations. In Article VI of the NPT, "each of the parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date". In March 1975 a conference of parties to the treaty will be held to "review the operation on this Treaty with a view to assuring that the purposes of the Preamble and the provisions of the Treaty are being reached". If there is inadequate progress at SALT, several of the near-nuclear-weapon powers will strongly question the good faith of the United States and Soviet Union and several of them may not accede to the treaty. The impact of this would seriously weaken any political restraint that the treaty provides.

II. *SALT agreements*

The objectives of SALT could best be achieved by a comprehensive agreement including (1) a total ban on ABMs, (2) a ceiling placed on offensive strategic missiles at a number significantly less than the numbers now deployed, (3) a ban on MIRVs, (4) a very severe restriction of anti-submarine systems, and (5) a ban on military research and development, especially testing, related to those weapon systems mentioned above.

A total ban on ABMs would be very much more desirable than a limited one because the latter would present an open invitation for a technological ABM race, with virtually unlimited possibilities for testing and deploying new systems. However, both sides have deployed or are in the process of deploying ABM systems, in the USA to protect certain Minuteman missile sites and in the Soviet Union to defend Moscow. It seems very unlikely that either side will be willing to dismantle these installations. At an early stage of SALT there was some talk of a zero ABM agreement—the United States was at that time just beginning to deploy its ABMs—but both sides apparently soon agreed that a low-level limitation would be more desirable. The ban has apparently been dropped from discussions and the negotiations are now centred around the number of sites to be permitted for each country. Both the USSR and the USA will most likely be allowed at least 100 missiles, and maybe up to 300. This means that each will probably have *more* ABMs than it has now.

On the basis of what is known so far about the content of SALT, it is very difficult to predict what type of agreement on offensive weapons, if any, will emerge. It is conceivable that there will be an agreement on ABMs only, at least next year. A determining factor for the conclusion of an agreement on offensive weapons may be the strong US desire to secure a limitation on the deployment of the Soviet SS-9 missile. If MIRVed, the SS-9 is considered to pose a threat to US land-based missiles. Since MIRVs appear to have been dropped from the discussions in the early rounds of SALT (see below), the USA will have to press for some other type of agreement which will achieve its goal of limiting the SS-9. The United States first proposed a numerical ceiling on all offensive weapons, with a special subceiling on large missiles of the SS-9 type. Later the United States suggested a freeze on construction of land-based missiles and submarines, which would also mean limitation on the SS-9. This proposal is reportedly under discussion in the current round. The Soviet Union is reportedly willing to accept a freeze on land-based missiles, but would like to delay a freeze on missile submarines, probably long enough to permit it to catch up with the United States in this area.

MIRVs have apparently been dropped from the discussions at SALT by mutual consent. One problem is the fact that the United States has begun MIRVing both land-based and submarine-launched missiles since the talks began, while the Soviet MIRV programme is apparently still in an early stage of development. A freeze on MIRVs at this stage would leave the Soviet Union in a technologically inferior position. The supposedly insurmountable problem of agreeing on an acceptable form of verification is also proffered as a rationale for the futility of negotiating an agreement on this type of weapon.

Some US experts have suggested that a meaningful MIRV limitation might still be possible, without on-site inspection, by imposing a strict limitation on the number and types of missile test launchings, including the launchings occasionally required to maintain confidence in systems already deployed. The usefulness of such a limitation is based on military decision-makers' need for a thorough testing of new systems before they would be willing to rely on them in an extensive deployment. This is particularly true for weapons which are supposed to constitute a first-strike threat. Furthermore, while it may be difficult to detect MIRV tests which are deliberately designed to disguise the system, it is improbable that the extensive testing that would be required to achieve or maintain a high-confidence MIRV capability could go undetected. This suggestion implies that the USA and the USSR would prefer to negotiate a freeze and no future testing rather than to have negotiated a MIRV freeze prior to any deployment. But the main obstacle to a MIRV agreement is still the lack of political will to obtain one.

The Soviet Union may be satisfied to halt deployment of an extensive ABM system in the United States, and the United States may be satisfied to limit the Soviet SS-9 missile. But beyond these immediate concerns, it is difficult to see how any of the agreements now under consideration at SALT or likely to emerge in the next few years will substantially contribute to the larger objectives of the Strategic Arms Limitation Talks. Neither a freeze nor a ceiling on offensive weapons will mean a reduction in the number of nuclear weapons to a more "stable" level, and a ceiling, if it is made higher than the present number deployed by each side, may even mean an increase in the number of nuclear weapons deployed. Therefore the prospective agreements will do little or nothing to fulfil the treaty obligations set out for the nuclear powers in Article VI of the NPT.

A comprehensive SALT agreement placing a limit on the total numbers of offensive missiles and bombers and a ban or limitation on ABMs could permit a phasing-out of ICBMs and bombers so that deterrence could rely solely on submarine-launched ballistic missiles, which will, for the foreseeable future, be invulnerable. Deterrence based on a limited deployment of submarine-launched missiles would provide the most stable strategic situation which can be envisaged. In practice, the strong desire of each military service to retain its component of the strategic forces, and inter-service rivalry, would make such an agreement difficult to implement. In the United States, for example, the Air Force would strongly resist losing its ICBMs and bombers, and the Army would resist a limit on its ABMs. Since the proposed freeze would not include bombers,[5] it might be hard to resist Air Force pressures to expand bomber forces, even though they are generally considered to be of very limited strategic importance. Pressures within the USSR and the USA by other vested interests would also be brought to bear to prevent the ratification of such an agreement. In fact, the formidable pressure of powerful domestic forces leads to the view that the main problem in limiting the arms race is domestic rather than international. Political leaders who wish to negotiate will have to resist these internal forces in order to obtain any significant agreement at SALT.

More importantly, the proposals now reported to be under consideration at SALT would permit the continued development and deployment of precisely those types of weapons which are said to pose the most serious threat to the so-called strategic balance. Neither a freeze nor a ceiling on offensive weapons will prohibit improvement and modifications of weapons already deployed. Hence the United States will probably proceed with the extensive MIRVing of land- and sea-based missiles and the Soviet Union can continue its MRV or MIRV programme. Programmes to improve warhead accuracy, radars, FOBS, etc., will also be unhampered by prospective SALT agreements. On the defensive side, with only a limitation of ABMs likely to emerge, ASW programmes—perhaps the potentially most destabilizing development of all—as well as anti-satellite systems, will probably be carried on by both countries. With a limit imposed on numerical increases, it is even likely that these new and possibly more destabilizing weapons will be developed and deployed much earlier than they would have been had there been no SALT agreement at all!

Nor will proposed agreements contribute to a reduction in arms expenditure. A concentration on weapons improvements will probably instead lead to increased expenditure, since research, development and production of new weapons are far more expensive than the mere increase in numbers of existing systems.

So far as is known, the question of controlling or limiting military research and development has not even been raised at SALT. Yet R&D is

[5] See page 32.

the technological driving force behind the arms race. The United States and the Soviet Union fear not only inferiority in actual numbers of weapons deployed but something called "technological inferiority" as well. Strategic planners on both sides seem to argue that weapons technology must be pushed ahead as fast as possible on all fronts even if many of the developments will never actually be needed or used, just to be certain that any new system developed by one side can immediately be matched by the other. The opposite side of the coin, the desire to have "technological superiority" in weapons development, also operates here.

Moreover, once begun, R&D projects seem to have a life of their own. It is often claimed at the start of R&D programmes that they are meant only as a sort of safety measure, and that a line can be drawn between R&D and actual procurement. But experience shows that once a major weapons programme is started, subsequent procurement of one version or another is very likely indeed. The drive for technological superiority often seems to weigh more heavily than the fact that a new system is not really dependable, is unnecessary to the stated goals of the national defence programme, or is even likely to have a destabilizing effect on the arms race. Many of the latter arguments were advanced by opponents to ABM deployment in the United States, for example. Yet R&D and deployment of this system continues.

The problem of verifying any sort of agreed limitation on R&D seems almost insoluable at first glance. But it has been suggested that for many systems a distinction may be made between research and development: unrestricted research could be permitted while development and, particularly, testing would be regulated. Research in weapons technology, which would probably be extremely difficult to control and check, is said to be much less "destabilizing" than actual development. But at least those large-scale weapons development programmes which would make a significant difference in the perceived relation of strategic forces could probably be detected with little difficulty by using the surveillance methods presently employed by both sides. By halting weapons development, one could break the chain reaction which now seems to lead inevitably from R&D to deployment by one country and from there to a similar weapons development programme by the other. Such a limitation could contribute greatly to stabilization of the strategic nuclear situation, even if the ultimate goal of arms reduction and, finally, total nuclear disarmament would still be far away.

III. *Summary and conclusions*

As noted earlier, the objectives of SALT could best be achieved by agreement on a total ban on ABMs, a ceiling on offensive strategic missiles at a number significantly less than the numbers now deployed, a ban on MIRVs, a restriction of anti-submarine systems, and a ban on military research and development, especially testing, relating to those weapon systems mentioned above.

An agreement, or series of agreements, falling far short of such a comprehensive one would not prevent a further erosion of the existing strategic "balance" between the USA and the USSR, would not curtail the enormous costs of the arms race and would further weaken the already fragile Non-Proliferation Treaty. In the absence of such a comprehensive agreement, the nuclear arms race will continue to accelerate. Without a halt in "vertical proliferation" the likelihood increases that new nuclear-weapon powers will emerge. In spite of this, the most likely SALT agreement that can be foreseen is one simply limiting ABM systems. And even this may place the limit higher than the number of ABMs now deployed, so that it would imply an actual build-up of ABMs.

Partial agreements would only be useful if they were a prelude to a series of substantial agreements leading to significant limitation and reductions of nuclear weapon arsenals. Past experience has, however, shown that partial agreements do not lead to more substantial ones, e.g., the PTB.[6] In the absence of further substantial progress, partial agreements could be counterproductive in that they could actually stimulate technological developments which would threaten the "balance" which the negotiations aim at maintaining and stabilizing.

Time is an important element in SALT because internal pressures in the USA and USSR are increasing for an early decision on a range of strategic weapons development programmes. If a comprehensive agreement is long delayed, the continuing deployment and development of strategic weapons will reduce the margin of negotiating options, increase the urgency for results, and therefore increase tension at the talks. Under these circumstances, each side will seek to strengthen its negotiating posture as the talks continue.

Continued arms escalation during SALT has been defended as an essential strategy to keep pressure on the other party in the negotiations. This strategy is clearly absurd. Both the USA and the USSR are afraid of losing

[6] For a discussion of negotiations leading to the Partial Test Ban Treaty and of considerations relating to a comprehensive test ban, see page 389.

ground in weaponry and technology and claim that they will not unilaterally surrender any of their bargaining positions at SALT.

Of particular concern is a continuation of the present high level of military research and development. This activity in itself provides a major impetus for the continuing acceleration of the arms race. If SALT agreements go no further than specifying quantitative limits on weapon systems, then all future weapons development efforts are likely to be concentrated into qualitative improvements of these systems. This would be a large step in the wrong direction.

But perhaps the most urgent requirement is for the political decision-makers in the USA and the USSR to recognize the importance of nuclear disarmament so that they will resist those vested interests within their societies which push for the application of every conceivable technological advance to weapon systems development, for the deployment of all new weapons that are developed and for the maintenance for all existing weapon systems.

With improvements in the accuracy of warheads and the deployment of MIRVs, immobile land-based ICBMs will relatively soon (within perhaps a decade) become vulnerable to a first strike from the other side. This situation could transfer reliance for deterrence from land-based forces to nuclear submarines which cannot be eliminated by a surprise attack nor by any means now foreseeable. The fact that land-based ICBMs and strategic bombers are or may soon be vulnerable and, therefore, in this sense obsolete should make it possible to arrive at an agreement to eliminate (or drastically reduce the number of) these systems—a move which would amount to a considerable step towards disarmament.

The issues at stake at SALT are so immense that the acceptance of certain theoretical risks is justified for the sake of a comprehensive and meaningful agreement. This is particularly true of verification issues. It is hardly conceivable that either country would take the huge risks inherent in attempting to cheat on an agreed limitation of strategic weapons for the purpose of developing and deploying a clandestine first-strike capability, the only rational reason for cheating.

Part II. The development and spread of arms races

Chapter 4. World military expenditure, 1970–1971

Introduction   Military expenditure, by region   Sources and methods

Chapter 5. The trade in major weapons with the third world, 1970–1971

Introduction   The main suppliers and recipients   Sources and methods   Arms trade register

Chapter 6. Resources devoted to military research and development

Introduction   The pattern of military R&D spending in 22 countries   The size of worldwide military R&D efforts   Conclusions   Statistical tables, sources and methods   US estimates of Soviet expenditure on military research: an analysis of data published in 1971 and early 1972

Chapter 7. Foreign military presence, 1971: armed forces and major bases

Introduction   Foreign military presence   Restrictions   Tables

Chapter 8. The economic and social consequences of military expenditure: comments on the UN report

The facts   Comments on the report

4. World military expenditure, 1970–1971

The trends and changes discussed in the following chapter are in real terms —that is, price corrections have been made to remove the price increases caused by inflation—unless otherwise stated.

I. *Introduction*

World military expenditure appears for the time being to have moved onto a new plateau (chart 4.1), after its very rapid rise from 1965 to 1968. In 1970 the total fell slightly. In 1971 it was about the same as in 1970; and such evidence as there is from budget figures suggests that there will not be much further change in the total in 1972 (table 4.1).

There have been plateaus before—for example, from 1955 to 1960; indeed the general course of world military expenditure has been for it to "go up sharply in periods of crisis or war, and then level off for a number of years, but without returning to the pre-crisis figures".[1] This appears to have happened on this occasion too. The level is about a third higher now, in real terms, than it was before the Viet-Nam War, and there seems no prospect of a return to the earlier scale of expenditure.

A plateau of this kind does not indicate the end of the arms race by any means. In previous plateaus, the technological arms race has gone ahead rapidly, and there is some evidence that this is happening now, given the increase in budget figures for military research and development (see page 149).

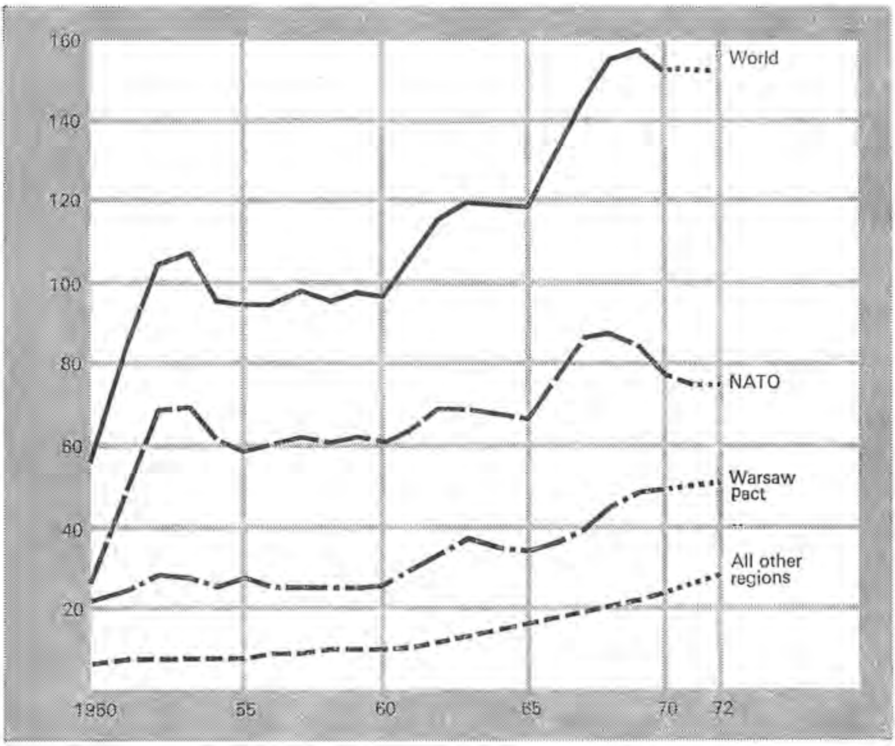
> The arms race has both qualitative and quantitative components. A decline in the volume of resources, relative to GNP or even in absolute terms, could be more than offset by the development of more deadly weapons. Economic evidence alone, therefore, cannot demonstrate that the arms race is abating.[2]

The proportion of the world's resources devoted to military expenditure is now around 6 per cent. The SIPRI estimate of the total in 1970 is $180 billion at current prices; this is not quite so high as the United Nations

[1] UN, *Economic and Social Consequences of the Armaments Race and its Extremely Harmful Effects on World Peace and Security* (Report of the Secretary-General, document A/8469, 22 October 1971), p. 17, para. 26.
[2] *Ibid.*, p. 18, para. 29.

Chart 4.1. World military expenditure, 1950–1972

US $ bn, at constant (1960) prices and 1960 exchange rates



estimate of $200 billion, based on ACDA figures.[3] The main reason for the differences is that SIPRI estimates of Warsaw Pact military expenditure are rather lower (page 76).

NATO and Warsaw Pact countries account for more than four-fifths of world military expenditure; naturally they dominate the world trend. The patterns of increase have been rather different. In the United States, with the Viet-Nam War, spending rose some 40 per cent between 1965 and 1968; then from 1968 to 1971, again mainly because of the partial withdrawal from Viet-Nam, military spending fell back some 17 per cent, and now seems likely to level off. In Warsaw Pact countries, military expenditure also rose some 40 per cent over the four years from 1965 to 1969, and has since levelled off. The estimate for Soviet military expenditure in the budget has been virtually the same for four years now—from 1969 to 1972 inclusive—at 17.7 to 17.9 billion roubles.[4]

[3] United States Arms Control and Disarmament Agency, *World Military Expenditure 1970.*

[4] There is no price correction to Warsaw Pact figures, since there is no good evidence on which to construct price indices; see the discussion on page 76.

Table 4.1. Long- and short-term trends in the volume of world military expenditure

Based on constant price figures

	Average per cent change per year						*Size of military expenditure in 1970, US $ bn, current prices and exchange rates*
	Long-term trend 1950–70	Year-to-year changes 1966–67	1967–68	1968–69	1969–70	Budgeted change in 1971	
USA	+ 6.2	+15.4	+ 2.6	− 4.2	− 9.8	− 3.9	*77.8*
Other NATO	+ 3.9	+ 4.5	− 2.8	− 0.6	+ 1.5	+ 2.5	*26.5*
Total NATO	**+ 5.5**	**+12.7**	**+ 1.4**	**− 3.4**	**− 7.2**	**− 2.3**	*104.3*
USSR[a]	+ 3.9	+ 8.0	+15.5	+ 5.9	+ 1.1	± 0	*42.6*
Other Warsaw Pact[a]	+ 5.7	+ 8.3	+18.4	+12.3	+ 7.4	+ 5.6	*7.5*
Total Warsaw Pact[a]	**+ 4.1**	**+ 8.0**	**+15.9**	**+ 6.8**	**+ 2.0**	**+ 0.8**	*50.1*
Other Europe	+ 5.3	± 0	+ 3.5	+ 3.6	− 0.2	+ 2.3	*3.0*
Middle East	+13.7	+29.7	+24.0	+15.4	+17.6	...	*4.1*
South Asia	+ 5.1	−11.8	+ 3.8	+ 6.7	+ 1.4	...	*2.2*
Far East (excl. China)	+ 7.4	+ 6.6	+14.0	+16.5	+13.7	...	*5.2*
Oceania	+ 5.3	+11.0	+ 5.1	+ 0.1	− 0.2	− 1.0	*1.3*
Africa	+11.6[b]	+ 6.2	+ 3.2	+12.2	− 4.5	...	*1.3*
Central America	+ 3.5	+ 9.2	+11.6	+ 2.8	− 0.9	...	*0.6*
South America	+ 3.7	+11.2	+ 2.9	+ 4.6	− 2.0	...	*2.6*
World[c]	**+ 5.1**	**+10.7**	**+ 6.4**	**+ 1.3**	**− 2.3**	...	*182.8*

[a] At current prices and Benoit–Lubell exchange rates.
[b] 1960–1970.
[c] Including an estimate for China of $8.0 billion in 1970.

Throughout this period, the military expenditure of other NATO countries has been basically flat: there was a slight rise, in real terms, in 1970 and 1971—but this has done no more than bring the figure back to the 1967 level. One of the main questions currently being discussed in NATO is whether, and to what extent, European NATO's military expenditure should rise to compensate for possible reductions in US military expenditure in Europe.

Whereas the military expenditure figures for NATO and Warsaw Pact powers have moved onto a plateau, there is no sign of any such plateau as yet in the spending of the underdeveloped countries[5] (though the figures for these countries are not so up-to-date). In the four years up to 1970—the latest year for which figures are available—the average rate of rise for this group was around 10 per cent. It must be borne in mind, however, that the underdeveloped countries still account for a minute part of the world total—about 8 per cent (chart 4.2). The UN report cited above comments as follows on this increase:

[5] China is excluded from the figures for underdeveloped countries throughout.

Chart 4.2. Military expenditure in developed and underdeveloped countries compared, 1960–1971

Chart 4.2A. Relative size, US $ bn, at current (1970) prices

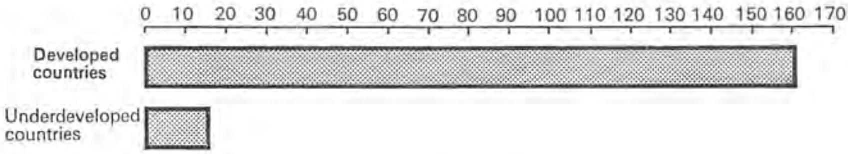
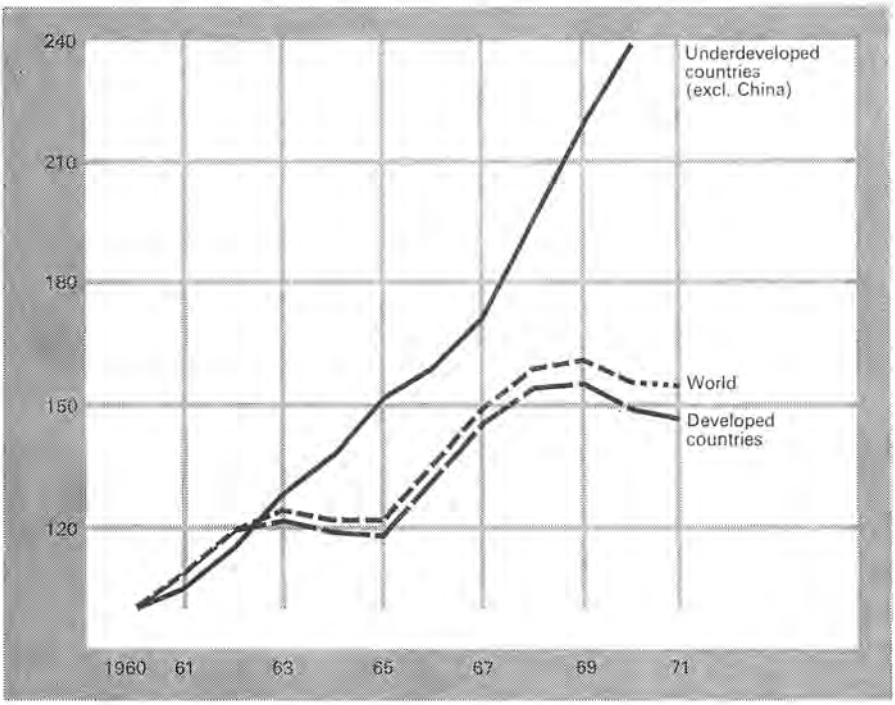


Chart 4.2B. The rise in military expenditure: index numbers, 1960 = 100



The rapid rate of increase in military spending in developing countries should, however, be interpreted with caution. The arms race in the third world can be directly related to the wars in which it has been engaged. But as is fully recognized, some conflicts have not been conducted independently of the great Powers, which have provided considerable supplies of weapons and of finance. In other regions military expenditures have been rising from a very low base. A number of new States have been building up their armed forces virtually from nothing. When stated in terms of percentages, the rates of increase in the countries will obviously appear very high.[6]

[6] UN, *Economic and Social Consequences of the Armaments Race and its Extremely Harmful Effects on World Peace and Security*, *op. cit.*, p. 19, para. 33.

Table 4.2. The Viet-Nam War[a] and US military expenditure[b]

US $ bn, fiscal years ending in June of the year given

	1965	1966	1967	1968	1969	1970	1971	1972[d]
Constant (1960) prices[c]								
Viet-Nam full costs	0.1	5.4	18.1	23.0	23.8	18.1	11.5	(7.3)
Other military expenditure	43.6	44.9	42.5	44.7	41.3	43.0	44.3	(48.0)
Total military expenditure	**43.7**	**50.3**	**60.6**	**67.7**	**65.1**	**61.1**	**55.8**	**(55.3)**
Viet-Nam incremental costs	0.1	4.0	13.6	17.4	17.8	13.6	9.0	(5.7)
Base-line force	43.6	46.3	47.0	50.3	47.3	47.5	46.8	(49.6)
Total military expenditure	**43.7**	**50.3**	**60.6**	**67.7**	**65.1**	**61.1**	**55.8**	**(55.3)**
Current prices								
Viet-Nam full costs	0.1	5.8	20.1	26.5	28.8	23.1	15.3	10.1
Other military expenditure	46.1	48.6	47.4	51.5	49.9	54.8	59.2	65.9
Total military expenditure	**46.2**	**54.4**	**67.5**	**78.0**	**78.7**	**77.9**	**74.5**	**76.0**
Viet-Nam incremental costs	0.1	4.3	15.1	20.0	21.5	17.4	12.0	7.8
Base-line force	46.1	50.1	52.4	58.0	57.1	60.5	62.5	68.2
Total military expenditure	**46.2**	**54.4**	**67.5**	**78.0**	**78.7**	**77.9**	**74.5**	**76.0**

Sources: "The Budget of the United States Government, FY 1967–69"; *Congressional Record — Senate*, 21 September 1971, p. S 14630.

[a] Includes "special expenditure" in other South-East Asian countries.

[b] These are actual or estimated expenditure figures, not appropriations or obligational authority. The figures include expenditure incurred by the Department of Defense only; it excludes military expenditure by the Atomic Energy Commission, and certain other defence-related activities, which are included in the general reference tables (page 82). The inclusion of these would not alter the general relationship of spending in Viet-Nam to other spending.

[c] Deflated by the consumer price index; see appendix 4A, page 74.

[d] Budget forecast.

Note:

Alternative estimates of Viet-Nam incremental costs have been given, which allow for the fact that actual military investment has been lower than the figure required to maintain the stock of military capital, and secondly for the fact that those drafted into the armed forces as a consequence of the Viet-Nam War are paid less than their economic reward in civilian life.

The critics of the incremental cost figures make the following two main points:

"The Department of Defense has failed to maintain 'investment component' of baseline expenditures at the estimated level required for normal peacetime operations. Since it is the estimated required level of baseline expenditures which is subtracted from actual budget expenditures to get incremental war costs, and not the lower level of actual expenditures, use of the former figure instead of the latter results in an understatement of war costs. ... The so-called investment component of baseline expenditures includes a large part, or all, of the following appropriation categories: Procurement, RDT&E (research, development, test and evaluation), Military construction. Our estimate of the backlog of baseline investment accumulated because of wartime deferments of expenditures is 14 billion current dollars. The estimate is based on official data from cited sources.

"A second understatement occurs because men who are drafted into military service can be and are paid less than their true economic worth as measured by what they could earn (and produce) in private employment. The excess of economic over budgetary costs for the draftees inducted because of the war must be added to the official figures to obtain a proper figure of the incremental cost of military personnel used in the war."

Total incremental cost, according to the above proposition:

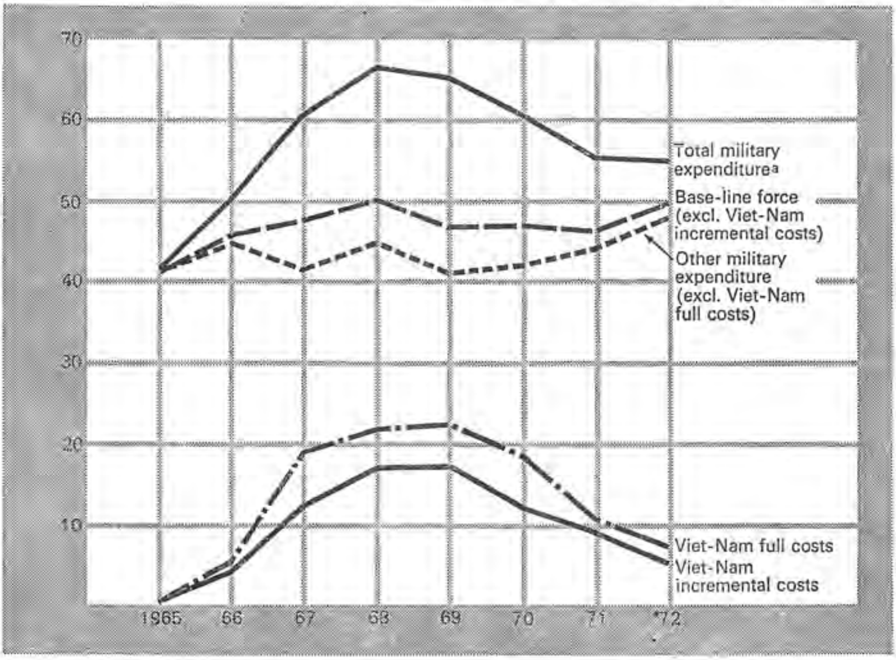
$ bn, current prices

	1966	1967	1968	1969	1970
Incremental cost	9.4	19.4	24.8	26.7	23.8

Source: "Department of Defense Estimates of the Budgetary Costs of the Indochina War, Methods and Data, FY 66–FY 70", Extracts from US House Appropriations Committee, *Defense Hearings for 1970*, Part 6, pp. 296–300.

Chart 4.3. The Viet-Nam War and US military expenditure

US $ bn, at constant (1960) prices, fiscal years



[a] Total military expenditure, as given here, equals Viet-Nam full costs plus other military expenditure, and also equals Viet-Nam incremental costs plus base-line force.

Source: Table 4.2.

II. *Military expenditure, by region*

The United States

With United States military expenditure, the first main point of interest is to establish how far the Viet-Nam War was responsible for the rise and subsequent fall. There are two definitions given for the cost of the war: Viet-Nam full cost and Viet-Nam incremental cost.[7] In brief, the full cost covers all operating costs in the war theatre, plus necessary support costs such as transportation, supply, equipment maintenance, training and medical services. The incremental cost is the additional cost of the war over and above what would be spent in peacetime for the base-line units involved.[8]

[7] The distinctions between these two definitions were explained in the *SIPRI Yearbook 1969/70*, pp. 3–7.

[8] The point is illustrated in the case of military aircraft, by the following quotation: "Air Force aircraft used a certain amount of aircraft fuel in the theater. The base-line units involved would have consumed about 37 per cent of that amount in normal peacetime operations. Therefore, the incremental war costs for fuel are equal to 63 per cent of the full costs. This represents the cost of (a) the extra hours flown by base-line units,

Table 4.2 shows both current and constant price figures for the full costs and the incremental costs of the Viet-Nam War set against total US military spending.

On either definition, the Viet-Nam War accounts for most of the movement up and down since 1965 (see chart 4.3). However, there has been some rise in base-line force expenditure, particularly in fiscal year 1972. There has been speculation in Congress about the Administration's plans in the longer term for the future course of US military expenditure. In a memorandum calling for Congressional studies of the five-year outlook, the suggestion was made that the Department of Defense plans to keep the total at around $76 billion at constant prices:

> What clues are presently available as to the future course of the defense budget under present programs and policies? There are a few:
>
> [Secretary of Defense] Laird's on-the-record estimates of $22–23 billion for procurement and R&D over the next five years in constant dollars is close to the recent level.
>
> Laird is understood also to have made an in-house estimate that the 1972 outlay level—$76 billion, now growing to $77 billion—when carried forward in constant dollars will provide a minimum but adequate defense program for the next five years under the world situation as it now appears and under present foreign policies and strategies. Put another way, the Defense Department appears to be contemplating a defense budget which will remain the same in constant dollars over the next five years, barring changes in situation or policy.[9]

If this is so, it means that there is no further 'dividend' to come from any further reduction of military expenditure in Viet-Nam, and that from now on, as Viet-Nam expenditure falls, base-line expenditure will probably continue to rise in real terms.

In fact, the defence statement by Secretary of Defense Laird indicates for fiscal year 1973 that forecasted military outlays will actually mean a decrease in real terms.

> Defense outlays for fiscal year 1973 are estimated at $76.5 billion, up by $700 billion from fiscal year 1972. . . . The increase is much less than that for other federal programs. The percentage of GNP devoted to defense continues to decline—from 7% in FY 1972 to 6.4% in FY 1973.[10]

above what they would fly in peacetime, and (b) *all* the hours flown by non-baseline units, which would not be in the force in peacetime." (*Department of Defense Appropriations for 1971*, part I, hearings before a subcommittee of the Committee on Appropriations, US House of Representatives, 91st Congress, 2nd session (Washington, 1970), p. 412.)

[9] *Congressional Record-Senate*, 21 September 1971, p. S14632.

[10] Statement of Secretary of Defense Melvin R. Laird before the Senate Armed Services Committee on the FY 1973 Defense Budget and FY 1973–1977 Program, 15 February 1972, p. 59.

Table 4.3. Trends in the volume of US Department of Defense Total Obligational Authority (TOA)

Fiscal years[a], index numbers 1968 = 100, current prices

	1968	1970	1971	1972	1973	*Value of TOA in 1973, current $ mn*
Military personnel	100	115	113	117	123	*24 656*
Operation and maintenance	100	103	98	100	102	*21 218*
Procurement	100	88	79	84	85	*19 313*
Research, development, testing and evaluation	100	102	99	107	118	*8 599*
All other[b]	100	101	142	145	190	*9 389*
Total (TOA)	**100**	**101**	**99**	**103**	**110**	*83 176*

[a] Fiscal years ending in June of the year given.
[b] Retired Pay, Special Foreign Currency Program, Military Construction, Family Housing, Civil Defense, Military and Civilian Pay Increase, Volunteer Armed Force, Military Assistance Program.

Source: Statement of Secretary of Defense Melvin R. Laird on the Fiscal Year 1972–76 Defense Program and the 1972 Defense Budget, before the House Armed Services Committee, 9 March 1971, p. 163; Statement of Secretary of Defense Melvin R. Laird before the Senate Armed Services Committtee on the FY 1973 Defense Budget and 1973–1977 Program, 15 February 1972, p. 189.

US military research and development expenditure

With the fall in US military expenditure in Viet-Nam, the Defense Department has used some of the funds so released to increase the budget for military research and development.

Although the requests for research, development, testing and evaluation have remained almost constant in current prices up to fiscal year 1971 (see table 4.3), the Department of Defense has requested an increase of 8 per cent for fiscal year 1972 for the R&D programme, and has requested a further rise of 10 per cent, or $1 billion, for fiscal year 1973. These requests will be followed by a concomitant rise in actual outlays. The official justification for these proposed rises, given in the 1973 defence report by the US Secretary of Defense, was:

Maintaining technological superiority requires a dynamic research, exploratory and advanced development effort. The Soviets appear to be seeking to surpass us in military related technological efforts, but we intend to maintain clear military technological superiority. We cannot afford the loss of that superiority ... we are continuing to support increased RDT&E expenditures in the face of an overall declining force level. The sheer magnitude and trend of Soviet scientific/technological endeavors appears to be unchanged from last year, and it is obvious that the Soviets are mounting a severe challenge to our own present technological superiority. We know that their latest research in several areas is comparable to our own.

This year, in order to maintain our technological superiority, we are requesting a substantial increase over last year. . . .[11]

(See further discussion of the level of Soviet military R&D in chapter 6, pages 195–207.)

Even the current level of R&D expenditure is sufficient for an enormous output of new weapons, so the increase in R&D expenditure proposed by the US Secretary of Defense—followed by procurement—would imply an acceleration of the already rapid rate of the technological arms race.

The military research and development programme in the United States covers a very wide field. In the strategic area, there were in fiscal years 1972 and 1973 substantial increases in the funding proposed for development of a new Undersea Long-Range Missile System, and for the continued development of a new strategic bomber. Other programmes cited by Mr Laird include improving the communication capability of the US fleet by means of satellites and underwater sound communication systems; accelerating the development of the surface-to-surface missile capability for US ships; developing less vulnerable helicopters with better surveillance capability; and improving the accuracy and stand-off capability of aerial-delivered munitions.

European NATO

The main question arising on military expenditure in European NATO countries is the extent to which European nations are preparing to raise their military expenditure, in reply to US criticism that the United States carries too large a part of the NATO burden.

After a Brussels meeting of European Defence Ministers on 7 December 1971, an increase of $1 billion at current prices was announced for fiscal year 1972.[12] Total European NATO military expenditure is currently running at about $24 billion. An increase of $1 billion would therefore represent a rise of about 4 per cent, which is roughly in line with the pres-

[11] *Ibid.*, p. 106.

[12] This is in addition to another $1 billion programme, spread over five years, which was referred to in the US defence statement of 1971 as follows: "Ten European nations agreed among themselves to provide almost a billion dollars of additional expenditures over the next five years, divided about equally between improvements to their own forces and contributions to an additional infrastructure programme for better communications and aircraft shelters. ... This is ... the first purely European endeavor of such importance in which the US has played no direct role." (Statement of Secretary of Defense Melvin R. Laird on the Fiscal Year 1972–76 Defense Program and the 1972 Defense Budget, before the House Armed Services Committee, 9 March 1971, pp. 37 and 56.)

Table 4.4. NATO: long- and short-term trends in the volume of military expenditure

Based on constant price figures

	Average per cent change per year								
	Long-term trend 1950–70	Year-to-year changes 1966–67	1967–68	1968–69	1969–70	Budgeted change in 1971	Budgeted change in 1972	*Size of military expenditure in 1970, US $ bn, current prices and exchange rates*
Belgium	+4.9	+ 5.1	+ 3.2	+ 0.8	+ 6.5	+ 3.1	...	*0.7*
Canada	+4.8	+ 7.6	− 5.8	− 5.6	+ 5.0	− 2.4	...	*2.0*
Denmark	+5.9	+ 0.5	+ 6.9	− 1.3	− 2.2	+ 4.0	...	*0.4*
France	+4.2	+ 5.4	− 0.1	− 1.4	− 0.5	+ 0.7	+2.9	*6.0*
FR Germany	+5.8	+ 4.2	−11.4	+ 8.9	+ 0.8	+ 8.2	+4.3	*6.2*
Greece	+6.2	+28.6	+16.7	+13.3	+ 7.8	+ 9.4	...	*0.5*
Italy	+4.1	− 2.3	+ 1.9	− 1.9	+ 5.4	+ 0.3	+9.9	*2.5*
Luxembourg	+2.8	−22.3	−14.3	± 0	+16.7	± 0	...	*0.008*
Netherlands	+3.9	+11.1	− 1.4	+ 4.5	+ 3.2	+ 3.3	+8.4	*1.1*
Norway	+6.0	+ 3.2	+10.8	+ 0.8	+ 0.4	+ 2.4	+2.7	*0.4*
Portugal	+8.3	+22.9	+ 5.3	− 7.2	+ 8.9	− 2.5	...	*0.4*
Turkey	+4.3	+ 0.9	+ 5.9	− 0.3	+ 6.9	+16.6	...	*0.4*
United Kingdom	+1.3	+ 3.0	− 2.0	− 6.3	− 0.2	+ 0.1	+2.0	*5.9*
USA	+6.2	+15.4	+ 2.6	− 4.2	− 9.8	− 3.9	−3.4	*77.8*

ent rate of inflation in Western Europe. It must remain an open question whether these increases will in fact raise military spending in real terms in Western Europe: but they will quite likely prevent a reduction which might otherwise have occurred. These countries have started important programmes for the modernization of their armed forces and for reshaping their ongoing defence programmes.

On US troops in Europe, Mr Laird has extended the commitment made so far for the maintenance of troops: he said, in his budget proposals for fiscal year 1973, that "given a similar approach by the other allies, the United States would maintain and improve its forces in Europe and would not reduce them except in the context of reciprocal East-West action".[13]

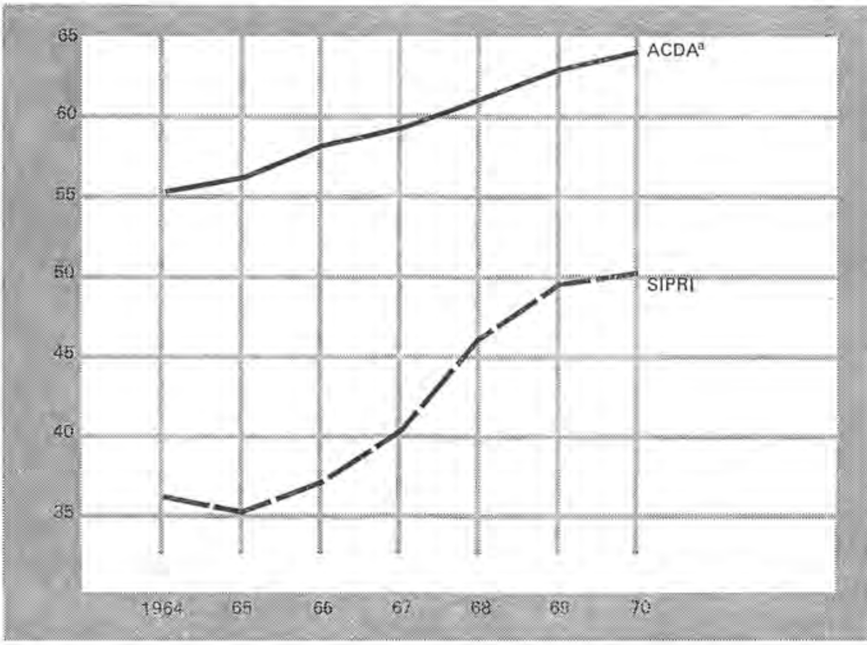
The longer-term prospects for military spending in Europe depend a good deal on whether any progress is made in any discussions with Warsaw Pact countries on mutual and balanced force reductions.

In the individual expenditure figures (table 4.4), these are the main points of interest. There has been a substantial rise in West German military expenditure since 1968—which seems likely to be continued in 1972. On the other hand, Britain's defence budget has fallen appreciably, in real terms, over this period, and the British defence outlay (in current dollars) is now

[13] Statement of Secretary of Defense Melvin R. Laird before the Senate Armed Services Committee on the FY 1973 Defense Budget and FY 1973–1977 Program, 15 February 1972, p. 112.

Chart 4.4. Alternative estimates of Warsaw Pact military expenditure figures

US $ bn



[a] US Arms Control and Disarmament Agency, *World Military Expenditure 1970.*

lower than the German. There has not been much movement in the French defence budget, in real terms, in the last four years.

Among the smaller countries, the main significant developments have been the continued rapid rise in military expenditure in Greece and, in the last two years, in Turkey.

Warsaw Pact military expenditure

There are considerable problems in making estimates of military expenditure in Warsaw Pact countries which are comparable with those in other countries. A comparison of two estimates—those of SIPRI and those of ACDA[14]—illustrates the difficulties (chart 4.4). The ACDA estimate shows a much *higher level* than the SIPRI one: on the other hand, it shows a much *lower rate of rise,* of 16 per cent over the six years from 1964 to 1970, as against the SIPRI figure of 39 per cent.

The SIPRI figures take the official budget defence estimates, on the

[14] US ACDA, *op. cit.*

Table 4.5. Price changes in the USSR since 1965

	Average money wages	Wholesale prices, heavy industrial goods	Wholesale prices, machinery
1965	100	100	100
1966	104	98	98
1967	108	114	98
1968	117	114	98
1969	121	114	95
1970	...	...	...
1971	...	...	...

Source: Congressional Record, Extensions of Remarks, 8 September 1971, p. E 9305.

grounds that there is no firm basis on which to make additions to them.[15] It uses an exchange rate which allows, among other things, for the very different cost-per-head of the average soldier in the United States and the Soviet Union. It makes no price correction to the Warsaw Pact figures. The ACDA figures adjust the Warsaw Pact military expenditure figures upwards, and assume a fairly rapid price increase, of the order of 25 per cent over the six years from 1964 to 1970.

This seems rather a high price increase to assume; it appears to assume that the rate of inflation in the Soviet Union was virtually as rapid as in Western countries. It is true that average money wages in the Soviet Union have risen quite rapidly—by 20 per cent in the four years from 1965 to 1969. But there seems no reason to think that the pay of conscript soldiers has risen as fast as this. Further, such price indices as exist in the heavy industrial goods and machinery field do not, on balance, suggest rapid price rises in this sector (though there is no way of knowing whether the prices of defence goods move in line with these civil prices or not). Again from 1965 to 1969, the wholesale price of heavy industrial goods rose 14 per cent; the wholesale price of machinery, on the other hand, fell 5 per cent (see table 4.5).

The recent figures in the Soviet military budget have already been mentioned. The 1971 figures for other Warsaw Pact countries show a continuation of the rapid rise of recent years. These rapid increases in the other Warsaw Pact countries since 1967 still have no satisfactory explanation. There is no evidence of any substantial rise in the numbers in the armed forces in these countries. One possible explanation is that the Soviet Union, like the United States, has been putting pressure on its allies to accept a larger share of the joint military burden, for instance, in terms of financing

[15] See the sources and methods appendix, page 74.

Table 4.6. Other Europe: long- and short-term trends in the volume of military expenditure

Based on constant price figures

	Average per cent change per year								*Size of military expenditure in 1970, US $ mn, current prices and exchange rates*
	Long-term trend 1950–70	Year-to-year changes 1966–67	1967–68	1968–69	1969–70	Budgeted change in 1971	Budgeted change in 1972		
Albania[a]	+9.0[b]	± 0	+11.6	+37.7	+12.3	+7.6	+10.2		*119*
Austria	+7.9	+ 1.9	+ 0.9	+ 2.7	+ 1.8	−4.3	+ 0.9		*165*
Finland	+3.8	− 1.9	+15.4	− 9.2	+ 3.2	+6.2	...		*140*
Ireland	+3.3	+ 3.5	+ 3.3	+ 6.5	+15.2	±0	...		*52*
Spain	+4.2	+17.9	− 1.6	+ 1.0	− 4.7	+8.8	...		*283*
Sweden	+4.0	− 2.5	+ 0.3	+ 5.0	− 3.9	−1.1	+ 6.0		*1 113*
Switzerland	+4.5	− 2.4	− 1.5	+ 3.2	+ 0.6	+1.5	+ 4.8		*456*
Yugoslavia	+8.9	− 0.9	+13.3	± 0	+ 2.3	+1.0	+19.8		*638*

[a] At current prices and Benoit–Lubell exchange rates.
[b] 1964–1970.

weapons procurement, infrastructure and operations. Another is that there may be some connection with the price reforms, and the prices of military goods may have been brought more into relation with their costs.

Other developed countries

Total military spending in the countries of "other Europe" has been moving up slowly in the last few years, at a rate of about 2–3 per cent a year in real terms (table 4.1). The most marked increases between 1967 and 1970 were in Ireland and Yugoslavia, where military expenditure has risen 26 per cent and 16 per cent, respectively; but neither country budgeted for a further rise in 1971. On the other hand, the budgeted forecast for Yugoslavia indicates a large increase—on the order of 20 per cent—in 1972. Sweden's military expenditure was budgeted to continue a slight downward trend, in real terms, in 1971, but is budgeted to rise in 1972. Albania shows a trend of sharper increases, but as no price correction has been made, these increases may be exaggerated (table 4.6).

Australian military spending rose fairly rapidly up to 1968. Since then it has been more or less on a plateau in real terms, and it appears from the last annual report of the Australian Defence Department that this is likely to continue. There have been a number of cancellations in procurement programmes, for example for helicopters. The 1971–72 budget shows an appreciable increase in estimated expenditure in money terms; however, most of this can be accounted for by an increase in wages and salaries. In New Zealand the level of spending has remained almost constant since 1965.

Japanese military expenditure has been increasing very sharply in recent years, by about 8 per cent a year on average, in real terms, since 1965. In fiscal year 1971, Japan completed its third defence build-up programme; the Defence Agency has now published, and the government has proposed, the fourth programme. This calls for a doubling of military spending over the next five years, and in the Agency's view would, by the end of the period, raise Japan from its present twelfth rank in world military expenditure to seventh behind the United States, the Soviet Union, China, West Germany, France and Britain. However, at the end of the period the proportion of national product devoted to defence would still be less than 1 per cent. The new programme plans for the procurement of larger quantities of sophisticated conventional weapons of all types, more of which are likely to be developed domestically during this period. Though the programme is based on the premise that the United States would not commit ground forces to Japan's defence, it would still provide Japan with assistance on sea and in the air, as well as shelter under its nuclear umbrella.

After three years of very little change in South African military expenditure, a large increase was budgeted in 1971, of some 16 per cent in real terms. Aircraft appropriations comprise the largest single item in the 1971 budget. The official defence force journal, *Paratus,* says that South Africa, as well as making almost all its own ammunition, now has a highly developed aircraft industry and is also making advances in the field of missiles.[16]

Underdeveloped countries

The very big increases in military expenditure, in absolute terms, in recent years have been in the Middle East and the Far East (see chart 4.5A). In the last decade, these two areas between them account for about two-thirds of the total rise in military spending in the underdeveloped countries.

If one looks, not at the absolute figures, but at the rates of rise, the fastest increase is still in the Middle East (see chart 4.5B); the second fastest, however, is not in the Far East, but in Africa, where military spending has risen rapidly from a very low level in the early sixties.

The two areas where there has not been the same rapid rise in real terms in recent years have been Latin America—where the growth rate has been slow throughout the post-war period—and South Asia, where the big increases came between 1963 and 1966, and where there has not been much movement since then, up to 1970; for India and Pakistan, however, there has been an increase in 1971.

[16] See *The Arms Trade with the Thf d World* (Stockholm: SIPRI, 1971), pages 682–83.

Middle East

The account of military expenditure in this region is of course dominated by Israel and Egypt, which between them explain over half the total spending in the area (chart 4.6). In both states, expenditure in real terms rose over 15 per cent in 1971; but in both states the budgeted rise for 1972 is rather less than this. Military spending in these two countries takes a higher share of national product than anywhere else in the world—around 20 per cent: and it is possible that they are approaching the economic limit for a peacetime economy.

Elsewhere in the Middle East, it seems that the very rapid rise in expenditure in Saudi Arabia was halted in 1971. Iranian military spending has continued to rise at well over 10 per cent a year, in real terms.

Africa

In North Africa the main point of interest is the very rapid increase in military spending in Libya.

The main reason for the rise in military spending in Sub-Saharan Africa between 1966 and 1969 was the Nigerian Civil War (chart 4.7): Nigerian spending, in real terms, more than quadrupled between 1966 and 1969. Then in 1970 it fell to about half the 1969 figure: and this is the main reason for the fall in African military spending in that year.

One Sub-Saharan country which has shown consistently big increases is the Sudan, where expenditure has more than doubled in four years, due to the continuing conflict between the North and the South, and Sudan's increasing identification with the Arab Nationalist movement.

South Asia and the Far East

Both India and Pakistan showed significant rises in military spending in 1971—of 6 and 7 per cent, respectively (chart 4.8). In the Far East, very rapid rates of increase have been normal: there have been relatively few exceptions—Burma and Malaysia have been two of these. (The figures in the tables for North Korea, North Viet-Nam and for China are highly speculative, since these countries do not publish any defence budgets.)

Chart 4.5. Military expenditure in the underdeveloped countries (excluding South Africa and Japan)

Chart 4.5A. Relative size, 1950–1970, US $ bn, at constant 1960 dollars and 1960 exchange rates

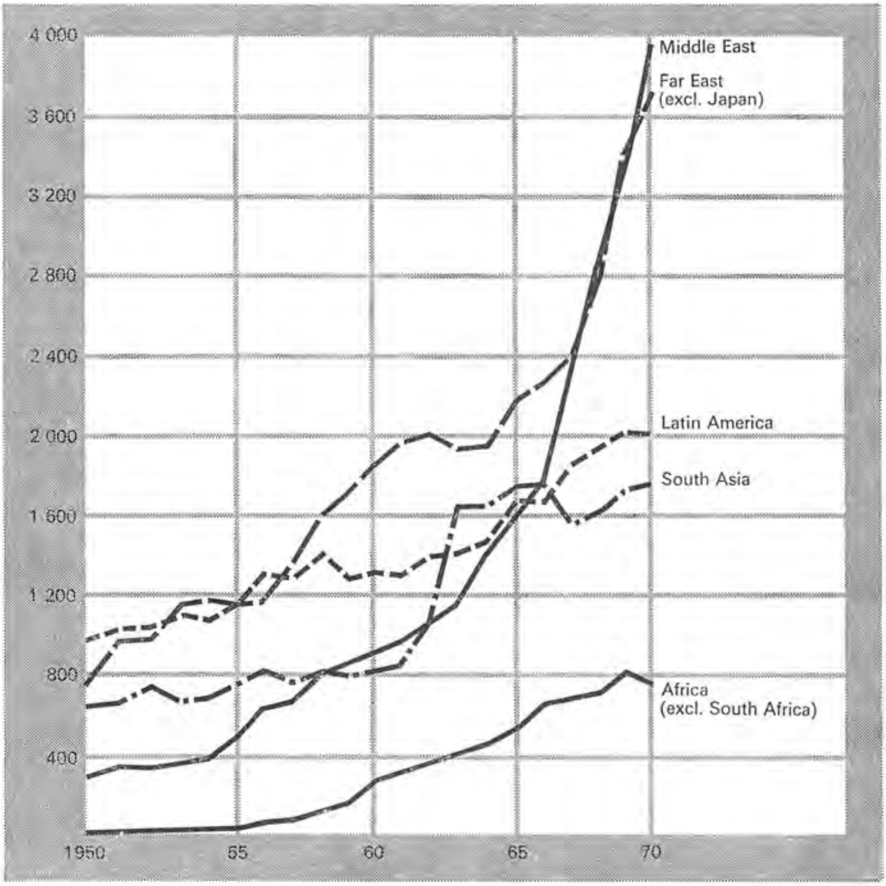


Chart 4.5B. Growth rate, 1960–1970: index numbers, 1960 = 100

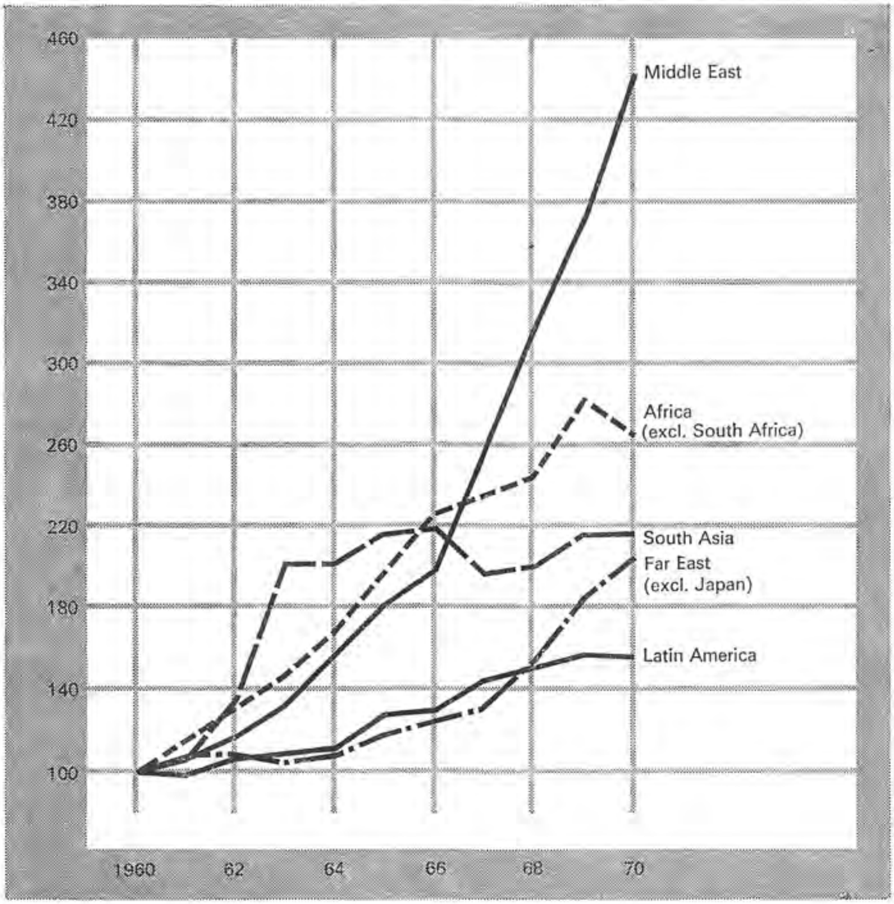


Chart 4.6. Military expenditure in Israel and Egypt, 1950–1971

US $ mn, at constant (1960) prices and 1960 exchange rates

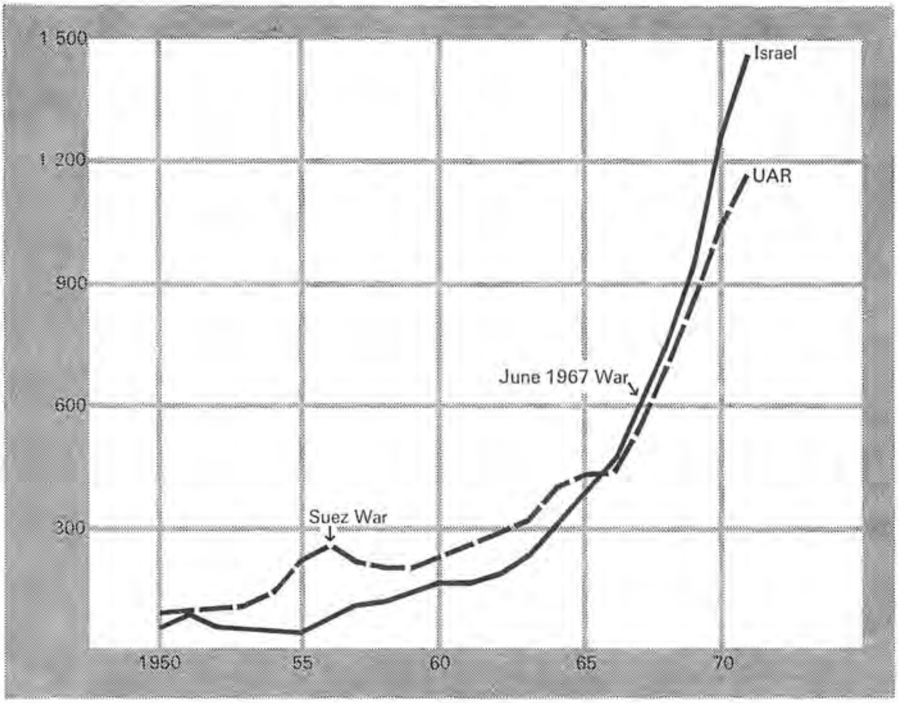


Chart 4.7. Military expenditure in South Africa and Sub-Saharan Africa, 1960–1971

US $ mn, at constant (1960) prices and 1960 exchange rates

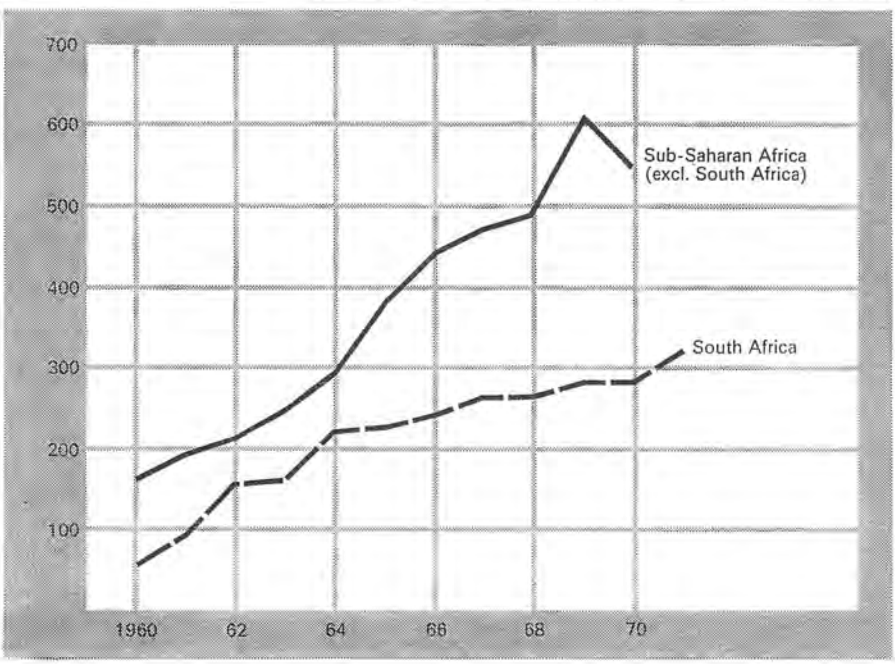


Chart 4.8. Military expenditure in India and Pakistan, 1950–1971

US $ mn, at constant (1960) prices and 1960 exchange rates

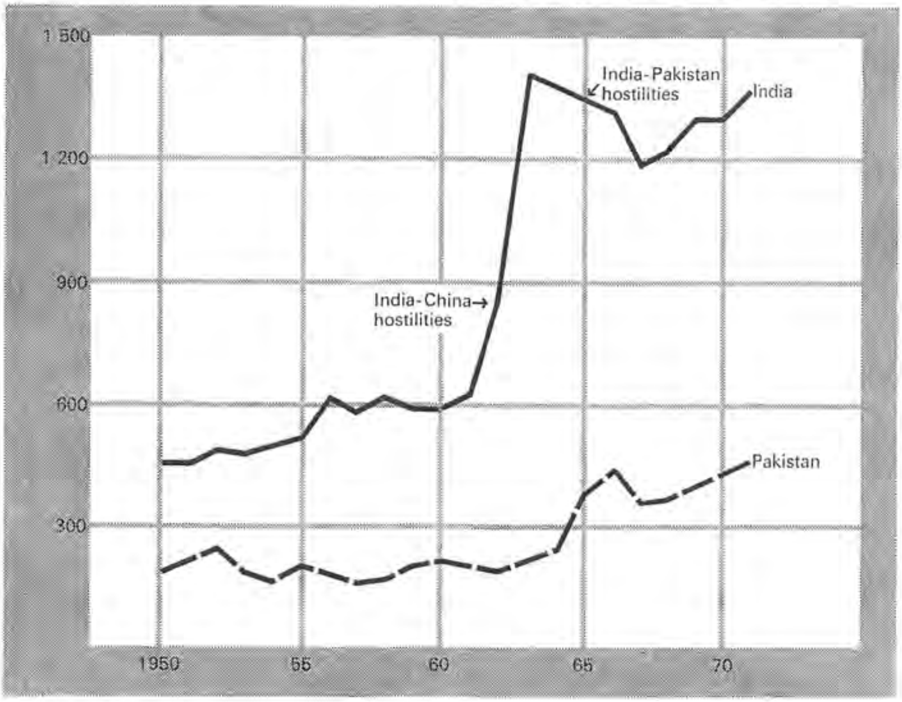


Table 4.7. Warsaw Pact: long- and short-term trends in the volume of military expenditure

Based on current price figures

	Average per cent change per year							Size of military expenditure in 1970, US $ bn, current prices and exchange rates	
	Long-term trend 1950–70	Year-to-year changes 1966–67	1967–68	1968–69	1969–70	Budgeted change in 1971	Budgeted change in 1972	(A)	(B)
Bulgaria	+ 5.9[a]	+10.1	± 0	+14.5	+ 6.9	+13.3	. . .	*0.3*	*0.3*
Czechoslovakia	+ 2.2	+13.8	+ 4.8	+ 6.9	+ 6.5	+ 1.6	+5.9	*1.7*	*2.1*
German DR	+12.4[b]	+ 9.0	+61.1	+ 9.5	+ 6.3	+ 6.7	+5.9	*2.0*	*3.0*
Hungary	+12.6[a]	+ 7.2	+18.5	+23.4	+12.0	+ 6.0	+2.9	*0.5*	*0.8*
Poland	+12.6[c]	+ 4.7	+10.3	+13.4	+ 7.3	+ 6.5	+5.7	*2.2*	*8.9*
Romania	+ 4.8[a]	+ 4.1	+ 3.8	+23.5	+10.1	+ 6.3	+4.7	*0.7*	*1.2*
USSR	+ 3.9	+ 8.0	+15.5	+ 5.9	+ 1.1	± 0	±0	*42.6*	*19.9*

(A) = At Benoit–Lubell exchange rates.
(B) = At official exchange rates.

[a] 1957–1970.
[b] 1958–1970.
[c] 1951–1970.

Table 4.8. Middle East: long- and short-term trends in the volume of military expenditure[a]

Based on constant price figures

	Average per cent change per year							*Size of military expenditure in 1970, US $ mn, current prices and exchange rates*
	Long-term trend	Year-to-year changes				Budgeted change	Budgeted change in	
	1950–70	1966–67	1967–68	1968–69	1969–70	in 1971	1972	
Egypt	+12.9	+ 23.2	+26.9	+25.5	+19.6	+11.4	− 1.5	*1 210*
Iran	+11.8	+ 28.2	+27.1	+15.3	+15.4	+10.9	...	*735*
Iraq	+11.8	+ 3.4	+17.4	− 7.7	−19.2	...	...	*252*
Israel	+19.9	+ 28.6	+26.0	+26.2	+35.5	+15.1	+14.8	*1 120*
Jordan	+ 7.9	+ 35.2	+19.8	− 7.2	−23.5	...	...	*98*
Kuwait[b]	+16.5[d]	+ 55.1	+16.6	+ 8.9	+ 1.6	+14.9	...	*70*
Lebanon	+10.9	+ 8.2	+ 7.0	− 2.6	+21.2	− 6.4	...	*53*
Saudi Arabia[c]	+20.5[e]	+113.4	+12.2	+ 6.9	+12.8	− 1.3	...	*387*
Syria	+ 9.8	+ 10.7	+57.7	+ 1.3	+ 9.8	...	...	*155*

[a] Figures are given for those countries whose military expenditure in 1970 exceeded $15 million (at current prices and exchange rates).
[b] At current prices.
[c] At current prices, fiscal years.
[d] 1964–1970.
[e] 1961–1970.

Table 4.9. South Asia, the Far East and Oceania: long- and short-term trends in the volume of military expenditure[a]

Based on constant price figures

	Average per cent per year							Size of military expenditure in 1970, US $ mn, current prices and exchange rates
	Long-term trend 1950–70	Year-to-year changes 1966–67	1967–68	1968–69	1969–70	Budgeted change in 1971	Budgeted change in 1972	
South Asia								
India	+ 5.4	− 9.8	+ 3.9	+ 6.3	− 0.2	+ 5.9	. . .	*1 511.9*
Pakistan	+ 4.2	−18.5	+ 2.8	+ 9.0	+ 5.4	+ 7.3	. . .	*603.4*
Far East								
Burma[b]	+ 7.7	− 3.2	+ 1.2	+ 5.6	+ 3.2	. . .	. . .	*112.2*
Cambodia	+12.4[c]	+ 5.9	+ 7.3	− 1.6	[+150.4]	[+85.9]	. . .	*119.5*
Indonesia	+ 1.2[d]	+15.2	[−22.3]	[+109.2]	+ 14.6	. . .	. . .	*272.0*
Japan	+ 3.9[d]	+ 8.9	+ 4.5	+ 7.8	+ 8.6	+11.1	+16.1	*1 535.2*
Korea, South	+10.9[e]	+10.8	+18.3	+14.5	+ 3.6	+13.6	. . .	*320.6*
Laos	− 2.1[f]	+ 0.5	+ 0.5	± 0	+ 10.6	. . .	. . .	*46.0*
Malaysia	+19.8	− 7.3	+ 3.3	− 2.3	+ 2.5	+ 4.4	. . .	*123.7*
Philippines	+ 6.9	+10.7	+18.1	+19.1	+ 18.9	. . .	. . .	*181.8*
Taiwan	+10.2[g]	− 1.4	+ 1.2	+20.5	+ 22.5	+22.5	. . .	*481.3*
Thailand	+11.4	+15.0	+19.8	+22.9	+ 26.1	. . .	. . .	*239.0*
Viet-Nam, South	+13.2[h]	−18.1	+75.8	+35.2	+ 22.9	+ 8.6	. . .	*480.0*
Oceania								
Australia	+ 5.5	+13.1	+ 6.3	+ 0.2	− 0.3	− 1.4	. . .	*1 190.0*
New Zealand	+ 3.7	− 5.0	− 6.3	− 1.1	+ 1.1	+ 3.4	. . .	*103.0*

[a] Figures are given for those countries whose military expenditure in 1970 exceeded $30 million (at current prices and exchange rates). North Korea and North Viet-Nam are not included because reliable figures are not available for most of the period.
[b] At current prices.
[c] 1961–1970.
[d] 1951–1970.
[e] 1952–1970.
[f] 1962–1970.
[g] 1953–1970.
[h] 1960–1970.

Table 4.10. Africa: long- and short-term trends in the volume of military expenditure[a]

Based on constant price figures

	Average per cent change per year						Size of military expenditure in 1970, US $ mn, current prices and exchange rates
	Long-term trend	Year-to-year changes				Budgeted change	
	1960–69	1966–67	1967–68	1968–69	1969–70	in 1971	
North Africa							
Algeria[b]	+ 3.3[c]	...	...	...	...	± 0	99.3
Libya	+25.3	−18.3	+ 1.9	+ 8.4	+67.9	+11.3	74.5
Morocco	+ 5.0	+ 4.6	+16.5	− 5.7	+ 3.0	...	83.6
Tunisia	+ 1.0	− 7.3	+22.0	− 4.0	+11.5	...	22.5
Sub-Saharan Africa							
Cameroon	+ 6.6	+ 5.8	+ 2.0	+ 5.3	± 0	+ 0.6	20.2
Ethiopia	+ 6.9	+ 2.6	− 4.2	− 8.7	−12.1	− 4.2	36.2
Ghana	+ 5.1	+64.0	+10.3	− 7.3	...	...	46.7[h]
Ivory Coast[b]	+ 6.5[d]	+24.3	− 3.6	− 6.8	...	...	14.8
Kenya	+21.2	+21.2	+ 1.5	+ 4.3	+ 9.7	...	19.0
Malagasy Rep.	+44.5	+ 7.4	+ 4.9	+ 1.9	...	...	12.2[h]
Nigeria	+33.6	+50.2	+32.6	+128.3	−50.0	+12.1	169.4
Rhodesia, S.	+ 7.2[e]	+13.2	+ 3.5	+ 6.2	+ 5.3	...	24.4
Senegal	+ 8.5[c]	± 0	± 0	+ 8.9	+ 6.7	+ 2.1	16.5
Somalia	+ 9.3[f]	+14.9	+ 7.4	+ 1.7	+23.7	...	11.2
South Africa	+18.5	+11.3	− 0.2	+ 3.3	− 0.1	+15.9	358.7
Sudan	+13.3	+ 1.9	+20.5	+16.8	+29.0	...	94.5
Tanzania	+33.0[e]	+16.2	+ 7.0	+12.0	...	...	12.3[h]
Uganda	+51.0[d]	+11.3	+22.7	−11.5	...	...	19.6[h]
Zaïre	+13.2[c]	−14.4	−22.0	− 3.0	+20.3	+13.6	69.4
Zambia	+17.4[g]	+ 9.2	+ 9.7	−25.3	...	...	18.6[h]

[a] Figures are given for those countries whose military expenditure in 1970 exceeded $10 million (at current prices and exchange rates).
[b] At current prices.
[c] 1963–1970.
[d] 1962–1969.
[e] 1964–1970.
[f] 1961–1969.
[g] 1964–1969.
[h] 1969.

Table 4.11. Latin America: long- and short-term trends in the volume of military expenditure[a]

Based on constant price figures

	Average per cent change per year						*Size of military expenditure in 1970, US $ mn, current prices and exchange rates*
	Long-term trend	Year-to-year changes				Budgeted change	
	1950–70	1966–67	1967–68	1968–69	1969–70	in 1971	
South America							
Argentina	+0.9	−21.4	+ 5.6	+17.7	+ 4.4	. . .	*450.0*
Brazil	+3.5	+40.7	+ 0.3	+10.2	−17.9	. . .	*1 387.0*
Chile	+3.6	+10.1	− 0.5	− 4.6	+29.6	. . .	*135.2*
Colombia	+9.2	+ 3.1	+31.7	− 7.0	+ 6.2	+ 1.2	*172.7*
Peru	+6.0[b]	+27.0	+ 0.1	− 4.8	. . .	. . .	*155.6*[c]
Venezuela	+7.0	+11.9	− 0.8	− 5.4	+ 1.8	+3.7	*200.2*
Central America							
Mexico	+5.0	+16.6	+ 4.1	+ 8.3	+ 1.7	. . .	*218.0*

[a] Figures are given for those countries whose military expenditure in 1970 exceeded $100 million (at current prices and exchange rates). Cuba is not included because reliable figures are not available for most of the period.
[b] 1950–1969.
[c] 1969.

Appendix 4A. Sources and methods

The main purpose of the collection of military expenditure material is to answer questions about long- and short-term trends in military expenditure, in individual countries, regions and the world as a whole. Because of differences in coverage, and the difficulty of finding appropriate exchange rates, expenditure figures are often unsuitable for cross-country comparisons, that is, for comparing the military efforts of two countries at a particular point in time. The expenditure figures of, for example, the USA and the USSR do not provide a good basis for comparing the military efforts of the two countries. They do, however, provide a basis for commenting on the rate at which military expenditure is rising.

I. *Definitions*

The aim is to present expenditure figures: series showing the amount of money actually spent (or likely to be spent, in 1972) for military purposes. In many countries there are other series—such as those for obligations or appropriations in the USA—which may be at a different level and show a different movement from the expenditure series. For most defence procurement, there is usually a long lag between the decision to spend the money and the actual use of resources in producing the items. It is the actual use of resources which we are attempting to measure.

Even in countries with highly developed accounting systems, the expenditure figures for any particular year are likely to have a margin of error of 1–2 per cent: when a major procurement contract has been spread over a number of years, the accounting authority may well find it difficult to state precisely the value of work done in any particular year. Small movements in the figures from one year to the next are not usually significant.

Expenditure is defined to include research and development, to include military aid in the budget of the donor country and to exclude it from the budget of the recipient country, and to exclude war pensions.

Adjustments were made for NATO country figures according to NATO definitions: these include, for example, allied services. For most other countries, however, it was not possible to obtain specific definitions of military expenditure, and consequently no adjustments were made.

All the figures are presented on a calendar-year basis. Conversion to calendar years is made on the assumption of an even rate of expenditure throughout the fiscal year. Figures for 1971 and 1972 were based on budget estimates. When the latest figures differed from the previous series chosen, the percentage change from the latest source was applied to the existing series, in order to make the trends as correct as possible.

The countries covered by each region in the world summary table are shown in the subsequent tables.[1]

For ex-colonial countries, no figures are shown before the date of independence except when it is known that the colony financed some military expenditure from its own budget.

Wherever possible, the military expenditure series are carried back to 1950. The *SIPRI Yearbook 1968/69* carries some series back to 1948. The figures are constantly revised as new information becomes available.

II. *Methods*

Selection of sources and coverage

Two worksheets have been prepared for each country. In the first sheet, all available figures were entered. A single continuous series was then prepared for as long a period as possible on the second worksheet.

For NATO countries, the series used were those corresponding to NATO definitions.[2] For Warsaw Pact countries, official national series were used.

The Warsaw Pact countries publish a single figure for military expenditure, with no functional or service breakdown, and no subsequent comparison of actual with estimated expenditure. The main problem is with the comparability of the Soviet figure with the military expenditure figures for NATO countries. All US analysts have come to the conclusion that there are important items included in NATO figures which are excluded from the Soviet figures.[3] In particular, they are fairly confident that a good deal of

[1] Albania is included in "other Europe": it announced its formal withdrawal from the Warsaw Pact in a unilateral declaration on 12 September 1968, having not participated in Warsaw Pact activities since 1960.

[2] See, for example, sources 8 and 9.

[3] J. G. Godaire, "The Claims of the Soviet Military Establishment", in *Dimensions of Soviet Economic Power* (US Congress, Joint Economic Committee, Washington, 1962). Timothy Sosnovy, "The Soviet Military Budget", *Foreign Affairs* 42 (3): 487–494, April 1964.

W. T. Lee and S. A. Anderson, *Probable Trend and Magnitude of Soviet Expenditures for National Security Purposes*, Research Memorandum SSC-Rm 5205-54, (Menlo research and development expenditure is excluded from the Soviet military budget and included in the science budget.[4] Further suggestions for omissions from the Soviet figures are: military aid, military stockpiling, military nuclear activities, and possibly also some investment in arms procurement industries. However, the evidence showing that particular activities are financed outside the defence budget is not conclusive, and the upward adjustments made for these alleged omissions are highly speculative. In general, the new estimates made tend to follow the trend of the official Soviet estimates but at a higher level. The figures in tables 4A.1 and 4A.4 have not been adjusted upwards for coverage: although the evidence is reasonably convincing that the coverage of the Soviet figures is lower, the size of the upward adjustment which would be right to compensate for this seemed so uncertain that it seemed better to allow the official figures to stand. There seemed rather more evidence on which to base an adjustment to the official exchange rate.

For countries outside NATO and the Warsaw Pact, the source usually preferred, when figures were available, was the *United Nations Statistical Yearbook*. For 1970, the military expenditure series of the African countries has been considerably altered, on the basis of material compiled by the United Nations Economic Commission for Africa. For a number of countries only rough estimates are available: thus, no official figures have been published for China, North Korea and North Viet-Nam.[5] Another source for third world countries is the AID publications.[6] The latest figures in the series have mostly been taken from journals and newspaper articles giving the most recent budget estimates.

A complete list of sources is given on page 79.

Comparability between countries: the exchange rate problem

If we wish to make any statements about world or regional trends in military expenditure, the series for individual countries have to be summed—and, consequently, converted into a common currency. The exact exchange rate chosen is important if the object is to compare the military efforts of

Park, California: Stanford Research Institute, Strategic Studies Center, 1969). (Prepared for Office of Chief of Research and Development, US Army.)
Abraham S. Becker, *Soviet Military Outlays Since 1955,* Rand Memorandum RM-3886-PR, (Santa Monica, California, 1964). (Prepared for US Air Force.)

[4] See the *SIPRI Yearbook 1969/70*, pp. 288–306, for a discussion of US estimates of Soviet expenditure for military research.

[5] The estimated figures are mostly based on figures from the US Arms Control and Disarmament Agency, the IISS *Military Balance* (London, annual), and several current journals.

[6] See source 11.

two countries. It is less crucial, however, if the need is simply for a weighting system to add together the various countries in a region. Small changes in the weighting are not likely to lead to significant differences in the movement of total military expenditure for a region.[7] The official exchange rates for 1960—the base year used for the consumer price indices—were therefore generally used.

As noted earlier, the conversion of Warsaw Pact countries' local currencies to dollars poses a special problem. Using the official exchange rates not only indicates figures for the USSR which are too low as compared with the USA, but also distorts the relationship between the countries of the Warsaw Pact. Thus, for instance, an extension of table A would show the USSR's military expenditure as being one-third that of the USA in 1970, while Poland's military expenditure would be 45 per cent of Soviet expenditure in the same year. This does not seem to match other knowledge about the relative size of resources devoted to military purposes by the countries concerned.

An alternative series is therefore presented in table 4A.4 using exchange rates estimated by E. Benoit and H. Lubell, who attempted to calculate defence-purchasing-power-parity exchange rates for these countries. The differences between these exchange rates and the basic official rates are shown in table A. The Benoit-Lubell exchange rate for the Soviet Union, for example, allows for the very different cost-per-head of the average soldier in the United States and the Soviet Union. In 1964 and 1965, the average cost-per-head for military manpower in the United States was roughly $5 000. In the Soviet Union, for 1959–1964, it was estimated to be roughly 1 000 roubles, or $1 100 at the official exchange rate.[8] These figures suggest that 4.5 : 1 is a more accurate dollar-rouble exchange rate for military manpower. An adjustment similar in direction but smaller in degree was estimated for the other categories of military expenditure. The average for military expenditure as a whole produced a dollar-rouble exchange rate lying between 2 : 1 and 2.5 : 1.

[7] An experiment was made using estimated defence-purchasing-power-parity exchange rates for European NATO countries. These rates were derived from E. Benoit and H. Lubell, "The World Burden of National Defence," in *Disarmament and World Economic Interdependence*, E. Benoit, ed. (Oslo, New York, London, 1967). The series derived for total European NATO from using these exchange rates was not significantly different from the series derived from the use of official exchange rates.

[8] The US figures are derived simply by dividing military personnel expenditure net of retired pay by the size of the armed forces. The Soviet figure is an approximation arrived at by a number of Western analysts: J. G. Godaire and A. S. Becker, quoted in *Soviet Interest in Arms Control and Disarmament, The Decade under Khrushchev, 1954–64*, (Cambridge, Mass.: Center for International Studies, Massachusetts Institute of Technology, 1965), p. 179; E. Benoit and H. Lubell, in *Disarmament and World Economic Interdependence*, E. Benoit, ed. (Oslo, 1967).

Table A. Official and Benoit–Lubell exchange rates for Warsaw Pact countries

		Value of US $ in national currency	
	Currency	Official basic rate, end-1960	Benoit-Lubell exchange rate
Albania	leks	50.00	39.67
Bulgaria	leva	1.17	1.16
Czechoslovakia	korunas	7.20	8.50
German DR	marks	2.22	3.39
Hungary	forints	11.74	17.36
Poland	zlotys	4.00	15.92
Romania	lei	6.00	9.43
USSR	roubles	0.90	0.42

Price corrections

The first step in preparing the military expenditure series was to choose one continuous series for each country. The next step was to find an appropriate exchange rate to convert local currency to dollars. The third and final step was to make price corrections, that is, to remove the price increases caused by inflation, since the main purpose of the series is to show whether the real quantity of resources absorbed by military expenditure—the "real cost" of this expenditure—is rising or falling. There is no price index or deflator that is self-evidently right for this. Some countries have a defence price index: but the use of this index leads to an understatement of the rise of the real cost of defence.[9]

[9] These considerations are relevant to the choice of a price index:

(*a*) It is not at all easy to say what the "real output" of the military sector of an economy is: there is no measurable end-product, as there is, for example, with the steel industry. One possible theoretical approach would be to attempt to measure the increase in the potential output of lethal power, since this is what military expenditure is about. This is not a very practical approach. It would give an astronomical rate of increase over this period. Also, any such measure would omit, for example, the increase in resources devoted to a wide range of ancillary equipment. If, for example, one measured the output of a bomber by the megatonnage of the bombs it could carry, this output would not be increased if the bomber were subsequently equipped with elaborate electronic countermeasures.

(*b*) The "real output" indices for military expenditure which are included in some countries' national accounts incorporate price indices for procurement and for research and development. For the armed forces themselves, the whole of the increase in armed forces' pay-per-head is usually assumed to be a price increase: that is, it is assumed that there is no increase in the productivity of any member of the armed forces.

(*c*) If, instead of thinking of the "real output" of the military sector, we think of the "real cost", in terms of the real quantity of civil output foregone, then some allowance has to be made for the general increase in output-per-head in the civil sector of the economy. A member of the armed forces who is transferred to the civil sector now will have a higher real output than one who was transferred ten years ago. It follows that for measuring the increase in this real cost, a defence price index is unsuitable: it rises too fast. It postulates no increase in the real output-per-head of the armed forces, where-

We have used a consumer price index. For a fairly large number of countries this is the only price index available. If we had used a GNP deflator or a general price index, instead, for those countries which possess one—that is, a price index for the output of all goods and services, not just consumer goods and services—the general trends shown by the constant price figures here would not have been significantly different.

All consumer price indices were rebased on the year 1960.

III. *Sources*

The following list of sources includes books and journals used for more than one country and newspapers and journals which are regularly examined for military expenditure information.

Books and journals

1. United Nations: *Statistical Yearbook* (annual, 1948–1970).
2. *Yearbook of National Accounts Statistics,* 1957–1959, 1961, 1964, 1966.
3. United Nations: *Economic Survey of Europe in 1969: Part I, Structural Trends and Prospects in the European Economy; Part II, The European Economy in 1969.*
4. *UN Monthly Bulletin of Statistics.*
5. "Economic and Social Consequences of Disarmament: Replies of Governments and Communications from International Organizations" (UN document E/3593/Rev. 1, 1962); "Economic and Social Consequences of the Armaments Race and Its Extremely Harmful Effects on World Peace and Security" (UN document A/8469, 22 October 1971); and "Economic and Social Consequences of the Armaments Race and Its Extremely Harmful Effects on World Peace and Security" (UN document A/8469/Add. 1, 12 November 1971).
6. Organization for Economic Cooperation and Development (Paris): *Statistics of National Accounts,* 1950–61, 1955–62, 1956–65, 1957–66.
7. *National Accounts of OECD Countries,* 1950–1968 (Paris, 1970).
8. *NATO Letter* 11 (1), January 1963; 14 (1), January 1966; 17 (2); February 1969; 18 (1), January 1970; 18 (12), December 1970.
9. *NATO Review,* January/February 1972.
10. United States Arms Control and Disarmament Agency (Washington): *World-wide Defense Expenditures and Selected Economic Data, Calendar Year 1964* (Research report 66–1). *World Military Expenditures 1966–67, 1969 and 1970* (Research reports 68–52, 69–53 and 70–51).

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as the real cost of foregoing their potential contribution to civil output rises through time.

(*d*) It is worth noting here that in any country with conscription, where the conscript is paid less than he could earn in civil life, the real cost of military expenditure and its share in the gross national product is understated, since the valuation put on the services of the armed forces in the military budget is too low.

11. United States Agency for International Development (Washington): *AID Economic Data Book: Africa,* 1967, 1968, 1970. *AID Economic Data Book: Far East,* 1967, 1968, 1970. *AID Economic Data Book: Latin America,* 1967, 1968, 1970. *AID Economic Data Book: Near East and South Asia,* 1967, 1968, 1970.
12. International Institute for Strategic Studies (London): *The Military Balance* (annual, 1959/60–1971/72). Brown, N. and Gutteridge, W. F., *The African Military Balance* (Adelphi paper no. 12, August 1964). Wood, D., *The Middle East and the Arab World: the Military Context* (Adelphi paper no. 20, July 1965). Wood, D., *The Armed Forces of African States* (Adelphi paper no. 27, April 1966). Wood, D., *Armed Forces in Central and South America* (Adelphi paper no. 34, April 1967). Booth, R. and Gutteridge, W. F., *The Armed Forces of African States, 1970* (Adelphi paper no. 67, May 1970).
13. Center for International Studies, *Regional Arms Control Arrangements for Developing Areas* (Cambridge, Mass.: Massachusetts Institute of Technology, September 1964).
14. *Great Soviet Encyclopedia.*
15. *Statesman's Yearbook* (annual, 1963/64–1971/72).
16. *International Air Forces and Military Aircraft Directory* (Stapleford, England: Aviation Advisory Services Ltd., 1968, 1969, 1970).
17. Benoit, E. and Lubell, H., "The World Burden of National Defence", in *Disarmament and World Economic Interdependence,* E. Benoit, ed. (Oslo, New York, London, 1967).
18. Coward, H. R., *Military Technology in Developing Countries* (Cambridge, Mass.: Center for International Studies, MIT, 1964).
19. Loftus, Joseph E., *Latin American Defense Expenditures, 1930–1965* (RAND memorandum RM-5310-PR/15 A), January 1968

Newspapers

Aftonbladet (Stockholm)
Christian Science Monitor (Boston)
Dagens Nyheter (Stockholm)
Daily Telegraph (London)
Financial Times (London)
Hindustan Times (New Delhi)
International Herald Tribune (Paris)
Japan Times (Tokyo)
Krasnaja Zvezda (Moscow)
Le Monde (Paris)
Neue Zürcher Zeitung (Zürich)
New York Times (New York)
Pravda (Moscow)
The Standard Tanzania (Dar-es-Salaam)
The Times (London)

Current periodicals

Africa Diary (New Delhi)
Arab Report and Record (London)
Asian Recorder (New Delhi)
Aviation Week and Space Technology (New York)
Government Business Worldwide (Washington)
Interavia Airletter (Geneva)
International Affairs (London)
Jeune Afrique (Paris)
Österreichische Militärische Zeitschrift (Vienna)
Osteuropa (Munich)
Survival (London)
Wehrkunde (Munich)

IV. *Conventions*

[ ] = Rough estimates.
( ) = Estimate based on budget figures or using an estimated consumer price index, or both.
■ = Date of independence.
·· = Figures not available.

Figures for all countries are given (*a*) at constant (1960) prices converted into US dollars at 1960 exchange rates; (*b*) at current prices, in local currency; and (*c*) for the year 1970, at current prices, converted into US dollars at current exchange rates. When 1970 figures were not available for this final column, the 1969 or the latest available figures were given instead.

Tables 4A.1, 4A.2, 6, 8, 10, 12, 14, 16, 18 and 20 give constant price figures converted into dollars at 1960 exchange rates, and also give a column, *1970 X*, for 1970 expenditure, at current prices converted into dollars at current exchange rates. Tables 4A.3, 4, 5, 7, 9, 11, 13, 15, 17 and 19 give current price figures in local currency.

Table 4A.1. World summary: constant price figures[a]

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
USA	17 733	37 781	52 992	54 409	46 915	44 428	45 307	46 843	46 432	47 085	45 380
Other NATO	8 959	12 450	15 495	15 878	14 796	14 557	15 375	15 539	14 379	15 342	15 955
Total NATO	**26 692**	**50 231**	**68 487**	**70 287**	**61 711**	**58 985**	**60 682**	**62 382**	**60 811**	**62 427**	**61 335**
USSR	19 731	22 948	25 952	25 666	23 881	25 476	23 167	23 029	22 286	22 310	22 143
Other Warsaw Pact	[2 500]	[2 500]	[2 500]	[2 500]	[2 500]	[2 500]	[2 750]	2 860	2 893	3 073	3 430
Total Warsaw Pact	**22 231**	**25 448**	**28 452**	**28 166**	**26 381**	**27 976**	**25 917**	**25 890**	**25 179**	**25 383**	**25 573**
Other Europe[b]	726	828	1 280	1 260	1 243	1 243	1 240	1 335	1 368	1 412	1 467
Middle East	300	330	320	350	390	500	640	670	790	870	900
South Asia	650	680	740	680	690	740	830	750	810	800	812
Far East (excl. China)	1 120	1 400	1 420	1 650	1 670	1 580	1 590	1 790	2 050	2 180	2 300
China	[2 750]	[3 500]	[3 000]	[2 500]	[2 500]	[2 500]	[2 500]	[2 750]	[2 500]	[2 800]	[2 800]
Oceania	342	496	595	596	536	547	535	496	491	498	496
Africa	50	90	90	80	80	90	130	150	170	210	350
Central America	270	270	270	280	260	270	280	300	300	310	330
South America	710	760	760	830	810	870	1 030	990	1 100	960	970
World total	**55 841**	**84 033**	**105 414**	**106 679**	**96 271**	**95 301**	**95 374**	**97 503**	**95 569**	**97 850**	**97 333**

[a] All Warsaw Pact countries at current prices and Benoit-Lubell exchange rates.
[b] Albania is included in Other Europe.

Table 4A.2. NATO: constant price figures

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
North America:												
USA	17 773	37 781	52 992	54 409	46 915	44 428	45 307	46 843	46 432	47 085	45 380	47 335
Canada	619	1 386	2 066	2 193	1 950	2 008	2 055	1 931	1 783	1 665	1 660	1 708
Europe:												
Belgium	202	301	446	442	435	376	365	380	377	380	386	391
Denmark	72	86	118	155	153	150	145	152	140	144	161	164
France	1 987	2 651	3 394	3 796	3 206	2 977	3 876	4 028	3 718	3 793	3 908	3 876
FR Germany	1 000	1 887	2 059	1 646	1 671	1 920	1 837	2 236	1 677	2 685	2 905	3 082
Greece	115	137	132	126	135	138	178	157	155	161	170	165
Italy	767	908	994	897	981	974	1 000	1 036	1 064	1 097	1 144	1 182
Luxembourg	4	6	10	11	12	13	9	9	9	8	5	6
Netherlands	325	344	402	428	486	511	551	514	452	403	458	534
Norway	78	107	142	179	183	152	148	158	146	155	148	161
Portugal	57	60	65	76	81	85	86	88	89	101	105	168
Turkey	165	183	191	211	217	228	215	211	218	251	266	289
UK	3 568	4 394	5 476	5 718	5 286	5 031	4 910	4 639	4 551	4 499	4 639	4 628
Total NATO	**26 692**	**50 231**	**68 487**	**70 287**	**61 711**	**58 985**	**60 682**	**62 382**	**60 811**	**62 427**	**61 335**	**63 689**
Total NATO (excl. USA)	**8 959**	**12 450**	**15 495**	**15 878**	**14 796**	**14 557**	**15 375**	**15 539**	**14 379**	**15 342**	**15 955**	**16 354**
Total NATO Europe	**8 340**	**11 064**	**13 429**	**13 685**	**12 846**	**12 555**	**13 320**	**13 608**	**12 596**	**13 677**	**14 295**	**14 646**

US $ mn, at 1960 prices and 1960 exchange rates (Final column, X, at current prices and exchange rates)

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	*1970X*
47 335	51 203	50 527	48 821	48 618	57 951	66 886	68 650	65 734	59 319	(56 990)	*77 827*
16 354	17 898	18 408	18 757	18 695	18 831	19 672	19 140	19 034	19 324	(19 814)	*26 493*
63 689	**69 101**	**68 935**	**67 578**	**67 313**	**76 782**	**86 558**	**87 790**	**84 768**	**78 643**	**(76 804)**	*104 320*
27 619	30 238	33 095	31 667	30 476	31 905	34 450	39 780	42 143	42 619	42 619	*42 619*
3 723	4 177	4 461	4 479	4 484	4 847	5 250	6 217	6 979	7 495	7 915	*7 495*
31 342	**34 415**	**37 556**	**36 146**	**34 960**	**36 752**	**39 700**	**45 997**	**49 122**	**50 114**	**50 534**	*50 114*
1 580	1 707	1 747	1 854	1 868	1 909	1 909	1 975	2 047	2 043	(2 089)	*2 966*
956	1 066	1 186	1 425	1 639	1 782	2 312	2 868	3 310	3 891	...	*4 100*
854	1 081	1 643	1 643	1 754	1 777	1 567	1 626	[1 735]	[1 760]	...	*[2 170]*
2 450	2 530	2 320	2 550	2 820	2 935	3 130	3 570	4 160	[4 730]	...	*[5 300]*
[3 300]	[3 800]	[4 300]	[4 800]	[5 500]	[6 000]	[6 500]	[7 000]	[7 500]	[8 000]	...	*[8 000]*
498	512	536	605	735	872	968	1 017	1 018	1 016	(1 006)	*1 293*
420	525	580	710	795	895	950	980	[1 100]	[1 050]	...	*[1 300]*
340	380	380	395	410	435	475	530	[545]	[540]	...	*[595]*
940	1 010	1 030	1 085	1 260	1 245	1 385	1 425	1 490	[1 460]	...	*(2 590)*
106 369	**116 127**	**120 213**	**118 791**	**119 054**	**131 384**	**145 454**	**154 778**	**156 795**	**153 247**	...	*182 748*

US $ mn, at 1960 prices and 1960 exchange rates (Final column, X, at current prices and exchange rates)

1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	*1970X*
51 203	50 527	48 821	48 618	57 951	66 886	68 650	65 734	59 319	(56 990)	(55 049)	*77 827*
1 778	1 653	1 720	1 536	1 576	1 695	1 596	1 507	1 582	(1 544)	...	*2 040*
415	427	459	444	448	471	486	490	522	(538)	...	*702*
200	203	209	220	217	218	233	230	225	(234)	...	*368*
4 182	4 110	4 225	4 293	4 415	4 651	4 645	4 582	4 560	(4 591)	(4 725)	*6 014*
3 894	4 371	4 193	4 131	4 057	4 227	3 746	4 080	4 112	(4 451)	(4 643)	*6 188*
168	172	179	193	210	270	315	357	385	(421)	...	*474*
1 298	1 447	1 482	1 537	1 662	1 623	1 654	1 622	1 710	(1 715)	(1 885)	*2 506*
7	7	9	9	9	7	6	6	7	7	...	*8*
569	575	626	610	594	660	651	680	702	(725)	(786)	*1 103*
178	185	188	217	216	223	247	249	250	(256)	(263)	*389*
191	187	204	204	214	263	277	257	280	(273)	...	*435*
306	303	328	376	338	341	361	360	385	(449)	...	*416*
4 712	4 768	4 935	4 925	4 875	5 023	4 923	4 614	4 604	(4 610)	(4 707)	*5 850*
69 101	**68 935**	**67 578**	**67 313**	**76 782**	**86 558**	**87 790**	**84 768**	**78 643**	**(76 804)**	...	*104 320*
17 898	**18 408**	**18 757**	**18 695**	**18 831**	**19 672**	**19 140**	**19 034**	**19 324**	**(19 814)**	...	*26 493*
16 120	**16 755**	**17 037**	**17 159**	**17 255**	**17 977**	**17 544**	**17 527**	**17 742**	**(18 270)**	...	*24 453*

Table 4A.3. NATO: current price figures

	Currency	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
North America:												
USA	*mn. dollars*	14 559	33 398	47 852	49 621	42 786	40 518	41 773	44 548	45 503	46 614	45 380
Canada	*mn. dollars*	495	1 220	1 875	1 970	1 771	1 819	1 888	1 829	1 740	1 642	1 654
Europe:												
Belgium	*mn. francs*	8 256	13 387	19 965	19 815	19 925	17 067	17 065	18 356	18 312	18 686	19 161
Denmark	*mn. kroner*	359	475	676	889	885	920	936	1 012	938	986	1 113
France	*mn. francs*	5 591	8 811	12 531	13 865	11 710	11 020	14 690	15 600	16 569	17 926	19 162
FR Germany	*mn. marks*	3 498	7 098	7 898	6 195	6 287	7 383	7 211	8 962	6 853	11 087	12 115
Greece	*mn. drachmas*	1 971	2 615	2 655	2 767	3 428	3 688	4 939	4 477	4 469	4 735	5 110
Italy	*bn. lire*	353	457	521	480	543	551	584	611	647	667	710
Luxembourg	*mn. francs*	170	264	436	488	566	614	395	439	429	402	263
Netherlands	*mn. guilders*	901	1 060	1 253	1 330	1 583	1 699	1 854	1 845	1 656	1 505	1 728
Norway	*mn. kroner*	357	572	831	1 067	1 141	953	967	1 049	1 024	1 107	1 058
Portugal	*mn. escudos*	1 516	1 553	1 691	1 975	2 100	2 224	2 297	2 391	2 485	2 820	3 023
Turkey	*mn. lire*	599	652	725	827	936	1 077	1 159	1 266	1 470	2 153	2 405
UK	*mn. pounds*	849	1 149	1 561	1 631	1 569	1 567	1 615	1 574	1 591	1 589	1 655

Table 4A.4. Warsaw Pact: current price figures[a]

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Bulgaria	...	...	139	...	...	...	...	133	149	141	154
Czechoslovakia	1 125	1 236	...	988	918	...	1 071	1 094	1 047	1 035	1 035
German DR	...	...	...	...	...	...	...	...	487	...	[750]
Hungary	...	...	...	...	...	...	...	110	...	144	[175]
Poland	...	232	415	647	666	792	754	634	704	898	936
Romania	...	...	...	...	...	...	...	405	381	365	[380]
USSR	19 731	22 948	25 952	25 666	23 881	25 476	23 167	23 029	22 286	22 310	22 143
Total Warsaw Pact	**22 231**	**25 448**	**28 452**	**28 166**	**26 381**	**27 976**	**25 917**	**25 890**	**25 179**	**25 383**	**25 573**
Total Warsaw Pact (excl. USSR)	**[2 500]**	**[2 500]**	**[2 500]**	**[2 500]**	**[2 500]**	**[2 500]**	**[2 750]**	**2 860**	**2 893**	**3 073**	**3 430**

[a] Albania is included in Other Europe.

Table 4A.5. Warsaw Pact: current price figures[a]

	Currency	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Bulgaria	*mn. new leva*	...	...	161	...	...	...	...	154	173	163	179
Czechoslovakia	*mn. korunas*	9 565	10 506	...	8 400	7 800	...	9 100	9 300	8 900	8 800	8 800
German DR	*mn. marks*	...	...	...	...	...	...	...	...	1 650	...	...
Hungary	*mn. forints*	...	...	...	...	...	...	...	1 912	...	2 500	...
Poland	*mn. zlotys*	...	...	...	10 300	...	12 600	...	10 100	11 200	14 300	14 900
Romania	*mn. lei*	...	...	...	...	...	...	...	3 817	3 597	3 446	...
USSR	*mn. roubles*	8 287	9 638	10 900	11 020	10 030	11 210	9 730	9 672	9 400	9 370	9 300

[a] Albania is included in Other Europe.

Local currency, current prices

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
47 808	52 381	52 295	51 213	51 827	63 572	75 448	80 732	81 443	77 827	77 791	78 170
1 716	1 810	1 712	1 813	1 659	1 766	1 965	1 927	1 899	2 061	2 061	. . .
19 561	21 111	22 230	24 853	25 036	26 313	28 432	30 110	31 488	34 866	37 431	. . .
1 180	1 551	1 651	1 764	1 974	2 080	2 249	2 591	2 640	2 757	3 039	. . .
20 395	22 184	22 849	24 280	25 300	26 732	28 912	30 200	31 700	33 200	35 000	37 828
13 175	17 233	19 924	19 553	19 915	20 254	21 408	19 310	21 577	22 573	25 713	28 158
5 034	5 102	5 385	5 647	6 290	7 168	9 390	11 003	12 762	14 208	16 062	. . .
749	861	1 031	1 118	1 212	1 342	1 359	1 403	1 412	1 562	1 637	1 889
290	355	348	462	477	497	413	374	391	416	456	. . .
2 013	2 186	2 307	2 661	2 714	2 790	3 200	3 280	3 682	3 968	4 346	4 949
1 179	1 371	1 465	1 570	1 897	1 947	2 097	2 399	2 502	2 774	3 001	3 240
4 922	5 744	5 724	6 451	6 680	7 393	9 575	10 692	10 779	12 501	12 773	. . .
2 718	2 930	3 157	3 443	3 821	3 996	4 596	5 159	5 395	6 237	8 111	. . .
1 709	1 814	1 870	2 000	2 091	2 153	2 276	2 332	2 303	2 444	2 697	2 892

US $ mn, at Benoit–Lubell exchange rates

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
187	222	233	224	199	207	228	228	261	279	316	. . .
1 118	1 282	1 329	1 282	1 212	1 282	1 459	1 529	1 635	(1 741)	1 768	1 873
[750]	815	815	815	826	974	1 062	1 711	1 873	1 990	2 124	2 249
205	288	349	346	284	292	313	371	458	513	544	560
1 068	1 156	1 300	1 376	1 482	1 583	1 658	1 828	2 073	2 224	2 368	2 504
[395]	414	435	436	481	509	530	550	679	748	795	832
27 619	30 238	33 095	31 667	30 476	31 905	34 450	39 780	42 143	42 619	42 619	42 619
31 342	**34 415**	**37 556**	**36 146**	**34 960**	**36 752**	**39 700**	**45 997**	**49 122**	**50 144**	**50 534**	. . .
3 723	**4 177**	**4 461**	**4 479**	**4 484**	**4 847**	**5 250**	**6 217**	**6 979**	**7 495**	**7 915**	. . .

Local currency, current prices

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
217	258	270	260	231	240	264	264	303	324	366	. . .
9 500	10 900	11 300	10 900	10 300	10 900	12 400	13 000	13 900	(14 800)	15 030	15 920
. . .	2 764	2 764	2 764	2 800	3 300	3 600	5 800	6 350	6 747	7 200	7 625
3 563	4 998	6 050	6 005	4 926	5 064	5 437	6 439	7 952	8 900	9 440	9 715
17 000	18 400	20 700	21 900	23 600	25 200	26 400	29 100	33 000	35 400	37 700	39 861
. . .	3 900	4 100	4 110	4 540	4 800	5 000	5 187	6 400	7 052	7 495	7 845
11 600	12 700	13 900	13 300	12 800	13 400	14 500	16 700	17 700	17 900	17 900	17 900

Table 4A.6. Other Europe: constant price figures

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Albania[a]	...	...	...	...	...	...	...	...	...	...	[70]	[70]
Austria	25	32	21	20	2	8	41	69	78	77	73	71
Finland	54	67	45	51	53	70	66	64	67	79	83	96
Ireland	20	22	26	29	27	26	24	24	23	24	26	27
Spain	79	78	98	95	103	99	106	112	100	94	111	114
Sweden	340	378	436	489	512	527	532	546	548	566	560	587
Switzerland	135	172	219	195	172	185	166	223	236	231	215	250
Yugoslavia	73	79	435	381	374	328	305	297	316	341	329	365
Total Other Europe	**726**	**828**	**1 280**	**1 260**	**1 243**	**1 243**	**1 240**	**1 335**	**1 368**	**1 412**	**1 467**	**1 580**

[a] Figures for Albania are at current prices and Benoit–Lubell exchange rates.

Table 4A.7. Other Europe: current price figures

	Currency	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Albania	*mn. new leks*	...	...	...	...	...	...	...	...	...	...	...
Austria	*mn. shillings*	383	623	476	443	47	188	1 001	1 714	1 986	1 989	1 893
Finland	*mn. marks*	99	151	107	121	124	163	170	184	206	246	267
Ireland	*mn. pounds*	4.9	5.8	7.5	8.9	8.4	8.1	7.9	8.1	8.3	8.6	9.2
Spain	*mn. pesetas*	2 834	3 037	3 770	3 716	4 105	4 084	4 665	5 441	5 534	5 557	6 688
Sweden	*mn. kronor*	1 138	1 441	1 786	2 026	2 147	2 264	2 389	2 557	2 706	2 820	2 898
Switzerland	*mn. francs*	505	666	880	775	688	750	682	930	1 009	972	924
Yugoslavia	*mn. new dinars*	395	431	1 822	1 674	1 627	1 593	1 580	1 590	1 785	1 956	2 077

Table 4A.8. Middle East: constant price figures

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Cyprus	...	...	...	...	...	...	...	...	...	...	[5.0]	[5.0]
Egypt	92.8	88.8	95.2	108.9	142.8	216.2	249.3	222.7	204.1	204.1	225.9	256.6
Iran	66.5	63.4	60.0	56.9	64.7	90.0	105.7	127.2	202.7	226.7	182.9	181.0
Iraq	21.8	22.5	31.9	47.1	53.1	53.2	75.1	82.4	88.5	103.1	118.7	123.5
Israel	49.2	78.0	49.9	39.7	35.8	38.6	77.1	109.2	122.5	138.8	163.1	163.1
Jordan	16.6	27.9	29.2	31.2	31.8	32.3	38.5	39.3	45.9	57.2	53.5	52.3
Kuwait[a]	...	...	...	...	...	...	...	...	...	...	[5.0]	[5.0]
Lebanon[b]	5.7	6.5	6.4	8.2	8.8	10.7	14.3	13.8	15.5	14.2	15.2	17.9
Saudi Arabia[c]	...	...	...	...	...	...	...	...	...	...	[50.0]	72.0
Syria	24.2	21.2	20.0	27.1	25.5	27.9	48.1	39.8	71.3	70.1	70.1	71.6
Yemen[d]	...	...	...	...	...	...	...	...	...	...	[7.0]	[7.0]
Total Middle East	**[300]**	**[330]**	**[320]**	**[350]**	**[390]**	**[500]**	**[640]**	**[670]**	**[790]**	**[870]**	**900**	**956**

[a] Figures for Kuwait are at current prices and 1960 exchange rates.
[b] Figures for Lebanon are deflated by the wholesale price index, base year 1963.
[c] Figures for Saudi Arabia are at current prices, fiscal years, and 1960 exchange rates.
[d] Figures for Yemen are at current prices.

US $ mn, at 1960 prices and 1960 exchange rates (Final column, X, at current prices and exchange rates)

1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	*1970X*
[70]	[70]	71	73	69	69	77	106	119	128	141	*119*
74	90	114	94	107	109	110	113	115	(110)	(111)	*165*
135	108	106	108	106	104	120	109	113	(120)	. . .	*140*
27	29	28	28	29	30	31	33	38	(38)	. . .	*52*
133	137	139	138	162	191	188	190	181	(197)	. . .	*283*
632	673	708	750	757	738	740	777	747	(739)	(783)	*1 113*
277	278	312	314	330	322	317	327	329	(334)	(350)	*456*
359	362	376	363	349	346	392	392	401	(405)	(485)	*638*
1 707	**1 747**	**1 854**	**1 868**	**1 909**	**1 909**	**1 975**	**2 047**	**2 043**	**(2 089)**	. . .	*2 966*

Local currency, current prices

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
. . .	. . .	. . .	282	288	272	272	304	420	471	508	558
1 890	2 076	2 608	3 408	2 957	3 474	3 661	3 775	4 006	4 263	4 193	4 449
314	460	383	417	446	456	471	589	549	586	646	. . .
9.9	10.5	11.3	11.5	12.4	13.0	14.2	14.9	17.4	21.6	23.1	. . .
6 968	8 586	9 609	10 460	11 736	14 704	18 368	19 026	19 597	19 701	23 160	. . .
3 107	3 500	3 839	4 173	4 646	4 990	5 072	5 176	5 596	5 755	5 936	6 560
1 096	1 264	1 316	1 521	1 586	1 746	1 770	1 787	1 889	1 969	2 088	2 295
2 477	2 701	2 862	3 321	4 305	5 070	5 381	6 406	6 933	7 976	8 838	11 180

US $ mn, at 1960 prices and 1960 exchange rates (Final column, X, at current prices and exchange rates)

1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	*1970X*
[6.0]	[7.0]	7.6	9.1	7.7	8.7	7.3	6.8	7.0	. . .	. . .	*6.5*
288.9	317.1	395.4	431.7	444.6	547.9	695.1	872.6	1 043.9	(1 163.0)	(1 145.2)	*1209.8*
180.1	183.0	201.2	250.1	285.8	366.3	465.7	536.9	619.5	(686.7)	. . .	*735.3*
132.2	153.6	181.2	218.3	223.7	231.3	271.5	250.6	202.4	. . .	. . .	*251.5*
183.7	228.1	316.0	375.0	458.0	589.0	742.0	936.0	1 268.0	(1 456.0)	(1 621.0)	*1120.0*
55.9	56.5	55.6	55.8	66.5	89.9	107.7	99.9	76.4	. . .	. . .	*97.5*
[10.0]	[20.0]	28.0	30.5	35.0	54.3	63.3	68.9	70.0	80.4	. . .	*70.0*
25.4	21.3	23.2	26.8	33.0	35.7	38.2	37.2	45.1	(42.2)	. . .	*52.9*
98.0	109.0	116.0	131.0	134.0	286.0	321.0	343.0	387.0	382.0	. . .	*387.0*
78.8	82.3	90.6	99.2	81.2	89.9	141.8	143.7	157.8	. . .	. . .	*155.1*
[7.0]	[8.0]	[10.0]	[11.0]	[12.0]	[13.0]	[14.0]	[14.0]	[14.0]	. . .	. . .	*[14.0]*
1 066	**1 186**	**1 425**	**1 639**	**1 782**	**2 312**	**2 868**	**3 310**	**3 891**	. . .	. . .	*4 100.0*

Table 4A.9. Middle East: current price figures

	Currency	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Cyprus	*mn. pounds*	...	...	...	...	...	...	...	...	...	...	...
Egypt	*mn. pounds*	31	33	35	37	47	71	83	78	71	70	78
Iran	*mn. rials*	2 477	2 477	2 533	2 545	3 430	4 905	6 167	7 898	12 589	15 629	13 857
Iraq	*mn. dinars*	7.0	7.7	11.8	15.2	16.7	17.2	25.8	29.7	31.0	35.8	42.4
Israel	*mn. pounds*	28	49	49	49	50	57	122	183	212	243	294
Jordan	*mn. dinars*	5.0	8.6	9.1	9.9	10.2	10.5	12.8	13.4	15.9	20.1	19.1
Kuwait	*mn. dinars*	...	...	...	...	...	...	...	...	...	...	...
Lebanon	*mn. pounds*	14.6	17.9	17.6	21.2	21.7	26.7	38.0	39.1	45.6	43.0	47.8
Saudi Arabia[a]	*mn. rials*	...	...	...	...	...	...	...	...	...	...	...
Syria	*mn. pounds*	68	69	70	87	76	82	161	140	234	237	251

[a] Figures for Saudi Arabia are for fiscal years.

Table 4A.10. South Asia: constant price figures

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Afghanistan[a]	...	...	...	...	...	...	...	...	...	...	7.4
Ceylon	1.2	2.2	2.9	4.0	6.5	6.0	7.2	9.8	13.8	15.0	15.0
India	452.0	452.0	475.0	470.0	503.0	524.0	624.0	567.0	621.0	577.0	582.0
Nepal[b]	...	...	...	...	...	...	...	...	...	...	2.6
Pakistan	186.0	219.0	246.0	193.0	170.0	200.0	192.0	159.0	166.0	195.0	205.0
Total South Asia	**[650.0]**	**[680.0]**	**[730.0]**	**[680.0]**	**[690.0]**	**[740.0]**	**[830.0]**	**[750.0]**	**[810.0]**	**[800.0]**	**812.0**

[a] Figures for Afghanistan are at 1964 prices and exchange rates.
[b] Figures for Nepal are at 1964 prices and exchange rates.
[c] 1969.
[d] 1968.

Table 4A.11. South Asia: current price figures

	Currency	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Afghanistan	*mn. afghanis*	...	...	...	...	...	...	...	...	...	...
Ceylon	*mn. rupees*	5.4	10.6	13.8	19.0	30.2	27.4	32.8	45.9	66.2	71.9
India	*mn. rupees*	1 748	1 833	1 878	1 926	1 969	1 932	2 118	2 665	2 797	2 699
Nepal	*mn. rupees*	...	...	...	...	...	...	...	...	...	...
Pakistan	*mn. rupees*	662	812	935	817	705	787	793	718	771	878

Local currency, current prices

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
...	...	...	2.7	3.3	2.8	3.1	2.7	2.6	2.7	...	...
91	100	110	143	178	200	248	327	424	526	602	625
14 137	14 170	14 469	16 523	20 941	23 850	31 075	39 750	47 300	55 700	64 819	...
44.8	48.2	58.3	67.9	81.0	83.9	88.9	105.8	106.5	89.8	...	...
313	386	511	746	952	1 255	1 642	2 101	2 730	3 920	4 958	5 797
18.9	20.6	21.1	21.1	21.5	26.0	35.7	42.6	42.6	34.8	...	...
...	...	...	10.0	10.9	12.5	19.4	22.6	24.6	25.0	28.7	...
56.4	80.6	68.9	76.6	90.1	114.3	128.4	136.0	139.1	171.8	166.2	...
324	441	490	522	589	603	1 287	1 444	1 545	...	1 723	...
261	279	297	346	365	316	366	587	600	670	...	...

US $ mn, at 1960 prices and 1960 exchange rates (Final column, X, at current prices and exchange rates)

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	*1970X*
[8.0]	[10.0]	[10.0]	12.6	12.7	11.3	9.6	11.6	11.4	11.8	...	*31.1*
15.2	13.9	11.9	11.6	12.0	12.7	13.1	13.9	14.2	[14.5]	...	*14.3*[c]
625.0	862.0	1 409.0	1 380.0	1 346.0	1 307.0	1 179.0	1 225.0	1 301.7	1 298.4	(1 374.4)	*1 511.9*
[3.0]	[3.0]	3.6	3.3	3.4	3.7	4.5	5.0	[5.0]	[5.5]	...	*6.8*[d]
202.8	192.5	208.3	235.3	379.6	442.6	360.5	370.7	404.1	425.9	(457.0)	*603.4*
854.0	**1 081.0**	**1 643.0**	**1 643.0**	**1 753.7**	**1 777.3**	**1 566.7**	**1 626.2**	**[1 735.0]**	**[1 760.0]**	...	[*2 170.0*]

Local currency, current prices

1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
552	...	...	...	907	1 019	1 087	1 150	(1 229)	1 325	1 400	...
71.3	73.2	67.8	59.5	59.6	62.0	65.4	69.1	78.0	85.1	...	...
2 774	3 046	4 336	7 306	8 084	8 651	9 279	9 535	10 170	10 868	11 398	12 193
21.4	...	...	35.1	37.7	41.9	51.9	61.1	69.1	...	...	...
978	984	938	1 029	1 208	2 059	2 575	2 240	2 307	2 594	2 881	3 200

Table 4A.12. Far East: constant price figures

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Burma[a]	25.3	32.3	49.0	70.3	87.9	76.9	76.3	76.1	85.1	96.6	89.2	82.9
Cambodia	...	...	...	...	...	...	...	...	...	...	[35.0]	43.0
Hong Kong	...	...	...	...	...	...	...	...	...	...	[8.0]	[8.0]
Indonesia	...	347.5	...	377.7	337.4	266.3	264.2	329.5	419.4	418.8	484.8	540.7
Japan	...	423.7	441.1	502.3	484.8	457.1	451.7	446.6	451.0	462.3	455.9	472.7
Korea, North	...	...	...	...	...	...	...	...	...	...	[200.0]	[225.0]
Korea, South	...	...	66.8	154.4	185.4	150.8	145.4	187.0	220.2	233.6	227.1	236.9
Laos	...	...	...	...	...	...	...	...	...	...	[20.0]	[20.0]
Malaysia	3.1	28.4	46.1	64.4	58.5	52.5	47.9	50.0	52.2	46.0	42.9	36.3
Mongolia[b]	...	...	...	...	...	...	...	...	...	...	[15.0]	[15.0]
Philippines	54.4	67.9	82.8	83.9	80.1	78.4	79.0	80.9	84.7	87.6	87.1	89.8
Singapore[c]	...	...	...	...	...	...	...	...	...	...	[8.0]	[8.0]
Taiwan	...	...	...	66.5	80.0	110.9	114.4	126.2	207.2	219.2	203.3	214.2
Thailand	22.3	31.0	52.0	53.3	52.3	45.8	41.2	74.1	62.4	66.2	65.2	68.8
Viet-Nam, North	...	...	...	...	...	...	...	...	...	...	[200.0]	[225.0]
Viet-Nam, South	...	...	...	...	...	...	...	...	...	...	157.0	162.0
Total Far East	**[1 120.0]**	**[1 400.0]**	**[1 420.0]**	**[1 650.0]**	**[1 670.0]**	**[1 570.0]**	**[1 590.0]**	**[1 790.0]**	**[2 050.0]**	**[2 180.0]**	**[2 300.0]**	**[2 450.0]**

[a] Figures for Burma are at current prices and 1960 exchange rates.
[b] Figures for Mongolia are at current prices and 1960 exchange rates.
[c] Figures for Singapore are at 1963 prices and exchange rates.

Table 4A.13. Far East: current price figures

	Currency	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Burma	*mn. kyats*	122.2	152.7	222.3	308.9	369.6	338.0	357.3	378.3	406.5	410.8	426.3
Cambodia	*mn. riels*	...	...	...	...▌	...	...	...	...	...	...	...
Indonesia	*bn. rupiah*	...	3.3	...	3.9	3.6	3.9	4.4	6.1	11.1	14.1	21.7
Japan	*bn. yen*	...	118.5	131.0	157.6	162.0	151.3	149.5	152.3	153.8	159.3	163.3
Korea, North	*mn. won*	...	...	...	...	...	...	...	...	...	...	...
Korea, South	*bn. won*	...	...	0.8	2.7	4.4	6.0	7.1	11.3	12.8	14.0	14.8
Laos	*mn. kips*	...	...	...	...	...	...	...	...	...	...	...
Malaysia	*mn. dollars*	8.6	97.5	160.9	210.1	184.4	160.5	148.1	160.6	166.2	142.3	131.3
Mongolia	*mn. tugriks*	...	...	...	...	...	...	...	...	...	...	...
Philippines	*mn. pesos*	113.6	153.6	174.6	171.9	162.3	157.2	161.6	169.1	182.4	186.9	193.4
Singapore	*mn. dollars*	...	...	...	...	...	...	...	...	...	...	...
Taiwan	*bn. dollars*	...	...	...	1.5	...	2.8	3.2	3.8	6.3	7.4	8.1
Thailand	*mn. baht*	297.5	455.5	844.4	961.0	943.6	855.2	816.7	1 566.7	1 389.7	1 420.5	1 378.4
Viet-Nam, North	*mn. dong*	...	...	...	...▌	...	...	...	...	...	...	...
Viet-Nam, South	*bn. piastres*	...	...	...	...▌	...	...	...	...	...	...	5.5

Table 4A.14. Oceania: constant price figures

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Australia	299	434	511	501	454	470	458	422	417	423	419
New Zealand	43	62	84	95	82	77	77	74	74	75	77
Total Oceania	**342**	**496**	**595**	**596**	**536**	**547**	**535**	**496**	**491**	**498**	**496**

US $ mn, at 1960 prices and 1960 exchange rates (Final column, X, at current prices and exchange rates)

1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	*1970X*
89.5	101.0	97.6	108.3	105.1	101.7	102.9	108.7	112.2	...	...	*112.2*
45.1	43.2	47.1	42.6	44.0	46.6	50.0	49.2	(123.2)	(229.0)	...	*119.5*
[8.0]	[8.0]	[9.5]	[10.0]	[10.0]	[10.0]	[10.0]	[10.0]	[10.0]	...	...	*[10.0]*
362.2	265.4	204.8	182.5	[200.0]	230.3	181.4	379.5	(434.9)	...	...	*(272.0)*
517.2	390.0	552.5	623.1	657.8	716.5	748.6	807.2	876.3	(973.4)	(1 130)	*1 535.2*
[250.0]	[275.0]	[300.0]	[350.0]	[400.0]	[450.0]	[600.0]	[600.0]	[700.0]	...	...	*745.0*
273.9	226.5	213.0	224.7	274.8	304.6	360.2	412.4	427.3	(485.2)	...	*320.6*
24.6	17.7	9.9	16.1	18.6	18.7	18.8	(18.8)	(20.8)	...	...	*(46.0)*
36.6	49.2	68.9	97.1	119.6	110.9	114.6	112.0	114.8	(119.9)	...	*123.7*
[15.0]	[20.0]	[20.0]	[20.0]	[20.0]	[20.0]	[20.0]	[20.0]	(22.5)	...	...	*(22.5)*
86.7	87.0	83.4	91.4	111.5	123.4	145.7	173.5	206.3	...	...	*181.8*
[8.0]	[10.0]	[15.0]	[20.0]	[20.0]	23.1	28.7	84.3	100.4	134.9	...	*107.8*
245.5	249.4	267.6	285.5	236.1	232.7	235.4	(284.0)	348.0	(426.4)	...	*481.3*
72.0	74.2	78.7	86.2	91.1	104.8	125.6	154.3	194.5	...	...	*239.0*
[250.0]	[275.0]	[300.0]	[350.0]	[400.0]	[450.0]	[500.0]	[500.0]	[500.0]	...	...	*[500.0]*
248.0	231.0	283.0	313.0	227.0	186.0	327.0	442.1	543.5	(590.1)	...	*480.0*
[2 530.0]	**[2 320.0]**	**[2 550.0]**	**[2 820.0]**	**[2 935.0]**	**[3 130.0]**	**[3 570.0]**	**[4 160.0]**	**[4 730.0]**	...	...	*[5 300.0]*

Local currency, current prices

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
408.0	431.9	477.7	466.3	517.4	502.2	485.9	491.8	519.5	535.9	...	...
1 610.0	1 736.0	1 764.0	1 964.0	1 845.0	1 895.0	1 992.0	2 264.0	2 370.0	(6 636.0)	(18 650.0)	...
31.7	57.4	91.4	144.7	521.9	...	20 325.0	36 070.0	80 000.0	103 000.0	...	...
178.3	208.6	169.1	249.0	299.1	332.0	376.0	414.0	471.0	549.0	645.0	785.0
...	...	...	...	...	...	...	1 617.0	1 798.0	1 918.0	2 183.0	...
16.7	20.5	20.5	24.9	29.9	40.7	50.0	65.5	84.3	101.3	129.0	...
...	2 280.0	3 144.0	3 480.0	6 384.0	8 400.0	9 120.0	9 600.0	(9 900.0)	[11 000.0]	...	...
110.9	112.0	154.9	217.0	303.0	380.8	366.6	379.3	367.0	381.0	411.0	...
...	...	...	100	100	100	80	(80)	80	90	...	...
201.5	207.7	219.3	227.1	260.0	330.8	391.1	464.6	571.2	708.9	...	...
...	...	...	...	...	...	76.0	95.0	278.0	332.0	454.0	...
9.2	10.8	11.2	12.0	12.8	10.2	11.0	12.0	15.2	19.3	24.5	...
1 473.0	1 580.0	1 643.0	1 777.6	1 964.0	2 150.8	2 575.2	3 151.7	3 953.4	5 019.4	...	...
...	...	...	(882.0)	(1 103.0)	(882.0)	(1 323.0)	(1 470.0)	(1 500.0)	...	...	...
6.0	9.5	9.5	12.0	15.5	18.1	21.4	47.7	(78.6)	132.0	155.0	...

US $ mn, at 1960 prices and 1960 exchange rates (Final column, X, at current prices and exchange rates)

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	*1970X*
425	441	465	521	641	772	873	928	930	927	(914)	*1 190*
73	71	71	84	94	100	95	89	88	89	(92)	*103*
498	**512**	**536**	**605**	**735**	**872**	**968**	**1 017**	**1 018**	**1 016**	**(1 006)**	*1 293*

Table 4A.15. Oceania: current price figures

	Currency	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Australia	*mn. dollars*	152	265	368	373	342	362	372	354	352	365
New Zealand	*mn. dollars*	20	32	47	55	50	48	50	49	50	54

Table 4A.16. Africa: constant price figures

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Algeria[a]	...	...	...	...	...	...	...	...	...	...	...
Burundi	...	...	...	...	...	...	...	...	...	...	...
Cameroon	...	...	...	...	...	...	...	...	...	...	8.9
Central African Rep.[a]	...	...	...	...	...	...	...	...	...	...	...
Chad	...	...	...	...	...	...	...	...	...	...	...
Congo (Brazzaville)	...	...	...	...	...	...	...	...	...	...	...
Dahomey[a]	...	...	...	...	...	...	...	...	...	...	...
Ethiopia	...	...	...	...	...	...	...	...	...	10.0	15.0
Gabon	...	...	...	...	...	...	...	...	...	...	[0.5]
Ghana	...	...	...	...	...	...	...	7.0	7.2	8.3	14.6
Guinea[a]	...	...	...	...	...	...	...	...	...	...	[3.0]
Ivory Coast	...	...	...	...	...	...	...	...	...	...	[2.0]
Kenya	...	...	...	...	...	...	5.3	5.7	5.0	4.6	2.6
Liberia[b]	...	...	...	...	...	...	...	...	...	1.1	[1.4]
Libya	...	...	...	...	...	...	...	...	...	4.0	3.9
Malagasy Rep.	...	...	...	...	...	...	...	...	...	...	0.4
Malawi[a]	...	...	...	...	...	...	...	...	...	...	...
Mali[a]	...	...	...	...	...	...	...	...	...	...	[2.0]
Mauritania	...	...	...	...	...	...	...	...	...	...	[1.0]
Mauritius	...	...	...	...	...	...	...	0.4	0.4	0.4	0.3
Morocco	...	...	...	...	...	...	...	...	...	...	41.6
Niger	...	...	...	...	...	...	...	...	...	...	[0.6]
Nigeria	...	...	...	...	...	...	...	...	...	...	16.0
Rhodesia and Nyasa-land, Fed. of	...	...	...	...	...	7.8	10.2	11.5	12.0	17.2	15.4
Rhodesia, S.	...	...	...	...	...	...	...	...	...	...	...
Senegal	...	...	...	...	...	...	...	...	...	...	[1.5]
Sierra Leone	...	...	...	...	...	...	...	...	...	...	2.1
Somalia	...	...	...	...	...	...	...	...	...	...	[1.5]
South Africa	41.5	75.7	79.6	68.0	64.0	66.5	74.3	76.9	58.0	41.4	61.6
Sudan	7.1	5.4	4.8	5.8	7.3	8.5	8.7	11.8	14.3	17.6	17.6
Tanzania	...	...	...	...	...	...	...	...	...	...	...
Togo[a]	...	...	...	...	...	...	...	...	...	...	[0.1]
Tunisia	...	...	...	...	...	...	4.1	5.9	10.0	15.4	17.6
Uganda	...	...	...	...	...	...	...	...	...	...	...
Upper Volta[a]	...	...	...	...	...	...	...	...	...	...	1.3
Zaïre[c]	...	...	...	...	...	...	...	...	...	...	...
Zambia	...	...	...	...	...	...	...	...	...	...	...
Total Africa	**[50.0]**	**[90.0]**	**[90.0]**	**[80.0]**	**[80.0]**	**[90.0]**	**[130.0]**	**[150.0]**	**[170.0]**	**[210.0]**	**[350.0]**

[a] At current prices and 1960 exchange rates.
[b] Figures for Liberia are at 1964 prices and 1964 exchange rates.
[c] Figures for Zaïre are at 1963 prices and 1963 exchange rates.
[d] 1969.
[e] 1968.

Local currency, current prices

1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
376	391	406	431	494	629	783	914	998	1 029	1 065	1 103
56	53	53	55	67	77	84	85	83	86	93	103

US $ mn, at 1960 prices and 1960 exchange rates. (Final column, X, at current prices and exchange rates)

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	*1970X*
...	[70.0]	79.0	(99.3)	(99.3)	(99.3)	(99.3)	(99.3)	(99.3)	(99.3)	(99.3)	*99.3*
...	1.6	1.8	2.0	2.9	3.1	3.7	3.9	4.8	...	...	*3.9*[d]
11.1	14.7	13.3	12.6	12.9	13.9	14.7	15.0	15.8	15.8	(15.9)	*20.2*
...	1.0	1.0	2.0	2.3	2.4	3.8	4.5	[5.0]	[5.0]	...	*4.5*[e]
...	1.2	1.3	1.5	2.6	4.2	4.3	4.4	5.3	...	...	*7.0*[d]
[2.0]	3.3	[3.6]	4.0	3.8	5.6	6.3	6.2	6.4	...	...	*8.4*[d]
2.5	3.4	3.9	4.6	5.1	4.8	5.1	(4.8)	4.5	...	...	*4.0*[d]
18.2	19.2	20.9	22.9	27.9	30.4	31.2	29.9	27.3	24.0	(23.0)	*36.2*
[1.0]	1.4	2.2	1.7	2.5	2.4	2.3	2.3	2.6	...	...	*3.1*[d]
20.6	19.7	17.6	15.9	14.2	13.6	22.3	24.6	22.8	...	...	*46.7*[d]
[4.0]	5.9	6.0	5.0	11.0	13.0	14.0	14.0	[14.0]	...	...	*14.0*[e]
[5.0]	8.0	7.3	10.0	11.2	11.1	13.8	13.3	12.4	...	...	*14.8*[d]
0.9	0.7	1.8	5.6	9.0	11.3	13.7	13.9	14.5	15.9	...	*19.0*
[1.7]	[2.0]	2.4	2.6	2.8	2.7	3.0	2.5	2.7	...	...	*3.4*[d]
4.9	11.1	12.1	13.5	17.2	32.8	26.8	27.3	29.6	49.7	(55.3)	*74.5*
0.8	[2.7]	4.6	8.1	9.1	9.5	10.2	10.7	10.9	...	...	*12.2*[d]
...	...	...	1.0	1.3	1.3	1.6	1.6	1.7	1.8	...	*1.5*
[5.0]	9.2	9.7	10.6	10.9	10.3	10.8	11.6	[12.0]	...	...	*5.8*[e]
[2.0]	2.4	3.5	1.6	1.6	3.1	4.5	5.9	[6.0]	...	...	*8.0*[e]
0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	[0.3]	...	...	*0.3*[e]
47.4	50.4	66.2	59.4	51.9	56.3	58.9	68.6	64.7	66.7	...	*83.6*
1.1	1.1	1.5	1.6	1.8	2.0	2.2	2.7	2.5	...	...	*3.3*[d]
21.9	29.0	38.8	47.4	54.4	48.2	72.4	96.0	219.2	110.2	(123.5)	*169.4*
22.3	24.2	[19.0]	—	—	—	—	—	—	—	—	
...	...	...	13.1	15.7	15.2	17.2	17.8	18.9	19.9	...	*24.4*
[3.0]	[6.0]	8.1	9.5	12.8	12.4	12.4	12.4	13.5	14.4	(14.7)	*16.5*
1.7	1.9	2.0	2.1	2.2	1.7	1.8	2.1	2.3	(2.3)	(2.3)	*3.0*
2.9	3.4	4.0	4.3	3.6	4.7	5.4	5.8	5.9	7.3	...	*11.2*
89.5	151.3	158.1	223.6	229.2	248.3	276.3	275.7	284.8	284.6	(329.7)	*358.7*
17.6	17.9	19.7	20.0	26.7	37.8	38.5	46.4	54.2	(69.9)	...	*94.5*
[0.6]	1.4	2.5	4.7	6.5	7.4	8.6	9.2	(10.3)	...	...	*12.3*[d]
0.3	0.6	0.9	2.8	2.8	2.4	2.6	2.7	3.2	3.4	...	*3.1*
19.7	15.7	16.4	19.1	15.4	17.7	16.4	20.0	19.2	(21.4)	...	*22.5*
...	0.7	2.7	4.9	8.4	11.5	12.8	15.7	13.9	...	...	*19.6*[d]
1.6	4.9	5.2	5.3	3.5	3.9	3.9	3.8	4.2	...	...	*3.8*[d]
[40.0]	[40.0]	44.5	60.7	98.3	137.0	117.2	91.1	88.4	106.3	(120.8)	*69.4*
...	...	...	5.7	14.9	14.2	15.5	17.0	12.7	...	...	*18.6*[d]
[420.0]	**[525.0]**	**[580.0]**	**[710.0]**	**[795.0]**	**[895.0]**	**950.0**	**980.0**	**[1 100.0]**	**[1050.0]**	...	**[*1 300.0*]**

Table 4A.17. Africa: current price figures

	Currency	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Algeria	*mn. dinars*	...	...	...	...	...	...	...	...	...	...
Burundi	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Cameroon	*bn. francs*	...	...	...	...	...	...	...	...	...	...
Central African Rep.	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Chad	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Congo (Brazzaville)	*mn. francs*	...	...	...	...	...	...	...	...	...	69
Dahomey	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Ethiopia	*mn. dollars*	...	...	...	...	...	...	...	...	...	26.6
Gabon	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Ghana	*mn. cedis*	...	...	...	...	...	3.6	5.6	6.9	7.1	8.4
Guinea	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Ivory Coast	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Kenya	*mn. pounds*	...	...	...	...	...	...	1.8	2.0	1.8	1.6
Liberia	*mn. dollars*	...	...	...	...	...	...	...	...	...	1.0
Libya	*mn. pounds*	...	...	...	...	...	...	...	...	...	1.4
Malagasy Rep.	*bn. francs*	...	...	...	...	...	...	...	...	...	...
Malawi	*mn. pounds*	...	...	...	...	...	...	...	...	...	...
Mali	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Mauritania	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Mauritius	*mn. rupees*	...	...	...	...	...	...	...	2.0	2.0	2.0
Morocco	*mn. dirhams*	...	...	...	...	...	...	...	...	...	...
Niger	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Nigeria	*mn. pounds*	0.8	0.8	0.8	1.3	...	1.4	1.5	1.8	4.2	5.2
Rhodesia and Nyasaland, Fed. of[a]	*mn. pounds*	...	...	...	...	...	2.6	3.5	4.1	4.4	6.4
Rhodesia, S.	*mn. pounds*	...	...	...	...	...	...	...	...	...	...
Senegal	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Sierre Leone	*mn. leones*	...	...	...	...	...	...	...	...	...	...
Somalia	*mn. shillings*	...	...	...	...	...	...	...	...	...	...
South Africa	*mn. rands*	21.0	41.0	47.0	42.0	40.0	42.0	48.0	52.0	40.0	29.0
Sudan	*mn. pounds*	1.6	1.4	1.5	1.7	2.4	2.8	2.8	3.8	5.0	5.5
Tanzania	*mn. pounds*	...	...	...	...	...	...	...	...	...	...
Togo	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Tunisia	*mn. dinars*	...	...	...	...	...	...	1.8	2.5	4.4	6.6
Uganda	*mn. pounds*	...	...	...	...	...	0.7	0.8	0.7	0.7	0.7
Upper Volta	*mn. francs*	...	...	...	...	...	...	...	...	...	...
Zaïre[b]	*mn. zaïres*	...	...	...	...	...	...	...	...	...	...
Zambia	*mn. kwachas*	...	...	...	...	...	...	...	...	...	...

[a] Former federation of the present states of Malawi, Southern Rhodesia and Zambia; dissolution 31 December 1963.

[b] Former Congo (Kinshasa).

Local currency, current prices

1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
...	...	...▌	392	(490)	(490)	(490)	(490)	(490)	(490)	(490)	(490)
...	...	85.9▌	99.9	118.9	181.9	199.8	239.0	268.0	345.1	...	...
2.2▌	2.8	3.8	3.8	3.8	4.0	4.4	4.8	5.0	5.3	5.6	5.9
...▌	203	247	247	494	571	588	946	1 109	...	...	...
...▌	4	319	367	441	820	1 426	1 476	1 540	1 934	...	...
98▌	...	1 070	...	1 235	1 235	1 910	2 218	2 275	2 336	...	...
...▌	610	829	968	1 145	1 261	1 194	1 256	(1 174)	1 099	...	...
37.3	45.1	49.2	54.4	61.2	83.8	101.3	105.3	101.1	93.5	90.5	91.1
...▌	...	371	618	494	741	741	741	741	860	...	...
14.9	21.9	23.5	21.9	22.2	25.4	25.5	39.0	47.2	47.7	...	...
...	...	1 457	1 482	1 235	2 717	3 211	3 458	3 458	...	...	...
...▌	...	2 148	1 976	2 742	3 162	3 236	4 125	4 199	4 100	...	...
0.9	0.3	0.3	0.7▌	2.1	3.5	4.7	5.7	5.8	6.1	6.8	...
...	...	...	2.4	2.6	2.8	2.8	3.3	2.8	3.4	...	...
1.4	1.8	4.2	4.7	5.4	7.3	15.0	12.7	13.5	15.9	26.6	30.0
0.1▌	0.2	...	1.2	2.2	2.6	2.8	3.0	3.2	3.4	...	...
...	...	...	...	0.3▌	0.5	0.5	0.6	0.6	0.6	0.6	...
...▌	...	2 270	2 393	2 621	2 697	2 553	2 676	2 871	(3 000)	...	...
...▌	...	...	988	494	494	988	1 482	1 976	...	...	...
1.5	1.2	1.4	1.5	1.5	1.5	1.5	1.5	1.5▌	(1.5)	...	...
210.5	244.3	272.5	379.0	354.2	319.7	343.8	356.0	416.7	405.0	422.7	...
...▌	...	302	430	463	541	687	778	902	921	...	...
5.7▌	8.3	11.4	15.2	19.0	22.7	21.9	31.6	42.3	106.3	60.5	75.0
5.5	8.6	9.5	—	—	—	—	—	—	—	—	—
...	...	...	...	5.1▌	6.3	6.3	7.2	7.6	8.1	8.7	...
...▌	...	...	2 223	2 717	3 705	3 705	3 705	3 705	(4 231)	4 569	4 823
1.5	1.3▌	1.4	1.5	1.7	1.9	1.6	1.7	2.0	2.3	(2.5)	2.6
...▌	22.6	26.4	32.0	38.6	36.9	46.4	53.8	59.6	64.3	80.2	...
44.0	65.0	111.5	117.7	170.8	181.6	203.8	234.3	237.8	252.6	257.3	301.7
6.1	6.7	6.9	7.9	8.3	10.9	15.7	17.7	19.3	25.3	32.9	...
...	...▌	0.5	0.9	1.7	2.5	2.9	3.5	3.9	4.4	...	...
...▌	66.3	144.3	228.6	682.2	678.4	583.5	635.5	662.2	779.6	849.1	...
7.4	8.6	6.6	7.1	8.6	7.4	8.8	8.4	10.5	(10.5)	...	...
0.4	0.1	0.3▌	1.0	2.0	3.9	5.1	6.0	7.1	7.0	...	...
311▌	403	1 201	1 294	1 313	860	960	960	(940)	1 045	...	...
...▌	...	...	3.3	6.1	9.7	15.7	18.3	21.8	24.0	30.0	34.7
...	...	...	...	4.2▌	12.0	12.6	14.4	17.5	13.3	...	...

Table 4A.18. Central America: constant price figures

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Costa Rica	1.4	1.9	2.0	2.0	2.2	2.2	2.2	2.5	2.4	5.7	5.8
Cuba[a]	...	...	...	...	...	...	...	...	...	...	[175.0]
Dominican Republic	...	...	...	...	...	...	...	...	33.5	41.7	33.4
El Salvador	5.2	5.4	6.6	6.9	6.6	6.6	7.0	8.0	7.5	6.2	6.1
Guatemala	5.5	5.4	6.3	6.2	5.8	7.2	8.2	8.6	9.2	9.6	9.6
Haiti	...	3.4	3.6	5.1	4.5	4.4	4.8	4.8	6.2	6.6	5.5
Honduras	3.2	3.3	3.7	3.4	3.3	3.1	4.6	4.5	5.0	4.6	4.1
Mexico	56.4	58.3	55.2	62.8	50.0	56.9	64.2	76.0	74.4	74.8	81.7
Nicaragua	...	...	...	...	...	...	...	7.4	5.9	6.2	6.7
Panama	...	...	...	...	...	...	...	...	...	...	[1.0]
Total Central America	**[270.0]**	**[270.0]**	**[270.0]**	**[280.0]**	**[260.0]**	**[270.0]**	**[280.0]**	**[300.0]**	**[300.0]**	**[310.0]**	**[330.0]**

[a] Figures for Cuba are at current prices.
[b] 1965.
[c] 1969.
[d] 1968.

Table 4A.19. Central America: current price figures

	Currency	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Costa Rica	*mn. colones*	6.8	9.6	9.8	9.9	11.2	11.6	12.0	13.6	13.2	13.3
Cuba	*mn. pesos*	...	...	...	...	...	...	...	...	...	...
Dominican Republic	*mn. pesos*	...	...	...	...	...	...	...	...	34.5	42.6
El Salvador	*mn. colones*	9.9	11.9	12.7	15.4	14.5	16.4	17.4	19.2	19.0	15.6
Guatemala	*mn. quetzales*	5.1	5.6	6.0	6.0	6.7	8.0	8.8	9.3	9.8	9.8
Haiti	*mn. gourdes*	17.7	19.8	22.9	26.3	25.7	25.9	27.2	29.7	35.0	34.4
Honduras	*mn. lempiras*	5.7	6.4	6.5	6.1	6.4	6.4	9.3	8.9	9.1	9.3
Mexico	*mn. pesos*	346	398	435	479	405	533	632	792	862	883
Nicaragua	*mn. cordobas*	...	...	...	...	...	...	...	...	...	...
Panama	*mn. balboas*	...	...	...	...	...	...	...	...	...	...

Table 4A.20. South America: constant price figures

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Argentina	268.3	281.5	247.8	270.1	291.7	231.4	292.6	247.0	279.1	253.7	284.9
Bolivia	...	...	...	4.2	...	...	2.4	2.5	2.1	2.8	4.0
Brazil	219.4	246.2	238.8	241.7	235.3	268.4	323.8	359.1	367.6	288.8	267.3
Chile	78.1	73.7	...	132.3	84.7	126.3	120.9	129.8	121.0	96.4	103.5
Colombia	23.2	29.3	40.8	54.4	64.1	63.4	61.7	54.9	50.8	42.2	47.3
Ecuador	...	...	7.5	12.1	...	18.2	20.1	19.3	18.4	16.5	22.2
Paraguay	...	...	...	...	...	...	4.8	4.8	[5.8]	[5.1]	[4.9]
Peru	31.3	36.2	35.0	34.2	32.2	34.3	56.5	50.9	57.7	50.8	50.1
Uruguay	...	...	...	...	...	...	...	...	...	[9.4]	[10.8]
Venezuela	63.5	63.5	70.5	71.1	69.6	111.4	139.2	117.6	186.2	195.1	174.6
Total South America	**[710.0]**	**[760.0]**	**[760.0]**	**[830.0]**	**[810.0]**	**[870.0]**	**[1 030.0]**	**[990.0]**	**[1100.0]**	**960.0**	**970.0**

[a] 1969.
[b] 1968.

US $ mn, at 1960 prices and 1960 exchange rates (Final column, X, at current prices and exchange rates)

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	*1970X*
5.6	5.7	5.6	5.3	5.8	[5.8]	[5.8]	[5.8]	[5.8]	[5.8]	*2.2*[b]
[175.0]	[200.0]	[200.0]	200.0	213.0	230.0	250.0	300.0	[300.0]	290.0	*290.0*
34.4	33.4	30.8	33.3	30.8	29.5	28.3	29.5	27.8	28.1	*31.6*
6.3	8.9	8.6	7.9	9.0	9.2	9.4	8.9	10.1	[10.0]	*10.5*[c]
9.3	9.0	9.3	10.9	14.1	14.5	16.1	15.2	14.7	15.8	*17.2*
5.1	6.0	5.7	6.2	6.1	5.3	5.6	5.5	5.5	5.5	*7.2*
7.1	7.0	7.3	4.9	5.0	5.3	5.2	5.3	5.7	6.9	*8.8*
88.1	97.9	108.0	121.0	121.3	126.0	146.9	152.9	165.6	168.4	*218.0*
6.9	6.9	7.1	6.9	7.2	7.4	8.4	8.1	[8.0]	[8.0]	*9.8*[d]
[1.0]	[1.0]	[1.0]	1.0	1.0	1.0	1.0	1.0	[1.0]	[1.0]	*[1.0]*
340.0	**380.0**	**380.0**	**395.0**	**410.0**	**435.0**	**475.0**	**530.0**	**[545.0]**	**[540.0]**	*[595.0]*

Local currency, current prices

1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
13.6	13.5	14.1	14.4	15.4	14.4	...	...	...	...	...
...	...	...	...	200	213	230	250	300	...	290
33.4	31.6	33.1	34.0	37.0	35.0	32.4	31.2	32.5	31.0	31.6
15.3	15.5	21.7	21.3	20.0	22.6	23.0	23.7	23.1	26.2	...
9.4	9.2	9.3	10.2	12.7	14.3	14.7	16.4	15.7	15.6	17.2
32.8	31.7	31.6	33.5	38.8	36.8	35.4	35.8	35.8	(35.8)	35.8
8.2	14.4	14.5	15.4	10.8	11.4	12.4	12.3	12.9	14.2	17.5
1 021	1 111	1 258	1 388	1 589	1 651	1 789	2 148	2 285	2 548	2 723
...	...	51.0	55.0	53.2	57.2	60.4	70.5	69.3	...	...
...	...	...	...	1	1	1	1	1	1	...

US $ mn, at 1960 prices and 1960 exchange rates (Final column, X, at current prices and exchange rates)

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	*1970X*
280.4	269.8	262.6	288.6	276.0	310.7	246.7	260.5	306.5	320.0	...	*450.0*
4.6	4.7	6.0	12.1	14.3	13.1	12.1	13.0	14.2	[15.0]	...	*19.1*[a]
245.1	264.6	259.8	276.8	406.9	340.5	478.9	480.4	529.4	434.6	...	*1 387.0*
105.2	111.6	95.9	94.2	111.5	116.1	127.8	127.1	121.2	(157.1)	...	*135.2*
56.2	88.8	97.1	94.6	101.6	101.6	104.7	137.9	128.3	136.3	(138.0)	*172.7*
21.1	20.1	17.4	19.8	22.2	24.0	21.9	24.2	24.5	[25.0]	...	*22.6*[a]
4.2	4.8	5.3	5.5	5.9	7.2	9.2	9.2	10.2	[11.0]	...	*23.6*[a]
[60.0]	[70.0]	80.7	78.7	78.8	78.4	99.6	99.7	94.9	[95.0]	...	*155.6*[a]
14.9	14.9	20.3	19.8	22.4	21.6	24.3	17.9	[18.0]	[18.0]	...	*21.2*[b]
151.9	157.8	188.3	197.6	219.1	231.8	259.4	257.2	243.4	247.8	(257.0)	*200.2*
940.0	**1 010.0**	**1 030.0**	**1 085.0**	**1 260.0**	**1 245.0**	**1 385.0**	**1 425.0**	**1 490.0**	**[1460.0]**	...	*2 590.0*

Table 4A.21. South America: current price figures

	Currency	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Argentina	*mn. pesos*	1 952	2 747	3 320	3 775	4 246	3 809	5 420	7 115	9 831	17 686
Bolivia	*mn. pesos*	...	...	...	1.7	...	4.7	9.7	23.9	35.0	41.0
Brazil	*bn. cruzeiros*	6.3	7.6	9.3	11.3	13.0	17.8	26.2	34.6	40.8	43.9
Chile	*mn. escudos*	3.7	4.5	6.0	11.7	13.2	34.3	51.7	73.1	82.2	91.1
Colombia	*mn. pesos*	81	110	150	214	275	272	283	289	306	272
Ecuador	*mn. sucres*	...	88	113	181	250	295	298	289	282	247
Paraguay	*mn. guaranis*	...	...	...	...	...	...	...	...	...	...
Peru	*mn. soles*	398	508	522	562	551	618	1 066	1 039	1 265	1 259
Uruguay	*mn. pesos*	...	...	...	...	...	...	...	...	...	...
Venezuela	*mn. bolivares*	182	201	212	210	270	338	382	496	601	607

Local currency, current prices

1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
24 027	27 367	33 608	40 188	45 158	64 703	96 229	98 933	120 431	152 121	180 000	...
39.0	57.9	61.0	66.0	147.0	178.0	175.0	179.0	203.0	226.0	...	...
54.8	69.6	114.5	194.5	338.5	924.0	1 157.0	2 066.0	2 574.0	3 492.0	3 420.0	...
109.0	119.3	144.1	178.5	256.0	369.0	472.0	614.0	774.0	964.0	1 654.0	...
317	410	664	965	1 072	1 218	1 467	1 627	2 263	2 321	2 639	(2 806)
336	336	329	307	370	428	483	456	527	566	...	...
...	...	...	1 348	1 436	1 613	2 016	2 592	2 605	2 968	...	...
1 340	...	...	2 614	2 824	3 286	3 575	4 994	5 957	6 022	...	...
...	187	221	365	509	900	1 500	3 200	5 300	...	...	...
540	533	509	613	650	734	796	890	894	867	901	959

5. The trade in major weapons[1] with the third world, 1970–1971

Since the publication of the SIPRI Yearbook 1969/70, *SIPRI has published a major study on the arms trade with the third world.*[2] *This Yearbook therefore comments on some of the more important events during 1970 and 1971, illustrated in the following tables and arms trade register. The reader is referred to the SIPRI arms trade study for a deeper analysis of supply and import policies and the trends in the arms trade since 1950.*

The value estimates in this chapter indicate orders of magnitude; they are not precise figures showing actual prices paid. The values were derived by the method described in the appendix on sources and methods, page 115. The figures for 1968 and 1969 have been revised in the light of new information in 1971. However, the conclusions concerning long-term trends presented in previous yearbooks and in the arms trade study are not substantially altered.

I. *Introduction*

In 1971 the value of major arms exports to the third world was higher than ever before, amounting to some $1.8 billion. This figure reflects the increasing tension in various parts of the world, involving both local and outside powers. Around 80 per cent of the major arms supplies went to the Middle East and Asia, while around 90 per cent came from the four major powers—the United States, the Soviet Union, Britain and France.

Two facets of the arms trade, in particular, are illustrated by the events of 1970 and 1971. First, the supply of weapons continues to replace the supply of troops as a less direct use of force. Thus, there has been a big increase in military aid to the Far East, particularly Indo-China and South Korea, in anticipation of US troop withdrawals. Similarly, there has been an acceleration of the arms build-up in the Persian Gulf area, in connection with the impending British withdrawal and the resurgence of conflicts such

[1] Major weapons include aircraft, ships, missiles and armoured fighting vehicles.
[2] *The Arms Trade with the Third World* (Stockholm: SIPRI, 1971).

as those between Iran and the Arab states or the social conflict in Oman. Most notable is the vast military potential being created in Iran.

Secondly, the course of the arms trade in the past two years also illustrates the growth of suppliers' commitments to clients involved in conflicts. Soviet supplies to Egypt and India and US supplies to Israel are responsible for a large part of the increase in total major weapon exports. The continued tension in the Middle East has exacerbated the mutual dependence of Israel and Egypt on their suppliers. Both the United States and the Soviet Union have used arms supplies as a lever to influence negotiating positions on the conflict, while the recipients have used their negotiating positions as levers to acquire more military aid. The Phantom fighter-bombers have, especially, become the symbol of the bargaining between the United States and Israel. In the Indian Sub-continent, the evolution of the conflict between India and Pakistan has served to clarify the alignments of the local powers—alignments that were partly borne of arms supplies. The identity of interests between India and the Soviet Union, and between Pakistan, China and the USA, became more apparent.

The involvement of supplying countries in the arms trade has not been without domestic criticism. The US Congress fiercely expressed its opposition to military aid, most manifestly in its defeat of the Foreign Aid Act of 1971. The British decision to lift the arms embargo on South Africa resulted in stormy debates both internally and within the Commonwealth, and was finally modified.

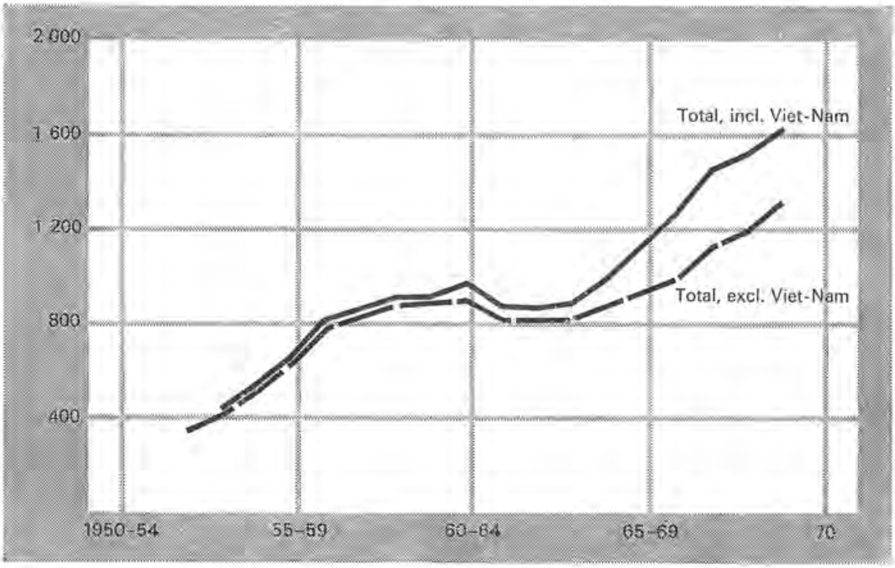
II. *The main suppliers and recipients*

In 1969 the USA, the USSR, the UK and France accounted for over 90 per cent of supplies of major weapons to third world countries excluding supplies to Viet-Nam.[3] In 1970, their share was again over 90 per cent and in 1971, 87 per cent of the total. While the dominant position of these four countries on the arms market has remained rather stable between 1950 and 1971, changes have occurred in their positions *vis-à-vis* each other. In 1969, the value of US major arms exports to the third world amounted to $590 million compared to $390 million for the Soviet Union, whereas in 1971 the total for the USSR was $660 million compared with $580 million for the United States.

[3] Viet-Nam is excluded throughout the text. All figures mentioned in the following are SIPRI valuations, derived according to the method described in the sources and methods, page 115, unless otherwise stated.

Chart 5.1. Total exports of major weapons to third world countries

US $ mn, at constant (1968) prices, five-year moving averages



Source: SIPRI worksheets.

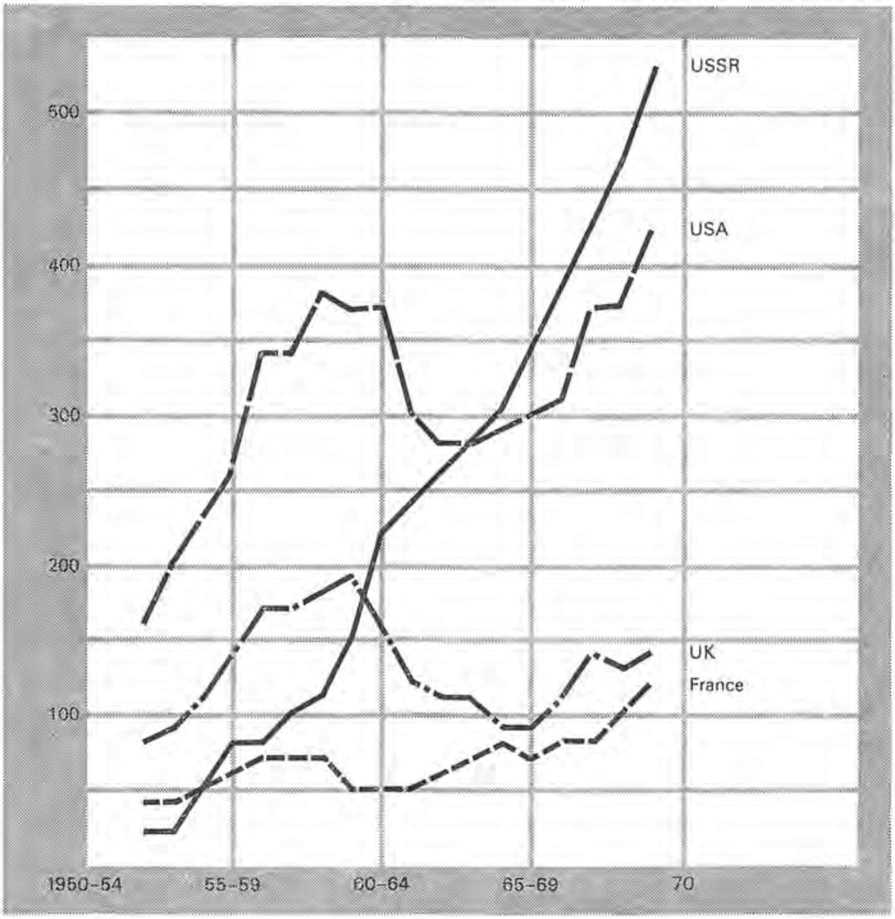
The United States

Despite a dip in 1970, the figures for 1969 and 1971 reflect a rising trend in US major weapon exports to the third world. The average level of major weapon exports for the years 1967–71 was 8 per cent higher than for the years 1966–70, as shown in chart 5.1. Moreover, because of the increasing emphasis on counter-insurgency (COIN) equipment, total US military aid and sales have been rising faster than major weapon exports. According to official US figures, the Administration budgeted $350 million each year for military assistance alone, under the Military Assistance Program (MAP). This excludes Viet-Nam, Laos and Thailand, for which another $2.5 billion was requested each year under the regular Department of Defense appropriations. A US estimate of the size of its total arms exports states:

During the last 20 years through the military assistance component of the AID program alone, we have bestowed on foreign governments $8.1 billion in military vehicles and weapons, $7.1 billion in aircraft, $6.1 billion in ammunition, $2 billion in ships, $2.2 billion in communications equipment, $5.1 billion in missiles and $3.1 billion in other supplies. ... To augment these massive gifts of arms, the Defense Department is now engaged in a rambunctious sales campaign. Our subsidized sales to foreign governments already exceed $16.1 billion, while Pentagon officials anticipate orders worth another $15 billion in the next decade. ... Today the US Government is the principal arms dispenser of the world, giv-

Chart 5.2. The main suppliers of major arms to third world countries, excluding Viet-Nam

US $ mn, at constant (1968) prices, five-year moving averages



Source: SIPRI worksheets.

ing away, arranging credit and promoting the sales of *a volume of arms more than six times that of our nearest rival, the Soviet Union.*[4]

In 1970 and 1971, the majority of US major weapon exports to the third world, around 65 per cent, went to the Middle East, in particular to Iran and Israel. In 1971 Iran received Phantom fighters and Lockheed transport aircraft worth $200 million. Israel received Phantom fighters worth around $200 million in 1969–70. Under the $500 million arms package authorized by Congress in January 1971, Israel received additional Phantoms, A-4 Skyhawk fighters, M-60 and M-48 Patton tanks, armoured personnel carriers, and Hawk missiles. Both the Phantoms and the Skyhawks were, however,

[4] News release from Frank Church, US Senator, Idaho, 11 November 1971, p. 1. (Italics added.)

embargoed from July 1971, when the Jarring talks broke down. The Phantoms are the principal strike force of the Israelis, and the resumption of deliveries of these planes has become the symbol of US support for Israel. The embargo remained in force throughout 1971, officially motivated by Soviet restraint in supplies to Egypt and the US efforts to negotiate a re-opening of the Suez Canal. However, Israel's refusal to agree on the Suez Canal discussions without more planes, and Congressional pressure, coupled with new Soviet pledges for military aid to Egypt in October 1971, finally brought about the lifting of the embargo on Skyhawks in December 1971 and on Phantoms in January 1972. Israel has requested about 50 additional Phantoms and 80 additional Skyhawks. In the new Foreign Aid Bill of November 1971, Congress authorized $85 million in supporting assistance and $300 million in credit for military sales to Israel.

The second largest recipient region of US major weapons is the Far East. Between 1970 and 1971, US major arms exports to this region almost doubled. This reflects the increasing emphasis on the Nixon Doctrine, under which the USA is re-equipping local forces in anticipation of the withdrawal of US troops. This policy is being pursued by the Administration in the face of increasingly severe Congressional scrutiny and criticism of the aid programmes. Thus, Taiwan was the largest recipient of US major weapons in 1970, receiving Super Sabres and F-104 Starfighters under the excess stocks programme, in place of the Phantoms vetoed by Congress in January 1970. Similarly, Thailand has been receiving aircraft, naval vessels and missiles under the Defense Department budget.

Congressional opposition to this method of evading Congressional scrutiny was manifested in the US Special Foreign Military and Related Assistance Act of 9 November 1971, which stated that:

> After June 30, 1971, no military assistance shall be furnished by the US to Thailand directly or through any other foreign country unless that assistance is authorized under this Act or the Foreign Military Sales Act.[6]

Cambodia (the Khmer Republic) has not received any sophisticated US weapons. In March 1970 the Lon Nol government requested a large number of very advanced weapons. The request was turned down, reportedly because this would have involved sending large numbers of US military instructors to Cambodia, which has been forbidden by Congress.[7] Instead, military aid was initiated on 1 May 1970, with a sum of $7 million, in connection with the US-led military operations involving South Viet-Namese

[6] *Supplemental Foreign Assistance Authorization 1970,* hearings on S.2542 and S.2543, before the Committee on Foreign Relations, US Senate, 91st Congress, 2nd session, 10 and 11 December 1970.
[7] *Ibid.,* on S.2819, 9 November 1971.

troops. The military hardware supplied by the USA was restricted to weapons which the Cambodians could operate themselves, such as propeller-driven aircraft, river patrol boats, etc. By December 1970 the President had, without Congressional approval, given or committed a total of $108.9 million in military aid to Cambodia, and the sum was increased to $341 million in the Military Assistance Bill, proposed as an interim measure in November 1971. However, Congress stated in this bill that "enactment of this section shall not be construed as a commitment by the US to Cambodia for its defense",[8] and also that "No funds may be obliged or expended ... on the behalf of Cambodia in any FY beginning after June 30, 1972, unless such funds have been specifically authorized by law enacted after the date of enactment of this section."[9] However, it should be noted that expenditure for carrying out combat air operations over Cambodia was excluded from the above proposal.

In January 1971 Congress approved $150 million as the first part of a 5-year programme for the modernization of South Korea's armed forces, in particular the Air Force. Under this programme, South Korea received about $95 million worth of major arms in 1971. These included Phantom aircraft, M-48 Patton tanks, armoured personnel carriers and howitzers. The programme was justified on the grounds that in 1970 the United States announced it would reduce its forces in South Korea by 20 000 men. Consequently, under the Nixon Doctrine the USA will provide military equipment for the indigenous armed forces of South Korea.

In Latin America, European intrusion on the US arms market has led to an increase in US supplies to the area from $30 million in 1969 to $80 million in 1971. The partial embargo on arms deliveries to Pakistan, in operation since 1965, was temporarily lifted in 1970. In October 1970 Pakistan ordered seven Canberra bombers, six Starfighters and 300 armoured personnel carriers under MAP. However, in April 1971 deliveries were halted retroactive to 25 March. On 8 November the US government announced that the orders for arms worth $3.6 million destined for Pakistan, held in Department of Defense stocks or licensed before 25 March, were cancelled. In the meantime, some deliveries, consisting mostly of spare parts, had been made. The 1965 embargo on India was never lifted.

The Soviet Union

The Soviet Union has surpassed the United States in terms of the *value* of weapons supplied, though not in the *number* of weapons supplied, nor in the number of recipient countries. The Soviet Union supplied major arms worth

[8] *Ibid.*
[9] Quoted in *International Herald Tribune,* 28 May 1971.

$640 million to 14 third world countries in 1971. India and Egypt together received 80 per cent of this total. Ceylon received $2 million worth of major arms in April 1971, to combat the so-called "guevarist" guerillas.

Egypt was the largest recipient of Soviet major weapons, importing arms worth $250 million in 1970 and $420 million in 1971; these consisted mostly of aircraft and missiles. The introduction of sophisticated weaponry in Egypt has necessitated the presence of a very large number of Soviet military personnel there. Most of the missile sites in Egypt are supervised by Soviet military personnel. The arms trade register (page 124) does not include aircraft believed to be operated exclusively by Soviet personnel in Egypt, such as the MiG-21J and the MiG-23 jet fighters and the Tu-16 bombers. In November 1971 about ten Tu-16s, equipped with air-to-surface missiles, appeared in Egypt. Twelve MiG-23s are reportedly based in Cairo; according to US intelligence, their function is reconnaissance missions.

On 27 May 1971, the Soviet Union and Egypt signed a pact of friendship and cooperation, pledging military assistance to Egypt for the next 15 years. The treaty formalized the presence of Soviet military personnel in Egypt, pledging that the USSR will specifically assist "in the training of Egyptian military personnel in mastering the armaments and equipment supplied to the UAR . . .".[10] In mid-October 1971, President Sadat visited the USSR, and the joint communiqué issued at the end of this visit implied a Soviet promise of further military aid.

India is the second largest third world recipient of Soviet arms, and the only country outside the Warsaw Pact which has licensed manufacture of the MiG-21, its Atoll missiles and the engine. Licensed production appears to be progressing, and the first airframe with Indian-made components was completed in 1970. The current plan involves the production of 300 aircraft from 1970 onwards to equip fifteen squadrons. From 1973 India will also produce the latest export version—the MiG-21M—used, for example, by Soviet Air Force units in Egypt in 1970. By 1971 India had received a large number of Su-7 fighter-bombers as well as SAM-2 and SAM-3 missiles. Large deliveries of tanks, including the PT 76 amphibious tank, were made during 1970–71. Politically, the massive military supplies to India manifested the presence of the USSR on the sub-continent, and this was formalized in the Treaty of Peace, Friendship and Cooperation signed by the USSR and India in August 1971. Article 9 of the treaty in fact indicates military cooperation, if needed:

In case any of the parties is attacked or threatened with attack, the high contracting parties will immediately start mutual consultations with a view to

[10] *Times*, 10 October 1971.

eliminating this threat and taking appropriate effective measures to ensure peace and security for their countries.[11]

The East Pakistani conflict brought the Soviet Union and India closer together. In April 1971 the Soviet Union asked the Pakistani government to seek a peaceful solution to the East Pakistani crisis. On 22 September the Soviet Deputy Foreign Minister visited India; the Air Force Chief of Staff followed on 30 October, and Indian Prime Minister Indira Gandhi visited the USSR in September 1971. Spare parts for MiG-21 and Su-7 aircraft were delivered during October–November, followed by freighters whose cargoes reportedly included S-A missiles, tanks and armoured personnel carriers. During the war, the Soviet Union also supported India verbally, in the international arena.

The United Kingdom

British exports of major weapons to third world countries totalled $90 million in 1970 and $170 million in 1971. In particular, the UK has managed to secure large Latin American orders for new ships: Argentina bought two frigates armed with Sea Dart missiles in 1970. Brazil bought six frigates and two submarines in 1969 and 1970. Chile has ordered two submarines and two frigates. In 1971 Panama received two patrol boats, its first British equipment for many years. Peru received two old destroyers in 1971, and two new patrol boats are under construction for Trinidad and Tobago. Several Latin American countries also bought refurbished British aircraft.

The bulk of British major arms exports during 1970 and 1971, however, went to the Middle East. The largest recipient was Iran, which received arms worth $40 million over the period. The UK and the USA have jointly undertaken a $1 billion defence programme since 1969 in order to modernize the Iranian armed forces in preparation for the British withdrawal from the Persian Gulf. Among naval supplies, four destroyers were ordered for Iran in 1966, of which two were delivered in 1971. The UK has been providing the hovercraft, and by 1971 the Iranian Navy had the world's largest fully operational hovercraft squadron, used for coastal defence and logistic duties. Under present plans, Iran will have received a total of 135 Phantom aircraft from the USA by 1975. Iranian ground troops and the hovercraft fleet will be supported by a fleet of more than 200 helicopters, most of them ordered from Italy. It is reported that the United Kingdom will deliver a total of around 700 Chieftain tanks, beginning with a first batch of 140 in 1972. Iran has become the second largest recipient of major weapons in the Middle East, after Egypt.

[11] *Hindustan Times*, 30 October 1971.

Saudi Arabia secured large orders from the UK, including COIN trainers, patrol boats and hovercraft. The formation of the Union of Arab Emirates, consisting of six of the seven Trucial States, is to lead to the creation of a new defence organization there, and already some of the states have been establishing their own armed forces in preparation. There has been a particularly heavy arms build-up in Oman, including British COIN aircraft and Italian helicopters, where attempts to crush the Dhofar guerillas are continuing with British assistance.

The Far East is the second largest market for British weapons. The build-up of the armed forces of Malaysia and Singapore is illustrated by the fact that British major arms exports to these two countries rose from $4 million in 1969 to $24 million in 1971. Malaysia is receiving fifteen Beagle Bulldog trainers, and Singapore refurbished Hawker Hunters. The UK is also building missile-equipped frigates for Malaysia and Thailand.

In 1970–71 British major arms worth $23 million were delivered to Africa as well as $12 million worth of arms to South Africa following the Conservative government's lifting of the arms embargo. The government stated its legal obligation to sell maritime defence equipment on 26 January 1971. The controversial Wasp helicopters are scheduled for delivery in 1972. Ethiopia received 12 Canberra bombers, and Kenya bought COIN trainers and Beagle Bulldogs. One missile-equipped frigate is under construction for Libya.

France

In 1970 France exported $140 million worth of major arms to third world countries, and by 1971 the figure had risen to around $200 million. South Africa alone accounted for 30 per cent of the supplies in 1970 and 20 per cent in 1971, making France South Africa's largest source of weapons. In 1970–71, South Africa received three submarines and about 40 helicopters, and in June 1971 an agreement was signed for licensed production of the Mirage III and the advanced fighter-attack version Mirage F-1 in South Africa. Tunisia, Libya and Zaïre (Congo, Kinshasa) also received considerable numbers of French weapons.

French arms exports to the Middle East increased from $17 million in 1970 to $40 million in 1971. Iran received 16 Super Frelon helicopters and SS.11 and SS.12 missiles; Iraq bought Alouette III helicopters and 70 armoured cars. The Cactus-Crotale missile system, jointly developed by France and South Africa, was sold to Lebanon. Saudi Arabia bought Alouette IIIs and 220 armoured cars.

In other areas, France became a main arms supplier to Greece, with the delivery of six missile-equipped gunboats similar to the type delivered to Israel, and 55 AMX-30 tanks. France has concluded several agreements for licensed production of weapons in India. India will build 80 Alouette IIIs, and AS.30, Harpon and SS.11 missiles. Pakistan had also planned to produce about 30 Alouette IIIs, but the programme was temporarily halted due to the East Pakistani conflict. Pakistan received three submarines in 1970, and bought 28 Mirage 5s and two Mirage IIIs for delivery in 1973. In the Far East as well, France's share in weapons supplies will increase after 1972. In 1970 Malaysia bought missile-equipped patrol boats and in 1971 about 12 Mirage 5s plus armoured personnel carriers.

France is the leading supplier of sophisticated arms to Latin America. Argentina, Brazil and Venezuela have bought the Mirage III, and Peru and Colombia the Mirage 5; Ecuador has ordered a large number of AMX-13 tanks and armoured vehicles for counter-insurgency warfare.

According to official French figures, its total arms exports tripled from 1969 to 1970. The French armaments industry has become the third largest in the world. In 1971, arms represented over one-quarter of France's industrial exports. The French government expressly fosters and supports arms exports, for instance by allowing barter deals when the industry wants to break in on a given market, as illustrated by the fact that Greece exchanged raisins and currants for its missile-equipped gunboats.

Small suppliers

The gap between these four main suppliers and the next group of small suppliers is very big. Among the suppliers in this group, China has a special place, since China exports major weapons to a very small number of countries, and according to the same non-commercial policy as the United States and the Soviet Union. The increase in China's arms exports during 1970–71 consists almost exclusively of deliveries of tanks to Pakistan. By 1970 Pakistan reportedly possessed about five squadrons equipped with MiG-19s, and in 1971 Pakistani sources reported that China had begun deliveries of as many as 400 fighter and bomber aircraft.

China's support of Pakistan in connection with the East Pakistani secession seems to have paralleled Soviet support of India. In May 1971 China received a Pakistani military delegation. The same month Pakistani newspapers reported that the People's Republic of China had offered military aid in addition to the $200 million promised in November 1970. In June 1971 the *Agence France Presse* reported that the Pakistani Army had ordered arms and ammunition from China for two divisions in East Pakistan, assigned to fight against the Bengali liberation movement. The small arms factory built with Chinese loans in East Pakistan was completed and production started in September 1971. In November Ali Bhutto led a delegation, including all the chiefs of staff of the armed forces, to China, which resulted in a promise of early deliveries of aircraft and additional tanks. China expressed political support for Pakistan throughout the crisis, and drew a parallel between what it denounced as the Soviet-Indian construction of the state of Bangladesh and the Japanese puppet state of Manchu-Kuo in Manchuria in the 1930s.

Indo-China is a most important area for China, and during 1970 and 1971 several agreements on military aid were signed with the governments of the Democratic Republic of Viet-Nam and Royal Cambodia. The details of these agreements are not known, and therefore these weapons do not appear in the arms trade register. On the whole, the end of the cultural revolution seems to have brought, among other things, an increase in Chinese military aid. In July 1971 the 1961 Sino-Korean mutual defence treaty was renewed and included free military aid. There were also signs indicating that African countries are becoming increasingly interested in buying Chinese weapons. Tanzania is so far the largest customer in Africa, expecting delivery of 24 MiG-17s. There are several Chinese military instructors in Tanzania, especially for the build-up of the air force. A military delegation from Mali visited China in October 1971, and a military assistance agreement was signed in September 1971 between China and Congo (Brazzaville).

The other small suppliers, notably Canada, Italy, the Netherlands and the Federal Republic of Germany, are also increasing their arms exports. Canada and Italy increased their major arms exports to third world countries from $20 million each in 1970 to $40 million each in 1971 and West Germany increased from $10 million to $80 million in the same period. Brazil ordered four minesweepers from West Germany; Argentina and Colombia ordered two submarines each; and Peru has bought a large number of armoured cars. Greece received West German Noratlas transports and four submarines, and Portugal received 15 Noratlas transports and three corvettes. Turkey is also receiving four German submarines as well as aircraft.

Of the countries listed in table 5A.2, only Sweden, Switzerland and Japan show a downward trend in arms supplies to third world countries. Swedish arms exports are small, and are mostly supplied to the industrialized countries of Europe, the only exception being the sale in 1971 of a 20-year-old cruiser to Chile.

In the case of Japan, the build-up of its armed forces, unprecedented since World War II, combined with a strong defence industry, might in the future lead to an increase in its arms exports. So far, however, the industry produces exclusively for its domestic market.

Appendix 5A. Sources and methods

I. *Introduction*

Neither the register nor the tables on the arms trade in major weapons makes any claim to be official, complete or final. They are published on our responsibility. When there were conflicting reports—and this was often the case for the number of items supplied—we have used our judgement, based on general experience of the reliability of different sources. Any corrections, additions or deletions, from official or unofficial sources, would be welcome.

II. *Sources of information*

In collecting the basic information, two types of sources have been used. Unofficial sources, for example technical journals, press reports, and other publications concerning defence equipment, military aid and alliances, were used. Second, information was gathered from official sources: parliamentary statements, hearings and debates, official publications and press releases.

III. *Coverage*

Weapons

Both the tables and the register cover the deliveries of major weapons: ships, aircraft, armoured fighting vehicles and missiles. The coverage of warships, combat aircraft and tanks is probably reasonable. Even if it were possible, very few countries attempt to conceal deliveries of these items. The coverage of such items as light aircraft, helicopters, armoured cars and missiles is not quite so good, but probably sufficient to provide a basically accurate picture of the trade in these weapons. Small arms, for example machine-guns, are not included.

The tables include spares and equipment for aircraft and ground equipment which is part of the missile system. But they do not include a whole range of equipment that may be needed to acquire a particular weapons system. For instance, a country purchasing a fighter squadron will, in addition to spares and equipment for the aircraft itself, need to acquire various kinds of munitions for the aircraft, a radar tracking and warning system, ground equipment, repair and maintenance facilities, training for its pilots and technicians, etc. Thus, the figures in the tables may appear rather low when compared with, for instance, figures for US grant aid or sales.

In a number of countries, the air force is responsible for some of the country's civil transport and for training pilots for civil planes. This is particularly true for many South American countries. The general principle of inclusion or exclusion in the arms trade tables has been to include all planes supplied to the armed forces of the countries concerned, except when it was known that the planes were for civil use only. Often, however, it was not known: and it should be borne in mind in considering the register that transport and trainer aircraft may be used for both civil and military purposes. Where it is known that a particular trainer has been purchased especially for counter-insurgency duties, this is indicated in the register in the column for comments.

Joint and licensed production of weapons have been included in both the tables and the register. In the register both countries involved in the production are shown in the column for suppliers.

Countries

The countries covered by the register and the tables are the non-arms-producing countries. Many of the countries under consideration do have domestic defence industries, but they are still heavily dependent on imports in meeting their defence requirements. The two countries possessing the most developed domestic defence industries—Israel and South Africa—are still far from self-sufficiency.

Viet-Nam—North and South—is shown separately in the tables of major weapon imports, and totals are given including and excluding Viet-Nam. In the table of major weapon exports by supplier, both North and South Viet-Nam are excluded. For the US supply of arms to Viet-Nam, only the major weapons supplied to South Viet-Namese forces are entered as arms trade: the weapons supplied to US troops do not appear in the tables. Since the United States is intervening directly in this conflict, while the Soviet Union is simply supplying arms to North Viet-Nam, any comparison of the arms supplies of the two great powers to the two sides would be inappropriate. The cost of the United States intervention vastly exceeds the whole of the trade in major weapons recorded in the tables.

The third world regions listed in the tables are as follows:

Far East. All countries east of Pakistan, except China, Japan, Australia and New Zealand. Viet-Nam is shown separately.

Middle East. Abu Dhabi, Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Southern Yemen, Syria, Egypt, Yemen, Sharjah.

North Africa. Algeria, Libya, Morocco, Tunisia.

Sub-Saharan Africa. The rest of Africa, except for *South Africa,* which is shown separately.

Indian Sub-continent. Afghanistan, Ceylon, India, Pakistan, Bangladesh, Nepal.

Central America. All countries from Panama northwards up to the United States.

South America. The rest of Latin America.

Europe. Only Greece and Turkey are included in the table. In the register, Portugal is also included, because Portugal's arms procurement is relevant to the discussion of the arms trade with Africa.

Arms supplies to colonies or dependencies are included when these countries have armed forces separate from the metropolitan power—for example, the Central African Republic during the 1950s.

IV. *The tables*

There may be some slight upward bias in the figures for recent years due to extra information. This upward bias could account for approximately 10 per cent of the total. But it is unlikely to be higher than this. It concerns primarily the smaller items—helicopters, light aircraft and inexpensive military vehicles, whose values are low compared with those of tanks and combat aircraft. It is unlikely that there is any upward bias in the estimates for ships and missiles. The ship estimates are based almost entirely on one source, *Jane's Fighting Ships.*[1] There were very few transfers of missiles in the earlier years.

In order to obtain aggregate statistics of the trade in major weapons, it was necessary first to reconcile conflicting data and to estimate the numbers and types of weapons and the dates of the deliveries when such information was not available, and then to value individual transactions.

[1] London, annual.

Reconciliation and estimation

There is little difficulty in obtaining reliable and unconflicting information about the deliveries of warships, combat aircraft and main battle tanks. In value terms, these amount to around 80 per cent of total arms deliveries. The problems of reconciliation and estimation primarily concern light tanks and other vehicles, missiles, light aircraft and helicopters. When there was conflicting information, we have, when possible, made our decision on the basis of general experience of the reliability of different sources.

For armoured fighting vehicles, other than main battle tanks, the main problem has been the lack of sources. For certain countries whose armed forces are well publicized, such as India, Pakistan, Egypt or Israel, the information on deliveries of armoured fighting vehicles has been fairly good. These are the countries in the third world which have been the major importers of main battle tanks. For some countries (which, for the most part, imported light tanks or armoured cars) there is only information on the types the country possesses and the numbers of battalions or armoured divisions in that country. To estimate the dates and numbers of tank deliveries, we took into account the dates of production of particular types or, in the case of second-hand equipment, the dates of replacement of the particular type in the supplier country, the dates of aid or sales agreements or other political and diplomatic ties between the supplier and the recipient countries, the dates at which the presence of these types was first reported, and the number of tanks, armoured cars and armoured personnel carriers in an armoured battalion or division. Where we have not known the latter, we have assumed that the size of a battalion or division is the same as that of the main supplier, or in the case of ex-colonies, the same as that of the former metropolitan power.

Estimates for light aircraft—helicopters, trainers, liaison and light transport types—have followed a similar pattern. Here we have taken into account the size of squadrons and the relative requirements in an air force for combat aircraft and other types.

The problems concerning missiles are somewhat different. Once it is known that a country possesses a particular missile, it is fairly easy to pin down the date of delivery. The period between the initial date of production and the date the missile was reported is usually limited. The main problem concerns the estimation of numbers of missiles, which are small and easily concealed. For missiles launched from tanks, ships or aircraft, the estimates are based on the numbers of tanks, ships and aircraft a country possesses which are capable of delivering a particular missile. The remaining missiles are almost entirely anti-tank and anti-aircraft missiles. The deliveries of anti-aircraft missiles such as SA-2, Hawk or Bloodhound have tended to attract considerable attention. There is usually, therefore, fairly good information on the numbers of missile sites, launchers or even of the missiles themselves. As far as we know, only a few countries possess anti-tank missiles and for most of these we have reasonable information.

Valuation

The purpose of valuing all items in a common unit is to be able to measure changes in the total flow of weapons and its geographical pattern. Various methods of valuation are conceivable. The obvious ones are military value and monetary value. Military value is generally unmeasurable because it depends on the circumstances in which the weapons may be used. Monetary value, on the other hand, measures something that is relatively precise and is interesting in itself—the quantity of resources used. It is therefore what we have used. The monetary values chosen may not correspond to actual prices paid. Actual prices paid vary considerably according to different pricing methods, the lengths of production series and the terms involved in individual transactions. We have tried to draw up a list of comparable prices in 1968 US dollars based on actual prices and on criteria such as weight, speed and role. These criteria have been different for each of the four different types of weapons—ships, aircraft, missiles and armoured fighting vehicles. One consequence of this method of valuation is that our values of Soviet weapon exports tend to be higher than their quoted prices. For this reason, our figures of the relative flows of major weapons from the United States and the Soviet Union may be much closer together than other statistics comparing weapon flows from these two countries. There is an additional reason for the smaller difference between the two figures. Soviet weapon exports to developing countries include a smaller proportion of small arms than exports from the United States; a comparison of *total* weapon exports from the two countries would look very different from a comparison of major weapon exports alone.

Ships

Ships were divided into eleven different categories.[2] For each category, we calculated a 1968 dollar price per ton, based on actual prices in 1968. We

[2] The categories were:

1. Aircraft carriers
2. Submarines
3. Cruisers
4. Destroyers, 1 300 tons and over
5. Frigates, corvettes, patrol vessels, 600–1 300 tons
6. Patrol boats, torpedo boats, gunboats, etc. 300–550 tons
7. Patrol boats, torpedo boats, gunboats, etc. 100–300 tons
8. Patrol boats, torpedo boats, gunboats, etc. under 100 tons
9. Minesweepers
10. Minelayers
11. Landing ships, landing craft, transports, supply ships, survey ships, oilers, tugs, etc.

also assumed a technical improvement factor of 3.5 per cent per annum. This means that the price of a ship completed in 1967 is 3.5 per cent less than the price of a similar ship completed in 1968. This improvement factor has nothing to do with general price inflation; it is merely intended to measure the increase in the sophistication of ships.

A large proportion of the ships sold to the countries under consideration are second-hand. It was therefore necessary to take into account the depreciation of ship values. A simple exponential depreciation was taken, based on the length of life of ships in each of the eleven categories and a scrap value of 1 per cent. This yields a rather rapid depreciation in the first few years of a ship's life. For this reason, among others, the export of warships by the United Kingdom, which has exported many new ships to developing countries, is higher in value terms than the export of warships from either the United States or the Soviet Union, both of which have exported large numbers of second-hand warships.

Aircraft

For aircraft we derived a price for each individual type of aeroplane. This price was based on two factors. First, it was based on actual prices, taking into account factors which cause these prices to vary, such as the length of the production series, the sales or aid terms, and the support facilities, spares and extra equipment included in the price. Secondly, we used kilo prices for the empty weight of different categories of aircraft,[3] as a rule of thumb. These categories were roughly divided into older construction and fully modern construction. We included a certain percentage of the price for spares and equipment for each of the three categories of aircraft. Explosives, missiles and ground equipment were not included.

The problem of depreciation is much harder for aircraft than for ships. The life of an aircraft is shorter than that of a ship and the scrap value approaches zero. A simple exponential depreciation yielded too rapid a depreciation in early years. Many of the second-hand aircraft sold in the period had been part of a long production series. It was often impossible to discover the date the aircraft had been built, the extent they had been used, and the extent of refurbishing. Since second-hand aircraft are a rather small propor-

[3] These categories were

(a) Combat aircraft (fighters, bombers)
Supersonic
Subsonic
(i) conventional
(ii) STOL (short take-off and landing)

(b) Helicopters

(c) Others (transport, trainers, etc.)
(i) piston-engined
(ii) turbo jet
(iii) turbo fan jet

tion of total aircraft deliveries[4] a blanket assumption of 10 per cent of the original price for each second-hand aeroplane was taken. An assumption of 50 per cent of the original price was made for planes having undergone a more thorough refurbishing.

Tanks

We calculated individual prices for each armoured fighting vehicle. The prices were based on the type and the date when the vehicle had first been used. The five types were: main battle tank, light tank, tank destroyer, armoured car, and armoured personnel carrier. Second-hand tanks were valued at 50 per cent of the original price.

Missiles

Here again, we calculated individual prices for each missile. The prices were based on type, date of production, range and guidance. There were seven types: artillery rockets, anti-tank missiles, surface-to-surface missiles, air-to-surface missiles, long-range surface-to-air missiles, short-range surface-to-air missiles and air-to-air missiles.

We had separate prices for missiles and their launchers, radar, computers, etc.

V. *Joint and licensed production*

Licensed production can vary from assembly to complete manufacture. In most cases, it is known what proportion of a particular weapon is imported and what proportion is produced at home. The tables include only the import content of the weapon. In obtaining values for weapons produced under licence, we took a percentage of the total value of the weapon equivalent to the proportion of the weapon which was imported. In the few cases where this percentage was not known, it was assumed to be 100 per cent.

Rounding

All figures above $10 million in the main tables are rounded to the nearest $10 million. Figures below $10 million are rounded to the nearest $5 million. The erratic year-to-year movement makes it difficult to see the trend

[4] Unless our sources indicated that a particular aircraft *was* second-hand or unless they gave a delivery date after the production line had closed down, we assumed that it was new. If we did not know when the production line had closed down, we took as the closing date the last date the aircraft had appeared in *Jane's All the World's Aircraft* (London, annual).

in the yearly figures: so five-year moving averages are presented in the tables and the charts. The five-year moving average shown under the year 1952 is the average for the years 1950 to 1954 inclusive; the figure under the year 1953 is the average for 1951 to 1955 inclusive, and so on.

VI. *The register*

For the register, no attempt was made to estimate where information was not available or to reconcile conflicting data from equally unreliable sources. In such cases, two dots (thus, . .) indicate that the information is not available.

The register is not simply a record of deliveries in 1970–71: it includes, as well as deliveries in these years, items known to be on order or ordered. The final columns indicate the information available about the dates of orders or deliveries. When no information is given about either the date of the order or of the delivery, this implies that the item is known to be on order. When deliveries have been spread over a number of years and it is not known how they have been divided among the years, the whole transaction has been entered, and the years over which the supplies were spread are shown in the delivery columns, thus: 1966–1969.

The information is arranged by region.

Conventions

..	= Information unknown, or information drawn from only one source, generally not sufficient for inclusion in tables. In this case, an estimate is made for the transaction for inclusion in the values. When later information confirms estimate, the value is revised accordingly.
—	= Nil
*	= Less than $2.5 million
( )	= A greater degree of uncertainty about, for example, the date of an order or the identity of a supplier
+	= When + is added to a figure, it means at least the number given and probably more.
bs.	= batteries (of missiles)
u.c.	= Unit cost
Displ.	= Displacement of naval vessels, in numbers of tons
t.	= Tons
1969–	= 1969 and subsequent years
Transport	= Transport plane
AAM	= Air-to-air missile
SSM	= Surface-to-surface missile
ASM	= Air-to-surface missile
SAM	= Surface-to-air missile
ASW	= Anti-submarine warfare
COIN	= Counter-insurgency action
STOL	= Short take-off and landing
MAP	= (US) Military Assistance Program

Table 5A.1. Values of imports of major weapons by third world countries: by region, 1950–

		1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Far East, excl.	A	100	160	60	170	120	180	140	160	330	300
Viet-Nam	B	—	—	120	140	130	150	190	220	250	250
South Asia	A	30	20	10	70	80	80	90	180	330	110
	B	—	—	40	50	70	100	150	160	170	190
Middle East	A	30	20	10	60	70	130	270	230	190	180
	B	—	—	40	60	110	150	180	200	190	140
North Africa[b]	A	—	—	—	—	—	—	20	*	*	5
	B	—	—	—	—	—	—	—	—	10	5
Sub-Saharan	A	*	5	5	10	10	10	*	*	10	30
Africa	B	—	—	10	10	10	5	5	10	10	20
South Africa	A	5	*	10	10	10	10	40	10	10	10
	B	—	—	10	10	20	20	20	20	20	10
Central America	A	5	*	20	10	10	10	10	5	10	10
	B	—	—	10	10	10	10	10	10	10	30
South America	A	40	50	20	60	110	140	90	90	110	30
	B	—	—	60	80	80	100	110	90	90	100
Greece and	A	10	20	70	140	110	50	110	70	320	90
Turkey	B	—	—	70	80	90	100	130	130	140	130
Total (excl.	**A**	**220**	**270**	**210**	**520**	**510**	**610**	**770**	**760**	**1 310**	**770**
Viet-Nam)	**B**	**—**	**—**	**350**	**420**	**520**	**630**	**790**	**840**	**890**	**890**
Viet-Nam,	A	—	—	—	—	10	10	10	5	40	5
North and South	B	—	—	—	—	—	—	10	10	20	30
Total	**A**	**220**	**270**	**210**	**520**	**520**	**620**	**780**	**760**	**1 350**	**770**
	B	**—**	**—**	**350**	**430**	**530**	**640**	**800**	**850**	**910**	**920**

[a] Figures rounded to nearest 10, except for figures under 10 which are rounded to nearest 5. Items may not add to total because of rounding.
[b] Five-year moving averages are calculated from the year arms imports began.

Source: SIPRI worksheets of arms transfers 1950–71. The figures in the *SIPRI Yearbook 1969/70*, pages 340–41, have been extensively revised in the light of new information.

1971[a] *US $ mn, at constant (1968) prices. A=yearly figures, B=five-year moving averages*

1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	**Total**
320	130	220	190	240	170	250	120	50	260	70	200	**3 930**
260	230	220	190	210	190	160	170	150	130	—	—	
160	190	120	130	60	80	280	190	210	260	180	240	**3 110**
180	140	130	120	140	150	160	200	230	220	—	—	
90	130	250	230	200	260	210	590	650	580	590	900	**5 860**
140	150	160	190	210	270	360	430	500	640	—	—	
5	10	20	20	10	40	60	60	30	30	70	70	**450**
10	10	10	20	30	40	40	40	50	50	—	—	
20	30	30	30	40	60	50	40	20	20	60	70	**560**
20	30	30	40	40	40	40	40	40	40	—	—	
*	*	10	80	20	120	50	40	20	40	40	50	**600**
5	20	20	50	60	60	50	50	40	40	—	—	
30	90	150	20	20	10	10	10	*	*	*	20	**460**
60	60	60	60	40	10	10	10	5	5	—	—	
120	140	50	40	20	50	70	60	80	90	100	150	**1 690**
90	80	70	60	50	50	60	70	80	100	—	—	
110	30	20	100	70	150	80	80	40	90	20	110	**1 880**
120	70	70	70	90	100	90	90	60	70	—	—	
860	**760**	**890**	**840**	**690**	**930**	**1 050**	**1 190**	**1 110**	**1 380**	**1 120**	**1 810**	**18 570**
920	**820**	**810**	**820**	**880**	**940**	**990**	**1 130**	**1 180**	**1 320**	—	—	
20	90	100	40	50	40	270	530	500	260	120	70	**2 160**
50	50	60	60	100	190	280	320	340	300	—	—	
880	**850**	**980**	**870**	**730**	**970**	**1 320**	**1 720**	**1 610**	**1 640**	**1 240**	**1 880**	**20 730**
970	**870**	**860**	**880**	**980**	**1 130**	**1 270**	**1 450**	**1 510**	**1 620**	—	—	

Table 5A.2. Values of exports of major weapons to regions listed in table 5A.1: by supplier,

		1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
USA	A	50	130	130	210	290	250	270	240	630	300
	B	—	—	160	200	230	260	340	340	380	370
USSR	A	20	30	20	120	*	50	80	160	120	80
	B	—	—	40	40	50	80	80	100	110	150
UK	A	70	30	40	120	120	130	140	190	260	140
	B	—	—	80	90	110	140	170	170	180	190
France	A	*	*	*	30	50	40	120	50	100	40
	B	—	—	20	20	50	60	70	70	70	50
Canada	A	20	5	*	*	20	20	80	30	5	50
	B	—	—	10	10	20	30	30	40	30	20
China	A	40	40	—	10	—	—	—	40	80	60
	B	—	—	20	10	*	5	20	30	30	30
FR Germany[b]	A	—	—	—	*	5	10	5	*	10	20
	B	—	—	—	—	—	5	5	10	10	10
Italy	A	5	30	—	*	*	*	20	20	20	*
	B	—	—	10	5	5	10	10	10	20	10
Czechoslovakia[b]	A	—	—	—	—	—	30	40	5	20	40
	B	—	—	—	—	—	—	—	30	30	20
Netherlands	A	20	10	5	*	*	60	*	*	—	5
	B	—	—	10	20	10	10	10	10	*	*
Japan	A	—	—	—	*	20	—	5	5	10	*
	B	—	—	—	—	—	5	10	5	5	5
Sweden	A	*	*	10	5	5	5	5	—	30	*
	B	—	—	5	5	5	5	10	10	5	5
Switzerland[b]	A	—	—	—	—	—	—	—	—	—	—
	B	—	—	—	—	—	—	—	—	—	—
All other[b]	A	—	—	—	20	*	5	5	5	30	30
	B	—	—	—	—	—	5	10	10	10	10
Total (excl. Viet-Nam)	**A**	**220**	**270**	**210**	**520**	**510**	**610**	**770**	**760**	**1 310**	**770**
	B	—	—	**350**	**420**	**520**	**630**	**790**	**840**	**890**	**890**

[a] Figures rounded to nearest 10, except for figures under 10 which are rounded to nearest 5. Items may not add to total because of rounding.
[b] Five-year moving averages are calculated from the year arms imports began.

Source: SIPRI worksheets of arms transfers 1950–71. The figures in the *SIPRI Yearbook 1969/70*, pages 340–41, have been extensively revised in the light of new information.

1950–1971[a]

US $ mn, at constant (1968) prices. A = yearly figures, B = five-year moving averages

1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	**Total**
470	230	200	280	250	420	290	270	300	590	370	580	**6 760**
370	300	280	280	290	300	310	370	370	420	—	—	
110	280	510	210	180	200	400	710	390	390	440	660	**5 160**
220	240	260	280	300	340	380	420	470	520	—	—	
170	180	50	80	80	140	110	60	170	190	90	170	**2 730**
160	120	110	110	90	90	110	140	130	140	—	—	
20	30	70	110	90	50	70	40	150	90	140	190	**1 470**
50	50	60	70	80	70	80	80	100	120	—	—	
10	10	—	100	30	40	5	5	30	10	20	40	**520**
10	30	30	40	40	40	20	20	10	20	—	—	
10	—	—	—	*	5	30	10	5	30	10	50	**400**
30	10	*	*	5	10	10	20	20	30	—	—	
20	10	5	10	30	10	110	10	10	10	10	60	**360**
10	10	20	10	30	40	40	30	30	20	—	—	
10	—	*	10	10	5	10	10	30	40	20	40	**300**
5	5	5	5	5	10	10	20	20	30	—	—	
30	5	5	10	5	*	5	5	5	—	—	—	**220**
20	20	10	5	5	5	5	5	5	*	—	—	
*	*	10	10	5	10	—	—	—	20	*	20	**200**
5	5	5	10	10	5	5	5	5	10	—	—	
*	10	20	20	10	10	10	30	10	—	—	—	**160**
10	10	10	10	10	20	10	10	10	10	—	—	
*	*	—	—	—	—	*	—	—	*	—	—	**60**
5	*	*	*	*	*	*	*	*	*	—	—	
—	—	—	*	—	*	*	*	*	—	—	—	**5**
—	—	—	—	—	*	*	*	*	*	—	—	
5	*	10	*	*	20	20	30	5	20	10	20	**230**
20	10	5	10	10	10	20	20	10	20	—	—	
860	**760**	**890**	**840**	**690**	**930**	**1 050**	**1 190**	**1 110**	**1 380**	**1 120**	**1 810**	**18 570**
920	**820**	**810**	**820**	**880**	**940**	**990**	**1 130**	**1 180**	**1 320**	**—**	**—**	

Appendix 5B. Arms Trade Register: register of major weapon transfers to third world countries, 1970–1971

This register includes all major weapons ordered or delivered during 1970 and 1971, and those on order at the end of 1971. A number of the items, therefore, appeared in the Preliminary Arms Trade Register for January to June 1970 in the *SIPRI Yearbook 1969/70*. While the information for 1970 is complete, information about weapons ordered and delivered in 1971 may not have appeared in the sources at the time of publication, and may therefore not be complete.

Third world countries include those countries classified by the United Nations as *developing*, plus South Africa, North Korea, North Viet-Nam, Greece, Turkey and Portugal. (See *The Arms Trade with the Third World* (Stockholm: SIPRI, 1971), page 6.)

The third world recipient regions appear in the following order: Middle East, Africa, Indian Sub-continent, Far East, Central America, South America and Europe.

						Date: number of items	
Recipient	Supplier	Number	Item	Description	Comment	Ordered	Delivered
Middle East							
Abu Dhabi	UK	10	HS Hunter FGA.9	Fighter	Of which 3 reconnaissance	June 1969	1970–71
		2	HS Hunter T.7	Trainer		June 1969	1970–71
		..	BAC Vigilant	Anti-tank missile		1971	..
		6	Patrol boat, "Dhafeer" class	Displ.: 10 t.	New	..	(1970): 5
	Canada	4	DHC-4A Caribou	STOL transport		1969	1969–70
Bahrain	UK	2	Shorland Mk 2	Armoured car		Jan. 1971	March 1971
Egypt	USSR	(120)	MiG-21	Fighter	Received 4 squadrons in 1970 and 2 in 1971	..	1970: 80 1971: 40
		50–60	MiG-15/17	Fighter		..	1971
		(40)	Sukhoi Su-7	Fighter/ ground attack		..	1970–71
		(24)	Sukhoi Su-11	Fighter	2 squadrons received	..	1971
		(80)	Mil Mi-8	Helicopter		..	1970–71
		20	Mil Mi-6	Helicopter		..	Mid-1971
		(120)	SA-2 "Guideline"	S-A missile		..	1971
		(120)	SA-3 "Goa"	S-A missile		..	1970–71
		..	SA-4 "Ganef"	S-A missile	Reportedly in Egyptian service	..	(1971)
		(50+)	SA-6 "Gainful"	S-A missile	2–3 battalions reportedly in Egyptian service	..	(1971)
		3	Motor torpedo boat, "Shershen" class	Displ.: 150 t.		..	1968–70
		4	Patrol boat, "Soi" class	Displ.: 215 t.		..	1968–70
	Spain/Egypt	90	Helwan HA-200B "Al Kahira"	Trainer	Licensed production started in 1964	(1959)	1967–

Iran	USA	32	McDonnell-Douglas F–4E Phantom	Fighter–bomber	In addition to 32 F–4Ds received in 1968–69. Some reports suggest 100 received by Nov. 1971	Dec. 1970	1971
		30	Lockheed C-130 Hercules	Transport	$122 mn	Late 1970	(1971)
		12	Cessna 337 Super Skymaster	Transport		..	1970
		4	Boeing-Vertol 114 CH-47C Chinook	Helicopter	Delivered prior to production of 22 in Italy	Early 1970	1971
		6	Sikorsky S-61B	Helicopter		..	(1970)
		..	Hughes TOW	Anti-tank missile		1971	1971–
		3	Patrol boat, "PGM" class	Displ.: 105 t.	New; MAP	..	1970
	UK	2 bs.	BAC Rapier	S-A missile	$113 mn; following contract with Marconi for fully mobile air defence radar and communications system	1970	1971–
		..	Short Seacat	Naval S-A missile	$2.5 mn; one triple launcher on each new Vosper destroyer; 1 quadruple launcher on destroyer "Artemis" delivered in 1967	Oct. 1971	1971–72
		4	Destroyer Vosper Thornycroft, "SAAM" class	Displ.: 1 110 t.	New; armed with Short Seacat and Contraves Sea Killer missiles	Aug. 1966	1971: 2 1972: 2
		8	SRN.6, "Winchester" class	Hovercraft, displ.: 10 t.	Cost, incl. 2 BH. 7s: $9.8 mn, new	(1967)	1969–70
		4	BH. 7, "Wellington" class	Hovercraft, displ.: 33 t.		(1967): 2 (1970): 2	1970: 2
		800	Chieftain	Main battle tank	$346 mn. incl. spares, training and support equipment	1971	1972–
	France	16	Aérospatiale SA 321 Super Frelon	Helicopter	$28 mn	(Feb. 1969)	1971
		..	Aérospatiale SS.11 and SS.12	S-S missile		(Feb. 1969)	1970–
	Italy	10	Agusta-Sikorsky ASH-3D Sea King	Helicopter		(Early 1971)	Late 1971–
		22	Meridionali Vertol 114 CH-47C Chinook	Helicopter		Early 1970	1971
		40	Agusta-Bell 205A	Helicopter	Cost for AB 205 and AB 206: approx. $50 mn	1968	1969–70
		70	Agusta-Bell 206A Jet Ranger	Helicopter			
		5	Agusta-Bell 212 Twin-Pac	Helicopter		(Early 1971)	(1971)
		..	Contraves Sea Killer	Naval S-S missile	To arm 4 new Vosper destroyers	..	1971–72

Recipient	Supplier	Number	Item	Description	Comment	Date: number of items Ordered	Delivered
	Netherlands	12	Fokker-VFW F.27 Friendship	Transport		Dec. 1970	1971–72
Iraq	USSR	. .	SA-2 "Guideline"	S-A missile		. .	May 1971
	UK	3	Britten-Norman BN2 Islander	Transport	Modified for photographic survey work	1971	1971
	France	12	Aérospatiale SA 316 Alouette III	Helicopter		1968	1970
		70	Panhard AML-90	Armoured car		1968	1970
Israel	USA	50	McDonnell-Douglas Phantom F-4E	Fighter	$300 mn, incl. Bullpup A-S and Sparrow A-A missiles	Dec. 1968	1969–70
		6	McDonnell-Douglas Phantom F-4E	Fighter	To replace losses, incl. special radar jamming equipment	. .	(May 1970)
		6	McDonnell-Douglas Phantom RF-4E	Fighter/ reconnaissance		Dec. 1968	Spring 1970
		16–18	McDonnell-Douglas Phantom F-4E	Fighter	Part of $500 mn arms package, authorized by US Congress Jan. 1971	June 1970	Jan.–July 1971: 12
		25	Douglas A-4 Skyhawk	Fighter	In addition to 48 delivered in 1967–68	Nov. 1968	1969–70
		18	Douglas A-4 Skyhawk	Fighter	Part of $500 mn arms package, authorized by US Congress Jan. 1971	June 1970	1971
		. .	Lockheed C-130 Hercules	Transport		. .	1971
		. .	Martin Bullpup	A-S missile	To arm Phantom fighters	Dec. 1968	1969–71
		. .	Raytheon Sparrow	S-S missile	To arm Phantom fighters	Dec. 1968	1969–71
		. .	Raytheon MIM-23 Hawk	S-A missile	Part of $500 mn arms package, authorized by US Congress Jan. 1971. To counter Egyptian missiles	June 1970	. .
		. .	NWC Shrike	A-S missile			1970–71
		180–200	M-60 and M-48 Patton	Main battle tank	$36 mn. Part of $500 mn arms package, authorized by US Congress Jan. 1971	June 1970	1970–71

		..	M-113	Armoured personnel carrier	Among new items displayed on National Day 1971	..	(1970–71)
		24	M-109	155 mm howitzer	$3.5 mn	..	1970
		12	Patrol boat, "PBR" class	Displ.: 7.5 t.	Added to official list in 1971	..	(1970)
Jordan	USA	18	Lockheed F-104 Star-fighter	Fighter	Option on second consign-ment of 18 taken up in April 1969	April 1969	1970
		..	M-60	Main battle tank		(Early 1971)	Aug. 1971
	Nether-lands/USA	100	Centurion	Main battle tank	Ex-Netherlands	..	1971
	UK	4	Hawker Hunter FGA.73	Fighter	Last of order for 25. Ex-UK and Dutch/Belgian stocks	(1967)	1970
		..	Short Tigercat	S-A missile	$16 mn, paid with credit from Saudi Arabia	Mid-1968	1969–70
	Saudi Arabia	..	Hawker Hunter	Fighter	Gift	..	(1971)
Kuwait	USA	2+	Lockheed C-130 Hercules	Transport		..	April 1971: 2
	UK	6	BAC 167 Strikemaster	COIN trainer	In addition to 6 delivered in 1969	..	1971
		50	Vickers 37 t.	Main battle tank	$15–17.5 mn	May 1968	(1970–71)
	(France/ S. Africa	..	Thomson-CSF/Matra Cactus Crotale	S-A missile	According to French industrial circles	(1971)	1972–)
	Italy	4	Agusta-Bell 206A	Helicopter		..	1970
Lebanon	USSR	..	Armoured personnel carrier		Part of $16 mn arms package	1971	..
		..	122 mm howitzer		To equip 1 artillery battalion	1971	..
	France/ South Africa	1 battery	Thomson-CSF/Matra Crotale	S-A missile		(Sept. 1969)	End 1972
Oman	UK	12	Hawker Hunter FGA. 76	Fighter	Refurbished; part of $96 mn arms order, incl. tanks and other equipment	Late 1971	..

Recipient	Supplier	Number	Item	Description	Comment	Date: number of items Ordered	Date: number of items Delivered
		8	Short SC.7 Skyvan	STOL transport	Cost of 5: $2.4 mn	1970: 6 July 1971: 2	1970: 6 Sept. 1971: 2
		8	BAC 167 Strikemaster	COIN trainer		Late 1971	..
	UK/Australia	2	Viscount 839	Transport	Ex-RAAF, refurbished in UK	1971	Late 1971
	UK	1	Flagship/patrol boat	Displ.: 202 t.	New; launched in 1969	..	1970
		3	Patrol boat		New	1970	..
	Canada	3	DHC-4 Caribou	STOL transport		July 1970	Sept. 1970
	Italy	8	Agusta-Bell 205	Helicopter		1970	1971
		4	Agusta-Bell 206 Jet Ranger	Helicopter		1970	1971
Qatar	UK	6	Hawker Hunter	Fighter	Refurbished	Mid-1969	(1971)
		..	Short Tigercat	S-A missile	$1.4 mn	Mid-1969	(1970–71)
Saudi Arabia	USA	30	Northrop F-5A Freedom Fighter	Fighter/reconnaissance	$130 mn, incl. automatic ground check-out equipment, spares, mobile training units	Late 1971	..
		20	Northrop F-5B Freedom Fighter	Fighter/reconnaissance		Late 1971	..
		7	Lockheed C-130 Hercules	Transport	In addition to 4 delivered in 1965	..	(1968–70)
	UK	25	BAC 167 Strikemaster	COIN trainer	Part of 1965 Lightning deal	Dec. 1965	1969–70
		22	Patrol boat	45 ft.		Jan. 1968	(1970): 8
		..	SRN. 6, "Winchester" class	Hovercraft, displ.: 10 t.	$12 mn, for shore and harbour defence	1969	1971–
	France	3+	Cessna F-172H	Cabin monoplane		..	1970
		6	Aérospatiale SA 316 Alouette III	Helicopter		1969	(1970)
		220	Panhard AML-90	Armoured car		(Jan. 1968)	(1969–70)
Sharjah	UK	6	Shorland Mk 2	Armoured car		Jan. 1971	Feb. 1971

Syria	USSR	(40)	MiG-21	Fighter	At least 21 received in first half of 1971	..	1970–71
		9	MiG-17	Interceptor/fighter		..	1971
		(10)	Sukhoi Su-7	Fighter/ground attack	At least 5 received in first half of 1971	..	1970–71
		22	Mil Mi-8	Helicopter		..	1971
		2	Mil Mi-4	Helicopter		..	1971
		..	SA-2 "Guideline"	S-A missile		..	Feb. 1971
		2	Submarine, "M" class	..		1969	..
		6	Motor torpedo boat	..		1969	..
		1	Destroyer	..		1969	..
Africa							
Algeria	USSR	2–3	Fast patrol boat, "Osa" class	Displ.: 160 t.	In addition to 1 delivered in 1967	..	1968–70
		..	"Styx"	Naval S-S missile	To arm "Osa" boats	..	1968–70
	France	28	Fouga CM 170 Magister	Trainer		July 1969	1970
		2	Aérospatiale/Westland SA 330 Puma	Helicopter		..	Jan. 1970
Central African Republic	France	1	Dassault Falcon	Transport	For VIP use	..	1970
	Italy	8	Aermacchi-Lockheed AL 60 C5	Light utility aircraft	For army liaison	..	(1969–70)
		2	Aermacchi-Lockheed AL 60 F5	Light utility aircraft	For presidential use	..	(1969–70)
Cameroon	Canada	1	DHC-4 Caribou	STOL transport		..	1971
Congo (Brazzaville)	USSR	1	Il-18	Transport	Gift	..	Late 1971
		2	Il-14	Transport	Gift	..	Late 1971
Ethiopia	USA	5	Fairchild-Hiller C-119 Packet	Transport	MAP	..	1970
	UK	10–12	BAC Canberra	Bomber	Ex-RAF	..	1968–70
	FR Germany	1	Cessna 337 Super Skymaster	Cabin monoplane	Part of small military aid package	..	March 1971
	Netherlands	1	Coastal minesweeper, "Wildewank" class	Displ.: 373 t.	Completed 1954–56	1971	1971

						Date: number of items	
Recipient	Supplier	Number	Item	Description	Comment	Ordered	Delivered
Gabon	France	1	Dassault Falcon Srs D	Transport	For VIP use	..	1970
		1	Aérospatiale SA 315 Alouette II	Helicopter		(1970)	(1970)
Guinea	USSR	(3)	Torpedo boat, "P-6" class	Displ.: 66 t.	Some reports suggest 6 delivered since 1967	..	1967–70
		(2)	Patrol boat	Displ.: 86 t.	Observed in Conakry in late 1970	..	1967–70
Ivory Coast	France	3	Cessna 337 Super Skymaster	Cabin monoplane		..	(Early 1971)
		1	Aérospatiale/Westland SA 330 Puma	Helicopter		1969	Nov. 1970
	Netherlands	2	Fokker-VFW F. 27 Friendship	Transport		(1970): 1 Mid-1971: 1	Jan. 1971: 1 Nov. 1971: 1
Kenya	UK	5	Scottish Aviation/Beagle B.125 Bulldog	Trainer	$240 000	Oct. 1969	1972
		6	BAC 167 Strikemaster	COIN trainer		Mid-1970	1971
	Canada	2	DHC-4A Caribou	STOL transport	In addition to 4 received earlier	1971	1972
Liberia	USA	1	Motor gunboat	Displ.: 100 t.	Being built in USA for MAP transfer	..	..
Libya	USA	6–8	Lockheed C-130 Hercules	Transport	$17 mn, incl. $13 mn for pilot and technician training	Aug. 1969	1970
		8	Northrop F-5A Freedom Fighter	Fighter/reconnaissance	Last of 18 ordered in 1967; new delivery agreement in May 1969	1967	1972–73
	USSR/Egypt	25	MiG-21	Tandem trainer	Delivered to Egypt for transfer to Libya after US withdrawal from Wheelus Air Base	..	(1971)

	USSR	20–30	T-54 and T-55	Main battle tank	Some Western sources suggest 200	..	July 1970
		36	(PT-76)	Amphibious vehicle		..	July 1970
	UK	1	Westland Wasp	Helicopter	To arm new frigate	Feb. 1968	Dec. 1972
		..	Short Seacat	Naval S-A missile	To arm new frigate; 2 triple launchers	Feb. 1968	Dec. 1972
		2	Patrol boat, "Garian" class	Displ.: 100 t.	New. In addition to 2 delivered in 1969	..	1970
		1	Frigate, Vosper Thornycroft Mk 7	Displ.: 1 325 t.	New. Armament: 2 triple Seacat S-A missile launchers, 1 Wasp helicopter	Feb. 1968	Dec. 1972
	France	58	Dassault Mirage 5	Fighter/ground attack			
		32	Dassault Mirage IIIE	Fighter/ground attack	$144 mn+	Jan. 1970	1970: 4 IIIB 1971: 8 IIIB-6
		20	Dassault Mirage IIIB/IIIR	Trainer/tactical reconnaissance			
		1	Dassault Falcon ST	Transport	Part of Mirage order	Jan. 1970	(1971)
		20	Fouga CM 170 Magister	Trainer	Part of Mirage order	Jan. 1970	(1971)
		8	Aérospatiale SA-321 Super Frelon	Helicopter	Refurbished in France	1970	(1971: 3)
Mali	USSR	..	MiG-17	Fighter		..	1970–71
Mauritius	UK	4	Shorland Mk 2	Armoured car		..	1971
Nigeria	USSR/Egypt	..	MiG-17	Fighter	Some may have been supplied via Algeria	..	Jan. 1970
	UK	2	Corvette, Vosper Thornycroft Mk 3 type	Displ.: 500 t.	New. Laid down in 1970	March 1968	1972
	..	1	Douglas DC-6			..	1971
	Netherlands	6	Fokker-VFW F.27 Friendship	Transport		Dec. 1971	1972
Rhodesia	(South Africa)	7	Aermacchi-Lockheed AL-60	Cabin monoplane	Purchased second-hand from source outside Italy	..	1971
Senegal	France/ Belgium	1	Patrol boat	Displ.: 235 t.	New	..	1971

Recipient	Supplier	Number	Item	Description	Comment	Date: number of items	
						Ordered	Delivered
South Africa	UK	3	HS 125	Transport	$4.3 mn. All 3 destroyed in accident on 26 May 1971	Spring 1969	1969–70
		3	HS 125	Transport	$3.6 mn. Replacement	(Sept. 1971): 3	Dec. 1971
		7	Westland Wasp	Helicopter	$2.4 mn incl. spares; order not confirmed by Westland	(Nov. 1971)	..
		1	Survey ship, "Yarrow" class	Displ.: 1 930 t.	New. Equipped with 1 helicopter	Nov. 1969	1971
	France/ South Africa	..	Dassault Mirage III	Fighter	Licensed production by Atlas Corp. of South Africa	June 1971	..
			Super Mirage F1	Fighter/interceptor			
	France	1	Dassault Mirage IIIE	Fighter	Replacement	..	1970
		9	Transall C-160Z	Transport		..	1969–70
		20	Aérospatiale/Westland SA 330 Puma	Helicopter		..	1970–
		(20)	Aérospatiale SA 316 Alouette III	Helicopter		..	(1969–70)
	France/ South Africa	6–10 bs.	Thomson-CSF/Matra Crotale	S-A missile	Initial cost: $100–120 mn, of which 85 per cent financed by S. Africa; joint development	..	1971: pre-production missiles 1973: definite system
	Francc	3	Submarine, "Daphne" class	Displ.: 850 t.	U.c.: $11 mn. New	(1968)	1970: 1 1971: 2
	Italy/ South Africa	234	Atlas/Aermacchi M.B. 326M "Impala"	Strike/trainer	Licensed production	1965	1966–(73)
	Italy	40	Aerfer/Aermacchi AM.3C	General-purpose monoplane		1971	..
	Portugal	6	Corvette	..	$60 mn. New; equipped with guided missiles Short Seacat or Exocet	Late 1971	..
Sudan	USSR	16	MiG-21	Fighter	Part of $50 mn + arms agreement, repayable over 10 years at low interest rate	Early 1968	1970
		5	An-24	Transport			
		..	An-12	Transport			

		..	Mil Mi-8	Helicopter		..	1970
		..	SA-2 "Guideline"	S-A missile	Displayed on National Day May 1971	..	1971
Tanzania	China	24	MiG-17	Fighter	To be based at new air base, built with Chinese aid; operational in 1972	..	1972
		..	Patrol boat	..	Incl. P6 torpedo boats and Swatow gunboats	..	March/April 1971
		12	Medium tank			..	March/April 1971
	Canada	8	DHC-4 Caribou	STOL transport	Ex-RCAF, 3+ Otters returned in part exchange	..	1971
	Yugoslavia	..	SOKO G2-A Galeb	Trainer		..	1971
Togo	France	1	Aérospatiale SA318C Alouette II	Helicopter		Aug. 1970	..
Tunisia	France	12	F-86 F Sabre	Fighter	Old	(1967)	(1971)
		(3)	Nord Noratlas	Transport	Military aid	..	1969–70
		..	Aérospatiale SS.12	S-S missile	To arm new P48 patrol boats	..	1970–71
		2	Patrol boat, "P48" class	Displ.: 250 t.	New. Military aid. Armed with SS.12 missiles	..	1970–71
		5	Patrol launches	Displ.: 38 t.	New. In addition to 2 delivered in 1969	..	1970: 3 1971: 2
		13	AMX-13	Light tank	Military aid	..	1969–70
		13	Panhard AML Scout Car	Armoured car	Military aid	..	1969–70
	Italy	1+	Aermacchi-Lockheed AL-60 B2	Transport		..	(1971)
Uganda	USA	6	Bell 212 Twin Pac	Helicopter		..	Late 1971
	UK	30	Saracen and Saladin	Armoured car/ armoured personnel carrier	\$2.6 mn	June 1971	1971
	Canada	1	DHC-6 Twin Otter	Transport	For Police Air Wing	(1969)	..
	Israel	2	Commodore Jet 1123 and 1121B	Transport		1971	Late 1971
		10	Sherman	Tank		(1970)	(1970)

Recipient	Supplier	Number	Item	Description	Comment	Date: number of items	
						Ordered	Delivered
Zaïre	USA	8	Lockheed C-130 Hercules	Transport	$17 mn, for air-lifting paratroopers	Jan. 1971	..
	France	30	Aérospatiale/Westland SA-330 Puma	Helicopter	U.c.: $540 000–630 000. 7 delivered by June 1971	1970	1970: 2 1971–: 28
		30	Panhard AML Scout Car	Armoured car		Dec. 1969	..
	Italy	14	Aermacchi M.B. 326 GB	Strike/trainer	In addition to 3 delivered in 1969. Incl. training 50 pilots and 150 technicians	(April 1968)	1970
		12	Siai-Marchetti SF 260 MX	Trainer	U.c.: $148 000. To replace P.148	Dec. 1969	1970
Zambia	UK	1	HS 748 Srs 2A	Transport	For VIP use	(Sept. 1970)	..
		..	BAC Rapier	S-A missile	Approx. $14 mn for 10 launchers, each with 4 missiles	1970	1971
	Italy	12	Aermacchi M.B. 326 GB	Strike/trainer	Incl. training assistance and construction of new jet base at a cost of $11.2 mn	1969	1971–
		5	Agusta-Bell 205	Helicopter			
		8	Siai-Marchetti SF. 260 MX	Trainer		(June 1970)	..
	Yugoslavia	4	SOKO J-1 Jastreb	Light attack	U.c.: $305 000	(1970)	1971
		2	SOKO G2-A Galeb	Trainer	U.c.: $460 000	(1970)	1971
Indian Sub-continent							
Bangladesh	India	3–4	DHC-6 Twin Otter	Transport	Emergence of Bangladesh Air Force, 7 Dec. 1971; gift	Dec. 1971	Dec. 1971
		1–2	Light helicopter				
Ceylon	USA	3	Bell 205A-1	Helicopter		..	1970
	USSR	1	MiG-15 UTI	Trainer	Long-term credit; emergency	April/May 1971	April/May 1971
		5	MiG-17	Fighter			
		2	Kamov KA-26	Helicopter			
		20	Armoured car				
	UK	6	Bell 206A Jet Ranger	Helicopter	Emergency re-imbursable aid; purchased by UK from USA	April/May 1971	April/May 1971
		18	Saladin	Armoured car	Emergency re-imbursable aid	April/May 1971	April/May 1971

India	USSR/India	(100)	HAL/MiG-21 M	Fighter	Licensed production	1971	1973/74: —
		(400)	HAL/MiG-21 FL	All-weather fighter	Assembly started in 1966. First airframe with Indian components produced in 1970. 300 MiG-21 FLs to be produced from 1970 to equip 15 squadrons. 90+ in service by 1971	(1963)	1966–71: 90+
	USSR	50	Sukhoi Su-7	Fighter/bomber	New batch probably ordered Sept. 1969 in addition to 100 ordered in 1968. By 1971 5 Su-7 squadrons	(Sept. 1969): 50	1971
		..	SA-2 "Guideline"	S-A missile	A new unit reported operating in 1971	..	(1970)
	USSR/India	..	"Atoll"	A-A missile	Licensed production; to arm MiG-21 FL	1963	1968–
	USSR	1	Submarine, "F" class	Displ.: 2 000 t.	Last of total of 4	Aug. 1965	1970
		1	Frigate, "Petya" class	Displ.: 1 050 t.	In addition to 5 transferred in 1969	1968	(1971)
		6	Torpedo boat, "Osa" class	Displ.: 165 t.		..	1970–71
		450	T-54/T-55	Main battle tank		..	1968–70
		150	PT-76	Amphibious tank		..	(1971)
	UK/India	27	HAL/HS 748 Srs 1 and 2	Transport	Licensed production for IAF, and Indian Airlines Corp. Current production rate: 9/month	1959	1970: 3 1971–: 12
	UK	12	Canberra B.Mk. 15 and 16	Bomber	Ex-RAF, refurbished	Early 1970	(1970–71)
		6	Westland Sea King	ASW helicopter	Cost of initial batch of 4: $4.8 mn	Feb. 1970: 4 Dec. 1970: 2	1972
		..	Short Tigercat	S-A missile	40 systems	Oct. 1971	..
	UK/India	(100)	"Vijayanta"	Main battle tank (Vickers 37 t.)	Licensed production from 1967; by 1971 60 per cent indigenously produced	1961	(1967–70)
	France/India	80	Aérospatiale SA 316 Alouette III	Helicopter	Licensed production. Power plant Artouste turboshaft also under licensed production in India	(1970)	..
		20	Aérospatiale SA 315 Lama	High-altitude helicopter			
	France	20	Aérospatiale SA 316 Aloulette III	Helicopter	Sales agreement included in above agreements	(1970)	1971

Recipient	Supplier	Number	Item	Description	Comment	Date: number of items	
						Ordered	Delivered
	France/India	..	Aérospatiale AS 30	A-S missile	Licensed production	April 1969	..
		..	Aérospatiale Harpon	S-S/S-A missile	Licensed production	1971	..
		..	Aérospatiale SS. 11	S-S missile	Licensed production; to arm Japanese utility trucks delivered 1970–71	April 1969	1970–71
	New Zealand	10	Canberra B(1) 12	Bomber		1970	1970: 2 1971: 8
Nepal	UK	1	Short Skyliner Executive	STOL transport	For VIP use	(Early 1970)	Oct. 1970
		1	Short SC.7 Skyvan Srs 3 M	Light STOL transport	For Army	Oct. 1970	1971
Pakistan	USA	7	Martin B-57 Canberra	Bomber	MAP: delivery cancelled in Nov. 1971. $15 mn, surplus stocks, which is one-third of original acquisation cost	Oct. 1970	..
		12	Northrop F-5 Freedom Fighter	Fighter			
		6	Lockheed F-104 Starfighter	Fighter			
		300	M-113	Armoured personnel carrier			
		4	Cessna T-37	COIN trainer		1969	Early 1971
	USSR	..	Mil Mi-8	Helicopter	For Army Aviation Wing	..	1970–71
	France	28	Dassault Mirage 5	Fighter/ground attack		1970	June 1972–
		2	Dassault Mirage IIIB	Trainer			
		3	Submarine, "Daphne" class	Displ.: 700 t.	New	1967	1970
	France/ Pakistan	(30)	Aérospatiale SA 316 Alouette III	Helicopter	Licensed production; delivery banned 1971	1970	..
	China	..	MiG-19	Fighter	Pakistani sources claim deliveries of 400 fighters and bombers began in late 1971		1971
		(100)	T-59	Main battle tank	Additional T-54s and T-59s promised late 1971	..	1970
		(110)	T-54/55	Main battle tank		..	1971
		2–3	Submarine, "W" class	..		1970	..
		9	Gunboat	..	For use as mineseekers	..	1971

	Saudi Arabia	10	DHC-2 Beaver	STOL transport	On loan	..	1971
		2	Aérospatiale SA 316 Alouette III	Helicopter	On loan	..	1971
Far East							
Burma	USA	12	Cessna T-37C	COIN trainer	MAP	1968	(1971)
Brunei	USA	2	Bell 212 Twin-Pac	Helicopter		..	1971
		4	Bell 206A Jet Ranger	Helicopter		..	(1970–71)
		2	Bell 205A-1	Helicopter		..	(1970)
	UK	1	HS 748	Transport	In operation 1971	..	(1970)
	Singapore	2	Fast patrol boat, Vosper Thornycroft type	..	$400 000; new	Feb. 1970	(1970)
Indonesia	UK	3	Short SC.7 Skyvan	Light STOL transport	$1.56 mn. Operated by Air Force on behalf of Ministry of Interior in West Irian	..	1970
	Australia	5	Cessna Turbo-Skywagon T 207	Utility aircraft	$332 000+	..	1970
	Malaysia	12	Scottish Aviation Twin Pioneer	Transport	Acquired by Malaysia from UK in 1961	..	April 1971
	New Zealand	(2)	AESL Airtourer T6	Light monoplane	Part of Colombo Aid Plan	1971	..
Khmer Republic	USA	6	Bell 205A-1	Helicopter	4 destroyed in Jan. 1971	..	1970
		..	NA T-28	Trainer	To replace 10 destroyed 22 Jan. 1971	..	1971
	Australia	6	Douglas C-47	Transport	Ex-RAAF	..	1971
Korea, North	USSR	..	Su-7	Fighter/ground attack		..	1971
		..	"Frog-5"	S-S missile		..	1971
		..	"Samlet"	S-S missile		..	1971
Korea, South	USA	..	McDonnell-Douglas F-4 Phantom	All-weather fighter	Under new defence agreement 1971, in addition to 18 supplied in 1969. Soviet sources suggest S. Korea will receive a total of 54	Jan. 1971	..

Recipient	Supplier	Number	Item	Description	Comment	Date: number of items	
						Ordered	Delivered
		10+	Grumman G-89 Tracker	Naval ASW aircraft	Under new defence agreement 1971	Jan. 1971	1971
		..	MGR-1 Honest John	S-S missile	MAP	..	June 1971
		2	Coastal minesweeper	Displ.: 320 t.	New, MAP	..	1970: 1
		..	M-48 Patton A2C	Main battle tank	MAP	..	June 1971
		..	M-113A	Armoured personnel carrier	MAP	..	June 1971
		..	M-107	157 mm howitzer	MAP	..	June 1971
		..	M-110	8 in. howitzer	MAP	..	June 1971
Royal Laos	USA	..	Douglas AC-47	Fighter/ground attack	According to statement by Souvanna Phouma	..	1969–70
Pathet Lao	(North Viet-Nam)	..	T-54	Main battle tank	At least 1 reported in March 1971	..	(1970–71)
Malaysia	USA	6	Sikorsky S-61 A4	ASW helicopter		1970	1971
	UK	15	Scottish Aviation/Beagle B.125 Bulldog. Srs 100	Trainer	$800 000	May 1971	Oct. 1971–July 1972
		2	HS 125	Transport	$2.3 mn. For VIP use	..	1970
		1	(Westland Wasp)	Helicopter	To arm frigate	Feb. 1966	Mid-1971
		..	Short Seacat	S-A missile	To arm frigate	Feb. 1966	Mid-1971
		1	Frigate, Yarrow type	Displ.: 1 250 t.	New, armed with 1 helicopter and 1 quadruple Seacat launcher	Feb. 1966	Mid-1971
		1	Survey ship, "Ton" class	Displ.: 1 360 t.	Ex-UK: converted from coastal minesweeper in 1964	1969	1970
	France	10–12	Dassault Mirage 5	Fighter/ground attack		June 1971	..
		..	Aérospatiale MM-38 Exocet	Naval S-S missile	To arm 7 patrol boats which can carry 8 each	Aug. 1970	..
		..	Nord SS.12 (M)	S-S missile	To arm missile boats delivered by UK in 1967	..	1971
		7	Fast patrol boat, "La Combattante II" class	..	$22.5 mn; armed with Exocet SSM	Aug. 1970	..

		44	VTT/AML Panhard	Armoured personnel carrier		Sept. 1971	..
	Australia	6	CAC Avon-Sabre	Fighter	Ex-RAAF: refurbished; in addition to 10 delivered in 1969	1971	Late 1971
	Singapore	1	Diving tender	Displ.: 120 t.		..	1971
Singapore	USA	1	Cessna 402	Transport	For communications duties	..	1970
		1	Landing ship, LST type	Displ.: 1 653 t.	Ex-US Navy	..	July 1971
	UK	12	Hawker Hunter FGA.74	Fighter			1971
		4	Hawker Hunter FR.74A	Reconnaissance	Refurbished	(June 1968)	1971
		4	Hawker Hunter T.75	Trainer			1970
		16	BAC 167 Strikemaster	COIN trainer	$7.2 mn. UK to contribute	(July 1968)	1969–70
		60	BAC Bloodhound 2	S-A missile	$24 mn, incl. spares; ex-RAF in Singapore, being refurbished	(April 1969)	1971
		2	Fast patrol boat, Vosper Thornycraft	Displ.: 100 t.	New; cost of 6: $9.6 mn; 4 being built by Vosper, Singapore	May 1968	1970: 1 1971: 1
		2	Landing ship, LCT type	Displ.: 1 657 t.	Ex-UK	..	1970
	Italy	16	Siai-Marchetti SF. 260X	Light trainer	U.c.: $48 000	(June 1971)	1971
	New Zealand	6	AESL Airtourer T6	Light monoplane	First 2 gift, as part of Colombo Aid Plan; cost of 4 plus option for further 2: $157 000	1971: 4	Sept. 1970: 2
Taiwan	USA	34	NA F-100 Super Sabre	Fighter	MAP, from excess stocks; cost of refurbishing: $5 mn	..	1970
		9	Grumman S-2A Tracker	ASW patrol plane		..	(1971)
		18	Lockheed F-104 Starfighter	Fighter	MAP, from excess stocks	..	1970
		6	Hughes OH-6A	Light observation helicopter	MAP	(1970)	1970
		..	Northrop F-5E	COIN fighter	U.c.: $1.5 mn. Armed with Sidewinder AIM-9 missile	..	1972–75
	USA/Taiwan	50 +	Bell 205A-1	Helicopter	Licensed production	1969	1970–
		35	Pazmany PL-1B	Light monoplane	Licensed production	1968	1970
	USA	1	Destroyer, "Allen Sumner" class	Displ.: 2 200 t.	Ex-US: completed in 1944. In addition to 3 transferred in 1969. Cost of 4: $1 mn.	May 1970	1970

						Date: number of items	
Recipient	Supplier	Number	Item	Description	Comment	Ordered	Delivered
Thailand	USA	..	Northrop F-5E	COIN fighter	U.c.: $1.5 mn. Total of 105 ordered for S. Viet-Nam and Thailand	..	1972–75
		16	NA-Rockwell OV-10C Bronco	COIN aircraft		Nov. 1969	1971
		(36+	Raytheon MIM-23 Hawk	S-A missile	Reports that order may be cancelled in favour of radar-equipped A-A batteries	..	..)
		2	Frigate, Corvette type	Displ.: 900 t.	New	End 1969	..
		5	Coastal gunboat	Displ.: 130 t.	New	..	Feb. 1970: 3 Dec. 1970: 2
		5	Fast patrol boat	Displ.: 20 t.	New	..	Sept. 1970
		1	Landing ship, LST type	Displ.: 1 625 t.	Ex-US; on loan	..	March 1970
	UK	..	Seacat	Naval S-A missile	1 quadruple launcher on new frigate	Aug. 1969	1973
		1	Frigate, Yarrow type	Displ.: 1 780 t.	New. $15.6 mn. Armed with Seacat S-A missile	Aug. 1969	1973
	New Zealand	(2)	AESL Airtourer T6	Light monoplane	Part of Colombo Aid Plan	1971	..
Viet-Nam, South	USA	..	Northrop F-5E	COIN fighter	U.c.: $1.5 mn. Total of 105 ordered for S. Viet-Nam and Thailand	..	1972–75
		(55)	Fairchild C-119	Transport	Re-equipping of transport squadrons	..	1970–
		150	Bell 205A-1	Helicopter	USAF requested $44.4 mn in 1969 to purchase Bell 205 for S. Viet-Nam.	(1969)	1969–70
		20	Boeing-Vertol 114 Chinook	Helicopter		..	Dec. 1970
	USA/ S. Viet-Nam	..	Pazmany PL-2	Light monoplane	Licensed production	1971	..
	USA	2	Frigate, "Casco" class, CG WHEC type	Displ.: 1 766 t.	Ex-US; completed in 1944	..	Jan. 1971
		2	Landing ship, LST type	Displ.: 2 366 t.	Ex-US	..	1970
		2	Destroyer escort, converted "Edsall" class, DER type	Displ.: 1 590 t.	Ex-US; completed in 1943 and 45. On loan, authorized by US Congress in 1970	(1970)	Feb. 1971: 1 July 1971: 1

		1	Escort ship	Displ.: 640 t.	Completed 1944	..	Early 1970
		21	Coast guard vessel, "Point" class	Displ.: 64 t.	Ex-US	..	1970: 10 1971: 11
		650	Small river and coast guard craft	..	125 were transferred in Dec. 1970	..	1969–71
		24	M-109	175 mm howitzer		..	June 1971–

Central America

Cuba	USSR	5	MiG-21	Fighter	According to US Department of Defense	..	Oct. 1971
Dominican Republic	USA	7	Hughes OH-6A	Helicopter	MAP	1970	..
Guatemala	USA	(6)	Cessna A-37	COIN fighter		..	1971
		..	Bell 205 A-1	Helicopter		..	1971
Honduras	USA	(4)	F.51 Mustang	Fighter	To replace losses in 1969 war with El Salvador	(1970)	1971
		2	Douglas B-26 Invader	Bomber	To replace losses in 1969 war with El Salvador	(1970)	1971
	Venezuela	4	F.86K Sabre	Fighter	$1.5 mn; part of 47 delivered to Venezuela from FR Germany in 1966	1969	1970
Jamaica	USA	1	Bell 206A Jet Ranger	Helicopter		..	Mid-1971
Mexico	USA	20	Beech Musketeer Sport	Cabin monoplane	$500 000	1969	Jan. 1970
		(1)	Bell 212 Twin-Pac	Helicopter	For VIP use	..	1971
		1	Lockheed Jet Star	Transport	For VIP use	..	Late 1971
		2	Destroyer, "Fletcher" class	Displ.: 2100 t.	Ex-US; completed in 1943	..	1971
	UK	3	Britten-Norman BN-2A Islander	Transport	Purchased through US distributor	..	Aug. 1971: 2
		1	HS 125	Transport		..	1971
Nicaragua	USA	4	Hughes OH-6A	Helicopter	MAP	1970	..

Recipient	Supplier	Number	Item	Description	Comment	Date: number of items	
						Ordered	Delivered
Panama	USA	1	Douglas DC-6	Transport		..	Jan. 1971
	UK	2	Patrol boat, Vosper Thornycroft	Displ.: 96 t.	$1.6 mn; new	..	1971
Trinidad and Tobago	UK	2	Patrol boat, "Trinity" class	Displ.: 100 t.	New	..	Jan. 1972
South America							
Argentina	USA	41	McDonnell-Douglas A-4B Skyhawk	Fighter	Refurbished. 25 for Air Force, 16 for Navy aircraft carrier	Nov. 1965: 25 1970: 16	1970: 25 1971: 16
		3	Lockheed C-130E Hercules	Transport		1970	1971: 2 1972: 1
		8	Bell 205A-1	Helicopter		..	1971
		7	Bell 206 Jet Ranger	Helicopter		(1968)	(1970)
		12	Hughes OH-6A	Helicopter	For Army, Cost: $626 500; of which 6 Model 500 for Navy	May 1971: 6 Model 500	1969–70: 12 OH-6A 2 Model 500
		8	Hughes 500M	Helicopter			
		3	Fairchild-Hiller Turbo Porter	STOL transport	For Navy	..	1971
		1	Douglas DC-6	Transport		..	1971
		4	Sikorsky S-61 D-4	ASW helicopter	For Navy	1971	1972
		1	Dock landing ship	Displ.: 5 480 t.	Ex-US	..	May 1970
	UK	10	B.62 Canberra	Bomber	$9.6 mn approx.; Ex-UK, refurbished	1969	1970–71
		2	T.64 Canberra	Trainer			
		5	Short SC.7 Skyvan Srs 3M	Light STOL transport	$2.4 mn: for Navy	Nov. 1970	1971
		1	HS 125	Transport	For Navy	Early 1971	April 1971
		2	Westland Lynx WG. 13	ASW helicopter	For use on 2 new Vickers frigates	Feb. 1969	1973
		..	Short Tigercat	S-A missile		1968	(1970)
		..	HSD Sea Dart	Naval S-A missile	2 twin launchers/new frigate		
		2	Frigate, Vickers type 42 "Sheffield" class	Displ.: 3 500 t.	New; $72 mn, incl. $24 mn for missile system and gas turbines. Second to be assembled in Argentina	May 1970	1973: 1

	France	12	Dassault Mirage IIIE	Fighter/bomber	Armed with 1 Matra R.530 A-A missile/aircraft	Oct. 1970	(1972)
		2	Dassault Mirage IIIB	Trainer		Oct. 1970	(1972)
		2	Aérospatiale SA 316 Alouette III	Helicopter	For Navy, in addition to 4 delivered in 1969	..	1970
		..	Matra R.530	A-A missile	To arm 12 Mirage IIIE	Oct. 1970	(1972)
	France/ Argentina	30	AMX-13	Light tank	Being assembled under licence	March 1968	Oct. 1969–71
	France	24	Howitzer	155 mm self-propelled		Aug. 1968	1969–70
	Netherlands	1	Fokker-VFW F.28 Fellowship	Transport	For presidential use	July 1970	1971
		2	Fokker-VFW F.27 Friendship	Transport		1971	(Dec. 1971)
	FR Germany	..	MBB Bo 810 Cobra 2000	Anti-tank missile	For use on Daimler-Benz Unimog general purpose vehicles purchased in 1969	..	1969–
		2	Submarine, type 205	Displ.: 450 t.	New; being built in Argentina from W. German material	Jan. 1969	(1972)
	Italy	18	Aermacchi MB.326 6B	Armed trainer	In addition to 6 delivered in 1969 for Navy	(1969)	(1970)
	Canada	1	Canadair CC-106 Yukon	Transport	Ex-RCAF; option for further 3	End 1970	..
Brazil	USA	15	McDonnell-Douglas A-4F Skyhawk	Fighter		(Jan. 1969)	(1971)
		25	Cessna 318 (T 37C)	Trainer/ground attack	$6 mn. For COIN training	(Aug. 1968)	Oct. 1969– March 1970–
		4	Sikorsky SH-3D Sea King	ASW helicopter		Aug. 1968	1969–70
	UK	..	Short Seacat	Naval S-A missile	To arm new Vosper Mk 10 frigates	(Sept. 1970)	1976–79
	UK/Australia	..	Ikara	ASW missile	To arm new Vosper Mk 10 frigates	(Sept. 1970)	1976–79
	UK	6	Frigate, "Nitheroi" class Vosper Thornycroft Mk 10	Displ.: 3 200 t.	New. $283 mn, of which $228 mn credit at 5.5 per cent over 8 years Versions: 2 general purpose and 2 ASW DLG type to be built in UK, 2 ASW to be built in Brazil. Armaments: Exocet S-S, Seacat S-A and Ikara ASW missiles	Sept. 1970	1976–79

Recipient	Supplier	Number	Item	Description	Comment	Date: number of items Ordered	Delivered
		2	Submarine "Oberon" class	Displ.: 1610 t.	New; $26.4 mn	1969	1972–73
	France	12	Dassault Mirage IIIE	Fighter	$70 mn	May 1970	1972
		4	Dassault Mirage IIIB	Trainer			
		..	Aérospatiale MM 38 Exocet	Naval S-A missile	To arm 3–4 new Vosper Mk 10 frigates	Late 1971	1976–79
	France/FR Germany	7	Breguet Atlantic	Trainer	German content of the export: $2.5 mn	June 1971	1971
	Canada	12	DHC-5 Buffalo	STOL transport	$30 mn, incl. spares and support. In addition to 12 delivered in 1969	1968	March–Oct. 1970
	Italy/Brazil	112	Aermacchi/Embraer EMB 326 GB TF-26 Xavante	Trainer	Licensed production. Projected cost: $70 mn. Mainly Brazilian components from 1975. Planned prod. rate: 2/month over 5 years	May 1970	1971: 4
	FR Germany	4	Fast minesweeper, "Schütze" class	Displ.: 230 t.	New; 6 more are projected	April 1969	..
Chile	USA	9	Beechcraft 99A Airliner	Transport	$7.1 mn	April 1970	Mid-1970
		1	Lockheed C-130 Hercules	Transport	$4 mn; part of US government $5 mn credit for military purchases	June 1971	..
		1	Piper PA-31 Turbo Navajo	Transport		..	Mid-1970
		4	Bell 206A Jet Ranger	Helicopter	For Navy	..	June 1970
		1	Tug	Displ.: 1235 t.	On loan	..	July 1971
	UK	4	Hawker Hunter FGA 71	Fighter	Ex-RAF	Oct. 1969	(1970)
		..	Short Seacat	Naval S-A missile	To arm new Leander frigates	Oct. 1969	..
		2	Submarine, "Oberon" class	Displ.: 1610 t.	New	Oct. 1969	
		2	Frigate, "Leander" class	Displ.: 2 500 t.	New; armaments: 1 quadruple "Seacat" launcher, 1 light helicopter	Oct. 1969	....
	France	..	Aérospatiale MM 38 Exocet	Naval S-S missile		(1971)	..

	Sweden	1	Cruiser	Displ.: 8 200 t.	$6 mn. Refurbished 1958	Aug. 1971	1972
Colombia	USA	1	Bell 212 Twin-Pac	Helicopter	For presidential use	..	1971
	France	14	Dassault Mirage 5-A	Fighter/bomber	Contract incl. training of 86 pilots in France	Dec. 1970	..
		2	Dassault Mirage 5-R	Reconnaissance			
		2	Mirage 5-D	Trainer			
	FR Germany		Submarine		$33 mn	1971	..
	Netherlands	1	Fokker-VFW F.28 Fellowship	Transport	For VIP use	Dec. 1970	Jan. 1971
Ecuador	USA	12	Cessna R172E (T-41D)	Trainer	$347 000	1970	Oct. 1970
		2	Fairchild–Hiller Turbo Porter	STOL transport	For postal and medical service	Early 1971	June 1971
	UK	3	HS 748 Srs 2A	Transport	Cost of 2: $2.4 mn; 2 for transport in remote areas, 1 for presidential use	1970: 2 1971: 1	Sept./Oct. 1970: 2 (Dec. 1970: 1)
		1	Short SC.7 Skyvan 3M	Light STOL transport	For Army Air Service	Jan. 1971	April 1971
		8	BAC 167 Strikemaster	COIN trainer		Dec. 1971	..
	France	41	AMX-13	Light tank	For COIN	Dec. 1970	..
		27	AML-245	Armoured reconnaissance vehicle		Dec. 1970	..
	Chile	1	Douglas DC-6B	Transport		..	1970
	(Portugal)	1	Douglas DC-6B	Transport		..	1971
Guyana	UK	2	Britten-Norman BN-2A Islander	Transport	Approx. $200 000	Jan. 1971	Feb. 1971
Peru	USA	6	Lockheed C-130 Hercules	Transport	Reportedly ordered together with 6 US helicopters	1970	1970–71
	UK	6	BAC Canberra	Bomber	$4.8 mn	May 1968	1970
		2	Destroyer, "Ferré" class	Displ.: 2 800 t.	Ex-UK "Daring" class: completed 1953, resp. 1954	1969	1971
	France	12	Dassault Mirage 5	Fighter/ground attack	$20–25 mn; repayable over 7–8 years	Oct. 1967	1968–70
		2	Dassault Mirage 5				

Recipient	Supplier	Number	Item	Description	Comment	Date: number of items Ordered	Delivered
		..	Aérospatiale MM 38 Exocet	Naval S-S missile	Estimated u.c. of installed missile: $252 000	1970	Nov. 1971
		78	AMX-13	Light tank		1967	1969–70
	Canada	16	DHC-5 Buffalo	STOL transport	$60 mn	March 1970	1971–72
		8	DHC-6 Twin Otter Srs 300	STOL transport	$5 mn	Dec. 1970	1971
	FR Germany	106	UR-416	Armoured car	In addition to 112 earlier received	1971	1971
Uruguay	USA	2	Fairchild-Hiller FH-227B	Transport		1971	1971
	Netherlands	2	Fokker-VFW F.27 Friendship	Transport		..	1970
Venezuela	USA	4	Lockheed C-130 Hercules	Transport		Dec. 1970	March 1971–
		12	Cessna 182 Skylane	Cabin monoplane		June 1971	1971
	France	13	Dassault Mirage IIIE	Trainer		Late 1971	Mid-1973–
		2	Dassault Mirage IIID				
	Canada	20	Canadair CF-5D	Trainer	Ex-RCAF. Cost of 18: $35 mn	Late 1971	..
	Norway	6	Fast patrol boat, "Storm" class	..	$21 mn; new	Mid-1971	1973–
Europe							
Greece	USA	1	Dock landing ship	Displ.: 4 790 t.	Completed 1945	..	1971
		2	Coastal minesweeper	Displ.: 320 t.	New	..	1969–70
	France	26	Aérospatiale MM 38 Exocet	S-S missile	U.c.: $252 000. Option for further 26. To arm new gunboats	..	Nov. 1971
		6	Fast gunboat	Displ.: 220 t.	New; armed with Exocet SSM; cost of 4: $21.1 mn. First units completed in 1971	Mid-1969	1971–
		55	AMX-30	Main battle tank	$32.4 mn, 7 per cent credit	July 1970	1971

	FR Germany	40	Nord Noratlas	Transport	NATO military aid: ex-Luftwaffe	(July 1969)	1970
		4	Submarine	Displ.: 900 t.	WEU approval Jan. 1971	1967	1971
	Netherlands	6	Republic F-84F	Fighter	Refurbished; NATO aid	..	Late 1971
Portugal	USA	2	Boeing 707	Transport	$18 mn. For troops and war material to Africa	July 1970	1971
		2	Boeing 747 Jumbo	Transport		1971	1972
	France	12	Aérospatiale/Westland SA-330 Puma	Helicopter		Jan. 1970	1970–71
	W. Germany	15	Nord Noratlas corvette,	Transport	Ex-Luftwaffe	..	(1970)
		3	"Joao Coutinho" class	Displ.: 1 252 t.	$37.5 mn. New	April 1968	1970
	Italy	..	Agusta-Bell 205	Helicopter		..	1970
	Spain	3	Corvette, "Joao Coutinho" class	Displ.: 1 252 t.	New	..	1970–71
Portuguese Angola	Netherlands	1	Fokker-VFW F.27 Friendship	Transport	Bringing total to 5. Airlines of Angola and Mozambique provide military transports	..	1971
Turkey	USA	12	Grumman G-89 Tracker S-2E	ASW trainer	MAP	..	March 1972–
		2	Grumman G-89 Tracker TS-2A	ASW trainer	MAP	..	July 1971
		5	Beech T-42A	Trainer	MAP. $550 000	..	1971
		3	Submarine, "Balao" class	..	Loan of 2 authorized by US Congress in March 1970; being refitted	(1970)	..
		1	Submarine, "Tench" class	..	Being refitted	(1970)	..
		1	Boom defence vessel	Displ.: 780 t.	Ex-Netherlands/ex-USA; completed in 1952	..	Sept. 1970
		1	Patrol boat, "Akhizar" class	Displ.: 280 t.	New	..	..
		5	Gunboat	..	New	..	(1971–72)
	UK/USA	1	Coastal minesweeper, MSC type	Displ.: 320 t.	Transferred from UK via USA	..	Nov. 1970
	France/USA	2	Coastal minesweeper, MSC type	Displ.: 320 t.	Transferred from France via USA	..	March 1970

						Date: number of items	
Recipient	Supplier	Number	Item	Description	Comment	Ordered	Delivered
	FR Germany	20	Transall C-160	Transport	NATO aid. U.c. $1.8 mn	(Dec. 1970)	1971: 9
		2	Dornier Do-28	Transport	U.c.: $184 000	Early 1970	(1971)
		4	Submarine	Displ.: 450 t.	New; NATO aid; partly built in Turkey	Jan. 1970	..
	Italy	3	Agusta-Bell 205A	Helicopter		1971	..

6. Resources devoted to military research and development

Even though the nuclear weapons stocks of the United States and the Soviet Union already incorporate a large measure of "overkill", the technological arms race goes on. There is no evidence of any reduction of the enormous military research and development efforts in these two countries. Nor are these vast efforts confined to the improvement of nuclear weapon systems: technological advances in "conventional" weapons as well continue at an unabated rate. During the last decade, the research and development efforts of most weapons producers other than the two main nuclear-weapon powers have been maintained at previous levels, or, in some cases, have grown substantially. The capacity for domestic development and production of a range of sophisticated conventional weapons has been spreading to more and more countries.

These are some of the main conclusions which emerge from this study of the size of military research and development efforts around the world. The main emphasis of the study has been on the level of expenditure for military research and development (R&D). An attempt has been made to assemble series of total military R&D outlays for as many countries and as long a time-span as possible, over the post-war period. Section II of this chapter analyses the estimates which have been assembled, covering 22 countries.

There are a number of countries with significant military R&D efforts for which it has not been possible to obtain reliable series of military R&D expenditures. To provide a basis for estimates of the size of worldwide military R&D efforts, additional data has been assembled on the major weapons development projects under way around the world during the 1960s. This data is analysed in section III. The conclusions of the study are summarized in section IV.

I. *Introduction*

The post-World War II rise in world military expenditure has been accounted for, to a large extent, not by a traditional proliferation of quantities of armaments, but by the technological arms race.[1] This race involves the continual replacement of "obsolete" weapons by generations of successively more and more complex, costly and lethal types. Research and development (R&D) efforts form the core of the technological competition: they are the source of the continual "improvements" in weaponry. If all R&D efforts were abruptly stopped, the manufacture of weapons for replacement purposes might still continue; the quantities of existing weapons might be increased; and the arsenals of the smaller and middle powers might even be brought technologically closer to those of the USA and the USSR through international arms transfers. But in its most important form—involving the continual production of new, more dangerous and ever more expensive weapons—the arms race would come to a halt.

Estimates of military research and development expenditures give a good impression of the magnitude of efforts to change and improve weapons. They do not necessarily measure the degree of technological sophistication of the armaments of different countries, since sophisticated weapons can be imported or manufactured under licence, as well as developed domestically. Relative levels of military R&D spending do, however, give a rough indication of the extent to which various countries currently play an *independent* role in the technological competition, through their own development and production of new weapons. As a result of the long lead-times involved in weapons development (often 5 to 10 years or more), military R&D estimates also form an important part of the data needed to answer more ambitious questions about the future of the technological arms race.

In assembling estimates of military R&D expenditure, an attempt has been made to obtain figures which represent *all* R&D financed by the defence department in each country, *plus* any other government-financed R&D which is directed at weapons development or supported primarily for military or defence reasons.[2] For the most part, the figures which make up total military R&D outlays have been taken directly from official sources. In a few cases, estimates for some portion of the total have been derived from partial or incomplete official data. Many of the estimates represent defence department expenditures only, and it is not known whether there are additional military R&D funds, channelled through civil government agencies.[3] The amount of additional, unidentified military

[1] See the *SIPRI Yearbook 1968–69*, pp. 90–96.

[2] This definition has been selected as the most useful one, among several more or less equally practicable alternatives. It should be noted that the figures given in this study may differ from those published in other sources, as a result of differences in the definition of military (or "defence") R&D. A detailed analysis of the considerations surrounding the selection of a definition is given in appendix 6A.

[3] A table showing the composition of the estimates—insofar as this is known—is given in appendix 6A, page 220.

R&D is not likely to amount to more than 10–20 per cent of identified military R&D outlays in the countries where the estimates are highest (around $100 million annually and higher); but it may be considerably higher in a few of the countries where the estimates are very low ($25 million annually and below).[4]

In the course of the study, an effort was made to obtain estimates of worldwide military research and development expenditures. The figures found are limited almost exclusively, however, to Western industrialized countries. No information on the level or trend of military R&D outlays is published in the Soviet Union or other East European countries, and it has not been possible to obtain reliable annual military R&D expenditure series for any of these countries.[5] Among non-industrialized countries, estimates have been found only for India. The group of 22 countries for which exact figures are given below covers, thus, the countries of Western Europe (except Portugal), North America, Japan, Australia and India. Despite the relatively small size of this group, it appears that the estimates cover most countries with significant military R&D efforts, with the important exceptions of the Soviet Union and, to a lesser extent, China. This assessment is based on examination of a separate set of data, set out in section III, on worldwide weapons development projects under way during the period from 1960 to 1968. An estimate of the likely dimensions of worldwide military R&D efforts is given in the conclusions of the study, in section IV.

II. *The pattern of military R&D spending in 22 countries*

The level of current military R&D expenditures

The pattern of spending on military research and development is one of enormous concentration in a very small number of countries (table 6.1 and

[4] This applies particularly to the estimates for Japan and India; and further details concerning the estimates for these two countries are given on page 174. A general assessment of the reliability of the estimates is given in appendix 6A.

[5] Various estimates of the level and trend of Soviet military R&D expenditures have been published in the United States, in research studies and in statements by official US spokesmen. An analysis of the methodology on which these estimates appeared to be based, published in the *SIPRI Yearbook 1969/70* (pp. 288–306), led to the conclusion that the US estimates of the Soviet effort were not sufficiently reliable to be used in this study. Since that analysis was prepared (mid-1970), new information on the methodology of the estimates has been released. This has tended to confirm that the figures for the Soviet effort published in the United States through 1971 are not at all reliable. In addition, in statements by official US spokesmen published in the first months of 1972, the attempt to provide exact estimates of Soviet military R&D expenditures appears to have been abandoned. None of the US figures is used, therefore, in this study. For further detail on the US estimates, see appendix 6B, page 232.

chart 6.1). The US effort alone, estimated at over $8.5 billion[6] in 1970,[7] vastly overshadows that of all other countries in this group. The combined military R&D outlays of the remaining countries, converted to US dollars at official exchange rates, amount to less than $1.7 billion. Of this amount, over three-quarters (about $1.4 billion) is spent by only three countries: the United Kingdom, France and the Federal Republic of Germany. The other eighteen nations—including Australia, Canada, Italy, Japan and Sweden—spend only about $0.3 billion in all. Thus, the United States currently accounts for about 85 per cent of the total military research and development expenditures of Western industrialized countries, and the USA together with the UK, France and Germany for about 97 per cent.

This pattern of concentration is not changed if, instead of expenditures, the actual quantities of manpower and material resources devoted to military R&D are considered. Expenditures converted at official exchange rates do not necessarily give an accurate picture of the resources absorbed by R&D efforts, mainly because there are substantial differences in the wages of R&D employees in different countries, and wages account for about half of all R&D outlays. To obtain some idea of the bias caused by using expenditures at official exchange rates as a measure of resources, approximate "R&D exchange rates", which allow for the international differences in wages, have been calculated.[8] Average annual military R&D expenditures for 1967–1970, converted to US dollars with these rates, are shown in table 6.1 (col. D) and chart 6.1. As is apparent, the differences

[6] The estimates for the United States which are given in the main text and used in accompanying tables and charts refer to total US military R&D expenditure *excluding* "Independent Research and Development". This term—IRD—is used in the United States to cover R&D which is financed as an *overhead* on various government contracts (especially those of the Defense Department, NASA, and, to a lesser extent, the AEC). The R&D financed in this way by the Defense Department is not in any way ordered or supervised by the department, but is instead planned and conducted entirely on company initiative. There is evidence that some "IRD" is concerned with weapons R&D; but also that some has involved company attempts to diversify from military products into civil fields. Estimates of total US military R&D expenditures including estimated IRD expenditures financed through contracts funded from "procurement" appropriations (but not those, which are already included, financed from R&D appropriations) are given in the statistical tables in appendix 6A. The inclusion of estimated IRD expenditures makes no significant difference with regard to the level or trend of total US military R&D expenditures, in the context of this international comparison.

[7] Throughout this section, the years refer to the national fiscal years which coincide with or *begin during* the year indicated in tables and text. For countries where the fiscal year begins on 1 April (e.g., the United Kingdom) or on 1 July (e.g., United States), "1970" refers to the fiscal year running from 1 April 1970 to 31 March 1971, or 1 July 1970 to 30 June 1971. This convention, which seemed most suitable in the light of the variety of fiscal years to be accommodated, has the consequence that the years cited in the text and tables for the United States are always one year ahead of the US "fiscal year"; i.e., the figure cited in the text here for 1970 refers to the US fiscal year 1971.

[8] These rates provide a crude approximation only. The methodology is explained in appendix 6A, in the section on the international comparability of the estimates.

Table 6.1. The level of current military research and development expenditures in 22 countries

US $ mn, current prices, official exchange rates

Countries ranked by level of average annual expenditure, 1967–70 A	Average annual expenditure, 1967–70[i] B	Current expenditure 1970[i] C	*Average annual expenditure 1967–70, at approx. R&D exchange rates*[j] D
United States	8 708.9	8 608.6	*8 708.9*
France	601.6	536.7	*770.8*
United Kingdom	583.3	544.8	*859.6*
FR Germany	271.0	314.2	*352.3*
Sweden	92.6	74.4	*106.4*
Canada	79.6	80.8	*89.0*
Australia	51.0	54.9	..
Italy	22.4	30.5	*33.1*
Japan	20.8[a]	25.3[b]	*52.8*[a]
India	18.8	24.4	*62.0*
Netherlands	12.1	13.9	*17.1*
Switzerland	7.0[c]	7.7[d]	*(9.8)*[c]
Norway	5.0[a]	5.5[b]	*7.3*[a]
Belgium	2.4	2.8	*3.9*
Spain	..	1.2[f]	*(2.4)*[f]
Denmark	0.5[a]	0.5[b]	*0.7*[a]
Greece	..	0.5[g]	*1.2*[g]
Austria	0.3	0.4	*0.5*
Turkey	..	0.1[f]	*0.3*[f]
Finland	0.1	0.1[e]	*(0.1)*
Ireland	..	0.0[e]	—[e]
Iceland	0.0[h]	0.0[h]	*0.0*[h]

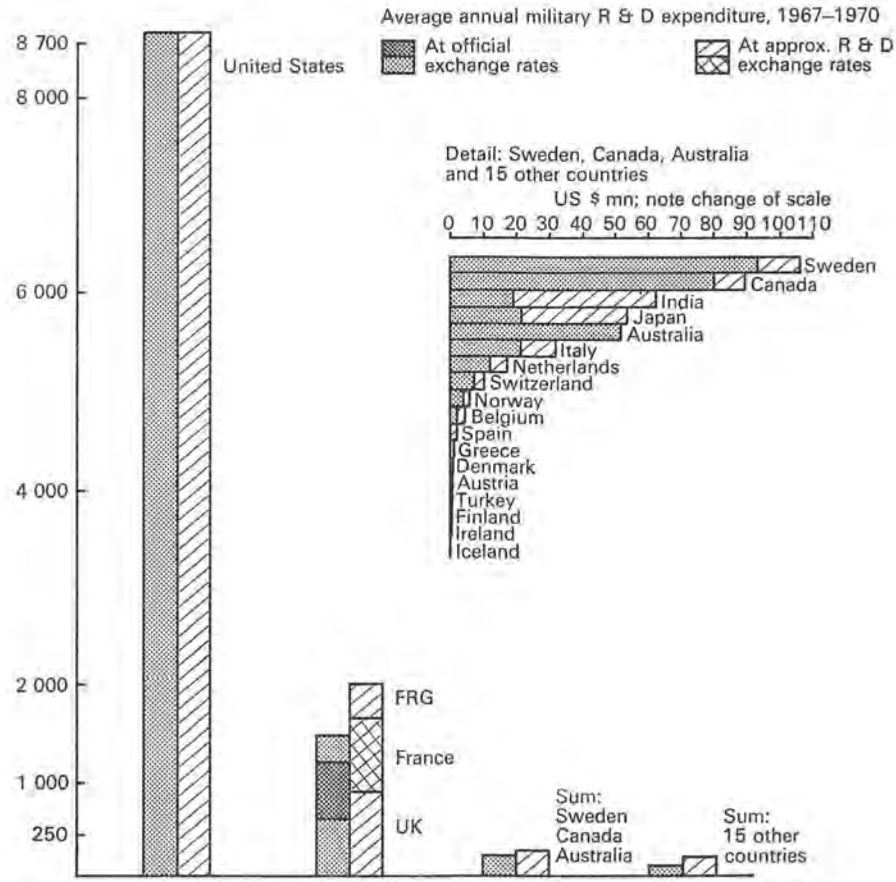
[a] 1966–69. [b] 1969. [c] 1966–68. [d] 1968. [e] 1967. [f] 1964. [g] 1962.
[h] Iceland has no national defence establishment, and no defence or military expenditure of any kind.
[i] Throughout this section, the years refer to fiscal years which coincide with *or begin during* the year indicated in tables and text. For countries in which the fiscal year begins on 1 April or 1 July, "1970" refers thus to the fiscal year running from 1 April 1970 to 31 March 1971, or 1 July 1970 to 30 June 1971. The years 1967–70 refer to the four fiscal years 1967–70 (or 1967/68–1970/71) inclusive.
[j] The use of special exchange rates is intended to allow for international differences in the costs of R&D input. The rates used here, which are based on manpower and expenditure data for R&D performed by business enterprises, make some allowance for international differences in the wages of R&D employees. They are not specific to military R&D and do not allow for international differences in the prices of R&D facilities and equipment, or in productivity. For further details, see appendix 6A.

Source: The tables beginning on page 222.

between the United States, on the one hand, and all the remaining countries, on the other, are not appreciably affected by the use of the estimated R&D rates; nor are the leads of the UK, France and Germany over the countries with smaller efforts significantly diminished. The gaps in the levels of military R&D spending are too great. Within the group of countries with relatively low military R&D outlays, there is, however, one shift of interest: Japan and India—where wages are much lower than in Europe and North

Chart 6.1. The level of military R&D expenditure in 22 countries[a]

US $ mn



[a] For sources and notes, see table 6.1.

America—move up roughly into the same class as Sweden, Canada and Australia, in terms of the resources devoted to military R&D. It should be noted that the special rates calculated here make no allowance for international differences in efficiency, management, planning and so on, which can result in considerable variations in the *productivity* of an R&D effort. If it were possible to measure qualitative differences of this kind, there might be further shifts in the rankings of some of the countries; and in this case, the rank order would indicate more accurately the magnitude of the expected total output of the various R&D efforts. The main features of the picture of expected output provided by the expenditure estimates—with the United States far in advance of all the other countries, and the UK, France and West Germany in the lead among these—would, however, remain unchanged if figures which allowed for productivity were available.

The very large gaps in military R&D spending are, to a large extent, to be expected from comparable gaps in total military spending (table 6.2, col. C, and chart 6.2). The surprising point that emerges is that, in comparison with total military outlays, military R&D funds are even more concentrated—and considerably so—in the hands of the big powers. In percentage terms, this means that while the United States, the United Kingdom and France each currently devote over 10 per cent of their total military expenditures to R&D, the comparable proportion for countries with moderate and low levels of military R&D spending ($1–150 million) is, on average, only 3.5 per cent: and in countries with extremely low military R&D outlays (below $1 million annually) only 0.5 per cent (table 6.2, col. E). A similar, but even more marked concentration is apparent with regard to total government R&D funds (covering civil as well as military R&D) and gross national product. Here again, the absolute figures for the United States are so high that they exceed the *combined* total for all the remaining countries (chart 6.2). This predominance "explains" a great deal of the vast US lead in military R&D spending. At the same time, however, the *share* of these very considerable resources going to military R&D is much higher in the United States. Over 50 per cent of total government R&D funds are devoted to military R&D in the United States, as against an average of 15 per cent among moderate-to-low military R&D spenders, and only 4 per cent of the total for countries with very low military R&D expenditures. Similarly, the proportion of gross national product which goes to military R&D is over 1 per cent in the USA, compared with less than one-fifth of 1 per cent, on average, for the moderate-to-low military R&D spenders, and one-hundredth of 1 per cent for the very low.

In fact, as suggested by this discussion, the data show a pattern of positive correlation between the absolute level of military expenditure, on the one hand, and the share of military funds devoted to R&D, on the other. In other words, the various countries do not tend to use the same percentage of military expenditures for R&D. Instead, those with larger military budgets tend to devote a larger share of these budgets to R&D than do the countries with smaller budgets. There is also a tendency for those with larger gross national products (GNP) to devote larger shares of GNP to military R&D, and for those with greater total government R&D expenditure to spend greater proportions of this on military R&D. These last two correlations are probably the result of a complex set of factors; and they are not, in any case, the result of direct political decisions to devote a certain share of GNP, or of total government R&D expenditures, to military R&D. In contrast, the level of military R&D spending is established politically—or militarily—with reference to the size of the total military budget. It is

Table 6.2. Military R&D expenditure as a share of gross national product, total military expenditure and total government R&D expenditure, 1967[a]

Countries ranked by level of military R&D expenditure	Military R&D expenditure	Total military expenditure	*Military R&D expenditure as a share of:* GNP	Total military expenditure	Total gov't R&D expenditure
	US $ mn, at current prices and official exchange rates		*Percent*		
A	B	C	D	E	F
United States	8 952.0	80 517.0	*1.06*	*11.1*	*52.6*
United Kingdom	636.2	6 044.9	*0.59*	*10.5*	*46.6*
France	627.9	5 856.1	*0.54*	*10.7*	*35.1*
FR Germany	255.8	5 352.0	*0.21*	*4.8*	*21.3*
Sweden	110.6	1 004.0	*0.44*	*11.0*	*44.2*
Canada	81.9	1 808.4	*0.14*	*4.5*	*19.8*
Australia	44.8	1 242.7	*0.17*	*3.6*	..
Italy	21.5	2 174.4	*0.03*	*1.0*	*7.5*
Japan	18.1	1 075.0	*0.02*	*1.7*	*3.9*
India	16.7	1 291.2	*0.04*	*1.2*	*11.8*
Netherlands	9.9	884.0	*0.04*	*1.1*	*4.6*
Switzerland	6.6	409.2	*0.04*	*1.6*	*10.3*
Norway	5.2	293.6	*0.06*	*1.8*	*11.1*
Belgium	2.1	568.6	*0.01*	*0.4*	*2.4*
Spain	1.2	348.7	*0.01*	*0.4*	*6.1*
Denmark	0.5	325.7	*0.00*	*0.2*	*1.0*
Greece	0.5	170.1	*0.01*	*0.3*	*6.9*
Austria	0.3	145.2	*0.00*	*0.2*	*1.1*
Turkey	0.1	382.6	*0.00*	*0.0*	..
Finland	0.1	137.8	*0.00*	*0.1*	*0.4*
Ireland	0.0	37.9	—	—	—

[a] All data are for fiscal year 1967 (1967/68), except for India (FY 1968), Greece (1962), and Spain and Turkey (1964).

Source: The tables beginning on page 222.

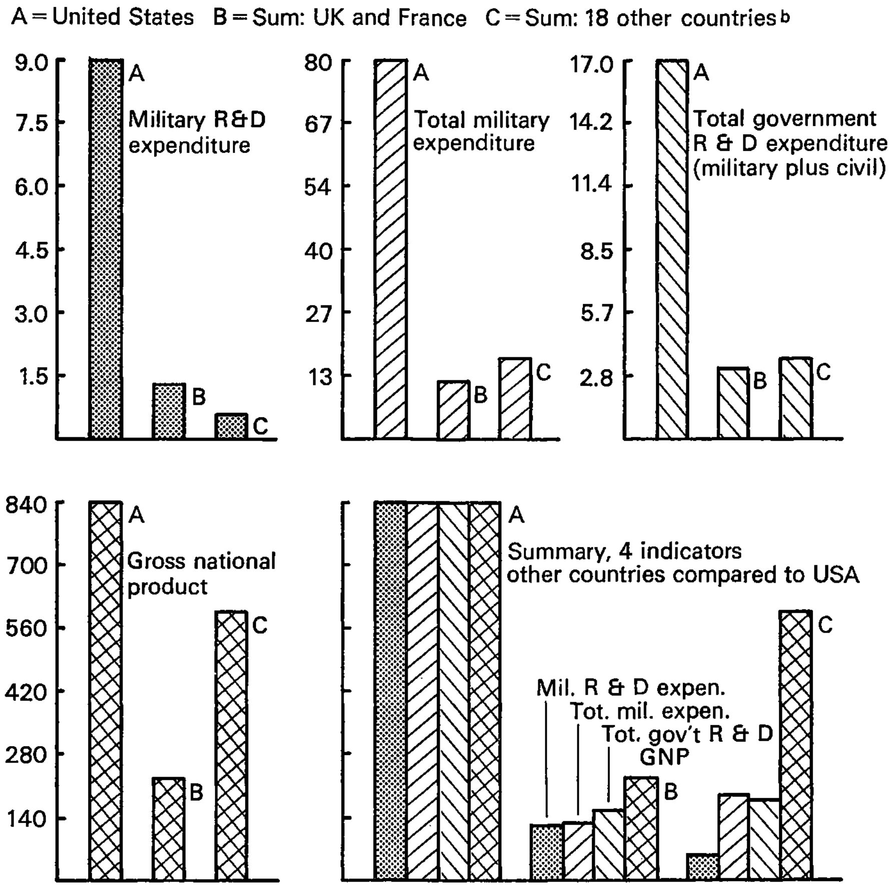
surprising, at first glance, that the proportions of military expenditure devoted to R&D are not roughly the same in all the countries, since in other respects the distribution of military funds among various functions (pay of the armed forces, procurement of weapons, construction of facilities, etc.) is usually about the same, regardless of the overall size of the military budget. The main factors which appear to account for the differing shares of military funds devoted to R&D—and, thus, for the actual levels of military R&D spending—are set out in the following section.

The correlation between the level of total military spending, and the share of this total devoted to R&D

The tendency for the *percentage* of military expenditures devoted to R&D to fall with decreases in the *level* of military spending is clear if the coun-

Chart 6.2. Military R&D expenditure compared with other economic indicators, 1967[a]

US $ bn, at official exchange rates. Note changes of scale



[a] All data are for fiscal year 1967 (1967/68), except for India (FY 1968), Greece (1962), and Spain and Turkey (1964).
[b] The eighteen other countries are: FR Germany, Sweden, Canada, Australia, Japan, India, Italy, Netherlands, Switzerland, Norway, Belgium, Spain, Denmark, Greece, Austria, Turkey, Finland and Ireland.
Source: SIPRI unpublished worksheets.

tries are grouped together by wide ranges of military expenditure (table 6.3). Thus:

1. Three of the four countries with annual military outlays of *$4 500 million and above* (USA, UK, France and FR Germany) have spent about *9–13 per cent* of their total military budgets on R&D (all but FR Germany).

2. Six of the seven countries with annual military outlays of *$700–1 900 million* (Australia, Canada, India, Italy, Japan, the Netherlands and Sweden) have devoted an average of *0.8–5.5 per cent* of military outlays to R&D (all but Sweden).

Table 6.3. The pattern of correlation between (a) the level of total military expenditure and (b) the share of the total devoted to military R&D, 1960–1969[a]

Countries whose rate of mil. R&D spending conforms to general pattern	A. Average annual level of total military expenditure, 1960–1969[c] *US $ mn*	B. Military R&D as a share of total military expenditure: Average annual percentage 1960–1969[c]	B. Military R&D as a share of total military expenditure: Range of all percentages 1960–1969[c]	Countries whose rate of spending is exceptional	Av. an. mil. expen. as in group:	Mil. R&D as share of mil. expen. as in group:
1. USA, UK, France	4 500–65 000	8.9–13.1	6.0–15.5	FR Germany[b]	1	2
2. Italy, Canada, India, Japan, Australia, Netherlands	700–1 900	0.8–5.5	0.4–7.9	Sweden	2	1
3. Belgium, Turkey, Spain, Denmark, Greece, Austria, Finland	100–500	0.03–0.4	0.03–0.6	Switzerland Norway	3 3	2 2
4. Ireland	under 50	0.00	0.00			

[a] Countries for which the figures used in this table and in chart 6.3 cover only part of the period are: for R&D as a percentage of total military expenditure; UK, India, Norway (1961–1969), Turkey, Spain (1964 only), and Switzerland (1966–1968): and for total military expenditure as well as the percentage going to R&D: Greece (1962 only), Ireland (1967 only), and Austria and Finland (1964–1969).
[b] The military R&D expenditures and total military expenditures of FR Germany in 1960 and Italy in 1964 covered transitional fiscal years of 9 months and 6 months respectively. The average annual expenditures given for these two countries here and in table 6.4 and chart 6.3 are based on 12-month fiscal year estimates, calculated by assuming that the actual average monthly rate of spending in the short years was continued over a 12-month period.
[c] Ranges cover figures indicated for all countries in group.

Source: The tables beginning on page 222.

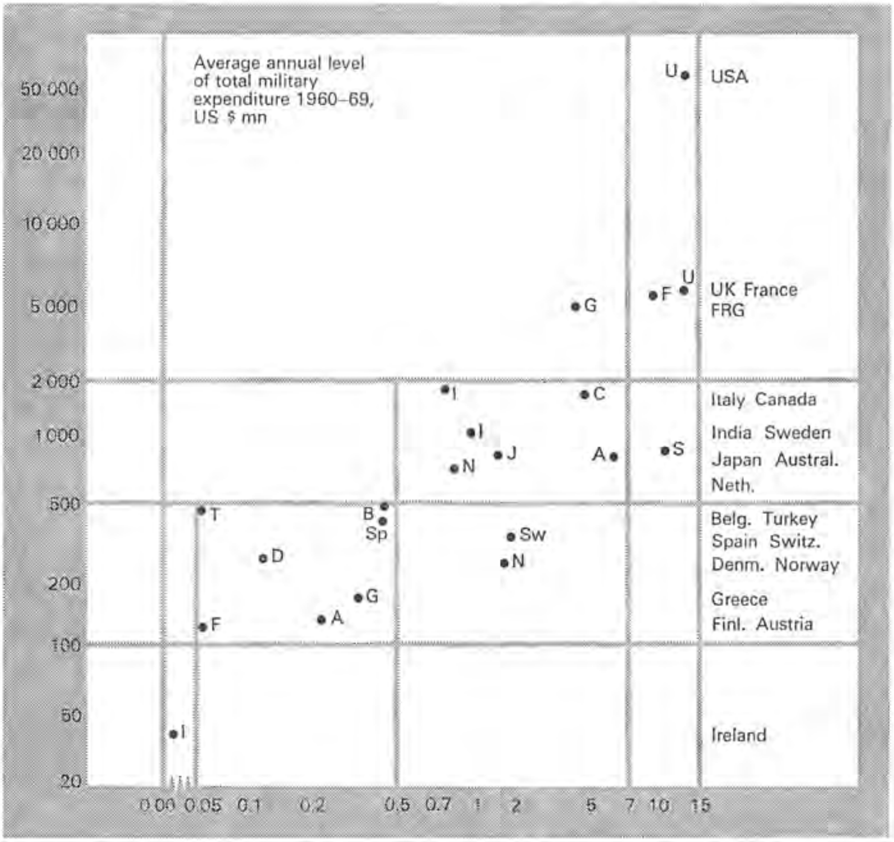
3. Eight of the ten countries with annual military expenditures *below $500 million* (Austria, Belgium, Denmark, Finland, Greece, Ireland, Norway, Spain, Switzerland and Turkey) have spent *0.4 per cent or less* of total military funds on R&D (all but Switzerland and Norway).

Moreover, the figures for the exceptions from the general pattern fall into the nearest half of the percentage range indicated for the next lower or higher level of military spending. There is, however, little or no correlation between the level of military spending and the percentage devoted to R&D *within* the three groups of countries set out here. Italy, for example, has the highest level of military expenditure of any country in the second group ($1 850 million annually), but the lowest share devoted to R&D (0.8 per cent): and there are other comparable "switches" (chart 6.3).

The main explanation for this pattern of military R&D spending appears

Chart 6.3. The pattern of correlation between (a) the level of total military expenditure and (b) the share of the total devoted to military R&D, 1960–1969[a]

Note logarithmic scales



Average annual share of military expenditure devoted to R&D, 1960–69, per cent.

[a] For countries where the figures do not cover the entire period, see note *a* to table 6.3.

to be as follows. First, it is likely that all of the countries discussed use about 30–45 per cent of total annual military expenditures for weapons procurement—including the financing of R&D, as well as the purchase of finished weapons, spares and related equipment. (The remaining military funds are required for the pay of the armed forces and for operating expenses, military construction, etc.) At the same time, there is probably a "threshold" of annual military spending, which may currently be somewhere between $2 000 million and $4 000 million, above which available procurement funds suffice for the development and production of the full range of major sophisticated conventional weapons. Countries with military expenditures above this threshold tend to fill their weapons "requirements" through domestic defence production. Currently, these countries tend to use about one-third to one-half of all procurement funds (the equivalent of about 10–15 per cent of total military outlays) on R&D; the remaining procurement funds are used for quantity production of the weapons developed with the R&D outlays. This produces a 1 : 1 to 1 : 2 ratio of average R&D : production costs, for the major weapons producers. These countries are likely to set the pace for the others, in establishing the highest current rate of innovation in armaments; and they are therefore likely to have the highest R&D : production ratio. (In other countries the ratio might be, for example, 1 : 3 or 1 : 4.) The countries with annual military expenditures below the, say, $2 000 million threshold cannot develop and produce the full range of up-to-date conventional weapons because their lower procurement budgets will not cover the necessary outlays in the limited time periods set by the major weapons producers, within which the latest generations of various types of weapon must be produced. Primarily as a result of economies of scale, these countries can obtain a greater range of major up-to-date weapons through import than they can procure with a domestic defence production effort.[9] They apparently place greater value on the strength of their arsenals than on the considerations which weigh in favour of a purely domestic weapons procurement programme:[10] they tend, thus, to use a portion of their procurement funds for import. This leaves a lower share of total military expenditures for any domestic R&D and production efforts than is available among the major weapons producers. Since the rate of innovation in armaments is also lower among these countries than among the major weapons producers, the share of procurement funds (or, by implication, of total military outlays) devoted to R&D is likely to be considerably

[9] The two main factors relating to scale which make import cheaper are first, the presumed smaller quantities of weapons procured by these countries with smaller overall defence efforts. The smaller quantities mean that the initial R&D and capital investment which may be required for the production of any type of weapon will be spread over a smaller number of finished weapons for these countries. In addition, the opportunity for "learning" effects during the production sequence—which tend to reduce the unit cost for a large quantity of items—may be less for these countries. Second, the perceived "margin" for R&D project failures may also be much smaller (proportionally) in these countries, with their much lower procurement budgets, than in the big military spenders. For various reasons, the main weapons suppliers may, furthermore, make weapons available at prices much lower than their original production cost; and this may also dampen the incentive for countries with smaller military budgets to establish domestic defence production facilities.

[10] Some of the considerations which favour a domestic defence production effort are: increased domestic employment; savings in foreign exchange; technological spinoff to related civil industries; potential gains in foreign exchange if the domestically produced weapons can be exported; greater possibilities of procuring weapons especially suited to the national defence effort; and, in the case of non-allied countries, increased capability to claim political independence in relation to potential weapons suppliers. It should be noted that several of these potential "benefits" may, in turn, have drawbacks: some of these are discussed in the chapter on "The economic pressures to export" in the SIPRI study, *The Arms Trade with the Third World* (Stockholm: SIPRI, 1971).

lower in these countries than in those with an independent defence production programme.

Applied to the specific countries, this general explanation takes the following form. First, none of the ten countries with annual military expenditures below $500 million[11] has devoted more than about 1.5 per cent of total military outlays to R&D. It may thus be assumed (*a*) that the scale of the overall military effort is so small in these countries that import of major weapons is always far cheaper than domestic production; (*b*) that the great bulk of procurement funds always goes to import; and thus (*c*) that the use of most procurement funds for import accounts for the very low shares of military expenditure devoted to R&D. The weapons development projects undertaken by this group will generally be limited to a few types of less sophisticated weapon; and they are likely to be concentrated in areas where the defence industry (or a related civil industry) has existed for a long time.

The pattern of R&D spending for the seven countries with annual military expenditures of $700–1 900 million[12] suggests that there may be a second significant threshold of annual military spending between $500 million and $700 million. Above this threshold, countries appear to need less incentive to devote a somewhat larger percentage of military expenditures to R&D than countries with military expenditures below $500 million. There may be a range of less sophisticated weapons which can be obtained as cheaply (or nearly as cheaply) by domestic development as by import with military efforts of this overall size. Alternatively, the pressure to obtain the greatest possible increase in the arsenal of operational weapons, for all procurement outlays, may be slightly less here than at the lower level of military spending. Either of these factors or a combination of the two might account for the higher shares of military funds devoted to R&D by these seven countries (0.8–10 per cent) than by the great majority of countries with the lowest level of military spending (0.4 per cent and below). The dis-economies of domestic production in comparison with import are presumably not entirely removed at the middle level of military spending, however: six of these seven countries have spent less than 6 per cent on R&D, while the USA, the UK and France have all spent 9 per cent or more of their total military outlays on R&D. Thus the countries with the intermediate level of military spending can presumably still procure a somewhat stronger arsenal if they use some of their procurement funds for import than if they devote all funds to domestic R&D and production.

[11] Switzerland, Norway, Belgium, Spain, Greece, Denmark, Turkey, Austria, Finland and Ireland.
[12] Sweden, Canada, Australia, India, Japan, Italy, and the Netherlands.

The main differences between the countries within this group where the proportions of military funds devoted to R&D are higher (Sweden, 10 per cent; Australia, 5.5; Canada 4.0) and those where the shares are lower (Japan, 1.5 per cent; India, 1.1; the Netherlands, 0.9; Italy, 0.8) appear to be accounted for by historical and political factors. First, there was essentially no defence industry in any of the latter four countries in the decade following World War II. Since the initial cost of establishing R&D and production facilities probably makes import cheaper than indigenous manufacture at any given point in time; and since it takes some years to build up technical expertise to a point where indigenously designed weapons are considered competitive with those which can be imported, a considerable length of time is probably required for countries in this group to shift a large proportion of procurement funds from foreign to domestic markets. Japan and India have been expanding their domestic defence production base since the mid-1950s. In the case of Japan, where there has been a strong post-war anti-military sentiment, the build-up has (at least until recently) been restrained to a slower pace than the maximum attainable rate implied by the overall rate and nature of industrial growth there. The Indian effort has probably aimed at a somewhat faster conversion, but this may have been impossible because of the country's technically limited industrial base. The further difference between Sweden, on the one hand, and Canada and Australia, on the other, may be accounted for by the extra incentive provided by Sweden's non-allied position to keep as large a share of procurement outlays as possible within the domestic market. For these countries, which have a long history of defence production (especially Sweden and Canada), the difference in direct cost between import and domestic development may be small for many major weapons. The lower shares of military expenditure devoted to R&D by Canada and Australia may simply reflect the judgement that, given allied status, and the extent to which this status makes import an acceptable alternative to domestic development, the potential gains of an equally large domestic effort are not worth the potential risks (risks of R&D project failures in particular). Since Sweden's defence effort does not involve commitments to help in the defence of foreign countries, the numbers of different kinds of major weapon which Sweden "requires"—though not their level of sophistication—may, however, also be less than is the case for Canada and Australia.

The final group of countries to be discussed consists of the United States, with average annual military expenditures of about $62 500 million; and the United Kingdom, France and the Federal Republic of Germany, with average annual military outlays of about $5 400, $5 100 and $4 600 million, respectively. The highest average annual share of military funds devoted to R&D in any country—about 13 per cent—is found within this group; the figure applies to the efforts in both the USA and the UK. The reason the US figure is not much higher, despite the enormous absolute differences in military spending, is, presumably, that with the current structure of defence efforts the maximum share of military funds available for R&D is no more than about, say, 13–15 per cent. The only countries among the 22 treated in this section which have completely independent defence production efforts, covering all major sophisticated conventional weapons (as well as nuclear weapons), are the United States and France. The countries which follow these two most closely, in having very low import : domestic production ratios, are the UK and Sweden. The average shares of military funds going to R&D in the four countries are: USA, about 13 per cent; UK, 13; Sweden, 10; France, 9. The next highest share for any other country is 5.5 per cent. These figures suggest that the share of military funds currently required to support an independent domestic development and production effort, involving up-to-date versions of sophisticated weapons, is about 10–15 per cent, regardless of the overall dimensions of the effort.[13]

The fact that the percentages of military expenditure devoted to R&D in the UK and Sweden, which are not completely independent in weapons production, are higher than those for France, which is independent, may be largely accounted for by (1) the differences in the share of total military funds used for procurement (this may range from 30 to 45 per cent), and (2) the differences in the balance between R&D costs and production costs —with R&D amounting to something between one-third and one-half of production—for domestically produced armaments. In addition, the French figures may under-estimate the French R&D effort slightly in comparison with the figures for the other countries: there is some evidence that the official French R&D statistics use a somewhat narrower definition for

[13] It is this upper limit—10–15 per cent—combined with the evidence for a number of countries that no more than about 30–45 per cent of total military outlays is generally used for all procurement, including R&D, which leads to the proposal earlier in this section that the current rate of innovation in armaments involves an R&D : production cost ratio of about 1 : 1 to 1 : 2. This is not assumed to be the maximum possible rate of R&D spending: it reflects both the rate of innovation which currently prevails and presumably also the fact that a large proportion of military funds is currently devoted to the maintenance of large standing armies. Cuts in the numbers of men under arms would presumably release a larger share of military funds for R&D and procurement. Furthermore, the similarity observed here between the United States and the other countries may be misleading, in the sense that it would probably be much easier for the United States than for the other countries to increase the R&D:production ratio, if this were considered militarily desirable. The other countries, with smaller procurement budgets, might then be placed in "intermediate" positions, possibly below the threshold for production of the full range of sophisticated conventional weapons, as is currently the case for the countries with military expenditures of $700–1 900 million.

"R&D" activities, and count more of the borderline types of expenditure as part of production costs. It may also be relevant that the share of military funds devoted to R&D in the UK at the end of the 1950s was higher than that in any other country, including the United States; but this policy was apparently found unsuccessful, and the percentage declined steadily from a high of 15.5 in 1961 to a low of 9.2 in 1970. The average figures for France and the UK for the period from 1966 to 1970, when the UK was engaged in substantial weapon imports for the first time, are the same—10.4 per cent.

The pattern of military R&D spending in the Federal Republic of Germany should be treated, in some ways, as a special case, since the effort here is maintained under unique constraints. First, there are "off-set" agreements between Germany and its NATO allies, under which Germany is obliged to import a large proportion of its armaments from its allies to off-set the cost of NATO troops stationed in Germany. Second, the Brussels Treaty restricts the armaments which may be developed and produced in Germany. The restrictions are enforced by the Western European Union. It is presumably these factors, and possibly to a lesser extent the late start of the German military R&D programme (1956), which account for the much lower share of military expenditure devoted to R&D here (3.7 per cent) than in the UK or France. The slightly lower level of military expenditure in Germany than in the UK or France probably has no significance in accounting for the lower share of military funds devoted to R&D. This level of military spending ($4 600 million, on average, during the 1960s) should not, thus, be viewed as necessarily below the threshold needed to maintain an independent defence production effort, covering the full range of sophisticated conventional weapons.

Long-term trends in military R&D expenditure

Turning now to trends in military R&D spending, the discussion will be largely confined to 15 countries for which longer series of annual expenditure figures are available.[14] In this group, there have been only a few dramatic changes in the level of military R&D spending during the past 10 to 15 years; for the most part, the long-term changes have been more gradual. At the same time, year-to-year movements in the level of military R&D funds have been erratic in many cases (tables 6.4 and 6.5 and charts 6.4 and 6.5).

Short-term rises and falls in military R&D spending can often be as-

[14] Australia, Austria, Belgium, Canada, Denmark, France, West Germany, India, Italy, Japan, the Netherlands, Norway, Sweden, the United Kingdom and the United States.

Table 6.4. Summary of military R&D expenditure, 1955–1971, at constant prices

US $ mn, at constant (1963) prices and exchange rates[a]

Countries ranked by level of average annual expenditure, 1965–69	Average annual expenditure			Budgeted expenditure		Change over previous period Per cent		Budgeted change Per cent	
	1955–59	1960–64	1965–69	1970	1971	1960–64/ 1955–59	1965–69/ 1960–64	1970/ 1969	1971/ 1970
USA	4 792.4	7 607.5	7 475.3	6 553.4	6 437.5	*58.7*	*−1.7*	*−4.0*	−1.8
UK	681.4[b]	761.0[c]	609.1	481.9	530.0	*11.7*	*−20.0*	*−10.6*	+10.0
France	253.0[d]	328.8	545.8	457.1	..	*30.0*	*65.1*	*−11.5*	..
FRG[h]	19.2	122.7	206.4	238.2	237.4	*539.1*	*68.2*	*3.7*	*0.0*
Sweden	..	67.1	81.3	53.9	58.6	..	*21.2*	*−12.1*	8.7
Canada	70.2	52.4	71.6	62.9	..	*−25.4*	*36.6*	*2.6*	..
Australia	37.9	37.0	40.4	43.0	..	*−2.4*	*9.2*	*0.0*	..
Italy[h]	7.7[d]	10.4	17.1	24.0	10.9	*35.1*	*64.4*	*34.8*	*−54.6*
India	3.7[e]	12.2[c]	17.1	23.2	..	*229.7*	*40.2*	*24.7*	..
Japan	6.0	8.2	15.8	19.4[f]	..	*36.7*	*92.7*	*1.0*[g]	..
Neth.	2.1	3.8	8.0	9.5	..	*81.0*	*110.5*	*0.0*	..
Norway	..	3.2[c]	3.8	4.3[f]	..	..	*18.8*	*8.0*[g]	..
Belgium	..	2.1	1.8	2.1	..	..	*14.3*	*5.0*	..
Denmark	..	0.2	0.4	0.4[f]	..	..	*100.0*	*0.0*[g]	..
Austria	..	..	0.2	0.3	..	..	..	*0.0*	..
Finland	..	..	0.1	0.1[f]	..	..	..	*0.0*[g]	..

[a] Figures deflated by the implicit GNP price deflator.
[b] Average of 1955 and 1958.
[c] 1961–1964.
[d] Average of 1958 and 1959.
[e] 1958.
[f] 1969.
[g] 1969/1968.
[h] See note *b* to table 6.3.

Source: The tables beginning on page 222.

sociated with the "life cycle" of one or a few weapons development projects. Early stages of design and development of large weapon systems are generally far less expensive than the subsequent phases, which involve prototype construction and testing. Several of the smaller military R&D efforts examined here are probably characterized by the conduct of only a few major projects concurrently: these projects will absorb a large share of total military R&D outlays, and the evolution of their costs will shape the overall pattern of spending. For countries with very large military R&D efforts, the cyclical cost patterns for the many major projects under way probably tend to cancel each other out: but even in these cases, a concurrent rise or fall in expenditures for the development of a few very expensive systems may produce an observable effect in the level of total military R&D spending. Of course, such effects merely confirm the absence of more dramatic long-term changes. In a period of major expansion, or contraction, rapid changes in the level of spending will dominate

Table 6.5. The proportion of total military expenditure devoted to military R&D, 1955–1971

R&D as a percentage of total military outlays

Countries ranked by level of military R&D expenditure, 1965–69	Average annual percentage			Estimated percentage		
	1955–59	1960–64	1965–69	1969	1970	1971
United States	9.82	14.81	11.45	10.56	11.26	11.32
United Kingdom	12.96[a]	14.41[d]	11.29	10.44	9.05	10.38
France	5.93[b]	7.09	10.76	10.11	8.98	..
FR Germany	0.88[f]	2.87	4.49	4.90	5.09	4.38
Sweden	..	9.19	10.89	7.09	6.48	6.85
Canada	3.83	3.22	4.79	4.27	4.24	..
Australia	7.68	6.97	4.06	4.26	4.31	3.99
Italy	0.60[b]	0.67	0.92	0.95	1.22	0.55
India	0.54[c]	0.99[d]	1.21	1.27	1.59	..
Japan	1.17	1.34	1.74	1.84	..	..
Netherlands	0.37	0.71	1.17	1.31	1.26	..
Switzerland	..	..	1.73[e]	..	..	..
Norway	..	1.63[d]	1.52	1.57	..	..
Belgium	..	0.48	0.39	0.40	0.41	..
Denmark	..	0.11	0.14	0.13	..	..
Austria	..	..	0.17	0.22	0.23	..
Finland	..	..	0.06	0.06	..	..

[a] Average of 1955 and 1958.
[b] 1958–1959.
[c] 1958.
[d] 1961–1964.
[e] 1966–1968.
[f] 1956–1959.

Source: The tables beginning on page 222.

the cost cycles of individual development projects. Rapid changes of this kind have also occurred in several of the countries during part of the period under study.

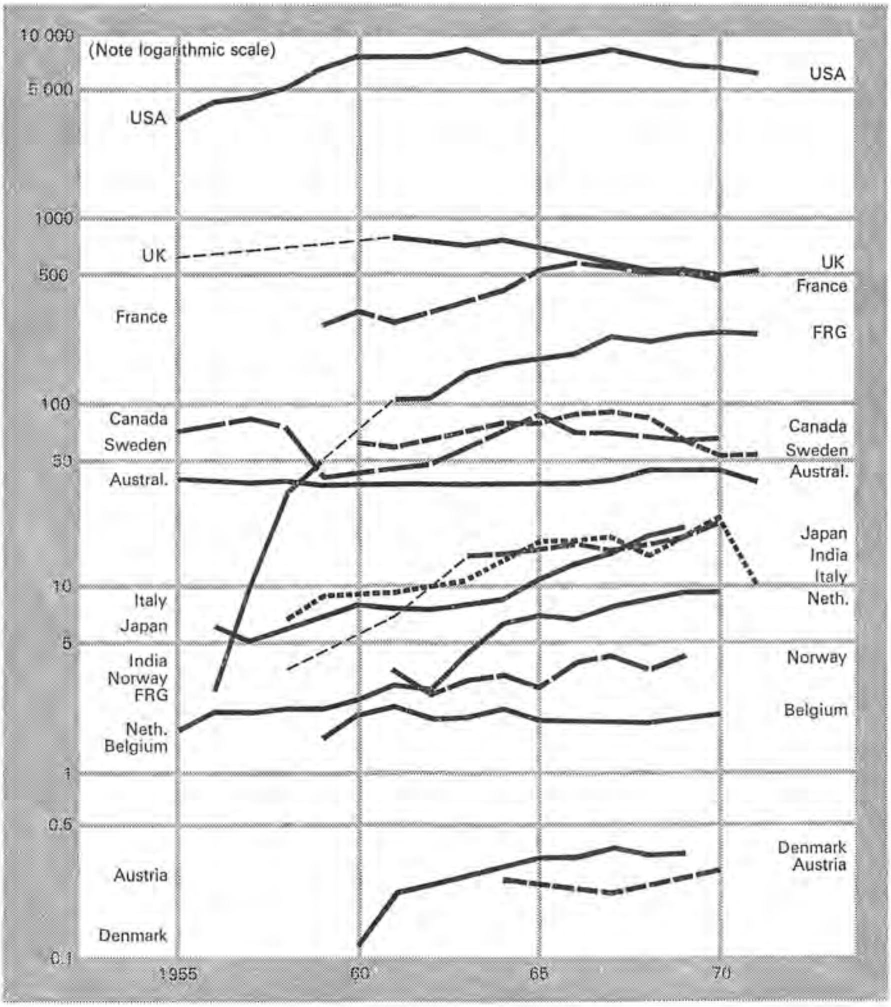
Trends since 1955

THE UNITED STATES

There was a major expansion of the United States military R&D effort between 1955 and 1960. At constant prices, the level of spending in 1960 was more than double that 5 years earlier; in current prices, expenditures amounted to about \$7.2 billion in 1960, compared with about \$3.0 billion in 1955. The increase came in two main spurts: a rise of about 25 per cent (at constant prices) between 1955 and 1956; followed by an increase of about 45 per cent between 1958 and 1960. In the USA, actual expenditures for R&D generally lag behind the appropriation of funds by Congress and the "obligations" of the Defense Department for approved R&D programmes, by one to three years. Thus, it seems likely that most of the big increase in 1956 was due to earlier decisions to pursue simultaneously both

Chart 6.4. Long-term trends in military R&D expenditure, 1955–1971

US $ mn, at constant (1963) prices and official (1963) exchange rates



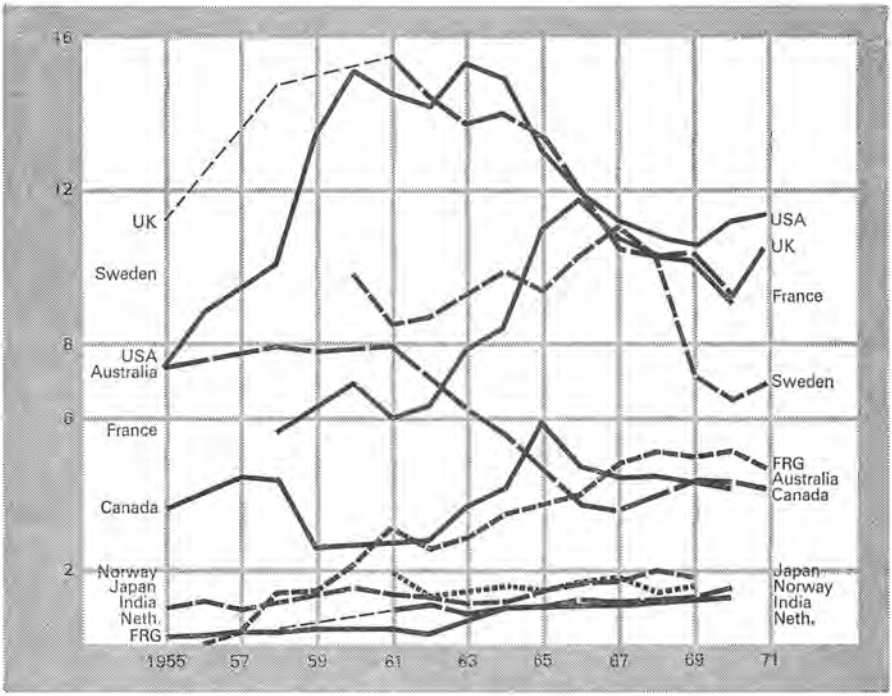
Source: The tables beginning on page 222.

further development of the most advanced weapon systems then in existence and initial development of the next generation of weapon systems.[15] These decisions may have been spurred on, or set, after the first Soviet thermonuclear test explosion in August 1953, but this is uncertain. It seems fairly clear, however, that the first successful satellite-launching by the Soviet

[15] A detailed description of developments during the 1950s is provided in *Race to Oblivion* (New York, 1970), by Herbert York, US Director of Defense Research and Engineering during the period 1958–1961.

Chart 6.5. Long-term trends in the proportion of total military expenditure devoted to R&D, 1955–1971

Percent



Source: The tables beginning on page 222.

Union, in October 1957, and the fears of a "missile gap" which this generated, were responsible for a large part of the increase in US military R&D spending between 1958 and 1960. On this occasion, much of this increase may have gone into speeding up programmes which were already under way following the expansion of the R&D effort in all directions earlier in the 1950s.

In the course of the next 8 years—from 1960 to 1968—the level of US military R&D spending did not change significantly. The peak year, in terms of expenditure at constant prices, was 1963. There was a rise, at current prices, in 1966–1968, which was partly off-set by inflation; the second highest level of spending, at constant prices, came in 1967. During the past 3 years—1969–1971—US military R&D outlays have been lower, at constant prices, than at any time since 1959. There was a slight decline in 1969, followed by a rise in 1970 and 1971; the upward trend has, however, been offset by inflation.

There are probably a number of factors which account for the levelling-off in US military R&D outlays since 1960 and the decline, in real terms, since 1968. *Total* US military expenditure did not increase very much between 1955 and 1965—only about 1 per cent a year, on average, in real terms. At the beginning of this period, the US military effort was not particularly R&D-intensive: only about 7 per cent of total military outlays were channelled into R&D in 1955. By the end of the 1955–1960 build-up in R&D spending, however, the proportion had reached 15.1 per cent. This high share, ranging from 14.2 to 15.3 per cent, was maintained through 1964. Thus it is likely that, by the beginning of the 1960s, an upper limit had been reached, within the framework of the total defence budget: all remaining procurement funds were probably required for the manufacture of the products of the intensive R&D effort. Other factors, which may have contributed to the levelling-off in the first half of the 1960s, should, however, also be considered. First, there was a ten-fold increase during this period in R&D outlays on the civil space programme; these rose from about $0.7 billion in 1960 to about $6 billion in 1965—in the latter year the equivalent of 80 per cent of current military R&D outlays. The overlap in technology between military missile and satellite programmes and the civil space programme is considerable. This suggests that governmental, industrial and "qualified R&D manpower" groups, who might otherwise have had a greater interest in a continued rapid expansion of the military R&D effort, may have been satisfied with regard to their respective interests when the space programme was expanded instead. Second, on a somewhat different level, it is possible that a breathing space, for adjustment to the management and planning problems posed by a radical increase in the level of military R&D spending, was required. Thus, the doubling of the size of an already enormous effort, at the end of the 1950s, may have necessitated some pause before a renewed expansion of the same order could be undertaken.

In the period since 1965, total US military expenditures have risen substantially at both current and constant prices. At the same time (perhaps partly in compensation) R&D outlays on the civil space programme have declined steadily, to an estimated $3.2 billion in 1971. If the full costs of the Viet-Nam War are subtracted from total military outlays, other military expenditures have remained largely unchanged since 1965 (at constant prices), leaving little room for a major expansion of the R&D effort. As noted earlier, military R&D outlays have in fact increased at current prices, and they have taken a slightly larger share of total military expenditures during the last two years (1970–1971) than they did at the peak of Viet-Nam spending. The decline in military R&D outlays in real terms since 1968 may in part be simply the result of an unusually high rate of inflation during this period.[16] Military pay increases and escalations in procurement costs may also have left a smaller proportion of total military outlays for R&D than was available before 1965. Furthermore, there has been no particular stimulus to an expansion of the military R&D effort during this period. Pressures for a re-ordering of priorities in the United States may have made military R&D a somewhat more unpopular government undertaking than it was earlier. There have been no dramatic challenges posed by the Soviet Union. On the contrary, the United States appears to have deployed the successive generations of increasingly advanced strategic nuclear weapons 5 years or more in advance of the Soviet Union throughout the period since 1960.[17] And, finally, there have been no further major breakthroughs in the development of completely new weapon systems or weapon technologies during the early 1960s comparable to those of the 1950s—the thermonuclear device or the intercontinental ballistic missile. There have been enormous improvements in the performance of existing types of weapon, based largely on incremental (and occasionally on radical) improvements in their innumerable components. But there have been no scientific technological breakthroughs which, to be incorporated in operationally developed weapons, require a quantum jump in the overall level of development expenditures.[18]

It has been suggested that the level of total US military spending may be kept roughly constant, at constant prices, over the next five years or so.[19] A substantial cut in the numbers of the armed forces may also be effected within this period. If so, increased funds might be available for R&D. There have already been pressures for a sizeable expansion of the US military R&D effort. In Congressional hearings and other public statements, the Department of Defense officials responsible for the major military R&D programme have expressed serious concern over the "stagnation" in the level of military R&D spending during the last few years. They have claimed that the Soviet Union is likely to catch up with, and then surpass, the United States in weapons technology, unless the level of US military R&D spending is significantly increased. And they have sug-

[16] The "Report on Military Spending", published by the Members of Congress for Peace through Law in July 1970, suggests that the increase in the rate of inflation, from about 2 per cent in 1965 to about 6 per cent in early 1970, may itself have been a consequence of the failure to cut defence spending during this period.
[17] Examples of earlier US deployments are given on page 204.
[18] Significant increases in the level of R&D expenditures may occur even without technological breakthroughs leading to completely new systems. Thus, full-scale further development work on some of the strategic weapon systems now at the design stage or under development in "first generation" form—such as ULMS, ABM and the new strategic bomber—could presumably involve substantial increases in the level of US strategic weapon R&D expenditures during the mid- to late-1970s.
[19] See chapter 4, page 57.

gested that Soviet technological superiority would be a grave threat to the security of the United States.[20] There has also been a slight increase in unemployment of scientists and engineers in the USA, which can probably be associated with the real decline in military and space R&D funds taken together, during the last few years. This has already showed signs of producing an unusually articulate, or prestigious, pressure group for a renewed expansion of the military R&D effort.

OTHER COUNTRIES

In real terms, the UK military R&D effort reached a peak in 1961. It was maintained at roughly the same level, however—about $700–800 million, at 1963 prices—throughout the period from 1958 to 1965, and possibly from 1955 onwards. The United Kingdom was the only country, other than the United States and the Soviet Union, to undertake a major military R&D effort, covering nuclear weapons as well as a broad range of conventional ones, soon after the end of World War II. This effort was well under way by the mid-1950s. A total of 25 nuclear tests was conducted between 1951 and 1964, with the bulk (18) conducted in the period 1956–1958. By 1955 several nuclear weapon delivery systems were under development: an intercontinental ballistic missile, a short-range nuclear missile, a long-range bomber, and a stand-off air-to-surface nuclear missile. At the same time, work was under way on the full range of sophisticated conventional weapon systems. As noted earlier, the share of total military outlays devoted to R&D in the period 1955–1961 was much higher in the UK than in any other country. In 1961–1965 a number of major projects which had absorbed a large part of military R&D outlays during the previous 5 to 7 years were cancelled. These included the two surface-to-surface nuclear missiles and a number of sophisticated conventional aircraft. From 1965 to 1970 there was a marked decline in UK military R&D expenditures: the average level of spending in the latter half of the 1960s was 20 per cent lower than in the first half; and outlays in 1970 were only 60 per cent of expenditures in 1961 (all data at constant prices). During this period, the UK has turned for the first time to foreign suppliers for a number of items of major equipment: ballistic missiles and other important components for a submarine-based nuclear weapon system, "tactical" nuclear weapons, a conventional air-to-air missile, and the technologically most advanced fighter aircraft in the UK force. Total military outlays have remained roughly constant dur-

[20] "Recovery from such a loss of U.S. technological leadership would require enormous expenditures over many years—years of grave risk to our national margin of safety." (Statement by the Director of Defense Research and Engineering, Dr John S. Foster, Jr, on the Fiscal Year 1972 Defense RDT&E Program, before the Armed Services Committee, US Senate, 92nd Congress, on 29 March 1971, p. 1–6.)

ing this period and R&D has taken a falling share of the total. The first rise in UK military R&D expenditures since 1964 occurred, however, in 1971: and a new upward trend may be appearing, since the rise was substantial (10 per cent, in real terms).

French military R&D expenditures rose sharply during the period 1958–1966. The average level in 1965–1969 was over 50 per cent greater than that in the previous 5 years: but there was a slight decline in spending, at both current and constant prices, from 1966 on, and a somewhat sharper decrease in 1970. The French defence industry was re-established much more slowly than its British counterpart after World War II; and the decision to initiate a domestic nuclear weapons development programme was not taken until the end of the 1950s. At this time, the French military R&D effort was only one-fourth to one-third the size of the UK effort. The rise through 1966, which, with the decline in UK expenditures during the latter half of the 1960s, brought the two efforts to about the same size, was probably accounted for both by the expansion of development efforts in the area of conventional weapons—especially aircraft and missiles—and by the major build-up of the nuclear weapons development programme. In the period since 1966, it is likely that the share of strategic weapons in the total military R&D effort has declined somewhat, and that a decline in outlays here has accounted for the levelling-off of the size of the total effort. Nuclear weapons testing, and development of the main nuclear delivery systems designed during the 1960s—a ballistic-missile submarine, a medium-range surface-to-surface ballistic missile, and a short-range "tactical" nuclear missile—were still under way in 1969, but the most expensive phases of development may have been largely completed by 1970.

In the period 1956–1961, West German military R&D outlays increased almost exponentially, from their initial level of about $2 million annually, to around $100 million. The factors which account for the very rapid growth here—unparalleled among other countries in this group—have already been indicated briefly. Germany had a comparatively high level of total military expenditure by the mid-1950s, and a rapidly expanding industrial economy. It was, however, obliged to import armaments from NATO allies; and domestic development and manufacture of weapons was forbidden until the Brussels Treaty was revised in 1954, after which development and production of certain types of weapon were permitted.[21] In the period 1961–1967, military R&D outlays doubled. This rate of rise, while

[21] The weapons which are not permitted include: nuclear, chemical and biological weapons, long-range missiles and guided missiles (except guided anti-tank missiles—permitted by an amendment in 1959; and guided anti-aircraft missiles—permitted by an amendment in 1961), warships with the exception of smaller ships for defence purposes, and bomber aircraft for strategic purposes.

significant, is not unlike that observed for several other countries. The outlays have been held at about the 1967 level, at constant prices, during the last three years (1969–1971).

The movement in the overall level of Swedish military R&D outlays during the period 1960–1971 has been largely determined by expenditures for "Viggen"—an advanced supersonic fighter. This project, for which design and development were initiated in 1958 and completed in 1970, probably absorbed between one-third and one-half of all military R&D outlays in Sweden during most of the 1960s. Following a decline in the development costs of Viggen at the end of the 1960s, and a concomitant reduction in total military R&D expenditures, there has been a substantial rise in the total in 1971. This upward trend, which reflects the start of the development of a modified version of Viggen for an interceptor role, can be expected to continue over the next several years. The trend in Canadian military R&D expenditures, which has been very erratic over the period 1955–1970, has probably also been determined, to a great extent, by short-term changes in primarily military aircraft projects. The large drop between 1958 and 1959, for example, was occasioned by the unsuccessful end of the last Canadian attempt to develop a supersonic combat aircraft (the "Arrow"). In both Sweden and Canada, military R&D outlays have generally been within a $50–100 million range, at both current and constant (1963) prices, throughout the period covered by the estimates. Australia's estimated R&D outlays have been essentially level, at constant prices, since 1955: at current prices there has been a slight rise—from $31.4 million in 1955 to $54.9 million in 1970.

In contrast to the case for countries with larger military R&D efforts, there are several countries with smaller efforts where military R&D expenditures have increased steadily throughout the period since 1955. This applies particularly to India, Japan and the Netherlands. In the Netherlands, the most rapid expansion, bringing the level from $2.7 to $13.9 million, at current prices, has occurred since 1961. In that year a military aid agreement with the United States providing assistance for weapons procurement was terminated.[22] As noted earlier, India and Japan have been engaged in a steady expansion of their capacity for domestic development of sophisticated conventional weapons since 1955. In Japan, development work on armoured vehicles and ships was undertaken first, and a rapid expansion in types of aircraft under development and the initiation of a few missile projects have followed during the 1960s. The Indian effort has hitherto been heavily concentrated on aircraft. It should be noted that estimated

[22] *R&D in OECD Member Countries: Trends and Objectives* (Paris: OECD stencil, 1971).

military R&D expenditures for both these countries refer to defence department expenditures on the main publicly identified R&D programme only. India has, in addition, a large nuclear R&D programme—with annual outlays substantially higher than the military R&D figures given here—conducted by the Indian Atomic Energy Agency. Up to now, the nuclear programme has been explicitly directed at civil uses only, but it will undoubtedly provide a well-developed technological base in the event of a decision to develop a nuclear weapon.[23] The Indian Atomic Energy Agency has also supported rocket launcher development, possibly with a view to potential future military applications. Similarly, Japan has a very substantial nuclear R&D programme which is not in any way covered by the estimates here. Development of nuclear power plants for ships is among the projects currently under way, and these will presumably be turned to naval use when sufficient progress has been made.[24] In addition, the Japanese Science and Technology Agency (STA) supports a very large R&D programme, covering a number of weapon-related areas of science and technology. Given the expanding nature of the military R&D effort, some of the work supported by the STA may be motivated by potential military applications.

There has been no major change in the level of military R&D spending in Italy, Norway, Belgium, Denmark or Austria during the period for which military R&D estimates have been assembled here. In the case of Italy, Norway and Denmark, however, it is likely that the average level of military R&D spending during the 1960s was somewhat higher than in the 1950s, in real terms.

Longer-term trends

Very large government-financed military R&D efforts are essentially a product of World War II, and a new phenomenon in the post-war period. Of course, to take a very long perspective, inventions in armaments have been made since ancient times; and at various periods and in different countries, scientists and scientific advisers concerned with warfare and weapons have been employed by heads of governments and, more recently, by business firms. By 1900–1939 a limited amount of more systematic government-financed "R&D" work was under way on, for example, military aircraft, submarines, tanks and/or chemical weapons in Japan, the United States, some South American countries, and the European powers. Judging, however, by available figures for the United States for the 1920–1935 pe-

[23] For further details on the Indian nuclear programme, see pages 298–301.
[24] For further details on the Japanese nuclear programme, see pages 317–19.

riod, when military R&D funds amounted to about $4 million annually,[25] these efforts were very small indeed, set against post-war programmes. In the United States, military R&D spending in 1955 (around $3 billion) was almost 1 thousand times larger than in 1935.

During World War II, intensive weapons R&D efforts were supported in the United States, Britain, Germany and the Soviet Union. There was also a smaller Japanese effort, and more limited efforts are known to have been under way in Canada and Sweden. Annual expenditure estimates are available for this period only for the United States and Canada. Canada, which worked together with the USA and the UK during the war, began the period with military R&D expenditures of about $0.5 million (1938).[26] The level doubled every year until 1942, when it had reached $7.5 million, and it then continued to rise, somewhat more slowly, to a peak of about $25 million in 1945. In 1946 the outlays dropped to $6 million, but by 1947 they were back up at $12 million, and the level rose steadily thereafter until 1959. (All figures in Canadian dollars, at current prices.)

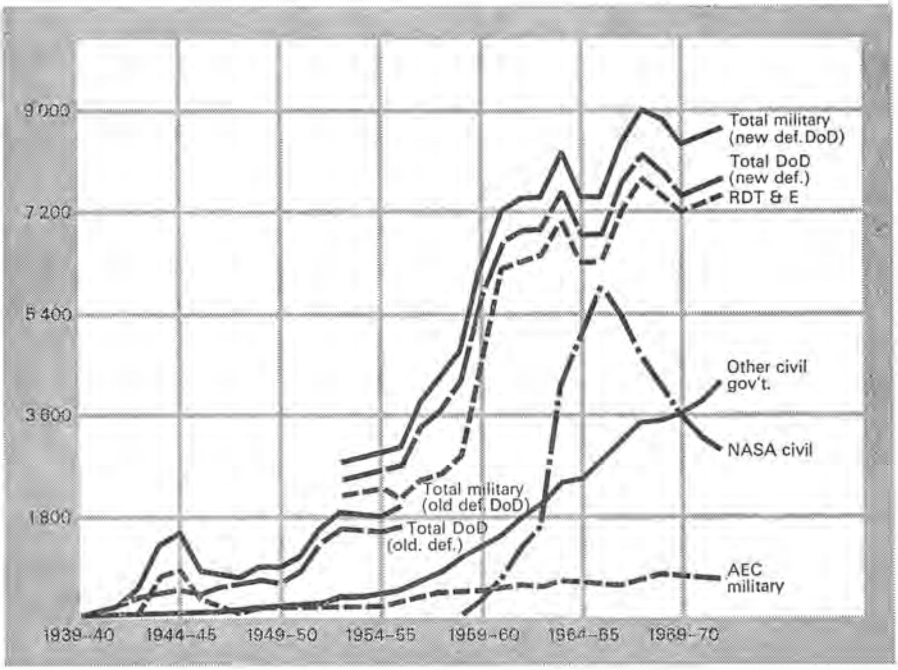
US military R&D outlays since 1939 are shown in chart 6.6 (chart and discussion here are based on current price figures[27]). There had apparently been a marked increase in aircraft R&D in particular in the preceding 5-year period, and by 1939–40 military R&D funds had reached a level of about $30 million. They jumped to $150 million by the following year; $535 million by 1942–43; and $1 510 million by 1944–45. The wartime activity had, thus, already brought the US military R&D effort above the billion dollar mark. Military R&D outlays dropped during the next three years, to a low of about $700 million in 1947–48, but they climbed to $900 million by the following year, and they continued to rise thereafter, in almost every year, to the 1963 peak. While there is a hundred-fold difference in magnitude involved, it may still be relevant to draw a parallel with the pattern in Canada. In both countries the wartime peak represented an enormous increase over the pre-war level: Canada about 50-fold; and the USA about 75-fold. In both, outlays dropped to less than half this peak in the immediate post-war years. But this left the level still more than an order of magnitude higher than pre-war funding, and in both countries the downward trend was then rapidly reversed, moving into the period of greatest increase from around 1950 to 1960.

Two further comments on the wartime and immediate post-war trend

[25] D. Swain, "Organization of Military Research", in M. Kranzberg and C. Pursell, eds., *Technology in Western Civilization,* Vol. II (London, 1967), p. 540.
[26] All of the figures given here for Canada are based on data given in *Reviews of National Science Policy: Canada* (Paris: OECD, 1969), p. 44.
[27] The figures on which chart 6.6 is based, and detailed notes on the composition of the various components of civil and military R&D are given in table 6A.9, in appendix 6A.

Chart 6.6. Trends in US government military and civil R&D expenditures, 1939–1971[a]

US $ mn, at current prices



[a] For sources and definitions, see table 6A.9, page 230.

in the United States may be added. First, most of the increase and more than half of the funds involved in the rise from about $200 million to $1 500 million between 1941–42 and 1944–45 went to the development of the first nuclear weapon.[28] Furthermore, almost all of the decline in the first three post-war years was accounted for by a decrease in nuclear weapon development expenditures, from $860 million to less than $100 million. Other military R&D expenditures, focused mainly on the development of conventional weapons, decreased only slightly in the first year after the war, and they had already risen above their wartime peak ($500 million) in the following year. The nuclear weapons R&D programme expanded again starting in 1948–49, but, even at current prices, it has never reached the wartime peak again (chart 6.6). Second, it is not possible

[28] The expenditures referred to here, and shown in chart 6.6 in the "AEC" line, for 1942–43 to 1946–47 were not actually AEC expenditures—this agency was not created until 1947—but rather the expenditures for the so-called "Manhattan Engineer District". This was the "agency" under the Defense Department (then called the Department of War) which was responsible for the development of the nuclear weapon. The entire expenditures of this agency are included in the official national R&D statistics—and therefore included here—as R&D expenditures. For further comment on this point, see the section on the reliability of the estimates in appendix 6A.

to pinpoint the years of greatest increase of the US military R&D effort in the period 1945–1955 because the statistical series for the wartime and immediate post-war period and for the period since 1952 are different. They leave an unaccounted gap in the level of spending between 1951–52 and 1952–53. The later series is based on a broader definition of "R&D" activities, including, in particular, large sums for late stages of weapons development undertaken after decisions to procure the various systems under development.[29] It is not known to what extent, or how far back, the use of the current definition would result in substantial increases in the estimates for 1939–1951. Presumably, with the less extensive and complex nature of advanced development work on the earliest military R&D products, the increase would represent a smaller share of the old total in earlier years than it did, for example, in 1952–53 (chart 6.6).

Little information has been found about the other main wartime R&D efforts under way in the UK, Germany and the USSR. In an official UK publication,[30] it has been stated that the level of total UK R&D expenditures (including civil government and private funds, as well as military R&D outlays) was ten times higher in 1964 than in 1939: and the official estimates for 1964 are about $2 100 million, implying a figure of about $200 million for 1939. A large share of this may have gone to military R&D. The military R&D build-up here probably started somewhat sooner than in the United States. It is unlikely that the UK wartime peak was as high as that in the United States—it may have been more of the order of several hundred million dollars, judging by the figures for the conventional and nuclear portions of US wartime military R&D expenditures. There was presumably a drop between 1945 and 1950, with a return to a level of, say, several hundred million dollars by 1951, when the independent UK nuclear weapons R&D programme reached the testing stage. By 1955 UK military R&D outlays had reached about $500 million at current prices. The German military R&D effort was also probably much smaller than the US effort during the war since there was no significant attempt to develop a nuclear weapon in Germany. The effort here was concentrated on military aircraft and aeroengines and on the development of the V-2 rocket, with additional work in, for example, radar and radar countermeasures and submarine propulsion. The development of the V-2 rocket reportedly absorbed about $120 million during the course of the war.[31]

[29] A more detailed description of the sources and differences of the two series is given in the notes to table 6A.9.

[30] *Industrial Research and Development in Britain* (London: Reference Division, Central Office of Information, 1968), p. 1.

[31] R. Sanders, "Three-Dimensional Warfare: World War II", in M. Kranzberg and C. Pursell, eds., *Technology in Western Civilization,* Vol. II (London, 1967), p. 568.

Table 6.6. The proportion of government R&D funds devoted to military R&D, 1955–1971

Military R&D as a percentage of total government R&D outlays

Countries ranked by level of military R&D expenditure, 1965–69	Average annual percentage			Estimated percentage		
	1955–59	1960–64	1965–69	1967	1969	1970
United States	83.6	63.2	51.5	52.6	54.3	53.9
United Kingdom	76.9[a]	65.8[b]	48.6	46.6	40.7	..
France	52.8[c]	40.2	36.6	35.1	33.7	32.2
FR Germany	7.9	21.1	19.7	21.3	18.6	16.7
Sweden	..	47.1	40.4	44.3	31.4	..
Canada	40.8	25.1	20.9	19.8	15.2	15.0
Italy	..	8.3[g]	7.7[h]	7.5	6.4	6.7
India	5.8[d]	..	12.2[e]	11.8[f]	11.8	..
Japan	5.3	3.8	4.0	3.9	4.1	..
Netherlands	..	4.4[b]	4.8	4.6	4.9	4.5
Switzerland	..	..	..	10.3	..	..
Norway	..	10.9[b]	9.8	11.1	8.9	..
Belgium	..	5.1	2.6	2.4	2.4	2.3
Denmark	..	..	..	1.0	..	..
Austria	..	3.0[h]	..	1.1	..	..
Finland	..	..	..	0.4	..	..

[a] Average of 1955 and 1958.
[b] 1961–1964.
[c] 1958–1959.
[d] 1958 only.
[e] 1965, 1968 and 1969.
[f] 1968.
[g] 1963 only.
[h] 1964 only.

Source: The tables beginning on page 222.

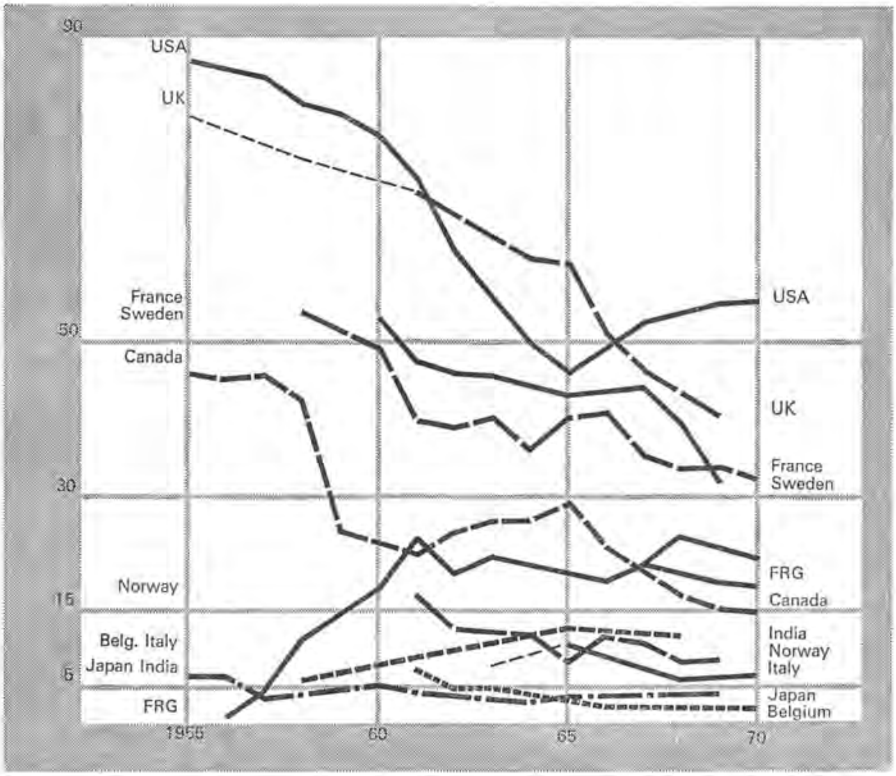
Some of the main wartime military R&D products which probably contributed heavily to the post-war recognition of the potential significance of continued technological advances in weaponry were—in addition to the nuclear weapon—the further development of radar for air defence use (UK), the initial development of jet engines for military aircraft (Germany), improvements in electronics for military use (e.g., the proximity fuse—USA), and the development of long-range rockets (Germany).

Comparison of trends in military R&D spending and civil R&D spending

Over half of all government funds allocated to R&D in the United States in 1969 went to military R&D. The comparable proportions in the United Kingdom and France were about 40 per cent and 35 per cent, respectively. While these shares are extraordinarily large, they are a good deal lower than the figures available for the period before 1960. About 90 per cent of government R&D outlays in the United States in the early 1950s were military R&D outlays; in the UK the share was about 80 per cent in 1955, and in France about 55 per cent in 1958 (the first years for which

Chart 6.7. Long-term trends in the proportion of government R&D funds devoted to military R&D, 1955–1970

Percent



Source: The tables beginning on page 222.

estimates are available). In almost all of the countries with lower military R&D expenditures, the proportions of government R&D funds devoted to military R&D have been much lower—around 10 to 20 per cent or less. Here too, though, the shares have generally been declining in the late 1960s, in comparison with the late 1950s and early 1960s (table 6.6 and chart 6.7).

The decline in military R&D expenditures as a share of total government R&D expenditures is mainly the result of a steady increase in civil government R&D outlays during a period when military R&D outlays have generally levelled off or declined somewhat. Government support of very large civil R&D programmes—financed with funds of the order of hundreds or thousands of millions of dollars—has become fairly widespread during the 1960s. At the same time, it has lagged behind the support of comparably large military R&D programmes by about 15 to 20 years. In 1955 when US military R&D outlays amounted to roughly $3 000 million, civil government R&D outlays—which were larger than military R&D outlays in 1939—had reached a level of only $400 million. The estimates available for the remaining countries suggest that in the same year civil government R&D outlays were probably less than $150 million in the UK, France and West Germany, and below $100 million—in most cases considerably below—in all the other countries. By 1969, these civil R&D efforts had reached or passed levels comparable to those for the major military R&D programmes 15 years earlier. Thus, in the United States, civil government R&D outlays (excluding the civil space effort[32]) had exceeded $4 000 million in 1969; in France, $1 000 million; in the UK, $800 million; Japan, Germany and Canada, $400 million; Italy and the Netherlands, $200 million; and Sweden and India, $100 million.

The substantial rise in civil government R&D expenditures during the 1960s and the change in the shares of government R&D funds devoted to military R&D and civil R&D are often explained in terms of "shifting priorities". In considering this interpretation, is is important to recall that there is not a predetermined total government R&D budget, within which military and civil programmes compete or claim their respective shares at the expense of one another. Instead, each competes with other, non-R&D activities within the overall civil and military budgets. The movement in military R&D outlays during the 1960s has probably not been affected in any important way by considerations about the relative level of civil R&D spending. The reverse may not be equally true: that is, the tendency of those responsible for civil government programmes to devote larger shares of their budgets to R&D during the 1960s may have been stimulated by the pattern set by the major military efforts during the 1950s. In particular, the allocation of very large sums—in the hundreds of millions of dollars—to civil R&D may reflect an enthusiasm for the potential civil benefits of R&D investment which has been spurred on by the earlier successes in weaponry of the very large-scale military R&D efforts. To the extent that

[32] As noted earlier, the US civil space effort has a number of aspects in common with military R&D, which differentiate it from other civil R&D efforts. The small quantity of civil *applications* in relation to the size of the overall effort, the close connection to national "prestige" considerations, and the actual scale of the effort may be mentioned. Other US civil government R&D undertakings have been more modest; and the largest of these—related to medical research—has had very obvious civil applications. The space effort might, of course, be seen as an undertaking concerned primarily with the advancement of scientific knowledge. In other areas, however, government support of basic science has been considerably more limited. In 1971, for example, the funds of all government agencies other than DoD, NASA and AEC for "basic research" amounted to less than $1 billion. The total R&D funds of the three agencies which most clearly support pure science for its own sake—the National Science Foundation, the Smithsonian Institution, and the Office of Science and Technology—amounted to less than $0.4 billion, while NASA civil space outlays came to about $3 billion.

Table 6.7. The proportion of total national R&D funds devoted to military R&D, 1955–1970

Military R&D as a percentage of total national R&D outlays

Countries ranked by level of military R&D expenditure, 1965–69	1955	1958	1961	1964	1967	1970
United States	48.0	47.7	47.3	34.4	34.1	30.6
United Kingdom	59.0	49.0	40.5	32.5[a]	24.3	..
France	..	35.9	26.3	23.6	23.5	..
FR Germany	..	5.4	11.2	10.3	9.9	8.3
Sweden	..	..	..	25.9	24.9	..
Canada	..	..	..	14.6[b]	9.9	8.3
Italy	..	..	..	3.3[a]	3.6	..
India	5.5	..	..	12.0[c]	10.5[e]	..
Japan	2.5	1.6	1.1	0.9	1.1	..
Netherlands	..	..	..	2.1	1.9	..
Switzerland	..	..	..	..	2.2	..
Norway	..	..	..	7.5[a]	6.4	..
Belgium	..	..	..	1.5[a]	1.2	..
Denmark	..	..	..	..	0.6	..
Austria	..	..	..	1.2[d]	0.4	..
Finland	..	..	..	..	0.2	..

[a] 1963.
[b] Average of 1963 and 1965.
[c] 1965.
[d] Military R&D 1964, total national R&D 1963.
[e] 1968.

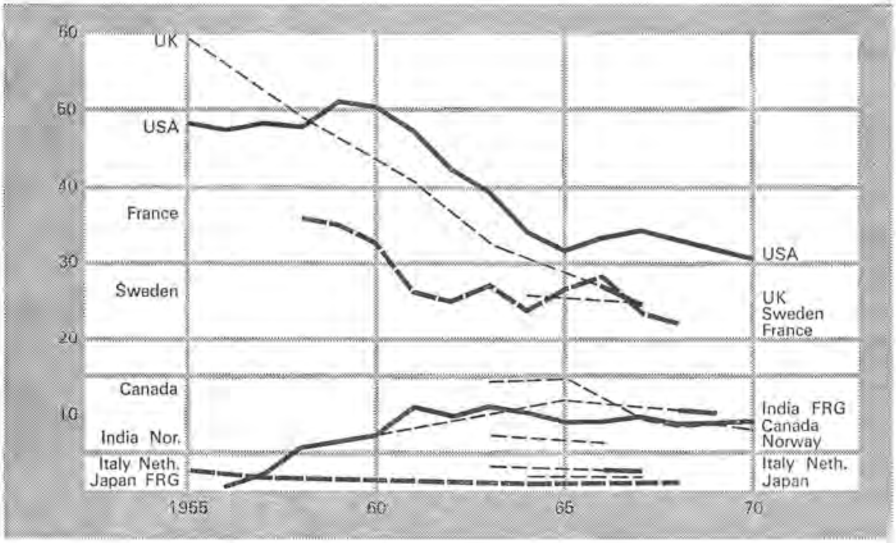
Source: The tables beginning on page 222.

this is so, it might be claimed that World War II has given rise not only to enormous military R&D efforts, but also, through these, to the present support of many very large government-financed civil R&D efforts.

In the context of *total national* R&D expenditures—which include, in addition to the government funds discussed above, mainly funds put up by private industry—military R&D expenditures have also generally represented a falling share during the 1960s (table 6.7 and chart 6.8). Like civil government R&D funds, industrial R&D funds have been rising steadily during the past decade. In considering the extent to which military R&D efforts may have had some impact on this rise, it is not possible to provide a very long-term comparison going back to the World War II period, because estimates of industrial R&D expenditures for this time are not available. The earliest figures which have been found, for the United States, show that by around 1955, total civil R&D outlays, including industry as well as civil government funds, were roughly equal to total military R&D outlays, at about $3 billion. It would, thus, probably be false to suggest that very large and growing R&D efforts in all civil areas may have been supported or stimulated merely in reaction to the earlier example and "successes" of military R&D efforts. A large share of US industrial R&D spending

Chart 6.8. Long-term trends in the proportion of national R&D funds devoted to military R&D, 1955–1970

Percent



Source: The tables beginning on page 222.

has, however, been concentrated in the industrial groups receiving the bulk of government (military) R&D funds. In 1959, for example, industries producing aircraft and guided missiles and electrical and communications equipment—which absorbed about 80 per cent of government R&D funds—also accounted for about 35 per cent of the R&D funds put up by private firms.[33] It is possible, therefore, that many of the big privately financed R&D efforts have been stimulated or carried along through the 1950s and 1960s, financially or technically or both, by the existing government-financed R&D programmes under way within the same business firms, or at least in the same industry. Still, without data on the 1940–1950 period and earlier years, a firm conclusion cannot be drawn about the original impact of government-financed military R&D efforts on private industry R&D undertakings.

III. *The size of worldwide military R&D efforts*

Worldwide weapons development projects under way, 1960–1968

This section summarizes the results of a survey of major government-financed weapons development projects undertaken around the world dur-

[33] Estimates based on data given in *Research and Development in Industry 1969* (Washington: National Science Foundation, 1971).

ing the period 1960–1968. The survey has been conducted for two purposes: first, to give an indication of the relative size of military R&D efforts in countries for which no military R&D expenditure estimates are available; and second, to give a picture of the uses to which military R&D funds go in all countries.

Introduction to the survey

The main results of the survey of weapons development projects are shown in table 6.8 (pages 184–85). The table covers all countries in the world where the average annual level of total military expenditure, during the period 1960–1969, is estimated to have equalled or exceeded $200 million (39 countries, shown in col. A).[34] The countries are grouped by level of total military outlays (average figures for 1960–1969), thus: $35 000 million and above, $4 500–5 500 million, $700–1 900 million, $200–500 million (col. B). Within each group, the countries for which military R&D estimates are available are listed first, ranked by level of military R&D expenditure (col. C). Countries for which no military R&D figures are available are italicized and listed second, ranked by level of total military expenditure. Column D shows the minimum number of nuclear test explosions in each country during 1960–1968.[35]

The remainder of the table (cols. E.1–H.4) shows the number of major weapons R&D projects believed to have been under way in each country for at least one year, during 1960–1968. (Since nuclear explosive development programmes—by any standard, "major" projects—are covered by col. D only, the remarks which follow do not necessarily apply to these programmes.) Only government-financed projects which have been supported at least through prototype construction and testing are included.[36] A count is made of both "new weapon systems" under development, shown in heavy (bold-faced) type, and "modified versions of existing systems", shown in ordinary type. Since one of the main concerns here is domestic development capability, projects which involved modifications to systems developed by foreign governments are set in parentheses.

Each national R&D project is counted only once, under one of the

[34] Countries with annual military expenditures below $200 million were also included in the survey. So little weapons R&D work of any kind was found for any of these countries that it was not considered worthwhile to include them in the main results here.

[35] See page 461. Evidence that the figures understate the real number of US and Soviet nuclear test explosions is examined in appendix 11A, page 433.

[36] This criterion, and the exclusion of small arms and light combat vessels, defines what is meant in the subsequent discussion by "major" weapons development projects. A comparatively small number of "major weapons development projects" were found, during the course of the study, to have been financed—through prototype construction and testing—by private industry. These are, however, excluded from the table and discussion.

Table 6.8. Preliminary survey of government-financed weapons development projects

0 = number of new versions of weapon systems under development.
0 = number of modified versions of existing systems under development.
(0) = number of modified versions of foreign-designed systems under development.

Countries by level of mil. expen.	1960–69 av. an. Tot. mil. expen. (US $ million)	1960–69 av. an. Mil. R&D expen. (US $ million)	Nucl. test expl. 60–68	Missile systems: ABM	Missile systems: Anti-land based target, range: Long	Missile systems: Anti-land based target, range: Int.	Missile systems: Anti-land based target, range: Med.-Sh.	Missile systems: Anti-air.	Missile systems: Anti-tank, anti-ship	Arm. veh.: Main bat. tank	Arm. veh.: Other
A	B	C	D	E1	E2	E3	E4	E5	E6	F1	F2
USA[b]	Over	7 955	286	**2**	**6** 1	**3** 1	**11** 7	**7** 21	**4**	**1** [h]	**11** [h]
USSR[c]	35 000	..	129	**1**	**6**	**3**	**8**	**6**	**5**	**1** [h]	**9** [h]
UK		705	4				**2**	**7** 7	**2** (1)	**1** [h]	**2** [h]
France	4 500–	465	29			**2**	**7**	**5**	**5**	**1**	**2** [h]
FRG	5 500	175						**1**	**3**	**2**	**5** [h]
China		..	8			**1**					
Sweden		80					**1**	**1**	**3**	**1**	**2** 1
Canada		70									
Australia		40							**1**		
India		15								(1)	
Japan[d]	700–	15					**1**	**2**	**1**		
Italy[e]	1 900	15						(1)			
Netherlands		7									**1**
Poland		..									
Czechoslovakia		..									**2** (1)
GDR		..									
Switzerland[f]		7								**1**	**1** 1
Norway		4							**2**		
Belgium		2									**1**
Spain		1									
Greece		< 1									
Denmark		< 1									
Turkey		< 1									
Romania		..									
Egypt	200–	..					**1** 1				
Brazil	500	..									
Yugoslavia		..							**1**		(1)
Israel		..					**2**		**1**	(1)	**1**
Argentina		..									
Iran		..									
Hungary		..									(1)
Portugal		..									
S. Africa		..						**2**			
Others[g]		..									

Table headings and notes

A Countries for which military R&D expenditure estimates are not available are listed second, with names in italics. For further detail on the order in which countries are listed, see text, page 183.

B Average annual level of total military expenditure in 1960–1969. Estimates converted to dollars at current prices and official exchange rates, except in case of Warsaw Pact countries and China. For further detail on the latter, see appendix 4A, page 74.

C Average annual level of military R&D expenditure in 1960–1969, at current prices and official exchange rates.

D Minimum number of nuclear test explosions conducted over the period from 1960 to 1968, as estimated in chapter 13, page 361.

under way 1960–1968[a]

Military aircraft and aeroengines																Combat ships							
Aeroengines				Fighter, jet tr.				Bomb-er, trans.		Hel., VTOL		Light plane		Drone		Submarine				Air.-car.		Other displ. over 1000 t.	
Jet G1		Other G2		Sup. G3		Sub. G4		G5		G6		G7		G8		Nucl.-pow. H1		Conv.-pow. H2		H3		H4	
11	24	9	25	4	25	4	12	8	54	31	36	12	8	8	7	3	1	1	4	1	1	10	13
h	*h*	*h*	*h*	7	12			8	14	6	1	3		*h*	*h*	5	1	2	3	1		4	5
12	4	1	7	5	9	2	4	7	11	13	7	3	4	1		4				2	4	4	4
7	3	9	12	6	5		2	4	3	5	1	1	2	2		1	2	2		1	1	55	2
2	1	4	10	1		1		2		5	1	1	2	2					1				(1)
1	1			1																		1	
	(1)			1	5	1	2					3	1					2	1				2
1		4			(3)	1	2	1	1	1	1	2	2	1					(1)		2	2	1
														1	2						1	1	(1)
1		1		1	3				(1)			3	1										
1				1				3	6		(4)	2	6	1				2		2	1	3	1
						2		1	(1)	2	(2)	3	(1)	2				1		2		1	3
													1					1		1		1	
1						1																	
1		6				2				3		4	3										
												1	6										
																		1				1	
														1									
						2	2	1				1							2	1	1		2
																				1		1	
																						1	
1				1																			
										1		5	2 (1)								(1)		
						2	2					3	5					1					
							(1)		(1)			1	(1)						(1)				
												3	2										
																						1	(1)
													(1)										
										1		1	1						(1)				

E1 Anti-ballistic missile systems.
E2–E4 Missile systems designed to attack land-based targets other than tanks. Intended targets may include grounded missiles or aircraft, radar systems, cities, etc.
E2 Long-range missiles: range over 4 000 km. (2 500 miles).
E3 Intermediate-range missiles: range 900–4 000 km. (550–2 500 miles).
E4 Short- and medium-range missiles: range under 900 km. (550 miles).
E5 Anti-aircraft missiles. Some missiles capable of intercepting other missiles are included.
E6 Anti-tank and anti-shipping missiles.
F1 Main battle tank.
F2 All other tanks, armoured cars, armoured personnel carriers, tracked support vehicles, and self-propelled artillery.

(For remaining table headings and notes, see page 186.)

20 categories of weapon.[37] The categories are grouped into four main classes of weapon systems: missiles (cols. E.1–6), armoured fighting vehicles (F.1–2), aircraft and aeroengines (G.1–8), and ships (H.1–4). The individual categories have been elaborated with a view to distinguishing between the different kinds of weapons development activity undertaken by the two main nuclear-weapon powers, the big powers, other main weapons producers and all other countries. One or a combination of the following criteria have been used in forming the categories: intended role in combat; performance characteristics; and size/weight/design criteria.

Concerning the reliability of the numbers of projects given in the table,

[37] Projects financed jointly by two or more countries are counted once under *each* main financer. In the case of countries which have contributed a small percentage of the funds to a joint project involving several other countries, the projects are not counted, however, for the small contributers.

Notes to table 6.8, pages 184–85.

G1 Jet aeroengines (aircraft engines).
G2 All other aeroengines.
G3–G4 Supersonic (G3) and subsonic (G4) fighters, fighter-bombers and jet trainers.
G5 All other aircraft with maximum take-off weight over 10 000 kg. (22 000 lbs.), including bombers, transports, command and reconnaissance aircraft, etc.
G6 All helicopters and other aircraft with vertical take-off and landing (VTOL) capability.
G7 All aircraft except those included under G3, G4 and G6, with a maximum take-off weight under 10 000 kg. (22 000 lbs.). Includes basic trainers, utility, etc.
G8 Drones are remote-controlled pilotless aircraft generally used as targets, but recently also employed for reconnaissance.
H1 Nuclear-powered submarines.
H2 Conventionally-powered submarines.
H3 All aircraft carriers, including helicopter carriers.
H4 All other combat ships (support ships not included) with displacement over 1000 tons. Includes mainly frigates, destroyers and escorts.

[a] Projects under way at least one year which were carried through prototype construction by 1968, or programmed to enter this phase by 1970. Joint projects are counted under each main country. All countries in world with annual military expenditure of $ 200 million or more (for 1960–1969) are included.
[b] Projects conducted abroad with some US assistance are not included in numbers of US projects.
[c] In the case of the Soviet Union, which does not publish the names, performance characteristics, or development and production schedule of its weapon systems, each new observed missile has been counted here as a new missile, rather than a modified version of a previously existing one, with the exception of the series of successively slightly modified short-range surface-to-surface missiles which have appeared over the period from 1957 to 1967. All systems which have been observed for the first time at some point between 1962 and 1969 are included here, unless there was evidence that the system was in production by 1960–61. As a result of the lack of official data, the figures given for the Soviet Union are likely to be less reliable than those for other countries, but it is not possible to tell whether the number of new systems would be higher or lower than that given here, if data comparable to that for other countries were available.
[d] Japan completed the development of a main battle tank, a light tank and an armoured car immediately before the period under study.
[e] Three missile systems in production or under evaluation in Italy for the Italian armed forces, between 1961 and 1969, are not shown here because they were developed entirely by industry on a private venture basis. Two of these (Indigo, development completed 1966, and Nettuno (Sea Killer Mk. 1), development completed 1967) were developed in Italy, and the third (Mosquito, development completed 1958) was developed in Switzerland.
[f] Several missiles have been developed in Switzerland by private industry, on a private venture basis. As far as is known, no government financial support for these projects was received.
[g] Others are: North Viet-Nam, North Korea, Pakistan, South Viet-Nam, Bulgaria and Iraq.
[h] Versions under development. Sufficient data for accurate count not available.

the following points should be noted. The estimates rely heavily on data given in the main reference works in this area.[38] Further study of sources such as newspaper and trade journal articles and government reports might lead to a revision of the figures given here in three main ways. (1) For a small proportion of the projects, improved data on the dates of development and production might lead to changes in whether or not an item is included. (2) A number of additional major weapon projects might be uncovered, among projects now believed to have been discontinued in early stages of development and within the R&D work begun during the last few years of the period. Alternatively, a few projects now believed to to have been carried through testing might be found to have been cancelled earlier on. (3) It might be possible to devise a more useful method than that employed here of identifying and distinguishing between "new weapon systems" and "modified versions of existing systems". The method used has been to rely on the names given to weapons by the military: when a new name appears, it is assumed that a "new" system is concerned, whereas when a code number or letter is appended to an old name (e.g., for the US B-52 bomber aircraft, the versions "B-52B" "B-52C" ... "B-52H"), it is assumed that the weapon is a modified version of an existing system.[39] A method which relied on the cost of changes or the difference in performance characteristics or a combination of the two might, if practicable, lead to revisions in the balance of "new" and "modified" weapons, for some countries and categories of weapon. For these reasons, the specific numbers given in the table should not be considered final. It is believed, nevertheless, that the figures are sufficiently accurate for the purposes of this study, and that they represent an improvement over the main alternative form in which the data might be presented—a mark in the relevant columns, to indicate some activity under way.

[38] The annual series, for the period 1960–1971, of *Jane's All the World's Aircraft* and *Jane's Fighting Ships;* and *Jane's Weapon Systems* (for 1969–70 and 1971–72 only) (London, annual); and F. von Senger-Ettelin, *Taschenbuch der Panzer* (Munich, 1969). A small number of newspaper and trade journal articles and a few other secondary sources were also used; but the estimates rely in the main on the *Jane's* series and the *Taschenbuch der Panzer.*

[39] In a very few cases, this general rule was not followed. The Polaris A-1, A-2 and A-3 systems, for example, were counted as new systems, on the basis of the evidence of very substantial modifications of the systems and improvements in performance assembled in the *SIPRI Yearbook 1968/69* (pp. 96–111). Similarly, successive developments in strategic nuclear weapon systems in the USSR were each treated as new systems. With regard to conventional weapon systems, the rule was followed in all cases except a few in which all of the main physical dimensions, components systems and performance values were changed between one system and a subsequent modification. Conversely, in a very few cases, where, for example, a land-based anti-aircraft missile was turned into a ship-based anti-aircraft missile with a new name, but where there was no substantial change in the weapon system, the later development was regarded as a modification of the earlier system, rather than as a new system.

It must be emphasized that this survey does not provide a basis for inferring precise estimates of military R&D expenditure, or precise comparisons of the size of military R&D efforts. First, the weapon categories used are not cost-determined, and there may be hundred- or thousand-fold differences in the resources devoted to developing one new system in one category, in comparison with one new system in another. There may also be large differences in the cost of individual items within the same category: in some cases, more funds may go into a modified version of a weapon in one country than into a new version of the same category of weapon in another. Second, the table does not cover all the different activities to which military R&D funds go. Thus, it does not cover military, political or economic studies; research relating to weapons effects and future war environments; or basic research in the natural and engineering sciences designed to advance the state of general knowledge in areas with potential weapons applications—to give a few examples from the "basic and applied research" end of the spectrum. Nor does it include weapons development projects discontinued in early stages of design and development, or R&D work on small arms, light combat vessels or support ships. Further, the survey does not give any separate indication of the amount of R&D activity under way in relation to a number of very important (and expensive) weapon components and support systems—for example, military satellites, electronic systems, communications systems, radar and other data collecting systems, computerized data processing systems, and nuclear power plants for ships and other military uses. Third, as noted earlier, there may be considerable differences in the efficiency or success with which R&D funds are employed in different countries. In expenditure terms, the most important factors are probably the rate of project failure—i.e., the number of projects carried through early or intermediate stages of development but then abandoned, in comparison with the numbers shown here, most of which have gone into production, and duplicative development work. It seems likely that there are substantial differences in efficiency from one country to the next. There are also the differences in the prices of R&D inputs in different countries. These would have to be taken into account in any attempt to convert estimates of the size of R&D efforts based on internationally comparable data to estimates of expenditures in local currency, or in dollars at official exchange rates.

Considering all the "unknowns" described above, and the uncertainties with regard to the specific numbers of projects given in the table, it should be apparent that exact estimates of the level of military R&D spending cannot be drawn from the data assembled. In illustration, it may be noted that the numbers and types of weapons development projects shown in the table for the United Kingdom and France might, at a glance, lead one to expect the French military R&D effort to be the larger of the two: the military R&D estimates indicate, however, that the reverse is true.[40] On the other hand, the survey of weapons development projects, like the analysis of military R&D expenditures, appears to put France and the United Kingdom into the same class, by comparison with all the other countries for which military R&D estimates are available. It is on broader, "order of magnitude" comparisons of this kind that the conclusions which follow are based.

Main results

The results of the survey, summarized in table 6.8, reveal that, with the exception of the Soviet Union's effort, there is comparatively very little weapons development under way in the countries for which military R&D estimates are not available. Only four countries in this group had an average annual level of total military expenditure above $700 million during the 1960s: the People's Republic of China, Poland, Czechoslovakia and the German Democratic Republic (GDR). For the GDR, no evidence of weapons R&D was found; and for the other three countries, the range and quantity of projects under way in 1960–68 is small in comparison with that in other countries with comparable levels of military expenditure. All of the remaining countries in the world for which military R&D estimates are not available have had an average level of total military outlays below $500 million—and, by implication, a potential for very limited military R&D undertakings only.

Countries for which military R&D estimates are available

Before looking more carefully at the countries for which no military R&D figures are given, it may be useful to examine and compare those where estimates are available. Four main factors, illustrated in table 6.8, appear to account for the order-of-magnitude gaps in the observed levels of military R&D spending. These are, for the respective R&D efforts: (1) the number of main classes of weapon system or component—nuclear devices, missile

[40] The possibility that the military R&D estimates may be unreliable cannot be ignored. It seems unlikely, however, that the French estimates under-estimate the magnitude of the resources devoted to the development of conventional weapon systems by amounts which could close the expenditure gap between the two countries—particularly in view of the greater purchasing power of UK outlays. (At the approximate R&D exchange rates calculated for 1967, the average annual military R&D expenditures of the two countries for the period 1960–69 come to: UK, $1 000 million; France, $600 million.) It seems more likely that differences in "efficiency" in the two countries—using the term to encompass both industrial productivity and rate of R&D project successes to failures —account for a good part of the difference in the numbers and range of projects carried through advanced development with their respective R&D funds.

systems, armoured vehicles, aircraft and aeroengines, and ships—covered; (2) within each class, the number of different categories of weapon covered; (3) the particular selection of categories, in terms of the minimum level of technical effort and specialization required to develop the types of weapon concerned; and (4) the quantity of new designs carried through prototype construction and testing (and, usually, production), for each major category. Thus the United States, with military R&D outlays in the $5–10 billion range, has had a large nuclear testing programme, and has generally developed 2–8 new weapons in each of the 20 major categories listed here, covering all main classes of weapon system, in the period from 1960 to 1968. The United Kingdom and France, with military R&D expenditures around $500–1 000 million (range covering estimates at both official and R&D exchange rates), have also supported nuclear weapon testing programmes, and developed new weapons in almost all major categories across the four main classes of weapon system. In these two countries, however, by comparison with the United States, the number of nuclear tests has been much smaller; the quantity of new designs developed through prototype testing has been markedly lower, for most categories of weapon; and development of the most expensive and sophisticated strategic nuclear weapons has not been undertaken. With a level of military R&D spending about one-third to one-half as great as that of the UK or France (at both official and R&D rates), the Federal Republic of Germany has had no nuclear testing programme, and a slightly narrower range of development projects in conventional weapons, excluding longer-range "offensive" missile systems and nuclear-powered submarines. The numbers of new aircraft, missile and ship types developed have also been somewhat lower, although in partial compensation there have been more projects in the area of tanks and other armoured vehicles.

With one exception, the countries with total annual military expenditures of $700–1 900 million and military R&D expenditures of $100 million and below (at both official and R&D rates),[41] have undertaken development work in only two or three of the four main classes of conventional weapon. The exception here is Sweden, which has developed several new missiles, a main battle tank, an advanced supersonic fighter and two new classes of conventionally-powered submarine during 1960–1968. Sweden has the highest level of military R&D spending of this group of seven countries. Japan, with military R&D outlays about half as high as Sweden's (at R&D rates allowing for wage differences; considerably less at official rates), has undertaken a range of projects only slightly more restricted: several somewhat

[41] Sweden, Canada, India, Japan, Australia, Italy, and the Netherlands.

less sophisticated missiles (the first generation of Japanese-designed missiles); no tanks; a broad range of aircraft including, recently, a supersonic jet trainer and domestically developed jet aeroengines; and two new classes of conventionally-powered submarine. It might be noted that a family of armoured vehicles, including a main battle tank, was developed in Japan at the end of the 1950s; and Japan presumably retains the capacity for further development work in this area, when the current series become "obsolete". The efforts of the remaining countries for which military R&D estimates are available have been mainly concentrated on aircraft, with additional work on ships (all but India), and, to a lesser extent, on missiles (Australia and Italy), or armoured vehicles (India and the Netherlands) or, as a significant sub-category, aeroengines (Canada and India). In these five countries, as in Sweden and Japan, there are very few examples of more than one or two newly designed systems for any major weapon category, apart from light aircraft. The average number of different categories in which any sort of development work has been undertaken is only 7 for this group, as compared with 16 for West Germany and 20 for the UK and France.

For the group of seven countries with total military expenditures of $200–500 million annually, and military R&D outlays of $10 million and below (at both official and R&D exchange rates),[42] weapons development projects have generally been limited to one or two newly designed weapons in two or three weapon categories, within not more than two main classes of weapon. The projects fall, for the most part, into the less sophisticated weapon categories, although Switzerland has designed a main battle tank, and Spain a jet fighter and a jet trainer (both subsonic).

Other countries

Among the countries for which annual military R&D expenditure estimates are not available, the Soviet Union has by far the largest military R&D effort. Indicators of the size of this effort are examined later in a separate section.

The military R&D effort of the People's Republic of China has been extraordinarily limited, not only in comparison with those of the United States and the Soviet Union, but also juxtaposed to the efforts of the UK, France, or even some of the other countries with lower military R&D expenditures. China's defence industry was built up during the latter part of the 1950s. The armaments manufactured at that time and throughout the 1960s consisted almost exclusively of Soviet weapons, produced, originally,

[42] Switzerland, Norway, Belgium, Spain, Greece, Denmark, and Turkey.

with the aid of Soviet technicians, and with components imported from the Soviet Union. These included medium bombers, light aircraft and helicopters, MiG-15, -17 and -19 fighter aircraft, and combat ships, including a conventionally-powered submarine with tubes for ballistic missiles. All these weapons had been developed in the Soviet Union by the mid- to late-1950s. A few Chinese-designed light aircraft and a destroyer escort had been produced by 1960. From the mid-1960s China produced Soviet weapons, without Soviet assistance or components. The only Chinese-designed systems known to have been under development in the first part of the 1960s are the nuclear weapon—a nuclear device was first tested in 1964, and a thermonuclear device in 1967—and an intermediate-range (1 600 km) ballistic missile, first tested in the mid-1960s. In 1968 the first of a new class of destroyer escort was laid down; and construction of a new class of nuclear-powered submarine—probably an attack submarine—is reported to have begun in 1971. Finally, in the late 1960s China flew a supersonic jet fighter, with improved jet engines, referred to in some sources as a copy of the Soviet MiG-21 (which was first shown in the Soviet Union in 1956),[43] and in others as a prototype or interim version of a new Chinese design (US designation: F-8), which was never manufactured in quantity. A further improved fighter aircraft, referred to in the United States as the "F-9N", is reported to have been in series production by early 1971.[44] According to the same sources, this aircraft—with a combat radius of 700–1 000 km. and a speed of Mach 2—would probably be out-performed by the US Phantom (in production late 1950s) or the Soviet MiG-21.

In sum, it appears that, although China has now designed several sophisticated weapons, the development effort has been based largely on experience gained in the manufacture of comparable, but less sophisticated, Soviet systems: there has been no evidence of an attempt to build up the capacity for production of the full range of conventional weapons, based on a Chinese R&D effort. The few weapons which have been developed domestically—including the nuclear weapon and the nuclear-armed ballistic missile—are, furthermore, comparable to those produced by the USA and the USSR 15 to 20 years ago; and there has been no attempt to develop even elementary versions of some of the more sophisticated strategic nuclear

[43] The *1968–69* issue of *The Military Balance* (London: International Institute for Strategic Studies, annual) describes China as possessing and then manufacturing MiG-21s, which are suggested to have been supplied by the Soviet Union in the early 1960s.
[44] W. Beecher, "China Said to Be Producing Jet Fighter of its Own Design", *International Herald Tribune*, 18 May 1971, p. 5, citing "senior American analysts", "officials", and "military sources", describes the "F-8" as a development of the late 1960s which was mistakenly identified by some as a copy of the MiG-21. The "F-9" is said to be a twinjet fighter. *The Military Balance 1971–72*, published in September 1971, described a new Chinese twin-jet fighter as being under development.

weapon systems, such as those now coming into production in France. Finally, the rate of nuclear testing has been relatively very low. It would seem unlikely, therefore, that China spent more than a few hundred million dollars annually at R&D exchange rates—and it may have spent considerably less, of the order of $100–150 million—during the 1960s.[45]

Of the three Warsaw Pact countries with average annual military expenditures estimated at $1 000–2 000 million, only Poland and Czechoslovakia are known to have undertaken any major weapons development projects; and the efforts here have been largely confined to light (maximum take-off weight under 2 000 kg.) multi-purpose aircraft, which may have been developed mainly for civilian use. Both countries have, however, recently developed subsonic jet trainers, with domestically designed and developed aeroengines. The Czechoslovak trainer has been exported to several other Warsaw Pact countries, including the Soviet Union. In addition, Czechoslovak aeroengines have been exported around the world for many years. (Among other countries with a comparable level of annual military expenditure, only Canada has a comparable aeroengine production effort.) Some indigenously designed armoured vehicles have also been produced in Czechoslovakia. Among the countries in the same group for which military R&D estimates are available, India has had a broadly similar effort in terms of the range, selection and quantity of weapons development projects. Since both Poland and Czechoslovakia have—unlike India—had a long history of domestic design and development of aircraft, it is likely that the costs of the efforts here, at R&D exchange rates, have been somewhat lower than

[45] Since the figures given here for China, and those given in the remainder of this part for countries for which estimates are not available are based on comparative weapons R&D output only (this applies to all but the Soviet Union), they involve assumptions concerning not only the relative prices of R&D manpower and materials, but also productivity or efficiency. The figures given for China thus assume, for example, that if the resources devoted to military R&D have amounted to much more than the estimated amounts, at R&D exchange rates—and since wages are presumably very low here, this may be the case—then this has been offset by a much lower productivity than is typical among the countries for which R&D estimates are available: this, too, is possible, since the Chinese R&D effort is presumably undertaken with more manpower but more limited equipment and facilities than its Western counterparts. If, on the other hand, the resources devoted to military R&D, calculated at R&D exchange rates, have not been much greater than the estimates made here, then relative Chinese productivity may be higher. It is thus inaccurate to present the figures as a measure of resources: instead they measure the relative dimensions of the effort with productivity factors taken into account. Since there is little evidence that, in the countries for which military R&D estimates are available, productivity factors can result in a difference suggesting more than, say, a doubling or halving of the "size" of the effort in relation to the efforts in other countries for which estimates are given, the comparisons between these countries and those for which estimates are not available may be considered justified, even though the figures in the former case refer to resources only. If productivity were taken into account, the rank order of the various countries' efforts would, thus, presumably not change from that suggested by the order-of-magnitude estimates provided here.

in India, probably amounting to no more than some tens of millions of dollars annually during the 1960s. It may seem surprising that these two countries, along with the German Democratic Republic—the three most industrially advanced socialist nations apart from the Soviet Union—have had such small military R&D efforts. This is apparently in large part the product of a deliberate policy in the Soviet Union, which may be motivated either by security reasons or by interest in an assured weapons export market, or both.

Among the 16 countries with military expenditures of $200–500 million annually for which no military R&D estimates are available, there are seven countries where, as far as is known, no major weapons development projects have been undertaken during the period under study. These are: Romania, the Democratic Republic of Viet-Nam, the People's Democratic Republic of Korea, Pakistan, the Republic of Viet-Nam, Bulgaria and Iraq. At the same time, there are four countries where development work of some kind has been undertaken in at least three of the four main classes of weapon.[46] This applies to Brazil, Yugoslavia, Israel and South Africa. The Israeli effort is unique in covering all four classes. This "achievement", at a comparatively low level of total military expenditure (about $350 million annually for 1960–1969), is the product of: (1) selective development of a small number of modest "new" systems (including one light aircraft); (2) reliance on foreign technology for the development of several of these systems; and (3) the establishment of facilities for maintenance and overhaul and for licensed production incorporating a level of technical skills such that modification of imported sophisticated weapons could be undertaken. On a more independent basis, Yugoslavia has developed a new light tank, a subsonic fighter and a jet trainer, and a new class of submarine during the period. The efforts of Brazil and South Africa have been less ambitious, centring on the capacity for independent development and production of light aircraft and helicopters. In addition, Brazil has been working on a basic anti-tank missile, and South Africa has supported work—undertaken primarily in France—on an anti-aircraft missile. Both countries have also financed the conversion of ships (Brazil: ex-UK aircraft carrier converted in the UK; South Africa: ex-UK frigate converted in South Africa), to accommodate helicopters for anti-submarine warfare.

The remaining countries in the $200–500 million annual military expenditure group—Egypt, Argentina, Iran, Hungary, and Portugal—have,

[46] It may be recalled that none of the countries with this level of total military spending ($200–500 million annually) for which military R&D estimates are available conducted weapons development work in more than two of the four main classes of weapon. The military R&D expenditure estimates of those countries may thus be lower than the comparable figures for several of the countries discussed here.

with one exception, undertaken development work on one or a few less sophisticated weapons only. The exception is Egypt, which undertook to develop a supersonic fighter with an indigenously designed engine and a medium-range missile, beginning in 1962.[47] These projects were cancelled in 1968 prior to the development of production versions.

In all, a generous figure for the *maximum average annual cost* of the military R&D efforts of the countries with military expenditures below $500 million during the 1960s might be around $20–25 million, with this range particularly applicable to the efforts of Israel and Yugoslavia.[48] There is evidence that Egypt spent about $5–10 million annually on its development effort during the period of greatest activity in the mid-1960s.[49] For the remaining countries in the group, the weapons R&D efforts have probably cost no more than a few million dollars annually, if that much.

The military R&D effort of the Soviet Union

The military R&D effort of the Soviet Union has probably cost some billions of dollars a year—at R&D exchange rates—during the 1960s. This is suggested both by the level of total military expenditure and by the

[47] As far as is known, the fighter aircraft with its indigenously designed engine was in fact never test flown.

[48] After the range given here—$20–25 million—had been estimated, a figure was found for Yugoslavian military R&D expenditure in 1964 (in E. Benoit, ed., *Disarmament and World Economic Interdependence* (Oslo, 1967), p. 31, citing an official national source): the estimate came to $12 million at official exchange rates, and $20 million at a purchasing-power-parity similar in purpose to the R&D exchange rates used in this study. Partial "confirmation" of the estimate with regard to Israel has also been found. An official publication—*Scientific Research in Israel* (Tel Aviv: Center of Scientific and Technological Information, 1971)—provides the following data: total Israeli R&D expenditures in 1969–70 came to about $100 million; "defence research" is explicitly included in the figure. Civil R&D expenditures, financed by the government and private sources, are estimated at $50 million. Military R&D presumably amounted, thus, to about $50 million, or the equivalent of about 50 per cent of total R&D expenditures, or 5 per cent of total military expenditures. For 1971–72, total R&D expenditures are estimated at $130 million. A "large percentage" of this is said to go to defence R&D. A figure of about $65 million might be assumed, by taking 50 per cent. This suggests a rapid rate of rise—of the order of 15 per cent annually. Total military expenditures were also much higher at the end of the 1960s than at the beginning, and rising rapidly. This would suggest much lower military R&D outlays for the period 1960–1965. Estimates of total national R&D expenditures for 1958–59 and 1966–67 are given in the same publication: they come to about $37 million and $66 million, respectively. It is noted, further, that "Whereas in the past R&D was devoted largely to agriculture ... the new needs and circumstances have demonstrated the importance of the contributions which an intensive R&D effort could make in industrial manufacture and exports involving more sophisticated products and processes." Presumably, thus, military R&D outlays were very low in the early 1960s—when total military expenditures amounted to less than $200 million—perhaps of the order of $5–10 million; and they may have increased to about $20–30 million by around 1966–67, and then to $50 million by 1969–70.

[49] Data taken from SIPRI worksheets on domestic defence production in third world countries.

nature and quantity of weapons development projects undertaken. It is difficult to hazard a more precise figure, since the evidence on which to base a closer estimate is scanty and inconclusive. An attempt will nevertheless be made to examine the available evidence relevant to a more exact quantification of the size of the effort. The main indicators relate to the financing of the total military effort, and to the range, quality and quantity of weapons development projects known to have been undertaken.

Total military expenditure as an indicator

The military budget of the Soviet Union—a single figure published each year with no breakdown—has amounted to 13.6 billion roubles, on average, during the 1960s. This is the equivalent of about $15.1 billion, at official exchange rates, or around $30–35 billion, at a rough purchasing-power-parity.[50] The latter figure clearly puts the USSR in the same class as the United States with regard to the overall size of the military effort, in comparison with all other countries. It also suggests that funds of the order of billions of dollars annually may be available for military R&D.

A more precise estimate of the potential level of military R&D spending could be derived by drawing a closer analogy to the pattern of spending in the USA, the UK and France. A range of possible military R&D outlays could be calculated by using the range of percentages found to go to R&D in the three main Western weapons producers, i.e., 9–13 per cent of total military expenditure. To allow for potential differences in military R&D funding which might result from, for example, the effect of the centrally planned nature of the Soviet economy on prices and on real costs, the range could be extended a few percentage points on either side—to, say, 6–16 per cent. This would also provide figures which cover all the percentage values for the three Western countries—and, at the higher end, for any country where figures are available—for all years in the period under study.

A certain amount of uncertainty would still be involved, since it is not known whether the announced defence budget of the Soviet Union covers the same range of military activities as the military expenditure series used in this study for the major Western countries. In a number of cases, the latter include other military expenditures, in addition to the funds of their respective "defence departments". The "national defense" category of government expenditure used for the United States, for example, includes the following kinds of funds, channelled through other government departments and agencies, in addition to Defense Department funds: outlays for civil defence; expenditures for the stockpiling of "strategic materials"; funds for

[50] The source and justification for the use of this purchasing-power-parity are given on pages 76–77.

the expansion of defence production facilities; military aid to foreign countries; and expenditures for the development, testing, manufacture and stockpiling of nuclear warheads, and for the development of nuclear power plants for military use. These "extra-Defense Department" outlays generally cover programmes initiated during or since World War II, which cannot easily be associated with the traditional functions of the army, navy or air force. This may account for their special budgeting in many cases. In recent years funds of this kind—channelled outside the Defense Department—have amounted to about 9 per cent of total "national defense" expenditures in the USA.

Western analysts have frequently suggested that funds of the kind excluded from the Defense Department budget in the United States (e.g., civil defence, military aid, nuclear weapons development) may also be excluded from the budget for "defence" in the Soviet Union. The analogy with the United States and other Western countries for which detailed accounting is available is *not* usually mentioned. Instead, reference is made to Soviet financial analyses which occasionally provide a brief description of the types of expenditure covered by the defence budget. In general, these descriptions mention only the traditional types of expenditure, and do not specify items typically excluded from defence department budgets in the West. Another item conspicuous for its absence from several Soviet lists of this kind is research and development—the bulk of which *is* included in defence department expenditures in Western countries.

No conclusive evidence concerning the range of activities covered by the official Soviet defence budget has been found.[51] However, the possibility that it covers a different—and in this case most probably smaller—range than the military expenditure series used for other countries cannot be ignored. Thus, given the frequency with which new post-war programmes —and especially military nuclear programmes[52]—are excluded from nar-

[51] Various types of Soviet data studied by Western analysts include information relating to the structure of the complete Soviet government budget, and data relating to the size of the national income and product, and the end-uses of output in the industrial sector. Some of the studies suggest that additional military expenditures generally covered by defence department budgets in the West—such as some procurement outlays and funds for military construction—may also be excluded. However, the method used in almost all cases involves attempts to distribute quantities of resources among potential or plausible civil uses; followed by assumptions that the residuals, for which no civil uses have been "found", are largely or entirely devoted to military purposes. No convincing evidence as to the definite exclusion of any particular type of expenditure has, to our knowledge, been offered.

[52] Military nuclear programmes are financed outside the defence department budget in the United States and the United Kingdom, and probably to some extent, though not fully, in France. To the extent that Japanese and Indian nuclear programmes have a military content, these are, as far as is known, also financed outside the defence department budgets.

rower definitions of defence expenditures in other countries, it would not be surprising if a similar practice had been adopted in the Soviet Union. It is also possible that some military R&D outlays are channelled through budget expenditures for "science" (the equivalent of the Western "R&D"), rather than through the defence budget. It does not seem likely that all military R&D outlays are financed in this way, since there is at least one Soviet financial statement which specifically includes the support of "scientific research institutes" in a list of the objects of defence budget expenditures.[53] At the same time, the funds channelled through the "science" category of the central government ("all-union") budgets for 1970 and 1971 have probably come to more than 5 billion roubles;[54] and at R&D exchange rates the amounts involved are probably more than $10 billion.[55] By way of comparison, recent federal government R&D expenditures in the United States on civil programmes only—including mainly the civil space programme—have come to only $7–8 billion. The amounts involved in the Soviet science budget might thus be large enough to encompass some military R&D outlays. These considerations suggest that somewhat greater confidence could be placed in the estimates obtained by the method outlined earlier, if a range for the level of total military expenditure as well as for the percentage which may go to R&D were used. At the lower end, official defence outlays could be taken. At the higher end, a figure could be calculated, assuming that official defence expenditures represent, say, 80–90 per cent of total military expenditures. This

[53] K. N. Plotnikov, *Gosudarstvennyi Byudzhet SSSR* (1959), p. 322; cited in F. Freeman and A. Young, *The Research and Development Effort in Western Europe, North America, and the Soviet Union* (Paris: OECD, 1965), p. 120.

[54] In the Soviet state budget for 1972, total national expenditures for science are estimated at 14.4 billion roubles (for 1972), and this is said to be an 8.8 per cent increase over expenditures during 1971, implying a figure of about 13.2 billion roubles for 1971. Actual expenditures for 1970 are estimated to have come to about 13 billion roubles. Throughout the period from 1965 to 1969 (the latest year for which this information is available), general government ("all-union" plus "republican") budget expenditures for science amounted to about 60 per cent of total national science expenditures, the remainder being accounted for by funds attached to enterprises and expenditures from other sources (some of which may be budgetary sources, including, potentially, the defence budget). In 1965 (the last year for which this information is available), "all-union" budget expenditures for science amounted to about 85 per cent of all budget expenditures for science; or about 50 per cent of all science expenditures. Assuming that these proportions still hold—or even allowing for a slight decline in the "all-union" budget share—"all-union" budget expenditures for science in 1970 and 1971 might have amounted to 5–6.5 billion roubles. (The science expenditure estimates are taken from *Narodnoe Chozyaistvo SSSR v 1967; 1968; 1969* [*National Economy of the USSR in 1967; 1968; 1969*] (Moscow, 1968, 1969, 1970), and from the report by the Minister of Finance, Deputy V. F. Garbuzov, on the USSR State Budget for 1972 ("O Gosudarstvennom Byudzhete SSSR na 1972 God", *Pravda*, 25 November 1971), (SIPRI translation).

[55] The figure is obtained by using the lower end of the range of possible R&D exchange rates set out later in this part.

would leave a margin of 10–20 per cent of the total to allow for the potential exclusion from the defence budget of (1) "peripheral" or new types of expenditure, often excluded from more narrowly defined defence expenditures in other countries; and (2) some military R&D outlays.

One further important problem in estimating the possible size of the Soviet military R&D effort by the suggested method concerns the appropriate exchange rate to use to convert the rouble figures to dollars, for comparison with other countries. Purchasing-power-parities have been used a few times in the discussion above, but only for providing a very rough indication of the amounts involved. To give a single figure for the Soviet R&D effort, a more accurate measure would be required. Few studies of Soviet R&D attempt to calculate a rouble–dollar R&D exchange rate, because there is little evidence to go on. Two general ranges, which appear to be about equally reliable, have been found: these are $2–3 per rouble,[56] and $2.50–3.50 per rouble.[57] There would seem to be something of a 'consensus', if the full range of $2.00–3.50 per rouble were taken. It should be emphasized that this range attempts to allow for differences between the United States and the Soviet Union in the wages of R&D employees and the prices of materials: it does not make any allowance for potential differences in "productivity".

In conclusion, the best approximation of the potential size of the Soviet military R&D effort which can be obtained by using estimates of total military expenditure as an indicator appears to require the use of three ranges, for (1) the level of total military spending, (2) the share of this total which, assuming a pattern comparable to those in the West, may go to R&D, and (3) the R&D exchange rates, to be used to convert the rouble estimates to dollars, measuring equivalent manpower and material input. Although the use of these ranges would seem to give somewhat greater confidence in the results than a selection of three single figures, it is possible that, for each of the three "variables", the true figure lies outside the range indicated here. This implies that the real size of the Soviet military R&D effort—measured in terms of the funds used, converted to dollars at accurate R&D exchange rates—could be larger or smaller than

[56] "Many experts ... believe that a reasonable conversion rate for Soviet Union military R&D work would be from $2 to $3 ruble." (in *Comparison of Military Research and Development Expenditures of the United States and the Soviet Union,* by the Comptroller General of the United States (Washington, 1971), reprinted in *Congressional Record-Extension of Remarks,* 31 July 1971, p. E8610.) In addition, it may be noted that the value for the R&D component of total Soviet military outlays used in arriving at the purchasing-power-parity employed in this book for total Soviet military expenditures is $2 per rouble.

[57] R. W. Davies, G. R. Barker and R. Fakiolas, "Appendix on the Soviet Union", in C. Freeman and A. Young, *op.cit.,* p. 128.

Table A. Illustrative calculation of potential level of Soviet military R&D expenditures

	Lowest value suggested by this study	"Mid-point"[a]	Highest value suggested by this study
Estimated possible:			
Level of average annual military expenditure, 1960–69 (bn roubles)	13.6	15.1	17.0
×			
Share devoted to R&D (per cent ÷100)	0.06	0.11	0.16
Level of average annual military R&D expenditure, 1960–69 (bn roubles)	*0.816*	*1.662*	*2.720*
×			
Approximate R&D exchange rate (dollars per rouble)	2.00	2.75	3.50
Level of average annual military R&D expenditure, 1960–69 (bn $, at R&D exchange rates)	*1.632*	*4.571*	*9.520*

Note: For sources and justification of data used in calculations here, see text.
[a] "Mid-point" refers to the mid-points of the ranges used for the share of military expenditures which may go to military R&D, and for the R&D exchange rate; and, in the case of total military expenditures, the value obtained by assuming that the defence budget represents 90 per cent (rather than 80 or 100 per cent, as at the two extremes) of the total.

the highest or lowest figure which may be calculated by the method outlined here. (These figures are shown in table A.) However, given the relatively wide ranges suggested for the share of military funds going to R&D and for the appropriate R&D exchange rate, it is more likely that the real size of the Soviet effort falls within the upper and lower extremes.

The extreme values obtained—around $1.5 and $9.5 billion—are very far apart. They are too far apart to provide any basis for a meaningful comparison with the United States. A further calculation of a narrower range, which should be treated with great caution, may be made to permit some kind of comparison. Here the lower end of the range might be assumed to be the figure—$4.6 billion—obtained by using the various "mid-points" shown in table A. A reasonable figure for the upper limit which still makes some allowance for the dearth of evidence might be calculated by (1) taking the highest level of total military spending which seems reasonable in the light of this study—17 billion roubles, on average, during the 1960s; (2) using a share for R&D comparable to that in the USA for the same period—13 per cent; and (3) converting the result (2.2 billion roubles) at the mid-point of the R&D exchange rate range, $2.75 per rouble. This produces a figure of about $6.1 billion. In comparison with the average level of military R&D expenditure in the United

States during the 1960s ($7.9 billion), this range—$4.6–$6.1 billion—suggests a Soviet effort about three-fifths to three-quarters as large. Again, the calculations make no attempt to allow for the relative productivity of the two efforts—and the factors here are generally believed to weigh in the advantage of the USA;[58] and finally the range is, unavoidably, a low confidence one.

The survey of weapons development projects

The estimates collected in the survey of weapons development projects (table 6.8), like available data on total military expenditures, place the Soviet Union together with the United States in a separate class from the remaining countries in the world. Thus the Soviet Union, in common with the United States, has: (1) conducted a considerably larger number of nuclear tests during the period than any of the other three nuclear-weapon powers; (2) been the only other country to develop new systems in all of the main categories of weapon identified here; and (3) developed a larger number of new systems, *on average,* within the various categories than any of the remaining countries.

With regard to potential differences between the United States and the Soviet Union, in the overall size of the military R&D efforts, it must be observed that the data assembled in table 6.8 are not very useful for distinguishing between the efforts of these two countries. The level of measurement, confined to counting new and modified systems within a relatively small number of weapon system categories, is suitable as a means of giving a compact worldwide survey. It is too crude to distinguish between the vast efforts of the two main participants in the technological arms race. The only notable difference between the two countries revealed by table 6.8 is an elementary quantitative one: the Soviet Union has apparently developed a smaller number of new and modified major weapon systems for most of the separate categories identified here—and particularly for modified shorter-range missile systems and new and modified aircraft—during the period; and it has conducted considerably fewer nuclear tests. While quantitative differences of this kind are perhaps not particularly significant from other points of view, they may well entail parallel differences in expenditures: and this is, of course, important in the context of the level of total military R&D outlays.

At the same time, however, the relative quantities of resources devoted to two R&D efforts for which the ranges of weapon system categories covered are comparable cannot be inferred simply on the basis of the rela-

[58] See, for example, papers in US Congress, Joint Economic Committee, *Economic Performance and the Military Burden in the Soviet Union* (Washington, 1970).

tive numbers of new and modified weapon systems under development. Several intervening factors are set out in the introduction to table 6.8, above: only those which seem most important in the context of the US–Soviet comparison will be mentioned here. First, the United States does not have a superiority in numbers for every category of weapon identified in the survey. Separate estimates would, therefore, have to be made for each of the categories, and these then added together. Data on which to base such estimates have not been assembled, although one preliminary indication that the areas of US quantitative superiority may reflect higher overall development expenditure has been found. Thus, expenditures on aircraft and missiles have absorbed the largest proportion of US military R&D funds among the four main classes of weapon system.[59] These are also generally the most expensive types of conventional weapon: and it is here that the US quantitative lead is greatest. Second, even if the United States had a superiority in numbers of weapons developed in every main category, a generally larger R&D input, in terms of manpower and material resources, could not be assumed (though it might be likely if the difference in numbers were great enough), because of probable differences in the productivity of the US and Soviet efforts. As noted earlier, Soviet productivity is generally believed to be lower, so that the Soviet Union might employ a larger quantity of resources on a smaller number of weapons development projects. Third, and perhaps most important, there is the question of potential qualitative differences in the specific new and modified systems developed within the various categories. Available evidence indicates that US systems are, across the board, qualitatively "better", in the sense of being more advanced technologically or more complex. While this does not necessarily mean that the weapon systems are in all cases superior in combat, it does imply that they are considerably more expensive.

A detailed and systematic qualitative comparison of US and Soviet weapon systems developed during the 1960s has not been undertaken. The statement that US systems are generally qualitatively superior is based, in part, on scattered evidence, all tending in the same direction. In part, it also relies on statements of US Defense Department spokesmen that US weapons are, across the board, technologically more advanced. Recent statements of this kind may be illustrated by the following extract from the statement by the US Director of Defense Research and Engineering on the planned US military R&D programme for 1971–72, made before the US Senate Armed Services Committee in March 1971:

[59] *Special Analyses, Budget of the United States Government, Fiscal Year 1970, 1971, 1972* (Washington, D.C., 1969, 1970, 1971).

Assessment of relative US/USSR technological efforts

Turning now from the summary of my statement to the supporting details, I would like to discuss the reasons for our concern today about the general level of the US Defense RDT&E effort.

One of our most serious concerns is an apparent Soviet challenge in outright investment rate in defense RDT&E. This kind of challenge is difficult for most people to accept as a reality. We are used to being ahead technologically, whether it is in weapon systems or in automobiles, commercial television, or home applicances. It is hard for an American who knows the Soviet standard of living to believe that the Soviet government could mount an across-the-board challenge to the United States in military technology. As a people, we tend to discount the ICBMs ... and the unmanned landing on Venus, which seems weak compared to our manned landings on the moon ... We again tend to discount past Soviet "firsts", such as space vehicles and large boosters for ICBMs, by which Soviet concentration in limited areas has produced technological leadership in the past—as least for a while.

The seriousness of a Soviet challenge in RDT&E investment rate really turns on whether the Soviets can accomplish across the board what they have done occasionally in the past in limited areas ....

Since analyses of resource inputs to research and development cannot address the question of whether these resources are used effectively, last year we initiated a study to compare the relative military and space technological *outputs* of the United States and the Soviet Union.

In this study, we compared the date on which each nation had the option to produce a given comparable weapon system; for example, in 1968, the Polaris boat was considered to have a 5-year technological lead over the comparable Y-class submarine.

By making many such comparisons over intervals, it was possible to follow technological changes over time and thus determine how many years it took the Soviet Union to reach given levels of US technology.

The findings of this net technological assessment were as follows:

- Both countries had about the same number of major systems under advanced (visible) development.
- While the technological lead time in years changed for individual major weapon systems and even for major weapon-system categories on the average the United States retained its 2- to 3-year technological lead in military systems.
- In space technology, the US advanced its technological lead by several years.

These findings are probably no real surprise to the members of this Committee. Thinking back, you may recall that we were ahead and stayed that way in most military systems and that we pulled sharply ahead in space systems during that time period.[60]

The assessment that the United States has had an across-the-board lead in the technology incorporated in the major weapon systems developed during the period (identified elsewhere as 1960–1968) is clear in this statement.

From the point of view of the amounts of military R&D expenditure in-

[60] Statement by the Director of Defense Research and Engineering, *op.cit.*

volved, the relative stage of work on advanced strategic nuclear weapon systems is most important. For these systems, as for conventional weapon systems, the successive generations of increasingly advanced versions have been more and more expensive; but for the strategic nuclear weapons the expenditures involved have been much larger. Although a detailed comparison has not been possible, the evidence which is available indicates rather longer US lead-times for strategic nuclear weapon systems, than the "2- to 3-year" US lead suggested in the above statement as applying to all major systems "on the average".[61] To take the newest and most advanced type of strategic weapon system, the Soviet "Y"-class ballistic-missile submarine is comparable to the US Polaris A-1 or A-2 submarine in that both have 16 tubes for ballistic missiles; in both cases the missiles are believed to carry single rather than multiple warheads; and the range assigned to the missiles in both cases is about 1 500 nautical miles.[62] But the Soviet submarine was operationally deployed for the first time in 1969, while the Polaris A-1 and A-2 systems were deployed in 1960 and 1962 respectively, implying a 7- to 9-year US lead. Only three parameters, with regard to which the US and Soviet system performances are similar, are pointed out here: for other important performance parameters, the US systems are probably better than their Soviet counterparts, implying an even greater US lead.[63] With regard to land-based strategic missile systems, the most significant advances during the 1960s have included the development of multiple warheads (MRV—multiple re-entry vehicle), followed by multiple independently targetable warheads (MIRVs), and improvements in guidance systems and penetration aids. It is not possible here to give US lead-times for the separate technologies involved, but it may be observed that the first operational deployment of MRVs (in the ballistic-missile submarines) in the United States took place in 1964–1966, while it is still uncertain, at the beginning of 1972, whether MRVs have actually been deployed in the Soviet Union during the last two years, or whether they are still being tested only. In either case, a US lead of at least 5 years might be assumed; and the real figure may be higher—again on the order of 7 to 9 years.

With regard to the major sophisticated conventional weapon systems developed in the United States and the Soviet Union, there are greater

[61] It has not been revealed how the "average" US lead of 2 to 3 years was calculated—whether the lead for different kinds of weapon systems were weighted according to system costs or weighted equally, or aggregated by some other method.

[62] See the table on page 7, and further the section on "submarine-launched ballistic missiles" in the *SIPRI Yearbook 1968/69*, p. 98. The range of the Polaris A-1, as estimated in the latter source, is slightly lower—about 1 200 nautical miles.

[63] Unpublished SIPRI worksheets of strategic weapons.

difficulties involved in giving overall lead-times, because in many cases the designs on the two sides differ considerably. Advantages in one aspect of performance of a type of weapon on one side may be counterbalanced by advantages in other aspects on the other side. Here, however, there is evidence that the US systems have generally been much more "complex", incorporating more sophisticated equipment and technologically advanced components. The following comparison (from a US Defense Department study) of US and Soviet undertakings in main tank development during the 1960s illustrates differences in the development efforts on the two sides which are likely to entail substantial differences in R&D outlays:

Tactical Warfare Equipment

Armored vehicles (tanks)

1. *General*

a. The Soviets *avoid fundamental changes* in their tank models; changes are made as necessary to lead, in their judgment, the capabilities of Western tanks. *Proven components are used on several consecutive tank models:* i.e., the diesel engine used in the T-34, T-54, T-55, and T-62[64] tanks is basically the same V-12 diesel engine with modifications to increase the horsepower wherever necessary. The T-54, T-55 and T-62 tanks used the same torsion bar/flat track suspension system. There is a considerable overlap in Soviet medium tank models: i.e., *production of an older model does not automatically stop with the introduction of a new model.* Production procedures are *designed to keep cost down with a minimum of attention paid to human engineering and maintainability.* Maintainability does not, however, equate to reliability. For example, *Soviet tanks may include components hard to service or replace in the interest of cheap and rugged design.*

b. The United States has generally avoided basic changes in each succeeding tank model *until the MBT-70.*[65] For example, the M-47 through M-60 A 1 tanks have used the same basic engine and transmission. *In each model, and in many of the modifications between tank models, the engine and transmission have been improved;* in the M-60 and late-model M-48's a diesel engine has been used. All tanks, up to the MBT-70, have used torsion bars and rubber-tired road-wheels: the medium and heavy tanks also have used a double-pin rubber-bushed track. *A major departure in the design of suspension systems is the MBT-70* use of a hydropneumatic springing medium. Fire control systems have largely been evolutionary *up to the advent of MBT-70,* highlighted by introduction of the optical rangefinder in the M-47 tank, and inclusion of an electro-mechanical ballistical computer with the M-48. *The MBT-70 introduces major changes* both in components and in concept, with its laser rangefinder and its sight-referenced main gun stabilization systems. *The MBT-70 also shows a major*

[64] *Editor's note:* This most recent Soviet main battle tank was deployed beginning in 1965.

[65] *Editor's note:* The MBT-70 was in development in the United States (and, until 1971, in West Germany) between 1963 and 1971.

departure from conventional tank weapon design in its main gun/launcher which can launch the antitank guided missile already fielded with the Sheridan vehicle and also fire a full spectrum of conventional ammunition equal to or better than those employed by previous US tanks. Generally, when a new model is adopted by the United States, production of the older models is terminated. *Major attention is devoted to human engineering factors, rapid replacement of major components, increase of the mean time to failure, and increase of the reliability of the fabrication techniques, such as welding.*

c. The US response to the threat of the Soviet T-34/85 medium tank was the M-47 and the M-48 tanks. [Deleted] which had appeared in quantity at about the time the M-48 was first being issued to the US Army. The US response to the T-54 series was the M-60, which is generally [deleted]. Then the Soviets again introduced a new tank, the T-62, within the time frame in which the M-60 was issued [deleted]. *The Soviets do not have a direct counterpart to the US MBT-70 development.* Their past reaction to new US medium tanks, however, indicates that within 2 years of the date the MBT-70 is issued to US forces in Europe, they probably will produce a medium tank that *they consider* to be an effective counterweapon.[66] (All italics added.)

Recently there has been a considerable debate in the United States about continuation of development of the supersonic fighters F-14 and F-15. Charges have been made of a tendency to "goldplate"—i.e., to incorporate a lot of heavy and very sophisticated electronic and other equipment, in the pursuit of rather esoteric performance goals, and to do this with funds which could otherwise be used for procuring greater quantities of weapons which could meet the essential performance goals as well as, if not better than, the more sophisticated aircraft.[67] In particular, unfavourable contrasts are drawn between the costly development work undertaken in the United States and the simpler and cheaper path which, it is asserted, is taken in the Soviet Union.[68]

In sum, almost all of the factors considered suggest a substantially larger US military R&D effort in comparison with that in the Soviet Union. This applies to: (*a*) the overall technological lead in the USA, asserted to

[66] This excerpt is taken from a study reproduced in the *Congressional Record—Extensions of Remarks,* 4 August 1971, pp. E8955–E8963, without a title, but with the introduction "The Defense Department's 1969 comparison of United States and Soviet weapon systems and technology follows".

[67] See, for example, "Letters to the Editor: F-14 Costs, Missions", *Aviation Week & Space Technology,* 10 January 1972, p. 70.

[68] For example, P. Sprey, a former weapons analyst in the Office of Systems Analyses, is reported to have said, in testimony before the Senate Armed Services Committee in December 1971, "that the current system for developing new weapons 'rewards the design of complex and expensive systems and penalizes work on simpler and therefore less expensive ones' " and "that the best 'Mig-killer' today is the French Mirage III, which has virtually none of the sophisticated electronics going into new U.S. fighters. Nor does the Mig carry such equipment". (M. Getler, "Pentagon Rewards Costly Weapons at Expense of Simplicity, Hill Told", *New York Times,* 9 December 1971.)

exist by Defense Department spokesmen; (*b*) the greater quantity of new and modified weapon systems under development in the USA in most of the major weapon categories examined in the survey, and particularly in the area of sophisticated conventional weapons; (*c*) the greater complexity of several of the most advanced major conventional weapons developed in the USA, in comparison with their Soviet counterparts; and (*d*) the very considerable US lead-time which appears to apply to strategic nuclear weapon systems. The only factor which weighs in the balance for a larger Soviet effort, in terms of the actual quantity of resources used, is the lower productivity generally assumed to exist in the Soviet Union. It seems unlikely that the difference in productivity in the military R&D sector between the two countries could be so great that the Soviet Union could have used as many resources, or more, in comparison with the United States, and still produced what appears to be a much more limited output in weapons technology. It is not possible at this time to estimate the level of Soviet military R&D spending on the basis of the comparison of weapons development projects in the USSR and the USA, or even to estimate how much it might have cost in the United States to produce a comparable output of new and improved weapons. Sufficient data on individual weapon system costs have not yet been assembled to permit this type of calculation. But the overall picture provided by the comparison does appear to support the estimates calculated earlier, by using total military expenditure as an indicator and assuming an R&D spending pattern comparable to that in the United States: these estimates suggested a Soviet military R&D effort about three-fifths to three-quarters as large as the US effort during the 1960s.

IV. *Conclusions*

A rough estimate of the annual level of world military R&D expenditure during the 1960s is suggested by this study: the figure comes to about $15–16.5 billion. Of this amount an estimated $12.5–14 billion, or almost 85 per cent, has probably been accounted for by only two countries: the United States and the Soviet Union. The US effort appears to have been the larger of the two. It alone may have absorbed as much as half of average annual world military R&D outlays during the period. It is not possible to give a precise estimate for the effort of the Soviet Union, and a range of values, which puts the Soviet effort at about 30–37 per cent of the world total, is used here. A further $2 billion is estimated to have been spent by only four countries: the United Kingdom, France, China and the

Federal Republic of Germany. Both the United Kingdom and France have almost certainly devoted a much larger quantity of resources to military R&D than has China throughout the period since 1960. While differently oriented, the Chinese military R&D effort may not have cost much more than that of West Germany during the 1960s, with each accounting for little more than 1 per cent of world military R&D outlays. The combined military R&D expenditures of all the remaining countries in the world are estimated to have represented not more than 3 or 4 per cent of the world total. The leading countries within this group are Sweden, Canada, Japan and India. In terms of the total quantity of resources employed, the military R&D efforts of these countries are negligible compared with those of the United States and the Soviet Union.

This pattern of spending is largely explained by the resources available for the support of military R&D—in particular, by the size of the military budgets. Military R&D efforts are, however, even more concentrated in the hands of a very few countries than are total military outlays. This does not mean that the vast majority of countries, apart from the first six named above,[69] do not participate in the technological arms race at all. It appears that most do participate, at least in the conventional armaments race—but they tend to participate as weapons importers rather than as weapons producers. Thus it is apparently the diversion of funds to import which accounts for the low shares of military expenditures devoted to R&D in almost all countries except the main military spenders. To the extent that countries import large quantities of sophisticated armaments from the main weapons producers, these countries may even contribute to the maintenance of the large military R&D efforts of the main producing countries.

The periods of greatest increase in the level of military R&D spending have varied. The first countries known to have undertaken a major expansion of their military R&D efforts during the post-war period were those engaged in wartime R&D efforts (excluding Germany and Japan): the USA, the USSR, the UK, Canada and Sweden. In the four countries of this group for which military R&D expenditure series are available (all but the USSR), military R&D outlays have during the last decade remained at around the level reached by the end of the 1950s or beginning of the 1960s. A second wave of major expansions of military R&D efforts, beginning in the late 1950s, has brought France, the Federal Republic of Germany and China into the group of major military R&D spenders. In France and West Germany, as in the USA, the UK, Canada and Sweden, there has been a decline in military R&D expenditures, in real terms, during the last few years. In all these countries, however, the level of military R&D spending today is

[69] The USA, the USSR, the UK, France, People's Republic of China and FR Germany.

considerably higher than in the 1950s. Among the remaining countries for which military R&D expenditure series are available, significant expansions appear to be under way in India, Japan and possibly the Netherlands. There are probably several other countries among those for which expenditure series are not available, which have been spending increasing amounts on military R&D in recent years. Israel and Yugoslavia appear to have the most ambitious weapons development efforts of the countries in this group.

Although the level of world military R&D spending has not, as far as is known, increased significantly during the last few years—it may have remained roughly constant, in real terms—there is no evidence of an abatement in the technological arms race. The current enormous size of the world's military R&D efforts is large enough for a continued rapid production of large quantities of new weapons, and for continued technological improvements and modifications of the stocks of existing weapons. As long as there is no large reduction of military R&D spending—of the order of, say, one-half to two-thirds of the current level—enormous advances in technology, for both nuclear and conventional weapon systems, can be expected to continue.

The trends in the type of weapons development work undertaken by countries with different levels of military R&D spending should probably be viewed in terms of two different "technological arms races". There is first the competition between the United States and the Soviet Union. This goes on at the frontier of weapons technology, and involves the most expensive, the most imposing, and probably the most dangerous weapons development work. The United States appears to be, at least in most respects, in a leading position in this race. Presumably, the primary concern of the United States and the Soviet Union, in their mutual competition, is the relative state of their strategic nuclear forces. In both countries, however, technological advances in sophisticated conventional weaponry continue at a very rapid rate; and in the United States about half of all military R&D funds appear to be devoted to conventional armaments.

For the most part, the research and development work under way in other countries appears to involve attempts merely to keep up with, or not to lag too far behind, the latest developments in the armaments of the two main military powers. This applies to developments in nuclear weapons as well as conventional ones. France is currently developing nuclear weapon systems comparable to those under development in the United States in the late 1950s and early 1960s; and China's nuclear weapons development programme appears to lag behind developments in the USA and the USSR even more, perhaps by about 15–20 years. With regard to conventional weapons, there are probably several countries—for example, France and

Sweden (for supersonic aircraft and missiles), and Germany (for tanks)—where the latest developments are on a par with those in the United States and the Soviet Union. In cases where the conventional weapons which can be developed are not as technologically advanced, countries have not, however, been deterred from initiating their own weapons development programmes. The capacity to develop increasingly sophisticated conventional weapons has spread to more and more countries during the 1960s. During the last decade, Japan and West Germany entered this field first; and other countries which have followed, with domestic development of types of weapon not undertaken during the 1950s, include: Brazil, Czechoslovakia, India, Israel, Poland, South Africa and Yugoslavia. Other countries, such as Australia, Italy, the Netherlands, Sweden and Switzerland, have maintained the scope of their weapons development efforts at roughly the same level as that in the 1950s. There have been contractions of the military R&D efforts, in terms of the range of weapons under development, in comparison with the state in the mid- to late-1950s, in only two countries: the United Kingdom and Canada. The continued expansion of nuclear weapons development efforts—at least in those countries which are now nuclear-weapon powers—along with the spread of the capacity to develop increasingly sophisticated conventional weapons can, therefore, be expected to continue during the 1970s.

It has often been remarked—recently, for example, in the United Nations report on the economic and social consequences of the arms race—that the funds devoted to military research and development represent a particularly important diversion of resources from constructive civil ends; in other words, military R&D efforts occupy large numbers of scientists, engineers, technicians and other trained personnel. A study of the "opportunity costs" of military research and development efforts has not been undertaken here; but the figures assembled on the magnitude of military R&D spending in comparison with civil R&D spending suggest that a large proportion of all the qualified manpower in the world currently engaged in research and development work are involved in weapons research and development. And this has been true throughout the post-war period. The question naturally arises, whether the security and well-being of the world would not be greater today if the skill and determination which, for 25 years, have gone into the largest concentrated scientific effort ever undertaken—the effort to develop improved implements of war—had been devoted instead to understanding and eradicating the problems which lead to war.

Appendix 6A. Statistical tables, sources and methods

I. *Definition of military R&D*

In preparing the military R&D estimates an attempt has been made to assemble figures which conform to the following definition of "military research and development":

1. all R&D financed through the budget expenditures of a country's "defence department" (or comparable administrative unit); and
2. all other R&D, financed by national government departments and agencies, which is officially identified as being conducted for military, defence, or civil defence purposes, or concerned mainly with weapons.

The significance of this definition may best be made clear by describing some of the main alternative definitions which might be considered suitable to delimit military R&D. These can be grouped into more or less equally *practicable* alternatives, which have been adjudged not equally useful; and *impracticable* alternatives which, while useful and relevant, cannot be applied because sufficient data to obtain expenditure estimates conforming to them do not exist.

Practicable alternatives

The main alternative definitions which it might have been practicable to apply—and for which, thus, official expenditure estimates exist in at least a few of the countries—are the following: (1) Earmarked R&D funds within the defence department budget: these funds, shown for example in specific R&D appropriations or votes, generally cover most but not all defence department R&D expenditure. (2) Total R&D expenditures of the defence department: these funds generally include, in addition to earmarked R&D funds in the defence budget, comparatively small amounts channelled through other budget votes, such as those for "procurement" and "pay of military personnel". They sometimes exclude some of the earmarked R&D funds of the defence department because the latter are devoted to non-R&D activities such as the collection of general-purpose scientific data or routine testing. This definition does not differ from the one used in this study, except in omitting the military R&D expenditure of civil government agencies. (3) Total "defence" R&D: this concept, which is often used in national and international R&D expenditure statistics, may differ from the definition used in this study in one or more of the following ways: some defence department R&D expenditures may be excluded because they are considered to go to R&D projects which have a primarily "civil" orientation; some civil government R&D expenditure for military R&D projects may be included, but this may not cover all civil government R&D expenditures included under the present definition; occasionally, some non-government R&D expenditures may be included, for example, private industry funds for R&D carried out in defence department laboratories, or foreign government funds provided either for joint projects or as a form of military assistance, and used for national military R&D projects; and finally, some defence department R&D funds may be excluded from R&D expenditure statistics because the latter confine their scope to R&D carried out within the country, and the defence department funds are used for R&D performed abroad.

The main reasons for the use of the SIPRI definition, instead of any one of these alternatives, are two: first, from the point of view of policy considerations, and for comparisons with the size of the total military budget, it seemed useful to confine the estimates to *government* expenditures, and to include *all* government R&D expenditures of the types defined. Second, there is no definition—this applies to the one used here as well—for which it was possible to be sure that the estimates for *all* the countries would conform. There was, thus, no advantage in terms of practicability and comparability to be obtained by using any of the above alternatives.

Impracticable alternatives

Among the impracticable alternatives, those which come closest to being practicable relate to the research and development financed by private industry in countries with market economies. First, it is known that private industry puts up funds for the development of military hardware (weapons and supporting systems) in a number of the countries for which estimates are given. Data on weapons development projects supported by private industry and official comments on the proportions of national weapons R&D financed by government and by private industry suggest that in countries with large military R&D efforts (the USA, the UK, France and West Germany; and probably Sweden and Canada), privately financed weapons R&D

amounts to no more than a small fraction of government-financed weapons R&D. In some of the countries with smaller government-financed military R&D efforts, however—for example, Italy, Japan and Switzerland—privately financed weapons R&D efforts may be substantial, amounting to, say, 25 or even 50 per cent of government military R&D programmes.

Second, there is the matter of defence-related R&D financed by private industry. The amounts put up by private industry for R&D on products which may be useful for both military and civil purposes—in areas such as computer technology, communications, precision instruments and possibly civil aircraft—are large in comparison with the larger military R&D efforts. Furthermore, indirect military support, in the form of purchase of the end-use products or services developed with private funds, may play a significant role in the inducement to industry R&D investment in these areas. However, annual estimates of industry-financed R&D supported partly or entirely as a result of foreseen military demand cannot be given at present.

A broader concept of military R&D, which can probably never be "quantified" in the sense of applying the concept as a definition of R&D expenditure estimates is: R&D which is conducted solely for military reasons or R&D which would not be conducted, say, in a disarmed world. Government-financed military R&D as defined here probably meets most of the requirements of this definition since the great bulk of the funds identified here goes to the development of weapon systems, and most weapons R&D funds are included in the current estimates. However, as suggested above, at least some and possibly a great deal of private industry-financed R&D would probably also have to be included under this concept. At the same time, some of the government-supported military R&D identified here might have to be excluded, because the work involved is fundamental research, which is civil in nature, or because it has civil as well as military applications. It should be observed, however, that, in considering the proportion of both government and privately supported R&D which would be continued in the absence of national defence efforts, it would not be sufficient to delineate the civil nature or the extent of the civil applications of the work in question. The *likelihood* that the actual or potential civil work would in fact receive financial support, in the absence of the additional military justification, must also be taken into account. Here the larger question arises of the impact of the technological arms race, and its civil "spin-off", on the values and priorities of post-war industrial societies. It might be possible to demonstrate that military R&D efforts—as these are defined here—have both stimulated and influenced the direction of public and private civil R&D efforts. But a precise quantification of the R&D

which would not be—or would not have been—conducted in a disarmed world would probably be largely a matter of speculation.

A final alternative concept, which would yield useful results if it were practicable, is: all R&D which has in fact served military purposes, or which is likely to do so in the near future. Here too, the work encompassed would probably include a good deal more than the currently identified government-sponsored efforts, at least for the countries with the most advanced state of military technology, and it would exclude some of the military R&D covered by this study. Once again, however, it is unlikely that a precise quantification could be obtained; and it has not been possible to undertake a special study within this framework.

II. *Sources of military R&D expenditure estimates*

In most countries, research and development expenditure statistics have been collected only during the last decade. Significant R&D efforts were undoubtedly under way earlier, but, until the early sixties, R&D was generally not perceived as a special kind of activity which could and should be quantified. In the mid-sixties, the Organization for Economic Cooperation and Development (OECD) and UNESCO began to assemble and publish international R&D statistics. This spurred a number of countries which had not previously done so to undertake surveys of their R&D expenditures. In addition, R&D funds began to be more carefully identified in government budgets and other financial documents.

The official data available today which is relevant to estimating military R&D outlays often consists of a variety of figures, compiled by different authorities, with different purposes and often different definitions. These may include: (*a*) an official OECD, UNESCO or, more recently, EEC estimate; (*b*) estimates of government R&D expenditures, assembled and published by central national authorities, such as the central statistical bureau or the national science council (or the national equivalent of either of these); and (*c*) estimates contained in the annual budgets and other financial documents of individual government departments and agencies. The centrally collected statistics (described under *a* and *b*) have the advantage that consistent definitions of what constitutes R&D expenditure are applied; but the budgetary and other documents of individual government departments are generally more useful from the point of view of identifying military R&D outlays and distinguishing these from civil R&D outlays. The complementary nature of the two types of data, and the limitations inherent in each considered separately, means that most confidence can be placed in estimates based on a study of both kinds of sources. A general description of the sources examined, for each of the countries for which annual expenditure estimates are given, is provided in table 6A.1, page 220.

III. *The reliability of the estimates*

During the last decade, a set of internationally accepted definitions of what constitutes "research and development" and "research and development expenditure" has evolved. Thus, *research and development* includes: basic research—any activity directed toward increasing scientific knowledge, without regard to practical applications; applied research—any activity directed toward increasing scientific knowledge, with a practical application in view; and development—the systematic use of scientific knowledge, including the results of basic and applied research, to introduce new or improved materials, products or processes. The planning, construction and testing of prototypes and pilot plants, up to the point where the new product or process is set, are included in development. *Research and development expenditure* includes all current and capital expenditures incurred in the support of R&D work.

Although these definitions are comprehensive, the practical identification of R&D expenditures—particularly with regard to military R&D—can involve difficult and sometimes arbitrary decisions. Areas which are especially problematic include: (1) costs of engineering and testing at the end of development; (2) investment in plant and equipment used for both R&D and production; (3) purchase of materials, manufacture of components and routine data collection which do not in themselves involve R&D work but which may be involved in a larger R&D project; and (4) overhead costs for, for example, administration, facilities, equipment and materials used, particularly when these are paid for in quantity, and they then go to both R&D and non-R&D activities. It may be difficult or impossible to make precise estimates of R&D expenditures in these areas, because sufficiently detailed accounting to permit identification of the R&D components may not exist. Aside from this, the multi-function nature of the activities involved may make it impossible even in theory to establish a single generally accepted method of delimiting the R&D component of certain types of expenditure. As a specific example, the difficulties of measuring nuclear weapons development costs may be mentioned. The figures for the development of the nuclear weapon which are given here (reproduced here from official R&D statistics), for the United States for the period 1942–1946, cover the entire costs of the US nuclear weapon project during this period.

These include the costs of the plants set up for the production of enriched uranium and, in fact, the manufacture of the first operational nuclear devices. Up to the time of the manufacture of these devices, all costs could legitimately be considered R&D costs, under the definition set out above. However, a large portion of the funds went to investment in facilities which were *later* used—and which were meant from the start to be used—for production, and not only for R&D. It appears that costs of this kind have not been included in the estimates given here (which are, again, based on official figures) for total French military R&D during the 1960s. This may also be considered a legitimate practice—even if, formally, such costs should perhaps be included under the internationally accepted definition of R&D expenditure. It is not possible to provide alternative estimates for either country without more detailed official accounting of the nuclear weapon programmes than has hitherto been published. The most that can be done is, therefore, to point out that differences of this kind exist.

A further problem in reliability concerns whether the estimates assembled here cover all military R&D—as this is defined here—or leave some military R&D expenditures within the estimates for civil government-financed R&D, included in the figures for total government R&D expenditures used in parts of the study. It is not possible to be absolutely certain about the estimates for any of the countries in this regard, but a general assessment may be given. For the United States, the United Kingdom, France and Sweden, where the series of military R&D expenditures given here represent a large fraction of officially estimated total government R&D expenditure (30–55 per cent in recent years, for the group), it is unlikely that unidentified military R&D funds amount to more than a further 10–20 per cent of identified military R&D outlays: data on the specific uses of civil government R&D expenditures have been examined, and there is no evidence that the amounts involved are as high as this. Similarly, for West Germany and Canada breakdowns of civil government R&D expenditure, by financing agency, have been examined, and it is unlikely that unidentified military R&D funds here amount to more than a few per cent of the currently identified outlays. For most of the countries with very small military R&D efforts—which at the same time constitute a small percentage of officially estimated total government R&D expenditures—it is not possible to be equally sure that unidentified outlays amount to a small proportion of the military R&D expenditures set out here. For many of these countries, it has not been possible to examine detailed data on civil government agencies' R&D expenditures. At the same time the possibility of concealment—either intentional concealment, or the failure of this study to obtain published documents which may reveal the presence of military R&D outlays—within the civil government funds is greater for these countries. The likelihood of substantial military R&D outlays financed by civil government agencies is, however, less for most of these countries, because over a long period of time their known military R&D programmes have shown no significant tendency to expand. This applies to all the countries with smaller military R&D efforts except Japan and India. A description of potential unidentified military R&D outlays in these two countries is given in the main text, on page 174. The specific composition of all the military R&D expenditure series given in this study, in terms of the kinds of government funds included, is set out in table 6A.1, page 220.

IV. *The international comparability of the estimates*

Three sources of some non-comparability in the estimates assembled have already been suggested. First, available figures may not be based on the standard definition of R&D expenditure or may be non-comparable as a result of differing national practices in applying this definition. Second, the estimates may differ in the extent to which they conform to the definition of military R&D used in the study. Third, there may be differences in the extent to which government-financed military R&D covers the real technological input into a country's overall military effort. Factors which may play a role here include not only the kind of supporting R&D financed by private industry, which is described above, but also (*a*) reliance on advances in foreign military technology; (*b*) import of know-how through licensed production of foreign-designed weapons or through cooperative military R&D projects; and (*c*) support of domestic military R&D projects with foreign funds.

Another sort of non-comparability may result from the use of *expenditure figures* as a measure of the resources devoted to military R&D. There are two main problems involved here. First, the monetary cost—in dollars at official exchange rates—of goods and services employed in R&D efforts may differ from one country to the next. An attempt has been made here to calculate approximate "R&D exchange rates" for 1967. These rates represent a very crude attempt to make some allowance for international differences in prices. They have been obtained as follows: (1) Non-wage R&D costs were assumed to be the same in all countries, so that no adjustment need be made to the official exchange rates for this portion of R&D expenditures. (2) An average figure of wage expenditure per qualified scientist and engineer for qualified manpower working on R&D in the business enterprise sector (for countries where most military R&D is performed in the government sector, this sector was used instead) was calculated for each country, by dividing available estimates of total wage expenditure in the sector by estimates of the number of qualified scientists and engineers employed on R&D in that sector in 1967. (3) The figure obtained for the United States was divided by the figures obtained for each of the other countries (converted at official exchange rates), to obtain the ratio of R&D exchange rate values : official exchange rate values, for R&D wages. (4) The distribution of military R&D outlays between wage and non-wage costs was assumed to be the same as that for the business sector in each country (government sector, where applicable). (5) Weighted averages of the wage and non-wage price ratios were then calculated; and the resulting ratio was applied to the official exchange rate. This procedure obviously involves a number of very gross assumptions. As noted in the text, the intention has merely been to give a very rough idea of the direction and magnitude of the bias in measuring comparable quantities of resources which may be caused by the use of official exchange rates. Before being applied, the exchange rates obtained were compared with two other sets of R&D exchange rates, available for some but not all of the countries, which had been calculated earlier in other studies.[1] In all cases, the rates used here imply a smaller difference between the official exchange rates and the R&D rates; and with this evidence that the rates calculated here were conservative, it was believed not unreasonable to try to use them, despite their many drawbacks.

Another problem caused by the use of expenditure figures is the question of what to do about inflation. Implicit gross national product price deflators have been used here, and there may be some inaccuracy in the extent to which these reflect price increases in the military R&D sector. To the extent that the latter have differed from general price increases more in some countries than in others, comparisons in the year-to-year movements in the different series may also be inaccurate.

In addition to these quantitative problems, there are also qualitative problems in comparison which arise from the use of expenditure figures. There is a tendency to assume that equivalent expenditures can purchase truly comparable "inputs" into R&D efforts, particularly if allowances have been made for price differences. The level of education and degree of initiative and efficiency of R&D employees can, however, vary from one country to the next, and the quality of equipment, materials and facilities can also

[1] C. Freeman and A. Young, *The Research and Development Effort in Western Europe, North America and the Soviet Union* (Paris: OECD, 1965), pp. 91 ff.; and Brunner, *The Cost of Basic Scientific Research in Europe: Department of Defense Experience 1956/65* (Santa Monica: Rand (RM 5275 PR), 1967).

vary. Another complicating factor is qualitative improvements in R&D inputs over time. The typical research scientist of today may know a great deal more than his counterpart of 10 or 20 years ago, but improvements of this kind may not be reflected in the price indices used to arrive at constant price expenditure figures. Finally, differences in the "style" of the military R&D effort from one country to the next may result in substantial differences in the costs of developing roughly comparable products. Factors which may play a role here include, for example: the extent of intentional or unintentional duplication of R&D work; the number of competing designs for a particular piece of military hardware which are carried through an advanced stage of development; and the type and size of overhead costs—travel and entertainment expenses, luxurious facilities, fringe benefits for employees, and so on—which are allowed and included in R&D expenditures.

Differing national practices in estimating R&D expenditures, providing government support of defence-related R&D, and publicly identifying government-funded military R&D efforts mean that the figures assembled cannot be considered more than a rough approximation of the relative quantities of resources devoted to military R&D. Qualitative differences in R&D efforts mean, further, that the quantity of resources devoted to military R&D, measured in expenditures, cannot be equated in more than a very general way with actual or expected military R&D output. Particularly in the case of countries with military R&D efforts of roughly the same size, it should be observed that inferences about the relative state of the art in military technology cannot be drawn from marginal differences in the level of military R&D spending.

Table 6A.1. General description of the sources and composition of the military R&D

	Sources of the estimates					
	Nat. equivalent of annual "def. dept." budget in detailed form	Other parts of central government budget	Other official documents (e.g., annual reports, "white papers")	Official nat. source of gov't. R&D expen. statistics	International (OECD, UNESCO, and/or EEC) R&D statistics	Estimates provided by letter from responsible nat. authorities
Australia	* 1970	(*) 1970	* 1963–71			* 1955–69
Austria					* 1964, 66	
Belgium					* 1961–70	
Canada			* 1952–58	* 1958–70		* 1955–70
Denmark	* 1960–69					
Finland	* 1967–70					
France			(*) 1966–69	* 1958–68	* 1960–70	
FR Germany			* 1970–71	* 1956–70		* 1956–71
Greece					* 1962	
India						
Ireland					* 1967	
Italy					(*) 1965–70	
Japan					* 1955–67	
Netherlands			* 1947–69		* 1961–70	
Norway	* 1962–67			* 1967–69	(*) 1961–65, 67	
Spain					* 1964	
Sweden	(*) 1970		* 1960–71	(*) 1964–67		
Switzerland	* 1966–68				* 1967	
Turkey					* 1964	
UK	(*) 1963–70		(*) 1960–71	* 1955, 58, 61–71		
USA	* 1945–71	* 1945–71	* 1964–70	* 1939–71		

Conventions:

* = source of data used in constructing estimates
(*) = examined as check on estimates; not direct source

Notes:

Dates refer to the period for which source or composition applies to the military R&D expenditure estimates. In the case of sources, the dates do not necessarily coincide with dates of publication. Some sources contain estimates for a period of several years; and it is the period for which data have been obtained, rather than the date of publication, which is shown.

expenditure estimates

	Composition of the estimates				
Secondary sources citing official sources	Sum of ear-marked R&D funds within defence budget	Total def. dept.-financed R&D: secondary source estimate	Total def. dept.-financed R&D: official estimate	Total "defence" R&D: official est.[a]	Total mil. R&D: SIPRI estimate[a] (SIPRI def.: tot. def. dept.-+all other gov't.-financed mil. R&D)
			1955–71		
* 1967–70	1967–70			1964, 1966	
* 1959–60		1959–60		1961–70	
					1955–70
	1960–69				
* 1962–63	1962–70				
					1958–70
* 1955–65					1956–71
			1962		
* 1958, 61–70	1958, 61–70				
				1967	
* 1958–70		1955–60, 64	1960–63, 65–67		
* 1968–69				1955–69	
					1952–70
			1961–69		
				1964	
	1969–71				1960–68
					1966–68
	1964				
					1955, 58, 61–71
					1939–71

[a] For a description of typical differences between official definitions of total defence R&D and the SIPRI definition of total military R&D, see page 212.

Table 6A.2. Military R&D expenditure, 1952–1971[a, b]

	Local currency	1952–53 1952	1953–54 1953	1954–55 1954	1955–56 1955	1956–57 1956	1957–58 1957	1958–59 1958	1959–60 1959
Australia[c]	*mn. dollars*	..	..	..	28	29	29	30	30
Austria[d]	*mn. shillings*	..	..	..	..	..	..	..	..
Belgium[d]	*mn. francs*	..	..	..	..	..	..	..	70
Canada[e]	*mn. dollars*	..	..	..	66.3	74.7	82.0	76.0	42.1
Denmark[e]	*mn. kroner*	..	..	..	..	..	..	..	..
Finland[d]	*mn. marks*	..	..	..	..	..	..	..	..
France[d]	*mn. francs*	..	..	..	..	..	..	925	1 125
FR Germany[f]	*mn. marks*	—	—	—	—	9	35	116	172
Greece[d]	*mn. drachmas*	..	..	..	..	..	..	..	..
India[e]	*mn. rupees*	..	..	..	..	..	..	15.0	..
Ireland[e]	*mn. pounds*	..	..	..	..	..	..	..	..
Italy[f]	*mn. lire*	..	..	..	..	..	..	3 450	4 600
Japan[e]	*bn. yen*	..	..	..	1.4	1.7	1.5	1.8	2.1
Netherlands[d]	*mn. guilders*	3.8	3.3	3.6	4.8	6.1	6.4	6.9	7.1
Norway[d]	*mn. kroner*	..	..	..	..	..	..	..	..
Spain[d]	*mn. pesetas*	..	..	..	..	..	..	..	..
Sweden[c]	*mn. kronor*	..	..	..	..	..	..	..	..
Switzerland[d]	*mn. francs*	..	..	..	..	..	..	..	..
Turkey	*mn. lire*	..	..	..	..	..	..	..	..
UK[e]	*mn. pounds*	..	..	..	177	..	..	234	..
USA (excl. IRD)[c, g]	*mn. dollars*	2 750	2 795	2 921	2 982	3 821	4 213	4 712	6 199
USA (incl. IRD)[g]	*mn. dollars*	..	..	..	..	..	..	..	..

[a] The periods covered by the annual figures set out in this appendix and in the main part of chapter 6 are national fiscal years. Unlike the estimates of total military expenditure given in chapter 4, the figures here have, thus, not been adjusted to a uniform, calendar-year base. The reason is that much smaller outlays and much larger year-to-year changes are involved in the military R&D expenditure series than in the total military expenditure series, so that more information would be lost if the military R&D figures were adjusted. For the purposes of international comparison, fiscal years which do not coincide with the calendar year are treated as equivalent to the calendar year in which they begin. In subsequent tables and in the main part of the chapter only the equivalent calendar year is shown.

[b] Iceland, which is not shown, has no national defence establishment and no defence or military expenditure of any kind.

[c] Fiscal year beginning 1 July. [d] Fiscal year beginning 1 January. [e] Fiscal year beginning 1 April.

Local currency, current prices

1960–61 1960	1961–62 1961	1962–63 1962	1963–64 1963	1964–65 1964	1965–66 1965	1966–67 1966	1967–68 1967	1968–69 1968	1969–70 1969	1970–71 1970	1971–72 1971
31	32	31	33	34	35	36	40	46	47	49	50
..	..	..	..	7.2	[7.0]	7.0	7.0	8.0	9.0	10.0	..
100	110	90	100	115	105	105	105	105	125	140	..
45.4	46.4	50.3	64.3	74.6	99.7	87.1	88.5	85.4	83.0	87.4	..
0.7	1.4	1.7	2.0	2.3	2.7	3.0	3.5	3.4	3.6	..	..
..	..	0.2	0.3	[0.3]	[0.3]	0.3	0.3	0.4	0.3	..	..
1 315	1 232	1 400	1 784	2 048	2 778	3 158	3 100	3 076	3 204	2 981	..
201	411	449	586	681	739	803	1 023	982	1 058	1 150	1 178
..	..	13.4	..	..	..	..	..	..	..	..	..
..	31.2	(51.4)	71.4	82.3	97.2	114.6	116.0	125.1	140.0	183.2	..
..	..	..	..	..	..	..	0.0	..	..	..	..
4 950	4 950	6 175	6 750	4 400	12 515	12 310	13 413	10 080	13 410	19 037	9 000
2.6	2.6	2.7	3.0	3.3	4.5	5.7	6.5	8.6	9.1	..	..
8.1	9.8	9.7	16.2	25.5	29.6	30.0	36.0	40.8	48.2	50.3	..
..	23.4	19.0	22.6	25.3	23.0	32.8	37.1	32.8	39.3	..	..
..	..	..	..	75	..	..	..	..	..	..	..
283	281	322	371	432	464	528	572	549	411	385	449
..	..	..	..	..	..	28.6	28.7	33.2	..	..	..
..	..	..	..	1.0	..	..	..	..	..	..	..
..	269	264	261	283	283	260	241	236	244	227	274
7 166	7 405	7 419	8 191	7 409	7 390	8 346	8 952	8 793	8 481	8 609	8 776
..	..	7 769	8 555	7 774	7 781	8 793	9 461	9 366	9 063	[9 159]	[9 326]

[f] Germany and Italy changed fiscal years in the middle of the period. The figures refer to the actual fiscal years as follows: Germany: 1956–59, 1 April–31 March; 1960, 1 April–31 December (transitional year); since 1961 the fiscal year begins on 1 January. Italy: 1958–63, 1 July–30 June; 1964, 1 July–31 December (transitional year); since 1965 the fiscal year begins on 1 January.

[g] "Independent Research and Development" (IRD) is R&D financed by the Department of Defense as an overhead on contracts with private business firms. This R&D is undertaken and carried out entirely on company initiative: it is not ordered or supervised by the Department of Defense. Official sources such as the Bureau of the Budget and the National Science Foundation do not include IRD expenditures in their estimates of US government R&D expenditures.

Table 6A.3. Military R&D expenditure, 1952–1971[a]

	1952	1953	1954	1955	1956	1957	1958	1959	1960
Australia	..	..	..	31.4	32.5	32.5	33.6	33.6	34.7
Austria	..	..	..	..	..	..	..	..	..
Belgium	..	..	..	..	..	..	..	1.4	2.0
Canada	..	..	..	66.4	77.8	83.2	78.8	44.2	45.6
Denmark	..	..	..	..	..	..	..	..	0.1
Finland	..	..	..	..	..	..	..	..	..
France	..	..	..	..	..	..	220.3	227.9	266.4
FR Germany	—	—	—	—	2.1	8.3	27.6	40.9	47.9
Greece	..	..	..	..	..	..	..	..	..
India	..	..	..	..	..	..	3.2	..	..
Italy	..	..	..	..	..	..	5.5	7.4	7.9
Japan	..	..	..	3.9	4.7	4.2	5.0	5.8	7.2
Netherlands	1.0	0.9	1.0	1.3	1.6	1.7	1.8	1.9	2.1
Norway	..	..	..	..	..	..	..	..	..
Spain	..	..	..	..	..	..	..	..	..
Sweden	..	..	..	..	..	..	..	..	54.7
Switzerland	..	..	..	..	..	..	..	..	..
Turkey	..	..	..	..	..	..	..	..	..
UK	..	..	..	495.6	..	..	655.2	..	..
USA (excl. IRD)[b]	2 750	2 795	2 921	2 982	3 821	4 213	4 712	6 199	7 166
USA (incl. IRD)[b]	..	..	..	..	..	..	..	..	..

[a] Ireland and Iceland are excluded from this table because they have no military R&D expenditure.
[b] See note *g* to table 6A.2.

Table 6A.4. Military R&D expenditure, 1952–1971[a]

	1952	1953	1954	1955	1956	1957	1958	1959	1960
Australia	..	..	..	38.7	38.4	37.7	38.4	36.1	37.1
Austria	..	..	..	..	..	..	..	..	..
Belgium	..	..	..	..	..	..	..	1.5	2.1
Canada	..	..	..	71.9	78.3	83.6	75.9	41.1	43.7
Denmark	..	..	..	..	..	..	..	..	0.1
Finland	.	..	...	..	..	..	..	..	..
France	..	..	..	..	..	..	236.0	270.0	305.8
FR Germany	—	—	—	—	2.8	10.4	33.6	49.0	56.3
India	..	..	..	..	..	..	3.7	..	..
Italy	..	..	..	..	..	..	6.6	8.8	9.2
Japan	..	..	..	5.3	6.2	5.2	6.3	7.1	8.4
Netherlands	1.5	1.3	1.4	1.7	2.1	2.1	2.2	2.2	2.5
Norway	..	..	..	..	..	..	..	..	..
Sweden	..	..	..	..	..	..	..	..	61.1
UK	..	..	..	627.3	..	..	735.4	..	..
USA (excl. IRD)[b]	3 374.2	3 387.9	3 494.0	3 479.6	4 307.8	4 604.4	5 045.0	6 525.3	7 433.6
USA (incl. IRD)[b]	..	..	..	..	..	..	..	..	..

[a] Iceland and Ireland are excluded from this table because they have no military R&D expenditure. Greece, Spain, Switzerland and Turkey are excluded because the estimates for these countries cover one or a few years only.
[b] See note *g* to table 6A.2.

US $ mn, at current prices and official exchange rates

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
35.8	34.7	37.0	38.1	39.2	40.3	44.8	51.5	52.6	54.9	56.0
..	..	..	0.3	[0.3]	0.3	0.3	0.3	0.4	0.4	..
2.2	1.8	2.0	2.3	2.1	2.1	2.1	2.1	2.5	2.8	..
44.9	46.5	59.5	69.0	92.2	80.6	81.9	79.0	76.8	80.8	..
0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.5	..	..
..	0.1	0.1	[0.1]	[0.1]	0.1	0.1	0.1	0.1	..	..
249.5	283.6	361.3	414.8	562.7	639.7	627.9	623.0	618.7	536.7	..
101.8	112.2	146.5	170.3	184.7	200.8	255.8	245.5	268.6	314.2	321.9
..	0.5	..	..	..	..	..	..	..	..	..
6.6	(10.8)	15.0	17.3	20.4	16.4	15.5	16.7	18.7	24.4	..
7.9	9.9	10.8	7.0	20.0	19.7	21.5	16.1	21.5	30.5	14.4
7.2	7.5	8.3	9.2	12.5	15.8	18.1	23.9	25.3	..	..
2.7	2.7	4.5	7.0	8.2	8.3	9.9	11.3	13.3	13.9	..
3.3	2.7	3.2	3.5	3.2	4.6	5.2	4.6	5.5	..	..
..	..	..	1.2	..	..	..	..	..	..	..
54.3	62.2	71.7	83.5	89.7	102.1	110.6	106.1	74.4	79.4	86.8
..	..	..	..	..	6.6	6.6	7.7	..	..	..
..	..	..	0.1	..	..	..	..	..	..	..
753.2	739.2	730.8	792.4	792.4	728.0	636.2	566.4	585.6	544.8	657.6
7 406	7 419	8 191	7 409	7 390	8 346	8 952	8 793	8 481	8 609	8 776
..	7 769	8 555	7 774	7 781	8 793	9 460	9 366	9 063	[9 159]	[9 326]

US $ mn, at constant (1963) prices and official 1963 exchange rates

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
37.5	36.3	37.0	37.3	37.2	37.0	39.9	44.5	43.6	43.8	42.1
..	..	..	0.3	[0.2]	0.2	0.2	0.3	0.3	0.3	..
2.3	1.9	2.0	2.2	1.9	1.8	1.8	1.7	2.0	2.1	..
44.4	47.3	59.5	67.1	86.8	72.5	71.1	66.2	61.3	62.9	..
0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	..	..
..	0.1	0.1	[0.1]	[0.1]	0.1	0.1	0.1	0.1	..	..
277.3	300.9	361.3	398.9	528.3	583.6	557.6	528.0	516.7	457.1	..
110.5	115.7	146.5	165.6	173.6	181.8	230.0	216.7	227.4	238.2	232.1
7.1	(11.4)	15.0	15.4	16.6	17.5	15.8	17.1	18.6	23.2	..
8.8	10.3	10.5	6.6	18.1	17.5	18.5	13.7	17.8	24.0	10.9
7.8	7.8	8.3	8.8	11.4	13.7	15.1	19.2	19.4	..	..
2.9	2.8	4.5	6.5	7.2	6.8	7.9	8.6	9.5	9.5	..
3.5	2.7	3.2	3.4	2.9	4.0	4.3	3.7	4.3	..	..
58.5	64.2	71.7	79.8	80.4	87.6	91.5	85.8	61.3	53.9	58.6
792.0	755.8	730.8	765.5	726.3	650.0	585.8	544.8	538.8	481.9	530.0
7 603.7	7 532.0	8 191.0	7 278.0	7 112.6	7 792.7	8 057.6	7 586.7	6 942.5	6 679.9	6 551.7
..	7 887.3	8 555.0	7 636.5	7 488.9	8 210.1	8 515.8	8 081.1	7 419.0	[7 106.6]	[6 962.3]

Table 6A.5. Military R&D expenditure as a percentage of total military expenditure, 1952–1971[a]

	1952	1953	1954	1955	1956	1957	1958	1959	1960
Australia	..	..	..	7.31	7.64	7.78	7.92	7.75	7.82
Austria	..	..	..	..	..	..	..	..	..
Belgium	..	..	..	..	..	..	..	0.37	0.52
Canada	..	..	..	3.61	3.99	4.54	4.43	2.56	2.72
Denmark	..	..	..	..	..	..	..	..	0.06
Finland	..	..	..	..	..	..	..	..	..
France	..	..	..	..	..	..	5.58	6.28	6.86
FR Germany	—	—	—	—	0.12	0.41	1.47	1.52	2.21
Greece	..	..	..	..	..	..	..	..	..
India	..	..	..	..	..	..	0.54	..	..
Italy	..	..	..	..	..	..	0.53	0.67	0.68
Japan	..	..	..	1.04	1.19	1.04	1.21	1.35	1.63
Netherlands	0.30	0.25	0.23	0.28	0.33	0.35	0.42	0.47	0.47
Norway	..	..	..	..	..	..	..	..	..
Spain	..	..	..	..	..	..	..	..	..
Sweden	..	..	..	..	..	..	..	..	9.75
Switzerland	..	..	..	..	..	..	..	..	..
Turkey	..	..	..	..	..	..	..	..	..
UK	..	..	..	11.21	..	..	14.71	..	..
USA (excl. IRD)[b]	5.44	5.93	7.15	7.30	8.79	9.45	10.09	13.50	15.12

[a] Iceland and Ireland are excluded from this table because they have no military R&D expenditure.
[b] See note *g* to table 6A.2.

Table 6A.6. Military R&D expenditure as a percentage of gross national product (GNP), 1952–1970[a]

	1952	1953	1954	1955	1956	1957	1958	1959	1960
Australia	..	..	..	.264	.252	.250	.240	.217	.212
Austria	..	..	..	..	..	..	..	..	..
Belgium	..	..	..	..	..	..	..	.013	.018
Canada	..	..	..	.237	.242	.255	.228	.119	.124
Denmark	..	..	..	..	..	..	..	..	.002
Finland	..	..	..	..	..	..	..	..	..
France	..	..	..	..	..	..	.371	.413	.436
FR Germany	—	—	—	—	.004	.016	.049	.066	.090
Greece	..	..	..	..	..	..	..	..	..
India	..	..	..	..	..	..	.012	..	..
Italy	..	..	..	..	..	..	.018	.022	.022
Japan	..	..	..	.016	.017	.013	.015	.015	.016
Netherlands	.017	.014	.013	.016	.019	.018	.019	.019	.019
Norway	..	..	..	..	..	..	..	..	..
Spain	..	..	..	..	..	..	..	..	..
Sweden	..	..	..	..	..	..	..	..	.401
Switzerland	..	..	..	..	..	..	..	..	..
Turkey	..	..	..	..	..	..	..	..	..
UK	..	..	..	.899	..	..	.999	..	..
USA (excl. IRD)[b]	.756	.761	.758	.718	.872	.942	.988	1.232	1.393

[a] Iceland and Ireland are excluded from this table because they have no military R&D expenditure.
[b] See note *g* to table 6A.2.

Per cent

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
7.88	7.24	6.33	5.58	4.68	3.79	3.61	3.95	4.26	4.31	3.99
..	..	..	0.21	[0.24]	0.20	0.19	0.21	0.22	0.23	..
0.56	0.43	0.45	0.46	0.42	0.40	0.37	0.35	0.40	0.41	..
2.67	2.82	3.70	4.21	5.91	4.80	4.53	4.45	4.27	4.24	..
0.11	0.11	0.12	0.13	0.14	0.14	0.15	0.13	0.13	..	..
..	0.05	0.07	[0.05]	[0.06]	0.06	0.06	0.06	0.06	..	..
6.04	6.31	7.81	8.43	10.98	11.81	10.72	10.19	10.11	8.98	..
3.12	2.61	2.94	3.48	3.71	3.96	4.78	5.09	4.90	5.09	4.58
..	0.26	..	..	..	..	..	..	..	..	..
1.00	(1.08)	0.87	1.02	1.10	1.26	1.20	1.21	1.27	1.59	..
0.61	0.65	0.63	0.79	1.03	0.92	0.99	0.72	0.95	1.22	0.55
1.42	1.26	1.21	1.18	1.47	1.65	1.68	2.04	1.84	..	..
0.49	0.44	0.70	0.96	1.09	1.08	1.13	1.24	1.31	1.26	..
1.98	1.39	1.54	1.61	1.21	1.68	1.77	1.37	1.57	..	..
..	..	..	0.36	..	..	..	..	..	..	..
8.49	8.62	9.18	9.91	9.26	10.32	11.01	10.27	7.09	6.48	6.85
..	..	..	..	..	1.64	1.62	1.92	..	..	..
..	..	..	0.03	..	..	..	..	..	..	..
15.50	14.44	13.72	13.99	13.43	11.90	10.52	10.16	10.44	9.05	10.38
14.49	14.20	15.28	14.94	13.01	11.91	11.12	10.82	10.56	11.26	11.32

Per cent

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
.213	.191	.183	.172	.168	.158	.165	.170	.157	..
..	..	..	.003	[.003]	.003	.003	.003	.003	.003
.018	.014	.014	.015	.012	.012	.011	.010	.011	..
.121	.122	.145	.154	.186	.148	.140	..	..	..
.003	.003	.004	.004	.004	.004	.004	.004	..	..
..	.001	.001	[.001]	[.001]	.001	.001	.001	.001	..
.375	.381	.433	.449	.567	.594	.541	.489	.442	..
.126	.127	.155	.165	.163	.167	.211	.182	.175	.170
..	.011	..	..	..	..	..	..	..	..
..	..	..	..	.045	..	..	.041	[.044]	[.055]
.019	.021	.021	.026	.034	.031	.031	.021	.026	..
.013	.013	.012	.011	.014	.015	.015	.016	.015	..
.022	.020	.031	.041	.043	.040	.043	.044	.047	..
.066	.050	.055	.056	.046	.060	.062	.051	.056	..
..	..	..	.007	..	..	..	..	..	..
.365	.385	.402	.422	.413	.434	.439	.391	..	..
..	..	..	..	..	.044	.042	.045	..	..
..	..	..	.002	..	..	..	..	..	..
.965	.898	.830	.833	.777	.673	.590	.540	..	..
1.345	1.272	1.318	1.112	1.012	1.063	1.063	.961	.872	.837

Table 6A.7. Military R&D expenditure as a percentage of total central government-financed R&D, 1952–1970[a]

	1952	1953	1954	1955	1956	1957	1958	1959	1960
Austria	..	..	..	..	..	..	..	..	..
Belgium	..	..	..	..	..	..	..	..	..
Canada	..	..	..	45.72	45.27	45.56	42.22	25.21	24.41
Denmark	..	..	..	..	..	..	..	..	..
Finland	..	..	..	..	..	..	..	..	..
France	..	..	..	..	..	..	53.78	51.77	47.52
FR Germany	—	—	—	—	1.43	4.37	11.27	14.61	17.90
Greece	..	..	..	..	..	..	..	..	..
India	..	..	..	..	..	..	5.75	..	..
Italy	..	..	..	..	..	..	..	..	..
Japan	..	..	..	6.38	6.36	4.38	4.56	4.81	5.10
Netherlands	..	..	..	..	..	..	..	..	..
Norway	..	..	..	..	..	..	..	..	..
Spain	..	..	..	..	..	..	..	..	..
Sweden	..	..	..	..	..	..	..	..	53.01
Switzerland	..	..	..	..	..	..	..	..	..
UK	..	..	..	79.73	..	..	74.05	..	..
USA (excl. IRD)[b]	88.68	88.79	88.30	86.54	85.63	84.41	81.16	80.05	77.19

[a] Iceland and Ireland are excluded because they have no military R&D expenditure. Australia and Turkey are excluded because estimates of total central government-financed R&D are not available.
[b] See note *g* to table 6A.2.

Table 6A.8. Military R&D expenditure as a percentage of total national R&D, 1955–1970[a]

	1955	1956	1957	1958	1959	1960	1961
Austria	..	..	..	..	..	..	..
Belgium	..	..	..	..	..	..	..
Canada	..	..	..	..	..	..	..
Denmark	..	..	..	..	..	..	..
Finland	..	..	..	..	..	..	..
France	..	..	..	35.85	34.91	32.74	26.25
FR Germany	—	0.61	1.94	5.40	6.62	7.30	11.23
Greece	..	..	..	..	..	..	..
India	..	..	..	5.51	..	..	..
Italy	..	..	..	..	..	..	..
Japan	2.50	2.29	1.50	1.57	1.41	1.40	1.06
Netherlands	..	..	..	..	..	..	..
Norway	..	..	..	..	..	..	..
Spain	..	..	..	..	..	..	..
Sweden	..	..	..	..	..	..	..
Switzerland	..	..	..	..	..	..	..
UK	59.00	..	..	48.95	..	..	40.51
USA (excl. IRD)[b]	47.97	47.25	47.96	47.67	50.70	50.25	47.25

[a] Iceland and Ireland are excluded because they have no military R&D expenditure. Australia and Turkey are excluded because estimates of total national R&D are not available.
[b] See note *g* to table 6A.2.

Per cent

1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
..	..	..	2.96	..	..	1.13	..	..	..
7.04	4.83	4.31	4.20	3.29	2.75	2.38	2.27	2.36	2.33
22.20	25.28	26.79	26.93	29.32	23.41	19.75	16.71	15.23	14.99
..	..	..	..	..	..	0.99	..	..	..
..	..	..	..	..	..	0.41	..	..	..
39.51	37.67	40.33	36.04	40.08	40.72	35.08	33.48	33.66	32.19
24.06	19.71	22.31	21.33	19.73	19.03	21.31	19.80	18.56	16.67
..	..	..	6.87	..	..	..	..	..	..
..	..	..	..	12.98	..	..	11.84	11.76	..
..	..	8.31	..	10.69	8.83	7.51	5.25	6.43	6.66
4.13	3.60	3.31	3.04	3.73	3.94	3.88	4.48	4.11	..
4.21	3.24	4.67	5.41	5.23	4.39	4.57	4.65	4.92	4.52
17.12	12.63	12.45	12.46	8.51	12.00	11.06	8.46	8.93	..
..	..	..	6.06	..	..	..	..	..	..
47.15	45.97	45.56	44.00	43.11	43.86	44.25	39.52	31.36	..
..	..	..	..	..	..	10.34	..	..	..
69.87	66.84	64.13	62.20	60.34	52.21	46.62	43.22	40.73	..
71.33	61.83	55.69	49.76	46.14	49.55	52.57	54.25	55.19	53.94

Per cent

1962	1963	1964	1965	1966	1967	1968	1969	1970
..	..	1.19	..	..	0.43	..	..	..
..	1.46	..	..	..	1.19	..	..	..
..	14.38	..	14.77	..	9.88	..	..	8.27
..	..	..	..	..	0.55	..	..	..
..	..	..	..	..	0.18	..	..	..
24.91	26.84	23.56	26.59	26.95	23.45	22.05	..	..
9.93	10.97	10.33	9.20	8.97	10.65	9.62	8.27	9.12
5.63	..	..	..	..	..	..	..	..
..	..	..	12.02	..	..	10.45	10.31	..
..	3.33	..	5.05	4.00	3.57	..	..	..
0.96	0.93	0.86	1.05	1.16	1.07	1.11	..	..
..	..	2.13	..	..	1.93	..	..	..
..	7.45	..	..	..	6.44	..	..	..
..	..	4.46	..	..	..	..	..	..
..	..	25.90	..	..	24.87	..	..	..
..	..	..	..	..	2.18	..	..	..
..	32.54	..	..	27.14	24.29	..	..	..
41.83	39.27	34.38	31.55	33.23	34.13	33.23	31.61	30.57

Table 6A.9. US federal government military and civil R&D expenditure, by source of finance,

	1939–40	1940–41	1941–42	1942–43	1943–44	1944–45
1. Dept. of Defense (DoD):						
a. Total R&D, old definition[a]	26.4	143.7	211.1	395.1	448.1	513.0
b. "RDT&E"[a]	—	—	—	—	—	—
c. Total R&D, new definition[a]	—	—	—	—	—	—
2. Other gov't. agencies mil. R&D						
a. AEC mil. R&D[b]	—	—	—	77.0	730.0	859.0
b. All other agencies mil. R&D[c]	2.2	7.9	16.0	62.0	105.2	138.6
3. Total mil. R&D, old def. DoD[d]	28.6	151.6	227.1	534.1	1 283.3	1 510.6
4. Total mil. R&D, new def. DoD[e]	—	—	—	—	—	—
5. NASA civil space R&D[f]	—	—	—	—	—	—
6. Other civil gov't. R&D[g]	45.5	46.3	53.2	68.3	93.9	80.1
7. Total gov't.-financed R&D[h]	74.1	197.9	280.3	602.4	1 377.2	1 590.7

	1956–57	1957–58	1958–59	1959–60	1960–61	1961–62
1. Dept. of Defense (DoD):						
a. Total R&D, old definition[a]	—	—	—	—	—	—
b. "RDT&E"[a]	2 406	2 504	2 866	4 710	6 131	6 319
c. Total R&D, new definition[a]	3 371.4	3 664.2	4 183.3	5 653.8	6 618.1	6 812.0
2. Other gov't. agencies mil. R&D						
a. AEC mil. R&D[b]	369.3	452.4	433.6	449.5	496.4	565.3
b. All other agencies mil. R&D[c]	80.0	96.6	95.2	95.6	51.9	28.6
3. Total mil. R&D, old def. DoD[d]	—	—	—	—	—	—
4. Total mil. R&D, new def. DoD[e]	3 820.7	4 213.2	4 712.1	6 198.9	7 166.4	7 405.9
5. NASA civil space R&D[f]	—	—	55.5	311.0	691.3	1 223.3
6. Other civil gov't. R&D[g]	641.2	777.4	1 038.8	1 234.3	1 426.6	1 751.0
7. Total gov't.-financed R&D[h]	4 461.9	4 990.6	5 806.4	7 744.2	9 284.3	10 381.1

[a] The official estimates of the total R&D expenditures of the Department of Defense (DoD), together with a retrospective series going back to 1939, published annually by the Bureau of the Budget and the National Science Foundation (NSF) since the early 1950s, included under the original definition ("old definition"), DoD expenditures made from funds appropriated for (1) R&D activities and (2) military construction (of R&D facilities). During the latter half of the 1950s, definitions and concepts of R&D and R&D expenditures—which mainly referred to DoD-financed R&D, since this accounted for over 80 per cent of all government-financed R&D—were continually under revision, as the R&D process, and understanding of it, evolved. Gradually it was recognized that expenditures from funds appropriated to other "functions", such as procurement, pay of military personnel and military assistance, were also supporting R&D activities; and such expenditures were included in the NSF estimates. By the beginning of the 1960s, a new definition, which has been used continually since that time, was firmly established. Retrospective estimates back to 1952 were then calculated, using this definition. The major change was the inclusion of large sums used for advanced stages of prototype development, testing and modification on weapon systems approved for quantity production, which had previously been financed from procurement appropriations. At the same time, there was a reorganization within the Defense Department, which was mainly concerned with bringing all the main R&D activities supported by the Department under a single administrative head, and into a single, broad appropriation "function" within the DoD budget. The new function was called "RDT&E—Research, Development, Test and Evaluation". It was broader than the old "R&D" function which had been in use for some years: like the new definition used in the NSF statistics, it included as R&D activities the late stages of development work which had previously been financed through procurement appropriations. A retrospective revision of the official functional breakdown of total DoD expenditures back to 1952, using the post–1960 RDT&E category, was then made. In the retrospective RDT&E estimates calculated by the DoD, considerably lower estimates were made of the share of procurement expenditures which should be counted under RDT&E, than those used in the retrospective series published by the National Science Foundation. For this reason, the NSF series of total DoD R&D expenditures shows a sharper rise from 1956 to 1959, and a slower rise from 1959 to 1960, than the DoD RDT&E series. From the time the new RDT&E definition was established, however, the NSF and DoD series are in accord; and the amounts by which NSF estimates are higher than DoD RDT&E outlays are made up of R&D expenditures which continue to be financed through other appropriation functions, such as pay of military personnel, military construction, and military assistance.

[b] The Atomic Energy Commission R&D expenditures counted here as military R&D expenditures consist of estimated outlays for the nuclear weapons development and testing programme, and the main programmes to develop nuclear power plants for military applications. There are two other main AEC R&D programmes, no portion of which is included in the military R&D estimates here, which may, however, have some military R&D component. These are (1) the general reactor development programme;

1939–1971 *US $ mn, at current prices. Fiscal years*[i]

1945–46	1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56
418.0	550.8	592.2	695.4	652.3	823.4	1 317.0	1 569.1	1 532.2	1 507.6	1 606.8
—	—	—	—	—	—	—	2 148	2 187	2 261	2 101
—	—	—	—	—	—	—	2 454.7	2 487.2	2 630.2	2 639.0
366.0	202.2	[67.1]	[151.2]	[167.6]	[185.5]	[184.1]	209.1	209.9	207.4	265.2
60.5	40.8	41.9	52.6	58.2	67.0	74.2	86.2	97.5	83.5	77.6
844.5	793.8	701.2	899.2	878.1	1 075.9	1 575.3	1 864.4	1 839.6	1 798.5	1 949.6
—	—	—	—	—	—	—	2 750.0	2 794.6	2 921.1	2 981.8
—	—	—	—	—	—	—	—	—	—	—
73.3	106.1	153.6	182.8	204.7	224.6	240.9	351.0	353.3	387.2	464.2
917.8	899.9	854.8	1 082.0	1 082.8	1 300.5	1 816.2	3 101.0	3 147.9	3 308.3	3 446.0

1962–63	1963–64	1964–65	1965–66	1966–67	1967–68	1968–69	1969–70	1970–71	1971–72
—	—	—	—	—	—	—	—	—	—
6 376	7 021	6 236	6 259	7 160	7 747	7 457	7 166	7 281	7 504
6 848.0	7 517.0	6 727.6	6 734.6	7 680.1	8 163.6	7 868.4	7 570.9	7 710.6	7 890.8
533.8	633.7	623.0	579.7	5 76.5	658.9	754.8	722.1	701.3	677.4
37.6	40.0	58.0	75.7	89.7	129.9	170.0	188.3	196.7	208.1
—	—	—	—	—	—	—	—	—	—
7 419.4	8 190.7	7 408.6	7 390.0	8 346.3	8 952.4	8 793.2	8 481.3	8 608.6	8 776.3
1 608.4	4 131.3	5 035.0	5 857.9	5 336.7	4 594.7	4 082.7	3 565.7	3 173.3	2 944.9
1 971.5	2 385.0	2 445.2	2 770.0	3 158.7	3 438.1	3 471.7	3 585.0	4 178.1	4 536.8
11 999.3	14 707.0	14 888.8	16 017.9	16 841.7	17 030.2	16 347.6	15 632.0	15 960.0	16 258.0

and (2) the R&D part of the special nuclear materials procurement and production programme. The latter may have been conducted mainly for military reasons, at least in the early years. The amounts used for special materials R&D were comparatively low—around $10–30 million annually. With no evidence on which to base even guesses of the military and civil "components" of this programme it therefore seemed best simply to omit this from the total military R&D figure. The amounts involved in the general reactor development programme—which is described in official publications as separate from both military and civil applied reactor development programmes, and which probably feeds into both—are of the order of $30–60 million annually, which is the equivalent of about 5–10 per cent of the current estimated AEC military R&D expenditures. Here again, however, there was no basis for a reliable estimate of the "military" component; and this programme, along with the special nuclear materials programme and the other AEC R&D programmes (basic research in physics, chemistry, biology and medicine, and the Plowshare programme, and civil reactor development) are included in the table here among the civil government R&D expenditures shown in row 6.

[c] This consists of (1) NACA (National Advisory Committee on Aeronautics), followed from 1959 on by NASA (National Aeronautics and Space Administration) R&D expenditures for programmes identified in the budget as being conducted mainly or entirely for military purposes (all NACA R&D expenditures between 1945 and 1958 fall into this category); (2) R&D expenditures of the Federal Civil Defense Administration (through 1956), and, from 1957, of the Office of Civil and Defense Mobilization, followed, starting in 1960, by the Office of Emergency Planning; (3) R&D expenditures of the General Services Administration on research relating to strategic and critical materials; (4) R&D expenditures of the Reconstruction Finance Corporation (1952–1953), followed by the Federal Facilities Corporation (1954–1955), and then the National Science Foundation (1956–1957) on research relating to strategic and critical materials; and (5) the total R&D expenditures of the Office of Scientific Research and Development, which cover the period 1940–1947.

[d] Sum of rows 1a, 2a and 2b.

[e] Sum of rows 1c, 2a and 2b.

[f] The great bulk of total NASA R&D expenditures from 1959 on are included here, as civil space R&D expenditures; only a very small proportion of NASA R&D expenditures have been officially described as being related to weapon development work. This small proportion is included in row 2b.

[g] This includes, for example, all of the R&D financed by the Department of Health, Education and Welfare (which has accounted for around 35 per cent of the total shown in row 6 in recent years); along with the total R&D expenditures of the Departments of Agriculture, Commerce, Transportation, and other government departments and agencies with lower R&D expenditures; and the civil R&D expenditures of the AEC (see note *b* above).

[h] Sum of rows 3 (through 1951) or 4 (from 1952 on), and 5 and 6.

[i] These are US fiscal years: 1939–40 is FY 1940. In text, FY 1940 is referred to as the year 1939.

Appendix 6B. US estimates of Soviet expenditure on military research: an analysis of data published in 1971 and early 1972

As a preliminary part of this study, an essay was published in the *SIPRI Yearbook 1969/70* analysing estimates made by US Department of Defense officials of Soviet expenditures on military-related R&D (military R&D and space activities). The conclusion was drawn that the US estimates, which had been published in 1969 and 1970, could not be considered reliable. In early 1971 refined estimates, which separated military R&D from civil space R&D, were set forth by the same US officials. The reliability of the new estimates was questioned by several members of the US Congress; and as a result, a considerable amount of new information on the methodology of the estimates was released during 1971 and early 1972. In the annual statement of the US Director of Defense Research and Engineering on the US military R&D budget and programme for 1972–73, published in February 1972, exact estimates of Soviet military R&D spending are no longer given; and it is noted in the annual report on the overall defence budget and policy by the Secretary of Defense that "there may be some debate as to whether—or how much—the Soviet Union is outspending us in Research and Development". Both officials nevertheless continue to claim that the Soviet military R&D effort poses a threat to US superiority in weapons technology; and references to a high level of Soviet military R&D spending are still made. To bring the earlier SIPRI analysis up to date, this appendix summarizes the results of a study of the expenditure estimates and related information which appeared in the USA in 1971; and it then comments on the new assessment of the Soviet effort presented in the 1972 budget statement of the Director of Defense Research and Engineering.

I. *US estimates published in 1971*

The official US estimates of Soviet military R&D spending published in 1971 were based on official Soviet "science" expenditure data. The Soviet data consisted of annual estimates of total national science expenditure for

1959–1970, and estimates of the following parts of this total: the "all-union" science budget (available through 1965); the science budgets of the union republics (through 1965); science expenditures from "other sources" (through 1965); and expenditures under the "all-union capital investment plan for the development of science" (1959–1970). To obtain estimates of Soviet military-related R&D outlays for 1960–1972, the US analysts took arbitrary, high percentages of all of the categories of science expenditure which are possible sources of finance for military R&D and space, and added them together. The percentages used appear to have been 85–90 per cent of the all-union science budget and capital investment funds, and 55–65 per cent of science outlays from "other sources". The overall level of the all-union science budget and science funds from other sources for 1965–1972 and of total national science expenditures for 1971–1972 were apparently extrapolated. As a result of the arbitrary nature of these calculations, the rouble estimates of Soviet military-related R&D funds obtained as the first step in the 1971 analysis cannot be considered to have been at all reliable.

Three further steps were involved in the analysis. First, a $2 per rouble exchange rate, assumed to provide an accurate conversion factor for measuring "equivalent Soviet R&D and space effort", was used to convert the rouble estimates to dollars. Next, estimates of the cost of the Soviet civil space effort were made on the basis of known Soviet space activities and subtracted from the estimates of military-related R&D, to provide figures for military R&D alone. The picture obtained following these calculations was one in which the assumed rise in total Soviet military-related R&D funds between 1960 and 1968 was estimated to have been accounted for almost completely by a rise in civil space outlays, leaving military R&D outlays roughly constant, at a level lower than US military R&D expenditures for the same period; and in which the continued rise in the estimated military-related R&D funds in 1968–1972 was assumed to have been accounted for entirely by a rise in military R&D funds—bringing Soviet military R&D outlays to a level considerably higher than the corresponding US outlays by 1971—as a result of a purported levelling-off in the funds devoted to civil space activities after 1968. As the final step in the analysis, an assessment was made of the extent to which the difference between estimated US and Soviet military R&D spending in 1960–1968 appeared consistent with the lag in Soviet weapons technology in the same period.

Very serious deficiencies are involved in the exchange rate used in the analysis and in the argumentation concerning US and Soviet weapons technology. Defense Department officials claimed that in using the $2 rate, an attempt was being made to compare not only the resources devoted to the

US and Soviet R&D efforts, but also the relative efficiency with which these resources are employed. It is highly doubtful whether a reliable rate of this kind could be calculated. The dearth of data on Soviet R&D costs has made it impossible for experts to arrive at a single figure for comparing resources alone—instead, ranges of $2.00–3.00 or $2.50–3.50 per rouble are proposed; and relative efficiency cannot be estimated without a more precise measure of resources. The $2 rate is thus probably an arbitrarily selected round number, set lower than realistic figures for comparing resources alone, to allow in a vague way for an assumed lower Soviet productivity. As such, the rate cannot, of course, be considered reliable.

In 1971 Defense Department officials stated that the USA had retained a constant 2- to 3-year lead over the USSR in weapons technology in 1960–1968. This constant lead was asserted to be consistent with the picture provided by the expenditure estimates, since both countries were estimated to have had roughly constant military R&D outlays during the same period. It was reasoned that if Soviet military R&D outlays had increased, then the US technological lead would have diminished; and if Soviet funds had declined, then the US lead would have grown. There are several flaws in this line of reasoning. First, the technological assessment is itself open to question, since it is based on subjective judgements of the leads for individual weapons and major weapon categories. Second, the technological assessment does not necessarily provide a good indication of the overall sizes of the US and Soviet military R&D efforts in any case, because it ignores factors such as the quantity of R&D resources devoted to undertakings in one country which have no counterpart in the other, including weapon system modifications; the time lag, and potential differences in the time lag in the two countries, between R&D spending and R&D output; and the extent to which defence-related R&D supported by private industry in the USA should be included in comparisons with state budget-financed R&D in the USSR. Third, even if these factors were taken into account, estimates of the relative sizes of the two R&D efforts still could not be inferred from data on R&D output, because of uncertainties about the efficiency—and possible changes in the relative level of efficiency—with which R&D resources are used in the two countries. For these reasons, the technological assessment cannot be considered to have confirmed the estimated trend in Soviet military R&D outlays in 1960–1968, or the $2 per rouble exchange rate used to convert the rouble estimates of military-related R&D funds to dollars.

For the 1968–1972 period, the Defense Department's estimates relied heavily on the arbitrary extrapolation noted earlier of certain high percentages of Soviet science expenditure as representative of the level and trend of military-related R&D funds; and on the assumptions concerning the relative level of Soviet R&D costs and efficiency which are implicit in the $2 per rouble exchange rate. No allowance was made in these calculations for the possibility of a substantial rise in the funds devoted to civil R&D in the USSR in this recent period, comparable to that occurring in other industrialized countries; nor was the possibility that the relative level of Soviet military R&D efficiency might decline taken into account, even though it was claimed that the USSR was, for the first time, moving closer to the forefront of weapons technology, rather than merely following US developments, during this period. The extent to which Soviet military R&D outlays were estimated to have risen in 1968–1972 also depended on the alleged levelling-off in civil space funds during this period. In Congressional hearings in the spring of 1971, officials in charge of the US civil space effort stated that "All that we have been able to learn about Soviet recent space endeavors suggests continued growth";[1] and evidence of continued growth in civil space in particular was underscored in September 1971 by a member of the Congressional Research Service: "The conclusion in this analysis supports a view that the Soviet space budgets, military and civilian, are still growing".[2] In sum, the Defense Department's estimates for the post-1968 period appear to have been highly speculative. As a study of the methodology of the estimates undertaken by the General Accounting Office of the US government concluded: "extreme secretiveness by the Soviet Union results in data which are insufficient for a realistic measurement of its military R&D efforts".[3]

II. *The 1972 US assessment of the Soviet effort*

In contrast to the 1971 statement, the 1972 statement on the US military R&D programme for the coming year[4] does not include exact figures for

[1] Dr James C. Fletcher, Administrator of NASA, before the Senate Appropriations Committee, 23 June 1971, cited in *Congressional Record,* 15 September 1971, p. E 9634. A similar assessment was given by Dr George Low, Acting Administrator of NASA, in hearings before the Senate Committee on Aeronautical and Space Sciences on 17 March 1971.

[2] Dr Charles S. Sheldon (Chief, Science Policy Research Division, Congressional Research Service), "Possible Overall Trends in the Soviet Space Program", in *Congressional Record,* 15 September 1971, p. E 9636.

[3] US Comptroller General, *Comparison of Military Research and Development Expenditures of the United States and the Soviet Union, Part II: Declassified version, Department of Defense Methodology for Assessing United States and Soviet Union Military Research and Development Efforts* (General Accounting Office Staff Study for the Subcommittee on Research and Development, Committee on Armed Services, United States Senate), 31 January 1972.

[4] *Statement by the Director of Defense Research and Engineering Dr. John S. Foster, Jr., On the Fiscal Year 1973 Defense RDT&E Program, before the Armed Services*

an estimated rate of increase in Soviet military R&D spending in recent years, or exact percentages by which the Soviet military R&D effort is alleged to be larger than the US effort. The absence of such figures suggests that the validity of criticisms of the kind outlined above may have been recognized. However, the picture of Soviet military R&D spending put forth in 1971 does not appear to have been abandoned or even altered in 1972: it is simply presented in a more cautious manner. Thus in the 1972 statement, it is asserted that "Capital investments in Soviet military RDT&E [research, development, test and evaluation] have grown substantially during the past decade".[5] In addition, a Soviet military R&D effort larger than the US effort in recent years is still implied in the suggestion that, following an increase in US military R&D appropriations in 1971, "The increase in this year's request [for military R&D funds] is sufficient to eliminate the remaining apparent divergence in the relative efforts of ourselves and [the USSR]."[6] No new evidence is presented to support the view that the Soviet military R&D effort has been larger than the US effort.

The main objects of attention in the 1972 statement are the official Soviet policy strengthening its overall R&D effort, and an alleged reduction in US military technological superiority. The references to expressed Soviet concern with science and technology imply that this concern relates mainly to military R&D. Thus, in the following statement—"The Soviets have taken notice of past US reductions in military RDT&E expenditures, but their public statements and new five-year plan describe a continuing and systematic increase in their own efforts"[7]—it is implied that the planned increase in Soviet scientific effort relates to military R&D, although there is no foundation for this in Soviet statements. It is often suggested in the Soviet Union that one of the main objects of the current and planned expansion of R&D is civil applications. This is illustrated, for example, in the following statements: "A considerable increase shall be effected next year in allocations for science, which exerts an ever greater influence on the process of material production and *the living conditions of the Soviet people*";[8] and "*the acceleration of scientific and technical progress is directed first of all* at the accomplishment of the five-year plan's chief task—*achieving a substantial upswing in the people's material and cultural living*

Committee, US Senate, 92nd Congress, on 17 February 1972. In the remainder of this appendix, this is referred to as "the 1972 statement".

[5] *Ibid*., p. 1–11.

[6] *Ibid*., p. 1–2.

[7] *Ibid*., p. 1–11.

[8] "On the USSR State Budget for 1972 and the Fulfillment of the USSR State Budget for 1970", Report by Deputy V. F. Garbuzov, USSR Minister of Finance, reprinted in *Pravda*, 25 November 1971. (SIPRI translation.)

standard"[9] (italics added). Soviet concern with civil R&D is ignored in the US Defense Department's 1972 assessment, in the same way that the possibility of a substantial increase in civil R&D spending is ignored in the calculations on which the military R&D expenditure estimates were based.

The alleged reduction in US technological superiority in weaponry is given a great deal of emphasis in the 1972 statement. The following excerpt is illustrative:

> We have worked extensively throughout the past year to determine and measure Soviet technological progress in the military area. The secrecy surrounding their efforts makes this a very difficult task. However, careful analysis of additional data supports and strengthens our conclusions that the US military technological lead is being eroded ... We have reexamined the analysis of technological lead time that I presented to you last year ... Our reexamination shows that, in the aggregate, the U.S. enjoyed a two-year technological lead over the Soviet Union in the early 1960s and that this lead has slowly decreased to a rough parity in many comparable systems in 1970.[10]

It is implied here that a US 2-year technological lead has been reduced in the last few years; but it is not clear how great the alleged reduction has been. A "rough parity" in 1970 is suggested, but this is qualified by the phrase "in many comparable systems", so that an assessment of overall parity does not seem intended. Nor is parity suggested elsewhere in the statement. Instead it is claimed that the "current US technological superiority is in jeopardy" and that the US lead is "slim and dwindling".

In support of this assessment the 1972 statement provides a list of types of weapon system, deployed in 1970, divided into: (1) systems for which deployed Soviet forces are superior to deployed US forces; (2) systems for which the deployed forces of the two countries have a rough technological parity; and (3) systems for which deployed US forces are technologically superior to deployed Soviet forces. There are 11 areas in which the USSR is claimed to have superiority; 17 areas in which the USA has superiority; and 4 areas of parity. The advantages with regard to tactical weapon systems appear in the list to be about equally divided, since 6 of the areas of superiority on each side are in tactical weapons. In offensive strategic weapon systems, communication, warning, control, surveillance and defence-suppression systems and long-range air and sea transports (a total of 9 specified systems) US superiority is unchallenged. The only Soviet counterbalancing systems given in the list are the fractional orbit ballistic missile, which has been observed for a number of years and for which the

[9] B. Volchkov, "Fundament Oboronoy Moshchi Strany" [The Foundation of the Country's Defensive Might], *Krasnaya Zvezda*, 17 November 1971. (SIPRI translation.)
[10] *Statement by the Director of Defense Research, op. cit.*, pp. 1–1, 1–2, 1–18.

USA has no intention of developing a counterpart; and the ABM, deployed in the USSR in 1964 and undoubtedly less advanced than the US ABM, which was, however, not yet operationally deployed in 1970. The Soviet Union appears to have an advantage in other strategic defence systems, with alleged superiority in air-defence interceptors, medium- and high-altitude surface-to-air missile defences, and civil defence (the latter constitutes one of the 11 areas in which Soviet superiority is claimed); but this is counterbalanced by a US lead in ASW sensors and patrol aircraft, which is particularly significant in view of the increasing importance of submarine systems and the declining importance of bombers in offensive strategic weaponry. In sum, the list appears to give the United States a clear advantage in the most complex and expensive weapon systems, as well as in numbers. Given the evidence of US leads of 5 years or more in offensive strategic weapons,[11] it appears doubtful whether, if a weighted average of the different lead-times on either side were calculated, giving weights according to the development costs of the various systems, the overall US lead would come to 2 years or less. The list does not, therefore, form a very strong basis for the claim that the US technological lead is "slim".

The comparison of weapon systems deployed in 1970 does not provide any evidence concerning recent *changes* in the relative technological positions of the USA and the USSR. It is possible that, if a comparable list were compiled for forces deployed in 1968 or 1966, the numbers and types of forces for which Soviet technological superiority would be claimed would not differ significantly. Soviet superiority in many of the systems now credited to that country has been alleged in the USA for a number of years. This applies to ABM, fractional orbit ballistic missiles, "some armored combat vehicles" (excluding tanks, for which parity is claimed), heavy-lift helicopters, air-defence interceptors and surface-to-air missiles, and civil defence. The list does not, thus, provide any evidence of a significant reduction in US technological superiority in the last few years.

It is claimed in the 1972 statement that the US technological lead in armaments is being eroded "because of the greater Soviet commitment of resources". It is suggested that a proposed 10 per cent increase in US military R&D funds "will help restore the momentum needed to maintain our security" and that "It could be very unfortunate for the United States if inadequate support were given to the military RDT&E by which we maintain our slim and dwindling technological lead". Aside from the highly questionable nature of the assumed large size of the Soviet military R&D budget and small size of the US technological lead, these assertions reflect

[11] SIPRI estimates of US lead-times are set out on page 204.

an over-simplified assessment of the affect of the overall level of military R&D spending in the two countries on the overall disparity in technology. Factors such as duplication of R&D work, inefficiency, goldplating, the development of systems in one country which have no counterpart in the other—including modified versions of existing systems as well as new systems—and the differing modes of management and production in the two countries probably affect the overall level of military R&D spending to such an extent that marginal increases or decreases in the military R&D budgets do not make a significant difference in the relative overall level of military technology. For all that is known, the United States could cut its military R&D budget by 20 or 30 per cent or more, and still retain technological superiority over the Soviet Union in all weapon systems essential to US defence policy *vis-à-vis* the USSR, assuming that such superiority were an objective. It is important to observe that the requested increase in US military R&D funds is not justified on the grounds of any specific deficiencies in the relative state of US weapons technology. It rather marks the initiation of a new US policy in which a wide margin of across-the-board technological superiority in weaponry is explicitly set out as an end in itself, within the overall defence policy. This is the first time that continued development of improved armaments, without regard to scientific needs for particular advances, has been put forth as a general requirement for US security. If technological superiority is accepted as an independent objective by the US Congress, it will lead to a new upward spiral in the arms race between the United States and the Soviet Union, and, until revoked, it will provide a formula for a permanent arms race.

7. Foreign military presence, 1971: armed forces and major bases

I. *Introduction*

The issues raised by foreign military presence have stimulated international debates and have been a frequent cause of public concern ever since the end of World War II. Recently the whole subject has again become topical, this time mainly because two big powers have announced the withdrawal of some of their forces. In 1967 the United Kingdom first made known its decision to withdraw from areas "East of Suez"—the withdrawal to be completed by the end of 1971—a decision which implied a substantial redeployment of troops and the abandonment of a number of British bases in various parts of Asia. In the United States, the proclamation, in 1969, of the so-called "Nixon Doctrine" meant a gradual disengagement of US military forces abroad, in particular from Asia. At the same time, there were discussions about a possible reduction or withdrawal, for economic reasons, of US troops from Western Europe, particularly from the Federal Republic of Germany. A number of US Senators and Representatives put forward specific proposals to this effect, and there was much public debate on the topic in the United States. In Europe itself, efforts have been intensified to achieve mutual and balanced force reductions of both indigenous and foreign troops.

In some areas, however, foreign military presence has actually increased. Beginning in 1967, there was a substantial rise in Soviet naval activities in the Mediterranean area and, soon afterwards, in the Indian Ocean as well. There have also been reports of the establishment of Soviet military presence in certain third world countries, particularly Egypt and Algeria. These events have given rise to considerable concern in the West and have spotlighted attention on to the consequences of the presence of military forces and bases on foreign territory.

The withdrawal of military forces from foreign territories has been a standing Soviet proposal at disarmament discussions for many years. In recent years the People's Republic of China has been insisting on the abolition of foreign bases, particularly those of the USA and the USSR.

Information on the general problem of foreign military presence is presented in this chapter. The aim is to facilitate a better understanding of the issues involved. The information is restricted to the bare presentation of data. The policies of the deploying countries are not discussed.

In public discussions of this controversial topic, extreme positions are frequently taken and dubious conclusions drawn purely because information is lacking. In general, the disengagements of Western powers have tended to be under-rated both by the West and the East, whereas the increase of Soviet military activities in third world regions has been exaggerated. Distortion of facts has also occurred so that support could be obtained for increased military expenditures or for a revision of plans for disengagement and withdrawal. At the present time, facts about foreign military presence are more urgent than analysis.

II. *Foreign military presence*

The concept of foreign military presence, as used here, refers to: (*a*) the actual access by a foreign power to, and the use of military facilities, usually provided by what is commonly called a military "base"; or (*b*) the actual presence of organized units of soldiers, sailors, marines or airmen in foreign territories; or (*c*) the actual deployment and permanent activities of fleets outside their own territorial waters. In this way, controversial questions, such as the formal status of military bases (whether they are under foreign or local jurisdiction, etc.), the legal basis for the presence of troops in the foreign territory, or the purposes of naval activities, are avoided. The criterion used for determining the existence of a military presence in foreign territories is thus actual physical presence rather than formalities regulating this presence.

Deploying countries

At present, more than twenty countries maintain military forces and bases abroad. The foreign military presence of these countries is, however, not equally significant from either a military or a political standpoint. In fact, with only one or two exceptions, four big powers—the USA, the USSR, the UK and France—play by far the dominant role. Not only do each of these four countries deploy significant numbers of military forces (tables 7.1–7.4) and maintain a naval presence in many areas of the world (table 7.10), but their foreign presence has a much greater impact on the world's military balance and strategic planning. In view of this, the emphasis has here been placed on the military presence of these big powers (see map 1, on the inside of the back cover).

So far as deployed forces of the smaller countries are concerned—such as troops of certain Arab countries in Egypt or the SEATO members in South Viet-Nam—the numerical strength of their troops abroad is relatively small and primarily of local political significance. Their presence in foreign territories is only of marginal importance, so far as worldwide military and political affairs are concerned. Nevertheless, for the sake of completeness and for comparison, some indication of the strength and geographical distribution of these forces is given in table 7.5.

Big powers

The policy of the big powers concerning foreign military presence differs in many essential aspects because of the considerable difference between them in the historical development, geographical position, political concepts, technological development and choice of weapon systems. Thus, for example, the present disposition of British and French military forces and bases in foreign territories reflects these countries' past positions as the world's strongest colonial powers. There are also some differences between the political thinking of the USA and the USSR concerning the purposes of a military presence abroad and, accordingly, between respective efforts in establishing such a presence. There are oceans between the USA and its allies, whereas most of the Soviet Union's allies are directly adjacent to its territory. In addition, it should be noted that the three Western big powers officially recognize the possession of their own military bases abroad, whereas the Soviet Union does not. However, it is a fact that the USSR maintains troops and has access to military facilities outside its own territory. Specifically, the Soviet Union claims that there are substantial formal differences between its arrangements for regulating the use of facilities and the presence of Soviet troops in foreign territories, and those of the Western countries. As stated above, these distinctions are not dealt with here.

Mutual confrontation

The military presence of the big powers in foreign territories is primarily part and parcel of the mutual confrontation between the two opposing military and political blocs. The military forces involved are to a large extent intended for use if an armed conflict breaks out between the two blocs. The disposition and strength of these countries' military forces and bases abroad reflect their strategic thinking and the climate of their mutual political relations. In some cases they also serve other purposes, such as preventing political changes, undesirable to the deploying country, from occurring in the host countries. It would, therefore, be mistaken to consider the deployment policy of the big powers as an isolated element: it is an integral part of both their military and their foreign policies with major implications for the balance of political and military power, the arms race, the spread of advanced military technology and disarmament positions.

Information on the foreign military presence of the big powers may serve several useful purposes. First, it will indicate sensitive areas in the confrontation between the blocs—areas where the opposing forces meet face-to-face. Secondly, it clearly indicates which third world regions are of special interest to the big powers. Finally, the information may be used to study the way in which the big powers act and react to each others' plans to escalate or de-escalate their military presence in various parts of the world.

Host countries

In addition to the mutual confrontation between the two blocs, which is undoubtedly the primary factor in the deployment policy of the big powers, the military presence of these powers beyond their national territories has an important bearing on the relations between them, as deploying countries, and the host countries (and, very often, also the countries surrounding the host countries). For some host countries, this foreign military presence is essential for the preservation of existing political régimes or for defending their sovereignty and national interests. Foreign military presence is then readily encouraged, welcomed and approved by the host country. But there are a number of countries where the governments or the general public, or both, strongly oppose this foreign military presence and initiate determined measures to rid themselves of it.

In a number of internal or local international crises, fleets stationed in various seas and oceans have been moved close to, or even into, the territorial waters of the countries concerned and have sometimes supported invasions. The existing deployment of these fleets reflects an important aspect of the big powers' global policy.

III. *Restrictions*

Use of public sources

The material presented here is restricted in several respects. First, the survey is entirely based on public sources and this immediately sets strict limits on the comprehensiveness of the information that could be obtained. Moreover, even heavily financed and well-established intelligence agencies may be unable to discover all the military facilities and all the military activities in the world. Therefore, although this presentation probably includes the majority of the major installations and activities abroad, it cannot be complete. Moreover, any such list will vary according to the criteria used to compile it: the minimum number of troops considered significant, the types of bases included, etc.

However, the identity of both host and deploying countries is, in the vast majority of cases, well known. It is much easier to identify a country in which there is a foreign military presence than to identify military installations. But, even so, there are a few cases of countries in which a foreign military presence is alleged but for which the available information is insufficient to support the allegation.

The aim has not been to include all kinds of installations. Instead, attention has been focused mainly on military forces and *major* bases. However, for those countries in which there is only a minor degree of foreign military activity, even small forces and their support installations are given simply to indicate such activity.

In addition to installations to support the armed forces of the different services, there are other military facilities on foreign soil. These serve particular purposes—communications stations, communication-monitoring stations, satellite-tracking stations, radar stations, and so on. Some of these, for example, early warning systems, are technically very sophisticated and of considerable strategic importance. The number of these installations is very large, probably well over one thousand, but they are usually manned by only small numbers of personnel. Such bases are listed here if they are the only, or the main, foreign military activity in the host country or if they are stated to be essential parts of a worldwide complex.

Although estimates are published on the general strengths of Soviet forces in Eastern Europe, almost no specific details are publicly known about them. Similarly, the location of Soviet bases is not publicly known. This should be borne in mind when comparing them with the Western powers' military presence, which is much more comprehensively reported in public sources and accounted for in this chapter.

Because the Western powers, particularly the United States, are in the process of withdrawing troops from foreign territories, a relatively large number of bases are being closed down. Consequently, some of the information presented here may be outdated at the time of publication.

Peacetime pattern

When considering the foreign military presence of the big powers, yet another restriction has to be borne in mind. The information presented reflects the peacetime pattern of the foreign military presence of these powers. Because this presence is primarily an expression of the two-bloc confrontation, the concept of a "peacetime pattern" here means an absence of direct armed conflict (world war) between the two major blocs. If war were to break out, an entirely different pattern of troop deployment and bases would probably be established.

In general, the "peacetime pattern" may not correspond to the probable deployment pattern in the event of a major conflict or even a limited war between the two blocs. Many forces, particularly the most mobile, would probably be quickly redeployed. And some bases might be considered too well known and vulnerable to maintain, or suitable only for training purposes. Instead, other bases probably exist for use by the big powers in wartime, under secret agreements, in which no foreign troops are deployed in peacetime. Also, wherever the basic facilities exist, a base could be established and complementary equipment—communications, stockpiles of spare parts, etc.—could rapidly be transported to the spot. Examples of such facilities are harbours and airfields built by the big powers as aid to third world countries but constructed in such a way as to be suitable to accommodate the warships, aircraft, etc. of the big powers.

In case of conflict, the troops presently deployed abroad would be substantially strengthened and fleets redeployed. However, the presentation of the "peacetime pattern" of foreign military presence is important because it represents an important aspect of the existing policy and strategy of the two blocs.

Local wars may or may not significantly affect the overall military deployment policy of the big powers or their military presence abroad, depending on the scale of the conflict and the interest of the powers involved. A recent local conflict which has significantly affected the deployment policy of one country is the Viet-Nam War. The active US involvement in this war has led to a considerable increase of US troops and bases in Viet-Nam (table 7.8) and in Thailand as well. Its termination will certainly reduce US military presence in Indo-China, but it is very unlikely that the end of this war alone will be a decisive factor determining the future extent of US military presence in the rest of Asia.

Similarly, the 1967 Arab–Israeli War was followed by the deployment of certain Soviet troops in Egypt.

Specific restrictions

Certain restrictions are specific to the deployment of troops, fleets and bases and, therefore, these elements are dealt with separately.

Troops

Only troops representing the regular armed forces of the deploying country, remaining under its own command or under allied command and fulfilling specific tasks given to them by the country or the allied command, are accounted for. Not included are, for example, military advisers, military instructors, and so on serving with the armed forces of other countries, or armies raised locally and led by foreign irregulars.

Fleets

The presence of naval fleets cannot be determined merely by recording their bases in foreign territories, because fleets can nowadays operate more independently than can other armed units. A strict differentiation between fleets, on the basis of formal geographical areas of operation, would be superficial. All home-based warships can be moved, for shorter or longer periods of time, into international or foreign territorial waters and those stationed in these waters can be moved back into home waters. In practice this means that the composition and numerical strength of a foreign-based fleet is very relative and depends on the specific needs of the deploying country. This should be borne in mind when considering the information given on the foreign fleets of the big powers. This information is restricted to the typical strength of the fleets of these powers operating far from their home bases in the Mediterranean area, the Indian Ocean and the Pacific Ocean.[1]

The relative disposition of the foreign fleets of the big powers have substantially changed over the past 25 years. After World War II, the oceans were almost completely dominated by the Western powers. Both Britain and France, particularly France, have virtually withdrawn their naval presence from outside European waters, leaving the United States as the only Western power with a substantial naval strength on the oceans. This has coincided with a substantial increase in Soviet naval activities.

A special feature which reflects maritime interests and naval presence in general is the practice of making naval visits. The recent increase of such visits on the part of the Soviet Union has attracted worldwide attention. The Soviet Union itself attaches great importance to these visits:

[1] The warships operating in the Atlantic Ocean are in principle "home-based". Typical strengths of such fleets operating far away from home bases are thus difficult to determine. Consequently, this area is not accounted for.

> Ships visits facilitate the development and strengthening of friendly relations between the Soviet people and the peoples of foreign countries, and they strengthen the authority and influence of our homeland in the international arena.[2]

To show the evolving pattern of the growing naval presence of the Soviet Union, a separate presentation of information on Soviet naval visits, particularly since 1965, is warranted (see maps 3, 4, 5, pages 273–75). This information does not include every visit of every Soviet warship to foreign countries. In particular, the Warsaw Pact countries must have received many more visits by Soviet ships than are shown. However, the trends are clearly visible: an increase in frequency of Soviet naval visits reflecting a tendency towards establishing a regular naval presence in all the oceans. This is probably the beginning of a process leading to the wide deployment of the Soviet Navy as a demonstration of its role as a world power.

The United States has been "showing the flag" around the world for many years but this activity has been overshadowed by the permanent presence of US fleets in various oceans.

Bases

A foreign military presence is primarily constituted by the deployment of forces (army, naval, marine and air force) in the respective areas. The term "base" is commonly used to describe the facilities[3] required to support these forces. The published information on army bases is often not very detailed and seldom allows an accurate assessment to be made of the real capacities of these bases. Consequently, army bases are only listed in the tables to indicate the general deployment of the forces actually present in a given country. It should be emphasized, however, that from a purely military point of view, the infrastructure of established army bases may in wartime be as important, if not more so, than the troops themselves. This is particularly true now that large numbers of troops can be rapidly transported over great distances as demonstrated by the "Big Lift" experiments by the USA.

Naval and air forces are highly mobile and can easily be redeployed to any place where appropriate facilities (docks, runways, etc.) are available. Air

[2] Fleet Admiral Kasatonov, writing for the military press on Soviet Navy Day, 1967, in *US Naval Institute Proceedings*, 95(6), June 1969, p. 796.

[3] These facilities include installations for (*a*) accommodation, (*b*) catering, (*c*) health service, (*d*) stockpiles of equipment, ammunition, fuel, etc., (*e*) repairs and maintenance, (*f*) communications, and (*g*) transportation to and from the area. Training and recreation facilities are also included. These elements are present, in general, in all kinds of bases. In addition, special bases have the extra facilities required for the activity for which they are designed, such as runways at air force bases, docks at major naval bases, and so on.

bases, naval bases and naval air stations[4] have therefore been listed in the tables unless the published sources clearly indicate that they are ancillary to another base or that they are of minor significance.

The period of time during which modern ships, particularly nuclear-powered ships, can be kept at sea without access to a base has been considerably extended. In addition, the possibilities to refuel, to resupply, to undergo repair and even to "dock" at sea have been substantially improved. These factors have decreased the real need for foreign naval bases.

The installations constituting a base are very often geographically separated. The distances involved are sometimes several kilometres and possibly even more. If these separate installations operate within the same base function, they are listed, for the sake of compactness, as a single base complex rather than as several different bases. For example, the Kenitra complex in Morocco consists of a US naval air station at Kenitra and outlying communications facilities at Sidi Yahia and Bouknadel. Each of these three installations is located about 30 kilometres from the other two, but logistically and administratively they are one base. A similar situation exists for many other bases, particularly the larger ones.

IV. *Tables*

The deployment of armed forces abroad is presented according to the deploying countries. The presentation consists of five main tables, namely, the USA (table 7.1), the USSR (table 7.2), Great Britain (table 7.3), France (table 7.4), and other countries (table 7.5). In addition, there is a presentation of numbers of US and British troops in certain areas (tables 7.6–7.9) and NATO and Warsaw Pact combat aircraft and armoured and infantry division equivalents in Europe (map 2, page 272).

In these tables, the forces deployed by one particular country are grouped by the host countries (territories), i.e., countries (territories) in which the forces are stationed. Overseas territories are considered to be "beyond the national boundaries" only if they are not internationally recognized as forming part of the national territory.

In the columns entitled "Forces", "Place", "Function" and "Comments" (in table 7.5 only "Numbers of troops" and "Comments"), the actual information is presented according to the following principles:

1. Foreign military presence in a country is accounted for in the tables by a list of all major installations. When a minor installation is considered to be

[4] Including access to such facilities by agreement or other authorization.

the only indication of foreign military presence in a country, this installation is also included in the tables. If possible, a total number of troops has been shown in the "Forces" column, which also indicates the appropriate service, (army, navy, marine corps or air force).

2. For army units, bases or base areas are indicated only to the extent necessary to show the general deployment of the forces. Information on outlying army air fields has been included when available.

3. Known naval bases and air bases are included when warships and combat aircraft units are or can easily be stationed at them. This includes bases now used as support bases but at which warships and aircraft could be stationed. Other support bases, e.g., those not associated with a harbour or an airfield, are excluded.

4. Bases for particular other purposes are not included. An exception is made for communications stations which are stated to be essential parts of a worldwide complex.

5. The following installations are not separately accounted for: depots; storages and plants; administrative, ordnance and quartermaster areas; repair and maintenance facilities; hospitals; staging areas; training facilities; firing ranges; and annexes.

6. Installations are included only when the forces deployed are foreign; installations made available by pact agreements (NATO, Warsaw Pact) are not included if they remain under full national control.

The study includes information to the end of calendar year 1971 unless otherwise stated (see sources for each table).

Table 7.1. Foreign military presence in four areas: the United States

Figures indicate numbers of men, unless otherwise stated

Host country (territory)	Forces	Place	Function	Comments	Sources
Europe					
Azores (Portuguese territory)	Navy		Maritime patrol aircraft detachment	*US-Portuguese defence pact*	3, 11, 19
	Air force	Lajes	Lajes field airlift base		3, 11, 19
Belgium	*Total: 2 000*			*Under NATO agreement*	22, 25, 28
		Casteau	Supreme HQ Allied Powers in Europe		22, 25, 28
	Army	Mons	Air base	Chievres air base	11
Berlin	Army	West Berlin	1 brigade	HQ in Berlin–Dahlem	10, 11
	Air force	Tempelhof	Support base	At the Tempelhof airport	10, 11, 19
FR Germany	*Total: 215 000 army and air force*			*Under NATO agreement*	22, 25
	Army	Mannheim-Seckenheim	HQ Central Army Group (the US combat forces in Germany are part of the Central Army Group)	2 armoured and 2 infantry divisions; 2 armoured cavalry regiments; 1 mechanized infantry brigade; support units; some outlying army airfields	15, 16
				Deployment areas: Franconia, Hessen, North Baden, North and South Bavaria, North Württemberg, Palatinate, Rheinland, Taunus and Volksberg	10, 11
	Air force	Wiesbaden	HQ US Air Force, Europe	Lindsey air station; US Air Force Europe commands 21 fighter squadrons, 5 tactical reconnaissance squadrons and 2 transport squadrons, based in the UK, Spain and Turkey	11, 19, 26, 29
			Support and weather base	Wiesbaden air base	10, 11, 19
		Bitburg	Tactical fighter base		10, 11, 19
		Erding	Fighter-interceptor base		10, 19
		Frankfurt	Tactical airlift base	Rhein-Main air base	10, 11, 19
		Hahn	Tactical fighter base		10, 11, 19
		Kaiserslautern	Support base	Sembach air base	10, 11, 19
		Landstuhl	HQ 17th Air Force	Ramstein air base; also a communications base until 1970	10, 11, 19
		Spangdahlem	Tactical fighter base		10, 11, 19
		Stuttgart	Air base	Echterdingen air base	11
		Zwerburchen	Air base	Zwerburchen air base	11
Greece	*Total: 3 000 navy and air force*			*Under NATO agreement*	22, 25, 31

Host country (territory)	Forces	Place	Function	Comments	Sources
	Navy	Souda Bay, Crete	Naval base	Also for NATO use. Following a bilateral agreement in January 1972, another US naval base will be established in Piraeus. Base will reportedly be home base for 6 destroyers and possibly 1 aircraft carrier plus support ships from US 6th fleet. About 6 500 US naval personnel said to be involved	17, 38
		Nea Makri	Naval communications station	Located near Athens at Marathon Bay	7, 11
	Air force	Athens	Support base	Athens airport; another support base at Iraklion	7, 11, 19
Iceland	*Total: about 3 700 navy and air force*			*Under NATO agreement*	33, 37
	Navy	Keflavik	Naval air station	Can also be used as fighter-interceptor base	11, 19
Italy	*Total: 10 000 all services*			*Under NATO agreement* (6th fleet under US command)	5, 22, 25
	Army	Vincenza and Livorno	Task force	Including HQ elements and 1 SSM-battalion	11, 15
	Navy	Naples	Naval base; naval air facility	US Navy Europe (6th fleet)	10, 19
		Sigonella, Sicily	Naval air facility	Anti-submarine warfare aircraft base	10, 21
	Air force	Aviano	Air base	Tactical group	10, 11, 19
		Udine	Air base	Tactical group	10
Netherlands	*Total: >1 000*			*Under NATO agreement*	10, 11
	Air force	Soesterberg	Fighter-interceptor base	Camp New Amsterdam	10, 11
Spain	*Total: 9 000 navy and air force*			*Under bilateral US-Spanish agreement, 6 Aug. 1970*	20, 22, 25
	Navy	Rota (near Cadiz)	Naval base; naval air station; naval communications station	Operating base for 9–11 Polaris submarines. Supports Navy's airborne anti-submarine and electronic surveillance. Naval air detachment	3, 11, 18, 24
	Air force	Torrejón De Ardoz (near Madrid)	Tactical fighter base	HQ 16th US Air Force	3, 19, 20
		Zaragoza	Tactical fighter training base	Reduced in 1966; reactivated in March 1970 for gunnery training of air force units, which previously trained at Wheelus, Libya. No aircraft permanently assigned	19, 20
		Morón (near Sevilla)	Reserve air base	Reduced to standby as of 30 June 1970. No aircraft permanently assigned	3, 19, 20
		Near Elizondo and on the Balearic Islands	Missile sites		39

Host country (territory)	Forces	Place	Function	Comments	Sources
Turkey	*Total: 7 000 air force*			*Under NATO agreement* Total number of US facilities in Turkey: 27 detachments and locations	7, 22, 25, 37
	Air force	Ankara	Air station	US Logistics Group, Turkey	7, 10, 11, 19
		Incirlick	Tactical fighter base		7, 10, 11, 19
		Karamursel	Communications station	Support base. Other support bases reported at Diyarbakir and Samsun	10, 11
United Kingdom	*Total: 20 000 navy and air force*			*Under NATO agreement*	22, 25, 31
	Navy	Holy Loch, Scotland	Naval base	Operating base for Polaris submarines	10, 18
		Greenock, Scotland	Naval activity	Including support activities, e.g., in Mildenhall	10, 11, 19
		Edzell, Scotland	Communications station		11
		Londonderry, Ireland	Naval communications station		11
	Air force	Alcombury	Tactical reconnaissance base		10, 11, 19
		Chicksands	Support base	Another 5 support bases have been reported, at least one with standby status (Croughton, Greenham-Common, Sculthorpe, High Wycombe, West Ruislip)	10, 11, 19
		Lakenheath	Tactical fighter base		10, 11, 19
		Mildenhall	Tactical airlift base		10, 11, 19
		South Ruislip	Air station: HQ 3rd US Air Force	Also communications base	10, 11, 19
		Upper Heyford	Tactical fighter base		10, 11, 19
		Wethersfield	Support base	Tactical fighter base until 1970	10, 11, 19
		Welford	Air base		11
		Woodbridge	Tactical fighter base	In Bentwaters	10, 11, 19
		Fylingdales Moor	Aerospace defence base	Part of Ballistic Missile Early Warning System (BMEWS)	17
Africa, Middle East and Indian Ocean					
Bahrain	Navy	Bahrain Island	Naval facilities	3 warships	26, 36
Chagos Islands (UK territory)	Navy and air force	Diego Garcia	Combined communications, naval and air base	Under joint US–UK construction; scheduled to be operational in 1974	12, 14, 27
Ethiopia	*Total: 1 800 army and navy*			*Under bilateral agreement*	8
	Army	Asmara	Strategic communications base	Kagnew	8, 11, 25
	Navy	Asmara	Naval communications station	Serves naval vessels in the Indian Ocean; airfield facilities	22, 27, 29

Host country (territory)	Forces	Place	Function	Comments	Sources
Iran	*Total: about 1000*		Communications station	Airfield facilities	22, 25, 27
Morocco	*Total: 1700 navy*			*Under bilateral agreement*	
		Kenitra	Naval air station	3 communications stations (2 outlying at Sidi Yahia and Bouknadel) serve US 6th fleet	9, 11, 37
Seychelles (UK territory)		Mahé	[See table 7.3]		14
East Asia and Pacific				*Under ANZUS Treaty*	
Australia	Navy	North West Cape	Communications station	Serves naval vessels, mainly Polaris submarines in the area; commissioned in 1967	14
	Air force	Alice Spring	Ballistic Missile Early Warning System		14
		Woomera	Communications station	Completed end 1970	14
Japan	*Total: 27 000 all services*			*Under bilateral security treaty 1970.* Total number of US military bases and installations in Japan has been reduced from 3 800 in 1952 to 125 in 1970. 9 000 men were withdrawn in 1971 (*inter alia*, Air Force bases Misawa, Yokota and Itazuke to be restituted to Japanese government in 1971)	5, 9, 26
	Army			Deployed, *inter alia*, in Asaka and Sagamihara; HQ Camp Zama, Asaka	5, 11
	Navy	Sasebo	Naval base	Activities previously located at Yokosuka transferred to Sasebo in 1971	5, 18, 26
	Marine corps	Iwakuni	Air station		5
	Air force	Wakkanai	Air station		5, 19, 26
		Fuchu	Air station		5
Johnston Islands (US territory)	Air force		Support base	Pacific Air Force	19
Korea, South (Republic of Korea)	*Total 43 000 mainly army and air force*			*Under bilateral agreement.* About 9 000 withdrawn in 1971	22, 25, 31
	Army			1 division and support elements. Division deployed north of Seoul. Other army deployment areas include Taegu and Pusan. Pusan has a port complex. Activities in Inchon will be definitely closed down in 1972	6, 11

Host country (territory)	Forces	Place	Function	Comments	Sources
		Yongsan, Seoul	HQ US Forces, Korea; HQ 8th US Army; HQ UN Command		6, 11, 19
		Dongduchon-Ni	HQ 2nd Division		6, 11, 19
	Air force	Kunsan	Tactical fighter base		6, 11, 19
		Kwan-Ju	Combat support base		6, 19
		Osan	Tactical fighter base	An air division base and communications base until 1970. Activities from Kimpo, which was restituted to the Korean government during late 1971, transferred to Osan	6, 11, 19
		Suwon	Combat support base		6, 19
		Taegu	Combat support base		6, 19
Marianas (US territory)	*Total: 14 000 navy and air force*				31
	Navy	Guam	Naval station		11
		Agana, Guam	Naval air station		11
		Finaguayac, Guam	Naval communications station		11
	Air force	Agana, Guam	HQ 8th Air Force, Strategic Air Command	Andersen air force base	11, 19
Marshall Islands (US territory)	Navy and air force	Majuro	Some functions previously located on the Ryukyus (Okinawa)	Allegedly under construction	23
Midway Island (US territory)	Navy	Midway	Naval station		11
Philippines	*Total: 18 000 navy and air force*			*Under bilateral defence agreement; around 2 000 withdrawn in 1971*	22, 25, 31
	Navy	Subic Bay	Naval station	HQ US Naval Forces, Philippines. Since the closure of Sangley Point base on 31 Aug. 1971, this base carries all main naval base functions in the area	1, 11, 18
		San Miguel	Naval communications station		1, 11
		Cubi Point	Naval air station		11
	Air force	Angeles	HQ 13th Air Force, Pacific Air Force	Clark air base; also communications base until 1970	1, 11, 19
Ryukyu Islands (including Okinawa)	*Total: 45 000 all services*			Okinawa is the largest of the Ryukyu Islands. The islands have been under US control under the 1951 US-Japanese peace treaty. After new treaty of 1971,	5, 22, 25

Host country (territory)	Forces	Place	Function	Comments	Sources
				out of total of 117 installations, about 20 will be closed in restitution of the Ryukyus to the Japanese government, spring 1972	
	Army	Koza, Naha and Ishikawa	Army deployment areas		5, 11
	Navy	Naha, Schwab	Naval fleet activities		5, 11
	Marine corps	Naha, Schwab, and others	Marine corps main deployment areas	HQ 3rd Marine division (Camp Courtney)	5, 11
		Futema	Marine corps air station		5, 11
	Air force	Koza	Tactical fighter base; strategic operations base	Kadena air base. Naha air base, which used to be a fighter-interceptor base, was transformed into a civilian airport in 1971	5, 11, 19
Taiwan (Republic of China)	*Total: 9 000 mainly air force*			*Under bilateral security agreement*. Only a minor part of the personnel is army and navy	22, 25, 31
	Air force	Pu Tzu Chien	Tactical airlift base	Ching Chuan Kang air base. Combat support base until 1970. Also used by Taiwanese Air Force	4, 11, 19
		Tainan	Support base	Pacific Air Force. Support base at Shu Lin Kou	4, 11, 19
Thailand	*Total: 32 000 army, navy and air force*			6 400 were withdrawn in 1971	22, 25
	Army			Army units are deployed at, *inter alia*, Khon Kaen, Korat and Udorn	2
		Bang Pla	Communications base		2
		Narai	Communications base		2
	Navy	Sattahip	Naval base		2
		U Tapao	Navy patrol plane detachment		2
	Air force	Korat	Tactical fighter base		2, 19
		Nakhon Phanom	Special operations base	Pacific Air Force	2, 19
		U Tapao	Strategic bomber base; combat support base	Commissioned in 1967. More than 50 B-52s and several KC-135s (in-flight refuelling planes) are based at U Tapao. According to reports from Hanoi, Thai troops in Laos are said to be operating from this base in Jan. 1972	2, 19, 32, 34
		Ubon	Tactical fighter base		2, 19
		Udorn	Tactical fighter base; reconnaissance base		2, 19

Host country (territory)	Forces	Place	Function	Comments	Sources
Viet-Nam, South (Republic of Viet-Nam)[a, b]	*Total: 171 000 all services as of 1 Jan. 1972*			172 700 were withdrawn in 1971; around 23 000 were withdrawn in Jan. 1972. The withdrawal of another 70 000 before 1 May 1972 has been announced	22, 35
	Air force	Bien Hoa	Tactical fighter base		19
		Cam Ranh Bay	Tactical base, airlift base and combat support base	Tactical fighter base only, until 1970	19
		Da Nang	Tactical fighter base		19
		Phan Rang	Tactical fighter base		19
		Phu Cat	Tactical fighter base		19
		Tan Son Nhut	HQ 7th US Air Force; Air division base and combat support base	Also rescue and recovery base, Military Airlift Command	19
North and South America, Antarctica					
Antarctica	*Total: 3 000*			Engaged on scientific research. Demilitarized territory according to the 1961 Antarctic Treaty[c]	22, 25
Bermuda (UK territory)	Navy	St. George	Kindley naval air station	USA was granted 99-year lease of sites for bases in 1941. Former air force air-lift base, transferred to Navy on 1 July 1970	11, 19
		Southampton Parish	Naval facility		11
Cuba	*Total: 3 000 navy and marines*				
	Guantánamo Bay		Naval base; naval air station	Established by treaty	11, 15, 18, 22, 25
Canada	*Total: 4 000*			*Under bilateral agreements*	22
	Navy	Argentina, New foundland	Naval facility		11
	Air force	St. Anthony	Air base	Goose Bay air base	11
		Cape DYE	Central station of Distant Early Warning system (DEW)	Stations in Alaska, Northern Canada, Greenland and Iceland	13, 17
Greenland (Denmark)	*Total: 4 000 men, air force*			*Under US-Danish agreement within framework of NATO.* No troops, combat aircraft or missiles deployed on Greenland	13, 22
	Air force	Thule	Air base (Aerospace defence base)	Part of Ballistic Missile Early Warning System (BMEWS)	13, 19
		Søndre Strømfjord	Air base	Part of Distant Early Warning chain (support central to 4 stations across Greenland inland ice). US Air Force detachment	13, 19

Host country (territory)	Forces	Place	Function	Comments	Sources
Panama, Canal Zone (under US control)	*Total: 11 000 army, navy and air force*			*Under bilateral US-Panamanian treaty.* 1 000 were withdrawn during 1971	22, 25, 31
	Army	Balboa and Christobal	Army deployment areas		11
	Navy	Rodman	Naval station		11
		Balboa	Naval communiations station		11
	Air force	Balboa	HQ US Air Force Southern Command	Albrook air base	11, 19
		Balboa	Support base	Howard air base	11, 19
Puerto Rico (US territory)	*Total: 6 000 navy and air force*				22, 25
	Navy	Roosevelt Roads, San Juan	Naval station; naval communications station		11, 18
	Air force	Aguadilla	Support base; Military Airlift Command	Ramey air base; strategic bomber base until 1970	11, 19

[a] Allegations regarding the presence of US forces and bases in the Khmer Republic (Cambodia) and Laos have been reported in the press. It has not been proved that there are US troops in uniform, representing regular armed forces, deployed in these countries at present. On the other hand, the US Air Force evidently takes part in the fighting in both countries, proving that there is a US military involvement. (*Cf.* Thailand (U Tapao).)
[b] Due to the present redeployment and continuous withdrawals, only air bases will be accounted for here.
[c] The 1961 Antarctic Treaty states that "Antarctica shall be used for peaceful purposes only. There shall be prohibited, *inter alia*, any measures of a military nature, such as the establishment of military bases and fortifications, the carrying out of military manoeuvres, as well as the testing of any type of weapons." On the other hand, the "present Treaty shall not prevent the use of military personnel or equipment for scientific research or for any other peaceful purpose."

Sources:

1.–10. *United States Security Agreements and Commitments Abroad*, hearings before the Subcommittee on US Security Agreements and Commitments Abroad of the Committee on Foreign Relations, US Senate, 91st Congress:

1. *The Republic of the Philippines*, Part 1, 1st session, September and October 1969 (Washington, 1969).
2. *Kingdom of Thailand*, Part 3, 1st session, November 1969 (Washington, 1970).
3. *Spain and Portugal*, Part 2, 2nd session, March, April and July 1970 (Washington, 1970).
4. *Republic of China*, Part 4, 2nd session, November 1969 and May 1970 (Washington, 1970).
5. *Japan and Okinawa*, Part 5, 2nd session, January 1970 (Washington, 1970).
6. *Republic of Korea*, Part 6, 2nd session, February 1970 (Washington, 1970).
7. *Greece and Turkey*, Part 7, 2nd session, June 1970 (Washington, 1970).
8. *Ethiopia*, Part 8, 2nd session, June 1970 (Washington, 1970).
9. *Morocco and Libya*, Part 9, 2nd session, July 1970 (Washington, 1970).
10. *US Forces in Europe*, Part 10, 2nd session, May, June and July 1970 (Washington, 1970).

11. *Selected Military Installations or Activities outside The United States*, Office of the Secretary of Defense (Washington, July 1971).
12. *Statement on the Defence Estimates 1965–1971*, presented to Parliament by the Secretary for Defence by Command of Her Majesty (London, annual).
13. *Problemer omkring dansk sikkerhedspolitik*, En redegørelse fra det sagkyndige udvalg under regeringsudvalget vedrørende Danmarks sikkerhedspolitik (Copenhagen, 1970).
14. Institute for Defence Studies and Analyses, *India and World Strategic Environment, Annual Review 1969–70* (New Delhi, 1970).
15. International Institute for Strategic Studies, *The Military Balance 1971–72* (London, 1971).
16. *Jane's Weapons Systems 1969–70* (London, 1969).
17. *Jane's Weapons Systems 1971–72* (London, 1971).
18. V. A. Kovalenko and M. N. Ostroumov, *Spravochnik po inostrannym flotam* (Moscow, 1971).
19. Air Force Association, *Air Force Magazine*, September 1969, May 1970 and May 1971.
20. *International Defense Review* 3, 1970.
21. *International Defense Review*, 4 (5), 1971.
22. *Kurier* (Vienna), 5 January 1972.

23. *Marine Rundschau*, 5, 1971.
24. *Mirovaya Economica y Mezhdunarodnye Otnosheniya*, 9, 1971.
25. *Newsweek*, 31 May 1971.
26. *Revue de Défense Nationale*, May 1971.
27. *Revue de Défense Nationale*, October 1971.
28. *US Naval Institute Proceedings*, 97 (819), May 1971.
29. *US News and World Report*, 62 (25), 19 June 1967.
30. *Wehr und Wirtschaft*, 6, 1971.
31. *Wehrkunde*, 6, 1971.
32. *AFP*, Hanoi, 15 January 1972.
33. *International Herald Tribune*, 15 July 1971; 20 October 1971.
34. *Svenska Dagbladet*, 11 January 1972.
35. *Svenska Dagbladet*, 14 January 1972.
36. *Svenska Dagbladet*, 17 January 1972.
37. *Borba*, 20 January 1972.
38. *International Herald Tribune*, 7 February 1972.
39. *Krasnaya Zvezda*, 14 January 1972.

Table 7.2. Foreign military presence in four areas: the Soviet Union

Figures indicate numbers of men, unless otherwise stated

Host country (territory)	Forces	Place	Function	Comments	Sources
Algeria[a]	Navy	Algiers	Refuelling station		16
		Oran	Refuelling station		16
		Mers El Kebir	Station for potable water and charge of batteries	Existence of Soviet base in Mers El Kebir has been officially denied	1, 2, 16
	Air force	Tamanrasset	Staging post		16
		Laghouat	Reconnaissance base		16
Antarctica			Military personnel	Engaged on scientific research. Demilitarized territory according to 1961 Antarctic Treaty	[See table 7.1, footnote *c*.]
Cuba[a]	Navy	Cienfuegos	Submarine facilities	Sheltered anchorage for a tender that can service the "Yankee"-class submarines in the area	12, 20
Egypt	*Total: 15–20 000*		Instructors and advisers including 6 fighter squadrons and air defence units	*Under Mutual Assistance agreement:* press reports in late 1971 have alleged prospective Soviet withdrawals from Egypt	3
	Navy	Alexandria	Port facilities	Soviet Mediterranean fleet	8
		Port Said	Port facilities	Soviet Mediterranean fleet	8
		Mersa Matruh[a]	Naval base	Under construction for the Egyptian Navy; to be shared by USSR	4
	Air force[a]	Assuan	Airfield	Shared with Egyptian Air Force; Soviet-controlled airfield	4, 6
		Beni Suef	Airfield	Shared with Egyptian Air Force; Soviet-controlled airfield	4, 6
		Cairo West	Airfield	Shared with Egyptian Air Force; Soviet-controlled airfield	4, 6
		El Mansoura	Airfield	Soviet-controlled airfield	4, 6
		Inchas	Airfield	Soviet-controlled airfield	4, 6
		Jiyanklis	Airfield	Soviet-controlled airfield	4, 6
		Mersa Matruh	Airfield	Under construction	4
Europe					
Czechoslovakia	*Total: 85 000 army and air force*			*Under Warsaw Pact agreement*	3, 7
		Milovice	HQ Soviet forces	5 motorized rifle divisions; tactical air force	9, 14
German Democratic Republic	*Total: 330 000 mainly army and air force*			*Under Warsaw Pact agreement*	3, 7
		Wunsdorf, near Berlin	HQ Soviet forces	10 tank divisions; 10 motorized rifle divisions; tactical air force	9, 14
Hungary	*Total: 60 000 army and air force*			*Under Warsaw Pact agreement*	3, 7
		Tokol, near Budapest	HQ Soviet forces	2 tank divisions; 2 motorized rifle divisions; tactical air force	9, 14

Host country (territory)	Forces	Place	Function	Comments	Sources
Poland	*Total: 45 000 all services*			*Under Warsaw Pact agreement*	3, 7
		Legnica	HQ Soviet forces	2 tank divisions; tactical air force	9, 14
		Swinoujscie	Harbour facilities	Units from the Baltic fleet; shared with the Polish navy	10
Indian Ocean[a,b]					
(Maldives)[c]	Navy	In the vicinity of the islands	Anchorages	In general, 2–8 warships (excl. support ships) in the area [see table 7.10]. The number was increased late 1971 due to Indo-Pakistani War	4
(Mauritius)[c]	Navy	In the vicinity of the islands	Anchorages		2, 4, 5
Mauritius	Navy	Port Louis	Port facilities for some trawlers; air port facilities for some aircraft	Since March 1968. Under bilateral agreement	18, 19
(Seychelles)[c]	Navy	In the vicinity of the islands	Anchorages		
Tanzania	Navy	Zanzibar	Port facilities	In general, 20–30 warships (excluding support ships) in the area. [See table 7.10.]	11
Mediterranean					
(Anchorages only)[c]	Navy	Hammamet Bay, East of Tunis	Anchorages		13
		East of Sicily	Anchorages		13
		Near Malta	Anchorages		13
		Alborran, East of Gibraltar	Anchorages		13
		Gulf of Sirte, off Libya	Anchorages		13
		Off Kithara island in the Aegean (both East and West of Crete)	Anchorages		13
People's Republic of Mongolia	*Total: probably about 45 000 army and air force*[a]			*Under Mutual Assistance Treaty*	
			2 army divisions; missile units	In a statement by Prime Minister Chou En-lai before Americans in Peking on 5 October 1971, it was alleged that the USSR had stationed 300 000 troops in the People's Republic of Mongolia	3, 17
Somalia[a]	Navy	Berbera	Port facilities		4, 21
	Navy	Mogadishu	Port and dockyard facilities		21
Southern Yemen[a]	Navy	Aden	Port facilities	Rumours concerning base on Socotra Island have been officially denied (through demonstration there)	4, 21
Syria[a]	Navy	Latakia	Port facilities		8
Yemen[a]	Navy	Hodeida	Port facilities		4, 21

[a] Not officially confirmed by the Soviet Union.
[b] Frequent rumours of other alleged Soviet base facilities in the area have been reported. Allegations concerning the port Trincomalee on Ceylon have been officially denied, as well as those concerning Indian and Pakistani ports (e.g., Moragao, previously Portuguese Goa, where the Soviets are building a submarine base. India is said to have offered the Soviet Union to share the port facilities due to an old agreement.) (Source 10.) "Rumours of bases [Soviet bases in the Indian Ocean] have been abundant but detailed examination deprives all of substance. Soviet squadrons visiting the Indian Ocean take their own supply ships with them, and their use of local facilities has in all cases been minimal." (Source 15.) As the Soviet fleets are mainly supplied at sea and use local bases to a much lesser extent than US, British or French naval forces, their common anchorages seem to be the nearest counterpart to deployment on bases, though a direct comparison is, of course, not completely accurate. It must be borne in mind that these anchorages are in international waters.
[c] These anchorages are located in international waters, outside the territorial waters of the respective islands.

Sources:

1. *United States Security Agreements and Commitments Abroad, Ethiopia*, Part 8, hearings before the Subcommittee on United States Security Agreements and Commitments Abroad of the Committee on Foreign Relations, US Senate, 91st Congress, 2nd session, June 1970 (Washington, 1970).
2. Assembly of Western European Union, Sixteenth Ordinary Session (Second Part), *European Security and Arms Control*, Report (van der Stoel), Document 527, 1971.
3. International Institute for Strategic Studies, *The Military Balance 1971–72* (London, 1971).
4. International Institute for Strategic Studies, *Strategic Survey 1970* (London, 1971).
5. Institute for Defence Studies and Analyses, *India in World Strategic Environment*, Annual Review 1969–70 (New Delhi, 1970).
6. *Flight International*, 25 June 1970.
7. *NATO Announcement*, 1 September 1971.
8. NATO Information Service, *NATO Letter*, January 1969.
9. *Newsweek*, 31 May 1971.
10. Presse- und Informationsdienst der Bundesregierung, Bonn, *Stichworte Zur Wehr- und Sicherheitspolitik*, 5, 1971.
11. *Revue de Défense Nationale*, October 1971.
12. *Time*, 20 December 1970.
13. *US Naval Institute Proceedings*, 93 (769), March 1967.
14. *US Naval Institute Proceedings*, 97 (819), May 1971.
15. "*The Soviet Union and the Indian Ocean*," *World Review* (Australia), July 1971. Reprint in *Survival* 13 (11), November 1971.
16. *Daily Telegraph*, 4 April 1969.
17. *International Herald Tribune*, 7 October 1971.
18. *Le Figaro*, 19 February 1971.
19. *Le Monde*, 26 August 1970.
20. *New York Times*, 4 October 1970.
21. *New York Times*, 13 November 1970.

Table 7.3. Foreign military presence: the United Kingdom

Figures indicate numbers of men, unless otherwise stated

Host country (territory)	Forces	Place	Function	Comments	Sources
Australia	Air force	Darwin	Australian air base	*Under bilateral agreement.* British have right to use facilities at the base	6
Berlin	Army	West Berlin	1 brigade (3 000)		5
	Air force	Gatow	Air base		3
Caribbean	*Army: about 250*	Guyana (independent, former British Guyana) and British Honduras (UK territory)	Garrisons in the territories mentioned	*Guyana: Under bilateral UK-Guyana defence agreement.* 1 company group (British Honduras). An engineer detachment in Anguilla withdrawn by Sept. 1971.	1, 5
	Navy, marine corps, and air force			2 escorts. One of them carries a small detachment of Royal Marine Corps. The ships supplemented by reconnaissance flights by Air Support Command.	10
Chagos Islands (UK territory)	Navy and air force	Diego Garcia	Combined base (naval refuelling station, air force reconnaissance base, communications base)	Under joint construction with the USA; scheduled to be operational in 1974	1, 6, 12
Cocos Islands (Australian territory)	Air force		Airport facilities	The islands have been taken over by Australia but UK has retained right to use facilities; some construction in common with USA	9, 12
Cyprus	*Total: about 2 000 (exclusive of UNFICYP forces)*			*Under multilateral treaty 1960*	1
	Army	Dhekelia		1 battalion; 1 armoured car squadron	1, 5
	Navy		Port facilities		17
	Air force	Akrotiri	Air base	2 squadrons. Military satellite communications station[a]	1, 5, 6
Falkland Islands (UK territory)	Navy and marine corps	Port Stanley		HMS Endurance; 1 unit with Hovercraft; 1 small detachment Royal Marine Corps	1, 10
FR Germany	*Total: 63 500 army and air force*			*Under NATO agreement*	5
	Army: 54 900	Mönchen-Gladbach	HQ British Army on Rhine (BAOR)	BAOR contains 3 divisions HQ, 6 brigades (one of which in England), 2 armoured car regiments, 2 artillery brigades and 1 Thunderbird SAM regiment	5, 7
		Detmold, Iserlohn, Minden, Osnabrück, Soltau	Deployment areas for one brigade each		7
	Air force: 8 600		About 14 squadrons		3, 5

Host country (territory)	Forces	Place	Function	Comments	Sources
		Bruggen	Air base		3
		Guttersloh	Air base		3
		Laarbruch	Air base		3
		Wildenrath	Air base		3
Gibraltar (UK territory)	*Total: >1000*				
	Army		Garrison	1 battalion group (infantry, artillery engineers)	1, 5
	Navy		Naval base		1
	Marine corps		Special boat detachment	1 frigate	1
	Air force		Combat and reconnaissance base		1
Hong Kong (UK territory)	*Total: about 6 000*				5
	Army		Garrison	5 infantry battalions; 1 artillery regiment	1
	Navy and marine corps		Naval base	1 frigate; patrol vessels and minesweepers	1, 8
	Air force		Support combat base	Whirlwind helicopters	1
Malagasy	Navy and air force	Mozambique Channel	On the Beira patrol	Control of imports of oil to Rhodesia (since 1966)	5
	Navy	Majunga		2 escort/frigates and 1 tanker (Beira patrol)	18
	Air force			1 detachment with 2 maritime reconnaissance aircraft (Beira patrol)	5
Maldives	Navy	Addu	Harbour facilities	*Bilateral agreement 1965.* Natural harbour	1, 6, 12
	700–800 Air force	Gan	Air base	Will be kept even after 1971	1, 2, 6, 14
		Hittavu	Communications base	Military satellite communications station[a]	1, 6, 12
Malta	*Total: 3 500*			The status of British forces on Malta is pending current negotiations between governments concerned. Base may be rented even in the future. Preparations for complete British withdrawal have been made	5, 17
	Army		Garrison	Around 1 battalion (possibly partly relieved by 1 commando Royal Marine Corps, supported by a light battery and an engineer unit)	1, 13
	Navy	Valetta	Naval base	Shared with NATO. 1 guided missile destroyer and 2 escorts, operating in the Mediterranean, have usually been based on Malta	1, 19
	Air force	Luqa and Hal Far	Combat support and reconnaissance bases	Shared with NATO. 2 squadrons	1, 19
Mauritius	Navy		Communications base; small troop detachment	*Under bilateral defence agreement*	1, 15
	Air force	Vacoas	Airport facilities		1

Host country (territory)	Forces	Place	Function	Comments	Sources
Oman		Masirah Island (20 km. off the Oman coast)	Air force base	Only country on Persian Gulf where British maintain military presence after 1971. Installations in Bahrain, Abu Dhabi and Sharjah reported to be dismantled at end 1971	11
Seychelles (UK territory)	Navy and air force	Mahé	Harbour facilities		9, 12
			Airport facilities	Civilian airport. The USA has a small installation (a satellite-tracking and telemetry station) on the Seychelles	6
Singapore and Malaysia; Brunei[b] (UK territory)	*Total: 4 500 Army: about 2 000; Navy: 1 500*			*Under multilateral defence agreement (UK-Australia-New Zealand-Singapore-Malaysia)*	16
	Army	Singapore	1 battalion		5
		Brunei	1 battalion (Gurkhas)	Naval dockyard transferred to the Singapore government by Dec. 1968	1, 8
	Navy	Singapore	Naval base	East of Suez will be deployed: 6 escorts, 1–2 submarines, support ships (will include ships on Beira patrol)	
	Air force		Air base facilities	Nimrod aircraft and Whirlwind helicopters. Also military satellite communications station[a]	1, 6

[a] The British military satellite communications system is code-named Skynet and consists of (*a*) a communications relay spacecraft stationed 23 000 miles above the Equator over the Indian Ocean, and (*b*) nine earth stations, two of these shipborne and two smaller transportable stations operated by the Army. (Fixed stations are located in Cyprus, Gan and Singapore, and possibly Masirah Island (previously on Bahrain). The central RAF control base is located at Oakhanger in Southern England.)
[b] Included here because of geographical position only.

Sources:

1. *Statement on the Defence Estimates 1965–1972*, presented to Parliament by the Secretary for Defence by Command of Her Majesty (London, annual).
2. *White Papers on the Defence 1971–72* (London, 1971), quoted in *Revue de Défense Nationale*, May 1971.
3. *Statements by the Ministry of Defence* (London, 1971).
4. *Treaty concerning the Establishment of the Republic of Cyprus*, Annex 2, Nicosia, 16 August 1960.
5. International Institute for Strategic Studies, *The Military Balance 1971–72* (London, 1971).
6. Institute for Defence Studies and Analyses, *India in World Strategic Environment*, Annual Review 1969–70 (New Delhi, 1970).
7. *Jane's Weapons Systems 1969–70* (London, 1969).
8. Kovalenko, V. A., Ostroumov, M. N., *Spravochnik po inostrannym flotam* (Moscow, 1971).
9. *Norsk Militært Tidsskrift* 10, 1971.
10. *Revue de Défense Nationale*, March 1971.
11. *Revue de Défense Nationale*, April 1971.
12. *Revue de Défense Nationale*, October 1971.
13. *Wehrkunde* 6, 1971.
14. *Times*, 9 February 1970.
15. *Times*, 13 March 1971.
16. *Times*, 27 March 1971.
17. *Borba*, 20 January 1972.
18. *Vaart Foersvar* 3, 1970.
19. *International Herald Tribune*, 1 and 2 January 1972.

Table 7.4. Foreign military presence: France

Figures indicate numbers of men, unless otherwise stated

Host country (territory)	Forces	Place	Function	Comments	Sources
Afars and Issas, French territory (former French Somaliland)	*Total: 3 800 all services*				1, 2, 8
	Army		Garrison	2 battalions	2
	Navy	Djibouti	Port facilities		4, 7
	Air force		Airfield	2 air force squadrons	2
Berlin	Army	West Berlin	1 brigade (1 700)		3
Cameroun	*Total: about 70*	Douala	Transit detachment	*Under bilateral agreement*	5
Caribbean[a] (French departments)	Army			1 battalion	2
Central African Republic	*Total: 130 air force*	Bangui	Airport	*Under bilateral defence pact*	5
Chad	*Total: 1300 army and air force*			*Under bilateral defence pact*	2, 5
		Fort Lamy	Air field	1 regimental group (600); 6 transport aircraft and 10 helicopters (700 men)	2, 5
FR Germany	*Total: 50 000*			*Formerly under NATO Command.* Still deployed in Germany under special agreement.	3, 6
	Army	Baden-Baden	HQ 2nd Corps		3, 6
		Trier		1 mechanized division	3
		Freiburg		1 mechanized division	3
Gabon	*Total: 200*			*Under bilateral defence pact.* 1 parachute company	2
Ivory Coast	*Total: about 400, all army*	Port Bouet		*Under multilateral defence pact (France, Niger, Dahomey, Ivory Coast).* 1 regimental group	2, 5
Malagasy	*Total: 2 500*			*Under bilateral agreement*	
	Army 1250			2 regiments	2
	Navy 450	Diego Suarez	Naval base	1 frigate and 2 minesweepers on patrol between Diego Suarez and Djibouti	2, 4, 7, 8
	Air force 800	Ivato (close to Tananarive)	Military installations at the airport of Ivato	1 attack squadron; 6 transport aircraft	2, 7
Niger	*Total: about 300, all army*			*Under multilateral defence pact (France, Niger, Dahomey, Ivory Coast)*	2, 5
		Niamey	Garrison	1 armoured car squadron	2, 5
Pacific (French territories)	About 2 000			2 battalions	2
		Papeete (French Polynesia)	Port facilities		4
		Noumea (New Caledonia)	Port facilities		4

Host country (territory)	Forces	Place	Function	Comments	Sources
Réunion[a] (French department)			Air and communications base		7
Senegal	*Total: 2 000*	Dakar		*Under bilateral defence pact*	2, 5
	Army 1200			1 regimental group	2
	Navy 500	Dakar	Port facilities	2 escorts	2, 4
	Air force 300		Airfield	6 transports	2

[a] Réunion and the Caribbean islands are departments of France and are listed here only to give a better picture of the deployment of forces in the respective areas.

Sources:

1. *United States Security Agreements and Commitments Abroad, Ethiopia*, Part 8, hearings before the Subcommittee on United States Security Agreements and Commitments Abroad of the Committee on Foreign Relations, US Senate, 91st Congress, 2nd session, June 1970 (Washington, 1970).
2. International Institute for Strategic Studies, *The Military Balance 1971–72* (London, 1971).
3. *Jane's Weapons Systems 1969–70* (London, 1969).
4. Kovalenko, V. A., Ostroumov, M. N., *Spravochnik po inostrannym flotam* (Moscow, 1971).
5. *Jeune Afrique*, 9 February 1971.
6. *Le Monde*, 17 February 1972.
7. *Revue de Défense Nationale*, October 1971.
8. *Le Figaro*, 19 February 1971.

Table 7.5. Foreign military presence: other countries

Deploying country	Host country	Numbers of troops	Comments
Australia	Malaysia and Singapore	Around 1 700	*Under multilateral defence treaty.* 1 army battalion, signal units, 2 air force squadrons
	Papua, New Guinea (Australian territory)	Around 2 000	2 battalions
	Viet-Nam, South (Republic of Viet-Nam)	Withdrawn or under withdrawal	Combat activities ceased at end of 1971. Most of the combat elements have been announced to be repatriated by Christmas 1971
Belgium	FR Germany	15 000	*Under NATO Command.* 2 divisions of 2 mechanized brigades each around Cologne and Kassel
Canada	FR Germany	5 000	*Under NATO Command.* 1 mechanized brigade Dortmund (2 800 men). 3 air force squadrons
Egypt	Sudan	200	Air force elements
Greece	Cyprus	950	*Multilateral treaty 1960*
Guinea	Sierra Leone	200	All army
India	Bangladesh	150 000 by mid-Dec. 1971; reduced to 50 000 by Jan. 1972	Following the Indo-Pakistani War in 1971
Israel	Egypt Jordan Syria		Occupied areas since June War 1967
Korea, South (Republic of Korea)	Viet-Nam, South (Republic of Viet-Nam)	50 000	10 000 have been announced to be withdrawn in 1972
Kuwait	Egypt	1 500	All army
Netherlands	FR Germany	5 000	*Under NATO Command.* 1 armoured brigade, Seedorf
New Zealand	Singapore	1 000	*Under multilateral defence treaty.* 1 infantry battalion (reduced). 1 air force transport squadron
	Viet-Nam, South (Republic of Viet-Nam)	Withdrawn or under withdrawal	Combat activities ceased at end of 1971
Portugal	Guinea (Bissau) Angola Mozambique (Portuguese territories)	25 000 60 000 45 000	
Saudi Arabia	Jordan	1 000	All army
	Egypt	2 000	All army
Spain	Ceuta Melilla Spanish Sahara (Spanish territories)	8 000 9 000 10 000	
Sudan	Egypt	2 000	
Thailand	Khmer Republic	Varying	
	Laos	Varying	
	Viet-Nam, South (Republic of Viet-Nam)	11 000	To be withdrawn during 1972

Deploying country	Host country	Numbers of troops	Comments
Turkey	Cyprus	650	*Multilateral treaty 1960*
Viet-Nam, North (Democratic Republic of Viet-Nam)	Viet-Nam, South Laos Khmer Republic	According to some estimates around 200 000	The figure probably varies from time to time
Viet-Nam, South (Republic of Viet-Nam)	Khmer Republic Laos	According to some estimates around 23 000	The strength of forces varies from time to time due to different offensive operations on part of South Viet-Nam and may at times exceed the above figure

Restrictions:

1. The United Nations Forces in Cyprus (UNFICYP) comprise about 3 000 men (approximately 1 000 British, 500 Canadian, 400 Danish, 400 Irish, 300 Swedish and some medical personnel from Austria).
2. Iraq has allegedly announced that it will redeploy its brigade in Jordan which was withdrawn during the fighting between the Jordanian army and the Palestinian guerillas. The announcement was made in December 1971. No date was set for this redeployment.

Sources:

Treaty concerning the Establishment of the Republic of Cyprus, Annex 2, Nicosia, 16 August 1960.
Treaty of Alliance (Greece-Turkey-Cyprus), Additional Protocol, Nicosia, 16 August 1960.
International Institute for Strategic Studies, *The Military Balance 1971–72* (London, 1971).
Jane's Weapons Systems 1969–70 (London, 1969).
Current Notes on International Affairs, Department of Foreign Affairs, Canberra, August 1971.
Wehr und Wirtschaft 10, 1971.
International Herald Tribune, 7 October 1971.
Svenska Dagbladet, 13 February 1972.

Table 7.6. Numbers of US armed forces deployed abroad, general

Numbers of men

	Shore-based		Afloat	
Date	Outlying US areas[a]	Foreign countries and areas	Foreign countries and areas	Total, shore-based and afloat
1960	25 000	532 000	103 000	**660 000**
1965	30 000	704 000	146 000	**880 000**
1967	34 000	1 021 000	146 000	**1 201 000**
1968 30 June	41 054	1 083 168	116 588	**1 204 810**
31 December	42 060	1 068 083	103 352	**1 204 376**
1969 30 June	40 556	1 060 682	94 233	**1 195 471**
31 December	40 635	996 028	92 410	**1 129 073**
1970 30 June	37 078	912 523	120 097	**1 069 698**
31 December	37 136	820 319	67 249	**924 704**
1971 30 June	30 791	721 286	82 615	**834 692**

[a] Consist primarily of Guam, Panama Canal Zone and Puerto Rico.
Sources: US Department of Defense, Directorate for Information Operations, *Selected Manpower Statistics* (Washington, annual).

Table 7.7. Numbers of US armed forces deployed in Europe and South East Asia (excl. South Viet-Nam)

Numbers of men

	1965	1966	1967	1968	1969	1970	1971	1972
Europe								
Belgium	500	500	1 000	1 000	1 000	1 000	1 000	2 000
FR Germany	270 000	270 000	270 000	230 000	228 000	220 000	215 000	215 000
Greece	4 200	3 500	3 500	3 100	3 300	3 200	3 000	3 000
Italy	12 000	12 000	10 000	10 000	10 000	10 000	10 000	10 000
Spain	14 000	12 300	12 300	12 300	10 000	9 000	9 000	9 000
Turkey	12 000	10 000	10 000	10 000	9 000	7 000	7 000	7 000
United Kingdom	30 000	25 000	25 000	25 000	25 000	20 000	20 000	20 000
South East Asia								
Japan	37 000	38 500	38 500	40 000	43 000	39 000	36 000	27 000
Korea, South	60 000	60 000	55 000	55 000[a]	55 000	52 000	52 000	43 000
Okinawa	59 000	62 000	62 000	55 000	45 000	52 500	35 000	45 000
Philippines	32 000	35 000	35 000	29 000	28 500	20 000	20 000	18 000
Taiwan	13 000	16 000	16 000	16 000	10 000	9 000	9 000	9 000
Thailand	13 500	33 000	43 500	45 000	45 000	38 500	38 400	32 000

[a] During the "Pueblo crisis", US forces in South Korea were strengthened by about 5 000 men attached temporarily to the existing units.

Table 7.8. Numbers of US armed forces deployed in South Viet-Nam

Numbers of men

Date		Army	Navy	Air Force	Marine Corps	Coast Guard	Total
1960		800	15	68	2	—	**885**
1961		2 100	100	1 000	5	—	**3 205**
1962		7 900	500	2 400	500	—	**11 300**
1963		10 100	800	4 600	800	—	**16 300**
1964		14 700	1 100	6 600	900	—	**23 300**
1965	30 June	27 300	3 800	10 700	18 100	—	**59 900**
	31 December	116 800	8 400	20 600	38 200	300	**184 300**
1966	30 June	160 000	17 000	36 400	53 700	400	**267 500**
	31 December	239 400	23 300	52 900	69 200	500	**385 300**
1967	30 June	285 700	28 500	55 700	78 400	500	**448 800**
	31 December	319 500	31 700	55 900	78 000	500	**485 600**
1968	30 June	354 300	35 600	60 700	83 600	500	**534 700**
	31 December	359 800	36 100	58 400	81 400	400	**536 100**
1969	30 April	363 300	36 500	61 400	81 800	400	**543 400**
	30 June	360 500	35 800	60 500	81 500	400	**538 700**
	31 December	331 100	30 200	58 400	55 100	400	**475 200**
1970	30 June	298 600	25 700	50 500	39 900	200	**414 900**
	31 December	249 600	16 700	43 100	25 100	100	**344 600**
1971	30 June	190 500	10 700	37 400	500	100	**239 200**
	30 September	166 800	10 000	35 200	500	100	**212 600**
	31 December	119 700	7 800	28 900	500	100	**157 000**
1972	1 May[a]	48 000	4 500	16 000	—	—	**68 500**

[a] Projected number announced by US officials on 13 January 1972.

Source: US Department of Defense, Directorate for Information Operations, *Selected Manpower Statistics*, (Washington, 15 April 1971). *International Herald Tribune*, 4 January 1972; 14 January 1972.

Table 7.9. Numbers of British armed forces abroad (including non-British personnel locally enlisted)

Numbers of men

Region	Service	1965	1966	1967	1968	1969	1970	1971	Comments
Europe	Navy	7	60	20	20	160	200	200	FR Germany,
Continental	Army	56 110	55 700	56 630	52 960	53 120	53 700	54 900	West Berlin
	Air force	8 680	7 700	7 100	6 630	6 920	8 600	8 600	
	Total	64 797	63 460	63 750	59 610	60 200	62 500	63 700	
Mediterranean	Navy	2 200	2 100	1 850	1 730	1 330	1 900[b]	..	Gibraltar, Malta,
	Army	10 100	9 300	8 850	7 980	7 780	10 400[b]	..	Cyprus, Libya
	Air force	9 850	8 900	7 800	7 770	8 500	11 000[b]	..	
	Total	22 150	20 300	18 500	17 480	17 610	23 300[a]	6 500	
Middle East	Navy	1 450	1 250	300	290			..	Bahrain, Sharjah,
	Army	17 450	12 200	4 700	5 320			..	Masirah, Aden,
	Air force	7 950	7 400	3 400	3 400			..	Mauritius
	Total	26 850	20 850	8 400	9 010			3 500	
Far East	Navy	4 250	4 400	5 000	4 540	4 260[a]	3 600	..	Gan, Singapore,
	Army	39 500	37 300	33 500	29 690	30 320[a]	19 200	..	Malaysia, Brunei,
	Air force	10 300	10 100	9 500	8 320	10 170[a]	5 500	..	Hong Kong
	Total	54 050	51 800	48 000	42 550	44 750[a]	28 300	13 500	
Caribbean	Navy	5	30	30	30				Bahama, British
	Army	1 430	250	250	240				Honduras, British
	Air force	40	—	—	—				Guyana
	Total	1 475	280	280	270			250	
Miscellaneous	Navy	630	510	400	330	670	700	..	
	Army	1 030	1 400	4 200	460	4 250	3 200	..	
	Air force	4 700	3 900	2 700	2 610	1 350	1 200	..	
	Total	6 362	5 810	7 300	3 400	6 270	5 100		
Navy at sea	Mediterranean	2 680	1 460	500	900	{ 760	{ 1 400	..	
	Persian Gulf	3 890	2 050	730	600			..	
	Far East	9 550	10 650	13 900	9 180	6 510	5 700	..	
	Australia	170	150	130	60				
	Caribbean	670	760	220	470				
	Miscellaneous	370	370	750	390	720	600	..	
	Total	17 330	15 440	16 230	11 600	6 990	7 700		
	Grand total	**193 014**	**178 340**	**162 460**	**146 920**	**135 820**	**126 900**		

[a] The figures refer to both areas: the Far East and the Middle East.
[b] The figures refer to both areas: the Mediterranean and the Middle East.

Source: Statement on the Defence Estimates 1965–1971 (for each year), presented to Parliament by Secretary of State for Defence by Command of Her Majesty, (London, annual).

Table 7.10. Typical strengths (approximate figures) of foreign fleets in three areas: USA, USSR, UK and France

Numbers of naval vessels

	Deploying country			
Area	USA	USSR	UK	France
Mediterranean	3 carriers (all types) 30 major surface warships 10 submarines (6th fleet)	0–2 helicopter carriers 10–20 major surface warships 8–10 submarines	3 major surface warships (1 destroyer, 2 escorts) Periodically reinforced	Home-based units
Indian Ocean	3 major surface warships (Bahrain)[a] 1–2 submarines[b]	1–6 major surface warships[a] 1–2 submarines[b]	*Mozambique Channel:* 2 major surface warships[c] *East of Suez:* 6 major surface warships 1–2 submarines	1 major surface warship (2 minesweepers) (Diego Suarez-Djibouti) —
West Pacific	5 carriers (all types) 80 major surface warships 30 submarines (7th fleet) (Additional coastal fleet in Viet-Nam)	Home-based units		

[a] Due to the Indo-Pakistani War in December 1971, both the USA and USSR have considerably increased their naval presences in the Indian Ocean by at least about 10 warships each. Nothing is said about the duration of this reinforcement. The US ships have been deployed from the 7th fleet, the Soviet ships probably from their Pacific fleet.
[b] Official information on submarines permanently assigned to the area is lacking.
[c] Will be included in the East of Suez force.

Source: SIPRI worksheets.

Map 2. Deployment of NATO and Warsaw Pact combat aircraft and armoured and infantry division equivalents in Europe (Insert: deployment of US, Soviet, British and French troops in Central Europe)[a]

[a] In addition, the following countries deploy troops in West Germany: Belgium: 1 1/3 mechanized division; Canada: 1/3 mechanized division; Netherlands: 1/3 armoured division.

Map 3. Soviet naval visits, 1962–1964[a]

SWEDISH NATIONAL MAP AND PRINTING ORGANIZATION

[a] Naval presence during the Cuba crisis not accounted for.

18 – 713385 SIPRI Yearbook 1972

Map 4. Soviet naval visits, 1965–1967[a]

[a] Several warships were stationed in Egypt from 1967 on (Alexandria, Port Said) and Syria (Latakia) due to the political and military situation in this area. This naval presence has been continued since 1967; it is not included in the maps.

Map 5. Soviet naval visits, 1968–1970[a]

SWEDISH NATIONAL MAP AND PRINTING ORGANIZATION

[a] See note *a* to map 4.

Sources of maps 3, 4 and 5: Marine Rundschau, No. 5, 1969; Nos. 1 and 8, 1970; and No. 4, 1971. *US Naval Institute Proceedings*, 97 (819), May 1971.

8. The economic and social consequences of military expenditure: comments on the UN report

In October 1971 the United Nations Secretary-General presented a report on the economic and social consequences of military expenditure to the General Assembly. This followed a suggestion which he had made in May 1970; it was carried further at the twenty-fifth session of the General Assembly on the initiative of Romania; and that Assembly adopted a resolution[1] *which, amongst other things, asked the Secretary-General to prepare a report on this subject with the assistance of qualified experts. The report which he presented was prepared and unanimously adopted by a panel of fourteen experts, which held three sessions between February and September 1971. The report is summarized below and then commented on.*

I. *The facts*

World military expenditure in 1970 amounted, roughly, to $200 billion.[2] This was, at constant prices, a rise of the order of $50 billion, or a third, since the beginning of the decade. To indicate an order of magnitude, $200 billion is roughly what the governments of the world spend on health and education.

So large an expenditure on military preparations in a period of comparative peace is a new phenomenon. In the period before World War I, for example, 3–3 $^1/_2$ per cent of world national output went to military spending. The figure is now 6–6 $^1/_2$ per cent of an enormously increased output, so that in real terms military spending has risen at least twenty-fold in the last fifty years.

The postwar trend has been jerky; world military spending has tended to go up sharply in times of crisis, level off, and then rise again. It has rarely fallen. It has been rising rather more slowly in the 1960s than in the 1950s.

Six nations account for the bulk—80 per cent— of world military spending, and so largely determine the world trend.

[1] UN General Assembly Resolution 2667(xxv).
[2] The reason for the difference between this estimate and SIPRI military expenditure figures is explained on page 61.

The developing countries account for 7 per cent of the world total. However, their expenditure has been rising faster than in the developed countries in the last decade. This is largely accounted for by the countries in the Middle East and Far East; and the conflicts there have not, of course, been independent of the confrontation between the great powers.

Other measures of the arms race—such as numbers in the armed forces, total manpower (estimated at about 50 million people throughout the world) engaged directly or indirectly for military purposes, stocks of weapons, or total stocks of lethal power—are not so useful as expenditure estimates for a study of economic and social consequences.

There are particular ways in which the 'share of national product' measure understates the impact of military spending. First, military uses absorb a disproportionately large amount of scientific and technological ability in military research and development. (The report roughly estimates that military research and development probably absorbs some $25 billion of an estimated world total research and development expenditure of some $60 billion.) Secondly, high levels of skills are needed for the operation and maintenance of sophisticated weapons. Thirdly, military expenditure is a charge on government revenue, and therefore sets a particular constraint on government social expenditure. Fourthly, military spending has been a disturbing factor in the world balance of payments.

Although the figures of military expenditure may have been rising rather more slowly in the sixties, a study of the weapons development of that period suggests that the technological arms race was accelerating. This technological arms race, which provides the main dynamic behind the upward movement of military expenditure, is carried forward to some extent under its own impetus. It is open-ended; in the absence of political action there is nothing to stop it going on indefinitely. Further, the level of military expenditure is now so high that it can continue even within the bounds of existing budgets. (The report devotes a good deal of space to a description of the technological arms race.)

The national consequences

The cost of the arms race consists of the sacrifice of the alternative uses to which the resources might have been put.

The resources might have been used to accelerate the rate of economic growth, either by being used to increase fixed investment, or to give more resources to 'invest in man'—the improvement of man's knowledge, skill, and organizational ability. The standard methods of calculation suggest that a transfer of resources to these purposes could have made a perceptible difference to growth rates.

There are many other possible claimants. For example, a small part of the resources which went to the military could have transformed the housing situation and abolished slums in many of the developed countries. The new demands for the preservation of the environment could well employ substantially increased resources. Medical research and research into the environment are both possible claimants for the resources employed in military research and development. A rough calculation suggests that all medical research in the world consumes about $4 billion, compared with the $25 billion which the report estimates is now spent on military research and development.[3]

Military expenditure has not only absorbed considerable resources; it has been a destabilizing element in the world economy. It cannot easily be adjusted to the economic situation of the country because it tends to establish a prior claim. In a number of countries and on a number of occasions there have been sharp increases in military spending. These have made the task of economic management very difficult and have frequently set off inflationary spirals.

These destabilizing effects are not only general; because of the rapid rate of obsolescence, military programmes are often suddenly discontinued, causing great disturbance in particular regions and industries and leading to high local figures of unemployment.

The balance-of-payments effects are felt particularly by developing countries, which have to import all the more sophisticated weapons from the industrial countries; this can pre-empt a good part of their earnings of foreign exchange, unless they are prepared to accept military aid (which has strong disadvantages).

The other main balance-of-payments consequence has been the significant contribution of military expenditure abroad first to Britain's balance-of-payments deficit and then to that of the United States.

If world military demand for strategic materials were replaced by civil demand, there would be only very minor consequences for the sales of so-called "strategic" materials.

The one significant benefit claimed for military expenditure is the civil spin-off from military research and development. However, if the same resources were devoted directly to civil problems, a much larger return in

[3] This is a rough estimate only, based on the assumption that all countries devote a certain percentage of their military expenditure to military research and development. A somewhat lower estimate, based on a comprehensive survey of the sources, is discussed on page 149.

usable civil technology could obviously be obtained. Further, military research and development has tended to distort the whole pattern of world research and development, away from the pressing needs of agriculture, population and medicine.

The social consequences of military expenditure are harder to establish categorically. But there is little doubt that the spectacle of a world increasing its already absurd levels of lethal power while neglecting the urgent welfare needs of billions of people has been one factor in the disillusionment of many young people.

The military-industrial complexes to which heavy military spending gives rise inevitably exert influence on policy, towards maintaining the circumstances and conditions which gave rise to them. (The change in the traditional relationships between the civilian and military sections of the economy can result in a threat to democratic processes.)

The international consequences

The arms race and international tension are inextricably intertwined. In many cases, international tension can certainly lead to arms races; but arms races in turn exacerbate that tension.

Nations which have spent large sums on armaments will be predisposed to look for military solutions to their disagreements.

Because of the very high research and development costs of modern weapons, medium-sized powers will seek to sell arms to third world countries in order to maintain a viable defence industry. There is also a strong economic incentive to sell surplus weapons as weapons rather than as scrap.

There are also a number of links between military expenditure and world trade. Strategic embargoes are a feature of a heavily armed world. The restrictions which still remain apply to a number of commodities which are of key importance in modern industrial and engineering development. It is not only trade that is affected: the exchange of knowledge and technical "know-how" is also impeded.

The level of trade between the developed, market economies and centrally planned economies is much lower than might be expected in a fully peacetime world; the armed tension between the two groups of countries is no doubt one reason for this.

Perhaps the main effect of military expenditure on aid to developing[4] countries is to put it lower in the list of national priorities. Certainly aid to developing countries is extremely small—only one-thirtieth of the world

[4] In this chapter we use the term "developing countries", used in the UN report, rather than "underdeveloped countries", the term preferred by SIPRI.

total of military expenditure; and since 1961 aid has been rising more slowly.

There is good reason to think that if world military expenditure had been substantially lower, aid would have been higher.

Military considerations have to some extent distorted the direction of aid; economic aid has followed closely the pattern of military aid, which would hardly be the case if it were properly serving the requirements of world economic development.

Military expenditure in developing countries themselves can be a strong constraint on their economic growth because it pre-empts scarce resources at three points. It takes scarce resources of government finance, scarce resources of foreign exchange, and scarce resources of skilled labour.

At the moment, very few research and development resources are devoted to the needs of developing countries. Since military research and development accounts for a substantial proportion of the world total, there is considerable scope here for a productive transfer—though it would take time.

In general, aid is so small, and military expenditure so large, that a very small transfer of resources would radically transform the aid picture. Five per cent of the world military budget would enable countries to meet the aid targets of the Second Development Decade. Ten per cent of world military expenditure could increase the total of fixed investment in developing countries by a third.

II. *Comments on the report*

The main point of a document of this kind is that it is an agreed, unanimous document, signed by scientists from Eastern countries, Western countries and the third world. Although the experts were, technically, appointed by the Secretary-General for their expertise, in fact they were put forward by their governments; the discussions in a group of this kind partly take the form of expert discussions and partly the form of diplomatic negotiations. The fact of agreement is as important as the opinions actually expressed.

The same point can be made about the report which was the predecessor of the present one: the report on *The Economic and Social Consequences of Disarmament* which was presented to the UN General Assembly in 1962. The most important point about that report was the agreement among the experts that disarmament was technically feasible in capitalist countries: the doctrine that military expenditure was economically essential to them was abandoned. The preface to that report by the Secretary-General emphasizes this:

It is a source of profound gratification to me, as I am sure it will be to all Governments, that, on a subject that has until recently been so beset by ideological differences, it has now proved possible for a group of experts drawn from countries with different economic systems and at different stages of economic development to reach unanimous agreement. It is particularly encouraging that the Consultative Group should have reached the unanimous conclusion that "all the problems and difficulties of transition connected with disarmament could be met by appropriate national and international measures", and that "there should thus be no doubt that the diversion to peaceful purposes of the resources now in military use could be accomplished to the benefit of all countries and lead to the improvement of world economic and social conditions".

The present report is mainly devoted to the economic consequences of the armaments race. There is one central point here: that $200 billion represents a very considerable quantity of resources indeed, and that if these resources could be transferred to other purposes a great deal could be accomplished. The group was not expected to study the problems of transition; that was the subject of the previous report.

The present report is much stronger on the economic consequences of the armaments race than on the social and international political consequences. This was to be expected, given that the experts were to some extent national representatives. It is not really possible for a group of this kind to go deeply into questions which are matters of acute political controversy. So the study does not go into any detail about the effects of the existence of a large military establishment, and its industrial concomitants, on the nature of society or on the values expressed in political discussions, in the mass media, and so on. One reason for the paucity of material presented on this subject was no doubt that virtually all the evidence and discussion on this question uses Western countries as examples. There are no published Soviet studies of the social consequences of the existence of a large military sector in the Soviet Union. Consequently, any extensive treatment of this subject would have appeared biased.

In much the same way, the report treats the international political consequences of the arms race and military expenditure delicately. In the first place, it is not absolutely clear from the group's terms of reference whether they were supposed to discuss this at all.[5] Secondly, here again it was not

[5] The heading of the General Assembly resolution 2667(xxv) is "Economic and social consequences of the armaments race and its extremely harmful effects on world peace and security". But the specific clause in the resolution referring to the study reads as follows: "3. *Requests* the Secretary-General to prepare, with the assistance of qualified consultant experts appointed by him, a report on the economic and social consequences of the arms race and military expenditure".

politically practicable for the group to have any extensive discussion of such matters as the consequences for conflict of the considerable supplies of weapons from the great powers to third world countries.

The main message of the report, therefore, is to serve as a reminder of the immense quantity of resources which the world wastes in preparation for mutual slaughter, and as a reminder of all the massive benefits which would accrue if these resources were devoted to positive ends.

Part III. The problem of the proliferation of nuclear weapons

Chapter 9. The near-nuclear countries and the Non-Proliferation Treaty

General background India Pakistan Israel Egypt South Africa Japan Australia Spain Brazil Argentina West Germany Italy The Netherlands Belgium Switzerland Conclusions Nuclear power reactors as a source of plutonium Enriched uranium technology

Chapter 10. Nuclear safeguards

Introduction Essential provisions of the safeguards system Significance of the agreement

Chapter 11. The test ban

Introduction History The frequency of testing Verification The military significance of tests Nuclear explosions for peaceful purposes Compromise treaties The political significance of a comprehensive test ban Conclusions Evidence on understatement of numbers of nuclear tests and its significance

Chapter 12. Non-seismic detection of underground nuclear tests

Introduction Present role of satellites or electronic intelligence in test detection and identification Possible satellite detection of underground nuclear testing The Vela satellite system Ground-based methods for detecting atmospheric and very high-altitude nuclear tests

Chapter 13. Nuclear-weapon testing programmes, 1945–1970

Nuclear tests conducted during 1970 The Soviet nuclear testing programme for civil purposes

Chapter 14. World uranium supplies

Introduction Background and demand Supplies Modes of international trade in uranium Conclusions

Chapter 15. China and disarmament

Introduction China and nuclear arms China's disarmament policy Summary and conclusions

9. The near-nuclear countries and the Non-Proliferation Treaty

This chapter describes the attitudes of fifteen key near-nuclear countries to the Non-Proliferation Treaty and thereby helps to assess the risks of proliferation of nuclear weapons. It consists of three sections. The first, General Background, presents the problem and provides the necessary background information. Section II contains case studies of the positions of fifteen near-nuclear countries which either have not signed the Non-Proliferation Treaty or, if they have signed it, have not yet ratified it. Section III sums up the conclusions to be drawn from the study. Square-bracketed references, thus [1], *refer to the list of references on page 360.*

I. *General background*

The proliferation issue

Since the late 1950s, when a situation of mutual deterrence had been established between the West and the East, the proliferation—in the sense of spread of independent ownership—of nuclear weapons to more nations than those which have them at a given moment has generally been regarded as detrimental to international peace and security. The reasons are obvious. If ever used again, nuclear weapons may lead to an unlimited human catastrophe—and the risks of use by any cause are likely to increase, at least to some degree, the more independent possessor nations there are in the world. This has been the prevailing view advocated as a global policy by practically all governments, even if they sometimes explicitly or implicitly make an exception for their own country. However, a few dissenting opinions are also on record. The French military strategist, General Beaufre, has maintained that the world deterrent situation would be more stable if more countries had independent nuclear forces [1]. And the former Chinese Foreign Minister, Mr Chen Yi, expressed the hope in 1965 that Afro-Asian nations would be able to make nuclear weapons themselves and also said that "it would be better for a greater number of countries to come into possession of atom bombs"; at the same time, however, he stated that it was not realistic to discuss Chinese help for foreign nuclear weapons programmes [2].

In order to prevent nuclear proliferation, nuclear-weapon states have relied on both national and international measures. None of the nuclear-weapon states (the United States, the Soviet Union, the United Kingdom, France and China) has been prepared to help another nation to "go nuclear". The US Atomic Energy Act of 1946 strictly prohibits the transfer of nuclear weapons to other states. Only in 1958 was an amendment introduced which permitted the transfer of non-nuclear parts of nuclear weapons and special nuclear material to US allies [3]. Such assistance was given to the United Kingdom, *after* it had become a nuclear-weapon state, but not to Italy, which required highly enriched uranium for research on propulsion of nuclear naval vessels. The policy of the Soviet Union has been equally strict, as evidenced by the fact that the Soviet Union broke off its nuclear assistance to China at the end of the 1950s, when that assistance could have become significant for the development of Chinese nuclear weapons. Neither is it realistic to expect China to help other nations to go nuclear, as was made clear in Mr Chen Yi's statement, referred to above. The United Kingdom and France have also observed the rules of the "nuclear club" by not spreading nuclear weapons technology, although France has been somewhat more lax with regard to deliveries of enriched uranium and the application of safeguards in foreign civil nuclear establishments, as will be made clear in the case studies of India, Israel and Italy below.

In the international arena the efforts to prevent nuclear proliferation started in earnest with the so-called Irish resolution in the United Nations in 1961; this resolution called on all states, particularly the nuclear-weapon powers,

> to use their best endeavours to secure the conclusion of an international agreement containing provisions under which the nuclear States would undertake to refrain from relinquishing control of nuclear weapons and from transmitting the information necessary for their manufacture to States not possessing such weapons, and provisions under which States not possessing nuclear weapons would undertake not to manufacture or otherwise acquire control of such weapons. [4]

The negotiations to achieve the Non-Proliferation Treaty took seven years, ending on 12 June 1968 when the UN General Assembly commended the joint US–Soviet draft treaty. For an account of these negotiations, see the *SIPRI Yearbook of World Armaments and Disarmament 1968/69* and the publication *International Negotiations on the Treaty on the Nonproliferation of Nuclear Weapons* issued by the US Arms Control and Disarmament Agency (ACDA).

The Non-Proliferation Treaty

The Non-Proliferation Treaty entered into force on 5 March 1970 after it had been ratified by the three depositary states—the United States, the Soviet Union and the United Kingdom—and forty other states. Its control provisions, which are aimed at preventing diversion from peaceful nuclear activities to the manufacture of nuclear explosives in non-nuclear-weapon states parties to the treaty, are, however, only now beginning to enter into force. For each non-nuclear-weapon state party to the treaty, a safeguards agreement is required between itself and the International Atomic Energy Agency (IAEA) within a 2-year time-limit. The safeguards negotiations are not yet concluded, although a model agreement has been drawn up as described in chapter 10.

The Non-Proliferation Treaty was analysed in detail in the *SIPRI Yearbook 1968/69*. For the sake of the following discussion, its essential provisions are summarized below.

Article I prohibits the transfer of nuclear weapons or other nuclear explosive devices (including devices for peaceful nuclear explosions in as much as they are identical to nuclear weapons) to any state, whether a signatory or not, whether a nuclear-weapon state or not, whether directly or indirectly through an alliance. It also forbids nuclear-weapon states to assist non-nuclear-weapon states to acquire nuclear weapons or devices.

Article II prohibits non-nuclear-weapon states parties to the treaty to manufacture or otherwise acquire nuclear weapons or devices, including devices for peaceful uses. It is only the actual manufacturing of nuclear weapons which is prohibited. Thus, parties to the treaty may legally make all the preparations for manufacturing nuclear weapons except assembling the warhead; this means that, with sufficiently advanced technology, it may be possible to implement a nuclear options policy within a very short period of time, perhaps a couple of months.

Article III puts an obligation on the non-nuclear-weapon states parties to the treaty to accept safeguards, as laid down in a special agreement with the IAEA, on their peaceful nuclear activities in order to ensure that there is no diversion to the manufacture of nuclear explosives.[1] The safeguards shall apply to all source or special fissionable material: enriched uranium-235, uranium-233 and plutonium-239. Article III further prescribes that no state party to the treaty may provide supplies of fissionable material or

[1] States may conclude safeguards agreements with the IAEA either individually or collectively. The latter alternative is mainly of interest to Euratom, which is presently negotiating a collective agreement for its five non-nuclear-weapon member states (see page 333).

equipment to any non-nuclear-weapon state unless it accepts the safeguards provided for in the treaty.

Article IV affirms that all states parties to the treaty have the right to undertake research, production and exploitation of nuclear energy for peaceful purposes; and it puts on all states in a position to do so an obligation to assist other countries.

Article V obligates nuclear-weapon states to make available nuclear explosives for peaceful purposes to non-nuclear-weapon states under appropriate international observation and procedure and subject to minimum charges excluding research and development costs.

Article VI stipulates that all parties to the treaty undertake to pursue negotiations in good faith on effective measures for nuclear disarmament. This is mainly an obligation for the nuclear-weapon states.

Article VII says that nothing in the treaty affects the rights of nations to agree on nuclear-free zones.

Article VIII says that a conference to review the operation of the treaty shall be held five years after its entry into force, that is, in March 1975.

Article IX says, *inter alia,* that when the treaty has been ratified by the necessary number of states and has entered into force, other states may accede to it. It further defines a nuclear-weapon state as one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January 1967.

Article X gives parties to the treaty the right to withdraw from it on three months' notice, provided they decide that extraordinary events, related to the subject matter of the treaty, have jeopardized the supreme interests of their countries. The same article also gives the treaty an initial duration of 25 years.

Simultaneously with the commending of the Non-Proliferation Treaty (NPT) by the UN General Assembly in June 1968, the USA, the USSR and the UK carried a draft resolution on security assurances to non-nuclear-weapon states parties to the NPT through the Security Council. As stated in this resolution, these powers, in accordance with the UN Charter, will assist a non-nuclear-weapon state party to the NPT which is "a victim of an act or an object of a threat of aggression in which nuclear weapons are used". The action should be taken through the Security Council, which means that it is liable to a veto from one of the permanent members; however, the resolution, and individual declarations by the three powers, also stressed the inherent right of individual and collective self-defence if an armed attack occurs before the Security Council can act.

In addition to the formal provisions of the NPT and the Security Council resolution, there exists a host of "interpretations" of individual points. These are mainly US clarifications aimed at its European allies regarding nuclear defence planning within NATO, a "nuclear option" for a future federal West European state, etc. These interpretations will be referred to below during the discussion of the Euratom countries and the NPT.

As of 31 December 1971, only about half the countries of the world have ratified or acceded to the NPT. (The full list of signatures, ratifications and accessions is given on page 575.) Among those non-nuclear-weapon countries which, for various reasons, did not sign the NPT before 5 March 1970 are Albania, Algeria, Argentina, Brazil, Chile, Cuba, India, Israel, Japan, North Korea, Pakistan, Portugal, Saudi Arabia, South Africa, Spain, Tanzania, North Viet-Nam and Zambia. The following countries are among those which have signed but not yet ratified the treaty: Australia, Belgium, Egypt, the Federal Republic of Germany, Indonesia, Italy, South Korea, Morocco, the Netherlands, Switzerland, Turkey, Venezuela, South Viet-Nam and Zaïre (former Congo-Kinshasa).

The countries which did not sign the NPT before 5 March 1970 must now accede to it in one step if they want to join it. Those which have signed but not ratified still have the option of ratification. Until they have ratified they are, of course, not bound by the treaty. However, on the basis of the rule expressed in Article 18 of the convention on the law of treaties, it could be maintained that signatories would violate an international obligation if they "go nuclear" before having made public their decision not to ratify the NPT.

Currently there is a certain hold-up of new ratifications and accessions to the treaty while states are waiting for the safeguards negotiations between the IAEA and Euratom to be concluded. When this has been achieved, perhaps during the second half of 1972, more countries can be expected to join the treaty. Further, when the NPT provision that supplies of fissionable material should be restricted to those non-nuclear-weapon states which have concluded safeguards agreements becomes effective, another round of accessions and ratifications appears likely.

Among the countries which have not yet ratified or acceded to the NPT, there is a group of countries whose nuclear policies are of special interest because they may have the technical capability to produce nuclear weapons in the future, if they should so wish. The rest of this chapter will be devoted to these countries, after some background information has been provided on the spread of nuclear technology.

The spread of nuclear technology

Nuclear technology is rapidly spreading round the globe, not only among the advanced nations but also to the underdeveloped nations. When one realizes that partly the same source material is used for both peaceful and military purposes and that not even the best safeguards system can ensure that there is absolutely no diversion from peaceful to military activities,[2] then the consequences may appear frightening.

The main factor behind the spread of nuclear technology is the recent demonstration that, in most situations, nuclear power reactors will provide the cheapest, if not the only, means of producing electricity in the future. In 1971, 16 countries had 128 nuclear power reactors in operation with a total capacity of 35 000 MWe (1 MWe is equal to 1 million watts of electricity); in 1977, 32 countries will have 325 nuclear power reactors with a total capacity of 174 000 MWe. Plans put forward indicate that by 1980 installed nuclear capacity will exceed 350 000 MWe. As a by-product of this nuclear power production considerable quantities of plutonium will be produced each year: about 13 tons in 1972, 65 tons in 1977, 130 tons in 1980. By 1980 about one-third of this plutonium will be produced in the present non-nuclear-weapon countries. This would, in theory, correspond to the production of some 100 nuclear weapons of nominal size[3] per week in the non-nuclear-weapon countries. However, since the plutonium produced in nuclear power reactors cannot be used directly for nuclear weapons manufacture without substantial investment in plants for chemical separation of plutonium-239 from plutonium-240, this may be somewhat misleading. Chemical separation plants exist in the five nuclear-weapon states, but also in Argentina, Belgium, India, Italy, Spain and West Germany; Japan is constructing one.[4]

Plutonium may be produced not only in nuclear power reactors but also in research reactors and in special plutonium production reactors. Indeed, some large research reactors may be operated very efficiently for plutonium production. This may have military significance for countries such as Israel whose only potential interest may be in a small nuclear weapons capability. Further, a country wishing to produce nuclear weapons in total secrecy

[2] "At the present rate of power reactor construction, we will soon reach 'a bomb a week' rate of diversion possibilities, even with the best of safeguard technology available." (Ryukichi Imai, *Bulletin of the Atomic Scientists,* May 1969.)

[3] Some 8 kg. of 95 per cent plutonium-239 would be needed for a nuclear warhead yielding a 20-kiloton explosion. If highly enriched (90–95 per cent) uranium-235 were used, some 25 kg. would be required for producing a warhead yield in the 20-kiloton range (see below).

[4] For an account of nuclear power reactors as a source of plutonium see appendix 9A, page 366.

could acquire a small reactor specifically for weapons-grade plutonium production.

While nuclear power stations have been proliferating, plants for the production of enriched uranium have not—so far. With the existing generation of nuclear reactors, enriched uranium is the most frequent fuel; the other material used is natural uranium.[5] The enriched uranium-235 used in power reactors has a much lower percentage of enrichment—1.5 to 4 per cent—than weapons-grade uranium, which is enriched to over 90 per cent; nuclear-powered submarines require uranium enriched to at least 35 per cent. Still, the production of enriched uranium presents formidable technical and economic problems.[6] At present only the five nuclear-weapon powers have enrichment plants, which are based on the gas diffusion process. However, in the last few years there have been significant developments in another enrichment process, the gas ultra-centrifuge process. Britain, the Netherlands and West Germany now cooperate on this process, while Japan is experimenting on both gas diffusion and gas centrifuge technology. South Africa has recently developed its own enrichment process (see below).

The background to the increased interest in uranium enrichment is the shortage of enriched uranium supplies for future nuclear power reactors, at least until the next generation of reactors, the so-called fast-breeder reactors, are installed. So far, the United States has been supplying almost all the enriched uranium for peaceful purposes in the Western world, but the US capacity is not likely to be sufficient for all nuclear power reactors in the 1980s. Another factor stimulating interest in enrichment technology is the wish of several countries with large civil nuclear programmes to become independent in their supply of nuclear fuel for political reasons. Indeed, there is now commercial competition between the United States and some West European states in the supply of enrichment facilities to other countries: both the United States and France have offered to supply information on the gas diffusion process to Japan and other Western nations [5], while a British and a West German group are competing for a contract to build a gas centrifuge plant in Australia [6]. Apparently any enrichment plants built in non-nuclear-weapon countries with the assistance of the nuclear-weapon states parties to the NPT will be placed under IAEA safeguards. Still, the fact that the treaty may be abrogated under certain circumstances, coupled with the fact that enriched uranium is much preferred, if not essential, for thermonuclear weapons manufacture, gives added significance to any proliferation of enrichment facilities.

[5] For an account of uranium production and trade see chapter 14 on world uranium supplies, page 470.
[6] For an account of enriched uranium technology see appendix 9B, page 371.

When the fast-breeder reactors become operational for use in nuclear power stations in a decade or so, they will produce more plutonium than they consume. They will, therefore, allow many more nations to become self-sufficient in the production of source material. Any nation with sufficient deposits of natural uranium, or thorium, can then—provided it has either natural uranium reactors or an initial stock of plutonium—have an independent nuclear fuel cycle, which is essential to any credible military programme. From the point of view of nuclear weapons proliferation, it is important to emphasize that the preferable fuel for fast-breeder reactors will be the same as that for efficient nuclear weapons—namely, plutonium rich in Pu-239, contaminated with only small amounts of other plutonium isotopes. The problem of preventing the diversion of fissile material from peaceful to military purposes will, therefore, become very much more difficult as fast-breeder reactors become more numerous and widespread.

The development described above will occur regardless of the Non-Proliferation Treaty. Indeed, the NPT will to a certain degree contribute to this spread of nuclear technology since it places an obligation on all member states to cooperate in the peaceful exploitation of nuclear energy, both regarding the exchange of scientific and technological information and regarding concrete applications in the territories of non-nuclear-weapon states.

It is only with respect to nuclear explosives for peaceful purposes, the value of which remains to be proved, that the NPT can be said to limit the civil nuclear programmes of individual countries. The manufacture of peaceful nuclear explosives is forbidden to non-nuclear-weapon states parties to the NPT. This, incidentally, is one of the main stated reasons why some countries, such as Brazil, have not joined the NPT. Two points should, however, be noted: (*a*) research and development on peaceful nuclear explosives is not forbidden; and (*b*) the prohibition only extends to nuclear explosives which have the same explosive effects as nuclear weapon devices, as all essentially have today. If, in the distant future, peaceful nuclear explosives were developed which are substantially different from nuclear weapons, then the prohibition may no longer apply; however, this issue would probably first have to be settled at an NPT review conference.

The Nth country problem

During the last decade many forecasts have been made about which present non-nuclear-weapon countries have the capability to develop nuclear weapons within a few years or less [7, 8, 9]. These forecasts have mainly taken into account the general wealth and technical advancement of the countries concerned as well as the consequences of the spread of nuclear technology. The point may be illustrated with a quote from a 1968 memorandum by the US Atomic Energy Commission:

> The resources necessary for the manufacture of a few rudimentary nuclear weapons are within the means of many nations. The essentials are a cadre of trained personnel, uranium, and an industrial base adequate to permit the construction of a nuclear reactor and auxiliary facilities large enough to provide the necessary quantities of plutonium. Thus many nations possess resources sufficient to undertake, without special outside assistance, to manufacture a few rudimentary nuclear weapons, given the national will to do so and the readiness, in some cases, to forego the benefits from the endeavors to which those resources might otherwise be applied. The time required would vary among the group of countries, and for those which have only the minimum resources, the time might be ten years or more.
>
> At the upper end of the scale, highly industrialized nations, with substantial national income, large numbers of trained scientific, technical and managerial personnel and a reasonably available source of uranium could become capable of manufacturing a few rudimentary nuclear weapons within a few years or less. [10]

An important point to make, however, is that while the five present nuclear-weapon powers all first developed a military nuclear capability and only afterwards turned to peaceful nuclear developments, any new nation considering "going nuclear" will probably first acquire a peaceful nuclear capability and benefit from its spin-off effects, in particular the production of plutonium. Aside from the influence of the technological development, the different approach is partly explained by the fact that the great powers wished to equip themselves with sophisticated nuclear forces based on thermonuclear warheads and thus required large enrichment plants for the production of uranium-235, while any medium-sized or small nation is likely to have more limited considerations and will, therefore, be content, at least initially, with nuclear weapons which only require plutonium-239, obtainable from nuclear power reactors or from large research reactors.

The AEC memorandum of July 1968 referred to above indicated that the following non-nuclear-weapon countries had industrial economies which were probably adequate to support a programme for manufacturing a sizable number of reasonably sophisticated nuclear weapons and systems for their delivery within 5 to 10 years from a national decision to do so: Australia, Canada, the Federal Republic of Germany, India, Italy, Japan and Sweden. Those states whose resources were said to be somewhat more limited, and who might therefore take somewhat longer to reach that level of numbers or types of weapons systems included Argentina, Austria,

Map 6. World map: the spread of nuclear power

SWEDISH NATIONAL MAP AND PRINTING ORGANIZATION

Non-nuclear weapon states which will have nuclear power stations in 1977 but which did not have such stations in 1972.

Belgium, Brazil, Chile, Czechoslovakia, Egypt, Hungary, Israel, the Netherlands, Pakistan, Poland, South Africa, Spain, Switzerland, and Yugoslavia. [10].

The UN Secretary-General's expert report on *The Effects of the Possible Use of Nuclear Weapons and the Security and Economic Implications for States of the Acquisition and Further Development of these Weapons,* of October 1967, contains detailed estimates of the costs of building up a nuclear force [8]. The critical areas are those pertaining to the production of weapons-grade fissionable material, production of the warheads, and the build-up of delivery systems and their accessories. The report estimated that it would cost about $5 600 million over 10 years to build up a small, high-quality nuclear force consisting at the end of the first 5-year period of 15–20 nuclear weapons and 10–15 bombers, and including at the end of the 10-year period 20–30 thermonuclear weapons, 100 intermediate-range missiles and 2 missile-launching nuclear submarines. A "modest" nuclear capability consisting of 100 plutonium warheads, 30–50 jet bomber aircraft and 50 medium-range missiles in soft emplacements was said to cost about $1 700 million over 10 years. Based on these estimates and on a comparison of defence budgets, the report mentioned the Federal Republic of Germany, India, Canada, Italy, Poland and Sweden as countries which could possibly afford the cost of the hypothetical small, high-quality nuclear force. About 20 more countries were said to be theoretically able to afford the cheaper, modest nuclear capability. Two caveats made in the report should be noted. First, the cost estimates referred to the situation in an industrialized country; for any underdeveloped country lacking the necessary industrial base the cost would be much higher. There is also the practically unavoidable risk of escalating costs due to the inherent mechanism of the arms race. Secondly, the manpower requirements, in particular for scientists and technicians, would for almost any non-nuclear-weapon nation probably be more damaging than the direct economic costs.

Nevertheless, it is probably true that in time more and more nations will be able to afford the economic and manpower costs of acquiring nuclear weapons. This is not to say that they will do so. There are powerful political, military and economic constraints operating in the other direction. They include such factors as whether the possession of nuclear weapons would increase a given country's security, regionally or globally; the likely military effects of a nuclear war involving a country that has just gone nuclear; and the economic opportunity costs of devoting a large part of scarce resources to weapons which may not provide increased security. Overall, in determining whether a given country will go nuclear, capabilities are probably less important than the security situation of the country. This varies greatly, and so the nuclear weapons policy and *eo ipso* the attitude to the Non-Proliferation Treaty will be different for different countries.

The main questions

The main issues shaping the attitudes to the Non-Proliferation Treaty of those countries which have not yet joined the treaty would seem to be the following:

1. Does the country want to forswear the possibility of becoming a nuclear-weapon power by joining the NPT? Or can it preserve the nuclear option inside the NPT?
2. How will its security situation be affected by joining the NPT or by staying outside? Would its security be enhanced or diminished by the possession of nuclear weapons? In particular, how will its relations with the great powers and with any hostile neighbours be affected by either decision?
3. Can it raise its international standing by going nuclear or would it become an international "suspect"? Is it sensitive to discrimination by the nuclear-weapon powers and will that discrimination increase by its becoming a party to the NPT—either overall or in the civil nuclear field?
4. Can it afford to go nuclear?
5. Is the full utilization of nuclear energy essential for its economy and would this be harmed by submitting to the rules of the NPT—for instance on peaceful nuclear explosives? Or is it better for peaceful nuclear purposes to be inside than outside the NPT, since it may otherwise be difficult to acquire fissionable material and assistance in nuclear science and technology?
6. Would the practical application of safeguards be harmful to its civil nuclear industry?
7. Can it most help in achieving great power nuclear disarmament by exerting pressure inside or outside the NPT?

The key countries

The answers to the above questions will vary from country to country. To illustrate the issues, a group of fifteen countries have been selected from the larger group of about fifty countries which have not signed or ratified the Non-Proliferation Treaty. The fifteen countries are *Argentina, Brazil, India, Israel, Pakistan, South Africa* and *Spain* among the non-signatories, and *Australia, Belgium, Egypt, the Federal Republic of Germany, Italy, Japan, the Netherlands* and *Switzerland* among those which have signed but not ratified the NPT. They are all countries which are capable of developing

Table 9.1. Nuclear capabilities of fifteen near-nuclear countries[a]

Country	Status on the NPT	Year of operation of first nuclear power reactor (actual or planned)	Nuclear power production in 1971[b]			Estimated nuclear power production in 1977[c]		
			Number of power reactors	Total MWe[d]	Approximate annual product. of plutonium (*kg*)	Number of reactors	Total MWe	Estimated annual product. of plutonium (*kg*)
Argentina	Not signed	1972	(1 under construction)	(320)	200	2	720	400
Australia	Signed 27 Feb. 1969	1976	(2 large research reactors)	—	(about 6)	1	(500)	(190)
Belgium	Signed 20 Aug. 1968	1962	1	11	4	4	1 660	646
Brazil	Not signed	1976	—	—	—	1	500	190
Egypt	Signed 1 July 1968	—	—	—	—	—	—	—
FR Germany	Signed 28 Nov. 1969	1959	9	1 020	387	19	8 142	3 078
India	Not signed	1969	3	580	220	6	1 180	600
Israel	Not signed	—	(2 large research reactors)	—	(about 10)	1	(300)	(114)
Italy	Signed 28 Jan. 1969	1962	3	597	227	5	1 387	524
Japan	Signed 3 Feb. 1970	1963	5	1 301	494	26	15 260	5 814
Netherlands	Signed 20 Aug. 1968	1968	1	52	19	3	1 050	418
Pakistan	Not signed	1971	1	125	90	1	125	90
South Africa	Not signed	1977	(1 large research reactor)	—	(about 5)	1	400	133
Spain	Not signed	1968	2	593	225	8	3 600	1 368
Switzerland	Signed 27 Nov. 1969	1970	3	1 006	382	5	2 500	950

[a] The data in the table is presented for information only. For an assessment, see the respective country sections.
[b] In addition, the following countries had nuclear power reactors in 1971: USA (16 814 MWe); UK (5 970 MWe); France (2 683 MWe); Soviet Union (2 641 MWe); Canada (1 497 MWe); Sweden (452 MWe); and GDR (70 MWe).
[c] In addition, the following countries will have nuclear power reactors in 1977: USA (94 700 MWe); UK (14 400 MWe); Soviet Union (10 500 MWe); Sweden (5 300 MWe); Canada (4 000 MWe); France (2 900 MWe); GDR (1 200 MWe); Taiwan (1 200 MWe); Finland (800 MWe); Bulgaria (800 MWe);

Other major nuclear installations	Uranium resources	GNP (*US $mn 1970*)	Military expenditure (*US $ mn 1970*)[e]	Possession of major weapon systems capable of delivering nuclear weapons
Small chemical separation plant	Medium	22 806 (1969)	450	Canberra bombers
Enrichment plant planned	Large	34 400	1 190	Phantom aircraft; Canberra bombers; F-111 aircraft on order
ENEA chemical separation plant	—	24 900	702	F-104 aircraft; short-range missiles
—	(Large thorium deposits)	30 318 (1969)	1 387	—
—	—	6 430	1 210	Tu-16 bombers
Chemical separation plant; future access to enrichment plant	—	185 000	6 188	Several types of aircraft, missiles and artillery
Chemical separation plant; enrichment plant planned	(Large thorium deposits)	49 000	1 512	Canberra bombers
—	—	5 400	1 120	Phantom aircraft; short-range missiles; artillery
Chemical separation plant	Small	93 200	2 506	F-104 aircraft; missiles
Chemical separation plant under construction; enrichment plant planned	Small	195 000	1 535	Phantom aircraft; short-range missiles
Enrichment plant under construction	—	31 300	1 103	Short-range missiles; artillery
—	(Small)	16 000	603	—
Enrichment plant under construction	Very large	17 600	359	Canberra and Buccaneer bombers
Small chemical separation plant	Medium	32 300	283	Phantom aircraft
—	—	20 500	456	—

Greece (800 MWe); Austria (700 MWe); South Korea (600 MWe); Yugoslavia (600 MWe); Mexico (600 MWe); Norway (500 MWe); Philippines (400 MWe); Thailand (300 MWe); Czechoslovakia (110 MWe).

[d] Megawatts of electricity: 1 MWe is equal to 1 million watts of electricity.

[e] The UN-Secretary General's expert study of nuclear weapons, of 1967, estimated the total 10-year costs of a small unsophisticated nuclear weapons force to $1 700 million and the costs of a small high-quality force to $5 600 million. The British and French nuclear forces have probably involved expenditure of about $10 000 million each.

nuclear weapons within the short- or medium-term future and therefore their attitudes to the NPT have an intrinsic interest. Some essential data about their nuclear capabilities are given in table 9.1. This chapter will not discuss the nuclear policies of countries such as Canada, Sweden and GDR, which have ratified the NPT but which otherwise might be regarded as near-nuclear countries. It is true, of course, that even these countries may preserve or develop a short-term nuclear-option policy to be put into effect in an emergency situation—or they may withdraw from the treaty—but the likelihood of their going nuclear cannot be rated as very high for the foreseeable future.

In the following sections the countries do not appear alphabetically. The countries which have important regional security problems, India (below) and Pakistan (page 307), and Israel (page 309) and Egypt (page 313), are treated first. Then follows South Africa (page 314), which is a rather special case both because its policies are in opposition to those of a large number of African countries and because of its large uranium resources. For the three industrialized countries, Japan (page 317), Australia (page 324) and Spain (page 328), economic-cum-security considerations seem to be decisive. Then there are Brazil (page 329) and Argentina (page 332), two developing countries that seem anxious not to lose any possible economic benefit from the development of nuclear technology. The next category includes four European countries—the Federal Republic of Germany (page 337), Italy (page 345), the Netherlands (page 349) and Belgium (page 351)—whose reasons for not yet ratifying the NPT are rather special, being connected with the Euratom treaty; but security considerations have also been important in deciding their attitudes towards the NPT. Finally there is Switzerland (page 352), an advanced neutral country which is susceptible to being influenced by the policies of its Euratom neighbours.

A résumé is given of each country's official position on the NPT and of its reasons for not having joined the treaty; there is also an account of the stage of development of nuclear technology in the country as well as an assessment of its general nuclear policies.

II. *Country studies*

India

Among the countries of the third world, India is the most advanced in nuclear technology. Indeed, its civil nuclear programme can in many respects be compared with that of industrialized Western countries. At the same time India has been one of the most persistent critics of the Non-Proliferation Treaty, stating flatly that it does not intend to join the NPT. When one further takes into account the fact that India is situated in a sensitive area and for many years has had troublesome relations with its two major neighbours, China and Pakistan; that India, as a traditionally non-aligned country, remains outside the protection of the Western and Eastern military alliance systems;[7] and finally, that it is very conscious of its potential position as a major power, resenting any status of inferiority in relation to the present five nuclear-weapon powers—then the picture becomes truly complex and it is easy to understand that speculations abound about India becoming the next nuclear-weapon power.

Development of nuclear technology in India

India has been active in the development of nuclear technology during the entire post-war period. It has a relatively large cadre of gifted nuclear scientists and substantial resources of uranium and of thorium. Thorium is the raw material for uranium-233, a fissionable material which can be used both in reactors and for weapons production.

India has devoted large resources to the construction of nuclear power stations, which are regarded as essential for the country's energy needs. The first power station, the 380 MWe Tarapur Atomic Power Station outside Bombay, became operational in October 1969. The reactor, which uses enriched uranium, was imported from the United States, which also helped in the construction of the station. The reactor is subject to US bilateral safeguards. The next power station to become operational, in 1971, was the 200 MWe Rajasthan Atomic Power Plant, based on a Canadian heavy-water, natural uranium reactor and built with Canadian assistance; in 1974, a second unit of 200 MWe will be ready. Under the bilateral safeguards agreement with Canada, India has consented to use the fissionable material produced in the reactor for peaceful purposes only; however, this restriction only applies to the plutonium produced in the first fuel cycle—not to the plutonium recycled after treatment.[8] A third 200 MWe nuclear power

[7] The Treaty of Peace, Friendship and Cooperation between the Soviet Union and India, which entered into force on 13 August 1971, does not ensure India of Soviet military protection. The treaty reconfirms India's policy of non-alignment and provides only for immediate consultations between the two countries in case of an attack or a threat of attack against either party. The significance of the treaty is probably largely political and has to be seen in the light of the changing relationships in the area, involving not only India and the Soviet Union but also China, Pakistan and the United States. The timing of the conclusion of the treaty is significant: it occurred during the Bangladesh crisis but before the Indian intervention in East Pakistan.

[8] There is, further, a Canadian–Indian agreement that in exchange for the Canadian inspection of this reactor, the Indians should inspect one Canadian reactor in Canada. Whether this involves an efficient application of safeguards for the Rajasthan reactor is open to question.

station is being built at Kalpakkam in Madras; it has been proposed that this station, too, should be enlarged to 400 MWe by adding a second unit. The Kalpakkam station will be a domestic construction to about 80 per cent, with the remaining assistance being provided by France. As far as is known, no safeguards will apply to the plutonium produced in the natural uranium reactor used in this power station. Further sources of unsafeguarded plutonium may be provided by domestic fast-breeder reactors based on thorium technology.

Natural uranium is likely to remain the preferred fuel for Indian reactors, since that increases India's independence in the nuclear fuel cycle as long as India has no enrichment plant. Thus, "The significance of the production of plutonium for the ultimate power programme of India—fast-breeder reactors—was thus one of the major considerations for launching a power programme based on the use of natural uranium" [11]. However, proposals have recently been put forward for the construction of a gas centrifuge enrichment plant; and in March 1972 it was reported that India had concluded a five-year agreement with West Germany for cooperation on the "nozzle" process of uranium enrichment (see page 338).

India's interest in and requirement for plutonium is further evidenced by the fact that it is one of the few non-nuclear-weapon powers which, for several years, has had a plutonium separation plant. This would be essential if India were ever to contemplate manufacturing nuclear weapons.

In May 1970 the India Atomic Energy Commission presented a very ambitious 10-year programme for nuclear development in India: "Atomic Energy and Space Research: a Profile for the Decade 1970–1980". The programme involved constructing three more 500 MWe power stations so as to bring installed capacity up to 2 700 MWe by the year 1980, construction of a large prototype fast-breeder reactor, development of gas centrifuge technology, as well as efforts in the field of space technology, detailed below. [12] In July 1971 it was reported that the Indian government had formally accepted the objectives of the 10-year programme.

If the 2 700 MWe programme were to be realized—which may be unrealistic because of the costs involved—this would correspond to a production of about 1 000 kg. of plutonium per year, a figure of obvious military significance considering that India already has a plutonium separation plant.

India has claimed an active interest in peaceful nuclear explosives which, according to official Indian opinion, may provide important benefits for the extraction of underground gas and similar purposes. Indeed, as will be seen below, the unwillingness to give up independent development of peaceful explosives has been one of the main strands in the Indian opposition to the NPT. In November 1970 the Prime Minister of India, Mrs Indira Gandhi, stated that underground explosions for peaceful purposes were definitely part of India's nuclear development programme and that data for making such explosions were then being collected [13]. A year earlier, in December 1969, the Indian UN representative had indicated that India was anxious to benefit from IAEA assistance in the field of peaceful nuclear explosives despite the fact that it was not a party to the NPT [14]. During the last 2 years, there have been several rumours that India is on the verge of testing a peaceful nuclear explosive, and that this may be a guise for a military programme. However, this has been denied by the government.

Under the aegis of the India Atomic Energy Commission, India has been pursuing a modest space programme. It has had an agreement with France since 1964 to develop a two-stage French rocket, the Centaur, capable of reaching an altitude of 150 km. with a payload of 30 kg. India has also cooperated with the US National Aeronautics and Space Administration (NASA) on the use of Nike-Tomahawk and Nike-Apache research rockets [15]. In 1965 the Space Science and Technology Centre was set up with the task of developing an indigenous Indian satellite-launching capability. According to the long-term programme of the Indian AEC, an orbiting satellite with an 80 kg. payload should be launched in 1974 and, using solid propellant, one with a payload of 1 200 kg. in 1980. The peaceful space applications mentioned include primarily communications satellites. In 1970 the whole Indian space effort received a stimulus with the announcement of the successful launch of a Chinese satellite. In the same year there was a report that gyroscopes for inertial guidance systems had been successfully developed at the Space Science and Technology Centre [16]. In January 1972 the atomic energy and space research functions were separated in India and an independent space body, the Indian Space Research Organization, was set up.

The Indian attitude to the NPT

India's attitude to the early negotiations of a non-proliferation treaty in 1964–65 was rather more positive than it seems to be now. In 1965 it put forward the following criteria for a non-proliferation treaty:

(1) An undertaking by the nuclear Powers not to transfer nuclear weapons or nuclear weapons technology to others;
(2) An undertaking not to use nuclear weapons against countries who do not possess them;
(3) An undertaking through the United Nations to safeguard the security of countries which may be threatened by Powers having a nuclear weapons capability or embarking on a nuclear weapons capability;
(4) Tangible progress towards disarmament, including a comprehensive test ban treaty, a complete freeze on production of nuclear weapons and means of delivery as well as a substantial reduction in the existing stocks;

(5) An undertaking by non-nuclear Powers not to acquire or manufacture nuclear weapons. [17]

With some stretching of the conditions laid down in points (2) and (4) it should have been possible, it seems, to reconcile the Indian position of 1965 with the eventual US–Soviet draft NPT and the declarations on security assurances.

Further, India has always said that it supported the principles on non-proliferation laid down by the United Nations General Assembly in November 1965:

(*a*) The treaty should be void of any loop-holes which might permit nuclear or non-nuclear Powers to proliferate, directly or indirectly, nuclear weapons in any form;
(*b*) The treaty should embody an acceptable balance of mutual responsibilities and obligations of the nuclear and non-nuclear Powers;
(*c*) The treaty should be a step towards the achievement of general and complete disarmament and, more particularly, nuclear disarmament;
(*d*) There should be acceptable and workable provisions to ensure the effectiveness of the treaty;
(*e*) Nothing in the treaty should adversely affect the right of any group of States to conclude regional treaties in order to ensure the total absence of nuclear weapons in their respective territories. [3]

From about 1966 the Indian attitude to the non-proliferation issue appreciably hardened, and India has since then consistently criticized the US–Soviet draft treaty on three grounds: imbalance of obligations between the nuclear-weapon powers and the non-nuclear-weapon countries; inadequate security guarantees; and discrimination in the development of peaceful nuclear explosives. [18]

Regarding the first issue, India has been demanding a stop to vertical proliferation—that is, continued nuclear weapons production within the nuclear-weapon powers—as a *quid pro quo* for a stop to horizontal proliferation of nuclear weapons. India has, in particular, advocated a comprehensive nuclear test ban,[9] a "cut-off" of production of fissionable material for weapons purposes, and reduction of nuclear armaments within the nuclear-weapon powers. While such demands have been popular with all the non-nuclear-weapon countries during the NPT negotiations, perhaps there was more psychological force behind the Indian argumentation, considering India's sensitivity to discriminatory treatment from the side of the great powers. India has also sharply criticized the NPT's provisions on unequal

[9] India has ratified the Partial Test Ban Treaty. Its enthusiasm for a stop to underground nuclear tests seems recently to have cooled off; this may bear some connection to India's interest in exploiting peaceful nuclear explosives, if not to other reasons.

treatment of civil nuclear establishments in nuclear-weapon and non-nuclear-weapon countries where the application of safeguards is concerned; the offer of the USA and the UK voluntarily to submit their non-military nuclear installations to IAEA inspection has not satisfied India.

India was one of the main countries demanding a security guarantee from the United States and the Soviet Union as a precondition for renouncing nuclear weapons. In April 1967 India's Foreign Minister, Mr M. C. Chagla, indicated that India was interested in obtaining a joint guarantee from both the United States and the Soviet Union against a nuclear attack [19]. But when the USA and the USSR, together with the UK, offered in the spring of 1968 to provide a sort of security guarantee by way of a joint Security Council resolution (see above), India was not satisfied, presumably because it considered the guarantee too weak as it would be subject to the veto. What India seems to have wanted then was a more binding guarantee from the USA and the USSR that they would protect India from a nuclear attack or nuclear blackmail by China. The Indian position on the joint USA–UK–USSR security assurances was that these did not go further than the existing obligations of the permanent members of the Security Council according to the Charter; that it resented the implicit discrimination in the draft Security Council resolution between non-nuclear-weapon states who were and who were not parties to the NPT [20]; and, further, that the question of security guarantees and acceptance of the Non-Proliferation Treaty were unrelated and that therefore a security guarantee could not be made a *quid pro quo* for signing the NPT [21]. The Indian view on security guarantees was stated quite forcefully in June 1968 by the Indian representative in the Security Council in a speech which seemed to contain an implicit threat that India might go nuclear:

> It is in the interest of the international community that non-nuclear-weapon States are encouraged to remain in that category. This can be done only by ensuring the security of all non-nuclear-weapon States in conformity with the Charter, regardless of whether or not they sign the nonproliferation treaty. [20]

The third issue shaping India's official policies to the NPT is the question of peaceful nuclear explosives. As mentioned above, India does not wish to renounce the right of indigenous development of such explosives. It says that there should be no ban whatsoever on the development, application and use of nuclear energy for purely peaceful purposes. Science and technology should be freely and fully accessible and available to all countries of the world without discrimination. It "therefore, does not share the view that the development of peaceful nuclear explosives should be the exclusive privilege of only a few countries and should be denied to others" [22].

Thus, the Indian government has maintained that India will not become a party to the Non-Proliferation Treaty. The reasons behind this policy were summed up by the Indian Defence Minister in a parliamentary answer in March 1970:

I continue to hold the view that we can never agree to sign a non-proliferation treaty which is essentially discriminatory in its character, which does not take note of vertical proliferation and which does not take us even a step further towards stopping the mad race of increasing the nuclear arsenal of the super-powers and those who belong to the nuclear club. Also, even in the development of nuclear energy for peaceful purposes, it puts constraints and restraints which are totally unacceptable to us. For all these reasons, we have taken the attitude that we will not sign it. That is a decision which has been made clear in the United Nations, in the Disarmament Conference and even in the discussions relating to the non-proliferation treaty. Nothing more has happened.

Everybody knows that after the non-proliferation treaty is ratified by 40 countries or so, it will become operative. That minimum number of ratifying countries has been reached and there are several countries who have signed this non-proliferation treaty. There are several countries who have not signed this treaty. That has not altered either the nature of the threat to us or the overall problem that we face in the matter of defence. [23]

India and "the bomb"

The debate on whether India should develop nuclear weapons has been intense, both inside and outside India. Three events having to do with China have provided a great deal of impetus to this debate. The first event was the Chinese military victory over India in 1962; the second, China's first nuclear weapon test in 1964; the third, the launching of a Chinese satellite in 1970. While there seems to be a strong pro-bomb lobby in the country, the Indian government has repeatedly said that it does not want nuclear weapons. This may be illustrated by the statements of three successive Indian Prime Ministers:

Prime Minister Nehru in 1957:

We have declared quite clearly that we are not interested in making atom bombs, even if we have the capacity to do so, and that in no event will we use atomic energy for destructive purposes. [18]

Prime Minister Shastri in 1964:

We in India stand committed to use atomic energy only for peaceful purposes and even though, in a purely technical and scientific sense, we have the capability of developing nuclear weapons, our scientists and technicians are under firm orders not to make a single experiment, not to perfect a single device which is not needed for peaceful uses of atomic energy. [24]

Prime Minister Gandhi in 1968:

India has repeatedly announced that she is not making an atom bomb and that she is developing her atomic energy programme exclusively for peaceful purposes ....

The choice before us is not only the question of making a few atomic bombs, but of engaging in an arms race with sophisticated nuclear warheads and an effective missile delivery system. Such a course, I do not think would strengthen national security. On the other hand, it may well endanger our internal security by imposing a very heavy economic burden which would be in addition to the present expenditure on defence. Nothing will better serve the interests of those who are hostile to us than for us to lose our sense of perspective and to undertake measures which would undermine the basic progress of the country. We believe that to be militarily strong, it is equally important to be economically and industrially strong. Our programme of atomic energy development for peaceful purposes is related to the real needs of our economy and would be effectively geared to this end. [18]

The arguments of those who advocate nuclear weapons for India have mainly related to the alleged threat to India from a hostile China. It is maintained that, as a non-aligned country and China's potential rival in Asia, India must be able to provide for its own security by deterring any Chinese advances. Pakistan is apparently no longer considered a serious threat. The cruder arguments refer to the necessity of having nuclear weapons in order to stop Chinese attacks in the Himalayas. In the more sophisticated argumentation, nuclear weapons are regarded as essentially political weapons, and it is maintained that India must have these in order to become an equal of China and prevent the great powers from bullying India. The status argument is probably one of the most important; the fact that all the present nuclear-weapon powers have a special status as permanent members of the Security Council is resented. It is also felt that since nuclear weapons seem to provide a stable deterrent situation in Europe, there is no reason why they should not do so in Asia. The argument that a broadly based nuclear weapons programme would produce important technological and economic spin-off effects is put forward, too. [25, 26, 27]

However, most of India's nuclear debate has centred on the cost issue. Various estimates have been put forward for different types of nuclear forces, ranging from highly optimistic ones to estimates which are clearly beyond India's capabilities. Most estimates take as their basis the two figures of $1 700 million for a modest nuclear force and $5 600 million for a small, high-quality force over 10 years given in the UN experts' report. The annual outlays required are then compared with the Indian defence budget of, at present, approximately $1 600 million. Other studies indicate, however, that in particular a sophisticated nuclear force of the French variety (which may cost about $10 000 million) would exceed India's resources. A nuclear physicist of the Rand Corporation, writing in 1967, said that "developing a limited capability of satisfactory quality would require annual expenditures in excess of the existing Indian defence budget" [28]. And an ACDA study of the effects of defence on developing economies, made in 1971, said about the costs of an Indian nuclear force:

> The building of a nuclear *force de frappe* was estimated to cut officially projected growth by a third. Its chief danger would be that it would be militarily useless and even dangerous, and that by the time this was politically acknowledged, the prior investment made in it would exert enormous pressure on the government to move ahead to a much more expensive programme with a retaliatory capability.
>
> To attempt to obtain such a capability within a limited and militarily significant period would be economically disastrous, since it would cost nearly as much as two years of total national product. If attempted by 1980 it would *reduce* the compounded civilian growth rate to *minus* 3.33 per cent a year. [29]

Other estimates indicate that the build-up of an intermediate nuclear force would push up the Indian defence budget to 37 per cent of the GNP by 1980, while the GNP itself would be reduced by 25 per cent in constant prices, compared to 1968; and that, in particular, it would be beyond India's means to develop the inter-range ballistic missiles required for any credible force. [30]

Assessment

In conclusion the following points may be made:

1. India has a broadly based nuclear development programme which eventually is likely to give it near, if not complete, self-sufficiency in nuclear technology, including nuclear weapons production. India is also making some advances in aircraft and spacecraft production.

2. The government is against the Non-Proliferation Treaty for a number of reasons. Whether it will change its attitude within the near future, when the NPT's provisions on supply of fissionable material and other assistance begin to take effect and before India has achieved self-sufficiency, remains to be seen.

3. The main factor influencing India's position on the NPT and on the nuclear weapon issue is its security situation, which to a large measure is perceived in terms of a Chinese threat. By not signing or acceding to the NPT so far, India has in fact signalled the seriousness of its attitude, including its nuclear option, to China and to the USA and the USSR. It is possible that India's recent military victory over Pakistan may so have stimulated its self-confidence that going nuclear becomes an attractive prospect for status reasons.

4. Even if India were to become a party to the NPT, it is likely to continue with its nuclear development programme, which will preserve the technical capability option for the future.

5. If India were to go nuclear it would probably, considering its size and security requirements, opt for a *force de frappe* of the French variety; nothing less would be of much use to India militarily. A start with a military weapons programme might be made in the field of peaceful nuclear explosives, in which India has taken an active interest. No national decision on the issue will probably be taken before 1974–75 when India's first indigenously produced plutonium becomes available on a large scale from the Kalpakkam reactor. Even so, the lack of suitable delivery systems for nuclear weapons will for a long time remain a serious constraint for a credible Indian nuclear weapons policy.

6. Besides the costs (which would weigh relatively much more heavily on India than on a developed country), the fact that nuclear weapons may not indeed provide added military security and that their long history of non-use may render them politically useless with time, speaks against India going nuclear, as it does for any other country.

7. India is clearly divided on the issue, and with a change of government the assessment of India's needs and requirements may be perceived differently from now. However, it is not only the bomb-lobby but also a strong force of traditional Indian non-violence attitudes which are shaping Indian public opinion and politics.

Pakistan

Pakistan's attitude to the non-proliferation of nuclear weapons is mainly determined by its fear of a nuclear India. Its position on the NPT, which it has not signed, demonstrates the interaction of security interests in a sensitive region. Pakistan is not a high-technology country and so would have great difficulty in exercising any nuclear weapons option. Therefore it has been seeking other protection for its security, through relationships with the United States and China. With the recent loss of East Pakistan, Pakistan's security situation has profoundly changed; now less than ever before can it counterbalance India militarily.

Nuclear technology in Pakistan

Pakistan has a modest nuclear programme, far from comparable with the Indian programme. The construction of its first nuclear power station has recently been completed with Canadian assistance. The station is situated outside Karachi and uses a Canadian 125 MWe natural uranium, heavy-water reactor. It is placed under IAEA safeguards. There have been plans for other nuclear power stations too, but so far they seem not to have advanced beyond the planning stage. In 1968 the Soviet Union undertook a feasibility study of a 140 MWe nuclear power plant in East Pakistan but as a result of the study dissuaded Pakistan from the project. Pakistan has also taken some interest in a nuclear desalination plant.

Some uranium mineral deposits have been found in the country during the last few years. In 1969 the Pakistan Atomic Energy Commission put into operation a pilot plant for the extraction of uranium ore at the Atomic Energy Centre, Lahore.

In the nuclear field, Pakistan has cooperated with a number of countries, including Canada, the Soviet Union, France, Italy, Australia and Czechoslovakia.

Pakistan's position on the Non-Proliferation Treaty

The Pakistani government has taken a positive attitude to the Non-Proliferation Treaty as such, but has indicated that it feels unable to adhere to the NPT because of its apprehension of Indian policies, in particular the fact that India is not prepared to accept the NPT. Obviously, Pakistan fears that India may go nuclear and therefore wants to preserve at least a theoretical nuclear option by not becoming a party to the NPT.

The general Pakistani attitude to adhering to the NPT may be illustrated by two statements made during the 1968 NPT debates in the United Nations: "The value of the treaty would largely depend on the extent of the unqualified adherence that it commands. In this context the attitude of the potential nuclear-weapon states will be of crucial importance" [31]; and "In the final analysis, the position of Pakistan with regard to signing the treaty will turn on considerations of its own enlightened national interest and national security in the geopolitical context of the region in which Pakistan is situated" [32].

Pakistan has been particularly concerned about the question of security guarantees. Like India, it regarded the joint USA–UK–USSR draft security assurances as inadequate and demanded that a security guarantee be given not on the basis of whether a country has adhered to the NPT but on whether it has renounced nuclear weapons. At the Conference of Non-Nuclear-Weapon States in September 1968, the initiative for which had come from Pakistan, Pakistan proposed that an effective security guarantee should contain the following provisions:

1. Prohibition of first use of nuclear weapons by nuclear-weapon states against non-nuclear-weapon states.

2. Immediate assistance to be given to non-nuclear-weapon states which are victims of nuclear aggression.
3. Assistance should be forthcoming before the Security Council can act.
4. The security guarantee should include all non-nuclear-weapon states which have renounced the manufacture or acquisition of nuclear weapons, irrespective of whether they sign the NPT or not. [33]

On a similar line, Pakistan has demanded that nuclear-weapon states should provide assistance in nuclear technology only to those non-nuclear-weapon states which have effectively renounced nuclear weapons, but irrespective of whether they are parties to the NPT or not.

On peaceful nuclear explosives Pakistan has taken a strict position, presumably out of fear that such explosives may be an avenue for an Indian nuclear weapons programme, stating flatly that "there is no difference whatsoever between an explosive nuclear device and a nuclear weapon: each is a bomb" [34]. Lately, Pakistan appears to have been more anxious than India to achieve a comprehensive nuclear test ban, which might introduce further restrictions on peaceful nuclear explosives.

Assessment

Pakistan's attitude to nuclear weapons and to the Non-Proliferation Treaty is determined by its relationship with India. While it apparently has no intention, or capability, of developing nuclear weapons itself, Pakistan has wanted to signal the determination of its position by not adhering to the NPT. At the same time, Pakistan has tried to achieve what it considers to be more effective guarantees for its security than the ones jointly agreed by the USA, the USSR and the UK; it has also tried to pursue disarmament measures as a means of increasing its national security. Pakistan's nuclear technology programme is so modest that it will probably not be forced for economic reasons to become a party to the NPT when its supply provisions become effective. The conclusion is, therefore, that Pakistan is likely "to sit on the fence" over the NPT until there is a change in the Indian position.

Israel

Of those countries which have not joined the NPT, Israel is probably in the most vulnerable security situation. Surrounded by hostile neighbouring states, it has been fighting for its right to exist since its establishment as an independent state in 1948. At the same time its situation has been influenced by the strategic interests of both the United States and the Soviet Union. Israel is technologically superior to the Arab states and has had a domestic nuclear programme going for more than a decade. Its conventional forces are well-equipped but may in the long run become inferior to any conventional forces marshalled against Israel by the Arab countries.

The Israeli nuclear programme

Israel has a small nuclear programme which produces sufficient plutonium for it to go nuclear, should it wish to do so. Israel has two nuclear research reactors: the IRR-1, constructed in 1959 with US assistance and placed under IAEA safeguards; and the IRR-2, near Dimona, constructed in 1960 with French assistance but not subject to French or IAEA safeguards. The Dimona reactor has aroused most interest, partly because of the fact that it is run by the military and that its operations are surrounded by secrecy. In the 1960s there were reports that the Israelis had opened it to informal annual inspections by US officials to assure the United States that it was not being used for military purposes [35].

The plutonium produced in the Dimona reactor in 1964–69 is estimated to amount to about 40 kg., which might suffice for 3–5 single nuclear weapons. As far as is publicly known, however, Israel has no plutonium separation plant. On the other hand, it is feasible to set up a small plutonium separation facility on a laboratory scale. Further, the details of Israel's nuclear agreements with France are not known. Israel does not have a uranium enrichment plant.

No commercial nuclear power station has yet been built in Israel. Considering the small size of the Israeli economy such a station would probably not be economical. However, Israel has been interested in a project for a combined nuclear desalination and electricity producing plant, on which it is seeking US cooperation. There have been reports that the United States has been hesitant to extend such cooperation as long as Israel is not willing to accept IAEA safeguards on all its nuclear installations, because the USA believes the project may produce too much plutonium of potential military value [36].

Israel has no easily accessible uranium resources. However, it has good resources of phosphate and oil-shale, from which uranium can be extracted as a by-product in the processing. The uranium produced in this way may suffice to fuel the Dimona reactor.

In the nuclear field Israel has cooperated extensively with France, but it also has cooperation agreements with several other countries, among them Brazil.

Israel and the NPT

Israel has not signed the NPT, while most of its Arab neighbours have. For constitutional reasons Israel would have had to sign and ratify the NPT in one operation before March 1970, had it then been prepared to take such a step [37].

Officially, Israel has taken the position that it endorsed the treaty in principle when it voted in favour of the UN resolution commending the text (but so did Pakistan and South Africa, neither of which has signed the NPT, and many other countries which have not ratified it) and that it is still engaged on a "deep, thorough, prolonged study to establish its attitude toward the Treaty" [38].

Israel has clearly indicated that the main reason why it has not joined the NPT is concern about its security situation. During the NPT debate in the United Nations in May 1968, the Israeli delegate said on this point:

> For obvious reasons my country has a special sensitivity to the security aspect. We are involved in an unresolved conflict in which our security is being threatened and which has thrice in two decades erupted into armed hostilities. That conflict is marked by a massive and unchecked arms race of conventional weapons which, by our standards, have a vast capacity to kill and destroy. We cannot know what dangers and threats may confront us in the future. It is only natural that we should give earnest scrutiny to the security provisions intended to accompany and compensate for the restrictions that non-nuclear powers would voluntarily assume under the treaty. [39]

In November 1968 there were reports that Israel had offered the United States to sign the NPT in exchange for a bilateral US–Israeli defence agreement [40]. If true, nothing came of this proposal.

In official statements about the NPT, Israel has often pointed to the dissemination of conventional weapons, which, it has said, "poses dangers no less grave and frequently more immediate than that of nuclear arms" [39, 41]. It has also criticized the discrimination between nuclear-weapon and non-nuclear-weapon states inherent in the NPT and showed sensitivity over the safeguards provisions. In that latter respect Israel is in a special position because it does not belong to any regional grouping within the IAEA; and no Israeli is employed by the IAEA.

Israel and "the bomb"

The Israeli government has repeatedly denied that Israel has any nuclear weapons, but some of the statements have been somewhat ambiguous. David Ben-Gurion, the first Israeli Prime Minister, officially stated that Israel's nuclear reactors were being operated only for peaceful uses of nuclear energy and not for atomic weaponry [42]. Prime Minister Levi Eshkol said in 1964 that Israel will not be the first country to introduce nuclear weapons into the Middle East [43]. And his successor as Prime Minister, Mrs Golda Meir, said in an interview in the spring of 1969: "Israel has no nuclear bomb, Israel has no intention of using nuclear bombs" [44]. These assurances have been repeated since.

On the other hand, Mr Eshkol is reported to have said in 1968 that Israel knew how to make a nuclear weapon, but from there it was a long way to an application [45].

It may safely be assumed that the Israeli statements have been intentionally vague so as to have a deterrent effect on the Arabs [46]; the same purpose is served by delaying any accession to the NPT and by the secrecy over the Dimona reactor.

During the last two years there have been several private reports, some of them apparently eminating from US intelligence, which have indicated that Israel may already have a crude nuclear weapons capability [47]. The reasons advanced for such an opinion are roughly the following:

1. Israel's nuclear programme produces enough plutonium for about one small nuclear warhead per year. There is substantial military secrecy surrounding the programme.

2. Israel should be capable of assembling at least a crude device; it may have what is termed a "turn-key" capability. It has the means of delivery—for instance Phantom aircraft and a short-range (440 km.) missile—required for the distances that may be involved. It is not likely that costs would be a major obstacle to a minimum Israeli nuclear weapons programme.

3. Because of Israel's special security situation, including its vulnerable geographic position, a few crude, even untested, nuclear weapons which could be delivered over short distances is all that might be required in another all-out war with the Arabs in which Israel was threatened with being overrun.

Assessment

In the local conflict situation prevailing in the Middle East, it is probably in Israel's interest to preserve the uncertainty about its real intentions in the nuclear weapons field. This might fulfil a certain deterrence function *vis-à-vis* hostile powers. This uncertainty might not be entirely dispelled if Israel should accede to the NPT because (*a*) it could exercise the withdrawal option, and (*b*) it could develop nuclear weapons technology up to a point of withdrawal from the NPT minus an X period of time, which can be very short.

If Israel were to embark on a nuclear weapons programme it would presumably not announce this, nor even that it might have a nuclear weapon. To do otherwise might worsen Israel's security situation because of Arab and Soviet reactions; in addition it would alienate Western opinion.

It might also provoke Egypt to try to go nuclear, although that country would doubtless require a much longer period of time to develop a nuclear capability than Israel (see below).

Even if Israel were to have nuclear weapons in the future, it would presumably continue to rely on its conventional forces to dispel any invading enemy forces and only contemplate use of nuclear weapons as a last resort. For this purpose one or two devices may suffice.

If this analysis is correct, one would expect that only a long-term settlement of the Middle East conflict and/or a strong Western defence guarantee for Israel might prevent Israel from developing any nuclear weapons option it may now have.

The Arab Republic of Egypt

Egypt's nuclear policies are mainly of interest in relation to Israel, in much the same way as Pakistani policies are of interest in relation to India. Egypt obviously has grounds for fearing Israel's capabilities. Egypt has a weak nuclear technology in comparison with that of Israel, although it is able to compete with Israel in other areas, for instance in overall economic resources and manpower.

The Egyptian nuclear programme

Egypt is reported to have a small Soviet research reactor at Inchas near Cairo. Although it is not under IAEA safeguards, it is probably too small for any production of weapons-grade plutonium.

Plans have been put forward for a 150 MWe power reactor near Alexandria but construction has not yet started; the project would obviously require a great deal of foreign assistance, presumably from the Soviet Union, if it were to materialize [48]. Some consideration has also been given to the construction of a 500 MWe power station after 1975.

At the Conference of Non-Nuclear-Weapon States in 1968, Egypt indicated that it was interested in projects for sea-water desalination and in prospects for tapping large underground water reservoirs and for excavation by means of nuclear explosives [49].

Egypt and the NPT

Egypt took a positive attitude to the Non-Proliferation Treaty when it was being negotiated in 1965–68, claiming that it would effectively stop horizontal proliferation of nuclear weapons. Thus, Egypt wanted the treaty to be of unlimited duration. Together with most Arab countries, Egypt signed the NPT in July 1968, but has not yet ratified it.

The reason for Egypt's delay in ratifying the NPT is obviously connected with the fact that Israel is not prepared to become a party to the treaty. During the NPT negotiations, Egypt indicated its concern for effective security guarantees for victims of nuclear aggression. It regarded the draft USA–UK–USSR security assurances as insufficient, asking instead that the assurances be made in the form of a pledge by the nuclear-weapon powers to consider the threat or use of nuclear weapons against a non-nuclear-weapon party to the treaty as sufficient reason to prevent and even to retaliate against nuclear aggression as a measure of collective self-defence. Egypt demanded that the three nuclear-weapon powers should categorically prevent nuclear aggression. It also stated that "it is of utmost importance that the treaty include the potential nuclear States—States which are on the threshold of becoming nuclear—in order to be meaningful" [50].

Assessment

The risk that Egypt should go nuclear within the near future seems rather slight. On the other hand, it will probably continue to be apprehensive of any new Israeli developments in the nuclear field and may not ratify the Non-Proliferation Treaty as long as Israel does not accede to it. It should be recalled that Egypt is practically as vulnerable to nuclear weapons as Israel, because of the high concentration of its population around Cairo and Alexandria; further, destruction of the Aswan dam would have disastrous consequences for the Egyptian people. Therefore, if a stable solution to the Middle East conflict cannot be achieved, Egypt will probably have to rely on Soviet support against Israel—as far as the Soviet Union is prepared to go.

South Africa

There are several reasons why South Africa's nuclear policies are of interest: the Republic has some of the world's largest uranium resources, about 300 000 tons in the economically exploitable price range. It has made substantial advances in nuclear technology, recently claiming a breakthrough on a new uranium enrichment process. It has not yet become a party to the NPT. And it is in potential conflict with the rest of Africa and the international community over its race discrimination policies.

South Africa's nuclear programme

As stated above, South Africa has very large uranium resources of great economic value. The uranium is extracted as a by-product in the mining of gold. So far, South Africa has been exporting its uranium as "yellow-cake" concentrates for enrichment elsewhere.

In July 1970 the Prime Minister of South Africa reported that South African scientists had invented a new process for uranium enrichment, which was to be applied in South Africa. The Prime Minister said that the South African Atomic Energy Board had been engaged since 1959 on a development programme for processing South African uranium to a more advanced form than uranium concentrate. He gave two main reasons for South Africa's interest in enriched uranium:

1. As a result of the increased demand for uranium in the enriched form, it is obvious that South Africa, as one of the largest uranium producing countries in the world, will consider it in its own interest to market uranium in the enriched form.
2. South Africa finds itself on the eve of a large nuclear power programme of its own—of the order of 20 000 megawatts (electrical) by the end of this century. If such a programme can be based on enriched uranium, it will result in a very marked capital saving. However, such a course can only be followed if the supply of enriched uranium can be guaranteed, which, in the difficult world in which we live, implies own production. [51]

The details of this process have not been disclosed. It is said to be unique and economically competitive with the gas diffusion method used by Western nuclear-weapon powers. However, it appears to be a mixture of existing enrichment techniques, possibly thermal diffusion and gas centrifuge. Emphasizing that South Africa's nuclear research and development is directed entirely towards peaceful purposes, the Prime Minister said in his July 1970 statement that South Africa was prepared to collaborate in the exploitation of the new process with any non-communist countries desiring to do so.

A pilot plant has been constructed for the production of South African enriched uranium. Managed by the South African Uranium Enrichment Corporation and situated at Pelindaba, near Pretoria, it started to produce enriched uranium in 1971. [52] When Prime Minister Vorster inaugurated the plant in August 1971, he stated that in 1980 South Africa would produce 6 000 tons of enriched uranium per year, equal to 14 per cent of the Western world's trade demand in 1980 and having an export value of about $290 million.

South Africa has at present a large nuclear research reactor but no nuclear power station. It plans to build a 350 MWe station in the Western Cape, which should start operations in 1978–1980.

South Africa has also shown an interest in peaceful nuclear explosives. The 1969 report of the Atomic Energy Board said that research was being conducted on building harbours, canals and other enterprises which required the removal and repositioning of large amounts of earth using nuclear explosives, and that the mechanics of crater formation were being investigated through model experiments [53].

South Africa and the NPT

South Africa has said that it strongly supports the objective of non-proliferation and that the reason that it has not yet acceded to the NPT is primarily connected with the application of safeguards. It has given repeated assurances on its uranium supply policies and on its own nuclear energy programme:

> One does not require special insight or foresight to realize the dangers to the security of the world inherent in the proliferation of countries possessing atomic weapons. It was indeed this realization which motivated South Africa in deciding many years ago, as one of the major producers of uranium in the Western world, to do absolutely nothing in the context of uranium sales to foreign buyers which might conceivably contribute to an addition to the ranks of the nuclear-weapon States. Formal assurances on this point were given in a number of quarters, *inter alia,* to the General Conference of the International Atomic Energy Agency, when the leader of the South African delegation said, on 22 September 1966:
>
> "South Africa is acutely conscious of her special responsibilities as a major uranium producer in relation to the problem of nuclear proliferation, and I should like here to repeat the assurance we have given elsewhere that it is South African policy, in the context of uranium sales, to do nothing which might conceivably add to the number of Powers with nuclear-bomb capability."
>
> This was our policy in the past, and it remains our policy. Our conscience as a producer of uranium is clear on this issue; our record is unblemished. The international community will readily acknowledge this. And, so far as our own atomic-energy programme is concerned, this programme, as we have so often stated . . . is devoted to peaceful purposes exclusively. [54]

When the Non-Proliferation Treaty was opened for signature in 1968, South Africa gave as the main reason for not signing the treaty its apprehension that the application of safeguards might be economically harmful to South Africa as a major uranium-producing country. In July 1970 Prime Minister Vorster indicated that South Africa would accede to the NPT provided there was a satisfactory solution to the safeguards issue:

> I also wish to state emphatically that South Africa is prepared to subject its nuclear activities to a safeguards system including inspection, subject to the conditions that:
>
> (i) South Africa will in no way be limited in the promotion of the peaceful application of nuclear energy;
>
> (ii) South Africa will not run the risk of details of the new enrichment process leaking out as a result of the safeguards inspection system; and

(iii) The safeguards system, while efficient, is to be implemented on such a reasonable basis as to avoid interference with the normal efficient operation of the particular industries.

South Africa has not yet acceded to the non-proliferation treaty, and has on various occasions clearly stated that it would consider participation as soon as the safeguards system to which South Africa would be subjected, is known. The International Atomic Energy Agency is at present devising its safeguards system and as soon as its nature and scope are known, South Africa will seriously consider accession to the treaty in the light of the foregoing exposition. [51]

Assessment

The recent South African statements indicate that South Africa might be willing to join the NPT in the near future. This may also be in its long-term economic interest since it intends to become an exporter of enriched uranium and otherwise might have difficulties in marketing its supplies.

As to South Africa becoming a nuclear-weapon power there can only be speculation. A few observations indicate the issues. Although South Africa has started to produce enriched uranium this probably has only a low enrichment for use in nuclear power reactors; that South Africa will produce weapons-grade enriched uranium seems improbable. If this is so, South Africa will have to wait until 1978–80, when its first nuclear power station will start to produce plutonium, to get access to fissionable material for weapons purposes (assuming that the station will not then be under IAEA safeguards, as it may well be). South Africa is in potential conflict with the rest of Africa over its racial policies. As yet there does not seem to be any real threat to South Africa's security. Should such a threat develop in the future and should South Africa's present superiority in conventional weapons over the Black African states be eroded, it is conceivable that South Africa would then consider the possibility of developing nuclear weapons—particularly if the proliferation process had started by one or two other near-nuclear countries going nuclear. In such a case, South Africa would of course be open to both a Soviet and a US reaction while not being in a position to deter either.

Japan

In several respects Japan is a key country with regard to the non-proliferation issue. Although it started late in the development of nuclear technology, it advanced rapidly and is now one of the leading countries in the civil nuclear field. Economically, though not militarily, Japan is a great power. It signed the Non-Proliferation Treaty only after a long period of hesitation. In the future, Japan may have security problems in relation to

China and the Soviet Union, particularly if present US policies should change and Japanese ambitions grow. At the same time Japan has strict constitutional and legal limitations on nuclear weapons. And there is the nuclear trauma from the time of Hiroshima and Nagasaki.

The development of nuclear technology in Japan

Japan's nuclear development programme only started in the mid-1950s but it has already reached large proportions. The reasons are obvious. Japan is a major industrialized country but it lacks cheap energy resources. For Japan, nuclear power therefore presents clear attractions in order to increase self-sufficiency and improve the balance of payments. In 1971 Japan had five nuclear power reactors with an installed capacity of about 1 300 MWe. Plans call for installed capacity to reach 15 000 MWe in 1977, and between 30 000–40 000 MWe in 1985. Almost all of this nuclear power will be provided by Japanese-built reactors. By 1985 nuclear power is expected to supply one-fourth of Japan's electrical power demand [55]. According to a 1971 report by the Japan Atomic Industrial Forum, this proportion is estimated to rise to 50 per cent in 1970 and 70 per cent in the year 2000.

Because of its large nuclear power requirements, Japan has a substantial interest in the supply of enriched uranium. So far, it has been supplied solely by the United States but according to present agreements US supplies are only assured for those reactors which are constructed up to 1973. For reactors constructed after that year, a further supply of enriched uranium is required. The Japanese demand for enriched uranium is estimated to rise to about 8 000 tons of separative work units[10] by 1985, making Japan the second or third largest consumer of enriched uranium by that year. Several options are open to Japan in order to meet its requirements for enriched uranium: construction of a domestic enrichment plant; a joint venture with a foreign country for constructing a plant outside Japan; and purchase of enriched uranium from non-US suppliers. For several years Japan has carried out research on both the gas diffusion and the gas centrifuge processes; in the spring of 1972 its first ten experimental gas centrifuges will become operational. It was reported in 1970 that Japan had asked the USA to supply information on enriched uranium technology and that the USA was prepared to extend such cooperation [56]. However, it has still not been established that a domestic enrichment plant would be an economical proposition for Japan. In addition, two other considerations

[10] A separative works unit, SWU, is a unit used to measure quantity of enriched uranium, but the actual amount the unit represents depends on the enrichment; for example, 100 tons of separative work equals 23 tons of uranium enriched to 3 per cent.

may influence a decision on a domestic plant: (*a*) an enrichment plant would be an obvious target in a nuclear war, a war in which Japan would be very vulnerable; and (*b*) the construction of a domestic enrichment plant might give rise to suspicion that Japan contemplates becoming a nuclear-weapon power.

The second alternative mentioned earlier seems to be the most attractive at present and there have been several reports about Japan's interest in joint ventures in uranium enrichment. The most topical scheme centres round a French offer to Japan for joint production of enriched uranium in a plant to be built before 1980 in Australia or in Europe; a decision on this plan will be taken in 1973 [57]. But other schemes have also been discussed, involving Canada and the United States as well as Japan. In particular, there seems to be rivalry between France and the United States to enlist Japanese cooperation. Finally, there were in 1971 reports that the Soviet Union had offered to sell enriched uranium to Japan [58].

The production of plutonium in Japan is expected to amount to 3 000 kg. in 1975 and 15 000 kg. in 1980. A chemical separation plant for plutonium is now being constructed with French assistance. It is scheduled to start operations in 1974.

By contrast, Japan lacks any exploitable uranium resources of its own. It is therefore dependent on the importation of natural uranium, even if it should develop its own enrichment facilities. Japan's requirements for natural uranium have been estimated to amount to 120 000 tons by 1985. In order to secure the supply of uranium, Japan has been prospecting abroad through its Overseas Uranium Resources Development Company. In particular, Japan has concluded a cooperation agreement with the French Atomic Energy Commission for the exploitation of uranium in Niger. Similar agreements with Italy have also been reported [59].

Japan is trying to develop both fast-breeder and advanced thermal conversion reactors. When this has been achieved its nuclear fuel supply problem will be partly solved.

As regards practical applications of nuclear energy, Japan has been engaged since 1963 on the construction of a nuclear-powered merchant ship—an 8 000 ton special cargo ship. Sea trials will start in 1972 and experimental operation is scheduled to begin in 1975 [60]. Some research has also been initiated on a nuclear-powered submarine merchant ship [61].

Japan has indicated an interest in the peaceful application of nuclear explosive devices, although it accepts the thesis that at the present stage of nuclear technology it is virtually impossible to distinguish between peaceful nuclear devices and nuclear weapons. It has also declared interest in such devices as fast critical assemblies, reactor excursion facilities and fusion reactors. This may be important since the information acquired from studying these devices has both civil and military applications.

Japan and the NPT

Japan only signed the Non-Proliferation Treaty in February 1970 after long hesitation; it was among the last countries to sign before the treaty went into force on 5 March 1970. Japan has still not indicated when it intends to ratify. One reason why Japan signed was probably that it wanted to take part in the important safeguards negotiations which were about to begin; and this would have been impossible without signing the NPT. At that particular time Japan was also engaged in sensitive negotiations with the United States over the return of Okinawa. The fact that West Germany had signed shortly before might also have influenced the Japanese signature.

When the Japanese government signed the NPT, on 3 February 1970, it issued a long list of reservations about its position, stating that it was deeply concerned with the matters listed and that it would take them into account before ratifying the treaty as well as when it participated in any future review conferences. These reservations are summarized here:[11]

1. Japan viewed the NPT as a first step towards nuclear disarmament and voiced hope especially that France and China would become parties to the treaty.

2. The discrimination inherent in the fact that the NPT permitted only the present nuclear-weapon states to possess nuclear weapons should ultimately be made to disappear through the elimination of nuclear weapons from the national arsenals of all the nuclear-weapon states. For attaining the purposes of the treaty it is essential that, above all, the nuclear-weapon states should take concrete nuclear disarmament measures in pursuance of their undertaking under Article VI of the NPT.

3. Nuclear-weapon states must not have recourse to the use of nuclear weapons or threaten to use such weapons against non-nuclear-weapon states.

4. The Japanese government attached great importance to the USA–UK–USSR declarations on security assurances to non-nuclear-weapon states. It would pay particular attention to the implementation of the Security Council resolution and continue to make a close study of other problems which required consideration for the safeguarding of its national interests.

5. The government took note of the provision of Article X of the treaty: "Each Party shall in exercising its national sovereignty have the right to withdraw from the Treaty if it decides that extraordinary events, related to

[11] SIPRI summary.

the subject matter of this treaty, have jeopardized the supreme interests of its country."

6. The treaty must in no way restrict non-nuclear-weapon states in their research, development or implementation of the peaceful use of nuclear energy, or in their international cooperation in these fields, nor must it subject them to discriminatory treatment in any aspect of such activities. In particular, no peaceful nuclear activities in non-nuclear-weapon states should be restricted or prohibited—nor should the transfer of information, nuclear materials, equipment or other material relating to the peaceful use of nuclear energy—merely on the grounds that such activities or transfers could also be used for the manufacture of nuclear weapons or other nuclear explosive devices.

7. The safeguards agreement to be concluded by Japan with the IAEA must not subject it to disadvantageous treatment as compared with the safeguards agreements which other parties to the NPT conclude with the IAEA, either individually or collectively. Safeguards should be subject to the principle that they should be applied at certain strategic points of the nuclear fuel cycle. Furthermore, adequate measures must be taken to ensure that the application of safeguards does not cause the leakage of industrial secrets or otherwise hinder industrial activities. [62]

During the NPT negotiations Japan also showed concern over the long period of duration of the NPT, 25 years. Further it has maintained that the treaty does not exclude nuclear alliance agreements. A particularly critical issue to the Japanese government has been the application of NPT safeguards, which has met with opposition from the Japanese nuclear industry. Japan has insisted, as indicated in the government statement, that there should be no discrimination between Japan and the Euratom countries, which are seeking a safeguards agreement with the IAEA which merely verifies the operation of the Euratom inspection system (see page 336). Japan is already subject to bilateral IAEA safeguards and some of the inspections carried out under these schemes seem to have been rather stringent, causing resentment within Japanese industrial circles [63].

Japan and nuclear weapons

Several factors speak against Japanese nuclear weapons:

1. Article IX of the Japanese Constitution provides that "the Japanese people forever renounce war as a sovereign right of the nation and the threat or use of force as a means of settling international disputes"; and further that "land, sea, and air forces as well as other war potentials will never be maintained". The 1970 Japanese Defence White Paper does not exclude

"defensive" nuclear weapons on the basis of the constitutional provisions (see below), but it states that "in any case Japan cannot possess weapons which will pose a threat of aggression to other nations such as long-range bombers like B-52s, attack aircraft carriers, and ICBMs" [64].
2. The Basic Law on Atomic Energy of 1955 provides that "research, development and utilization of atomic energy shall be limited to peaceful purposes and shall be undertaken in manners democratic and independent of foreign interventions, and the result thereof shall be opened to the public and used for positive international cooperation" [65].
3. The government has put forward "the three-point non-nuclear principles" as its policy: the non-production, non-possession and non-introduction of nuclear weapons. In accordance with this policy, Japan has not allowed the United States to station or to introduce nuclear weapons onto Japanese territory. The only exception to this policy has been Okinawa which has been occupied by US forces; when Okinawa is returned to Japan in 1972, US nuclear weapons on the island will presumably have to be removed—although there may still be some disagreement between the US and Japanese governments on the implementation of this policy.
4. Japan has a bilateral defence treaty with the United States and would therefore presumably be covered by the US "nuclear umbrella".
5. Because its territory is so small—as compared to the USA, the USSR and China—and because of its high population density, Japan would be in a vulnerable position if it were to become involved in a nuclear war.
6. The trauma of the nuclear weapons dropped on Hiroshima and Nagasaki is still a strong factor in Japan.

There are, however, a few trends which point to a certain erosion of some of these constraints:

1. Recently there has been some discussion in Japan that "defensive" nuclear weapons may be permissible under the Constitution. The 1970 Defence White Paper says on this point:[12]

> Even though it would be possible to say that in a legal and theoretical sense possession of small nuclear weapon(s), falling within the minimum requirement for capacity necessary for self-defence and not posing a threat of aggression to other countries, would be permissible, the government, as its policy, adopts the principle of not attempting at nuclear armament which might be possible under the Constitution. [64]

The question of the constitutionality of "defensive nuclear weapons" has now been brought before the Supreme Court of Japan. When US Secretary

[12] When the White Paper was published it was reported that an early version of the text had contained a statement that "Japan was against nuclear arms at present", but that this phrase was deleted in the final version. (*Japan Times*, 23 October 1970.)

of Defense Laird visited Japan in July 1971 there were some newspaper reports that he would view "with equanimity" a possible nuclear choice by Japan. This was subsequently denied by the US State Department which said: "We know of no responsible body of opinion in Japan or in the United States that advocates the possession of nuclear weapons by Japan or even foresees such a possibility." [66]

2. Despite Article IX of the Constitution, Japan does maintain the so-called Self-Defence Forces. The Air Force is equipped with US Phantom bomber aircraft, and an advanced US surface-to-air missile, the 108 Nike-J, is to be deployed in quantity around Japanese cities within a year or so; this missile could readily be fitted with a nuclear warhead. Japanese military expenditure is, however, relatively low, about 1 per cent of the GNP, but the current defence plan envisages an increase in absolute terms. Japan has sophisticated aircraft, electronics and shipbuilding industries which have an obvious military potential. In addition, Japan has developed an advanced space programme. In the beginning of 1970 Japan became the fourth space power by orbiting a satellite. It is experimenting with a solid fuel "MU" rocket, which reportedly could be developed into a long-range rocket capable of carrying about 5 000 kg. of equipment over a distance of 4 000 km. [67] In addition, Japan will produce US Thor rockets under licence, which will be used as the first stage for Japanese satellite-launching programmes in and after 1975.

3. Within a few years Japan will be self-sufficient in almost every aspect of nuclear technology, which theoretically may provide it with a nuclear option. The former Chairman of the US AEC, Mr Glenn Seaborg, stated in 1970 that "if Japan started today and went all out she could build a crude atomic bomb in three to five years". But he also said that it could not be done secretly and that it certainly would be an abrogation of Japan's international treaties. [68]

4. Japan has shown concern that the security situation in Asia may change during the long period of duration of the Non-Proliferation Treaty. Japan is clearly interested in how the strategic policies of China and the Soviet Union will develop in the future. It would not be surprising if the Japanese government occasionally had second thoughts about the effectiveness of any nuclear umbrella in the age of second-strike capabilities—hence the reported recurrent interest in Japanese defensive nuclear weapons (ABMs). Further, Japan may not always wish to be protected by the United States. There is also the possibility that in the future Japan might want to play a more active foreign policy role in East Asia, commensurate with its economic great power status, and that this might influence Japanese perceptions about developing nuclear weapons for quasi-political reasons.

Japan is in the long run not likely to remain inferior to China in any qualitative respect, not even in weaponry.

5. There are all the strong reservations entered about the Non-Proliferation Treaty, which is not popular with Japanese public opinion, neither on the right nor on the left.

6. Although "anti-bomb" feelings are still rampant in Japan, public opinion polls indicate a certain softening of these attitudes. In a poll by a leading Japanese newspaper in 1969, 16 per cent of those interviewed wanted Japan to have nuclear weapons while 72 per cent were against; 32 per cent believed that Japan would possess nuclear weapons within 10 years as against 35 per cent who believed that Japan would not. Another recent poll of the views of Japanese young people, conducted by Professor Tanaka, found that 55 per cent thought that Japan would have nuclear weapons within 20 years.

Assessment

The Japanese opposition to the Non-Proliferation Treaty appears rather entrenched and if there is no reversal of government policy it seems unlikely that Japan will ratify soon. However, if the NPT influences Japanese uranium supply policies negatively this might cause Japan to hasten ratification.

Irrespective of whether or not Japan ratifies the NPT, it will probably continue to develop its nuclear capability to the point of being able to go nuclear within a certain period of time, probably less than two years, should changing circumstances necessitate this in Japan's view.

Whether Japan would actually want to possess nuclear weapons is impossible to say. Japan will always remain geographically vulnerable to attack and will therefore probably never be able to pursue a credible deterrent policy against the major continental powers—the USA, the USSR and China. Considering that only a substantial nuclear capability would seem to be of any value in Japan's case, the high costs would also mitigate against a decision to go nuclear. Were Japan, on the other hand, to develop nuclear weapons in the future, a nuclear ballistic-missile submarine force is likely to be the preferred weapon system for security reasons.

Australia

Australia signed the Non-Proliferation Treaty on 27 February 1970, following West Germany and Japan. The treaty entered into force one week later. The many Australian reservations to the NPT, the fact that Australia is a wealthy country capable of advancing in nuclear technology and the government's perception of Australia's security interests give a certain profile to Australian nuclear policies.

Development of nuclear technology in Australia

Australia has made only a slow start in nuclear technology, despite the fact that it has rich deposits of natural uranium. Its first nuclear power plant, a 500 MWe station on the coast of New South Wales, is only now being designed; it will not be operational until the late 1970s. The reason for this slow development of nuclear energy in Australia is primarily that Australia has abundant resources of cheap coal.

During the last few years Australia has become interested in uranium enrichment technology, presumably both for commercial reasons—in order to enter the valuable enrichment market—and political reasons—in order to develop a nuclear-weapon option in the future. Some experimental work on gas centrifuges has been undertaken in Australia. During 1970 Australia indicated interest in participating in the Anglo-Dutch-West German gas centrifuge agreement. At the end of 1970 it was reported that a preliminary agreement had been secured; under the terms of this agreement Australia would gain access to the technology, provided that the output would not be used for weapons purposes and that the enrichment be subject to IAEA safeguards [70]. Earlier in 1970 it had been reported that a British group and a German group were competing for a contract to build a gas centrifuge plant for enriching uranium in Australia sometime between 1975 and 1980 [71]; the British offer was coupled to the sale of a British reactor for the New South Wales station. In July 1971 the United States offered to share gas diffusion technology with Australia—the same offer that had also been made to Japan and other Western nations. Finally, as mentioned above, there have been reports about Australian and Japanese cooperation on uranium enrichment.

Australia has also shown interest in peaceful nuclear explosives. In 1969 there were discussions between the Australian Atomic Energy Commission and the US AEC about excavating a harbour at Cape Keraudren in Western Australia by using thermonuclear explosives to be supplied by the United States. The project was soon shelved for political and technical reasons [72]; if realized, it might have conflicted with the partial nuclear Test Ban Treaty.

The Australian attitude to the NPT

Australia has been rather hesitant about the Non-Proliferation Treaty. The speech on the treaty by the Australian representative to the United Nations in May 1968 conveyed an unmistakably hostile tone. He mentioned the "Chinese menace" as a factor influencing Australian policies and continued: "Let it be said plainly, Australia would be bound to oppose any moves which it considered could increasingly expose it and its neighbours in Asia and the Pacific to the unrestrained nuclear capacity of Communist China." The statement also said that, if there was lack of détente between the nuclear-weapon powers, the peaceful settlement of disputes and the effective deterrence of aggression would also diminish: "In such circumstances, it would be unrealistic to expect nations exposed to threat, nuclear or conventional, to deny themselves the most effective means of defence they could acquire, including nuclear weapons." The withdrawal clause of the NPT was mentioned as "an essential ultimate resort for non-nuclear countries which might be faced with the prospect of aggression". [73]

The Australian signature of the Non-Proliferation Treaty at the end of February 1970 was preceded by a statement of intent by the Australian Prime Minister, saying, *inter alia,* that the decision to sign should not be taken in any way as a decision to ratify the treaty and that, as a matter of course, the treaty was not binding on Australia until it had ratified. The Prime Minister further said that the Australian signature would be accompanied by a series of reservations, and that Australia did not propose to ratify the treaty until matters of concern to Australia had been clarified to its satisfaction [74]. The main provisions accompanying the signature were the following:[13]

1. The government hoped that the treaty would lead to enhanced cooperation, in particular between the nations of the Asian and Pacific region.

2. It wished to be assured that there was a sufficient degree of support for the treaty.

3. It regarded it as essential that the treaty should not affect continuing security commitments under existing treaties of mutual security.

4. It attached weight to the statements by the governments of the USA, the UK and the USSR about security assurances to non-nuclear-weapon states.

5. It took note of the withdrawal article of the NPT.

6. It noted that the treaty would not inhibit nuclear research in non-nuclear-weapon states, stressing that there should be no discrimination against any state or states in their peaceful pursuits in nuclear activities. No nuclear development should be prohibited except when such activities had no other purpose than the manufacture of nuclear weapons or other nuclear explosive devices.

7. It expressed concern about the safeguards provisions, saying that there must be no unequal treatment and no burden on research, development, production and use of nuclear energy for peaceful purposes.

[13] SIPRI summary.

8. It would cooperate closely with other governments in seeking clarifications and understandings in relation to these matters, which must be resolved before Australia could proceed to ratification. [75]

Thus, Australia's main reservations to the NPT have concerned its implications for Australia's security. Australia is linked to the United States via the ANZUS and SEATO treaties. Less than two weeks after Australia had signed the NPT, the Australian Defence Minister stated in parliament that the United States had proclaimed that it would stand by its treaty obligations, despite some contraction of total US forces from the Pacific area [76]. As indicated above, the Australian government has claimed to take seriously the question of a Chinese nuclear threat for Australia. During the UN debates on the draft treaty in 1968, Australia showed some concern lest the nuclear disarmament promise contained in the NPT might lead the USA and the USSR to a situation in which they would be less able than now to deter Chinese nuclear aggression. The government appears also to have been concerned about the future nuclear policies of Indonesia, but this may be mutual: Indonesia only signed the NPT three days after Australia.[14]

Assessment

Despite the strong Australian reservations to the Non-Proliferation Treaty, it seems unlikely that in the final analysis Australia would want to stay outside the treaty, particularly if countries such as Japan, West Germany and Italy ratify. As a latecomer to nuclear technology, Australia will have a great deal to gain from the treaty's beneficiary provisions on assistance and cooperation in the nuclear energy field; Australia will also, at least until it has a uranium enrichment plant, stand to lose on any restrictions on nuclear supplies to non-parties to the treaty.

The question of Australian nuclear weapons seems rather remote, despite the apparent nuclear-option policy of former Prime Minister Gorton's government. First, Australia is not likely to be technically capable of producing nuclear weapons for a decade; in contrast to some other countries in the same category, however, Australia has a potential nuclear weapons carrier in its US F-4 aircraft. Secondly, although some concern has been expressed in Australia about the future nuclear policies of China and Indonesia, it would appear that the military alliance with the United States will offer Australia sufficient protection for its security.

[14] The Indonesian government's statement on signing the NPT said, *inter alia,* "that its decision to sign the Treaty is not to be taken in any way as a decision to ratify the Treaty. Its ratification will be considered after matters of national security, which are of deep concern to the Government and people of Indonesia, have been clarified to their satisfaction."

Spain

Spain did not sign the Non-Proliferation Treaty before 5 March 1970, nor has it acceded to the treaty since it entered into force. The reasons for this delay have probably been concern about Spain's security and about any adverse economic effects on its well-developed nuclear programme. There are two special features in Spain's security situation: it is situated strategically at the entrance to the Mediterranean and has the added problem of Gibraltar; it is linked to the United States through a bilateral military agreement.

Spain's nuclear programme

Spain has abundant natural resources of uranium and has embarked upon an ambitious nuclear programme. It has two operational nuclear power stations with a total capacity of nearly 600 MWe. Four more power plants are under construction or in an advanced stage of design. The total installed capacity will reach 3 600 MWe in 1977. A small chemical separation plant for plutonium has recently become operational. At the UN debates about the NPT in May 1968 the Spanish representative spoke enthusiastically of the economic benefits of peaceful nuclear technology. [77]

At the Conference of Non-Nuclear-Weapon States in 1968, the Spanish delegate stated that "Spain's raw materials and the level of its technological development would in fact have enabled it to undertake a military programme" [78].

The Spanish attitude to the NPT

In contrast to, for instance, Australia, Japan, Pakistan and South Africa, which have also been doubtful about the Non-Proliferation Treaty, Spain abstained in the UN vote commending the treaty; it was thus in the same company as, among others, Argentina, Brazil and India. [79] The main reason given for the Spanish position was concern about its security:

> Indeed it is no secret that my country is situated in a geographical area of the greatest strategic importance. The entrance to the Mediterranean is a veritable cross-roads. The military base of Gibraltar has been established on Spanish territory against our will and serves as a shelter for nuclear naval units; furthermore, it is in the service of one of the great military alliances to which ... we do not belong. [80]

Spain maintained that it required security guarantees because of its special situation. It found the Security Council resolution on security assurances insufficient, and wanted the text to include provisions for immediate and full implementation of the principle that the signatory nuclear-weapon powers would not threaten or attack with nuclear weapons the parties to the treaty that do not possess nuclear weapons [81]. Such a "negative" or "no-use" security guarantee is clearly in Spain's interest since it risks being drawn into any US–Soviet nuclear exchange due to the US nuclear weapons stationed on its territory. The USA and the USSR have never been prepared to give such a guarantee. The so-called "Kosygin formula" of 1967 indicated a Soviet willingness to give a no-use guarantee to parties to the NPT which had no nuclear weapons stationed on their soil, but even the question of such a guarantee was dropped in the later stages of the NPT negotiations.

The Spanish attitude to the entry-into-force provision of the NPT indicated strong doubts about the effectiveness of the treaty. A Spanish government memorandum to the Geneva Disarmament Conference said on this issue:

> It would therefore be advisable to require that the ratifying countries should include at least twelve which possess power reactors in operation or under construction, or else possess within their territories uranium deposits which have been proved economically exploitable. Lastly, the number of forty for the countries ratifying the treaty seems too small, and should be raised to sixty at least. [82]

Like many other countries, Spain also complained that the safeguards provision might prove economically harmful to it.

Assessment

It would seem likely that Spain will continue to seek its security within the Western alliance systems, in particular in its relationship with the United States, rather than in developing any strong domestic military programme. However, the Spanish government has shown some concern for the implications of US disengagement tendencies; on occasion, for instance over the Gibraltar issue, it has also played with a "neutralist" posture, aligning itself with third world countries, in particular the Arab states.

On the other hand, the interests of the Spanish civil nuclear energy programme may lead the Spanish government to reconsider its attitude to the NPT when the latter's provisions on nuclear assistance and fuel supplies become effective following the safeguards negotiations. In the meantime it may well continue to use its position on the NPT as a useful bargaining card in its negotiations with the United States.

Brazil

Together with India, Brazil has been one of the most outspoken critics of the Non-Proliferation Treaty, which it has not signed. Brazil has stated its basic position to be that it is prepared to renounce nuclear weapons but not the benefits of nuclear technology, including peaceful nuclear explosives, which it fears would be a consequence of the NPT. Behind this is a perception that a Brazil-first policy is necessary for the country's economic development, and that a dependent position cannot be tolerated. A similar perception has guided Brazilian foreign policy on other issues as well, for instance regarding the exploitation of the oceans. The fact that Brazil, like Argentina, has a military government may have influenced its policies on the NPT. No real military threat to Brazil can be said to exist; consequently, the question of Brazilian nuclear weapons has not received much attention.

Brazil's nuclear programme

Brazil has a modest nuclear programme on which it places great hopes for the country's future economic development. In particular, it is interested in peaceful nuclear explosives technology, claimed to be essential for the exploitation of Brazil's natural riches.

Some finds of high-grade uranium have been made in Brazil although they have not yet been much exploited. In addition, Brazil has very large deposits of thorium, second only to those of India, which makes it interested in uranium-233 technology. According to recent reports, Brazil has started work on gas centrifuge technology for uranium enrichment.

Brazil has three small nuclear research reactors but no nuclear power station has yet been built in the country. A first station, to be powered by a 500 MWe American reactor, is scheduled to start operations in 1976. According to the forecasts of the Brazilian Nuclear Energy Commission, Brazil may have 1 500 MWe installed capacity in 1980 and 7 000 MWe in 1985. [83]

The Brazilian government has insisted that Brazil will develop peaceful nuclear explosives "as soon as possible". The applications that have been discussed include schemes for improving river navigation, releasing water for irrigation and releasing oil from crushed shale. [84]

Brazil has a nuclear assistance agreement with the United States which runs until 1975. It has cooperation agreements with several other countries including the United Kingdom, France, West Germany, India and Israel. A few years ago there were also reports about a secret Brazilian pact for nuclear sharing with Argentina, which possesses Latin America's only existing nuclear power reactor and a chemical separation plant. [84]

Brazil and the NPT

During the course of the NPT negotiations, Brazil said repeatedly that it supported the arms control purpose of the treaty but strongly opposed the restrictions on nuclear technology for peaceful purposes which it saw in the treaty. Brazil feared that, as a developing country, it might be placed in an intolerably dependent position *vis-à-vis* the nuclear powers.

Brazil has advocated that peaceful nuclear explosives should be permitted for national development, maintaining that this is the case under the Latin American Nuclear Free Zone Treaty (the Treaty of Tlatelolco). This Brazilian—and Argentinian—interpretation of the Tlatelolco Treaty is, however, not shared by the other parties to that treaty. Brazil has ratified the Tlatelolco Treaty but it has not entered into force for Brazil because Brazil has not waived the necessary requirements (see page 542). Furthermore, Brazil has asked that the IAEA should provide a service to its member states on peaceful nuclear explosives, but that this should be separate from any function the IAEA has under the NPT. [85]

Like several other states which are negative to the Non-Proliferation Treaty, Brazil has taken the view that the Security Council resolution on security assurances to non-nuclear-weapon states which are parties to the NPT is inconsistent with the sovereign equality of UN member nations, since it would discriminate against those member states which did not subscribe to the treaty or had withdrawn from it [86].

Brazil has equally argued that the NPT must lead to nuclear disarmament within the nuclear-weapon powers, making the specific proposal that a substantial part of the resources liberated by nuclear disarmament should be used for economic development in underdeveloped countries through a special UN fund set up for the purpose [87].

During the course of the NPT negotiations, Brazil insisted that the withdrawal clause should be weakened. It wanted the reference to circumstances prompting a state to withdraw from the treaty to be extended to include circumstances which "may arise" and "may affect" the supreme interests of the country concerned. [87]

The Brazilian opposition to the Non-Proliferation Treaty was reconfirmed in a communication received in 1971 from the Brazilian Ambassador in Stockholm:

> The Brazilian attitude of strong opposition to the Treaty has not changed. Brazil considers the Treaty incompatible with the interests of her economic development and her national security. The restrictions that the Treaty imposes on the development of nuclear technology for peaceful purposes by the militarily "non-nuclear" countries are unacceptable. The Treaty does not provide any guarantee for the security of the non-nuclear countries against an attack or a threat of aggression with nuclear weapons, nor does it create any kind of actual engagement, on the part of the nuclear powers, that they will proceed to their own partial or total nuclear disarmament. To sum up, the Treaty does not

establish an acceptable balance between the rights and obligations of nuclear and non-nuclear countries. [88]

Assessment

It is difficult to say whether there will be any change in the Brazilian attitude to the NPT in the coming years. The safeguards issue does not yet affect Brazil much. Since Brazil will not have any nuclear power station until the late 1970s, it could still afford to wait. Its nuclear assistance agreement with the United States expires in 1975; after that date Brazil might have some difficulty in securing supplies of enriched uranium unless it becomes a party to the treaty. To some extent, however, Brazil might try to compensate any adverse effects of the NPT on its nuclear energy programme by cooperating with Argentina.

The main factor influencing Brazil's attitude to the NPT is probably its independent stance regarding Brazilian national interests. As in the case of India, there are considerable elements of national pride involved in this policy. But, in contrast to India, this outlook does not seem to go so far as thinking about acquiring nuclear weapons for Brazil.

Argentina

The Argentinian policy on the Non-Proliferation Treaty has been rather similar to the policy of Brazil, although perhaps less outspoken; this may partly be due to the fact that Argentina only became a member of the Geneva Disarmament Conference in 1969 while Brazil has been a member since 1962. Like Brazil, Argentina is primarily concerned with the contribution of nuclear energy to economic development and it is mainly in this respect that Argentina has criticized the Non-Proliferation Treaty. The Argentinian nuclear programme is more advanced than that of Brazil. There are elements of competition in the relationship between the two countries.

Argentina's nuclear programme

Argentina is building the first nuclear power station in Latin America. The station is situated on the Parana River and is scheduled to become operational in 1972. The natural uranium reactor provides 320 MWe and was sold by West Germany. In addition, Argentina has four nuclear research reactors.

Argentina is one of the few countries of the world other than the nuclear-weapon powers which has a chemical separation plant, although its output is small. Theoretically, this brings Argentina one stage closer to a future nuclear weapons option, particularly since Argentina also has substantial uranium deposits.

Argentina and the NPT

Argentina has neither signed nor acceded to the Non-Proliferation Treaty. Like Brazil, it abstained on the UN vote commending the treaty. Argentina has signed but not ratified the Tlatelolco Treaty on a Latin American nuclear-free zone.

The main Argentinian objection to the NPT is that it may hamper the full utilization of peaceful nuclear technology considered necessary for Argentina's economic development. Argentina has also said that it will defend the principle of national independence in all matters involved in research and development in nuclear technology for peaceful purposes, and that it cannot consent to being reduced to a position of constant dependence in the field of nuclear technology, having already laid the groundwork for the necessary nuclear techniques to assist its economic development. An indication of Argentina's concern about the effects of the NPT on economic development is its proposal that a widening technological gap should be included as a possible cause for withdrawal from the NPT. [89]

On the other hand, Argentina has not been so demanding as Brazil regarding the right to develop and use peaceful nuclear explosives. It has been perhaps even more concerned than Brazil that there should be an assured exchange of nuclear material and equipment.

Like many other countries, Argentina has asked for a pledge by the nuclear-weapon powers that they should not use nuclear weapons against non-nuclear-weapon countries.

Assessment

It is difficult to assess how much importance should be attached to the Argentinian, and Brazilian, claims that the Non-Proliferation Treaty will hamper their economic development. On the contrary, it seems that a country like Argentina has much to gain from the provisions of the NPT on nuclear assistance and fuel supplies. Possibly, the government's position is that it can still afford to wait. Undoubtedly, elements of national pride are also involved, as well as a strong feeling of resentment against the discriminatory provisions of the NPT.

Euratom and the NPT

Before describing the non-proliferation policies of the Federal Republic of Germany, Italy, the Netherlands and Belgium, it is necessary to discuss the

Euratom organization and its relationship to the Non-Proliferation Treaty. Together with France, a nuclear-weapon state, and Luxembourg, whose nuclear policies can be left aside,[15] the Federal Republic of Germany, Italy, the Netherlands and Belgium are the members of Euratom, the European Atomic Energy Community. These four countries are all guided in their NPT policies by this fact. The main illustration is that when they signed the NPT in 1968–69, they had, at the behest of the EEC Commission, which is the managing body of Euratom, to make a statement saying they would not ratify the treaty until a satisfactory safeguards agreement had been concluded between Euratom and the IAEA. France has not signed the NPT, but has declared that it will behave exactly as the states adhering to the treaty.

According to the Euratom treaty the supranational Supply Agency of Euratom has an option to buy all uranium produced in the community. It alone has the right to contract a supply of fissionable materials from countries inside and outside the community. It also owns all enriched uranium and all plutonium present in the community except material definitely reserved for military use. The agency is obliged, if possible, to furnish material ordered by consumers without discrimination because of the intended use of the material, provided the use is not illegal or contradicts conditions stipulated by a supplier outside the community. Illegal uses are those not complying with national law, e.g., on health and safety, and with international agreements, e.g., disarmament treaties. [90]

There are now nearly 400 civil nuclear installations in the six Euratom countries which are subject to Euratom control, which is generally regarded as efficient. In 1968 Euratom safeguards controlled the use of 10 000 kg. of enriched uranium-235 and more than 500 kg. of plutonium in over 200 nuclear installations.

Euratom has experienced a great deal of internal difficulty because of a conflict of interest between France and the five non-nuclear-weapon states. There is, of course, no Euratom inspection of French military nuclear installations nor is Euratom allowed access to the 10–20 per cent of the French civil nuclear industry which uses French-produced fuels. The remaining part of the French civil nuclear industry is, however, subject to inspection. France has not always observed Euratom's provisions regarding the exportation of fissionable material. These provide that all trade agreements must be made through the supply agency of Euratom. In disregard of these provisions—albeit when Euratom was in abeyance in the late 1960s—France has sold, for instance, 5 000 kg. enriched uranium to

[15] Luxembourg signed the NPT on 14 August 1968 with the usual Euratom reservation for ratification (see below).

Italy for use in the nuclear naval vessel *Enrico Fermi*. The French infringement of the rules was brought before the Court of the European Communities which ruled against France.

Euratom must import most of the natural uranium for its member states. France has uranium deposits but these are not nearly sufficient for the whole community.

Euratom has long-term supply agreements with the United States concerning deliveries of plutonium and enriched uranium which last until 1995. The plutonium agreement provides for a global import quota of 500 kg., but the annual quantities are negotiated separately. In the future, however, the Euratom countries will produce the bulk of their own plutonium: 11–15 tons by 1975, 35–55 tons by 1980, and 80–140 tons by 1985. There is a similar, but more important, supply agreement for enriched uranium. According to the long-term agreement, the United States is pledged to deliver 215 tons uranium-235, of which about 50 tons had been negotiated under the yearly agreements up to 1971; however, only 8.5 tons were actually imported in 1967–69. The long-term agreement with the USA should cover Euratom's demand for fuel for nuclear power reactors at least until 1975. But beyond this the US enrichment capacity may not suffice to cover Euratom's fuel needs. This is one major reason for the Euratom countries' interest in developing their own enrichment facilities. It should be noted that the nuclear fuel supply agreements at present give the USA a certain leverage *vis-à-vis* the Euratom countries. [91]

The question of how to secure a steady supply of the substantial quantities of enriched uranium required in the future remains of primary political importance for the Common Market countries, including Britain. Several alternatives are possible: continued cooperation with the United States, reliance on the Anglo-Dutch-West German gas centrifuge schemes, and expansion of the French gas diffusion facilities. The final solution adopted will depend as much as anything else on how the Common Market countries will view their future position in world politics and may involve considerations about a future West European nuclear-weapon federation (see below). A decision on the issue will probably have to be taken by 1973.

Euratom interests were largely taken into account when Article III of the Non-Proliferation Treaty, the safeguards article, was drafted. The main point was to make Article III allow for the possibility of a collective safeguards agreement between the IAEA and a group of states, in practice Euratom. Prior to the drafting of Article III, the United States and Euratom had reached an understanding that: (*a*) safeguards should not be extended to facilities but confined to the flow of fuel; (*b*) relations between the IAEA and Euratom should be feasible, implying a possibility of IAEA verifying Euratom inspections; (*c*) existing supply agreements should not be jeopardized by the NPT; and (*d*) no guillotine clause should be included in the treaty whereby after a given period of time Euratom controls would be automatically superseded by IAEA controls. [92] The Soviet Union was apparently also interested in satisfying some of Euratom's demands on Article III, since this would make West German adherence to the treaty more probable and also reduce the likelihood of the FRG attempting self-sufficiency in the nuclear field. For the same reasons the Soviet Union seems to support a positive solution to the current IAEA–Euratom safeguards negotiations.

When the Non-Proliferation Treaty was opened for signature in July 1968, the five non-nuclear-weapon members of Euratom asked the Brussels Commission whether the NPT was compatible with the Euratom treaty. The answer of the Commission was that the two treaties were compatible and that the EEC governments could sign the Non-Proliferation Treaty. However, when they signed the NPT they should make a reservation to the effect that they would not ratify until a satisfactory safeguards agreement had been concluded between Euratom and the IAEA. Such reservations were made when the five non-nuclear-weapon members of Euratom signed the NPT in 1968–69.

The Brussels Commission agreed on a mandate for the safeguards negotiations at the beginning of 1970, a few months after West Germany had signed the NPT. The mandate was based on two main principles: (*a*) the agreement with the IAEA must not restrict the operations of Euratom, including the free trade in fissionable material, or lead to discriminatory treatment between the non-nuclear-weapon members—West Germany, Italy and Benelux—and the nuclear-weapon power—France; and (*b*) the IAEA should merely verify that Euratom inspections were satisfactory from the point of view of NPT safeguards and there must not be any double inspections. The political reasons behind this posture were, on the one hand, that the non-nuclear-weapon states, in particular West Germany, were anxious that France should not get more favourable treatment in connection with the economically cumbersome safeguards inspections; on the other hand, that France was concerned that there should be no IAEA inspection of its nuclear installations.

The actual negotiations between Euratom and the IAEA started in November 1971. They are likely to be completed in the summer of 1972. At the time of writing, March 1972, a positive outcome is expected, even though it is not easy to see how Euratom's demand that no inspection of facilities should take place can be reconciled with the IAEA's requirement for an acceptable application of NPT safeguards.

The Euratom–IAEA safeguards negotiations affect many other countries. The four new EEC member states—Britain, Norway, Denmark and Ireland —have had to include a clause in their safeguards agreements, now being negotiated with the IAEA, that these will be superseded by the Euratom agreement when it becomes effective. Japan, Switzerland and other industrialized nuclear countries which have signed but not ratified the NPT insist that they should not be subject to any different safeguards régime than the Euratom countries, because this, they maintain, would mean economic discrimination. Partly for this reason, they are withholding their ratifications until they know the outcome of the Euratom negotiations. Even countries which have ratified the NPT are delaying their own safeguards negotiations with the IAEA for the same reason, although for those countries for which the NPT entered into force on 5 March 1970, this will mean surpassing the deadline established in the NPT for the conclusion of safeguards agreements. (For a substantive account of the safeguards negotiations, see chapter 10.)

The Federal Republic of Germany

The case of West Germany and the Non-Proliferation Treaty is very special. The NPT was to a large extent tailored to solve the impasse in East-West relations which had arisen over West German demands in the early 1960s for nuclear sharing within NATO, and after such measures as the MLF (the NATO Multi-Lateral Force) had failed. The compromise achieved was the NPT *and* a reorganization of nuclear planning within NATO—the setting up of the DPC (the Defence Planning Committee), and the NPG (the Nuclear Planning Group).

Since World War II, West Germany has been at the centre of great power politics. Until recently, its relations with the Soviet Union and the other East European states were plagued by difficulties, not the least of which were Soviet fears that West Germany might one day go nuclear. At the same time, West Germany constitutes NATO's foremost forward defence area; any future East–West war in Europe is certain to involve German territory. The West German armed forces, which are fully integrated into NATO, are quite substantial and include several nuclear weapons delivery systems such as strike aircraft, nuclear artillery systems, Honest John, Sergeant and Pershing surface-to-surface missiles, and Nike-Hercules surface-to-air missiles. The nuclear warheads for these systems are, however, under strict US control.

The Federal Republic of Germany (FRG) renounced the manufacture of nuclear weapons in 1954 when it acceded under the Paris Agreements to the Western European Union (WEU), then being formed. This commitment, which does not exclude manufacture outside German territory or possession through purchase or gift, is binding on future German governments as long as the WEU exists. The non-manufacture of nuclear weapons in West Germany is controlled by the Armaments Control Agency of the WEU.

Although West Germany has no nuclear weapons, it has a very advanced civil nuclear industry, which is second to none outside the nuclear-weapon powers.

The West German nuclear energy programme

The West German nuclear energy programme includes a domestic reactor industry and several operational nuclear power stations. According to current forecasts, the FRG will have 19 reactors with an installed capacity of nearly 10 600 MWe in 1977. It has an advanced programme in nuclear research and development, including, for instance, uranium enrichment processes, fast-breeder reactors and controlled-fusion reactions.

The FRG has a chemical separation plant for plutonium—the West German output of plutonium currently being of the order of 400 kg. per year—but as yet has no uranium enrichment plant. In the early 1960s, the FRG was working on gas centrifuge technology but the work was then discontinued after it had become classified at American prompting [93]. In addition, West Germany has been conducting research on the so-called nozzle method for uranium enrichment at the nuclear research centre at Karlsruhe, but so far this method has not proved successful. In March 1970 the FRG concluded jointly with the United Kingdom and the Netherlands a Tripartite Agreement to develop gas ultra-centrifuge technology. The agreement foresees the construction of two facilities for uranium enrichment, in Britain and the Netherlands, from the output of which West Germany will benefit. The facility in the Netherlands will be situated on the West German border, which may be significant. Until this new source of supply has been established, the FRG is dependent on US deliveries of enriched uranium through the Euratom supply agency.

All nuclear installations in West Germany are subject to Euratom safeguards in addition to the legal control by the WEU Armaments Control Agency.

Among the practical applications of nuclear energy in West Germany is the construction of a nuclear-powered merchant ship, the *Otto Hahn*. According to the Paris Agreements, the construction of nuclear-powered warships is prohibited to the FRG.

In conclusion it may be said that were it not for the political and constitutional restraints, West Germany would certainly be able to develop nuclear weapons within a few years.

West Germany and the NPT

The West German government took a long time to sign the Non-Proliferation Treaty. It did so only on 28 November 1969, nearly a year and a half after the treaty had been opened for signature. The reasons for this delay had more to do with domestic West German politics—in particular the necessity to reconcile the views of the Conservative CDU/CSU party and the Social Democratic SPD party, which formed a coalition government in the FRG from 1966 until 1969—than with any major foreign policy issues. In general, the Social Democrats, whose party leader Willy Brandt was Foreign Minister in the coalition, wished to hasten a West German adherence to the NPT, while the Conservatives led by the Chancellor, Herr Kiesinger, and the Minister of Finance, Herr Strauss, wanted to delay the procedure. Signature of the treaty therefore only took place after Willy Brandt had become Chancellor in October 1969. One positive result of this long delay was that the NPT was submitted to an extensive political debate and analysis, which helped to clarify the effects of the NPT upon West German foreign, military and economic policies.

The West German government took an active part in the NPT negotiations, mainly through bilateral contacts with the US government. Thus, it was instrumental in getting a provision into the preamble of the treaty which said that safeguards should be applied to the flow of source and special fissionable materials by use of instruments and other techniques at certain strategic points. The purpose of this provision was to reduce the necessity for manned inspections and to diminish the alleged risks of industrial espionage. The more substantial issues of concern to the West German government related to the continuation of its security arrangements with the United States and NATO and to the possibility of establishing a Federation of European States with a nuclear defence in the future. In the bilateral talks with the United States, it by and large obtained satisfaction on the first issue, but not on the second. This became clear in the so-called six US interpretations of the treaty, which answered questions on the NPT raised by US allies, primarily West Germany:

Questions on the draft non-proliferation treaty asked by U.S. allies together with answers given by the United States:

Q. What may and what may not be transferred under the draft treaty?

1. A. The treaty deals only with what is prohibited, not with what is permitted.
2. It prohibits transfer to any recipient whatsoever of "nuclear weapons" or con-

trol over them, meaning bombs and warheads. It also prohibits the transfer of other nuclear explosive devices because a nuclear explosive device intended for peaceful purposes can be used as a weapon or can be easily adapted for such use.
3. It does not deal with, and therefore does not prohibit transfer of nuclear delivery vehicles or delivery systems, or control over them to any recipient, so long as such transfer does not involve bombs or warheads.

Q. Does the draft treaty prohibit consultations and planning on nuclear defense among NATO members?
4. A. It does not deal with allied consultations and planning on nuclear defense so long as no transfer of nuclear weapons or control over them results.

Q. Does the draft treaty prohibit arrangements for the deployment of nuclear weapons owned and controlled by the United States within the territory of non-nuclear NATO members?
5. It does not deal with arrangements for deployment of nuclear weapons within allied territory as these do not involve any transfer of nuclear weapons or control over them unless and until a decision were made to go to war, at which time the treaty would no longer be controlling.

Q. Would the draft prohibit the unification of Europe if a nuclear-weapon state was one of the constituent states?
6. A. It does not deal with the problem of European unity, and would not bar succession by a new federated European state to the nuclear status of one of its former components. A new federated European state would have to control all of its external security functions including defense and all foreign policy matters relating to external security, but would not have to be so centralized as to assume all governmental functions. While not dealing with succession by such a federated state, the treaty would bar transfer of nuclear weapons (including ownership) or control over them to any recipient, including a multilateral entity. [94]

According to the official West German view, these "interpretations" are part of the legislative history of the treaty and in that sense binding upon future US governments. The US government has notified the Soviet government of the interpretations; the fact that they have not met with any Soviet rejoinder indicates, in the West German view, Soviet acceptance of them.

The sixth interpretation deals with what is termed the "European option", that is, the possibility that a federated European state could become a nuclear-weapon power by inheriting the nuclear status of France and/or Britain. While the West Germans and the Italians wanted to retain this possibility for a loose European federation—a European Defence Community—the US interpretation permits only a future more or less unitary European federal state which has control over *all* its external security functions, including defence, and *all* foreign policy matters relating to external security, to become a successor to a present nuclear-weapon power. Such a degree of political unity appears very remote and therefore the possibility of the "European option" must be said to be effectively foreclosed, at least for the next two decades. [95] Furthermore, it is uncertain whether a European nuclear confederation could become a nuclear-weapon state in the sense of the NPT, because the treaty requires that a nuclear-weapon state must have existed on 1 January 1967.

The issue of a joint West European anti-ballistic missile system was also discussed during the NPT negotiations. Here too, the West Germans, and the Italians, had to retreat and admit that if they wanted the European Community to have an independent nuclear ABM defence they would first have to withdraw from the NPT. [96]

On the other hand, the United States accepted the position of the West German government that a dissolution of NATO would be a cause for West Germany to withdraw from the NPT. [97]

The West German government was similarly successful in eliminating a potential source of discrimination against West Germany in the application of the UN Security Council resolution on security assurances. Initially, the Soviet Union held the view that these assurances could not be applied to Germany, the reason being that, according to the UN Charter, the four wartime allied powers, including the Soviet Union, had special obligations to prevent renewal of aggressive policy on the part of Germany. This, the Soviet Union also maintained, gave it a potential legal right to intervene in West Germany to stop German "militarism" and "revanchism". This Soviet interpretation of the UN Charter was denied by the Western allies, and the US government stated publicly that such a Soviet intervention would provoke NATO reaction. In the end the Soviet Union withdrew its claim. On 28 February 1969, the West German government received a Soviet note which said that the Security Council resolution on security assurances would be applicable to West Germany as a party to the NPT.

In the light of the West German–Soviet dispute one may also see the West German proposal that the NPT should contain a clause prohibiting "nuclear blackmail". The 1967 "Kosygin formula" by which the nuclear-weapon powers would guarantee not to use nuclear weapons against those non-nuclear-weapon states which had no nuclear weapons on their territory, would of course not have applied to West Germany because of the presence there of US nuclear weapons.

Besides the security problems, the assured access to nuclear technology for peaceful purposes was of major concern to the West German government when it made up its position on the NPT. As described in the preceding section on Euratom, it received assurances on US fuel supply policies at least until 1975. Further, continued US deliveries were formally linked not to West German acceptance of the NPT but to its acceptance of the safeguards/verification agreement with the IAEA. In practice, already the

West German signature of the NPT helped to ensure continued US fuel deliveries and assistance in the field of nuclear technology. [98]

The case for a West German adherence to the NPT was clearly set out in an analysis made by the West German Foreign Ministry in 1969 at the request of the Social Democratic group in the West German Parliament:

Question: Which reasons speak in favour of the FRG becoming a party to the NPT?

Answer:[16]

1. The FRG gave up the right to manufacture nuclear weapons in 1954. Therefore, it has an interest in other near-nuclear powers doing the same. There is no doubt that some of the hesitant European states are waiting for a West German decision on the NPT.
2. The NPT is an instrument of cooperation between West and East which will contribute to international peace and security and to nuclear disarmament. Adherence to the NPT by the FRG is therefore consistent with the government's peace policy.
3. A West German accession would, at least in the short term, lead to an improvement in the relations between the FRG and the Soviet Union. In any event, future Soviet accusations against the FRG would become less credible.
4. Only by becoming a party to the NPT would the FRG avoid the disadvantages which would ensue from remaining outside the NPT—in particular, the serious risk of becoming isolated.
5. The NPT brings substantial advantages in the civil nuclear energy field, which are available only to parties to the treaty.
6. To the extent that a West German accession is important to the United States, which is responsible for West Germany's security, this is a major reason for joining the NPT.

Question: What would be the consequences of a West German refusal to join the NPT?

Answer:[17]

1. The FRG would still be bound by the 1954 prohibition against manufacturing nuclear weapons. Theoretically, it might have the possibility of nuclear sharing with a nuclear power which has not acceded to the NPT, in practice France. France is, however, not interested in such a solution and, in fact, prefers West Germany to join the NPT so that there is no change in its nuclear status.
2. West German relations with the United States would be damaged and this could lead to serious consequences for West Germany's security.
3. West German relations with the United Kingdom, Canada, the Scandinavian countries and the Benelux countries would also deteriorate. All this would lead to West Germany's isolation within the Western alliance.
4. West German–Soviet relations would become much worse. The Soviet attacks against West German policy would increase. The Soviet Union would probably increase its efforts to apply the 1945 allied control agreements on

[16] SIPRI summary.
[17] SIPRI summary.

Germany. Further, the Soviet Union might refuse to ratify the NPT, putting the blame for this on West Germany.

5. The international status of East Germany would improve.

6. The West German "Ostpolitik", that is, the efforts to improve relations with East European countries, would probably collapse.

7. A West German non-acceptance of the NPT would spoil Euratom's possibility of securing equal treatment for its member states, to which Italy and Benelux would be opposed. Generally, Euratom's position *vis-à-vis* the IAEA would be weakened.

8. Further, a West German non-acceptance of the NPT would not improve the prospects for the "European option", because the other countries which would have to be involved would be bound by the provisions of the NPT.

9. The FRG would risk being deprived of supplies of special source and fissionable material by not joining the NPT. Neither would it be able to profit from the nuclear assistance provisions of the treaty.

10. While the prospects for West German exports of nuclear equipment and source material to other non-parties might improve, prospects for exports to countries which are parties to the NPT would deteriorate—and this would be a more serious risk.

11. Generally, there would be an increased "credibility gap" for West German foreign policy. The West German image would become even more tarnished.

12. The West German government was closely involved in the NPT negotiations and gained satisfaction on many issues. It would therefore be impossible for it to reverse its position now and say that an accession to the NPT would have to wait until a German Peace Treaty had been achieved.

13. The only possible alternative would be to accept the IAEA–Euratom verification agreement but not the NPT. But then the FRG would have all the disadvantages of the safeguards system without being able to influence it as a party to the NPT. [99]

When the new West German government under Willy Brandt signed the Non-Proliferation Treaty on 28 November 1969, it issued two documents containing its understandings and reservations. One was a note addressed to the three depositary governments—the USA, the UK and the USSR—the other a government statement. The note contained, *inter alia*, the following understandings and reservations:[18]

1. The provisions of the treaty should be interpreted and applied equally to the FRG and to other parties to the treaty.

2. The security of the FRG and its allies should continue to be ensured by NATO or by an equivalent security system.

3. The Security Council's resolution on security assurances and the accompanying declarations by the governments of the USA, the UK and the USSR should also apply without any restriction to the FRG.

4. The treaty should not hamper the unification of European states.

[18] SIPRI summary.

5. The parties to the treaty should without delay commence the negotiations on nuclear disarmament.

6. The purpose of the treaty is to prevent present non-nuclear-weapon states from manufacturing or otherwise acquiring nuclear weapons or other nuclear explosive devices. In no instance may it lead to a restriction in the use of nuclear energy for other purposes by non-nuclear-weapon states.

7. The treaty must never be interpreted or applied in such a way as to hamper research and development regarding the peaceful uses of nuclear energy.

8. No peaceful nuclear activities or transfers may be denied to non-nuclear-weapon states on the basis of allegations that such activities or transfers could be used for the manufacture of nuclear weapons or other nuclear explosive devices.

9. The treaty must not hamper progress in the field of developing and applying the technology of using nuclear explosives for peaceful purposes.

10. There is no incompatibility between the aims of the NPT and those of the Euratom treaty. The verification procedures to be agreed between Euratom and the IAEA must be so defined that the rights and obligations of Euratom member states remain unaffected.

11. The government of the FRG intends to postpone the ratification procedure of the NPT until the negotiations between the Commission of the European Communities and the IAEA have led to agreement.

The government statement of the same day repeated several of the above points. In addition, it contained, *inter alia,* the following three provisions:

It stated that the FRG, in a situation in which it considered its supreme interests in jeopardy, would remain free, by invoking the principle of international law laid down in Article 51 of the United Nations Charter, to take the measures required to safeguard its interests. (The reason the withdrawal clause was not invoked was probably that this would not be an effective measure for the FRG since it has renounced nuclear weapons under the WEU agreements.)

It stressed the vital importance it attached, with a view to ensuring equal opportunities in the economic and scientific fields, to the fulfilment of the assurance given by the USA and the UK concerning the applications of safeguards to their civil nuclear facilities; and hoped that other nuclear-weapon states as well would give similar assurances.

It reaffirmed its view that, until the conclusion of the agreement between the IAEA and Euratom, the supply contracts concluded between Euratom and the parties to the NPT should remain in force; and that after the entry into force of the NPT, supply contracts should, in the interest of an unhampered exchange of information, equipment and materials for peaceful purposes, be freed from any additional political or administrative restrictions.

Assessment

There cannot be much doubt that the present West German government intends to ratify the Non-Proliferation Treaty after there is agreement between Euratom and the IAEA on safeguards. The positive advantages of ratifying, respectively the political disadvantages of not ratifying, appear to outweigh any other conceivable course. This is not to say that there may not be some further delay; in particular there will have to be agreement among all the six Euratom members, including France, that the verification agreement with the IAEA is acceptable. It is also possible, although not likely, that an outside political event, such as in the past a crisis over Berlin or the events in Czechoslovakia, may delay the ratification procedure.

The West German opposition parties, the CDS/CSU, appear more doubtful about the value of the NPT. In the end they opposed the government's signature of the NPT in November 1969. They might also vote against an early West German ratification of the NPT. But even a Christian Democratic government could not possibly postpone a West German adherence to the treaty too long in view of West Germany's peculiar security situation at the heart of the conflict between the East and West blocs.

West Germany will certainly always be close to a nuclear option because of its advanced technology. It is difficult to see, however, that it will ever wish to exercise this option unless there is a major upheaval in the world security situation, including a break of its military alliance with the United States through NATO.

Italy

Italy belongs to Euratom and in several respects its nuclear policies are similar to those of West Germany. Thus, Italy signed the Non-Proliferation Treaty, on 28 January 1969, but made the usual Euratom reservation as regards ratification. Italy has a fairly advanced nuclear technology programme which, according to Italian government statements, would allow Italy to manufacture nuclear weapons if it so wished. [100] However, the Italian Peace Treaty of 1945 forbids Italy to possess, manufacture or test nuclear weapons. Italy's security is ensured through NATO and the relationship with the United States. The Italian armed forces are well-equipped and all three services dispose of weapons systems capable of carrying nuclear warheads. The warheads are kept under US control but stocked in Italy.

The Italian nuclear programme

Italy has at present three nuclear power stations with a total capacity of 600 MWe. One of these has a British Magnox reactor, installed in 1962, for which Britain has undertaken to separate the plutonium and return it to Italy. Installed capacity is expected to increase to 1 400 MWe in 1977. In 1971 Italy was producing about 300 kg. of plutonium per year as a by-product from its nuclear power stations; it has a plutonium laboratory for research on plutonium production. A plant for reprocessing irradiated fuel, EUREX, became operational in 1970. It is used in cooperation with Euratom, which means that the other Euratom countries have access to it as well.

Italy has a wide-ranging research programme in the field of nuclear technology. It is experimenting with fast-breeder reactors and other advanced developments. So far, Italy has no domestic uranium enrichment facilities, although a plant for producing uranium hexafluoride, the raw material for enriched uranium, is being planned. [101] For the time being, Italy is therefore dependent on US deliveries of enriched uranium. Italy is interested in joining the Anglo-Dutch-West German Tripartite Agreement for developing ultra-centrifuge technology, but has not yet been admitted.

Italy must import natural uranium. A semi-state company, ENI Mining, has made several agreements with African countries and with Canada for the mining of uranium ore for subsequent processing in Italy. Italy has a plant, ITREC, for processing and refabricating fuel elements.

As a maritime nation, Italy has taken a great deal of interest in nuclear ship propulsion. As mentioned above, it is constructing a military logistics supply vessel, the *Enrico Fermi,* for which it is obtaining 5 000 kg. of enriched uranium from France. No safeguards will apply to this fissionable material since it will be used for a permitted military purpose. Italy is also conducting research on nuclear-powered submarines. [101]

Although Italy has a varied nuclear programme, it is still dependent on foreign assistance. As was made clear during the NPT negotiations, Italy is anxious to obtain technological assistance on uranium enrichment, nuclear ship propulsion, heavy-water production, and on peaceful nuclear explosives. Most of this technological assistance has to come from the United States. It is possible, though, that the French assistance to the *Enrico Fermi* may indicate closer cooperation between France and Italy in the future.

Italy and the NPT

As a member of the Geneva Disarmament Conference since 1960, Italy was actively involved in the NPT negotiations. As a preliminary to the NPT, Italy proposed in 1965 an international moratorium on non-nuclear-weapon countries going nuclear, that is, non-nuclear-weapon states should bind themselves not to acquire nuclear weapons for a limited period while a final agreement was being negotiated. In 1967 Italy proposed that the nuclear-weapon states should transfer certain amounts of fissionable material from their military stockpiles to peaceful uses in the non-nuclear-weapon states. The income from these transfers should be channelled to the underdeveloped countries through the United Nations. [102]

Further, Italy was instrumental in getting Article IV, on peaceful uses of nuclear technology, inserted into the NPT, as well as in obtaining a limitation of the duration of the treaty to 25 years. Together with the Netherlands, Italy also achieved that NPT safeguards will not apply to permitted non-explosive military applications, such as the propulsion of nuclear naval vessels. This is the famous "loophole" clause, since in the absence of safeguards there may be diversion from permitted military applications to the manufacture of nuclear explosives.

When the Non-Proliferation Treaty was opened for signature in July 1968, the Italian representative stated that the Italian government intended to sign the treaty. The statement made clear the government's views on the treaty, namely:[19]

1. The NPT was compatible with the Euratom treaty.
2. Nothing in the NPT constituted an obstacle to the unification of the countries of Western Europe.
3. Freedom of scientific and technological research was in no way restricted by the treaty.
4. The prohibition on peaceful nuclear explosives only concerned those explosives that are not different from nuclear weapons; when the technological progress has made possible the development of peaceful nuclear explosives clearly different from nuclear weapons, the prohibitions would no longer apply.
5. The Italian government would apply the same control on export of nuclear materials and equipment to nuclear-weapon states as to non-nuclear weapon states. [103]

The procedures for signing the Non-Proliferation Treaty were initiated in the Italian parliament in the summer of 1968. They were, however, broken off in August 1968 following the Soviet and Warsaw Pact intervention in Czechoslovakia. The reason invoked by the Italian government was that the preamble of the NPT requires that, in accordance with the Charter of the United Nations, states must refrain in their international

[19] SIPRI summary.

relations from the threat or use of force against the territorial integrity or political independence of any state. By intervening in Czechoslovakia, the Soviet Union had, in the Italian view, violated the spirit of the NPT and changed the basis for its acceptance by other states. The Italian signature of the NPT was thus postponed for 5 months until the end of January 1969.

When signing the treaty on 28 January 1969, the Italian government issued a statement and a note to the three depositary governments. The statement contained, *inter alia,* the Italian reservation not to ratify the NPT until the negotiations between the European Economic Community and the IAEA on safeguards had led to an agreement. It also stated the known Euratom views on such an agreement. Further, the Italian government declared that, in its view, the principles in the preamble that states must refrain from the threat or use of force against the territorial integrity or the political independence of other states were an "intransgressible presupposition" of the treaty, and that scrupulous and general respect for such principles constituted a supreme interest for all states. [104]

The note set forth the Italian understandings of the NPT regarding the above points but also regarding the compatibility between the NPT and the Euratom treaty, the freedom of scientific and technological research, peaceful nuclear explosives, and further negotiations on nuclear disarmament and on peaceful applications of nuclear energy. With regard to the "European option", the Italian government said that "it signs the Treaty in the firm belief that nothing in it is an obstacle to the unification of the countries of Western Europe and to the justified expectations that the peoples of this area have in the developments and progress towards unity with a view to the creation of a European entity". It also declared that it understood the definition of nuclear-weapon states in the NPT to mean only those states which had exploded a nuclear weapon or other nuclear explosive device before 1 January 1967; presumably the significance of this point was to prevent any state which might have developed nuclear weapons secretly to claim the status of a nuclear-weapon state in the sense of the treaty. Finally, the Italian government formally declared that it took note of the "full compatibility of the treaty with the existing security agreements". [105] The Italian representative at the NATO Council had earlier declared specifically that the treaty did not constitute an obstacle to nuclear planning within NATO. [100]

Generally, the Italian government has showed greatest concern about the unhampered development of nuclear energy for peaceful purposes. Among other things, it has proposed the setting up of a special UN committee in this field. The fact that Italy wants to become a permanent member of the Board of Governors of the IAEA may also have influenced its NPT policies.

Assessment

There seems to be little doubt that Italy will ratify the Non-Proliferation Treaty as soon as Euratom has secured an agreement with the IAEA. The Italian government places substantial hopes on the beneficiary provisions of the NPT which it believes will assist Italy's nuclear energy programme. Italy already has quite a wide-ranging programme, but it still lacks an independent source of enriched uranium. In the long term, it seems likely that Italy, like so many other developed countries, will develop a nuclear-option policy in case there should be substantial changes in the international security environment.

The Netherlands

As a small country and a member of a military alliance, the Netherlands has a basic interest in the non-proliferation of nuclear weapons. It has therefore fully supported the Non-Proliferation Treaty. The only reason for including the Netherlands in this chapter is that, as a Euratom member, it had to make the same reservation on ratification of the treaty as the other member states, when it signed the NPT in August 1968. It may also be useful to contrast the Dutch non-proliferation policies with those of other countries discussed here.

The Dutch nuclear programme

The Netherlands has one nuclear power station with an installed capacity of 52 MWe. It plans to have three stations with a total capacity of 1 050 MWe in 1977. It does not have a chemical separation plant for plutonium, but uses the facilities of the European Nuclear Energy Agency (ENEA) at Mol in Belgium. Dutch scientists have made great progress in ultra-centrifuge technology for uranium enrichment and the Netherlands is a party, together with Britain and West Germany, to the Tripartite Agreement for developing this technology. One of the two enrichment plants to be constructed under this agreement will be at Almelo in the Netherlands.

During the NPT negotiations the Netherlands emphasized the obligation for nuclear-weapon states to assist non-nuclear-weapon states in nuclear technology. It also showed interest in nuclear ship propulsion.

The Netherlands and the NPT

The Netherlands signed the Non-Proliferation Treaty on 20 August 1968 with the usual Euratom reservation for ratification. The government statement issued at the time of signature stressed, *inter alia,* that it was of decisive importance that as many as possible of the non-nuclear-weapon countries, in particular those having significant technical and industrial capabilities in the nuclear field, become parties to the treaty. It also said that the nuclear-weapon countries would have to make strenuous efforts for nuclear disarmament. In contrast to the corresponding statements by the West German and Italian governments, the Dutch statement did not refer to any "European option" nor to any concern over security implications [106].

In 1967, before signing the NPT, the Dutch government had made clear its views on the application of IAEA safeguards in the Euratom countries. In contrast to West Germany and Italy, it did not wish the IAEA merely to verify the functioning of the Euratom system but wanted it to have a real possibility for controlling the fulfilment of the non-production obligations of non-nuclear-weapon Euratom countries parties to the NPT. [107]. In 1970–71, the Dutch government showed concern over the slow start and slow progress of the safeguards negotiations between Euratom and the IAEA. In March 1971 the Dutch Foreign Minister stated in parliament that if agreement were not achieved in the near future between Euratom and the IAEA, he would explore, together with the other four non-nuclear-weapon Euratom countries, the possibility of a bilateral agreement with the IAEA [108]. This must be taken as a warning to France and to those circles in West Germany and Italy which are opposed to the NPT.

Assessment

The Dutch nuclear weapons policy has been defined in this way:

1. The Netherlands does not wish to produce its own nuclear weapons although it has the capability of doing so.
2. The Netherlands does not wish to acquire a national nuclear force or participate in forms of collective ownership of nuclear weapons.
3. It does not want to decide independently on the use of nuclear weapons or participate in the use of these weapons.
4. For its security the Netherlands relies entirely on the nuclear guarantee given by the United States through NATO. The power to decide on the use of the nuclear weapons of the alliance should rest entirely with the President of the United States. This attitude implies a rejection of the existence of national nuclear powers within the alliance, and of a European nuclear force not integrated with US force.
5. For political considerations the Netherlands does wish to consult and participate in the planning concerning nuclear weapons, such as has been realised in the NPG and the NDAC.
6. The Netherlands is against the proliferation of nuclear weapons and regards measures to control this spread as most urgent. [109]

The main significance of Dutch non-proliferation policies lies in the fact that the Netherlands is able to work for an early acceptance of the Non-Proliferation Treaty by all the non-nuclear-weapon members of Euratom. Together with the other two Benelux countries, the Netherlands in a sense has a veto on an excessively negative Euratom attitude to the NPT, by being able to threaten to break up Euratom over this question.

Belgium

The Belgian attitude to the Non-Proliferation Treaty can be said to fall between the Dutch attitude and the Italian and West German views. Thus, like the Netherlands, Belgium fully supports the NPT, having itself no intention of developing nuclear weapons. But regarding the possibility of a "European option" and the Euratom-IAEA safeguards issue, its views seem closer to those of Italy and West Germany.

Belgium has a domestic nuclear programme which includes one nuclear power station of 11 MWe in operation and three more under construction or in the design stage. Total installed capacity will probably reach 1 660 MWe in 1977. The ENEA chemical separation plant is located in Belgium. Although not a party to the Anglo-Dutch-West German Tripartite Agreement on ultra-centrifuge technology, Belgium, like Italy, has indicated interest in participating in this cooperative effort. There are reports that Belgium may have stockpiled uranium from its former mines in the Belgian Congo.

The Belgian government signed the Non-Proliferation Treaty on 20 August 1968, on the same day as the Netherlands. It made the same reservations regarding Euratom and ratification as did the other Euratom members. In addition, the Belgian statement contained two points which did not appear in the Dutch statement:

It recalled that, especially in Europe, the collective security agreements had helped to create the situation which led to a successful outcome of the NPT negotiations; and added that the 1948 NATO agreement permitted Belgium to subscribe to the provisions of the NPT without risks to its security.

It further mentioned Belgium's concern that the NPT should not conflict with existing European institutions, nor prove an obstacle to future progress in achieving the unity of Europe. [110]

Earlier during the NPT negotiations, Belgium, concerned about the imbalance of obligations between nuclear-weapon and non-nuclear-weapon states, had proposed that the former should renounce their veto in the

Security Council "when because of their actions the sovereignty and independence of a state had become an issue before the Council" [111].

Like the Netherlands, Belgium will probably ratify the NPT as soon as a Euratom–IAEA agreement has been achieved.

Switzerland

Of the neutral European countries, Switzerland is the only one which has not ratified the Non-Proliferation Treaty. It signed the treaty only after long hesitation. Constitutional requirements may make a Swiss ratification more difficult to obtain than that of other countries. There has been some serious discussion about whether Switzerland should acquire tactical nuclear weapons in order to be able to defend its permanent neutrality. Further, Switzerland has a modern nuclear industry and is concerned about both the positive and the possible negative effects of the NPT on its industry and economic development.

The Swiss nuclear programme

Switzerland has an ambitious nuclear programme. At present it has three nuclear power stations, with a total capacity of 1 000 MWe; one station is shared with France and West Germany on the Rhine. Five more nuclear power stations are under construction or in the design stage, so that total capacity will reach 2 500 MWe in 1977. Switzerland also has several nuclear research reactors. The Swiss plutonium production in 1971 can be estimated at nearly 400 kg.

During the course of the NPT negotiations, Switzerland has been concerned to obtain access to new nuclear technology for peaceful purposes, in particular in the field of uranium enrichment. It has shown some interest in peaceful nuclear explosives and in fusion technology, in which it is well advanced.

The Swiss attitude to the NPT

As already mentioned, the Swiss government has been rather hesitant in its attitude to the Non-Proliferation Treaty. In 1967 and 1968 it expressed doubts on many issues, including the length of the duration of the treaty, safeguards, universality of the treaty and the form of security assurances.

The main aspects of the government's position on the NPT were propounded in three documents: a memorandum of November 1967 to the Geneva Disarmament Conference; a memorandum of May 1968 to the US government; and in the Swiss speech to the Conference of Non-Nuclear-Weapon States in September 1968.

The 1967 memorandum contained several reservations about the draft treaty. These included unimpeded access to peaceful nuclear technology and the application of safeguards, in particular the risk of industrial espionage. The memorandum said further that the nuclear-weapon states should solemnly and formally undertake never to use or threaten to use nuclear weapons against non-nuclear-weapon states parties to the treaty, and that it would be desirable for the treaty to provide for a mandatory arbitration procedure for all disputes over its interpretation and application. On the question of Swiss adherence, it was stated that Switzerland could only be a party to the treaty if most of the powers likely to possess nuclear weapons adhered to it, and that so long as that condition was not fulfilled, the treaty would contain a gap endangering the security of the small states on which it would be binding. [112]

The 1968 memorandum repeated several of these points, but also criticized the long delay in getting the safeguards issues through the IAEA and the long duration of the treaty, 25 years. [113]

The Swiss statement to the Conference of Non-Nuclear-Weapon States made several demands on the nuclear-weapon states in compensation for the obligations falling on the non-nuclear-weapon states. The nuclear-weapon powers were asked to provide effective security guarantees regarding the non-use of nuclear weapons or nuclear blackmail against non-nuclear-weapon states; to agree on a comprehensive nuclear test ban and on a quantitative and qualitative freeze on their nuclear weapons; and to pledge themselves to supply enriched uranium for peaceful purposes to non-nuclear-weapon states and to liberalize the access to nuclear technology, in particular regarding uranium enrichment. [114]

When signing the Non-Proliferation Treaty on 28 November 1969, the Swiss government issued a statement saying that it would propose the ratification of the treaty only when it regarded it as having become sufficiently universal in its membership. [115]

At the beginning of 1972, the position of the government was that the treaty still had not achieved the necessary degree of universality to justify Swiss ratification; in particular, several of the important near-nuclear countries had still not deposited their instruments of ratification or accession and the question of the application of safeguards in the Euratom countries had not been settled. On the positive side, the government noted that the contents of the safeguards obligations had now become clarified. [116]

For constitutional reasons the government may have to submit the ratification of the NPT to the electorate in a facultative referendum.[20] This may cause further delays.

[20] The Swiss Constitution provides that treaties with a duration longer than 15 years should be subject to a referendum.

The issue of Swiss nuclear weapons

The debate about Swiss nuclear weapons has been surprisingly intense. The main argument of the "bomb lobby", including the military and many conservatives, is that, as a neutral state, Switzerland has an obligation to maintain a strong defence which can repel attacks from any quarter.

In a loosely worded statement issued in July 1958, after the Hungarian events and under the influence of the cold war, the Swiss government said that in order to safeguard Swiss neutrality effectively, the army would one day have to be equipped with tactical nuclear weapons. This statement caused a public debate and led to two constitutional initiatives for a referendum on the issue. In the first referendum, held in April 1962, the electorate rejected a Social Democratic proposal to forbid Switzerland to produce, import or permit the transit, storage or utilization of nuclear weapons or any parts of such weapons. In the second referendum, held in May 1963, the electorate equally rejected a proposal that the government should consult the electorate before deciding to introduce nuclear weapons into the military arsenal. Thus the government may be said to have received a carte blanche from the electorate to embark upon a nuclear weapons option whenever it deemed this to be necessary. [117]

A factor that may influence the government's nuclear policies is the fact that several of Switzerland's neighbours—including France, Italy and West Germany—have nuclear weapons stationed on their territories, and that nuclear weapons can be easily deployed in the countries of Eastern Europe.

Assessment

Despite the neutrality and other arguments put forward in favour of tactical nuclear weapons in the Swiss nuclear debate, it would seem inconceivable that Switzerland would decide to develop nuclear weapons. Such weapons are not likely to be of much military utility, since the only real threat to Switzerland's security problem would come from a general European war—and then a few nuclear weapons would not matter much. Further, the risk that a Swiss nuclear weapons policy could be used as precedent by other countries which may want to go nuclear for other reasons than Switzerland's, must speak against such a Swiss decision. This is not to say that consideration of a nuclear-weapon option is a likely motive for Switzerland's hesitation in ratifying the NPT. This hesitation is probably caused more by a desire to weigh carefully the economic and technological consequences for Switzerland of an adherence to the NPT, and by an attitude that Switzerland can afford to wait until the more important near-nuclear countries have committed themselves irrevocably to the Non-Proliferation Treaty.

III. *Conclusions*

At the beginning of this chapter seven questions were asked which were said to determine the attitudes of the critical near-nuclear countries to the nuclear proliferation issue. An answer will now be attempted to each question on the basis of the assessments made for the individual countries.

1. *Does the country want to forswear the possibility of becoming a nuclear-weapon power by joining the NPT? Or can it preserve the nuclear-weapon option within the NPT?*

It seems rather clear that a few countries, in particular India and Israel, are not yet prepared to forswear the possibility of acquiring nuclear weapons. Both countries have important security problems. Israel's may be more real, but the Indian perceptions of the threats to its security are politically no less forceful. Together with Egypt and Pakistan—which lack any credible nuclear weapons capability—India and Israel are the only near-nuclear countries which have been engaged in major hostilities during the post-war period. Neither of them is formally protected by a military alliance with a great power, although each enjoys, to a varying degree, the support of a superpower: the USA in the case of Israel, the USSR in the case of India. But even if the possession of nuclear weapons must offer temptations to these two countries, this is not the only course open to them. There is nothing inevitable about the spread of nuclear weapons, given the political will to prevent it. In particular, it is still possible to change the security environment in which these countries are situated, so as to alter the nature of the perceived threat—or possibly to remove it altogether.

A nuclear-option policy within the NPT seems, to a greater or lesser extent, to be the preferred course of several developed countries, including Japan and Italy. This is, of course, a perfectly legal policy since nothing in the Non-Proliferation Treaty forbids a country to make all the preparations for manufacturing nuclear weapons except assembling the warheads. It seems rather likely that more and more countries will opt for such a policy as a last-resort insurance to be implemented in a situation where an all-out war threatens and when they can legally make use of the withdrawal clause. At least, this will probably always be the advice of military advisers. A nuclear-option policy will not produce the same political effects—deterrence, status, and adverse counter-reactions—as an overt nuclear-weapon policy; but in some situations, it may convey similar implications.

2. How will the country's security situation be affected by joining the NPT or by remaining outside? Would its security be enhanced or diminished by the possession of nuclear weapons? In particular, how will its relations with the great powers and with any hostile neighbours be affected by either decision?

For the countries which have an effective military alliance with one of the superpowers or for which there are no serious threats to their security, the answer seems clear—they will not lose but may possibly gain greater security by joining the NPT. Among the countries in this category, Australia, Spain, the Netherlands, Belgium, Brazil and Argentina can be included. For West Germany it can be positively said that the possession of nuclear weapons would diminish its security because of its position in the midst of the East–West confrontation and, in particular, because of the Soviet fears for a remilitarized Germany. The same negative effects may also apply to an *overt* Israeli nuclear weapons policy. Japan is a more doubtful case where two different arguments can be made: (*a*) that it is best protected by the military alliance with the USA and that its going nuclear may mean an end to that protection while not offering any more real security in the face of the possible threats confronting Japan in the future; and (*b*) that the US nuclear umbrella will not be effective because in the face of a superpower war the USA might not be prepared to risk the same amount of self-destruction for the sake of Japan as in the case of a major war involving its European allies, and that, further, the possession of nuclear weapons would offer political advantages to Japan as a rival to China in Asia.

For most countries the situation almost certainly is that they would not gain more military security by going nuclear. At the very best, for example for a country like Switzerland, nuclear weapons would be meaningless for security and would remain an expensive luxury. For other countries, however, possession of nuclear weapons is likely to lead to a worsening of the national security situation because of hostile counter-reactions of apprehensive neighbouring countries. Local arms races would spiral, in some cases—such as those involving India–Pakistan and Israel–Egypt—to dangerous levels. Hostile reactions from the side of the superpowers cannot be excluded either, although the reactions would probably vary—from a very hostile reaction to a nuclear West Germany, Israel or South Africa, to, perhaps, rather little reaction to a nuclear Australia or Brazil; it may be recalled that the French nuclear weapons policy in the end did not evoke much reaction from either the USA or the USSR.

3. Can the country raise its international standing by going nuclear or would it become an international "suspect"? Is it sensitive to discrimination by the nuclear-weapon powers and will that discrimination increase by its becoming party to the NPT—either overall or in the civil nuclear field?

Status is important in international politics. The reasons why Britain and France went nuclear probably had as much to do with status as with anything else. But the results were different for the two countries. Britain seems to have gained practically nothing by going nuclear; in fact its power declined and part of the reason for this may have been the increased dependence on the United States and the economic strait-jacket imposed by the nuclear weapons programme. France, however, probably achieved an increase in status; this may have been due to the conscious and constant application of the status policy argument by General de Gaulle. On the other hand, West Germany and Japan are examples of non-nuclear-weapon powers which have managed to improve their status and influence in world politics considerably, to some extent overshadowing Britain and France.

The fact that permanent membership of the UN Security Council now only belongs to nuclear-weapon countries provides an important argument for status-conscious countries such as India and Japan. If the basis for representation in the Security Council were to be changed, this might therefore remove part of the status argument.

Because of their special situations both Israel and, to an even greater extent, South Africa, would become very isolated internationally if they went nuclear. And there would not just be isolation—there would be suspicions that both these countries had acquired nuclear weapons for military reasons and might use them in the near future. In contrast to the case of India, status does not seem to be a major concern to Israel or South Africa, and so one can omit this as a motive for their going nuclear. What this implies is that it may be more acceptable to the international community if a country acquires nuclear weapons for status reasons than for military security reasons. This may indeed have been shown by the experience of Britain and France. Both countries went nuclear primarily for status reasons and there was very little hostile international reaction to them. Of course, the fact that both countries emerged as victors of World War II and commanded respect as great imperial powers may have contributed to the absence of adverse reaction.

The arguments about discrimination are, on the other hand, difficult to take seriously. Discrimination is one of the basic facts of international politics, for instance both in the conventional military and economic fields;

it is thus not unique to the nuclear sector. Such complaints therefore, seem mostly to be a subterfuge for other reasons.

4. *Can the country afford to go nuclear?*

Costs are a relative thing. If that which is gained in exchange has a high value attached to it—for instance, the safeguarding of national security—or brings important diplomatic benefits, then the costs may not seem too high. Whether or not the costs are bearable may also depend on the length of the time-period over which they are spread. It is probably true to say that all the fifteen countries whose nuclear policies have been discussed in this chapter—with the possible exceptions of Pakistan and Egypt—are or will in the near future be able to afford at least a crude nuclear weapons capability. Whether or not that will be too expensive will depend on the countervalue. It may be too expensive for Japan but not for Israel.

5. *Is the full utilization of nuclear energy essential for the country's economy and would this be harmed by submitting to the rules of the NPT—for instance, on peaceful nuclear explosives? Or is it better for peaceful nuclear purposes to be inside than outside the NPT, since it may otherwise be difficult to get fissionable material and assistance in nuclear science and technology?*

That the utilization of nuclear energy for peaceful purposes will make important contributions to industrial development, in particular as the major source of energy after the depletion of fossile fuels, is indisputable. The only possible future alternative to fission energy is fusion energy but this is still far off. The future nuclear energy needs of the industrial countries are immense: by 1990 nuclear energy will supply 50 per cent of Japan's demand for electricity, for instance. Cheap nuclear energy, as will be provided by breeder reactors in particular, offers great attractions to the underdeveloped countries, too, as possibly the main means of accelerating their development.

For most peaceful nuclear purposes it would seem to be better for a country to be inside than outside the NPT. Being a party will facilitate the obtaining of foreign nuclear material, equipment and assistance. It will also, in most cases, improve prospects for export of nuclear material. The only exception is for exports to non-parties, but this is a small market.

Despite all the clamour about peaceful nuclear explosives, their economic value remains unproven. In particular, it is doubtful whether countries would gain more from developing their own peaceful nuclear explosives, if and when they become economical, than from relying on an international agency to supply them.

6. *Would the practical application of safeguards be harmful to the country's civil nuclear industry?*

The application of safeguards can have important effects on the civil nuclear industry but their economic significance for the overall nuclear policies of a country has probably been much exaggerated, as have the risks of industrial espionage. That a country should stay outside the NPT because it could not stand the application of safeguards for *economic* reasons seems not to be a serious proposition.

7. *Can the country help most in achieving great power nuclear disarmament by exerting pressure inside or outside the NPT?*

Paradoxically, it may be said that some key countries, such as India and Japan, have been able, at least initially, to exert more pressure on the USA and the USSR to engage in nuclear disarmament by remaining outside the NPT than if they had joined immediately. SALT may partly be seen in this light—as a serious effort to meet the objectives of the near-nuclear countries. In the future, however, the parties to the NPT may be able to achieve more in the way of nuclear disarmament by participating in the NPT review conferences and there negotiate with the superpowers about the fulfilment of the disarmament provisions of the NPT. Any moral force attaching to, say, the Indian non-participation in the NPT—because of its "unbalanced" and "discriminatory" provisions—is likely to have worn off by now and have been changed into feelings of suspicions or at least uneasiness on the part of the international community about the real motives of the country concerned.

In summary, nuclear capabilities will continue to spread but there is nothing inevitable about the proliferation of nuclear weapons. Their own local security is by far the most important factor when nations decide about their nuclear policies. Status seems important for some countries. Both factors are susceptible to influence by other countries' policies.

The political and opportunity-cost constraints against nuclear proliferation are probably growing the more nuclear weapons become non-used weapons. A successful outcome of SALT—and/or a comprehensive nuclear test ban—would almost certainly have a decisive influence in forestalling more nations going nuclear. Indeed, the process may one day go in the other direction—some of the medium-sized countries possessing nuclear weapons may in the end prefer to give them up.

The Non-Proliferation Treaty is only one factor which influences the nuclear policies of the near-nuclear countries. It may not yet be the most important factor. But to the extent it will command general adherence, its importance is likely to grow. Nations generally do not take their treaty obligations lightly, and the nuclear weapons prohibitions of the NPT may eventually develop into a kind of customary law constraint, reinforcing other political and economic constraints. Viewed against this background the future of the treaty may not seem too bleak.

References

1. Beaufre, André, *Dissuasion et Stratégie* (Paris, 1964).
2. News Conference statement, 29 September 1965, reported in *Peking Review,* 8 October 1965, pp. 8–9.
3. ACDA, *International Negotiations on the Treaty on the Nonproliferation of Nuclear Weapons* (Washington, 1969), p. 1.
4. For the text of this and all other international documents on the Non-Proliferation Treaty, see reference 3.
5. *International Herald Tribune,* 29 November 1970.
6. Beaton, Leonard, "Sales before Sanity", *Times,* 27 May 1970.
7. *A World of Nuclear Powers?,* Alastair Buchan, ed., The American Assembly (New York: Colombia University Press, 1966).
8. *Effects of the Possible Use of Nuclear Weapons and the Security and Economic Implications for States of the Acquisition and Further Development of these Weapons* (Report of the Secretary-General, United Nations, 1968).
9. *Preventing the Spread of Nuclear Weapons,* C. F. Barnaby, ed. (London: Pugwash Monograph, 1969).
10. *Memorandum by the US AEC on Nuclear Weapon Manufacturing Capabilities,* in *The Non-Proliferation Treaty,* hearings before the Committee on Foreign Relations, US Senate, 90th Congress, 2nd session, July 1968, pp. 30–31 (ACDA, *Documents on Disarmament,* 1968, p. 508).
11. *Atomic Energy and Space Research: a Profile for the Decade 1970–1980,* Report by the India Atomic Energy Commission (Bombay, May 1970), p. 6.
12. *Atomic Energy and Space Research: a Profile for the Decade 1970–1980,* Report by the India Atomic Energy Commission (Bombay, May 1970).
13. *Financial Times,* 27 November 1970.
14. Statement by the Indian representative to the First Committee of the United Nations General Assembly, 10 December 1969, UN document A/C.1/PV. 1718, pp. 16–17 (ACDA, *Documents on Disarmament,* 1968, p. 696).
15. *Nuclear India,* 8(7), p. 1 (Department of Atomic Energy, Bombay, March 1970).
16. *Nuclear India,* 9(1), p. 1 (Department of Atomic Energy, Bombay, September 1970).
17. Statement by the Indian representative to the Disarmament Commission of the United Nations, 4 May 1965, UN document DC/PV. 75 (ACDA, *Documents on Disarmament,* 1965, p. 142).

18. For an account of the Indian position, see the statement by the Indian representative to the First Committee of the United Nations General Assembly, 14 May 1968, UN document A/C.1 PV. 1567, (ACDA, *Documents on Disarmament*, 1968, p. 325).
19. *Hindustan Times*, 13 April 1967, reported in Williams, L. Shelton., *The US., India and the Bomb*, Studies in International Affairs No. 12, (Baltimore: John Hopkins University, 1969), p. 50.
20. Cf. the statement by the Indian representative to the United Nations Security Council, 19 June 1968, UN document S/PV. 1433.
21. Statement by Prime Minister Gandhi in the Indian parliament, 14 March 1968.
22. Memorandum received from the Indian Ambassador, Stockholm, 7 June 1971.
23. Statement by the Indian Defence Minister in the Indian parliament, 3 November 1970.
24. Statement by Prime Minister Shastri to the Cairo Conference of Non-Aligned Nations, October 1964, reported in *Indian and Foreign Review*, 2(16), 1 June 1965.
25. "Nuclear Weapons and India's Security", special issue of *The Institute for Defence Studies and Analyses Journal*, 3(1), New Delhi, July 1970.
26. Subrahmanyam, K., "The Role of Nuclear Weapons: an Indian Perspective", paper submitted to the Conference on "The Role of Nuclear Weapons in the Politics and Defence Planning of Non-Nuclear Weapon States", organized by the Norwegian Institute of Foreign Affairs, Oslo, Norway, 9–13 March 1971.
27. Patil, R. L. M., *India—Nuclear Weapons and International Politics* (Delhi, 1969).
28. Schlesinger, J. R., *Nuclear Spread: The Setting of the Problem*, Rand Collection, P-3557 (Santa Monica, California: The Rand Corporation, March 1967) p. 19.
29. *Effect of Defense on Developing Economies*, report prepared for US ACDA by Emile Benoit, et al., Vol. I, Summary, ACDA/E-136, June 1971, p. 28.
30. See the papers by Anna B. Dutka, "The Economic Aspects of India's Defense Policies", and Geoffrey Kemp, "The Availability of Major Weapons Systems as a Constraint on Alternative Indian Defense Programs", in Vol. IV of the study "India and Japan: the Emerging Balance of Power in Asia and Opportunities for Arms Control, 1970–1975", prepared for US ACDA by the Southern Asian Institute/East Asian Institute, Columbia University (ACDA/IR-170, April 1971).
31. Statement by the Pakistani representative to the First Committee of the United Nations General Assembly, 13 May 1968, UN document A/C.1/PV.1566 (ACDA, *Documents on Disarmament*, 1968, p. 317).
32. Statement by the Pakistani representative to the First Committee of the United Nations General Assembly, 6 June 1968, UN document A/C.1/PV. 1580.
33. Draft resolution submitted by Pakistan to the Conference of Non-Nuclear-Weapon States, Geneva, September 1968 (annex VII of the final document A/7277), referred to in a statement by the Pakistani representative

to the First Committee of the United Nations General Assembly, 18 November 1968, UN document A/CI./PV.1610
34. Statement by the Pakistani representative to the Second Committee of the Conference of Non-Nuclear-Weapon States, Geneva, 17 September 1968, A/Conf. 35/C.2/SR.9.
35. Finney, John W., "Israelis Reported to be Reluctant at This Time to Sign Treaty Barring Spread of Nuclear Arms", *New York Times,* 19–20 November 1968.
36. Quester, George H., "Israel and the NPT", *Bulletin of the Atomic Scientists,* June 1969.
37. Barnaby, C. F., "Limits on the Nuclear Club", *New Scientist,* 12 March 1970.
38. Statement by the Israeli Foreign Minister in the Israeli parliament, 17 December 1968.
39. Statement by the Israeli representative to the First Committee of the United Nations General Assembly, 29 May 1968, UN document A/C. 1/PV. 1576 (ACDA, *Documents on Disarmament,* 1968, p. 402).
40. *Neue Zürcher Zeitung,* 30 November 1968.
41. Statement by the Israeli representative to the Conference of Non-Nuclear Weapon States, Geneva, 12 September 1968.
42. "'Near-Nuclear' Israel Wary of Joining Pact", *Christian Science Monitor,* 25 July 1968.
43. Quester, George H., "Israel and the NPT", *Bulletin of the Atomic Scientists,* June 1969.
44. *International Herald Tribune,* 10–11 May 1969.
45. *Neue Zürcher Zeitung,* 5 October 1968.
46. Cf. *supra* 35.
47. Dowty, Alan, "Israeli Perspectives on Nuclear Proliferation", paper submitted to the Conference on "The Role of Nuclear Weapons in the Politics and Defence Planning of Non-Nuclear Weapon States", organized by the Norwegian Institute of Foreign Affairs, Oslo, Norway, 9–13 March 1971, p. 16.
48. *Supra* 43.
49. Statement by the Egyptian representative to the Second Committee of the Conference of Non-Nuclear-Weapon States, Geneva, 20 September 1968, A/Conf.35/C.2/SR.12.
50. Statement by the Egyptian representative to the First Committee of the United Nations General Assembly, 28 May 1968, UN document A/C.1/PV. 1575 (ACDA, *Documents on Disarmament,* 1968, p. 397).
51. Statement by Prime Minister Vorster to the South African Parliament, 20 July 1970.
52. *Times,* 14 August 1971, and *Rand Daily Mail,* 18 November 1971.
53. *Japan Times,* 8 August 1970.
54. Statement by the South African representative to the First Committee of the United Nations General Assembly, 20 May 1968, UN document A./C.1/PV. 1571 (ACDA, *Documents on Disarmament,* 1968, p. 378).
55. Imai, Ryukichi, "Japan and the Nuclear Age", *Bulletin of the Atomic Scientists,* June 1970, pp. 35–39.

56. *International Herald Tribune,* 12–13 September 1970 and 24–25 October 1970.
57. *Le Monde,* 18 January 1972.
58. *Japan Times,* 9 June 1971.
59. *Le Monde,* 3 January 1970.
60. Japan Atomic Energy Commission, *Thirteenth Annual Report,* 1968–1969, p. 60.
61. Japan Atomic Energy Commission, *Long-Range Program on Development and Utilization of Atomic Energy,* 13 April 1967, p. 24.
62. Statement of the Japanese government on signing the Non-Proliferation Treaty, 3 February 1970.
63. *Le Monde,* 3 February 1970 and *Svenska Dagbladet,* 3 November 1970.
64. Japan Defense Agency, *The Defense of Japan,* October 1970, p. 39.
65. Quoted from Hisashi, Maeda, "The Nuclear Non-Proliferation Treaty", *Japan Quarterly,* 15(4), October–December 1968, p. 458.
66. *Times,* 12 July 1971.
67. Kishida, Junnosuke, "Atoms for Peace", *Times,* 17 June 1970.
68. *Japan Times,* 25 March 1970.
69. Murata, Kiyoaki, "Reluctance over the NNT", *Japan Times,* 12 November 1970.
70. Gelber, Harry G., "Australia and Nuclear Weapons", paper submitted to the Conference on "The Role of Nuclear Weapons in the Politics and Defence Planning of Non-Nuclear Weapon States", organized by the Norwegian Institute of Foreign Affairs, Oslo, Norway, 9–13 March 1971, p. 10.
71. *Times,* 27 May 1970.
72. Kalkstein, M., *International Arrangements and Control for the Peaceful Applications of Nuclear Explosives,* Stockholm Paper No. 4. (Stockholm: SIPRI, 1970), pp. 22–23.
73. Statement by the Australian representative to the First Committee of the United Nations General Assembly, 17 May 1968, UN document A/C. 1 PV. 1570 (ACDA, *Documents on Disarmament,* 1968, p. 362).
74. Statement for the press by Prime Minister Gorton, 18 February 1970.
75. Statement of the Australian government on signing the Non-Proliferation Treaty, 27 February 1970.
76. Statement by the Australian Defence Minister in the Australian parliament, 10 March 1970.
77. Statement by the Spanish representative to the First Committee of the United Nations General Assembly, 16 May 1968, UN document A/C.1/ PV. 1569.
78. Statement by the Spanish representative to the Second Committee of the Conference of Non-Nuclear-Weapon States, Geneva, 5 September 1968, A/Conf.35/C.2/SR.2.
79. UN document A/RES/2373 (XXII) 18 June 1968. The voting record is also reproduced in *supra.* 3, p. 165.
80. Statement by the Spanish representative to the United Nations General Assembly, 12 June 1968, UN document A/1672.
81. Statement by the Spanish representative to the First Committee of the

United Nations General Assembly, 10 June 1968, UN document A/C.1/PV. 1582.

82. Spanish Memorandum to the Co-Chairmen of the ENDC, 8 February 1968, ENDC/219 (ACDA, *Documents on Disarmament,* 1968, p. 39).
83. The Brazilian Nuclear Energy Commission, *Essential Information,* July 1970, p. 6 a.
84. Rosenbaum, H. J., and Cooper, G. M., "Brazil and the Nuclear Non-Proliferation Treaty", *International Affairs,* London, Vol. 46, January 1970, pp. 74–90.
85. Statement by the Brazilian representative to the First Committee of the United Nations General Assembly, 10 December 1969, UN document A./C.I/PV.1718 (ACDA, *Documents on Disarmament,* 1969, p. 698).
86. Statement by the Brazilian representative to the First Committee of the Conference of Non-Nuclear-Weapon States, Geneva, 21 September 1968, A/Conf.35/C.1/SR.15.
87. Statement by the Brazilian representative to the ENDC, 8 February 1968, ENDC/PV.363 (ACDA *Documents on Disarmament,* 1969, p. 49).
88. Communication received from the Brazilian Ambassador, Stockholm, 11 June 1971.
89. Statement by the Argentinian representative to the First Committee of the United Nations General Assembly, 22 May 1968, UN document A./C.I/PV. 1572.
90. Quoted from, Prawitz, Jan, "A Nuclear Doctrine for Sweden", *Co-operation and Conflict,* No. 3, 1968, p. 191.
91. "Die Brennstoffversorgung der Euratom", *Neue Zürcher Zeitung,* 16 January 1971.
92. Scheinman, Lawrence, "Nuclear Safeguards, the Peaceful Atom, and the IAEA", *International Conciliation,* No. 572, March 1969, p. 40.
93. Sommer, Theo, "The Objectives of Germany", in *A World of Nuclear Powers?* Alastair Buchan, ed., The American Assembly (New York: Columbia University Press, 1966), p. 41.
94. *The Non-Proliferation Treaty,* hearings before the Committee on Foreign Relations, US Senate, 90th Congress, 2nd session, July 1968, pp. 262–63.
95. For a discussion of the prospects for a European nuclear force, see Smart, Ian, *Future Conditional—The Prospect for Anglo-French Nuclear Co-Operation,* Adelphi paper No. 78 (London: International Institute for Strategic Studies, 1971).
96. CDU/CSU, I. Fragen zum Sicherheitsbereich, (prepared answers on the NPT by the Foreign Ministry of the FRG), November 1968, p. 27.
97. *The Non-Proliferation Treaty, op.cit.,* pp. 43 and 47.
98. *Vertrag über die Nichtverbreitung von Kernwaffen: Dokumentation zur deutschen Haltung und über den deutschen Beitrag, Presse- und Informationsamt der Bundesregierung,* Bonn, December 1969, p. 45. (Contains all the official West German documents on the NPT.)
99. SPD I. Friedenssicherung und Abrüstung (prepared answers on the NPT by the Foreign Ministry of the FRG), 1969, pp. 75–89.
100. Statement by the Italian Foreign Minister in the Italian Senate, 18 July 1969.
101. Celletti, Franco, "The Role of Nuclear Weapons in the Politics and Defence

Planning of Non-Nuclear Weapon States: An Italian Perspective", paper submitted to the Conference on "The Role of Nuclear Weapons in the Politics and Defence Planning of Non-Nuclear Weapon States", organized by the Norwegian Institute of Foreign Affairs, Oslo, Norway, 9–13 March 1971.

102. See the statement by the Italian representative to the First Committee of the United Nations General Assembly, 10 May 1968, UN document A/C.1/PV. 1565 (ACDA, *Documents on Disarmament*, 1968, p. 314).
103. Statement by the Italian representative to the United Nations General Assembly, 12 June 1968, UN document A/PV. 1672.
104. Statement of the Italian government on signing the Non-Proliferation Treaty, 28 January 1969.
105. Italian government note to the USA, the UK and the USSR on signing the Non-Proliferation Treaty, 28 January 1969.
106. Statement of the Dutch government on signing the Non-Proliferation Treaty, 20 August 1968.
107. Statement of the Dutch Foreign Minister on the draft Non-Proliferation Treaty in a committee of the Dutch parliament, 22 November 1967.
108. Statement by the Dutch Foreign Minister in the Dutch parliament during the debate on the Anglo-Dutch-West German Tripartite Agreement, 3 March 1971.
109. Leurdijk, J. H., "Nuclear Weapons in Dutch Foreign Policy", paper submitted to the Conference on "The Role of Nuclear Weapons in the Politics and Defence Planning of Non-Nuclear Weapon States", organized by the Norwegian Institute of Foreign Affairs, Oslo, Norway, 9–13 March 1971, p. 11.
110. Statement of the Belgian government on signing the Non-Proliferation Treaty, 20 August 1968.
111. Statement by the Belgian Foreign Minister to the United Nations General Assembly, UN document, A/PV. 1689, 10 October 1968.
112. Swiss Aide-Mémoire to the Co-Chairmen of the ENDC, 17 November 1967, ENDC/204., 24 November 1967 (ACDA, *Documents on Disarmament* 1967, p. 572).
113. Swiss Aide-Mémoire to the United States government, 9 May 1968.
114. Statement by the Swiss representative to the Conference of Non-Nuclear-Weapon States, Geneva, 10 September 1968, reported in *Neue Zürcher Zeitung*, 13 September 1968.
115. Note of the Swiss government to the governments of the USA, the UK and the USSR on signing the Non-Proliferation Treaty, 27 November 1969.
116. *Rapport du Conseil fédéral à l'Assemblée fédérale sur les relations de la Suisse avec l'Organisation des Nations Unies et ses institutions spécialisées de 1969 à 1971*, 17 November 1971, p. 11.
117. Schwab, George, "Switzerland's Tactical Nuclear Weapons Policy", *Orbis* 13(3), autumn 1969, pp. 900–914.

Appendix 9A. Nuclear power reactors as a source of plutonium

When nuclear power reactors are operated for *the production of the cheapest electricity,* the plutonium (Pu) they produce as a by-product is not suitable for use as the fissionable material for very efficient nuclear weapons because the fissionable isotope of plutonium—Pu-239—is contaminated by the presence of non-fissionable isotopes of the element, particularly Pu-240. "Weapons-grade" plutonium should contain no more than 10 per cent of these non-fissionable isotopes, and preferably less.

One way in which nuclear power reactors could be used to produce weapons-grade plutonium would be to limit the burn-up of the uranium fuel (i.e., the amount of energy which the uranium fuel has released) to values of less than 1 000 megawatt-days per ton[1] of uranium.[2] This could be achieved by removing some of the reactor fuel elements from the reactor after a period of a few weeks, thus limiting the burn-up value and the amount of Pu-240 produced.

Under normal operating conditions for producing electricity, the fuel burn-up in most types of power reactor is typically an order of magnitude higher than this value. The fuel elements are left in the reactor for periods of between one and one and a half years and the plutonium recovered from the spent fuel elements then has a Pu-239 content of about 70 per cent. The British Magnox (gas-cooled) reactors are an exception because they are normally operated at burn-up values of only about 3 500 megawatt-days per ton; the Pu-239 content is about 85 per cent.

Even though contaminated with up to 30 per cent Pu-240, the plutonium normally produced in nuclear power reactors would still be usable as the fissile material for more primitive, but still effective nuclear weapons. A relatively larger amount of this plutonium would have to be used for a given explosive yield and consequently the physical size of the weapon would be larger. And steps would have to be taken to prevent the device from over-heating due to the spontaneous fission of Pu-240.

[1] One metric ton (1 000 kg.) is equal to 1.1 short tons (2 000 lb.).

[2] One megawatt-day is equal to 24 000 kilowatt-hours and is the amount of heat which would be produced, for example, by 1 000 electric fires of one kilowatt each operating for a 24-hour period.

protons

I. *The production of plutonium*

Ordinary uranium (U), as dug out of the earth, consists of a mixture of three isotopes: U-234, U-235 and U-238. Each of the three types of uranium atom contains 92 portions in their nuclei, but the nucleus of an atom of U-234 contains 142 neutrons, the nucleus of an atom of U-235 contains 143 neutrons and the nucleus of U-238 contains 146 neutrons. U-234 occurs in such small proportions as to be unimportant.

When a nucleus of a uranium atom absorbs an extra neutron it sometimes splits up into two fragments—the fission process. A relatively large amount of energy is released during fission. A nucleus of U-235 will undergo fission when any neutron, even one moving very slowly, collides with it; and, in fact, the slower the neutron the more probable it is that the U-235 nucleus will "capture" it and fission. But a neutron can cause fission in U-238 *only* if its velocity exceeds a certain value. If a U-238 nucleus absorbs a slow neutron, the new nucleus so produced does not undergo fission but instead is ultimately transformed, by radioactive decay, into Pu-239.

In a nuclear reactor, which uses uranium as fuel,[3] the following processes occur. Some U-235 nuclei undergo fission. During each fission process two or three neutrons are emitted, in addition to the two fission fragments (called fission products) and energy. The speeds of these neutrons are usually too slow to produce fission in U-238 and so the fission process is mainly sustained by the further fissioning of U-235. Some of the fission neutrons are, however, captured by U-238 nuclei which are then transformed into Pu-239. Pu-239 is radioactive but has the very long half-life[4] of 24 000 years; after radioactive decay it becomes U-235. But if Pu-239 captures a neutron before it decays in this manner, it will undergo fission: therein lies its importance. Moreover, like U-235, Pu-239 has the important property that it will undergo fission regardless of what speed the initiating neutron has.

[3] Natural uranium by itself cannot be used to produce a self-sustaining chain reaction because of the large proportion of U-238 contained in it. In a reactor, natural uranium, or uranium in which the proportion of U-235 has been increased significantly about its natural value, is mixed with a substance (like graphite or water) whose nuclei are small in size so that if a fast neutron collides with one of them it will lose a large fraction of its velocity—just as a billiard ball will lose velocity when it collides with another one. The neutron's velocity is thus rapidly "moderated" to the low velocity at which it can be efficiently captured by a U-235 nucleus, producing fission, and at which it will have a relatively high probability of avoiding capture by a U-238 nucleus. A substance used to slow down fission neutrons is called a moderator.

[4] The half-life is the time taken for half of a large number of atoms of a radioactive substance to decay.

The amount of plutonium produced

During the 1970s, the use of light-water reactors will increasingly dominate in nuclear power programmes.[5] By 1980 these reactors, together with advanced graphite reactors,[6] will account for most of the nuclear power reactors installed. Both types use uranium enriched to between 1.5 and 3 per cent in U-235 (natural uranium contains only 0.72 per cent U-235) as fuel. In these reactors about one atom of plutonium is produced for every U-235 atom which is destroyed; i.e., the so-called initial conversion ratio is about 0.5. A small fraction of nuclear power will be produced in reactors which use their fuel more economically—the high-temperature, gas-cooled reactors[7] and heavy-water reactors[8]—and in which the initial conversion ratio is about 0.8.

The fabrication of reactor fuel elements is a very expensive process and, consequently, these elements are kept in the reactor for as long as possible, usually for about one to one and a half years. Towards the end of this period, the plutonium formed earlier (by neutron-capture in U-238) is itself being partially consumed as fuel. It is this consumption of plutonium which produces the isotope Pu-240, formed in about 30 per cent of the neutron reactions with Pu-239. The remaining 70 per cent results in fission and this in turn leads to a partial (about 50 per cent) regeneration of the plutonium burned. The plutonium produced in the reactor fuel elements is extracted chemically in a reprocessing plant. Reprocessing plants are becoming increasingly widespread and, within a few years, no country should have any difficulty in obtaining access to one.

Although the operational parameters of nuclear power reactors vary from system to system, it is possible to calculate crudely the world's net production of plutonium in nuclear reactors. Taking reasonable figures for the economic operation of power reactors, an approximate value for the net conversion ratio (U-235 destroyed/Pu-239 extracted) of 0.45 is obtained for the total mix of reactors expected in the world over the next decade. The thermal-to-electric conversion efficiencies of nuclear power reactors also vary with type but a world average of about 33 per cent can be reasonably assumed. This means that about 3 grams of U-235 will be destroyed and about 1.3 grams of Pu-239 produced for each megawatt-day of electricity generated. Nuclear power plants will be generally operated

[5] Reactors in which light (i.e., ordinary) water is used both as moderator and to cool the reactor.

[6] Reactors moderated by graphite and cooled by a gas, usually carbon dioxide.

[7] Reactors moderated by graphite and cooled by helium gas, which operate at very high temperatures.

[8] Reactors moderated by heavy water.

at about 80 per cent of their maximum capability throughout the year. In other words, each megawatt of nuclear capacity will produce 292 megawatt-days of electricity in a year. Therefore, on average, one megawatt of nuclear capacity will produce about 380 grams ($0.8 \times 1.3 \times 365$) of Pu-239 for extraction.

The total nuclear electrical-generating capacity in 1980 (taking this year as an example) will be about 350 GWe (gigawatts of electricity)[9] and this will produce about 130 000 kilograms (380×350) or 130 tons of Pu-239. This plutonium will become available in 1982—the two-year delay being the time during which the fuel is kept in the reactor and the time needed for the extraction of plutonium from the spent reactor fuel elements.

II. *Fast-breeder reactors*

During the early 1980s, the character of the growth and spread of nuclear power will change. This change will result from the development and use of commercial fast-breeder reactors. These reactors differ from other types in that they produce more fuel than they consume.

It is possible, by a suitable design, to convert U-238 in the core of the reactor and U-238 placed in a "blanket" around the core, into plutonium. And "breeding" occurs because the fission chain reaction proceeds with a greater neutron surplus than is possible in an ordinary reactor. The stockpile of fissionable material is, therefore, steadily increased, and about every 4 years an amount of fuel equal to that initially put in is produced. Thus, after about 8 years, enough fuel becomes available not only to keep the breeder-reactor operating, but to fuel a new one of the same size.

The amount of U-238 in a breeder-reactor is typically about fifteen times greater than the amount of plutonium, and, since about 70 per cent of this U-238 can be utilized, only a small yearly replenishment of U-238 is needed. For comparison, only about 1 per cent of the uranium is utilized in most other reactors. Fast neutrons direct from the fission process are used to induce further fission. Pu-239 is the preferred fuel for a fast-breeder reactor because more fast neutrons are available from its fission than from that of U-235. Normally, plutonium metal or oxide is mixed with natural, or depleted, uranium and this material is fabricated with fuel elements for the fast-breeder reactor. But, because most of the fissions are caused by fast neutrons and because the probability of causing fission with fast neutrons is only one-three-hundredth as great as that with very slow

[9] One GWe is equal to 1 000 MWe.

neutrons, a relatively large quantity of fissionable material is necessary to maintain a chain reaction. About 3 tons of plutonium are needed to fuel initially a breeder reactor of 1 GWe. Some of the U-238 in a breeder reactor is fissioned by fast neutrons and this process significantly contributes both to the surplus of neutrons and to the production of heat.

By 1982 the world will probably be commissioning at least 100 GWe of new nuclear power reactors each year. And a large fraction, probably about one-half, of this new capacity will be breeder reactors. The plutonium required to fuel initially 50 GWe of breeder reactors in 1982 will exceed the amount of plutonium produced from reactors operating in 1980. The excess will have to be taken from plutonium stocks. After 1982 breeder reactors will provide a rapidly increasing fraction of the new nuclear capacity installed. And the large demand for plutonium will continue until the mid-1990s when the world's fast breeders will be producing enough plutonium to fuel the new fast-breeder reactors subsequently installed to meet the world's supply requirements.

III. *Summary*

Nuclear power reactors will rapidly spread throughout the world during the next two decades. By 1980 over 40 countries will have them. The reactors in operation in 1980 will probably produce about 130 tons of plutonium per year. This is an order of magnitude greater than the present plutonium production rate.

During the 1980s most of the new power reactors installed throughout the world will be fast-breeder reactors. Until the mid-1990s the demand for plutonium to fuel these reactors will exceed the yearly production of plutonium from operating reactors. Plutonium stocks are being accumulated to meet this excess of demand over supply. The switch to breeder reactors will be stimulated by economics;[10] the electricity generated by breeders will be considerably cheaper than that generated by existing reactor types, and by the pressure on resources of cheap, new uranium.[11]

[10] In the United States, where about 2.7 trillion kilowatt-hours of electricity will be generated in 1980, a saving of one-tenth of a cent per kilowatt-hour on generation costs would equal $2.7 billion per year. Breeder reactors will probably save more than twice this figure on generation costs, compared with present costs.

[11] See page 470.

Appendix 9B. Enriched uranium technology

For use as a reactor fuel and as the fissionable material in nuclear weapons, the concentration of uranium-235 in ordinary uranium has to be increased from its "natural" value of 0.72 per cent in uranium ore to values of up to 4 per cent for reactor fuel and values of over 95 per cent for nuclear weapons, a process normally called "enrichment".

Uranium-235 (U-235) and uranium-238 (U-238), the two important isotopes in natural uranium, are chemically identical and so it is necessary to use a physical method to separate them.

I. *Gas diffusion*

The gas diffusion method is, at present, the only method actually used to produce uranium enriched in U-235 on a large scale. This method of enrichment is based upon the fact that, in a gaseous mixture of two isotopic molecules, the molecules of the lighter isotope will diffuse more rapidly through a porous barrier than those of the heavier one. Uranium hexafluoride (UF_6) which is solid at room temperatures but easily vaporized, is the gas used for diffusion. But because UF_6 gas is extremely corrosive and reactive, special materials must be used for the construction of the pipes and pumps used in the process, and the entire installation must be completely free from grease and oil. Furthermore, the fact that the proportion of U-235 is raised by only a small factor in each diffusion stage means that many stages are required to obtain the desired enrichment. For "weapons-grade" enriched uranium, for example, several thousand stages are necessary.

A gaseous diffusion plant is a gigantic industrial undertaking. A typical plant covers tens of acres of floor area and contains hundreds of acres of diffusion barriers connected by an incredible maze of hundreds of miles of piping with thousands of valves and joints, all requiring intricate welding. The precision with which the components of the plant must function is very high, and the process is fully automated. The plant consumes enormous quantities of electrical power, usually requiring the construction of a large, independent power station.

Eight diffusion plants now exist: three in the United States; two in the Soviet Union; and one each in the United Kingdom, France and China. These plants were all originally built for military purposes, but they are now mainly used to produce enriched uranium for power reactors. No plant has so far been built outside the nuclear-weapon countries.

II. *Gas centrifuge*

Several countries are attempting to develop an alternative method of uranium enrichment. In particular, development work on the gas centrifuge is being undertaken in the United States, the United Kingdom, South Africa, West Germany, the Netherlands, Japan and Australia. The centrifugal method of separating isotopes in gaseous form is based on the principle that the gravitational force on a particle is proportional to its mass. A centrifuge provides a field of force analogous to gravity but much more powerful.

In essence, a suitable gas centrifuge for uranium enrichment would probably (the details are secret) consist of a vacuum tank containing a long, rotating pipe-like drum with concentric nozzles at one end and concentric orifices at the other. Uranium hexafluoride gas would be pumped in via the nozzles and, as the gas moves up inside the rotating drum, molecules would tend to be flung outwards. But, because a pressure gradient builds up, molecules of the lighter U-235 isotope would tend to diffuse towards the centre. In practice, the gas would move through the centrifuge in two streams and, under equilibrium, there would be no net mass transfer between them. This means that the number of molecules of each mass flowing in each direction is slightly different; the inner stream thus becomes enriched in U-235, which is then collected by the inner exit orifice. This slightly enriched flow would be fed to the inner nozzle of the next centrifuge in the cascade, and so on. Although a separative factor per stage about ten times higher than that for the diffusion process can probably be achieved, a centrifuge plant would still require a very large number of centrifuges in cascade to provide a useful output of enriched uranium.

Throughout its history, the gas centrifuge has been dogged by material problems. The limiting factors governing performance have been the tensile strength and density of the material of the outer casing of the drum and the rotor bearings. Drum speeds of about 450 metres per second are now believed possible and, therefore, a centrifuge rotating at 60 000 revolutions-per-minute will have a diameter of about 14 cm. Such a centrifuge is likely to be about 1 metre long. These parameters rule out the use of nickel and aluminium alloys usually used to handle uranium hexafluoride in diffusion plants. Conventional steels seem little better. And it is likely that the current developments in gas-centrifuge technology, mainly in Britain, the Netherlands and West Germany, are largely the result of a somewhat revolutionary material having become available. The material referred to is possibly carbon fibre. In this case, strength could be supplied to the outer wall of the rotor using a filament-winding technique, with resin-coated carbon fibre being wound continuously round a mandrel (cylindrical round rod of metal) of rotor diameter. This fibre case could then be pushed over a liner of aluminium resistant to uranium hexafluoride.

Where the centrifuge is more attractive than the diffusion process is in running costs. The amount of electricity required to operate a centrifuge installation is said to be one-fifth (some sources say one-tenth) that needed to power an equivalent diffusion plant. The capital costs are about the same, but the structures of the two investments are different. While a diffusion plant needs a massive initial injection of capital for the thousands of stages before enriched uranium can flow, a working centrifuge plant can be economically built up step-by-step as demand for enriched uranium increases.

III. *The need for enriched uranium*

For many countries, an important aspect of the general problem of future nuclear fuel supplies is the availability of enriched uranium. Large quantities will be required during the 1970s to fuel gas-cooled reactors and light-water reactors. At present, the only exporters are the United States and the Soviet Union. But the capacity of the three US gas diffusion plants—at Oak Ridge, Paducah and Portsmouth—will become inadequate to meet the Western world's needs by about 1975. There are, therefore, powerful reasons for other countries to consider how they can best obtain their future enriched uranium supplies.

In the United Kingdom, the requirements for the British civil nuclear programme will be produced by the gas diffusion plant at Capenhurst. The military purpose for which Capenhurst was originally built was completed by 1962. And, since that time, the plant has been adapted to the requirements of the civil nuclear programme. In 1965 it was decided to modify, at a cost of $39 million, the largest stages of the plant. This will enable the output of enriched uranium to be increased considerably. But, even with the modifications, Capenhurst will only be able to supply about one-quarter of the demand in 1980. The countries of Western Europe are facing similar problems—the capacity of the French gas diffusion plant at Pierrelatte will become inadequate by the mid-1970s.

The countries of Europe must, therefore, decide whether to rely on the United States for enriched uranium, assuming that US capacity will be increased to keep pace with the total demand, or to produce their own material. The United Kingdom, the Federal Republic of Germany and the Netherlands, having opted for independence, have decided to collaborate in the construction of gas centrifuge plants, arguing that this is a more attractive economic proposition than a new European diffusion plant. Because a plant large enough to satisfy European demands will require several million centrifuges, it is necessary to obtain the economies of mass production—hence the three-nation agreement. Two experimental plants are to be built, one at Almelo in the Netherlands and the other in the United Kingdom, probably at Capenhurst.

10. Nuclear safeguards

I. *Introduction*

At present, the world's nuclear reactors are producing thousands of kilograms of plutonium each year. In 1975 they will be producing tens of thousands of kilograms, and by 1980 well over a hundred thousand (see page 366). Because 10 kilograms of plutonium are more than enough for the manufacture of one nuclear weapon, and because plutonium has a very high monetary value and is an extremely toxic material, the need for nations to safeguard the plutonium they produce is obvious. No state would rest content unless it could account, at all times, for the vast majority of the plutonium and other fissionable[1] material on its territory. The greater the quantity of fissionable material in a state's possession, the more effective must be its control system. The first such controls were national safeguards systems developed by the major nuclear states.

International transfers of fissionable material for peaceful uses of nuclear energy have for many years been subject to safeguards against military use on the basis of bilateral agreements. In the late 1950s, regional safeguards systems were established by two organizations: the European Atomic Energy Community (Euratom) and the European Nuclear Energy Agency (ENEA) of the Organization for Economic Cooperation and Development (OECD).

One of the main tasks of the International Atomic Energy Agency (IAEA), which came into being in 1957, has been to "administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities and information made available by the Agency or at its request or under its supervision or control are not used in such a way as to further any military purpose".[2]

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which entered into force on 5 March 1970, has added a new dimension to safeguards. Each non-nuclear-weapon state party to the treaty has undertaken to accept safeguards for the purpose of verifying the fulfilment of its non-

[1] Fissionable (or fissile) material is that which is capable of undergoing fission when hit by a slow neutron (see page 367).
[2] Article III.5 of the IAEA Statute.

proliferation obligations "with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices".[3] To meet the above requirements, the signatory states must conclude an agreement with the IAEA. For those states which have been parties to the NPT since the original entry into force of the treaty, the agreements with the IAEA were to be ready for application within 180 days (to commence the negotiations) plus 18 months (for the negotiation itself), that is, by 29 February 1972. The safeguards envisaged in the NPT are to be applied on "all source or special fissionable material in all peaceful nuclear activities within the territory of such state [i.e., non-nuclear-weapon state party to the treaty], under its jurisdiction, or carried out under its control anywhere".[4] However, the NPT has not specified the nature of the safeguards to be adopted.

The existing safeguards system of the IAEA was inadequate for the purposes of the NPT for several reasons. First, the system had been designed mainly to be applied when the IAEA provided assistance ("project agreements") and when parties to a bilateral agreement asked the IAEA to administer safeguards to the material and facilities provided for under such agreement ("safeguards transfer agreements"). Consequently, the safeguards system was directed to application in connection with particular facilities or to material coming from a particular country. Secondly, and to some extent as a result of this approach, the system was considered rather onerous for a country submitting its entire peaceful nuclear efforts to safeguards, especially in view of its lack of limitation on the access by IAEA inspectors and in view of the frequency and duration of inspections at large facilities. Thirdly, the safeguards system contained a number of principles that were considered inappropriate in relation to the NPT, such as the "right of pursuit" which basically provided that safeguarded material could only be exported under IAEA safeguards. Another important principle was the starting-point of safeguards: the old system made it possible to safeguard nuclear material from the moment it was mined and this, too, was considered unduly burdensome, particularly in the case of countries which simply produce uranium ore concentrate for export (e.g., South Africa).

A new system of safeguards applicable to NPT conditions therefore proved necessary. A Safeguards Committee was set up by the IAEA Board of Governors in April 1970 to propose the structure and contents of the agreements to be concluded between the IAEA and the non-nuclear-weapon parties to the Non-Proliferation Treaty. The committee was attended by

[3] Article III.1 of the NPT.
[4] *Ibid.*

some 50 IAEA member states and completed its task in March 1971. On 20 April 1971, the IAEA Board of Governors approved the committee's recommendations[5] and requested the Director General to use them as the basis for negotiations.

Verification issues will increasingly enter into future disarmament and arms control discussions. Because the safeguards system for the NPT is a unique example of a developed verification measure, a detailed analysis of the system is given below. The significance of the document will also be examined.

II. *Essential provisions of the safeguards system*

In defining the basic content of the agreement between states and the IAEA, the Safeguards Committee recommended a text which is a logical consequence of the text in the Non-Proliferation Treaty itself. But, whereas the treaty refers to the right and obligation of the IAEA to verify the prevention of the diversion of nuclear *energy* from peaceful purposes to nuclear explosive devices, the committee's document limits the verification procedure to nuclear *material*. The agreement is, therefore, less inclusive than the treaty although, at present, this will have no practical consequences.

Control of nuclear material

The term "nuclear material" is used to mean any source or special fissionable material as defined in the IAEA Statute.[6] The term "source material" does not apply to ore or ore residue. Thus, countries whose only nuclear activity is the production of uranium and thorium minerals are exempt

[5] IAEA document INFCIRC/153.

[6] The definitions used in the IAEA Statute (Article XX) are as follows:

1. The term "special fissionable material" means plutonium-239; uranium-233; uranium enriched in the isotopes 235 or 233; any material containing one or more of the foregoing; and such other fissionable material as the IAEA Board of Governors shall from time to time determine; but the term "special fissionable material" does not include source material.
2. The term "uranium enriched in the isotopes 235 or 233" means uranium containing the isotopes 235 or 233 or both in an amount such that the abundance ratio of the sum of these isotopes to the isotope 238 is greater than the ratio of the isotope 235 to the isotope 238 occurring in nature.
3. The term "source material" means uranium containing the mixture of isotopes occurring in nature; uranium depleted in the isotope 235; thorium; any of the foregoing in the form of metal, alloy, chemical compound, or concentrate; any other material containing one or more of the foregoing in such concentration as the Board of Governors shall from time to time determine; and such other material as the Board of Governors shall from time to time determine.

from safeguards. Any determination by the Board of Governors adding to the materials considered to be source material or special fissionable material would have effect under the agreement only upon acceptance by the state concerned.

The objective of safeguards is defined as the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and the deterrence of such diversion by the risk of early detection. This is to be attained by the application of measures for material accountancy, supplemented by containment and surveillance.

The technical conclusion of the IAEA's verification activities should be a statement, in respect of each material balance area, of the amount of material unaccounted for over a specific period. "Material balance area" means an area in or outside a nuclear facility such that the quantity of nuclear material in each transfer into or out of each "material balance area", and the physical inventory of nuclear material in each "material balance area", can be determined when necessary, in accordance with specified procedures. The "material unaccounted for" means the difference between book inventory and physical inventory. Thus the *main* safeguards measure is material accountancy.

"Containment" includes the use of locks, seals and other devices designed to establish, for example, that between two inspections material in storage is not removed. Containment is also inherent in the design of buildings and layout of equipment, and the number of exits for nuclear material. "Surveillance", which includes instrumental and human observation, is used to back up material balance accounting by the observation of nuclear material flows, inventory locations and nuclear processing activities, to ensure that the material balance obtained is realistic.

The agreement specifically requires that in carrying out its verification activities, the IAEA should make full use of the state's system of accounting for and control of all nuclear material subject to safeguards and thereby avoid unnecessary duplication of safeguards activities.

The extent to which the IAEA will make use of the national system is to be defined in so-called subsidiary arrangements with the state concerned. These will spell out precisely how the procedures laid down in the agreement with the state are to be applied.

An appropriate national system would be one based on a structure of material balance areas and would provide for a measurement system for the determination of the quantities of nuclear material received, produced, shipped, lost or otherwise removed from inventory, and the quantities on inventory; the evaluation of precision and accuracy of measurements and the estimation of measurement uncertainty; procedures for identifying, reviewing and evaluating differences in shipper/receiver measurements; procedures for taking a physical inventory; procedures for the evaluation of accumulations of unmeasured inventory and unmeasured losses; a system of records and reports showing, for each material balance area, the inventory of nuclear material, and the changes in that inventory including receipts into and transfers out of the material balance area; provisions to ensure that the accounting procedures and arrangements are being operated correctly; and procedures for the submission of reports to the IAEA. The need to establish these various measures will depend on the kind and size of the national nuclear programme. The main function of the national system is, in fact, the generation of information and its collection and transmission to the IAEA.

A state having a system with the above characteristics would presumably be subject to correspondingly less IAEA verification activity. But there would always be a certain amount of independent verification by the IAEA (even in respect of the best national system) to give it the necessary international credibility. In fact, there are elements of national systems without which the IAEA could not apply safeguards at all: the system of records and reports, for instance, or procedures for physical inventory-taking.

Nuclear material of a composition and purity suitable for fuel fabrication or for isotopic enrichment will become subject to safeguards specified in the agreement as soon as it has left the plant or the process stage in which it has been produced. In the case of international transfers, the IAEA will also have the right to identify and verify the quantity and composition of nuclear material. Although safeguards will not apply to material in mining or ore-processing plants, the IAEA must be informed of the quantity, composition and destination of any exported and imported material containing uranium or thorium which has not reached the stage of the nuclear fuel cycle described above, when non-nuclear-weapon states are involved in the transaction and unless the material is to be used for non-nuclear purposes.

The functioning of the system

The safeguards system itself is based on four main elements incorporated into the safeguards agreement and the subsidiary arrangements: examination of the design of nuclear facilities, records, reports and inspections. Safeguards are to be applied on source or special fissionable material used in all peaceful nuclear activities. It would be mistaken to believe that the facilities themselves are "under safeguards".

The design-examination requirement implies verification of the information provided by the state to the IAEA to ensure that safeguards can be effectively applied at each facility. It will permit, among other things, the determination of material balance areas to be used for IAEA accounting purposes and to select the "strategic points" which will be used for measuring nuclear material flows and inventories. A "strategic point" is a location where the information necessary and sufficient for the implementation of safequards measures is obtained and verified, and where containment and surveillance measures are carried out.

The records for each material balance area are, presumably, to be kept by the facility operator. These records, consisting of accounting records of all nuclear material subject to safeguards and of operating records for facilities containing such material, should be made available for examination by the IAEA. The state may maintain a central records system but it is essential for the application of safeguards that each material balance area should do so.

The state should provide the IAEA with reports based on the above-mentioned records. In addition to accounting reports, special reports should be submitted if any unusual incident or circumstances lead the state to believe that there is, or may have been, loss of nuclear material exceeding the limits specified in the subsidiary arrangements; or if the containment has unexpectedly changed from that specified in the subsidiary arrangements to the extent that unauthorized removal of nuclear material has become possible. At the request of the IAEA, the state should supply clarifications of any report.

The IAEA should be able to derive from the inventory-change reports an up-to-date picture of the movement of material between material balance areas. The promptness of these reports is one of the factors influencing the actual inspection effort to be applied.

The IAEA will have the right to make *ad hoc* inspections, routine inspections and special inspections.

The purpose of inspections is to verify the information contained in the reports: the location, identity, quantity and composition of nuclear material subject to safeguards, information on the possible causes of material unaccounted for, as well as other uncertainties. The inspectors will perform their duties by examining the records, making independent measurements of nuclear material, checking the functioning and calibration of instruments and other measuring and control equipment, applying and making use of surveillance and containment measures, and using other methods.

The number, intensity and duration of routine inspections are to be kept to the minimum consistent with the effective implementation of the safeguards procedures.

The agreement lays down formulae for determining the maximum "intensity" of inspection in terms of man-days or man-years of inspection effort for each category of nuclear facility. The maximum is related to the inventory or the throughput, i.e., the rate at which nuclear material is introduced into a facility. The inspection effort for reactors falls into two categories: those with an inventory or annual throughput of under 5 effective kilograms[7] and those with more. In the case of facilities such as reprocessing plants, which are in many ways the most sensitive, the maximum inspection effort would rise in proportion to the square root of the throughput—reflecting the concept that large plants give economies not only in terms of operating cost but also of the inspection effort needed. (This is apparently the first time that a square root appears in an international agreement.)

The criteria for determining the actual inspection effort within the defined maximum include: the form of nuclear material, the effectiveness of the national accounting and control systems, characteristics of the state's nuclear fuel cycle, the extent to which the state's nuclear activities are interrelated with those of other states, and technical developments in the field of safeguards.

Since the inspection effort is determined by category of nuclear facilities for the whole state, it is left to the discretion of the IAEA to allocate the available man-days or man-years of inspection effort as it considers necessary within each category. In other words, the IAEA can use part of the effort available for one facility and add it to its inspections of another facility in the state, in the same category.

The IAEA will give notice to the state before arrival of inspectors. The notice will give the names of the inspectors, but other particulars will be submitted before the inspector is designated for the country. The notice will also indicate the facilities to be visited. The state can object to an individual inspector, and, moreover, has the right to have inspectors accompanied during their inspections by representatives of the state. As a supplementary measure, the IAEA may carry out without advance notifica-

[7] "Effective kilogram" means a special unit used in safeguarding nuclear material. The quantity in "effective kilograms" is obtained by taking: (a) For plutonium, its weight in kilograms; (b) For uranium with an enrichment of 0.01 (1%) and above, its weight in kilograms multiplied by the square of its enrichment; (c) For uranium with an enrichment below 0.01 (1%) and above 0.005 (0.5%), its weight in kilograms multiplied by 0.0001; and (d) For depleted uranium with an enrichment of 0.005 (0.5%) or below, and for thorium, its weight in kilograms multiplied by 0.00005.

tion a portion of the routine inspections in accordance with the principle of random sampling. It shall then take into account the operational programme provided by the state.

The inspectors must be given access to appropriate locations and/or strategic points. In exercising their functions they should avoid hampering or delaying the construction or operation of facilities, or affecting their safety.

Precautions must be taken by the IAEA to protect industrial secrets coming to the inspectors' knowledge. There are several ways in which industrial secrets are protected. First, access is limited and when the strategic points are laid down in the subsidiary arrangement the state may ensure that particularly sensitive processes are excluded from access. The IAEA becomes liable if, nevertheless, industrial data should be divulged through the application of safeguards, but the state will have to prove that a leakage has occurred and that it had been caused by the IAEA's access for inspection. There is then a possibility for compensatory action to be taken by the IAEA against the individual concerned. He may, moreover, be punishable by law in his own or another country. The IAEA applies strict "internal safeguards" to avoid the leakage of industrial secrets. The fact that inspectors may be accompanied also helps to ensure against leakage and, naturally, the inspector who can be proven to have revealed such information is liable to the IAEA.

It should, however, be borne in mind that the IAEA does not and cannot possess a mechanism whereby a disclosure of classified information by its officials would be directly punishable by penalties similar to those existing in most countries.

Financing

The cost of applying safeguards in all non-nuclear-weapon states is estimated to be about $2 million at the start, and to rise probably to about $5 million in 1975 and to about $12 million by 1980. As a percentage of the cost of electricity generated by nuclear reactors, the cost of safeguards will decrease from about 0.7 per cent in 1972 to about 0.4 per cent in 1980. The total number of professional safeguards staff required for treaty verification duties will rise from an immediate figure of 100 to a figure of upwards of 400 in 1980. The majority of the inspectors will be engaged in the next few years in safeguarding nuclear research and development activity but, after about 1975, most inspectors will be safeguarding plutonium. However, in the mid-1970s there may, in fact, be very large quantities of plutonium in research and development activities (particularly for fast-breeder reactor projects). The IAEA is already beginning to shift its emphasis from small research facilities to larger ones—power reactors, reprocessing and fabrication plants and eventually enrichment facilities.

The number of inspectors required to implement the treaty safeguards does not rise in proportion to the increase in the use of nuclear energy. During the 1970s, the increase required in the force of inspectors will be linear whereas the increase in nuclear energy will be a fast-rising exponential.

It has been agreed that a state member of the IAEA will bear the expenses it incurs in implementing its responsibilities under a safeguards agreement. However, if the state or persons under its jurisdiction incur extraordinary expenses as a result of a specific request by the IAEA, the latter will reimburse them, provided it has agreed in advance to do so. The IAEA will bear the cost of any additional measuring or sampling which inspectors may request. According to the newly adopted principles for the assessment of contributions of IAEA members towards the administrative expenses of the IAEA, an entire category of states, generally the underdeveloped ones, will be assured of not being assessed for a higher percentage of the regular budget than they contribute at present. A non-member of the IAEA shall reimburse fully to the IAEA the safeguard expenses incurred by the IAEA, except for extraordinary expenses resulting from a specific request by the IAEA.

Non-compliance

Reference is made in the model agreement to Article XII, paragraph C of the IAEA Statute, according to which the case of non-compliance with the obligations assumed shall be reported by the IAEA Board of Governors to the IAEA members and to the United Nations Security Council and General Assembly; assistance provided by the IAEA or by its members may be curtailed or suspended; the recipient member may be asked to return the materials and equipment made available to it; and the IAEA membership of the non-complying state may be suspended.

None of the sanctions enumerated above is sufficiently severe to deal with an actual violation of obligations under the Non-Proliferation Treaty. The IAEA can hardly be blamed for this deficiency. The IAEA's terms of reference under the NPT are restricted to verification of the fulfilment of the obligations; it is not competent to enforce the fulfilment. The NPT itself envisages no other concrete action in the event of its violation than a withdrawal from the treaty by other states.

Settlement of disputes

Any dispute arising out of the interpretation or application of the agreement, other than a dispute regarding the Board of Governors' finding on non-compliance or an action taken by the Board pursuant to such a finding, may be submitted to an arbitral tribunal. Each party would designate one arbitrator, and the two arbitrators would elect a third to be chairman. If either party fails to designate an arbitrator, the President of the International Court of Justice (ICJ)[8] may be requested to appoint one. The same procedure would apply if the third arbitrator is not elected: the decisions of the tribunal would be binding.

Entry into force

Under the NPT, the safeguards agreements with the IAEA can be concluded by non-nuclear-weapon states either individually or together with other states. The latter provision has been included to meet the demands of Euratom, which already has a safeguards system of its own. In signing the NPT, the non-nuclear-weapon Euratom members made ratification of the NPT subject to a satisfactory agreement on safeguards.

The main problem has been whether the IAEA should only verify Euratom's safeguarding methods (e.g., records and reports) or also have the right of direct control, including independent access to the nuclear facilities. Some states which are not members of any regional grouping insist, for political and commercial reasons, on being treated in the same way as members of the Euratom community. Japan, in particular, has opposed any discrimination and demands parity treatment. The common view that the new IAEA safeguards régime resembles the Euratom system is misleading. In general, it may be said that the Euratom system is close to the previous IAEA system and could, rather, be used in the same way as a national system can, in that it contains most of the elements listed above.

On 20 September 1971, the Council of Ministers of the European Community approved the mandate of the Community's Commission to begin negotiations with the IAEA on the basis of the model agreement. The negotiations started on 9 November 1971 and were still in progress in the spring of 1972.

The agreement between the state and the IAEA enters into force on the date on which the IAEA receives from the state written notification that

[8] Some agreements, already signed, name the UN Secretary-General for this purpose.

the constitutional requirements have been met. For some countries, the agreement may enter into force on signature, and will remain in force as long as the state is party to the Non-Proliferation Treaty.

III. *Significance of the agreement*

Considering the divergent and at times conflicting interests of the parties engaged in the negotiations (both signatories and non-signatories of the NPT), the adoption by the IAEA of a model safeguards agreement must be considered a success. The prospects of securing widespread implementation of the NPT have been improved.

An acceptable solution of the problems involved proved possible because of the importance attached by most nations to the prevention of nuclear weapons proliferation (by subscribing to the NPT, they explicitly committed themselves to accepting safeguards), and also because the nuclear-weapon powers' interests are not directly affected. It is true that the United States and the United Kingdom have agreed that IAEA safeguards be applied to their peaceful nuclear activities, but from the point of view of non-proliferation of nuclear weapons this offer coming, as it does, from the countries which remain unrestricted in their military nuclear programmes, is more symbolic than real. From the point of view of commercial interests of the nuclear industry, which within a decade will most certainly become a multi-billion dollar enterprise, safeguards on peaceful nuclear activities of the nuclear-weapon powers could reduce the sense of discrimination of the non-nuclear-weapon states. (It is important to stress that unless *all* peaceful nuclear activities in *all* states are subject to equal safeguards, some degree of commercial discrimination will still remain.) But by providing a semblance of parity, safeguards cannot correct the asymmetry inherent in the NPT itself. It is even questionable to what extent IAEA resources for safeguards should be strained in order to verify the fulfilment of obligations which do not exist. In any event, the nuclear-weapon powers should bear the entire cost of their safeguards themselves.

In characterizing the agreed system of safeguards, the following points can be made:

Safeguards apply to material strictly defined—enriched uranium, plutonium and thorium. The system also provides a framework for agreements covering nuclear material in enrichment plants, and the IAEA has been studying the possible implications of new techniques for uranium enrichment, including gas-centrifuge technology, for the application of safeguards.

Verification procedures are concentrated on those stages in the nuclear fuel cycle from which nuclear weapons or other nuclear explosive devices could readily be made.

The system relies to a great extent on national accounting and control, but only the minimum of data on the nuclear activities, necessary for safeguards purposes, should be communicated to the IAEA.

The IAEA has the right and duty to verify independently the state's findings; it must take due account of the technical effectiveness of the state's system.

Inspection is one of several aspects of verification activities. It will be performed according to the concept of "strategic points", which means that inspectors will normally confine their access to locations selected in advance. The use of improved procedures, such as tamper-proof devices, may gradually reduce the need for personal visits to the relevant facilities.

Commercial secrets should be protected, and undue interference with the nation's legitimate activities should be avoided.

The system cannot totally prevent diversion of nuclear material to weapons uses, and a country that intends to cheat could always take the necessary precautionary measures. But cheating under safeguards would be considerably more difficult than without safeguards. In addition, any serious obstacles preventing the IAEA from verifying that there has been no diversion of nuclear material required to be safeguarded to nuclear weapons, would immediately arouse suspicion and alert the parties to the NPT, although not each information purporting non-compliance is likely to be followed up by the IAEA Board—for political or other reasons. Allowance should also be made for human frailties to which inspectors cannot be immune. In any event, this is practically all that can be expected from any international system designed to control observance of a non-armament commitment.

The IAEA will not control the actions of individuals or organizations within a nation. Each country is responsible for preventing misappropriations of nuclear material while in transit from one point to another or for preventing embezzlement of the material within a plant.

The system has a number of weak points. Since the NPT is directed at preventing the manufacture of nuclear weapons, and other military use is permitted, such as the manufacture of power plants for nuclear submarines, in joining the agreement a state would be able to withhold any quantity of nuclear material from its existing stocks for use in a permitted military activity. A diversion for weapons purposes of stocks not subject to verification would then be possible.

The concept of "strategic points", to make safeguards less intrusive, may give rise to different interpretations. In particular, it is not clear under what circumstances the inspectors will be allowed access to areas between these points.

The efficacy of verification procedures will depend to a great extent on the features of nuclear facilities relevant to safeguarding nuclear material. The IAEA has no authority to bring about changes in the design of facilities that would make the facilities more easily inspectable.

The system leaves unresolved the problem of clandestine activities; the IAEA does not and cannot carry out intelligence and/or police operations. At present the loophole may not be serious: operation of a secret nuclear plant would involve a high risk of detection by other nations. With the passage of time, however, when the volume of material handled and the number of facilities will increase, the potential for diversion will also increase. But the system provides no means of submitting, considering and pronouncing on complaints of evasion based on information gathered by other than the IAEA verification activities. Nor does it include a special procedure by which a party suspected of or charged with having violated the prohibitions could prove its innocence.[9]

The document agreed upon contains only statements of principle and descriptions of procedures. Its purpose is to guide the IAEA in concluding specific agreements with the parties to the NPT.

The elaboration of all important details of application of safeguards is left to subsidiary arrangements between individual states and the IAEA.

Nevertheless, the IAEA document provides a code of control which is legally and technically more developed than any other ever agreed between nations. With necessary modifications, it could be used in the verification of some disarmament measures.

The important question which remains to be solved is whether supplies of source or special fissionable material as well as equipment or material specially designed or prepared for the processing, use or production of special fissionable material should be allowed to states non-parties to the NPT, or to the parties which have not concluded new safeguards agreements with the IAEA.

Under Article III, paragraph 2 of the NPT, each state party to it undertakes not to provide the above specified material and equipment to any non-nuclear-weapon state, unless the source or special fissionable material is subject to the safeguards required by this article, i.e., presumably safeguards

[9] The Treaty for the Prohibition of Nuclear Weapons in Latin America provides for special inspections when prohibited activity is suspected or charged by the parties (Article 16).

applied in all peaceful nuclear activities within the territory of such state under its jurisdiction, or carried out under its control anywhere.

One interpretation is that supplies to non-signers of the new safeguards agreement should not be halted; they should be effected, as heretofore, under safeguards applying only to the material supplied. Any other action—according to this interpretation—would run counter to the objectives of the IAEA and would amount to discrimination among the IAEA members.

On the other hand, continuation of such supplies without safeguards being applied in *all* peaceful nuclear activities, as provided for in the new safeguards agreement, would contradict the spirit and the letter of the NPT. Given the nature of the NPT and the fact that it deals with matters of vital importance to international security, its provisions should be considered overriding. If this point of view is generally accepted, the non-nuclear-weapon countries will be faced with a choice: either to adhere to the NPT, accept the safeguards provided therein, and benefit from the ever-expanding international cooperation in the peaceful uses of nuclear energy, or to remain outside the treaty and the new safeguards régime, and risk ever-increasing difficulties in their peaceful nuclear activities. The cause of disarmament would certainly not be advanced by letting those countries have it both ways.

By 1 March 1972, only seven safeguards agreements, as required by Article III of the NPT, had entered into force between the IAEA and the non-nuclear-weapon states party to the NPT, namely those with Canada, Denmark, Finland, Greece, Iraq, New Zealand and Norway. Agreements with twelve other countries had been approved by the IAEA's Board of Governors, namely with Austria, Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Ireland, Malaysia, Poland, Romania, Uruguay, Yugoslavia and Zaïre. Seven of these had been signed and were about to take effect.

Negotiations were proceeding with 32 states, while 17, which should have commenced negotiations, had not even made a request for them. With 10 of the 17 states, agreements should have entered into force by 1 March.

11. The test ban

I. *Introduction*

The object of this chapter is to analyse the various issues involved in a comprehensive nuclear test ban (CTB). There has been a tendency in Geneva and elsewhere to concentrate on the technical issues, notably the problems of verification, to the point where the political and military significance of a CTB is lost to sight or is too readily taken for granted. This has happened with other partial disarmament measures, too. The most extreme case was the Sea-Bed Treaty: such issues as the verification of the enforcement of this treaty and the limits of the area to which it should apply were debated at length despite the fact that the treaty is virtually devoid of significance for arms limitation—it outlaws activities on the ocean floor that no one wishes to undertake.[1] The aim here is to analyse the political and strategic aspects of a test ban so as to set the technical issues in some perspective. SIPRI has previously produced reports on the seismic verification of a test ban.[2] We do not discuss here the details of the possible agreements that might be made in order to achieve a general ending of nuclear tests. For example, this might be achieved by introducing an underground test ban as a complement to the Partial Test Ban Treaty (PTB) or by signing a separate treaty. For simplicity of presentation we use the term CTB to mean any approach that would achieve a general ending of tests. (For a discussion of possible agreements which have been suggested in the latest UN General Assembly debate, see chapter 17, page 523.)

The test ban was pursued up to 1963 for at least four distinct, though related, purposes. Interest was first created in a test ban as a means of reducing pollution of the environment with radioactive material. Later, emphasis was placed on its role in inhibiting the arms race between the nuclear powers and in preventing more countries from acquiring nuclear

[1] See the *SIPRI Yearbook of World Armaments and Disarmament 1969/70* (Stockholm: SIPRI, 1970), pp. 92–184.
[2] These are: *Seismic Methods for Monitoring Underground Explosions*, Stockholm Papers No. 2 (Stockholm: SIPRI, 1969); *Progress Report of the Seismic Study Group* (SIPRI, February 1970); and *Seismic Methods for Monitoring Underground Explosions, 1971 Progress Report* (SIPRI, October 1971). The rapporteur who prepared these three reports was Dr David Davies.

weapons. Finally, after the Cuban missile crisis of October 1962, the main interest was in the test ban as a means of fostering détente between the Soviet Union and the United States.

Another interesting aspect of the CTB is that it impinges on testing and development, not on deployment and use of weapons.

It is useful first to survey the history of test ban negotiations between the two principal parties—the United States and the Soviet Union—and to look briefly at the positions of Britain, China, France and other countries.

II. *History*[3]

A test ban was first proposed internationally in 1954, after both the United States and the Soviet Union had tested thermonuclear devices and after the fallout from a 15 megaton (mt.) US test in Bikini on 28 February 1954 had been unexpectedly severe and had hit the crew of a Japanese fishing boat. In April 1954 India proposed a standstill on tests, and repeated the proposal at the UN General Assembly in 1955. The proposal was not put to a vote. Instead, a proposal, also made by India, that there should be a study of radiation and the effects of tests, was adopted; a scientific committee of enquiry was established.

In 1955 the Soviet Union included in the proposals it made for general disarmament a clause proposing that one of the first steps should be a cessation of tests, supervised by an international commission reporting to the UN Security Council and the General Assembly. The United States indicated that it was not willing to eliminate or limit tests unless nuclear weapons were eliminated or limited.[4]

In 1956 the Soviet Union proposed that partial measures, including an immediate stop to tests, should go ahead independently of general disarmament. The Western powers proposed a test ban as part of a comprehensive disarmament programme and subject to verification arrangements made in that context. At this early stage one basic difference between the two sides was that the Soviet Union maintained that tests could be detected adequately by national means so that no international control mechanism was

[3] There are a number of histories of the negotiations leading up to the conclusion of the Partial Test Ban Treaty of 1963, as well as many volumes of official documents relating to the negotiations and parliamentary debates on them. A neutral and bare account of the negotiations is given in the UN official history of disarmament negotiations, *The United Nations and Disarmament 1945–1970* (New York: UN, 1970).

[4] US Disarmament Administration, *Geneva Conference on the Discontinuance of Nuclear Weapon Tests*, Department of State publication 7258 (Washington, October 1961), p. 5.

needed; the Western powers maintained that international control was needed.[5]

On 4 June 1957, the Soviet Union proposed an immediate ban on tests for at least two or three years, accompanied by the establishment of an international supervisory commission and the establishment on a reciprocal basis of control posts in the United States, the Soviet Union and elsewhere. The West initially welcomed the proposal, stating that the duration of the temporary stop should be fixed and that experts should be appointed to develop an inspection system. However, on 29 August 1957 the West proposed that a test ban should be one item in a package of twelve inseparable items embracing conventional and nuclear disarmament. Different people in the West appear to have had different reasons for wanting a test ban to be part of general disarmament. Some attached first priority to general disarmament and considered a test ban a less important diversion; undoubtedly others found the pursuit of General and Complete Disarmament (GCD) to be a futile but convenient way of avoiding the whole question of the test ban. Still others feared that the Soviet Union wanted a test ban as a prelude to a total ban on nuclear weapons, in order thus to eliminate the West's nuclear superiority which, in their view, counterbalanced Soviet superiority in conventional forces. They felt that it would be detrimental to the West if control of nuclear forces were separated from control of conventional forces.

In 1957 testing continued at a higher rate than in previous years and there was further international concern about fallout.

On 26 March 1958, President Eisenhower, referring to a forthcoming programme of US tests, said that US scientists had succeeded in reducing radioactive fallout and invited observers to witness a test. On 31 March 1958, the Soviet Union passed a decree stopping tests and Premier Khrushchev invited the Western powers to do likewise, reserving the right of the Soviet Union to resume tests if the West refused to stop. On 8 April President Eisenhower replied: he accused the Soviet Union of making this proposal just after it had completed "a series of tests of unprecedented intensity",[6] a remark which, as is shown later, scarcely seems justified by the figures. He repeated that a test ban should be part of a general disarmament agreement and proposed again that a group of experts should be established to study control measures, having first stated that secret tests were possible. At the end of April the United States and Britain resumed tests on an intensified scale. Considerably later the Soviet Union did so, too.

In May Premier Khrushchev said he feared a technical study would delay

[5] *The United Nations and Disarmament 1945–1970, op. cit.,* p. 197.

[6] *Geneva Conference on the Discontinuance of Nuclear Weapon Tests, op. cit.,* p. 14.

the stopping of tests but nevertheless agreed that both sides should designate experts "who would immediately begin a study of methods for detecting possible violations of an agreement on the cessation of nuclear tests".[7] The United States accepted this proposal, subject to the caveat that the agreement to let experts meet should not prejudice the position of the two sides concerning the timing and interdependence of various aspects of disarmament. The United States was thus still preserving the possibility of linking a test ban to general disarmament.

The experts met from 1 July to 21 August 1958. They reported that it would be possible, within limits, to detect and identify nuclear explosions, including low-yield explosions (1–5 kt.), by using various methods—collecting radioactive debris, recording seismic, acoustic and hydro-acoustic waves, radio signals, and on-site inspection of suspicious events—if, in order to apply these methods, 160 to 170 control posts were established on land and ten on ships, if special aircraft flights were made to collect air samples, and if on-site inspections were provided for.

The Soviet Union, the United States and Britain started negotiating a test ban on the basis of the experts' report in Geneva on 31 October 1950.

In August 1958 the United States and Britain proposed that, on the basis of reciprocity, tests be stopped for a year from the beginning of negotiations and that the ban be renewed annually provided that an inspection system was installed and working satisfactorily and provided satisfactory progress was being made on implementing other disarmament measures. After a burst of testing and argument, both sides stopped testing as the negotiations began: the moratorium lasted from November 1958 until September 1961. However, in this period France started its nuclear testing programme.

At the test ban conference of the three nuclear powers in early 1959, the Western powers (the UK and the USA) dropped the linkage of the test ban to other disarmament measures, but the United States brought up three new technical difficulties and called for technical groups to study them: (*a*) detection of nuclear tests in outer space; (*b*) new seismic data suggesting that detection and identification of explosions was more difficult than was thought when the experts met in Geneva and that there would be 1 500, not 20 to 100, ambiguous events (new evidence later reversed this view[8]);

[7] *Ibid.*, pp. 14–15.

[8] See the evidence of Dr Carl F. Romney in *Developments in Technical Capabilities for Detecting and Identifying Nuclear Weapons Tests,* hearings before the Joint Committee on Atomic Energy, 88th Congress, 1st session, March 1963, pp. 86–102. Similar evidence was given by Mr William C. Foster on 25 July 1962 in hearings on *Renewed Geneva Disarmament Negotiations,* 87th Congress, 2nd session, 1963; however, these hearings were first made public after a year's delay. (See H. K. Jacobson and E. Stein, *Diplomats, Scientists, and Politicians, The United States and the Nuclear Test Ban Negotiations* (Ann Arbor, 1966), p. 385.)

and (*c*) decoupling, whereby the test would be conducted in a large cavity so as to weaken the seismic signal. There was argument over whether on-site inspections should be automatic and over the extent to which the control system should be internationally staffed and should operate by majority rule rather than rely on national agents and operate by unanimity.

The West proposed a quota of on-site inspections and the immediate conclusion of a partial ban outlawing tests above ground up to 50 km. altitude while talks continued on banning testing below ground and in space. The Soviet Union rejected the latter proposal, but accepted the idea of an annual quota of on-site inspections.

On 29 December 1959, President Eisenhower issued a statement noting that the voluntary moratorium (which on 26 August he had extended to the end of the year) would expire on 31 December; although the United States considered itself free to resume testing it would not do so without announcing its intention in advance. Meanwhile it would continue its "active program of weapon research, development and laboratory-type experimentation".[9] On 3 January 1960, Premier Khrushchev said the Soviet Union would not resume testing unless the West did so.

In February 1960 the West proposed a "threshold treaty", that is, a ban on nuclear tests other than those below ground of seismic magnitude 4.75 and less, and other than those in space beyond the height at which control was possible (i.e., those which they then held could not be adequately monitored). The Soviet Union responded with a variant of the Western proposal: there should be a moratorium on underground tests below 4.75, while all other tests were outlawed by treaty. The West agreed to this, provided that a regional programme to improve detection procedures was started forthwith and provided the moratorium was for a fixed term only.

The positions of the two sides were thus close to one another when the Geneva conference adjourned for a recess pending the summit meeting of heads of states in Paris in May 1960. But that meeting was put off and the international atmosphere shattered by the U-2 episode. The Geneva conference—like other aspects of détente in that period—seems never to have recovered from this blow.

At the 1960 UN General Assembly, the United States emphasized that, although it had not resumed tests, the moratorium had ended on 31 December 1959.[10] It was concerned that an indefinite prolongation of the moratorium should not come to be regarded as a substitute for a treaty that

[9] *Public Papers of the Presidents of the United States, Dwight D. Eisenhower 1959,* p. 883.
[10] *The United Nations and Disarmament 1945–1970, op. cit.,* p. 214.

was verified. At Geneva on 26 July 1960, the Soviet Union proposed a quota of three on-site inspections a year.[11]

When Premier Khrushchev met the newly-elected President Kennedy in Vienna in June 1961, he proposed that either a test ban be concluded on the Soviet basis or the test ban be considered in the context of general and complete disarmament so that all disarmament problems would be solved together. This was similar to the position taken earlier by the United States. Both involved a link to other disarmament measures. But the West opposed the proposal and protested that Soviet policies blocked progress on a test ban. They proposed to drop the 4.75 threshold if enough control posts and on-site inspection were provided for.

On 30 August 1961, the Soviet Union declared that, faced with the increasing aggressiveness of NATO, it was forced to take various steps, including the resumption of nuclear tests. This was the period of unease and challenges between the Soviet government and the new Administration in the United States—the period of the Bay of Pigs, of Soviet pressure on Berlin, the building of the Berlin Wall, and US increases in military expenditure including, in particular, the adoption of a huge programme for the construction of long-range missiles on the basis of a false scare about a "missile gap". The Soviet Union started testing in the atmosphere at the beginning of September. In response, the United States resumed underground tests (of which it already had some experience) in mid-September, and only in March 1962 announced that it would resume atmospheric tests.[12]

At the UN General Assembly of 1961 there were protests against the renewed tests. These were provoked, in particular, by a Soviet announcement on 17 October that it was about to test a 50 mt. prototype of a 100 mt. weapon.[13] The test took place on 30 October 1961 and was estimated by the US authorities at 58 mt.[14]

On 28 November 1961, the Soviet Union proposed a treaty outlawing tests above ground and monitored by national means, combined with a moratorium on underground tests until an inspection system was introduced as part of general and complete disarmament. The West rejected the view, put forward by the Soviet Union, that inspection before general disarma-

[11] US Department of State, *Documents on Disarmament 1960,* Department of State publication 7172 (Washington, July 1961), p. 178.
[12] US Arms Control and Disarmament Agency, *Documents on Disarmament 1962,* Volume 1, January–June, ACDA publication 19 (Washington, November 1963), pp. 66–75.
[13] US Arms Control and Disarmament Agency, *Documents on Disarmament 1961,* ACDA publication 5 (Washington, August 1962), p. 535.
[14] "Announced Nuclear Detonations", appendix B in *The Effects of Nuclear Weapons* (Washington: US AEC and US DOD, April 1962; revised ed. reprinted February 1964).

ment meant espionage and held that the new Soviet proposal went back on the recommendation of the 1958 Conference of Experts.

On 29 January 1962, the Geneva conference on the test ban adjourned *sine die*.

In March 1962, the Eighteen-Nation Disarmament Committee (ENDC) met for the first time. In April the eight non-aligned members proposed a test ban control system based on national networks. In August the West submitted two alternative draft treaties—a comprehensive test ban (CTB) with on-site inspection, and a partial test ban (PTB) which would outlaw tests other than those (of all sizes) conducted underground, without international verification.

Then came the Cuba crisis of October 1962. It has been regarded by many as the progenitor of the Partial Test Ban because it created an urgent need for a demonstrative act of reconciliation and détente. It is interesting that a test ban was mentioned in precisely this connection at the height of the crisis. Thus, in the first published message in the exchange which led to a settlement of the Cuba crisis, Premier Khrushchev, on 27 October 1962, concluded by saying:

> If you accept my proposal, Mr. President, we would send our representatives to New York, to the United Nations, and would give them exhaustive instructions to order [*sic*] to come to terms sooner. If you would also appoint your men and give them appropriate instructions, this problem could be solved soon.
>
> Why would I like to achieve this? Because the entire world is now agitated and expects reasonable actions from us. The greatest pleasure for all the peoples would be an announcement on our agreement, on nipping in the bud the conflict that has arisen. I attach a great importance to such understanding because it might be a good beginning and, specifically, facilitate a nuclear test ban agreement. The problem of tests could be solved simultaneously, not linking one with the other, because they are different problems. However, it is important to reach an understanding to [*sic*] both these problems in order to make a good gift to the people, to let them rejoice in the news that a nuclear test ban agreement has also been reached and thus there will be no further contamination of the atmosphere. Your and our positions on this issue are very close.
>
> All this, possibly, would serve as a good impetus to searching for mutually acceptable agreements on other disputed issues, too, on which there is an exchange of opinion between us. These problems have not yet been solved but they wait for an urgent solution which would clear the international atmosphere. We are ready for this.[15]

In his last message in the exchange, President Kennedy, on 28 October, concluded:

> I agree with you that we must devote urgent attention to the problem of disarmament, as it relates to the whole world and also to critical areas. Perhaps

[15] *Department of State Bulletin*, 12 November 1962, pp. 742–43.

now, as we step back from danger, we can together make real progress in this vital field. I think we should give priority to questions relating to the proliferation of nuclear weapons, on earth and in outer space, and to the great effort for a nuclear test ban. But we should also work hard to see if wider measures of disarmament can be agreed and put into operation at an early date. The United States government will be prepared to discuss these questions urgently, and in a constructive spirit, at Geneva or elsewhere.[16]

In December 1962 the Soviet Union proposed the use of automatic, unmanned seismic stations ("black boxes"). The United States expressed interest but held that black boxes would not eliminate the need for manned stations or for on-site inspections. Britain proposed that the whole idea be studied by experts.

At the turn of the year there was an exchange of letters between Premier Khrushchev and President Kennedy in which Mr Khrushchev offered two to three on-site inspections together with verification by national means and by black boxes but not by manned control posts. In justifying two to three on-site inspections, he said:

You and your representatives, Mr. President, refer to the fact that, without a minimum number of on-site inspections, it would be impossible for you to persuade the United States Senate to ratify an agreement on the cessation of testing. This condition, as we understand it, ties your hands and is preventing the signature of a treaty which would enable all of us to turn our backs forever on the nuclear weapons proving grounds. Very well: if this is the only obstacle to agreement, we are prepared to meet you on this point in the interests of the noble and humane cause of ending nuclear weapons tests.

We have noted that on 30 October 1962, in discussions held in New York with Mr. V. V. Kuznetsov, the First Deputy Minister for Foreign Affairs of the USSR, your representative, Ambassador Dean, said that in the opinion of the United States Government 2–4 on-site inspections a year in the territory of the Soviet Union would be sufficient ... with a view to overcoming the deadlock and reaching a mutually acceptable agreement at last we would be prepared to agree to 2–3 inspections a year being carried out in the territory of each of the nuclear Powers, when it was considered necessary, in seismic regions where any suspicious earth tremors occurred.[17]

In reply, President Kennedy welcomed the Soviet leader's proposal. He said:

I am encouraged that you are prepared to accept the principle of on-site inspections. These seem to me to be essential not just because of the concern of our Congress but because they seem to us to go to the heart of a reliable agreement ending nuclear testing. ...

[16] *Ibid.*, p. 746.
[17] US Arms Control and Disarmament Agency, *Documents on Disarmament 1962*, Volume II, July–December, ACDA publication 19 (Washington, November 1963), p. 1241.

With respect to the number of on-site inspections there appears to have been some misunderstanding. Your impression seems to be that Ambassador Dean told Deputy Minister Kuznetsov that the United States might be prepared to accept an annual number of on-site inspections between two and four. Ambassador Dean advises me that the only number which he mentioned in his discussions with Deputy Minister Kuznetsov was a number between eight and ten. This represented a substantial decrease in the request of the United States as we had previously been insisting upon a number between twelve and twenty. I had hoped that the Soviet Union would match this motion on the part of the United States by an equivalent motion in the figure of two or three on-site inspections which it had some time ago indicated it might allow.[18]

In reply, Premier Khrushchev said he took the President's reply to mean that he did not object to national means and automatic seismic stations (i.e., no manned control posts) as a basis for inspection. He repeated the statement that the representatives of the Western powers had previously agreed to about three on-site inspections a year. This view was repeated again at Geneva on 23 February 1963 by Mr Kuznetsov, the Soviet representative who had been involved in the exchange of views during which, in the Soviet view, these low numbers were agreed. He used the following words:

As for the actual figure of two to three inspections a year, it is not a chance one. Before the Soviet Government decided to put it forward, the representatives of the Western Powers had given us to understand that that figure would suit them completely.[19]

The Soviet view, that the United States had indicated that it might be satisfied with two to four on-site inspections, appears also to have been based on an informal meeting between Professor Wiesner and Professor Federov, senior scientists from the two countries who had previously met at test ban negotiations. While this story has never been denied—or affirmed—by the US government, an American account of it suggests that Wiesner urged that the Soviet government should again declare its readiness to accept some on-site inspections and that agreement on numbers would then be negotiable.[20] In a personal interview, Mr Khrushchev indicated that he had experienced some difficulty in persuading his Council of Ministers to agree to the offer of three on-site inspections at this time and that he had persuaded them that the offer would be accepted.[21]

The whole episode remains somewhat obscure. It is impossible to say how

[18] *Ibid.*, pp. 1277–78.
[19] Disarmament Conference document, ENDC/PV. 101, p. 26.
[20] H. K. Jacobson and E. Stein, *op. cit.*, pp. 426, 431 and 439.
[21] N. Cousins, "Notes on a 1963 Visit with Khrushchev", *Saturday Review*, 7 November 1964, pp. 16–21, 58–61.

far there was a misunderstanding and how far US representatives discussed tentative proposals at informal meetings which the government was later unwilling to endorse.

When the ENDC met in February 1963, the discussion confirmed that there was agreement on several methods for monitoring a comprehensive test ban: the use of national means, the use of black boxes, and an annual quota of on-site inspections of suspicious events. There was disagreement on the number of black boxes, and more important, on the number of on-site inspections: the Soviet Union proposed two to three a year, the United States eight to ten, later coming down to seven. In addition, attention was beginning to be turned to the modalities of on-site inspection, an issue which might have been the cause of a further round of disagreement, even if the number of on-site inspections had been settled.[22]

This impasse over numbers was not broken. In June 1963 it was announced that the three powers were to meet in mid-July. On 2 July Premier Khrushchev declared that the West was asking for on-site inspections not in order to monitor the cessation of tests but in order to legalize espionage, and that Western demands for on-site inspection made a comprehensive test ban impossible. (He thus withdrew the offer of two to three on-site inspections.) However, he stated that the Soviet Union was ready to sign a PTB excluding all underground tests. So the details of a PTB without a moratorium or any other limit on underground tests were negotiated in Moscow in July; the treaty was signed in August and came into force on 10 October 1963.

So far this history has been based almost wholly on published international exchanges between the two main parties and so shows for the most part only what views were transmitted between nations, after agreement on what view to take had been reached within the government of each nation. That is only part of the story. In the first place, the negotiations largely consisted of sparring round a few issues—whether a test ban should be linked to wider measures of disarmament, and whether and how intrusive on-site verification should be provided for. A second and related point is that it is important to look as far as one can at the way in which the national positions were reached. Many groups are bound to have a say—the military, diplomats, scientists of various political views, political parties, and so on. These groups engage in internal negotiation as a prelude and accompaniment to external negotiations. In the case of the Soviet Union, secrecy prevents us from observing these phenomena. But in the case of the United States, the processes of government are more transparent.

[22] US Arms Control and Disarmament Agency, *Documents on Disarmament 1963*, ACDA publication 24 (Washington, October 1964), pp. 141, 182 and 205.

US policy

From 1958 onwards US policy towards the test ban negotiations was formulated through a committee which came to be known as the "Committee of Principals". It consisted of the Secretary of State, the Secretary of Defense, the director of the CIA, the chairman of the Atomic Energy Commission and the special assistant to the President for science and technology. In addition, the special assistant to the President for national security attended regularly, but without having a vote, and the director of the US Information Agency attended occasionally. During President Kennedy's Administration, the director of the Arms Control and Disarmament Agency was added when that agency was created in September 1961[23] and the Chairman of the Joint Chiefs of Staff was added on 22 May 1963, just before the eventual negotiation of the PTB.[24]

Of the agencies originally belonging to the committee, the Atomic Energy Commission, which was responsible for making nuclear weapons, appears to have been the most strongly opposed to a test ban. The Department of Defense appears to have come second to the AEC, being less hostile and by no means unanimous: the Joint Chiefs of Staff were clearly hostile to a test ban, while the civilian heads were certainly not always so. "Next, in a center, although slightly positive position, would be the Central Intelligence Agency."[25] The Department of State followed, favouring a test ban, and the Office of the President's Science Advisor, supported by the President's Scientific Committee, was the strongest supporter of a test ban.

The addition of ACDA brought in a new supporter of a test ban, as well as an agency equipped to pull together work on the whole problem. The addition of the Joint Chiefs of Staff brought in an additional opponent to the test ban.

The history of the first years of test ban negotiations during the Eisenhower Administration gives the impression that policy often consisted of reactions to events and pressures from outside, rather than a calculated strategy to achieve a predetermined end. Moreover, at this period of the cold war there was a strong tendency to mistrust the motives of the other party and any general statements it made; this was accompanied by a preference for trying to avoid the issue by pursuing technicalities.

Following the experts' report in Geneva in 1958, the United States agreed to proceed to negotiate a test ban, but only if progress were made with

[23] H. K. Jacobson and E. Stein. *op. cit.*, p. 474.
[24] *Ibid.*, p. 451.
[25] *Ibid.*, p. 471; see also p. 88.

other types of disarmament. This caveat is reported to have been insisted upon by the Department of Defense and the Atomic Energy Commission.[26] When this link with progress on other types of disarmament was dropped, in January 1959, the Department of Defense and the AEC may have acquiesced in this concession because they thought that the introduction a fortnight earlier of new data—which indicated that seismic detection and identification were much harder than had previously been estimated—made it very unlikely anyway that there would be agreement on a test ban.[27] Later the internal argument largely focused on verification requirements, with the opponents of a treaty setting high requirements and finding obstacles to satisfying them, and the proponents setting lower ones and finding ways of satisfying them. Outside the government machine, there was much debate of these technical issues amongst scientists. Their opinions were in some cases highly coloured by political preconceptions.

Summing up this period, a study based on interviews with many of the Americans involved, including President Eisenhower, as well as on the many documents on the subject, reached the following conclusions:

> The Eisenhower Administration was deeply divided on several questions relating to the nuclear test ban negotiations, including even the wisdom of attempting to negotiate on this issue. President Eisenhower himself saw little advantage from the viewpoint of American security policy in a test ban as such, and—responding to the advice of the Atomic Energy Commission—he was not convinced of the great danger of the radioactive fallout that would result from continued testing. Fundamentally, he was doubtful that when the chips were down the Soviet Union would agree to a treaty acceptable to the United States, or that a treaty, even if agreed upon, would be followed by a substantial slowdown in the arms race.[28]
>
> Because the Eisenhower Administration was deeply divided concerning the wisdom of a nuclear test ban, and because President Eisenhower did not take decisive steps to end this division, until 1961 American policy toward the nuclear test ban negotiations was characterized by ambiguity and vacillation. The United States often appeared not to know whether or not it wanted a test ban or what the minimum conditions were that it would accept. It is difficult, if not impossible, to say whether this situation was due primarily to President Eisenhower's basic belief that the Soviet Union was not prepared to accept any agreement except on terms disadvantageous to the United States or to his reluctance to resolve differences within the Administration. In fact, he remained skeptical of the wisdom of the Moscow Treaty even after it was negotiated.[29]

These views, gleaned from President Eisenhower in his retirement, may be more sceptical than those he held at the time of the events.

[26] *Ibid.*, p. 92.
[27] *Ibid.*, p. 141.
[28] *Ibid.*, p. 471.
[29] *Ibid.*, pp. 490–91.

In a book he wrote after retiring, the British delegate described the position as follows:

> It took the Eisenhower administration nine months from May 1959 until February 1960 to decide to accept the proposal for a fixed annual inspection quota first floated by Mr. Macmillan and officially proposed by Mr. Khrushchev. There were similar delays over taking a decision about a moratorium on small underground tests, and on numerous other matters.
>
> This slowness in taking decisions was the reflection of the struggle of varying ferocity between proponents and opponents of a treaty during the last eighteen months of the Eisenhower administration. No one was really able or willing to resolve the inter-agency disputes and to give that positive direction to United States policy which President Kennedy supplied in full measure as soon as he took office. Since the struggle between the protagonists was conducted to a considerable extent in public, and since the arguments on both sides were freely aired in the press and in Congressional hearings, all this is a matter of open record.[30]

President Kennedy's rule saw a somewhat Pyrrhic victory for the advocates of a test ban. The opposition of the Joint Chiefs of Staff to a CTB and the conditions they extracted from the President before recommending the ratification of the PTB to the Senate appear to have been of key importance in determining the final US negotiating position.

When in the spring of 1963 the United States was preparing its position for the final Moscow negotiations, the Joint Chiefs of Staff, whose chairman then became a member of the Committee of Principals, pronounced that the US proposal for a comprehensive test ban with seven on-site inspections was inconsistent with national security. On 14 June, before the Moscow negotiations, when the Committee of Principals recommended that the United States should continue to give priority to efforts to achieve a comprehensive treaty, the Joint Chiefs of Staff dissented, but Secretary of Defense McNamara concurred in the recommendation, which the President accepted.

Afterwards, General LeMay, head of the Air Force and a member of the Joint Chiefs of Staff, claimed that he was surprised at the Administration's seriousness in trying to get a treaty. In the Congressional hearings on the partial test ban, he said: "It wasn't until we saw the instructions to Mr. Harriman [the Chief US delegate to the negotiations in Moscow] that it dawned on me, anyway, that we were really serious about trying to negotiate a treaty."[31]

[30] Sir Michael Wright, *Disarm and Verify, An Explanation of the Central Difficulties and of National Policies* (London, 1964), p. 121.

[31] *Military Aspects and Implications of Nuclear Test Ban Proposals and Related Matters,* Part II, hearings before the Preparedness Investigating Subcommittee of the Committee on Armed Services, US Senate, 88th Congress, 1st session (Washington, 1963), p. 733.

A further element in the situation was the opposition to a test ban in the Senate.

It was against this background that the Joint Chiefs of Staff made their support for ratification of the PTB, without which the Senate could not have been expected to ratify the treaty, dependent on a number of conditions which robbed the treaty of its substance as a measure to check the nuclear arms race between the Soviet Union and the United States. In order to get the treaty through, President Kennedy assured the leaders of both parties in the Senate, in writing, that he accepted these conditions. The fulfilment of these "safeguards", as they are called, is reviewed each year by Senator Jackson, the chairman of the Nuclear Safeguards Subcommittee of the Senate Committee on Armed Forces. In one of these reports, the origin and content of the safeguards is described as follows:

> During the course of those lengthy hearings, the Chairman and all the members of the Joint Chiefs of Staff testified. These five eminent military leaders of our Armed Services supported the limited test ban treaty, but in doing so they set forth to the Senate the need for establishing safeguards for our security which would make possible our consent to this treaty.
>
> Those four safeguards which the Joint Chiefs of Staff recommended and which President Kennedy endorsed in a letter to the Majority and Minority leaders of this body during the floor debate on the test ban treaty read as follows:
>
> 1. The conduct of comprehensive, aggressive, and continuing underground nuclear test programs designed to add to our knowledge and improve our weapons in all areas of significance to our military posture for the future.
> 2. The maintenance of modern nuclear laboratory facilities and programs in theoretical and exploratory nuclear technology which will attract, retain, and insure the continued application of our human scientific resources to these programs on which continued progress in nuclear technology depends.
> 3. The maintenance of the facilities and resources necessary to institute promptly nuclear tests in the atmosphere should they be deemed essential to our national security or should the treaty or any of its terms be abrogated by the Soviet Union.
> 4. The improvement of our capability, within feasible and practical limits, to monitor the terms of the treaty, to detect violations, and to maintain our knowledge of Sino-Soviet nuclear activity, capabilities, and achievements.[32]

These words should be compared with the opening paragraph of the PTB which spoke of

> Seeking to achieve the discontinuance of all test explosions of nuclear weapons for all time, determined to continue negotiations to this end, and desiring to put an end to the contamination of man's environment by radioactive substances.

[32] Senator H. M. Jackson, "Remarks on Nuclear Test Ban Safeguards", US Senate, 1 October 1965, pp. 1–2.

Soviet policy

The fact that one cannot see internal differences amongst policy-makers in the Soviet Union does not mean that there were none: it is scarcely plausible that there were not different internal views on the test ban negotiations throughout the period or that the balance between those who held different views never shifted. Nor does the evidence that, at some periods at least, the US government was not wholehearted in its pursuit of a test ban prove that if it had been more positive a comprehensive treaty could have been made. It is always possible that had the US position been different, the Soviet government would have had second thoughts.

What one can see from the international exchanges is that the Soviet Union went a long way to meet the Western demand for verification, including on-site inspection, but instead of maintaining a steady positive position on all points, it reversed its position on some of the most important ones, for example, its positions regarding on-site inspection, the link to other disarmament measures and the resumption of testing. Those changes can be explained in many ways—as reactions to changes in the general international climate and the state of the arms race, as reactions to action, or inaction, on the part of the West in the test ban negotiations, as evidence of shifts in the balance between various groups within the relevant part of the Soviet government, or as evidence that the more forthcoming Soviet positions were assumed for propaganda purposes and were not serious (the explanation preferred by critics of the Soviet Union).

A recent Soviet appraisal of the PTB and of the need for a CTB is very similar to the appraisals one might find in many other countries, apart from the fact that, while mentioning US underground testing, it makes no mention of Soviet underground testing:

> The Moscow Treaty has to a certain degree contributed to the reduction of the arms race, because it has become impossible to test nuclear warheads in the environment for which they are destined, and a limit has been put on the development of new weapons of a high yield expressed in megatons. Nevertheless, the possibilities of a restriction of the nuclear arms race have not been fully utilised.
>
> Between 1963 and 1969 the USA carried out over 200 nuclear underground tests (new warheads equipped with guidance systems, etc.) and it continues these tests until today. It is necessary to use every effort in order that long-term measures be adopted with the aim of limiting and stopping the nuclear arms race and especially to reach an international agreement which would prohibit underground nuclear tests.
>
> The Moscow Treaty, the first international agreement related to the actual problems of disarmament, is a concrete manifestation of the possibility of solving

major international problems, which has created very favourable conditions in the sphere of the limitation and cessation of the arms race.[33]

The positions of other countries

The positions taken by countries other than the Soviet Union and the United States can be explained, broadly speaking, by their positions in the nuclear hierarchy.

Britain's policy towards the immediate cessation of tests seems to have been less positive before it had completed a series of tests of thermonuclear weapons than it was afterwards.[34] A close ally of the United States, Britain later played an important role in keeping the negotiations alive and in trying to find ways through the various obstacles that arose. This was true of both political problems and the technical problems of verification.

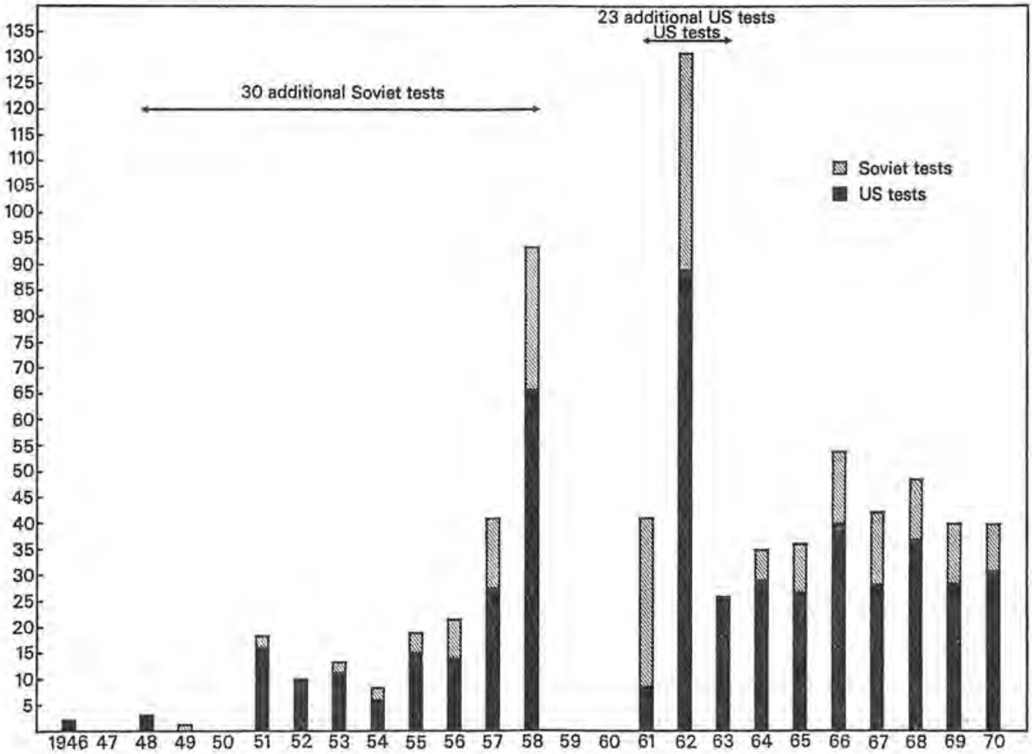
France became increasingly hostile to a test ban and to all measures short of nuclear disarmament by all nuclear powers, as it pursued its own programme of nuclear weapons development and testing precisely in order to avoid the inferior status and uncertain security that it felt to be the consequences of not having nuclear weapons.

On the occasion of the signing of the PTB on 31 July 1963, China delivered its first all-out official attack on the Soviet Union. In a statement calling for the destruction of all nuclear weapons and for a world conference of heads of governments, the Chinese government denounced the PTB as an attempt by the Soviet Union, Britain and the United States to consolidate their nuclear monopoly, called it a fraud and accused the Soviet government of capitulating to US imperialism.[35] It seems that this was the culmination of the reversal of Sino-Soviet nuclear relations. At first, the Soviet Union provided technical support for Chinese nuclear research; later it withdrew that support, and then it negotiated with the United States a treaty which could be, and commonly was, interpreted as a measure which would help to stop more nations acquiring nuclear weapons. Understandably, the policy of China, like that of France, was to advocate full nuclear disarmament of all nuclear powers.

All other countries were without nuclear weapons and, at this time at

[33] A. Kaliadin, *L'Energie Nucléaire et la Sécurité Internationale* (Editions de l'Agence de Presse Novosti, Moscow), pp. 68–69. (SIPRI translation.)
[34] A. J. R. Groom, *British Thinking about Nuclear Weapons* (to be published 1972).
[35] "Statement of the Chinese Government Advocating the Complete, Thorough, Total and Resolute Prohibition and Destruction of Nuclear Weapons and Proposing a Conference of the Government Heads of All Countries of the World", 31 July 1963, in *People of the World, Unite for the Complete, Thorough, Total and Resolute Prohibition and Destruction of Nuclear Weapons* (Peking, 1963), pp. 1–6.

Chart 11.1. Nuclear tests conducted by the USA and the USSR, 1946–1970



Source: SIPRI Yearbook 1969/70, p. 386.

least, largely without nuclear ambitions. They generally supported a test ban if for no other reason than their concern about atmospheric pollution.

III. *The frequency of testing*

The figures for nuclear tests conducted by the Soviet Union and the United States, reported by the United States, are shown in chart 11.1; chart 11.2 shows in more detail the figures for the period 1956–63, during which the test ban negotiations were active. No figures are published by the Soviet Union. The only other series is published by Sweden.

It is important to note that these figures understate the number of tests and that the extent of understatement and its bias as between the figures for different countries is not known. The available evidence is set out in appendix 11 A, page 433.

The main points which stand out are these:

1. Between 1956 and 1963 the number of reported tests was much greater for the United States than for the Soviet Union. This was also true before and has been since that period.

2. In the period before the 1958–61 moratorium, the two countries seem from the figures almost to have taken turns conducting test series. Whatever the reasons for this were before 1958, it was associated in 1958 with bargaining about a moratorium. At the end of March 1958, the Soviet Union stopped testing and proposed a moratorium. As noted earlier, President Eisenhower rejected the proposal on the grounds, *inter alia,* that the Soviet Union had just completed "a series of tests of unprecedented intensity", an accusation which scarcely seems justified by the figures for Soviet tests shown in the chart: it is true that for the first three months of the year the figures indicate two tests in 1957 and eight in 1958, but for the first four months of the year they show seven tests in 1957 and nine in 1958. In the following months the United States conducted many tests before the Soviet Union began testing again in September.

3. After the moratorium ended in 1961, the United States conducted mainly underground tests of which it had acquired much experience before the test ban. On the other hand, the United States reported only one Soviet underground test before the PTB was concluded. According to one Soviet representative, that test was performed in order to demonstrate "to the whole world how effective and sensitive were the national means of control".[36]

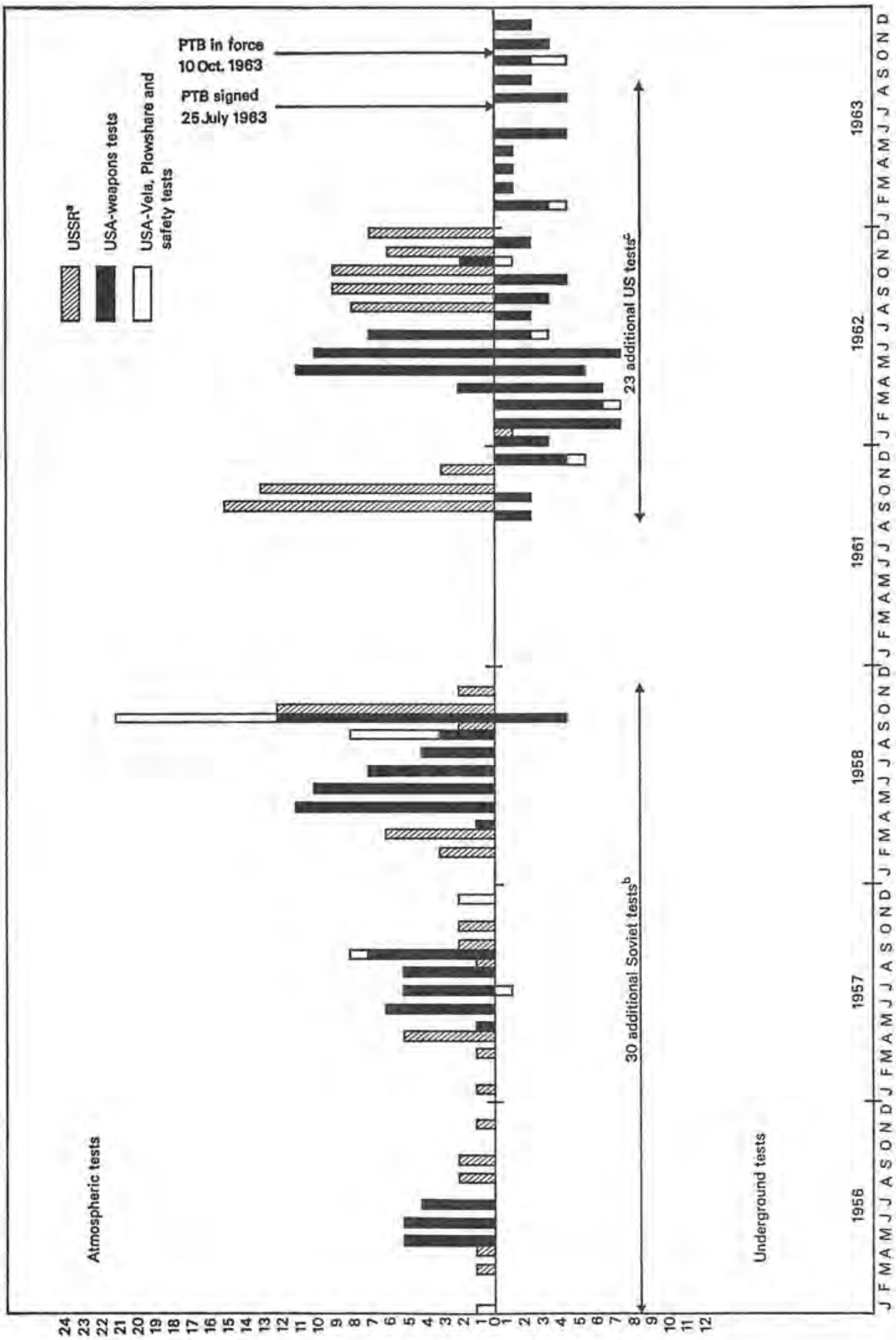
Compared with the Soviet Union and the United States, other countries had conducted few tests by the date of the test ban: twenty-three reported tests by Britain and seven by France.

Since the PTB was concluded, nuclear testing has gone on unabated. It has simply been diverted underground. The reported figures for the Soviet Union and United States are shown in chart 11.3. The chart includes an indication of some tests by each country which have been reported but not specified by year by the US authorities. Whereas testing was concentrated in short, intense bursts before the 1958–61 moratorium and again before the PTB was concluded in 1963, it has proceeded rather steadily since then at a rate about equal to that of the highest year before the PTB, apart from these two periods of intense testing.

The total number of reported tests, including those conducted before and since the PTB, up to the end of 1970, are: United States—539, Soviet Union—236, Britain—25, France—37, and China—11. These are figures for all tests, including those US tests designated as being for purposes other

[36] Disarmament Conference document, ENDC/S.C.I/PV.36, pp. 20–21.

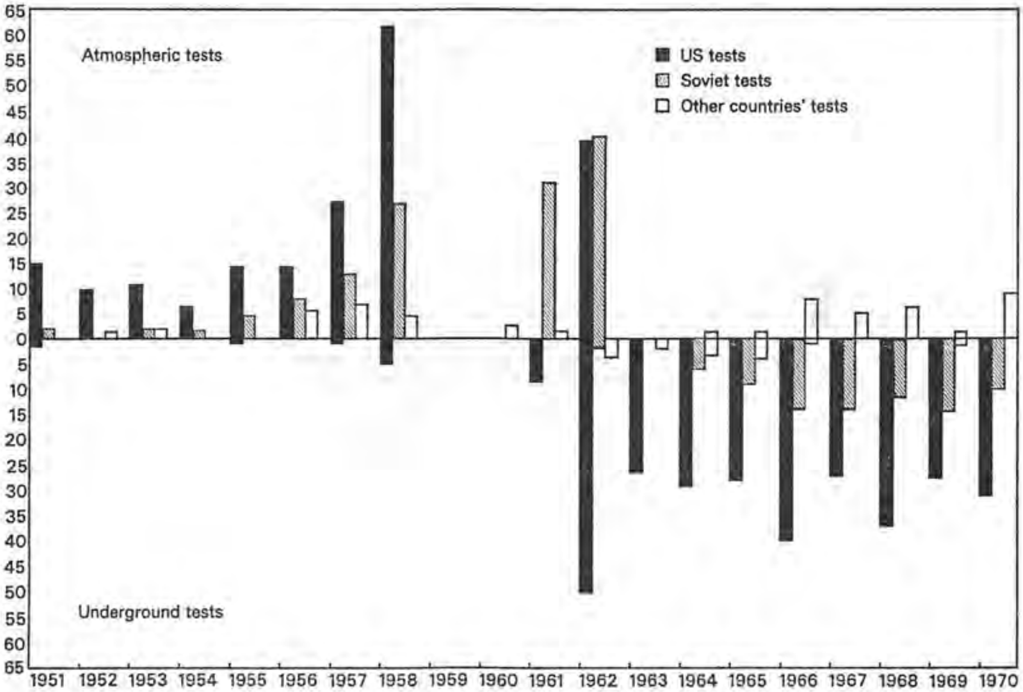
Chart 11.2. Nuclear tests conducted by the USA and the USSR during the negotiating period for the Test Ban Treaty, 1 January 1956 – 31 December 1963



[a] Presumably these were all nuclear weapons tests.
[b] 59 tests announced in period 1949–1959.
[c] 103 tests announced in period 15 September 1961 to 20 August 1963.

Sources: "Announced Nuclear Detonations", appendix B in *Effects of Nuclear Weapons* (Washington, US AEC and US DOD, revised ed. 1964); and I. Zander and R. Araskog, "Kärnladdningsexplosioner 1945–66" (FOA 4 Rapport No. A 4493), (Stockholm: Swedish Research Institute for National Defence, June 1967).

Chart 11.3. Nuclear tests conducted by the USA, the USSR, the UK, France and China, 1951–1970



than weapons development—i.e., for peaceful uses, weapons safety and test detection. Details of this kind are not available for countries other than the United States.

The distribution of reported tests according to yield (measured in equivalent tons of high explosive) is shown in table 11.1. It appears that there is a much higher proportion of small tests to total tests reported for the United States than there is for the Soviet Union. This should not necessarily be taken as evidence of the extent to which Soviet small tests are understated because of the difficulties of monitoring them. The United States may have concentrated more on low-yield weapons, at least in the period before the PTB.

IV. *Verification*

The negotiations leading to the Partial Test Ban Treaty of 1963 were remarkable for the concentration of attention on the technical problems of verifying that the treaty was observed, in particular the problems of seismic

Table 11.1. Yield distribution of US, Soviet and UK nuclear weapons tests, until January 1971

Number

	Low	Low-intermediate	Intermediate	High	Other
	Less than 20 kt.	20 kt. to 200 kt.	200 kt. to 1 mt.	Greater than 1 mt.	(No yield indicated)
USA[a]					
Before PTB[b]	160	25	28	14	71
After PTB[b]	120	65	10	4	0
USA total	**280**	**90**	**33**	**18**	**71**
USSR[c]					
Before PTB[b]	20	12	32	43	17
After PTB[b]	5	24	9	1	5
USSR total	**25**	**36**	**41**	**44**	**22**
UK	**6**	**12**		**7**	**0**

[a] Omits all Vela, safety and Plowshare tests.
[b] The Partial Test Ban Treaty came into force on 10 October 1963.
[c] These numbers are Soviet tests announced by the US Atomic Energy Commission: they are therefore lower than SIPRI figures.

verification of underground tests and the question whether on-site inspection was needed to identify ambiguous seismic events. On the one hand, greater progress was made towards establishing a system, including agreement in principle on on-site inspection, than has been achieved in any other post-war disarmament talks. Many clauses of a treaty were agreed, and such issues as the manning of instrumented control posts on the territory of the other party were agreed in detail. On the other hand, the inability to agree on the number of on-site inspections was the issue over which negotiations were broken off.

At the present time, discussions of a comprehensive test ban in Geneva and elsewhere again tend to focus on the technical problems of verification. The progress that has been achieved and still might be achieved with seismic methods of detection and identification is discussed at length, and the question whether long-range means of verification, without on-site inspection, would not now be sufficient to monitor a comprehensive test ban is debated. The concentration of attention on seismic verification has probably been caused by several factors—first, a tendency to avoid direct debate of big political issues in favour of technical issues; secondly, of all the technical issues one might discuss, seismic verification is the one about which there has been most public information available to experts from all countries, nuclear and non-nuclear-weapon, and the only one which can be discussed in a precise, quantitative way and which can be handed over to technicians—or perhaps it would be more accurate to say, taken over by technicians. Other relevant technical issues, such as the importance of nuclear tests of different sizes, have been shrouded by more secrecy.

This narrow focus of argument may now be ending. As noted below, the justification for on-site inspection has been weakened by the progress in seismology, so that the debate is likely to shift to new and more general grounds. (There is some evidence of this in the latest Senate hearings in the United States.) Also, the US Senate, as a whole, is now showing greater interest in dealing with substantive military-strategic issues, which previously were the domain of the Joint Committee on Atomic Energy and the Armed Services Committee.

The truth of the matter is that the level of technical ability to monitor a comprehensive test ban is only one amongst a number of variables which make up the political equation which defines whether or not it is desirable to make such a treaty.

There has been little concern expressed about clandestine testing in violation of the PTB, since underground testing is sufficient to satisfy most of the goals of a testing programme. If, however, a CTB becomes a real possibility, its opponents may revive such arguments as the risks of clandestine testing in outer space, but arguments of that kind seem likely to have a hollow ring to the US public at this time.

Seismic verification

Seismic means of verifying underground tests have received, and may continue to receive, most attention. There are two problems: one is to *detect* that a seismic event of some kind has occurred and to locate it; the second is to *identify* whether that event was a nuclear explosion or an earthquake. Since the PTB was concluded, there has been considerable progress in seismic techniques. Thus as long ago as 1966, in his annual report on nuclear test ban "safeguards", Senator Jackson stated that the US programme of research on test detection, which was pursued both in order to see what could be learned from underground tests of other nations as well as for possible relevance to a future CTB, had "greatly improved our capacity to detect underground events ... as well as to better locate such events. Also, the number of so-called unidentified events each year has been greatly reduced."[37]

[37] Senator H. M. Jackson, "Remarks on Nuclear Test Ban Treaty Safeguards", US Senate, 18 October 1966, p. 12.

A particularly important development is establishment of the fact that it is possible to discriminate between explosions and earthquakes (i.e., to identify seismic events) down to a certain level on the basis of differences in the seismic signals they generate.[38] It was not clear to what extent this would be possible at the time the Partial Test Ban Treaty was negotiated. Theoretical understanding of the phenomena has been increasing and so has the performance achieved with the best equipment. The most expensive and most advanced research is concentrated under the auspices of the United States, but the equipment and capability of other countries has been improving and scientists from other countries have made important contributions to the subject. In addition, progress is being made in analysing and exchanging the information that is available from existing sources.

Nevertheless, there is a limit to what is possible by seismic means. The main progress has been in identifying seismic signals of a magnitude which previously could be detected but were ambiguous as to cause (earthquake or explosion). However, it will probably never be possible to identify *all* detected seismic events: more information is needed to identify a signal than to detect it; and the fundamental problem remains that, below some size, it is not possible to detect seismic events from great (teleseismic) distances. In other words, the identification threshold (the size of event for which identification is possible with a given probability of error) has been lowered towards the detection threshold, but the scope for further progress is limited since there will always be a threshold below which underground tests cannot even be detected seismically.

In the pre-1963 test ban negotiations, the Western position was generally that identification of underground tests would be possible with a politically acceptable probability down to body wave magnitude[39] of 4.75 (the seismic signal generated from about a 10 kt. explosion in hard rock), but that below that level seismic identification would not be sufficiently reliable. Thus, in February 1960, the West proposed a ban without on-site inspection on tests greater than 4.75. In that period, the view that 4.75 was the threshold was based on technical views as to what would become possible by way of seismic identification more than on well-established results based on operating experience.

The advances in seismology since then have shown that identification down to magnitude 4.5 (about 5 kt. in hard rock) is now achievable with a high probability of success assuming proper instrumentation. For example, representatives of the US Department of Defense have recently referred to 4.5 as a magnitude above which there would be few seismic events in the

[38] *Seismic Methods for Monitoring Underground Explosions, op. cit.*
[39] For an explanation of this and other seismic terminology, see *ibid.*, pp. 15–27.

Soviet Union which could not be identified at long range.[40] In saying this it is not clear how far these spokesmen were taking into account the US classified (i.e., secret) system of seismic stations around the Soviet Union, the existence of which is evident from Congressional hearings and which can be presumed to improve on the performance of the open stations.[41] The current area of technical exploration and political-cum-technical debate is about what may be possible below magnitude 4.5, with different levels of instrumentation, with data exchange, and so on. There seems to be little talk of identification at or below 4.0 (about 1–2 kt. in hard rock).[42]

If tests were to occur in porous material such as dry alluvium rather than in hard rock, smaller seismic signals would result. Consequently larger yields (by approximately a factor of 10) than those indicated for hard rock can be tested without being identified or even detected. However, the availability of dry alluvium beds sufficiently deep and thick to contain nuclear tests above about 20 kt. (equivalent to 1–2 kt. in hard rock) is limited.[43]

Concealment

During the pre-1963 test ban negotiations, the opponents of a ban in the United States put considerable effort into demonstrating that nuclear tests in outer space and underground can be concealed. Techniques for concealing underground tests that are still discussed include:

1. Decoupling (firing a shot in a large hole). This has been tested on a small scale and shown to be a theoretically valid method,[44] but the costs of secretly making holes large enough to conceal tests with yields much above the detection threshold for tests in alluvium may be prohibitive and the risks of detection by non-seismic means (i.e., intelligence) high. For example, completely to decouple a 100 kt. explosion, 8 million tons of material occupying a cavity approximately 200 metres in diameter must be dispersed.[45] On the other hand, partially to decouple a 10 kt. explosion so

[40] See the evidence of Dr Carl Walske, Assistant to the Secretary of Defense for Atomic Energy Affairs, before the US Senate Foreign Relations Subcommittee on Disarmament as reported in the *International Herald Tribune*, 26 July 1971, and the working paper (CCD/330, 30 June 1971) presented at Geneva by Dr Lukasic, Director of the Advanced Research Projects Agency of the US Department of Defense.

[41] *Military Aspects and Implications of Nuclear Test Ban Proposals and Related Matters, op. cit.*, pp. 84–85, 98–99, 102–107.

[42] *Seismic Methods for Monitoring Underground Explosions, 1971 Progress Report, op. cit.*

[43] *Ibid.*, section 8, and *Seismic Methods for Monitoring Underground Explosions, op. cit.*, p. 67.

[44] *Seismic Methods for Monitoring Underground Explosions, op. cit.*, pp. 73–75, and *1971 Progress Report, op. cit.*

[45] *Seismic Methods for Monitoring Underground Explosions, op. cit.*, p. 74.

that it would be undetected or at least unidentified seismically would be far less difficult and perhaps technically and economically feasible.

2. Firing a shot during an earthquake so that the signals it generates are buried in those generated by the earthquake. It looks as if this technique would work if the earthquake were sufficiently large and if no answer to the trick has yet been found. Assuming a government wanted secretly to break a test ban, the question remains whether it would believe that it was feasible to wait for earthquakes before testing and, also, whether it would believe that the risk of getting the timing wrong or choosing too small an earthquake was so low that the chances of being found out were acceptably low. That a trick will work if done properly is one proposition; that you can rely on doing it properly every time or in a high proportion of cases is another proposition.

3. Firing a sequence of shots so as to mimic an earthquake. Our current *Progress Report* suggests that there are techniques of analysing the seismic signal which may reveal this trick.

The last two evasion techniques, unlike the first, do not reduce the seismic signal; they only seek to confuse it.

One should remember that there are many technical difficulties that must be overcome to make significant progress in nuclear technology and that these difficulties may be seriously compounded by the requirements imposed by clandestine testing. On the other hand, for occasional "confidence" testing of stockpiled weapons or checking out minor variants of existing designs, the added difficulties of concealment are probably less serious.

Non-seismic monitoring

Non-seismic means of monitoring a test ban are rarely discussed. The nations that use these methods do not reveal their capabilities, no doubt for fear of compromising them. Other nations will therefore tend to be ignorant about them and probably also hesitant to start open discussions of matters that lie in the realms of secret intelligence: if a government breaks the silence that customarily surrounds such matters, it may compromise intelligence capabilities by provoking countermeasures, such as improved camouflage or more secure communications; or it may suffer embarrassment later, either through a general erosion of secrecy, or, for example, because it may no longer be able to exchange secrets so readily with other nations.

Yet it is clear that non-seismic means of monitoring a test ban are used and may be important. Broadly speaking, they may be divided into two categories—technical means and traditional means (including short-range technical devices for eavesdropping).

A comprehensive review of the available information on technical means is given in chapter 12. It appears that satellites are a very important vehicle for carrying monitoring apparatus, so that the USA and the USSR, which possess a lead in satellites, must now enjoy much better capabilities than other nations. There is certain evidence that satellites have been investigated for underground test monitoring. Of the monitoring techniques that are probably employed in satellites, photography must certainly be capable of detecting, in suitable conditions, drilling and other preparations for a test carried out in the open and, afterwards, the subsidence craters or changes in vegetation, if any, caused by a test; it may possibly be capable of detecting a cloud raised at the time of a test. There are many other physical effects of tests, some of which may be observable with different kinds of apparatus in a satellite.

Between the technical and traditional means, there is the monitoring of radio communications connected with tests. This again may best be done by satellite, at least in the case of large countries. But it may also be done from the ground, from ships or from aircraft. There are reports that radio monitoring is used for monitoring nuclear tests.[46]

Finally, there are traditional means. These include traditional espionage, information obtained from defectors and the scrutiny of open flows of information (press, radio, technical journals and so on) for direct and indirect evidence.

Some of the technical methods may be made ineffectual by concealing the testing. For example, an old mine might be used as the site for an underground test so as to make it invisible; communication by cable might be used instead of communication by radio, and so on. These steps would add to the cost and difficulties of testing. That, in turn, might make detection by other (non-technical) means more likely.

It is impossible for outsiders to say how the totality of non-seismic means compares with seismic means of monitoring underground tests. It seems natural to suppose that seismic means must be the most reliable, because a seismic signal cannot be avoided and can be moderated, by decoupling or by other techniques of concealment, only at high cost. Moreover, it is natural to suppose that, because they are likely to be expensive if used continuously, techniques such as satellite photography will be used to check events which have first been detected by seismic means, or for periodic surveys of known or suspected test areas. The continuous surveillance of

[46] See appendix 11A, and chapter 12.

large areas the size of the United States and the Soviet Union for small or transitory clues seems impractical. But it is always conceivable that other sensors have superior capabilities that we do not know about.

In any event, it is clear that seismology should not be regarded as the only means of monitoring underground tests but as a major means which is complemented by many others. Two relevant points about non-seismic means are:

1. The technical means seem likely to have improved since the late 1950s and early 1960s when the previous debate on verification took place. Since then the resolution of the cameras is likely to have been improved considerably and much experience has been gained.

2. The performance of some of these methods, for example traditional means of intelligence, is not strongly influenced directly by the size of tests. They may reveal a small test no worse and no better than a large one—though this is not to say that taking all means together, larger tests will not be easier to detect and identify than smaller ones.

Finally, it should be noted that when the USA and the USSR dispute the need for on-site inspection they avoid statements that deny or confirm the existence of non-seismic means.[47]

In sum, the significance of non-seismic detection is that it is secret, that some of its possible methods are not subject to any inherent limitation according to the size of test, while the limitations of others, besides being unknown, will in varying degrees be different from those of seismic detection. Moreover, since there are many ways of detecting tests and there is uncertainty about them, it will be hard to find ways to deceive them all. Hence a potential violator cannot feel secure. A test, however small, may be found out. The probability that a series of tests will be discovered is larger yet and also increases rapidly with the number of tests.

Assessment

It is clear that there has been a marked improvement in verification capabilities since 1963. It is not possible to say precisely what is now feasible. Secrecy surrounding the US classified seismic network and around all non-seismic means prevents that. What can be said is this.

As regards seismic monitoring, there is a threshold above which all seismic events can be detected. There is a higher threshold above which they can be identified as earthquakes or explosions. Both thresholds are being

[47] See, for example, the Soviet and US statements made in Geneva on 13 May 1971 (CCD/P.V. 516, pp. 12 and 18).

reduced, and the gap between them is closing: the area of unidentified events is being reduced. Further lowering of the detection threshold will continue to become more difficult and so, at some point, will further reduction of the identification threshold. For these reasons, the point of diminishing returns will soon be reached in seismology.

For underground testing in hard rock, we can assume that the USA and the USSR are in a position to achieve a detection threshold of about 1 kt. and an identification threshold of about 5–10 kt. Theoretically these numbers are higher by a factor of ten for testing in alluvium and much higher still for testing in a large hole (i.e., "decoupling"). But taking into account technical realities, we can say that underground testing above 10–20 kt. can be made extremely risky for the tester by the use of seismic monitoring alone.

Non-seismic methods are also used: these include satellite observation and more traditional methods of intelligence. These methods are not subject to the same thresholds as seismic means. They add a secret capability for detection which may operate at all yield levels. So they add to the risks the would-be clandestine tester must face.

The demand for on-site inspection has been justified as a means of clearing up unidentified seismic events in the upper reaches of the gap between the detection threshold and the identification threshold. The progress in seismic monitoring, by narrowing the gap (and reducing the thresholds on both sides of it) also reduces the strength of the argument for on-site inspection, particularly if, as seems always to have been taken for granted, non-seismic evidence is not likely to be placed on the table as a basis for demanding on-site inspection. The Soviet Union and the United States know seismology well. If they wanted to test secretly, they would be unlikely to do it in a way which would generate a suspicious seismic signal.

The effectiveness of on-site inspection is, in any event, not well understood. The procedures for inspection were never settled and it is uncertain what chances there are of finding evidence unless intrusive techniques, for example drilling, are used. Such a technique may well be politically unacceptable even if on-site inspection is accepted in principle. No doubt, national studies of these problems were undertaken by governments. Nevertheless, it is remarkable that if on-site inspection were indeed a sensitive matter so much time has been devoted by international negotiators to demanding and refusing it and so little to discussing how it would work. It is true that a low but uncertain probability of success in on-site inspection may be expected to help deter a potential violator; and it seems unlikely that a violator would ever admit an inspection team to the place where an illicit test had taken place.

It is clear that before 1963 the US President, in considering and making proposals for a CTB, was ready to live in seismic ignorance of possible Soviet tests below a size dictated by the seismic detection threshold. If it could be said that the same condition rules today, then it could be said that seismic progress, quite apart from any progress in non-seismic means, has greatly reduced the need for on-site inspection and hence that, in this respect, the way is open for negotiation of a CTB.

But it is plain that there are those in the USA and the USSR who have opposed a CTB and who believe that there is greater military security in continuing testing than in stopping it. They may well turn to the issue of testing below the seismic detection threshold, thus raising the demands upon seismic monitoring compared with 1963. This would mean that greater importance than before was being attached to the seismic monitoring of the smallest tests—and that, as before, non-seismic means were being ignored.

It is a matter of judgement, in the light of considerations like this, how highly one values in military-cum-political terms the results now derived by the USA and the USSR from nuclear tests. It seems clear that the results are not so important as the results of the first tests taken by these or any other nations. Diminishing returns obtain, and both the military and political returns may now be low. If the returns are low, the benefit of a CTB as a direct step to stop the arms race between the USSR and the USA is low but so are the obstacles to achieving that step. If the returns are high, the benefits are high and so will be the obstacles—in terms of the arguments about what the other side might gain if it were to cheat. In either case, the institutional pressure to continue tests from those who work in the nuclear weapons and test programmes will be present.

V. *The military significance of tests*

The next question to consider is what are the military attractions to the USA and the USSR of continuing nuclear tests and, in particular, what, if anything, could be gained by illicitly conducting nuclear tests after a comprehensive test ban was introduced.

Nuclear tests can be classified in four categories as follows:

1. *Confidence tests:* occasional tests for the purpose of maintaining confidence in weapons already stockpiled. Since materials age, inadvertent changes may occur in production, and other things can go wrong, military authorities frequently insist on sampling the performance of their weapons. These tests are not intended to advance the state of the art.

It is not clear that such tests are really needed since a bomb has no movable parts and it is possible to test the operation of the whole device short of "going nuclear". Nuclear fuels work, as the world knows too well, and their chemical integrity can be checked by conventional chemical means. If all tests were prohibited, steps would surely be taken to minimize the possible deterioration in weapons reliability. Bomb designs, material standards, production methods and so on would be rigidly frozen.

To the extent that confidence diminishes, it is more likely to affect the attitude of those who plan a first use than those who plan retaliation only. The effect, if any, is to widen the firebreak between non-nuclear and nuclear weapons and to shift nuclear weapons, gradually, towards the role of weapons that are useful only to deter nuclear attack.

2. *Proof tests:* tests of newly designed weapons where the design is based on accepted and established principles. New designs are needed to meet size, weight, shape or other performance requirements. It is necessary to test before stockpiling a new weapon to see whether indeed the new model works as intended and expected.

Tests without nuclear explosives or at less than full yield will give less than full confidence. But occasional, single tests can do the job and full diagnostic instrumentation, which raises the risk of detection by non-seismic means, is not necessary, though it is useful in the event of failure.

Without proof tests it would be necessary to design new weapon systems around existing nuclear-bomb designs.[48] The effect is different for weapons for deterrence and weapons to enhance war-fighting capability.

For the purpose of maintaining a credible deterrent, the case for continued nuclear testing is hardly persuasive for several reasons: (*a*) Deterrent weapons tend to be in the larger yield class where warheads of high efficiency are already available to both the USA and the USSR. (*b*) Several different bomb designs can be used to make up a deterrent force, thus minimizing the possibility of a catastrophic failure in its retaliatory capability. (*c*) So much overkill already exists that greater efficiency in the nuclear weapon arsenals of either power can hardly add to its deterrent capability.

It is interesting in this regard to speculate whether the deterrence capability of either power would have suffered if a CTB had been in effect for the last decade. For example, in the development of MIRVs—which is the most significant advance in long-range nuclear weapons in the past decade—it is safe to assume that a system could have been made using warheads of existing design and that testing has merely permitted a somewhat better combination of numbers and sizes of warheads to be achieved for a given missile.

[48] J. C. Mark, "Nuclear Weapons Technology" in *Impact of New Technologies on the Arms Race* (Cambridge: MIT Press, 1971), pp. 133–39.

For weapon systems intended for war-fighting, the value of continued testing is more debatable. In this case, weapon systems are designed to deal with other weapon systems, be they surface-to-air missiles, tanks, or field armies, and superior performance may make military sense. Technical improvements in nuclear-warhead design can make for superior weapon systems. On the other hand, it can be argued that the USA and the USSR, with their long history of intensive nuclear research and development and with their many weapon tests, undoubtedly have a very complete warehouse of weapon designs already, so that a suitable, though probably not optimal, weapon design can be found to fit almost any particular requirement. Moreover, a nuclear weapon system for war-fighting purposes consists of much more than a bomb. Other technical aspects of the system (for example, aircraft speed and agility, tank speed and range), in addition to such factors as military tactics and troop training, will generally be more important to the performance of the system than the precise character of the nuclear bomb it delivers.

3. *Effects tests:* nuclear explosions are used to provide a realistic nuclear condition in which to test materials, electronic devices, the survival of weapons against defence measures, and so on.

Tests of this kind are now conducted underground in order to improve designs of warheads for ABM interceptors and for missiles intended for ABM defences. The USA and the USSR by now have had so much experience with underground tests that they could pursue a serious programme of effects tests restricted to yields below the seismic detection threshold. With time and with the growing disillusionment with the military utility of ABM, the need for effects tests should be less compelling and an international limitation of ABM, if stringent, would greatly reduce the argument for effects tests. Some effects tests are ruled out now by the PTB's prohibition on atmospheric testing. For example, current hardened missile silos appear not to have been subjected to nuclear blast by either the Soviet Union or the United States.

4. *R&D tests:* this includes tests to investigate entirely new principles in weapon design. Such tests would be needed to advance the state of the art towards laser-initiated pure fusion bombs, neutron bombs, or major advances in yield-to-weight ratios for very small weapons. Large weapons are already very close to their theoretical maximum in yield to weight, and improvement by a factor of about two is all that we can reasonably expect. That is quite insignificant compared with the advances made to date: the yield of current weapons per unit of weight is about 1 000 times greater than that of the first Hiroshima bomb.[49]

[49] *Ibid.*

Vigorous research and development appears to be continuing on the assumption that a breakthrough, comparable in significance to the original development of nuclear weapons and thermonuclear weapons, may lie around the next scientific corner. Before the PTB, advocates of the importance of nuclear research and development to military security came up with the possibility of a "clean" bomb for strategic use which minimizes radioactive fallout and a "neutron" bomb for tactical use which reduces blast effects but maximizes harmful neutron radiation. Neither of these potential weapons seems significant in the military equation, and the advocates of tests have not come up with anything exciting since then—perhaps because the test ban issue has been quiescent. But of course it is impossible to prove that something of significance will *not* be invented. Fears of the undiscovered will undoubtedly persist, although they lose a great deal of their strength as time passes and nothing spectacular emerges from research programmes. It is now about two decades since thermonuclear weapons were developed. Progress has not stopped, but research and development in nuclear bomb technology seem, as might have been expected, to have been yielding diminishing returns. Much of the technical cream was skimmed in the first decade after the A bomb was developed.

Research and development can continue without nuclear testing, but, of course, with a greatly reduced scope.

The United States and the Soviet Union

While there are no particular grounds for assuming that if either the USA or the USSR chose to break a CTB it would do so secretly, not openly, it is useful to speculate about the conceivable character of a clandestine test programme. If one assumes that a violator would risk non-seismic detection but not seismic detection and identification—an assumption for which there is no strong foundation—then for this and other reasons small tests will be safer than big ones. A clandestine programme might therefore conceivably include:

1. Series of tests at a fraction of a kiloton thus permitting small R&D tests and effects tests, as well as confidence and proof tests of the smallest weapons.

2. Occasional tests—once every year or two in the shadow of an earthquake—in the 20–80 kt. range, thus allowing some confidence and proof testing of larger weapons (e.g., the MIRV warhead for the US Poseidon missile).

Thus a programme of this kind would permit research and development, and the measurement of effects, to be carried further than would be possible with no tests but probably not so far as is now possible with unlimited underground testing.

On the other hand, no proof or confidence testing of big warheads would be possible, nor final development of weapons using new technology except those of very small yield.

This suggests that, as between the USA and the USSR, with their huge armouries of nuclear weapons, the testing and development of small nuclear weapons could scarcely be expected to change the balance of power. The US and Soviet military may show an interest in improving small weapons which might, they believe, improve their ability to fight nuclear wars short of a major nuclear exchange which would involve their homelands. But it is questionable whether the notion of a limited nuclear war is at all realistic.

It is sometimes suggested that a small version of a new nuclear device might be tested and that a full version might then be deployed without further testing. Testing "small" and adding nuclear material or extrapolating might be sufficiently reliable for producing a warhead on the basis of well-established techniques and designs. But it is questionable whether the reliability of testing small and relying on predictions will be great enough when the warhead is based on a new design or technique, and it is then that there is the greatest temptation to test.

One proposition is that if a treaty ceased to be in force—because it was not renewed or was abrogated—the nation that had continued small tests and had maintained some vigour in its weapons laboratories would have a start over a nation which had not continued them. This argument rests on the highly questionable premise that a start of this kind could give either the USA or the USSR a significant political and military advantage over the other even though each of them already has such a vast and variegated armoury of nuclear weapons. Another argument is that continued nuclear tests may lead to the design of a new and effective defensive system that would be of critical importance to the strategic balance. But for the USA and the USSR, improvements in warheads are not likely to be so important as new developments in other parts of present defensive systems. In the many US debates about technical limitations of ABM, the limits imposed by nuclear technology are not mentioned: all the emphasis is on the problems of radar, computers, component reliability, and so on.

Altogether an analysis of this kind makes the importance of small tests conducted by the USSR and the USA seem rather slight. If this is correct, it means on the one hand that the temptation for them to cheat is slight and, on the other hand, that one country's fear of the consequences of cheating by the other should also be slight.

In this context it is important to note that propositions about cheating by the other side have mostly been made and discussed openly in the United States, not the Soviet Union, and that they are usually based not only on the assumption that non-seismic methods of monitoring do not exist but also on asymmetrical assumptions:

1. that the Soviet Union would cheat if it could, whereas the United States could not cheat if it wanted to; and

2. that the Soviet Union would believe that the United States was not cheating and would confidently base its policies on that belief, whereas the United States could not entertain any such beliefs about the Soviet Union.

This is not the place to debate the validity of these asymmetrical assumptions, but one point should be noted. Both assumptions rest on the view that the United States, in contrast to the Soviet Union, is so open that it could not keep cheating a secret. But it is one thing to say that the US government would be inhibited from cheating by this belief (assumption 1). It is a different matter to say that the Soviet Union would believe that to be so. Any scenario about cheating relates to a situation of mistrust and hostility between nations. In a situation of that kind, perceptions are usually mistrustful on both sides.

Other countries

Next we consider briefly the military significance of nuclear tests for countries other than the Soviet Union and the United States and the question of verifying that they observe a CTB.

China and France, which are actively testing, are so far behind the USA and the USSR in nuclear weapon technology that they must have a relatively large amount to learn from continued testing. By the same token, they would be able to catch up in the sophistication and variety of their warheads only if they conducted a large, and therefore observable, number of tests. It is important to recognize that of equal or greater importance to these secondary powers is the development of strategic delivery systems. Full-scale tests of delivery systems can be easily monitored by the USA and the USSR and will in fact be the main way in which they will follow the progress of these countries' strategic systems development.

Britain appears to be further ahead in nuclear weapon technology. This has no doubt been one reason why it has not conducted any tests since 1965. If Britain, with France, were to try to create a European nuclear force which sought to rival the United States and the Soviet Union in the variety and sophistication of its weapons. Britain might feel a need to resume testing.

Those countries which have the technical and economic capability to produce nuclear weapons but have not yet done so—the "near-nuclear countries"—can go very far in the development and testing of weapons without conducting a nuclear explosion. But unless they conduct a full test, they can never achieve full confidence in their weapon, nor will they demonstrate their possession of nuclear weapons to their opponents. An untested weapon whose existence is regarded as probable by a rival nation may have some deterrent effect, but the degree of deterrence will surely be less than if the weapon has been tested so that there is certain knowledge of its existence and performance. Thus a first test is important.

Although the technical and military significance of tests is greater the fewer a nation has conducted, we can observe that in discussions of a comprehensive test ban treaty, the USA and the USSR displayed rather little concern about other countries. At the 1958 Conference of Experts, the United States insisted that the experts should devise a "worldwide" monitoring system which should ultimately be capable of application to China.[50] Apart from that, one comes across few references to the problems of monitoring countries other than the USSR and the USA. The Soviet Union and, as a rule, the United States claim that monitoring US compliance with a CTB is not a problem, and the discussion of test ban verification has really been confined almost exclusively to the problems of monitoring the Soviet Union.

The fact that there has been no fuss about monitoring tests elsewhere can be explained by several factors:

1. Disarmament negotiations have been and still are a highly polarized debate between the USA and the USSR in which verification has been the main bone of contention between them. It often appears to have been a proxy issue doing service for real political and military obstacles to disarmament.

2. The idea that other countries would test clandestinely, if propounded, would not seem very plausible. In going nuclear, Britain, China and France have made no secret of their tests. On the contrary, the acquisition of nuclear weapons has been a demonstrative act from which governments have sought to derive political advantage, external and internal. Tests have been of the essence.

3. The policies of the USA and the USSR, which in any case have been directed at stopping proliferation, would not have been different if they had suspected or detected illicit testing by others.

[50] See H. K. Jacobson and E. Stein, *op. cit.*, pp. 65–66.

4. The greatest importance will be attached to monitoring nuclear tests by near-nuclear-weapon countries which are involved in an actual or potential confrontation in which testing by one side could lead to a significant shift in the balance of strength. An obvious case is the Arab–Israeli confrontation. But with these countries, and with any other non-nuclear-weapon country confronted by another that might go nuclear, the desire to know whether the opposing nation has tested a nuclear weapon, or is developing one, exists anyway. Regardless of the Non-Proliferation Treaty (NPT) or a test ban, good monitoring is wanted.

5. Monitoring is conducted anyway, notably by the USA and the USSR but also by others; and a number of these countries, for example, the United States and Sweden, publish their findings.

There are two technical considerations that are germane to the problems of monitoring tests in non-nuclear-weapon countries:

1. The variation in ease of monitoring may be great. Israel, a very small, barren area, should be easy to monitor; Japan, larger and highly seismic, relatively hard to monitor. In addition, there is the variation in the political openness of different countries.

2. Countries going nuclear are likely to start with tests large enough to be detected. To date, first tests have usually been around 20 kt. This appears to be the size which is technically easiest and most economical. To start with the constraint that tests must be concealed and therefore must not be above a lower yield would add to the difficulty and cost of making a first weapon and probably to the number of tests required: the designers would have to work up cautiously from a size well below the estimated detection threshold.

VI. *Nuclear explosions for peaceful purposes*

One problem of a comprehensive test ban is how to deal with nuclear explosions for peaceful purposes.

Possible peaceful uses of nuclear explosives were first explored in the United States as Project Plowshare. Applications investigated include earth-moving and excavation, natural gas and mineral extraction, extraction of geothermal energy, and the creation of underground storage areas. The enthusiasm of US scientists for peaceful application of nuclear explosives stimulated interest in exploiting this technology elsewhere in the world. But in recent years, US enthusiasm for peaceful nuclear explosions has diminished. Preliminary experiments and detailed analyses now suggest that the potential of nuclear explosions for peaceful purposes is limited and that other methods of accomplishing the same results can be found.

Contributing to the disillusionment with peaceful applications of nuclear explosions is the realization that full exploitation of nuclear explosions for each feasible application would require very large numbers of explosions. For example, it may take hundreds of nuclear explosions to excavate a canal. It may take many hundreds of explosions to extract significant amounts of gas or other minerals from the soil. If several countries were to exploit nuclear explosions for such purposes, hundreds of explosions per year would occur. This might again provoke fears of radioactive contamination. But the major question here is whether it would be possible to separate civilian from military nuclear explosions, and hence whether it would be possible to prohibit military explosions in a CTB while permitting explosions for peaceful purposes.

For a country going nuclear, the development programme and the first test of a peaceful or a military nuclear device are indistinguishable. Both provide the knowledge and experience of how to produce destruction. To pretend there is a substantial difference between the two is humbug.

Various schemes have been suggested whereby the existing nuclear powers would provide devices for peaceful uses and yet might be prevented from developing new military devices,[51] but they would involve complicated and intrusive inspection and little progress has been made towards serious discussion of them, let alone their acceptance.

The benefits from a programme of explosions for peaceful purposes hardly seem to match the costs, if those include ruling out a CTB. But a CTB need not rule out possible peaceful applications for ever. One approach would be to ban all nuclear explosions initially, stipulating that for a period of several years parties to the agreement should jointly assess the knowledge so far gained of nuclear explosions for peaceful purposes and should investigate methods of verifying that military applications are not being pursued in a programme of nuclear explosions for peaceful purposes. If the further analyses indeed suggested that nuclear explosions for peaceful purposes were more promising than they now seem, the incentive to exploit such nuclear explosions constructively while having a ban on military tests might encourage the required international cooperation.

[51] See, for example, M. Kalkstein, *International Arrangements and Control for the Peaceful Applications of Nuclear Explosives,* Stockholm Paper No. 4 (Stockholm: SIPRI, 1970) and U. Ericsson, *The Question of Nuclear Explosions for Peaceful Purposes by Non-Nuclear-Weapon States and the Possibility of Misuse of Such Technology for the Production of Nuclear Weapons,* Conference of Non-Nuclear-Weapon States, Geneva, 1968 (A/Conf. 35/Doc. 3/3 July 1968).

VII. *Compromise treaties*

Various modified versions of a CTB have been suggested. Two stand out. One is a revival of the idea of a threshold treaty forbidding tests above a seismic magnitude at which the ability to detect and identify tests by seismic means is undisputed. The second is a declining quota treaty, whereby tests would not stop abruptly but would be phased out over a period. (See page 524 for a discussion of these proposals.)

Neither seems likely significantly to change the main problem, namely whether the countries principally concerned really want a CTB.

VIII. *The political significance of a comprehensive test ban*

At the start of this chapter four motives were mentioned for a CTB—the effects on pollution, on slowing weapons development, on proliferation and on détente.

The pollution caused by underground tests appears to be very much less than that caused by tests above ground. Underground tests quite often vent (i.e., radioactive material breaks through the surface), but when they do so they cause far less pollution than an atmospheric test. When they do not break through the surface, they may stimulate minor earthquakes; and there is also some risk that they may pollute ground water and, from a test site on a small island, also stimulate tidal waves; but the extent, if any, of these effects does not seem yet to be well established.

The other three criteria—the slowing of weapons development, the slowing of proliferation and the promotion of détente—appear in a rather different light compared with the early 1960s, when they were commonly discussed. In the first place, the effect of a CTB on détente between the USA and the USSR would be less now that they are engaged in SALT talks; relations between the two have become calmer than they were in 1963, in the aftermath of the Cuba crisis. Secondly, the NPT, which was opened for signature in 1968 and came into force in 1970, has replaced the test ban as the main instrument for expressing a willingness not to acquire nuclear weapons—or, looked at from another point of view, the main instrument for stopping proliferation. Moreover, the stopping of proliferation has been made in some degree conditional upon progress in nuclear arms limitation by the USA and the USSR. There is a clause in the Non-Proliferation

Treaty which commits the USA and the USSR to negotiate to this end. Many of the near-nuclear-weapon countries have not yet finally committed themselves to the treaty. Some of them, for example, India, Israel and Japan, appear to be holding back on account of their local security problems. Nevertheless the slowing of weapons development by the Soviet Union and the United States and the stopping of proliferation have become more explicitly interrelated than they were before. The CTB is of interest in this context.

It is useful to analyse the position of different nations grouping them as follows: the USA and the USSR, the secondary nuclear-weapon powers, the near-nuclear-weapon powers and the others (who are far from nuclear).

The United States and the Soviet Union

The visible position is a continued deadlock over on-site inspection, as indicated earlier. Either side could break this deadlock within the narrow technical-cum-political framework in which the debate takes place. The progress in seismic and other means of detection is such that (*a*) the United States could almost certainly say that on-site inspection is no longer needed, or (*b*) the Soviet Union could revive its proposal of three on-site inspections and say that this number would now be more than adequate.

But it is doubtful whether either side strongly desires a CTB now, or whether they have conducted serious reviews at a high level of their policies towards a CTB. Their negotiating postures in Geneva seem stale, and it is likely that the attention of their policy-makers has been focused on the big items under discussion at SALT, namely the deployment of ABMs and long-range nuclear weapons. They are likely to have considered a CTB, if at all, as a collateral measure which might follow and reinforce SALT agreements. In that context, it seems reasonable to argue that, since much recent testing has been connected with ABM systems and countermeasures, a CTB would be a good collateral measure to reinforce an ABM agreement between the Soviet Union and the United States. But that will probably be easier if ABMs are eliminated than if they are "frozen" at some limited level and qualitative improvements are permitted. Once improvements are permitted, the advocates of testing will have more substantial grounds for arguing that they must be able to go on testing both to improve their own ABM and to ensure penetration of the other side's ABM. A second qualification is that, as noted earlier, the possibilities of improving ABMs lie largely in parts of the system other than the warhead, so that a test ban might not be very relevant to major improvements in ABM systems. Altogether it is probably better to regard a CTB not as a collateral measure that is technically more appropriate to one SALT measure than another, but as a measure which, within the context of SALT, would help generally but modestly to check the bilateral nuclear arms race between the USSR and the USA. A second aspect is the possible effect of a CTB on the nuclear policies of other countries. When they review their policies toward a CTB, the Soviet Union and the United States are bound to consider this.

In general, the conclusion of a CTB by the USA and the USSR, even if, for example, it was bilateral only, might help to ease the criticism that is directed against them for their failure to curb their arms race and in particular it might make the NPT more palatable. How great this effect would be is unpredictable. The PTB received acclaim out of proportion to its importance as a measure to limit the arms race. Now a CTB would have to compete for attention with any results that emerged from SALT. Any general dividend of improved feeling of this kind might be expected to accrue from all nations in a more or less indiscriminate way. Nothing much else could be expected from countries which have not the ability to go nuclear.

The possible reactions of the near-nuclear-weapon nations to a CTB are set out below. In the light of an assessment of that kind, the USA and the USSR would have to consider how many near-nuclear-weapon nations would be likely to abstain from a CTB as well as from the NPT in order to keep their nuclear option open; how many would regard the CTB as a complement to the NPT, encouraging them to subscribe to the latter; how many would consider the CTB as a substitute for the NPT, i.e., as an alternative and less objectionable way of renouncing nuclear weapons; and how many of the nations in this category would, and how many would not, have subscribed to the NPT in the absence of a CTB supported by the Soviet Union and the United States.

As regards the actions of the secondary nuclear-weapon nations, one would have thought that the USA and the USSR might reckon that China and France might not subscribe to a CTB when it was made but that, if the treaty left those two countries alone or almost alone conducting tests, the effect, if any, on them would be to hasten rather than delay the day when they stopped tests. Any country which continued or started testing would be likely to be subject to a greater concentration of criticism and political pressure to stop tests than if there were no CTB and more nations were testing. The USA and the USSR might also reckon that continued testing on their part would scarcely be a rational response to continued testing by the secondary nuclear-weapon nations: continued development of an ABM system is the only response by the USA or the USSR that anyone might claim was rational, but that is a claim that is highly disputable. And if either the USA or the USSR were to yield to the proposition that the ABM should continue to be developed, perhaps on a limited scale, for defence against the secondary nuclear-weapon powers and for this reason were to limit the scope of the limitation on ABMs that it was ready to enter into in the SALT negotiations now, it would thereby tend to confirm and reinforce, at least for China, the proposition put forward by China that the SALT talks are a conspiracy directed against it. It would also confirm the views of others who regard the SALT negotiations with scepticism.

These reasons for thinking that the USA and the USSR would not make the conclusion of a CTB dependent on the participation of all the secondary nuclear-weapon powers, together with the absence of any explicit qualifications of this kind by either the USA or the USSR in its advocacy of a CTB in Geneva, make it surprising that we have recently encountered indications that the Soviet Union, or at least some of its representatives, incline to the view that the conclusion of a CTB should be dependent upon Chinese participation. Confirmation of this view is to be found, in somewhat ambiguous form, in Mr Brezhnev's speech to the 24th Congress of the Soviet Communist Party, when he stated that one of the objectives of the Party was: "To work for an end to the testing of nuclear weapons, including underground tests, by everyone everywhere."[52]

In looking at the other groups of countries, we apply the kind of reasoning we have applied to the USA and the USSR, partly in order to see the limitations of that kind of reasoning.

There are two important assumptions. The first and most debatable one is that the acquisition of nuclear bombs by any nation, or improvements in the quality or number of its nuclear bombs if it already possesses them, bring to it military and political advantage; the second is that nuclear testing is subject to diminishing returns.

Secondary nuclear-weapon powers

On these assumptions, the secondary nuclear-weapon powers—China, France and the United Kingdom—gain relative to the USA and the USSR in terms of warheads if they continue to test, provided the USA and the USSR do not test at a rate so much more rapid than the secondary nuclear-weapon powers that their superior number of tests outweighs the inferior

[52] Leonid Brezhnev, *Report of the Central Committee of the Communist Party of the Soviet Union, 24th Congress of the CPSU* (Moscow, 1971, translation by Novosti Press Agency), p. 50.

technical gain they derive from each test—a possibility that seems rather remote given how few tests Britain, China and France have had compared with the Soviet Union and the United States. This proposition scarcely fits Britain in recent years when it has not been testing and has been partially dependent on the United States in nuclear weapon matters, but it does fit China and France to some degree. Indeed the assumptions have some reality: these two countries have faced nuclear threats from the USA and the USSR; China has no nuclear-weapon allies, and France has felt unable to rely exclusively on the protection of its nuclear-weapon allies.

On the other hand, continued testing and development of nuclear weapons by secondary nuclear-weapon powers may provoke their non-nuclear-weapon neighbours to acquire nuclear weapons. For example, Chinese nuclear weapons development may help to provoke India or Japan to acquire nuclear weapons. That would be a disadvantage to be weighed by China against the advantage of catching up closer to the USA and the USSR. China would have to reckon whether by going ahead it would be able to keep a lead over its neighbours if they went nuclear. For example, because of technical and industrial superiority Japan would very probably be able to leap ahead. On the other hand, China could scarcely be sure that, only by stopping testing, it could stop Japan or India from going nuclear; nuclear testing is only one element in the interaction over nuclear weapons policy between these countries. For example, political developments are likely to be more important, and so may be the development and deployment of delivery systems. To stop nuclear testing might be important, because it is a visible and unequivocal act, but a lot would probably depend on the surrounding circumstances in which it was done.

Near-nuclear-weapon nations

Most of these nations have not yet finally committed themselves to the Non-Proliferation Treaty. Their attitudes to the acquisition of nuclear weapons differ considerably.[53]

Some countries—India, Israel and Japan—appear to feel, with greater or lesser certainty, that they must keep open the possibility of going nuclear on account of local threats to their security. The policies of these countries may not be greatly influenced by a CTB or by the course of the arms race between the USA and the USSR. They are likely to be influenced more by

[53] See the discussion in chapter 9, page 283.

the political and military policies of their potential enemies. Thus a cessation of Chinese testing would be more likely to influence the evolution of the nuclear policies of India and Japan than would the cessation of tests by the USA and the USSR. Other near-nuclear-weapon countries, which do not feel they have such immediate local security problems, are likely to compare the CTB with the NPT as instruments which close their nuclear option.

It is clear that the CTB is a much less restrictive instrument. It involves no overt commitment not to go nuclear, no control over fissionable material and no prohibition of transfers of nuclear weapons from nuclear-weapon nations to non-nuclear-weapon nations. But another aspect of the matter is that the CTB is much less discriminatory than the NPT. As was evident from the negotiations over the NPT, many people dislike the discrimination involved in it. It divides nations into two classes—those that are allowed to have nuclear weapons and those that are not—and it requires that the non-nuclear-weapon nations should be subject to intrusive inspection while the nuclear-weapon nations accept no obligation to be inspected.

These nations might regard a CTB as a complement to the NPT or as a substitute for it. In the first case, a near-nuclear-weapon power might argue that if it committed itself to a CTB which was also subscribed to by the USA and the USSR and possibly by other nuclear-weapon powers, they were all engaging in what could be regarded as an act of equal restraint—if the inequality of previous experience is ignored. It could be argued that a success had been scored in persuading the Soviet Union and the United States to accept a CTB and that now it was reasonable to subscribe to the NPT. In this way the CTB might complement the NPT.

The second possibility is for near-nuclear-weapon nations to subscribe to the CTB, arguing that this was a non-discriminatory way of indicating that they did not intend to acquire nuclear weapons, and to continue, tacitly if not explicitly, to reject the NPT. It might be difficult for the USA and the USSR to object, since, until the NPT was devised, a CTB was often held to be the appropriate way to set about stopping proliferation. Yet, as indicated earlier, the degree of restraint would be far less than under the NPT.

In fact, it is somewhat unrealistic to analyse the problems of the different groups of countries like this, in terms of a narrow calculus of nuclear strength, assuming away other political, strategic and institutional aspects of the situation. The fact that those non-nuclear-weapon nations which could go nuclear have not done so expresses one set of strategic circumstances and political valuations. Similarly, the fact that the USA and the USSR go on testing and arguing about verification is an expression of these countries' politics, external and internal.

Other countries

Since they are incapable of going nuclear, these countries sacrifice nothing from a CTB—or an NPT—and they gain in so far as either measure stops the nuclear arms race or improves the political climate.

IX. *Conclusions*

The CTB is not a measure which is of much importance compared with more direct approaches to disarmament—for example, the banning of ABM or agreement to move to a minimum deterrent. It may be asked why, if this is so, there is so much attention paid to it in disarmament debates. The reasons for the focus on the CTB appear to be institutional and historical. The USA and the USSR have taken mainstream arms limitation negotiations away from Geneva to SALT, thereby keeping out other countries. About the only issue connected with nuclear weapons that is still open for discussion is the CTB. Most delegations and governments are well versed in the intricacies of argument about a test ban: it has been debated on and off for more than ten years. Moreover, many may feel that they and the public were swindled when they were led to believe that the Partial Test Ban Treaty would limit or stop tests. It is now evident that it merely served to divert tests underground.

Nevertheless a CTB might at this juncture have significance of a symbolic and psychological kind. This arises not only from its possible role in bargaining between the near-nuclear-weapon powers and the USA and the USSR but also from its significance in other contexts: a cessation of testing has long been demanded and discussed to the point where its introduction might be felt to be a political achievement, regardless of its true significance; the fact that tests were stopped would mean that the lobbies for nuclear weapons had in some degree been defeated.

On the other hand, it can be argued that these are trivial and illusory results, the effect of which might be to lull the politicians and public into a false sense of achievement and complacency such as followed the Partial Test Ban.

In short, as with all partial measures of arms limitation, the possible benefits of a CTB depend mainly on what further steps towards disarmament, if any, accompany and follow it and upon the political trend of which it is a part.

Appendix 11A. Evidence on understatement of numbers of nuclear tests and its significance

The US authorities state that they do not announce the full figures for their own or Soviet tests, and there are indications that the number omitted is large. Thus in his 1968 report as chairman of the US Senate Nuclear Safeguards Subcommittee, Senator Jackson, after stating that 157 US tests had been announced in the 50 months between 5 August 1963, the date when the test ban was signed, and 1 July 1968, added: "A large number of additional tests have not been announced in consonance with the policy established in 1961 to refrain, for national security reasons, from making public the specific level of tests operations."[1] The implication that all US tests were announced before 1961 is contradicted by other statements by the US Atomic Energy Commission (AEC).[2] An examination for a sample period in 1964 of the records from seismographic stations in the USA revealed twice as many tests as had been announced.[3] This tends to confirm the statement that the number of omissions is large, but the sample period was short —only three months—and so the degree of understatement may be atypical.

As regards Soviet tests, the Swedish figures, which are based on Swedish seismic data as well as on published US information, are considerably higher than the US figures.[4] Moreover, in one case the US authorities have given an indication of the extent to which they understated Soviet tests. This referred to atmospheric tests, not to underground tests. Thus in the notes to a set of figures on nuclear tests sent to the US Senate Foreign Relations Committee by the chairman of the US Atomic Energy Commission in August 1963, the remark that there were additional unlisted tests was followed by two indications of the understatement: in 1954 the AEC stated that the Soviet Union had conducted "a series of nuclear detonations", whereas the figure for 1954 was and still is one test; secondly, on 9

[1] Senator H. M. Jackson, "Remarks on Nuclear Test-Ban Treaty Safeguards", US Senate, 25 September 1968.

[2] This was confirmed by the US AEC in the following terms in a letter to SIPRI of 14 July 1971: "Please accept this letter as an Atomic Energy Commission statement that the United States did not announce all of its nuclear tests before 1961."

[3] D. Davies, "A Comprehensive Test Ban", *Science Journal* 4 (11): 78–84, November 1968.

[4] See pages 461–68.

December 1961 the AEC announced that there had been "approximately 50 atmospheric tests" in the Soviet 1961 test series,[5] whereas the number of Soviet tests reported for 1961 by the Atomic Energy Commission, and still included in the figures for that year, is 31. The Swedish figure for that year is 32.[6] It seems unlikely that "approximately 50" was a rounded statement of 31 or 32; and in any case the apparent objective of the AEC in comparing "approximately 50" with 31 was to emphasize that its normal published figures are understatements.

There have been reports that the available figures for Britain and France are understatements too.[7] For 1964, the French reported only an undisclosed number of underground tests; the British list one underground test in the Sahara and the US AEC lists three underground tests.[8]

While the US authorities' policy of not reporting all US or Soviet tests of which they have knowledge may have been adopted for several reasons, it is clear that one of the effects of the policy is to permit the government to maintain flexibility in political arguments about the problems of verifying a comprehensive test ban.

If the United States announced all the Soviet tests it detected by seismic and other secret means, it would tend to reveal its intelligence capabilities. That would indicate to the Soviet Union and other countries the yield below which it was possible to test and avoid detection. Keeping other nations uncertain about the limits of your monitoring capabilities is one way of deterring them from cheating. But in this case the policy of maintaining secrecy and inducing uncertainty seems so far to have been associated with understatement rather than overstatement of US capabilities; the monitoring capabilities claimed in negotiation never appear to have been more than could readily be explained by seismic methods and systems that were public knowledge. There is evidence that a classified seismic system and non-seismic methods exist. (See page 413.)

If the United States were to announce all its own tests, this would permit the Soviet Union to claim that they had detected them all and hence that verification was no problem.

In the discussions of verification in the negotiations leading up to the test ban, the United States and the Soviet Union occasionally challenged and

[5] *Nuclear Test Ban Treaty,* hearings before the Committee on Foreign Relations, US Senate, 88th Congress, 1st session (Washington, August 1963), p. 984, footnote to statistical table.

[6] See pages 461–68.

[7] *SIPRI Yearbook 1969/70,* page 386.

[8] *Scientist and Citizen,* November–December 1967; "The Detection and Recognition of Underground Explosions", a special report of the UK Atomic Energy Authority, December 1965, p. 118; and the US AEC list of "Announced Tests since Signing of Limited Test Ban Treaty (5 August 1963 – 10 June 1971)", mimeographed.

teased each other about test numbers. For example, in October 1962 the Soviet representative quoted in his speech the US published figures for the number of US underground tests. The US representative replied:

> Would the Soviet Union claim that it has records of each of these detonations? We say frankly that we have not made all of our shots public. Is the Soviet Union willing to show us its records of all those United States underground detonations which have not been announced but about which the Soviet Union is allegedly informed by distant instrumentation?[9]

Another and most interesting example was on 30 July 1958 when the Soviet representative at the Conference of Experts said: "Through various means, the control stations in the Soviet Union recorded thirty-two explosions, although the United States Government had reported only fourteen explosions."[10]

According to Jacobson and Stein:

> Although the United States task force in charge of the series had in fact planned and attempted to detonate thirty-two explosions only thirty of these attempts had actually been successful. The Western scientists could only conclude therefore that the USSR had obtained its data through some technique other than those being discussed at the Conference. Conceivably the Soviet data could have been gained through monitoring the American communication network from Soviet ships stationed near the Pacific area.[11]

There is a further twist to the story. A press release from the US AEC, put out on 10 March 1959, nine months after the Soviet representative's remarks, lists fourteen tests within the period mentioned, and two additional ones slightly later.[12] But when the same authority published a list of announced nuclear tests in 1964, it listed thirty-one tests.[13] In each list, the date and code name were given for each test. It can be seen precisely which tests were added to the list between the two dates. The story gives an indication of the way in which cat-and-mouse games are played with the figures.

How, in the light of all this, should one interpret the announced figures for the Soviet Union and the United States?

It is clear that the officially announced numbers are too low, but one

[9] US ACDA, *Review of International Negotiations on the Cessation of Nuclear Weapon Tests, September 1962 – September 1965*, p. 26.

[10] Conference of Experts to Study the Possibility of Detecting Violations of a Possible Agreement on Suspension of Nuclear Tests, document EXP/NUC/PV. 22, pp. 4–5.

[11] H. K. Jacobson and E. Stein, *Diplomats, Scientists, and Politicians, The United States and the Nuclear Test Ban Negotiations* (Ann Arbor, 1966), p. 70.

[12] US Atomic Energy Commission, Press Release B-39, 10 March 1959.

[13] "Announced Nuclear Detonations", appendix B in *The Effects of Nuclear Weapons* (Washington: US AEC and US DOD, April 1962; revised ed. reprinted February 1964).

does not know what the degree of understatement is with respect to the number of tests by either side. It is likely that the main omissions are small tests by both sides, but the threshold below which tests are omitted and the pattern of omission (an abrupt cut-off from full reporting to zero reporting, or a tapered cut-off depending on yield) is unknown and may not be the same for both sides. And we do not know how far medium or big tests, above or below ground, are sometimes omitted for political or other reasons. It is clear that atmospheric tests, as well as underground tests, have been understated.

Apart from this, the proportion of small tests in total tests may be different for different countries (see table 11.1 above). At the time of the Congressional hearings on the Partial Test Ban, it was repeatedly said and never disputed that the United States was further advanced in the technology of low-yield weapons, and the Soviet Union probably further ahead in high-yield weapons. This suggests that there may have been a corresponding difference in the pattern of testing. If so, the proportion of tests in that period omitted according to a threshold criterion would be higher for the United States than for the Soviet Union.

Altogether, one might interpret the figures in several ways:

1. As a reliable record of all tests above a threshold common to both sides (an optimistic interpretation).

2. As a rough approximation to (1) but inferior to (1) on account of technical errors and/or political bias, conscious or unconscious. It is not obvious which way political bias would go. For example, in some contexts there might be a desire to play up Soviet tests and play down US tests, while in other contexts there might be the opposite desire.

3. As a set of figures whose meaning is so uncertain that they are useless (the pessimistic interpretation).

It is certainly to be hoped that countries other than the United States which have the capacity, singly or jointly, to produce figures of this kind, using their own instruments and analysing seismic records from other countries, will start producing and publishing figures.

Meanwhile it seems best to look at the figures in a fairly sceptical spirit.

12. Non-seismic detection of underground nuclear tests

Square-bracketed references, thus [1], *refer to the list of references on page 455.*

I. *Introduction*

There are numerous methods of detecting nuclear test explosions. A lesser number of these methods is applicable to underground testing, but these still include several non-seismic methods.

This chapter examines in turn:

1. Statements implying a present role of satellites or of electronic intelligence (ELINT) in underground nuclear test detection and identification.
2. Methods that are theoretically possible for underground test detection by satellites.

It also summarizes publicly available information on ground-based and satellite-borne detection methods for nuclear weapons tests that might be conducted in space or in the atmosphere. There is, however, no indication that any of these latter methods have so far found application in the detection or identification of underground nuclear weapons tests.

Nuclear explosions release energy primarily as particle and electromagnetic radiation which is converted to other energy forms: mechanical, aerodynamic, seismic, optical (light), infra-red (heat), etc., depending on the environment in which the explosion takes place. These energy forms can be sensed by different instruments, either directly or quite often through their *interactions* with other molecules or physical forces in the atmosphere or on the earth's surface. The bomb radiations and outputs most important to detection are listed in table 12.1. *All detection techniques depend either on the detection of prompt and decay product radiations, or on the secondary effects, which are caused by the interaction of these types of radiation with the atmosphere or by the interaction of debris with the atmosphere* (see table 12.2). Thus there can be secondary or even tertiary effects, and some of these may be sensible or measurable by remote instrumentation when the primary effect or irradiation is itself not sensible over the same distance. The primary effects are particularly characteristic of a nuclear event as contrasted to a natural event largely because of their rapid onset and unique time dependencies. Those techniques that detect the secondary effects generally must cope with more difficult problems of natural background effects.

Table 12.1. Bomb radiations and outputs important to nuclear test detection

Type of output	Fraction of yield
Radiation	
Prompt X-ray	$\simeq 0.7$
Prompt nuclear	
Gamma	<0.01
Neutron	$\simeq 0.01$
Delayed nuclear	
Gamma	$\simeq 0.02$
Beta	$\simeq 0.02$
Debris kinetic energy	$\simeq 0.25$

Source: H. Dickinson and P. Tamarkin, "Systems for the Detection and Identification of Nuclear Explosions in the Atmosphere and in Space", *Proceedings of the IEEE*, 53(12): 1921–34, December 1965.

Considering the various parameters or effects of nuclear tests, several factors which determine the limits or feasibility of remote detection methods should be kept in mind:

1. "observation range": How far from the explosion source is the effect measurable? The boundaries one is particularly interested in are whether the effects extend far enough to be measurable beyond national borders, and whether the effects extend into or can be sensed from space.
2. "observation universality": Is the effect dependent on (or independent of) any particular terrain?
3. "observation time": the duration of the effect. Is the effect visible immediately, or with a delay; in either case, is it observable for a short time or for a long time?
4. "random or particular observation": Is the sensor looking at a very large area, and not necessarily expecting anything, against a variable background? Or is it looking at a particular site at which it expects a particular physical phenomenon to occur, in which case a small increment in some quantity might be indicative, especially if it could be correlated with other evidence.
5. "observation hinderability": Can the effect be masked or countermeasures applied, either to make real effects invisible or to supply spurious positive values elsewhere?

In seeking a universally applicable method, one is also asking for detectable evidence under a conjunction of the most limiting conditions:

1. the lowest test yields;
2. the maximum test emplacement depths; and
3. the maximum distances between sensor and test events.

Table 12.2. Techniques and characteristics of ground-based systems used to detect nuclear explosions in the atmosphere and in space[a]

Techniques	Altitude régime for detection of low-yield burst (km.)	Information obtained	Sensitivity generally expected	Time of sensor response (after speed of light)	Major background problems
Acoustic	0–50	Detection Location Time Other	High	Hours	Meteor, earthquake, volcano, chemical explosion, aurora, tornado, winds
Debris sampling					
Aircraft	0–12	Other	High	5–20 days	Previous tests
Rocket	12–100				
Radio flash (electromagnetic pulse)	0– >10^8	Location Time Other	High	Microsecond to second	Atmospherics (lightning)
Satellite					
X-ray	60– >10^8	Detection Location Time Other	Very high	Microsecond	Solar radiation, trapped particles, cosmic ray showers
Gamma-ray (prompt)	30– 10^5		Medium	Microsecond	
Neutron	30– 10^5		Medium	Second	
Atmospheric fluorescence	<10– 10^6	Detection Time	High	<Millisecond	Lightning
Very low frequency (phase)	50– 10^5	Detection Crude location Time	Medium to low depending on altitude regime	<Second–minute	Ionospheric disturbances, atmospheric noise (sferics)
Low frequency	50– 10^5	Detection Crude location Time	Medium to low depending on altitude regime	<Second–minute	Ionospheric disturbances
High frequency	0– 10^8	Detection Crude location	High to medium depending on altitude regime	Millisecond to minutes	Ionospheric disturbances
Radio sounders	50– 10^6	Detection Time	High to low depending on altitude regime	Millisecond to minutes	Ionospheric disturbances
Cosmic noise (riometer)	70– 10^4	Detection Time	Low	Second	Ionospheric disturbances, man-made interference
Magnetic-telluric	>100– >10^8	Detection Time	High	Second	Ionospheric disturbances, magnetic and auroral disturbances
Debris resonance Scatter of sunlight	100– 10^3	Detection Other	Low	>5 days	Previous tests and natural dust

[a] In the source, the table also includes columns of information on problems of confusing signals; difficulties with site location, geography and system grid pattern; cost per sensor location; other major costs required; and number of sensors required for tests below a few thousand kilometres and in space.

Source: H. Dickinson and P. Tamarkin, "Systems for the Detection and Identification of Nuclear Explosions in the Atmosphere and in Space", *Proceedings of the IEEE*, 53(12): 1921–34, December 1965.

There will be trade-offs in the expectance of cratering, for example, with yield, emplacement depths and terrain.

Evidence which pertains to seismic data but which is not itself seismic in origin is also of considerable importance, such as the detection of an event with an epicentre in a known test site or one occurring (in addition) at a time which does not appear random, for example, on the minute of the hour.

Satellite photography is likely to be far more useful in identifying than in detecting underground nuclear tests, and pre-test preparations by personnel may be the most important indicator, as these are more readily and uniformly observable than post-test consequences. Drilling duration is often long, a test site is complex and identifiable, and the satellite role is greatly facilitated by knowing where to look. Satellites are subsequently also in a much more advantageous position to be prepared for and to see any post-shot consequences that might occur, such as subsidence craters or dust clouds. It is important to point out that evidence obtained by satellites may also be correlated with seismically obtained evidence into a sequence:

1. observation of a known test site;
2. satellite photography of bore-hole drilling and the termination of test preparation;
3. seismic evidence; and
4. satellite photography of any possible test consequences.

Such a sequence probably provides the most certain evidence. It is this conjunction, corroboration and integration of evidence which also makes it highly uncertain that a potential test evader can count on successful evasion simply because the test is held underground. The possibilities of detection, such as changes on the earth's surface, or other reasons for suspecting that an explosion has occurred, are *many* and each has a *varying* probability of occurring and of being detected which is impossible to determine prior to the test by the presumptive evader.[1] Thus testable yields under clandestine conditions would be far lower than permitted even by the margin of safety calculated as necessary to escape detection by any single detection modality. As early as 1963, W.C. Foster, then Director of the US Arms Control and Disarmament Agency, gave some numerical indications, in terms of test yields, of non-seismic test detection capabilities. Referring at that time to a "cheater's threshold" for seismic detection of 3 kt. in al-

[1] The likelihood of avoiding detection will be $(1-p)^n$ where p is the probability of detection with each technique and n is the number of independent techniques in use. Thus with three techniques and a 1 in 5 probability of detection with each, the chance of avoiding detection is $0.8 \times 0.8 \times 0.8 = 0.512$, though in the example discussed here the various detection and identification methods benefit by cross-provision of information, and are not altogether independent.

luvium and 0.3 kt. in tuff, granite or salt, he indicated that even below these levels, detection would be risked by non-seismic means of detection:

Let me discuss first, however, the risk of cheating. Our best scientists cannot conceive of a realistic seismic detection system, however complex and costly, which would not have some threshold below which underground tests could escape detection. However, this threshold cannot be precisely defined. It varies from test site to test site, from station to station, and from day to day. A potential cheater could never know with assurance the exact threshold at which he could be sure of escaping detection from a particular site at all the many stations around the world on a particular day. He would therefore have to assume a lower threshold, if he wants to have some assurance of escaping detection, than those operating the detection system, who want to be sure to detect. Even below this "cheater's threshold", a would-be violator would risk detection by non-seismic means.

With this background, let me quote from a statement of Dr Harold Brown, Director of Defense Research and Engineering and formerly head of the AEC's Livermore Laboratory. He said: "We feel confident of our detection capability for 10 kilotons in dry alluvium. However, the violator would have to work below 3 kilotons in yield in order to feel relatively secure in being undetected by seismic means. These numbers have to be sealed downwards, by a factor of about 10, if the medium of the tests is of harder material—like tuff, granite or salt." [1]

Finally, there always exists some real—though small—risk of detection through unintended leakage to the atmosphere of radioactive products produced in a test.

II. *Statements implying a present role of satellites or of electronic intelligence in underground nuclear test detection and identification*

US Congressional hearings on the topic of a nuclear test ban and the detection of underground nuclear testing have made explicit the existence both of a classified seismic detection capability and of other "national detection systems". [2]

In 1963 Dr Franklin Long, then Assistant Director for Science and Technology, ACDA, testified as follows:

Application of non-seismic information in a nuclear test ban. The particular focus of these hearings has been on the accomplishments of Project Vela. It is not surprising, therefore, that attention has been heavily oriented toward information gained by purely seismological means. It is, however, a perfectly obvious point that information highly relevant to the monitoring of nuclear tests will be obtained from other sources. In fact, our planning would be remiss if it did not take into account the role in a test ban of the large-scale and intensive collection of various other kinds of nonseismic information. When all other types of sensitive informations are integrated, and completely analysed, they are lumped under the collective heading of "National Intelligence". Intelligence capabilities, of course, cannot be predicted with confidence and should not be regarded as a substitute for formal control systems. Nevertheless, any objective discussion of the test ban environment must recognize the strong and pervasive influence of U.S. intelligence on the actions of the other party to the treaty. I would suggest, however, that detailed exploration of this aspect of the problem be done in executive session. [3]

Dr Long did not mention satellites, or any particular sensor, though photoreconnaissance satellites had by then been in operation for some three years. A few months later Franklin Lindsay, President of the ITEK Corporation, one of the organizations producing the relevant instrumentation, was more explicit.

Soon it may even be possible to detect clandestine underground nuclear explosions with satellite cameras that can observe subtle changes in the surface of the ground above the point of detonation. [4]

Earlier in the same year testimony given by the Advanced Research Projects Agency (ARPA) described a remote sensing system pertaining to on-site, post-shot inspection capabilities. It is not apparent why this system could not be made satellite-borne.

Perhaps the most complex inspection technique development within Vela Uniform involving extensive electronics is the spectral reconnaissance system of both airborne and ground data equipments being developed by ITEK Laboratories, Inc. This system concept is based upon the premise that virtually any object or condition at the earth's surface can be made to "sign" itself distinctively in some part of the electromagnetic spectrum. For the Vela Uniform problem, the radiation region of interest is considered to have wavelengths of 4 000 to 50 000 Angstroms, i.e., 0.4 to 5.0 microns. As a consequence, it is necessary to use both films and infrared detectors in the sensory equipment. . . . Of particular interest is the spectral camera coverage from 4 000 to 9 000 Angstroms which is acquired by use of nine matched lenses with different filters that take simultaneous exposures of the same scene. Eight of the exposures represent signatures in eight different parts of the spectrum, while the ninth exposure is a normal full panchromatic photograph. Data reduction techniques capable of taking full advantage of this comprehensive spectral coverage are also new and are diagrammed in figure 11. [5]

Some press reports have explicitly specified another classified means of nuclear test detection: electronic intelligence.

This electronic surveillance center [Bada Beir, Pakistan] along with one in Turkey could monitor Soviet radio traffic. Americans could listen to the countdown of the Soviet space shots in Kazakhstan or the testing of the hydrogen bomb in Central Asia. [6]

The base was established in 1959 when Pakistan was America's staunchest ally in South Asia. It was part of a chain of intelligence listening posts that ringed the Soviet Union, permitting the Americans to monitor radio communications.

Americans at the base were able to listen to the countdown on space shots or nuclear explosions the Soviet Union held in Central Asia. With its highly sophisticated electronic equipment, it could listen in to radio conversations between Soviet tanks, army headquarters, and even fighter planes. [7]

Finally one of the world's most sophisticated American electronic monitoring establishments is situated on Hokkaido. But must we absolutely know each time the commandant of a Soviet or Chinese nuclear proving grounds winds his watch. [8]

Much of the intelligence on Chinese nuclear missile installations in Sinkiang province, to the north of India, comes not from satellites but through electronic eavesdropping from here. [9]

With above-ground nuclear tests it is probably difficult to avoid the use of radio, but radio communications presumably could be coded. With underground tests the direct detonation of the explosion could be performed by cable, but the sacrifice of radio communication would presumably prohibit weather reporting and other ancillary activities which usually precede and follow a nuclear test. Nations now testing may not see the point in incurring significant costs or the loss of aids in testing for the sake of secrecy of communications.

It has sometimes been said that the reference to "all other kinds of intelligence" includes reference to spies and defectors. One rare reference in Congressional testimony may refer to this, though the content of the word "spying" in the reference is somewhat ambiguous.

Dr Ruina: "... Intelligence is intelligence, and I don't think we can speak further about it. ... Whatever capability the United States has need not necessarily be limited to seismic detection. There undoubtedly are other methods, and these come in their natural course, and are not included in Project Vela."

Representative Hosmer: "Like spying?"

Dr Ruina: "Perhaps spying." [10]

A Soviet source that refers to various unspecified detection methods dates from the period when most nuclear tests were conducted above ground: thus this source most likely refers to the kind of ground-based detection methods described on page 439, rather than to detection of underground tests.

It is well known that many methods exist with the aid of which explosions of atomic and hydrogen bombs can be detected at long-range distances. This includes, for instance, the study of seismic oscillations, subsonic waves, and radioactivity of the atmosphere.

The Supreme Soviet should know that we also have at our disposal other even more sensitive means of detecting distant explosions of atomic and hydrogen bombs. [11]

III. *Possible satellite detection of underground nuclear testing*

There are two general categories of events, constructions or artifacts indicative of underground nuclear testing that might be observable by satellite photography. One group precedes the test itself: the drilling of the emplacement hole, test chambers and adjunct instrumentation tunnels, and the general activity and preparations at the test site. The second group is a series of geophysical events which occur with varying delay after the test and which produce effects which may be visible by black and white or infra-red photography, or by radar. Though there are many different things to look for in the second group, there is greater uncertainty as to their visibility by satellite, and the first group—drilling and other preparations—seems the more certain of being observed. The following material is presented as a summary of those events or artifacts which have been discussed and have received attention in this regard in the technical literature. It is a list of possibilities.

In the last two years, photographs of nuclear test sites, drill towers and other equipment have appeared in several open sources. [12–19] The sizes or lengths of towers, cable tracks, cable railings, etc., are well within the requirements for present photoreconnaissance satellite resolution capabilities. Nuclear test holes are lined with steel casings as wide as 10 feet in diameter for their entire length, and the emplacement holes themselves can be over 5 000 feet deep; a pile of such casings adjacent to a drilling site would be quite visible. [12] As with several of the items discussed below, this sort of observation can be integrated into a sequence if it is made on a known test site, and completion of drilling is correlated with a subsequent seismic disturbance. Observing construction of access roads to new sites would also be well within the capabilities of photoreconnaissance satellites.

Resolution of present-day satellite photography is now frequently described as being about 1 foot.[2] [20–23] (This means 1 foot in any dimension

[2] In this section, American units of measurement—i.e., feet, miles and pounds—are used throughout, since these units are given in US sources about devices relating to US nuclear tests and test detection. For readers unfamiliar with these units of measurement, the following conversion factors may be helpful:
1 foot = 0.30 metres
1 mile = 1.61 kilometres
1 pound = 0.45 kilogrammes

and thus an object that was longer but thinner than 1 foot would be observed.) This is remarkably close to the technically feasible limits: several inches for the optical systems and another few inches lost by thermal degradation in the atmosphere through which the optics must function. A recent public description of intelligence technology stated that "cameras in satellites 100 miles high can clearly photograph objects on the ground the size of small cars", but not smaller ones. [24]

There are several consequences of nuclear tests which would also be observable by satellite-borne sensors:

1. *Subsidence craters* [13–15, 19, 25–27, 101]. These occur in hard rock as well as in tuff. [26] Once formed they are subject to long-term observation and cannot be concealed.

2. *Raising of a dust cloud by the formation of the subsidence crater* [13–15, 19]. This is "time-limited"; it would have to be observed at the moment of formation.

3. *Raising of a dust cloud by the test itself.* When the initial shock wave reaches the earth's surface after an underground test, it can produce earth movement and a dust cloud, depending on the test energy and the depth of its emplacement. "As the picture stabilizes, a great curtain of dust, possibly miles wide, rises over the detonation point, then slowly settles." [28] In fact, the breadth of the earth's surface displacement is proportional to the depth of the shot, which may often be over a mile deep.

Data from which one can derive the relationships between a test yield and the amount of energy required by the shock wave to raise a particle from the surface have been published. [29, 30] Films which portray tests often show a cloud of dust rising subsequent to an earth heave, and the US Plowshare test Rulison, a 40 kt. shot in shale, in a hole 8 700 feet deep with the device emplaced at 8 443 feet, was reported to have raised "clouds of dust". [31, 32] It is thus possible to photograph the dust cloud directly. This method is also time-limited, and would be obscured by cloud cover. In addition, the dust cloud raised by a nuclear test contains mercury, and this has been monitored by airborne instrumentation after an underground test in experiments performed for the US AEC in the Dribble series and in the Shoal and Salmon tests. [46] It is not clear whether the instrument used, an airborne Mercury Spectrometer, would be sensitive enough to detect mercury in the air that might be raised by such a cloud and cross national borders at high altitudes after a test.

4. *Radar.* If the wave-length of an electromagnetic wave (infra-red or radar) is greater than the average "particle" size on a ground surface, there is very little diffuse reflection and the surface will appear black on the sensor (radar) screen. By using different wave-lengths one can determine particle

size. (For example, the Cornell Arecibo radio-telescope (radar) and the similar facility at Jicamarca, Peru reportedly determined the distribution of particle sizes on the surface of the moon. One report indicates that the roughness of the lunar surface, on the scale of a metre, was deduced.) [33] However, radar resolution of the particles—sand, small rocks, etc.—is not necessary in order to obtain the kind of information, reflectivity, that is relevant here. Following an underground nuclear test, the surface of the earth is displaced and a dust cloud is often raised. "Another major close-in effect was fluffing of the soil by strong vertical accelerations near ground zero so as to create a flour-sifter effect in the surface material." [34] It is likely that the average roughness in such a region would be increased, thus increasing the brightness of the radar reflection in the same area. Even small changes in ground texture should show up. The ground may be as flat after as before, the only difference being a change in roughness.

There is sufficient evidence to make clear that radar is carried by satellites. Manned and unmanned space vehicles have used radar for guidance in approaching, docking and landing on surfaces. A proposed US Navy satellite system was reported as "probably [carrying] a phased-array radar[3] to give it an all weather capability". [35] Some meteorological satellites carry radar. Electronic intelligence ("ferret") satellites reportedly carry radar. [24] The use of airborne side-scan radar[4] at high altitudes has been reported in the technical literature; however, there is no available information as to whether side-scan radar is satellite-borne as well, though this also has been recently implied by reference to satellite-borne radar "to peer through cloud cover". [24] Another popular article on the US space reconnaissance programme stated: "Ultramodern versions of World War II radar, circling in outer space, now penetrate cloud covers and forest vegetation to reveal objects such as hidden missile sites, tanks and even troops." [23] The claims of resolution and discrimination here are not the point, solely the indication of a satellite-borne radar *per se*. In 1963 General Dynamics/Convair suggested a "high resolution ground mapping satellite radar". It was stated that five radar-carrying satellites symmetrically spaced 12 miles apart would be able to supply pictures with a ground resolution of 10 feet, which was "at least three times the resolution believed possible with a single radar-mapping satellite". [36] Finally, radar is one of the sensors that have been suggested for an earth resources satellite programme.

[3] "Phased-array radar" is a radar which is steered electronically rather than mechanically.
[4] "Side-scan radar" is a radar which "looks", or scans, to each side, producing a panoramic photograph.

[37] It has also become possible to identify particular minerals (rocks) by various remote sensors. [38–43]

5. The shock wave of a nuclear explosion often kills grass or other ground plants on the earth's surface above the test site.

There has been speculation that a shock wave can produce effects more easily detectable outside the visible light range. Agronomists have used infrared photography to detect plant disease at an early stage, studying the change in reflectance that results from a change in the water content of the plants. It has been suggested that shock-induced changes in plant root hairs and soil water conditions and soil density might likewise change the infrared reflectance. [44]

Another review considered this technique not very promising. [34] The effect sometimes occurs, but sometimes does not. A single test is sufficient to produce the effect. Yield and depth relationships of the effect are unreported—since the strength of the shock wave decreases with the cube of the distance—nor are the relationships to different vegetation types or geological environments known. However, much information developed in the presently very active civil research programmes on infra-red remote sensing applications in agriculture and in geological exploration would be relevant here.

6. Aerial archeology has demonstrated that construction or agricultural activity of thousands of years past produces exceedingly long-term changes in the earth's surface and in vegetational growth that are clearly visible from the air. These changes (soil marks and crop or vegetation marks) are dependent on alterations of drainage, soil density and other surface soil parameters affecting the growth of plants. [45] "Vegetation growth differentials are revealed by either the colour or physical form—usually both—of the plant cover", which in turn may be amenable to infra-red detection. Deuel writes that photography has demonstrated

. . . that virtually any disturbance of the soil wrought by human agency is well-nigh indestructible. Like the inevitable bloodstain in whodunits, it will leave its mark in some way or another. Have your ancestors of two thousand years ago bore a hole to erect a wooden pole or dig a pit into which to dump refuse, let men and the ravages of time fill it and pack it, let it be overgrown by weeds or make the plough run over it for generations, the soil in the cavity will never be the same again as the surrounding undisturbed area. Pithily it has been said that there is nothing so permanent as a hole in the ground. [45]

It is not known whether similar effects are caused by deeper earth events such as underground nuclear tests, which might produce a packing effect on the earth above the shot through which the shock wave passes, and if so, how much time must pass before the secondary effects on vegetational growth might become visible from the air.

7. A project is being initiated to test a technique which could lead to a satellite-borne sensing element for the nitrogen dioxide produced after an underground test. Radiation produced by the test is expected to cause enough ionization to produce nitrogen dioxide in the atmosphere, which would be measured by "a remote sensing correlation spectrometer". A satellite-borne sensing element would be able to detect the nitrogen dioxide.[5] [46]

The two sections which follow, on the capabilities of the Vela satellite system and on ground-based methods for the detection of nuclear weapons tests in the atmosphere and in space, summarize publicly available information in these areas. However, there is no indication that any of these methods have so far found application in the detection or identification of underground nuclear weapons tests.

IV. *The capabilities of the Vela satellite system*

Excellent reviews in the professional literature describe the Vela satellite programme. [47–67] The proposal for the programme was established in 1958 and the programme substantially begun in 1961. Before the first pair of Vela satellites was launched, preliminary experiments to aid in designing the sensor instrumentation were carried by some of the Discoverer and Ranger satellites, by sounding rockets, and on balloon-borne packages that reached altitudes of up to 120 000 feet.

This programme was first called "Vela Hotel", and with the signing of the Partial Test Ban Treaty in 1963 it became (with Vela Sierra and Vela Uniform) one of the three Vela programmes established by the United States to support the treaty "safeguards", though the "requirement" and the project had been conceived long before a treaty was signed. The first pair of satellites was launched one month after the signing of the treaty. The satellites are now referred to as Nuclear Detection Satellites (NDS) and officially, Project 823 (USAF) and Project 638. The programme has been considered highly successful. No tests in contravention of the treaty have ever been detected.

The Vela satellite programme is a joint activity of the US Department of Defense and the US Atomic Energy Commission. Various agencies and contractors of the two agencies manage the programme, design instrumen-

[5] It has been suggested, however, that if a nuclear explosion occurs so close to the surface of the earth that the radiation from the explosion produces sufficient amounts of nitrogen dioxide in the atmosphere for detection, then other detection methods will work even better.

tation and launch the vehicles. Though all the satellites have performed successfully far beyond their expected lifetimes (18 months for the latter pairs of satellites), the programme and the satellites are officially constantly referred to as "an interim operation capability", a "research and development effort", and a "feasibility programme", implying a successor system. The objectives of the programme are described as the estimation of costs and the capabilities of alternate detection systems.

The Vela Satellite Program ... was designed primarily to evaluate the feasibility of using X-ray, gamma-ray, and neutron detectors in orbital satellites. The research and development effort has been directed toward accumulating a maximum of experimental data and gaining the broadest possible understanding of basic theoretical and physical principles related to the detection of nuclear explosions in space. [51]

The primary objective of the Vela Satellite Program, sponsored by the Advanced Research Project Agency (ARPA), is to conduct space-based studies to verify the feasibility of X-ray, gamma-ray, and neutron detection applications in far-earth radiation detection systems intended to detect and identify high-altitude radiation phenomena. ...

The design and operation of the spacecraft has been so successful that not only has the basic mission been accomplished but also an interim space-based nuclear detection capability has been realized. [52]

The payload on the currently orbiting Vela satellites represents a first attempt at developing a system that can detect detonations at distances up to two astronomical units[6] and which is relatively free of interfering effects from the natural environment. Identification of a nuclear detonation is made by sensing the X-ray, gamma-ray, and neutron signals from the explosion, and requiring high-order coincidences among the X- and gamma-ray detectors, as well as supporting information from other spacecraft instruments and other Vela spacecraft. Since the detection instruments themselves are poor indicators of the characteristics of background radiation, some of the satellites carry instruments which are specifically designed to investigate the background. [49]

The six pairs of satellites were launched in October 1963, July 1964, July 1965, April 1967, May 1969 and April 1970.

The spacecraft are launched in pairs to avoid registering a false alarm due to a cosmic-ray shower hitting one of them. An almost circular far-earth orbit was selected for the satellite locations to place them beyond the trapped particles in the Van Allen belt. The pairs of spacecraft are in orbit between 60 000 and 70 000 miles from the earth[7] and on opposite sides of it separated by between 150 and 180 degrees. Each successive pair of satel-

[6] A single astronomical unit is the distance from the earth to Venus or from the earth to the sun. It implies interplanetary distances.

[7] For reference, the moon is 240 000 miles from the earth.

lites was said to have carried improved instrumentation. The first three pairs weighed 320 lbs. each, and subsequent pairs 520 and 730 lbs. The more spacecraft there are, the lower the minimum altitude at which a test can be detected. In addition to the Velas themselves, a large number of smaller subsidiary satellites have also been part of the programme. Though these OV, ORS and ERS "scientific satellites" are not intended to detect a nuclear explosion, they are often launched by the same booster which places the Velas in orbit, and their function is to study background solar or Van Allen belt radiation at particular altitudes, thus enhancing the discrimination capability of the Vela satellites.

The primary instrumentation on the Vela satellites are neutron, gamma-ray and X-ray detectors. The last three satellites also contain direct optical and EMP sensors. These last three pairs of satellites are also constantly earth oriented, i.e., one face of the satellite permanently faces the earth. The earth orientation aids in the recording of optical and electromagnetic radiations (EMP) from nuclear detonations that might be conducted below the satellites in the earth's near atmosphere, rather than in deep space. With improvements in instrumentation the space-detection capability of the satellites is stated to have gone from 100 000 000 miles in the first pair to 200 000 000 miles by the third pair, beyond the orbits of Mars and Venus, though this would depend on the yield and design of an exploded device. The satellites contain extensively redundant sensors; for example, the very first satellite was to carry ten X-ray counters, six gamma-ray detectors and two or more neutron counters, plus ten "guard" counters to distinguish cosmic rays and other background radiation. The third and successive pairs of Velas carried twenty-eight detectors of nineteen types. Twenty types of instrument assemblies with more than 100 sensors have been designed, developed and tested for the satellites. Because transmission of raw data from all the detectors would produce a very heavy telemetry requirement, an on-board decision-making and data-processing system (a logics system) was designed, and the satellites also carry data-processing electronics and telemetry for communicating their gathered data to a "world wide network of Air Force ground stations", the US Air Force Satellite Control Facility. Data accumulation is enormous: it comprised 1 500 reels, each 7 200 feet long, from the first four satellites only by 1965. The satellites can be operated in real time as well as by data storage. These modes were designed within the capabilities of the existing Air Force satellite tracking network as of 1965. [51]

Of most interest here is the downward-looking capability of the present Vela satellites and the description of their "mission". If a nuclear detonation occurs in the lower atmosphere, little or no primary radiation will escape from the atmosphere. However, the explosion creates a fireball and an electromagnetic pulse (EMP) signal which may be detected by satellite-borne optical and EMP detectors. These systems may extend a satellite's capability to detect nuclear explosions to the surface of the earth. With the addition of these two types of sensors to the fourth, fifth and sixth pairs of Vela satellites, the descriptions of the satellite role changed from simply test detection in the upper atmosphere and deep space to include "surveillance of tests in the earth's atmosphere", to "development of a satellite-based nuclear detection capability for events occurring on the earth's surface to the outre reaches of deep space...". [65] Finally:

> Major refinements and the overall success of the NDS program thus far seem to indicate the space-borne Vela program will assume an expanded role of detecting nuclear blasts on the earth's surface and underground; both missions now come under the Vela Uniform effort. Supporting such a possibility is the fact that the Air Force is studying a nuclear detection satellite system involving orbital mechanics, tracking systems, space and ground-based communications, data processing and alpha-numeric displays. Meanwhile, primary emphasis on NDS in the future will deal with developing sophisticated optical and electromagnetic pulse systems.
>
> ... [The] principal mission of the fifth launch will be to further extend the capability developed following the fourth launch of Velas of looking deeper into the atmosphere with earth-oriented optics. The fifth pair of Velas will augment the earlier capability by providing improved optics and more reliable orientation. [66]

Efforts in the Vela satellite programme in its later phases were clearly concentrated on near-earth capabilities. Moreover, the successor to Vela is indicated to be the Integrated Satellite (Program 949), which would comprise technology from present Vela "Samos" type (photoreconnaissance) and "Midas" type (early warning) satellites. [66] Nevertheless, photographic or infra-red sensors for nuclear test detection or identification are apparently not now carried on Vela satellites; such information would have to be obtained from general photoreconnaissance satellites.

There are some data on the cost of the Vela satellite programme, though the data available seem somewhat contradictory. Tables 12.3 and 12.4, which provide data over long time-periods, indicate discrepancies in reported funds spent on the Vela satellite programme. The fiscal year 1965 budget was reported to contain $61 million for the Vela Hotel Satellite programme. [64] In fiscal year 1969 the US Department of Defense was reported to be requesting only $10.5 million for the programme. [60]

An interesting question is whether the Soviet Union has a programme analogous to that of the US Vela satellites. The kinds of sensor carried by Vela satellites can be assumed to be both basic and easily identifiable.

Table 12.3. Project Vela funding

US $ thousand, fiscal years

	1960–63	1964	1965	1966	1967	1968	1969	1970	1971
Space									
Satellite	50 065	26 623	21 806	18 559	14 181	15 455	5 335	2 420	0
Atmosphere									
Radio, optical, acoustic	10 114	3 951	4 372	4 707	5 323	2 074	1 526	1 225	361
Total Vela funding[a]	**146 620**	**52 257**	**67 428**	**49 953**	**47 561**	**34 968**	**23 118**	**21 838**	**10 129**

[a] Also includes the cost of Project Vela Uniform (underground test detection) and research in on-site inspection methodology.

Source: Status of Current Technology to Identify Seismic Events as Natural or Man-Made, hearings before the Subcommittee on Research, Development, and Radiation, Joint Committee on Atomic Energy, 92nd Congress, 1st session (Washington, 27 and 28 October 1971), p. 19.

Through the publication of scientific data on the space environment, the USSR often indicates the instrumental payload on some of its Kosmos vehicles, and such instrumentation may at times be directly identified. [68] The USSR is also concerned with the effects of solar flares on the functioning of other of its satellites and on its manned space programmes. In short, the Soviet Union certainly may be assumed to have the general capability of putting Vela-type instrumentation into space.

There is only inferential data, however, on whether or not it has done so. Some of it suggests that the Soviet Union does not have such operational satellites. In a definitive US summation of US and Soviet space payloads, the US Vela satellites are listed under the category of "Military Support" satellites for the USA and identified by name with the other types of satellites in this category. [69] In another comparison of US and Soviet payloads, which indicates separate categories for such military satellites as "Navigation/Ferret" and "Observation", the category "Miscellaneous Military" indicates only five satellites for the USSR (while there are 218 entered for the USA). There is a separate category of "Geocentric Science" with fifty-two Soviet satellites. However, since US Velas were placed in the category "Military Support" in the first comparison, one should expect any Soviet Vela-type satellite to have been placed in the "Miscellaneous Military" group in the second comparison. A more recent publication by the same author corroborates this view. It provides a more detailed breakdown by category of US and Soviet space satellites. The category that presumably includes Vela-type satellites, "Military Synchronous or Higher Orbit", lists seventeen for the USA and none for the USSR. [70] On the other hand,

Table 12.4. Cost of research, development, testing and evaluation for the Vela satellite programme, 1965–1970

US $ mn, fiscal years

	1965–67	1968	1969	1970
R.D.T. and E.	171.9	44.8	40.0	93.9[a]

[a] Includes Atomic Energy Detection System (AEDS) budget request. Total for both programmes compares with $94.3 million for FY 1969. (This implies around $50 million for Vela satellites and implies that the satellite effort *without* a known photographic component is costing the same as or more than the seismic detection effort.)

Source: "Nuclear Detection Satellite", *Defense Market Intelligence Report,* May 1969.

evidence which suggests that the Soviet Union does have a Vela-like capability is indicated by Soviet reports that at least one of the Kosmos flights measured results of US high-altitude nuclear tests. Kosmos 159 flew a suitably high orbit.

V. *Ground-based methods for detecting atmospheric and very high-altitude nuclear tests*

As with the Vela satellites, excellent technical reviews exist concerning ground-based methods for the detection of atmospheric and high-altitude nuclear tests. [48, 71–100] Some ten ground-based methods are listed in table 12.2. Short comments are included here to describe several of these methods, all of which pertain to the period before nuclear testing went underground. Some of the methods are best suited to explosions taking place within the earth's magnetic field, which produce artificial aurora and other associated effects, and others are more suitable for the detection of explosions which take place outside the earth's magnetic field. [48, 71–73] These may be the detection of direct optical or EMP signals, or the indirect effects resulting from alterations in ionospheric characteristics.

At the time of the 1958 Geneva discussions on the discontinuance of nuclear testing, it was recognized that acoustic techniques for detecting nuclear bursts occurring low in the atmosphere were generally well-developed. This acoustic detection provided guidance for subsequent aircraft flights to collect samples of debris which then could be analysed by radio-chemical techniques to provide conclusive evidence of the occurrence of the test, as well as to provide other information on weapon design. Acoustic or electromagnetic signals and other means of remote but rapid detection provided information on the following items about the suspected atmospheric nuclear tests:

1. the time of explosion: to better than an hour;
2. the location of the explosion: within a circle of 100 miles or so radius; and
3. the approximate yield and height of burst so that approximate altitude ranges for the cloud's presence could be estimated.

A survey of the experience of the USA as of 1958 was given to the Conference of Experts at Geneva. The results of a considerable aircraft sampling experience with over 100 nuclear clouds, some in the 1 to 10 kt. range as well as many with greater than 10 kt. yield, were highly successful in collecting debris. The experts pointed out the marked superiority of aircraft operations as opposed to fixed surface stations, particularly for very low fission yield detonations. The United States was able to sample all but one of the 100 nuclear clouds which they desired to intercept. On the other hand, there were formidable problems associated with clouds beyond the aircraft sampling ceiling. [74, 75]

Microbarograph arrays are ground-based sensors which respond to atmospheric pressure variations resulting from nuclear explosions. The signal must be distinguished on the basis of its pattern, velocity and frequency structure. [76, 77]

Fluorescent light induced in the upper atmosphere by the absorption of X-rays produced by a nuclear explosion can be detected. [71, 72, 78–80] The light is produced by a nitrogen molecule when it absorbs radiation. This is described as being a major technique in the Vela Sierra programme, the US ground-based system for detection of nuclear explosions in space. [81, 82]

Photometers "detect the presence of nuclear debris from high-altitude nuclear explosions by observing scattering of sunlight from debris and identifying spectral lines of trace amounts of debris elements". [83, 84, 72]

A high-altitude nuclear explosion produces disturbances in the ionosphere. These disturbances, motion in the ionosphere and changes in electron density in turn produce measurable effects, for example, the frequency below which a very low-frequency radio signal will be reflected from or will pass through the ionosphere. [85–94, 71–73] The phase and amplitude of radio waves propagating through or near a disturbed area are altered. High-frequency radio waves (3 to 30 megacycles per second) propagating through regions of enhanced ionization experience attenuation and Doppler frequency shifts. Waves of lower frequencies, particularly at VLF (3 to 30 kilocycles per second), may experience a phase shift resulting from a reduction in the effective height of reflection. Increased ionospheric ionization also results in greater absorption of cosmic radio noise, measured by an instrument called a riometer. [100]

A high-altitude nuclear explosion also produces magnetic effects [95, 96] and induces electric currents in the ground. [72, 97, 98] "During the first two seconds after a high-altitude nuclear detonation, two distinct signals are detected at stations all over the world." These are called the "prompt" and the "second" signal. The prompt signal is generated directly by the detonations. The second signal is generated indirectly by magneto-hydrodynamic interaction between the bomb debris and the ionosphere. (There should be some magnetic field changes also produced by an underground detonation.) The intense electron clouds caused by outer space explosions result in a violent disturbance of the earth's magnetic field. The electric disturbances can be detected at great ranges by using earth current or telluric equipment (the insertion of two electrodes into the ground), and the magnetic fluctuations by the use of magnetometers. The US Argus high-altitude explosions in 1958 gave rise to electric and magnetic field fluctuations which were detected at several widely separated international geophysical year stations in Antarctica, Africa, the Soviet Union and Europe. [72]

References

1. *Military Aspects and Implications of Nuclear Test Ban Proposals and Related Matters,* hearings before the Preparedness Investigating Subcommittee of the Committee on Armed Services, Part 1, US Senate, 88th Congress, 1st session, May, June and August 1963, p. 11.
2. *Ibid.*, pp. 84–85, 98–99, 103, 105, 107.
3. *Developments in Technical Capabilities for Detecting and Identifying Nuclear Weapons Tests,* hearings before the Joint Committee on Atomic Energy, 88th Congress, 1st session, March 1963, p. 403.
4. Lindsay, F. A., "Our Gamble in Space, the Costs and the Choices", *Atlantic,* 212 (2), August 1963, p. 52.
5. Bates, C. C., in *Developments in Technical Capabilities for Detecting and Identifying Nuclear Weapons Tests, op. cit.,* p. 202. See also Bates, C. C. and George, T. F., "On Site Inspection for Underground Nuclear Tests, Proceedings of the International Symposium on Space Phenomena and Measurement", *IEEE Transaction on Nuclear Science,* NS-10, No. 1, January 1963, pp. 308–309.
6. Weatherall, E., "Bada Beir Exit Ends U.S. 'Spy' Era", *Christian Science Monitor,* 14 January 1970.
7. Weatherall, E., "Pakistan Orders Closure of U.S. Listening Post", *Christian Science Monitor,* 28 May 1968.
8. Elegant, R. S., "U.S. Military Role in Japan Unique", *Japan Times,* 10 February 1970.
9. Coughlin, W. J., "Shifted from Pakistan in 1968, U.S. Spy Base in India Eyes China Atom, Missile Activities", *International Herald Tribune,* 26–27 June 1971.

10. *Developments in Technical Capabilities for Detecting and Identifying Nuclear Weapons Tests, op. cit.*, p. 59.
11. Kurchatov, I., *Pravda,* 1 April 1958 (quoted in Kramish, A., *Atomic Energy in The Soviet Union,* Stanford University Press, 1959, p. 140).
12. US Atomic Energy Commission, "Underground Nuclear Testing", TID 25180, September 1969, pp. 42–43.
13. Hemmendinger, A., "Neutrons from Nuclear Explosions", *American Scientist* 58 (6): 624–25, November–December 1970.
14. *Newsweek,* 15 December 1969, p. 69.
15. *Newsweek,* 4 January 1971, p. 33.
16. *New York Sunday Times Magazine,* 27 July 1969, pp. 6–7.
17. *Annual Report to the Congress of the Atomic Energy Commission for 1967,* January 1968, p. 59.
18. "Earthquakes and Nuclear Tests: Playing the Odds on Amchitka", *Science* 165 (3895), 22 August 1969, p. 774.
19. Lyons, R. D., "Cannikin, Is This Test Really Necessary", *New York Times,* 12 September 1971.
20. Bylinsky, G., "From a High Flying Technology a Fresh View of Earth: Remote Sensors in Planes and Satellites are Bringing a Big New Market into Focus", *Fortune,* 77 (6): 100–103, 144–148, 4 June 1968.
21. Stone, J. J., "Can the Communists Deceive U.S.?" in *ABM, An Evaluation of the Decision to Deploy an Antiballistic Missile System,* A. Chayes and J. B. Wiesner, eds. (Signet, 1969), pp. 193–198.
22. Crangel, R. D., *The New Methodology of National Intelligence* (Cambridge, Mass.: Harvard University, Dept. of Government, May 1969), pp. 35, 63, 66.
23. "Spies in Space; They Make An Open Book of Russia", *U.S. News and World Report,* 9 September 1968, pp. 69–72.
24. "The Beep, Blink and Thrum of Spy Gadgetry", *Newsweek,* 22 November 1971, p. 34.
25. Houser, F. N., "Subsidence Related to Underground Nuclear Explosions, Nevada Test Site", *Bulletin of the Seismological Society of America,* 59 (6): 2231–51, December 1969.
26. O'Toole, T., "Lower Megaton Tests Hinted in AEC Environment Report", *International Herald Tribune,* 20 May 1971.
27. *Scientific American,* 215 (1): 19, July 1966.
28. Hill, G., "About 355 of 'Those Things' Have Exploded in Nevada", *New York Sunday Times Magazine,* 27 July 1969.
29. Environmental Research Corporation, "Buggy, Analysis of Ground Motion", PNE-326, 12 December 1969.
30. US Atomic Energy Commission, "Ground Motion", Chapter 9 in *A Report; Underground Nuclear Testing,* NVO-40; Rev. No. 2, September 1969, pp. 99–116.
31. *Newsweek,* 22 September 1969.
32. Ripley, A., "A Nuclear Device Fired in Colorado", *New York Times,* 11 September 1969, p. 28.
33. *Research Report RS 71,* Arecibo Ionospheric Observatory, Cornell University, Center for Radiophysics and Space Research, 31 July 1967, p. 77, and RS 72, 31 January 1969, pp. 86–87.

34. Bates, C. C. and George, T. F., "On Site Inspection for Underground Nuclear Tests, Proceedings of the International Symposium on Space Phenomena and Measurement", *IEEE Transactions on Nuclear Science,* NS-10, No. 1, January 1963, p. 308.
35. "Navy Plans Ocean Surveillance Satellite", *Aviation Week and Space Technology,* 95 (9): 13, 30 August 1971.
36. *Air Force Magazine,* January 1963, p. 79.
37. "Sensors Pose Earth Satellite Challenge", *Aviation Week and Space Technology,* 92 (25), 22 June 1970.
38. US Office of Aerospace Research Progress, "New Concept in Remote Sensing", 1968, pp. 103–104.
39. Salisbury, J. W. and Hunt, G. R., "Compositional Implications of the Spectral Behaviour of the Martian Surface", *Nature,* 222 (5189), 12 April 1969.
40. Gowen, R. C., "Apollo 15 to Map Chemicals", *Christian Science Monitor,* 4 June 1971.
41. Lyon, R. J. P., *Minerals in the Infrared, A Critical Bibliography* (Stanford Research Institute, 1962).
42. Vincent, R. K. and Thomsen, F. V., "Discrimination of Basic Silicate Rocks by Recognition Maps Processed from Aerial Infrared Data", Seventh International Symposium on Remote Sensing of Environment, 17–21 May 1971.
43. Lintz, J. and Brenna, P. A., "Remote Sensing of Some Sedimentary Rocks", Seventh International Symposium on Remote Sensing of Environment, 17–21 May 1971.
44. Westphal, W. H. and Rubin, S., "Techniques of On-Site Inspection", *Geophysics,* 29 (2): 253, April 1964.
45. Deuel, L., *Flights into Yesterday* (New York, 1969), pp. 44–56.
46. Novick, S., Private communication, 20 May 1971.
47. Taschek, R. F., "Satellite-Based Detection of Nuclear Detonations in Space", *IEEE Transactions on Nuclear Science,* NS-10, No. 1, January 1963, pp. 230–235.
48. Dickinson, H. and Tamarkin, P., "Systems for the Detection and Identification of Nuclear Explosions in the Atmosphere and in Space", *Proceedings of the IEEE,* 53 (12): 1921–34, December 1965.
49. Singer, S., "The Vela Satellite Program for Detection of High-Altitude Nuclear Detonations", *ibid.,* pp. 1935–48.
50. Glore, V. P. and Aiello, W. P., "Vela Satellite System Detector Electronics," *ibid.,* pp. 1949–58.
51. Goldrick, W. B. *et al.,* "A Modular System of Logic for the Vela Satellite Program", *ibid.,* pp. 1959–68.
52. Noneman, E. M. and Maxey, T. J., "Redundancy Design for the Vela Spacecraft", *ibid.,* pp. 1969–80.
53. Lukasik, S. J. and Scholz, L. L., "Computer Simulation of Satellite Systems", *ibid.,* pp. 1981–88.
54. Modesitt, G. E., "Statistical Analysis of Spacecraft Replenishment", *ibid.,* pp. 1989–93.

55. Stambler, I., "Vela Hotel Satellites", *Space/Aeronautics*, 37 (6): 54–56, June 1962.
56. *TRW Space Log:* December 1963, pp. 26–27; Winter 1965–66, pp. 30–32; Summer 1967, pp. 38–41; Summer-Fall 1969, 9 (2): 60–64.
57. "Third NDS Pair Launched", *Missiles and Rockets*, 26 July 1965, pp. 29–31.
58. Hunter, G. S., "USAF to Orbit 2 Advanced Velas in April", *Aviation Week and Space Technology*, 36 (6): 271–73, 13 February 1967.
59. USAEC, *Major Activities of the Atomic Energy Program* (USAEC annual report: 1963, p. 8; 1964, pp. 76–78; 1967, pp. 65–66; 1970, p. 140).
60. US NASA, *Astronautics and Aeronautics* (NASA annual chronology) (a) 1967 volume: entries for 28 April, 1 May, 12 May, 16 November; (b) 1968 volume: entry for 23 April.
61. Taschek, R. F., "Space Based Detection of Radiations from Nuclear Detonations", *The Physics Teacher*, November 1969.
62. "The Vela Series", *Interavia*, 23 (11) 1968, p. 1406.
63. "Nuclear Detection Satellite; (Vela and Advanced Vela)", *Jane's All the World's Aircraft*, 1968–69, p. 575; 1969–70, p. 649.
64. *Aviation Week and Space Technology*, 80 (11): 112, 16 March 1964.
65. "Message from the President of the United States", *U.S. Aeronautics and Space Activities*, 31 January 1967, pp. 57, 79–80.
66. "Nuclear Detection Satellite", *Defense Market Intelligence Report*, May 1969.
67. *Department of Defense Appropriations for 1968*, hearings before a Subcommittee of the Committee on Appropriations, Part 3, R.D.T. and E., 90th Congress, 1st session, 1967, pp. 155–56.
68. Kurnosova, L. J., "Short-Lived Intensity Increase of the Nuclear Component of Cosmic Rays as a Result of Solar Activity", *ARS Journal*, Russian Supplement, 32 (5), May 1962, pp. 831–35. (This source is included solely as an example.)
69. *Review of the Soviet Space Program*, Report of the Committee on Science and Astronautics, US House of Representatives, 90th Congress, 1st session, 1967, pp. 34–35.
70. Sheldon, II., C. S., *United States and Soviet Progress in Space: Some New Contrasts*, QB 1 CGen., 71–25 SP, Congressional Research Service, July 1971, p. 41.
71. Pearse, C. A., "Ground Based High Altitude Detection Systems", *IEEE Transactions on Nuclear Science*, NS-10 (1), January 1963, pp. 236–41.
72. Abercrombie, S. D., "Ground Based Detection of Atomic Weapons", *IEEE Transactions, ibid.*, pp. 254–72.
73. Jean, A. G. *et al.*, "Techniques for Detection of High Altitude Nuclear Explosions", *Proceedings of the IEEE*, 53 (12): 2088–98, December 1965.
74. Machta, L., "Detection of Debris from Atmospheric Tests", *IEEE Transactions, op. cit.*, pp. 273–78.
75. Kalkstein, M. I., "Test Detection by Nuclear Chemistry", *IEEE Transactions, op. cit.*, pp. 279–84.
76. Donn, W. L. *et al.*, "The Microbarographic Detection of Nuclear Explosions", *IEEE Transactions, op. cit.*, pp. 285–96.

77. Varghese, T. G. and Kumar, V., "Detection and Location of an Atmospheric Nuclear Explosion by Microbarograph Arrays", *Nature,* 225, 17 January 1970, pp. 259–61.
78. Westervelt, D. R. and Hoerlin, H., "Los Alamos Air Flourescence Detection System", *Proceedings of the IEEE, op. cit.,* pp. 2067–71.
79. Donahue, T. M., "Detection of High-Altitude Explosions by Observation of Air Flourescence", *Proceedings of the IEEE, op. cit.,* pp. 2072–78.
80. "Sneak Blast Detector set up at Los Alamos", *Missiles and Rockets,* 8 (4), 23 January 1961.
81. US Atomic Energy Commission, *Major Activities of the Atomic Energy Program,* 1961, pp. 166–67.
82. US Atomic Energy Commission, *Major Activities of the Atomic Energy Program,* 1967, p. 66.
83. "Photometers Detect Nuclear Debris", *Aviation Week and Space Technology,* 77 (21), 19 November 1962.
84. Cunningham, S. P. and Murray, B. C., "Ground Based Optical Detection of Deep Space Nuclear Detonations", *Proceedings of the IEEE, op. cit.,* pp. 2058–66.
85. Jean, A. G. and Crombie, D. D., "Detection of High Altitude Nuclear Detonations Using the VLF Phase Shift Technique", *IEEE Transactions, op. cit.,* pp. 242–53.
86. Pierce, E. T., "Nuclear Explosion Phenomena and Their Bearing on Radio Detection of the Explosions", *Proceedings of the IEEE, op. cit.,* pp. 1994–2008.
87. Field, E. C. and Engel, R. D., "Detection of Daytime Nuclear Bursts below 150 Km by Prompt VLF Phase Anomalies", *Proceedings of the IEEE, op. cit.,* pp. 2009–17.
88. Chilton, C. J. *et al.,* "A Comparison between Solar X-ray Emission and VLF Sudden Phase Anomalies", *Proceedings of the IEEE, op. cit.,* pp. 2018–26.
89. Crombie, D. D., "On the Use of VLF Measurements for Obtaining Information on Lower Ionosphere", *Proceedings of the IEEE, op. cit.,* pp. 2027–34.
90. Sollfrey, W., "Effects of Propagation on High Frequency Electromagnetic Radiation from Low Altitude Nuclear Explosions", *Proceedings of the IEEE op. cit.,* pp. 2035–42.
91. Wickersham, A. F., "Identification of Acoustic and Gravity Wave Modes Associated with Travelling Ionospheric Disturbances Caused by Nuclear Explosions", *Nature,* 218 (5137), 13 April 1968.
92. "Nuclear-Ionospheric Waves; Upper Atmosphere Physics Laboratory, AFCRL", *OAR Research Review,* 6 (2), February 1967.
93. Buckmaster, H. A. and Skirrow, J. D., "V.L.F. Phase Anomaly Induced by a Nuclear Explosion", *Nature,* 218 (5137): 155–56, 13 April 1968.
94. "Nuclear Detection Method", *Aviation Week and Space Technology,* 76 (3), March 1962.
95. "Magnetic Events Occurring within Two Seconds after Nuclear Detonation; Upper Atmosphere Physics Laboratory, AFCRL", *Office of Aerospace Research* (OAR), *Research Review,* 6 (6), June 1967, pp. 16–17.

96. Johler, J. R. and Morgenstern, J. C., "Propagation of Ground Wave Electromagnetic Signal with Particular Reference to a Pulse of Nuclear Origin", *Proceedings of the IEEE, op. cit.*, pp. 2043–52.
97. University of Alaska Telluric Current Project, Contract AF 19 (604) 6180, 1962.
98. "High Altitude Nuclear Explosion Detected with Simple Equipment", *Naval Research Reviews,* 15 (9), September 1962, pp. 23–25.
99. Meecham, W. C., "Simplified Normal Mode Treatment of Long-Period Acoustic-Gravity Waves in the Atmosphere", *Proceedings of the IEEE, op. cit.*, pp. 2079–87.
100. Potts, B. C., "Utilization of Riometers for the Detection of Nuclear Explosions in Space", *Proceedings of the IEEE, op. cit.*, pp. 2053–57.
101. Springer, D. L. and Kinnaman, R. L., "Seismic Source Summary for U.S. Underground Nuclear Explosions, 1961–70", *Bulletin of the Seismological Society of America,* 61 (4), August 1971, pp. 1095–96.
102. O'Toole, T., "Cannikin; The Last of the Big Blasts", *Washington Post,* 31 October 1971.

13. Nuclear weapon testing programmes, 1945–1970

This chapter brings up to date the examination of the nuclear weapon testing programmes of the five nuclear powers, as of 31 December 1970. During 1970, the USA, the USSR, France and China conducted 49 reported nuclear tests. There is also a discussion of the Soviet Union's nuclear testing programme for civil purposes.[1] *An extensive discussion of the political and military aspects of a comprehensive ban on nuclear weapons testing is found on pages 389–432. Evidence on the understatement of numbers of nuclear tests and its significance is presented on pages 433–36. Readers are particularly directed to the material in these sections as well. Square-bracketed reference numbers, thus* [1], *refer to the list of references on page 468.*

I. *Nuclear tests conducted during 1970*

Information on nuclear weapon testing programmes is presented in the light of the text of the 1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water (the Partial Test Ban Treaty). The two preambular paragraphs of the treaty read:

Proclaiming as their principal aim the speediest possible achievement of an agreement on general and complete disarmament under strict international control in accordance with the objectives of the United Nations which would put an end to the armaments race and eliminate the incentive to the production and testing of all kinds of weapons, including nuclear weapons.

Seeking to achieve the discontinuance of all test explosions of nuclear weapons for all time, determined to continue negotiations to this end, and desiring to put an end to the contamination of man's environment by radioactive substances.

During 1970 four of the five nuclear powers—the USA, the USSR, China and France—reportedly conducted 49 nuclear tests (table 13.1). The United States reported that it had conducted 30 tests and that the Soviet Union had conducted 10 tests. France performed 8 atmospheric tests and China performed 1 atmospheric nuclear test. France has now conducted a total of 38 reported tests, compared with 25 tests performed by the UK.

[1] A more detailed discussion of the nuclear weapon testing programmes of the five nuclear powers may be found in the *SIPRI Yearbook 1968/69*, pp. 241–58; this information was continued in the *SIPRI Yearbook 1969/70*, pp. 384–87. The US nuclear testing programme for civil purposes was described in the *SIPRI Yearbook 1968/69*, pp. 252–54.

Table 13.1. Reported nuclear test explosions, 1945–1970

Number

	USA						USSR[d]					
	AEC[a]											
	Test detection	Plowshare	Safety[b]	Weapon	Total	FOA[c]	AEC[a]	FOA[c]	UK	France	China	Total all nations[e]
Pre-PTBT[f]												
1945				1	1	1						**1**
1946				2	2	2						**2**
1947												**—**
1948				3	3	3						**3**
1949							1	1				**1**
1950												**—**
1951				16	16	16	2	2				**18**
1952				10	10	10			1			**11**
1953				11	11	11	2	2	2			**15**
1954				6	6	6	1	2				**8**
1955				15	15	15	4	4				**19**
1956			1	13	14	14	7	8	6			**28**
1957			4	24	28	28	13	13	7			**48**
1958			14	52	66	66	25	27	5			**98**
Pre-1959								30[g]				**30**
1959												
1960										3		**3**
1961		1		8	9	9	31	32		1		**42**
1962		3		86	89	88	40	42	2[h]	2		**133**
1963 (pre-10 Oct.)		1		16	17	17				1		**18**
Date unknown					23	23[i]				1[i]		**24**
Total, pre-PTBT		**5**	**19**	**263**	**310**	**309**	**126**	**163**	**23**	**8**		**502**
Annual rate of testing, pre-PTBT: 1951–1963					24.3			12.8				39.4
Post-PTBT												
1963 (post-10 Oct.)	1	1		7	9	8				1		**10**
1964	1	6		21	29	28	3	6	1[h]	3	1	**39**
1965	1	1		25	28	27	4	9	1[h]	4	1	**42**
1966	1	4		35	40	40	7	14		6	3	**63**
1967		3		25	28	28	4	14		3	2	**47**
1968	1	8[j]		28	37	37	7	12		5	1	**55**
1969		1		27	28		12	(14)[k]			2	**44**[m]
1970	1	1		28	30		10	(10)[k]		8	1	**49**
Total, post-PTBT	**6**	**25**		**196**	**229**		**47**	**79**[l]	**2**	**30**	**11**	**349**
Annual rate of testing, post-PTBT: 1963–1970					31.6			10.9				41.8
Total, all tests	**6**	**30**	**19**	**459**	**539**		**173**[n]	**242**[n]	**25**	**38**	**11**	**851**

[a] Atomic Energy Commission. [b] These are experiments to determine the safety of nuclear weapons in case of accident. [c] Swedish Research Institute for National Defence (Försvarets Forskningsanstalt). [d] No official Soviet information is available for the USSR.
[e] When two sources give different figures, the higher of the two is chosen. [f] Partial Test Ban Treaty (signed 10 October 1963).

Table 13.2. US underground nuclear tests reported as venting, 1970

1. 21 April 1970
2. 1 May 1970
3. 1 May 1970
4. 21 May 1970
5. 26 May 1970
6. 18 December 1970

Six of the tests performed by the United States in 1970 vented—that is, released radioactive material into the atmosphere (table 13.2). No Soviet test was reported to have vented in 1970. But on 23 March 1971, a large Soviet test vented and released radioactive debris which clearly crossed national borders [1]. This test was reportedly one of four civil-application tests begun by the USSR in September 1969 along a watercourse system in the Ural Mountains (see page 467).

Table 13.1, which lists all reported nuclear test explosions from 1945 through 1970, brings information in the *SIPRI Yearbook 1969/70* up to date.[2] In particular, two changes in the numbers of tests reported increase the total number of tests listed. In the case of France, information released by the US Atomic Energy Commission (AEC) indicates that France conducted 3, 4 and 6 tests during the years 1964, 1965 and 1966, respectively, in place of 0, 2 and 5 tests for these years—an increase of six tests.

In addition, the number of Soviet nuclear tests in 1966, 1967 and 1968 reported by Sweden has been increased to 14, 14 and 12, respectively, from 12, 13 and 9 (in the *SIPRI Yearbook 1969/70*). These figures increase the margin of discrepancy between the numbers of Soviet tests reported by Swedish agencies and the numbers reported by US agencies. Thus, since the signing of the Partial Test Ban Treaty in 1963, the United States AEC has reported 47 Soviet tests, while Sweden has reported 79, a discrepancy of 32 tests.[3] In 1972 an official Swedish source reported a total of 548 US

[2] See the *SIPRI Yearbook 1969–70*, table 2C.1, page 386.

[3] Up to 30 December 1970.

Notes to table 13.1:

[g] These tests were reported by FOA as additional tests which took place at unspecified dates before 1959. [h] Four joint US/UK underground tests—two conducted in 1962 and one each in 1964 and 1965—are counted in both the US and the UK columns, but included only once in the total, all nations column.

[i] These tests are reported by the AEC as having taken place between 15 September 1961 and 20 August 1963: the date of the French test is unknown. [j] Including five devices separately used in the same test (Project Buggy), counted here as five. [k] No FOA figures are available for 1969 and 1970: AEC figures combined with SIPRI press cuttings give 14 for 1969 and 10 for 1970.

[l] The total 79 includes the earlier FOA figures, the SIPRI figure of 14 for 1969, and the AEC figure of 10 for 1970.

[m] A total of 14 tests has been included for the USSR.

[n] This table does not distinguish Soviet nuclear weapon tests from tests for civil applications. The data discussed on page 465 indicate that there have been at least 17 Soviet civil-application tests.

Table 13.3. Reported nuclear test explosions, by environment, 1945–1970

Number

	Air	Underwater	Underground	Total
USA	193	5	341	**539**
USSR	161	1	80	**242**
UK	21	0	4	**25**
France	25	0	13	**38**
China	10	0	1	**11**
Total	**410**	**6**	**436**[a]	**852**[a]

[a] Figures do not add up to totals, because both the United States and the UK are counted as benefiting from four US/UK joint underground tests although the tests are only counted once in the totals.

tests and 266 Soviet tests. [2] The totals in tables 13.1 and 13.3 have not been adjusted upwards to take account of those few instances where there is some evidence as to the extent of under-reporting of numbers of nuclear tests (page 433). It should be noted that the extent to which there are other, still unknown and unreported minor tests by the United States, and probably also by the Soviet Union, may be substantial.

Table 13.4 shows the cost of the US nuclear testing programme from 1962 to 1972.

In addition to the tables presented here, another table and chart are relevant to this discussion. Chart 11.2 (page 407) records the monthly number of nuclear tests from 1 January 1956 to 31 December 1963, the period when the Partial Test Ban Treaty was being negotiated. Table 11.1 (page 409) shows the distribution of energy yield (kilotons or megatons) of the tests conducted by the United States, the Soviet Union and Britain.

II. *The Soviet nuclear testing programme for civil purposes*

A table (13.1) in the present and previous SIPRI Yearbooks distinguishes four categories of US nuclear test explosions: weapon tests, Plowshare tests, Vela tests and safety tests.[4] The *SIPRI Yearbook 1968/69*[5] examined the US programme of nuclear tests designed to develop nuclear explosives for civil engineering purposes, the Plowshare programme. It was not then possible to give similar information on the Soviet nuclear testing programme

[4] Vela tests are nuclear explosions designed to provide basic information on the geologic effects of nuclear explosions so as to improve the capability of detecting and identifying unknown events. Safety tests are designed to determine the safety of nuclear weapons in case of accident.

[5] See the *SIPRI Yearbook 1968/69*, pp. 252–54.

Table 13.4. Cost of the US nuclear testing programme, 1962–1972

US $ mn, fiscal years

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972 (est.)
Dept. of Defense											
DNA[a]	98.6	108.3	31.2	29.9	37.8	39.6	37.0	40.0	49.4	46.2	46.3
ARPA[b]	7.2	1.8	3.7	7.6	3.8	1.7	2.8	5.3	3.1	3.3	0
Services (est.)[c]	2.0	1.0	9.0	21.0	22.0	20.0	20.0	18.0	8.0	24.0	26.0
Dept. of Defense Total	**108.0**	**111.0**	**44.0**	**59.0**	**64.0**	**61.0**	**60.0**	**63.0**	**61.0**	**74.0**	**72.0**
Atomic Energy Commission	**182.2**	**133.0**	**206.5**	**214.8**	**201.6**	**193.2**	**242.7**	**304.8**	**246.5**	**212.8**	**189.9**
Total[d]	**290.0**	**244.0**	**451.0**	**274.0**	**266.0**	**254.0**	**303.0**	**368.0**	**308.0**	**287.0**	**262.0**

[a] DNA = Defence Nuclear Agency.
[b] ARPA = Advanced Research Projects Agency.
[c] The expenditures shown for the military services are the cost of hardware exposed in effects tests and are only estimates.

Source: Prospects for Comprehensive Nuclear Test Ban Treaty, hearings before the Subcommittee on Arms Control, International Law and Organization of the Committee on Foreign Relations, US Senate, 92nd Congress, 1st session, (Washington, 22 and 23 July 1971).
[d] Ten-year total, $ 3 307.0 million.

for civil purposes, and the tables do not present separate categories of Soviet nuclear test explosions. In September and November 1969, the Soviet Union for the first time publicly described Soviet nuclear tests for civil applications [3–6]. In early 1970, the Soviet Union released a substantial amount of information at international meetings, both describing the kinds of application tests that have been carried out and giving some indication of the numbers of such tests [7].

Representatives of the USA and the USSR have met on three occasions to exchange evaluations of the use of nuclear explosives for civil-application purposes; these meetings took place in April 1969 in Vienna, in February 1970 in Moscow, and in July 1971 in Washington. The Soviet Union also released information concerning its programme in September 1969 and at an International Atomic Energy Agency (IAEA) symposium in March 1970.

The seismic events listed below are thought to be explosions in aseismic regions in the Soviet Union and away from the two main Soviet test sites. It is therefore likely that they were civil-application explosions. The list was compiled from information in seismological bulletins from 1966 to 1971, and is probably not a complete list [8]. None of these 17 seismic events was small: the majority were equivalent to at least tens of kilotons. The Soviet Union has also reported 17 civil-application explosions by type of applications [7, 9]. However, 7 of these are of very low yield—1 kt. or less—and are therefore not likely to be included in this list. The number 17 should therefore be taken as a minimum number of Soviet civil-application tests: there have probably been others as well.

By date

1. 22 April 1966*	North of Caspian
2. 30 September 1966*	Bukhara
3. 6 October 1967*	East of Urals
4. 21 May 1968*	Bukhara
5. 1 July 1968	North of Caspian
6. 2 September 1969*	Urals region
7. 8 September 1969	Urals region
8. 26 September 1969*	West of Caspian
9. 6 December 1969	East of Caspian
10. 25 June 1970*	North of Caspian
11. 12 December 1970	Caspian region
12. 13 December 1970	Caspian region
13. 23 March 1971	Northern Urals
14. 10 July 1971	Northern Urals
15. 19 September 1971	Urals region
16. 4 October 1971	Western Russia
17. 21 October 1971	Western Russia

Of the 12 presumed explosions listed here from 1966 through 1970, the US Atomic Energy Commission failed to report 7 (indicated by an asterisk). Swedish sources report 5 of the 7 tests which the AEC did *not* report [10]. Thus, 2 of the 12 tests were reported by neither Sweden nor the US AEC. This would raise still further the actual *total* number of Soviet nuclear tests, discussed above.

Information available in Soviet publications and in Western newspapers and journals provides some further indication of the number of Soviet civil-application tests and of their purpose [7, 9, 11–20]. However, none of these publications identifies the tests by date, and it is sometimes difficult to know whether they are discussing a previously unreported test or one already referred to in another report. A Western newspaper report on Soviet disclosures at the February 1970 meeting in Moscow and the March 1970 IAEA symposium states that "the Soviet Union has already conducted at least 13 experiments", although it subsequently refers specifically to only 12 explosions [11]. The same report indicates that the first Soviet civil-application test occurred in December 1964. The claim in this newspaper report that three excavation shots used explosives with yields of

Table 13.5. US and Soviet nuclear explosive civil-application projects[a]

	Completed		Proposed	
	USA	USSR	USA	USSR
Canal excavation	100 kt. crater (Sedan); five 1.1 kt. shots, row crater (Buggy); 2.3 kt. crater (Cabriolet); 31 kt. crater (Schooner)	0.2 kt. crater (T–1); three 0.2 kt. shots, row crater (T–2)		Kama-Pechora Canal, 250 charges (actual status unclear)
Underground storage	3 kt. (Gnome)	1.1 kt.; 25 kt.	Project Ketch	Two 35 kt.; three 40 kt.
Natural gas stimulation	29 kt. (Gasbuggy); 43 kt. (Rulison); 80 kt. (Miniata)	Undescribed project completed	Three 30 kt. (Rio Blanco); five 100 kt. (Wagon Wheel)	Three 40 kt.
Underground mining	12 kt. in dolomite (Handcar)	1 kt. in granite		1.8 kt.
Overburden removal				1 mt. row crater
Bulk or landslide dams and retarcs	0.1 kt. in basalt (Sulky)	5.3 kt., Madeo River	Retarc for construction material	Row retarc
Water reservoir		1.1 kt. crater (1003); 100–125 kt. lip dam (1004)		Two 150 kt. lip dam
Oil stimulation		Two 2.3 kt. and one 8 kt.; two 8 kt.		Three 20 kt.
Extinguish gas-well fire		40 kt.; 30 kt.		
Scientific experiments	Asymmetrical cavity (Marvel); heavy element production (Hutch)			

[a] Does not include device-development tests. Except in one case, proposed projects have been listed only for those categories in which an actual detonation has occurred. Other proposed projects also exist, for example for radioactive waste disposal, harbour construction, etc.

Source: See references 7, 17, 18, 19 and 20, page 468.

100 kt. is not correct [7, 22]. Soviet reports at the 1970 IAEA symposium referred to 7 specific detonations [13, 14].

In September 1970, *Komsomolskaya Pravda* reported the use of two nuclear explosions to quench a gas-well fire and a runaway oil-well [15]. The Soviet Union recently disclosed that the gas-well fire was extinguished in Uzbekistan in the autumn of 1966 [21]. This is the first civil-application test for which the Soviet Union has disclosed an exact location. In March 1971 Swedish sources indicated that Soviet tests conducted on 2 and 8 September 1969, 25 June 1970 and 23 March 1971 were part of a series [16].

An article in *Nuclear Technology* in July 1971 summarized Soviet reports of 11 nuclear projects which had by then involved the use of 15 nuclear explosives [7]. Nine proposed nuclear projects for further experimentation were also described. The Soviet Union reported 2 further explosions at the Eighth World Petroleum Congress in Moscow in June 1971 [9].

Table 13.5 summarizes US and Soviet civil-application tests conducted up to December 1971, and the additional projects suggested under both programmes.

Three further general points may be noted concerning the Soviet testing programme for civil purposes. Information about Soviet civil nuclear explosions serves, in fact, to reduce the reported number of Soviet nuclear *weapon* tests; until 1970, all Soviet nuclear tests had been regarded as weapon tests. The total of Soviet tests remains the same. In addition, the discussion in the *SIPRI Yearbook 1968/69* concerning venting and its relations to the US Plowshare excavation tests would be equally applicable to Soviet excavation tests as well, and it is probable that some of the Soviet tests reported as having vented radioactive material across national borders were of this type, as indicated by the 23 March 1971 example. Finally, this programme probably accounts for the multiplicity of Soviet test sites reported by the US AEC.[6]

References

1. *Dagens Nyheter*, 24 March 1971, 15 April 1971, and 20 April 1971; *Svenska Dagbladet*, 15 April 1971; and *International Herald Tribune*, 23 April 1971.
2. Prawitz, J., Restrictive treaties (excerpts from annual report on strategy for 1971), presented at the Royal Naval Society, 14 January 1972.
3. "Review of Possible Peaceful Applications of Nuclear Explosions in the National Economy of the Soviet Union", AEC-tr-7121 (Moscow, 1969).
4. Izrael, Yu. A., ed., "Radioactive Contamination of the Environment by Underground Nuclear Explosions and Methods of Forecasting It", AEC-tr-7122 (Moscow, 1969).
5. "Mechanical Effects of Underground Nuclear Explosions", AEC-tr-7120 (Moscow, 1969).
6. Gubarev, V., "Two Steps from the Epicentre", *Komsomolskaya Pravda*, 1 November 1969. (SIPRI translation.)
7. Werth, G. C., "The Soviet Program on Nuclear Explosives for the National Economy", *Nuclear Technology* 11 (7): 280–302, July 1971.
8. Personal communication, 1 November 1971.
9. "Two Experiments Detailed", *Nuclear News* 14 (8): 42, August 1971.
10. Bath, M., "Statistics on Nuclear Weapon Tests", 5 November 1970 (mimeographed).

[6] See the *SIPRI Yearbook 1968/69*, p. 244.

11. Finney, J. W., "Civilian Atom Blasts in Soviet Found to Outpace US Project", *New York Times*, 5 March 1970.
12. *Peaceful Nuclear Explosions, Phenomonology and Status Report, 1970* (Proceedings of a Panel on the Peaceful Uses of Nuclear Explosions, organized by the International Atomic Energy Agency and held in Vienna, 2–6 March 1970), pp. 62–65.
13. Parker, K., "Engineering with Nuclear Explosives", *New Scientist*, 46 (695): 9–11, 2 April 1970.
14. Werth, G. C., "USSR Program on Peaceful Uses of Nuclear Explosives", *Nuclear News*, 13 (5), May 1970.
15. "Putting A Stop To It, Atomically", *Standard Tanzania*, 26 September 1970. (Dispatch datelined Moscow, and quoting *Komsomolskaya Pravda*).
16. "New Soviet Nuclear Test—the Biggest in a Series of Tests for Peaceful Purposes", *Dagens Nyheter*, 24 March 1971 (SIPRI translation).
17. Werth, G. C., "Nuclear Explosives Applications", *Nuclear News*, 14 (10): 103–104, October 1971.
18. Werth, G. C., "Comparison of US and USSR Projects", Lawrence Livermore Laboratory, 25 August 1971, p. 1.
19. Wilson, A. R. W., "A Review of the Current Status of Civil Engineering and Mineral Resources Development Applications of Peaceful Nuclear Explosions", A/Conf. 49/A762.
20. Cowen, R. C., "Sharing at Geneva Talks, Peaceful A-Bombs Find Growing Uses", *Christian Science Monitor*, 17 September 1971.
21. Shabad, T., "Soviet Underground A-Blast Ended 3-Year Gas-Field Fire", *International Herald Tribune*, 3 December 1971.
22. Nordyke, M. D., Personal communication. 15 December 1971.

Sources of the tables

1. "Announced Nuclear Detonations", appendix B in *Effects of Nuclear Weapons* (Washington: US AEC and US DOD, April 1962; revised ed. reprinted February 1964).
2. "Announced Underground Nuclear Detonations", in *Major Activities of the US Atomic Energy Programs* (Washington: AEC, annual 1965–68).
3. Hohenemser, C. and Leitenberg, M. "Announced Nuclear Detonations: 1964–67", in "A Comprehensive Nuclear Test Ban: Technical Aspects 1957–67", *Scientist and Citizen* 9 (9–10): 212–13, November–December 1967.
4. Zander, I. and Araskog, R., "Kärnladdningsexplosioner 1945–66" (FOA 4 Rapport No. A 4493), (Stockholm: Swedish Research Institute for National Defence, June 1967.)
5. Springer, D. L. and Kinnaman, R. L., "Seismic Source Summary for US Underground Nuclear Explosions, 1961–1970", *Bulletin of the Seismological Society of America* 61 (4): 1073–98, August 1971.
6. US Atomic Energy Commission press releases.
7. "Summary of Announced Nuclear Tests by All Countries as of December 31, 1970" (Washington: Division of Military Application, US Atomic Energy Commission), (mimeographed).
8. SIPRI press cuttings.

14. World uranium supplies

I. *Introduction*

The coming spread of nuclear technology has obvious implications for the proliferation of nuclear weapons, a process which the Non-Proliferation Treaty is designed to halt. But the rate of development of nuclear power programmes is directly related to uranium supplies. For example, a shortage of uranium would increase pressures for the rapid development of fast-breeder reactors.[1]

This chapter is strictly limited to an examination of the potential demand for uranium and of the available supplies. It presents a background of the military demand in the 1950s which brought into being a large supplying industry. Thereafter military demand fell off and production and hence exploration consequently declined. The demand for uranium for electrical power generation has been slow to emerge; currently there is a state of over-supply in the uranium market. Yet this picture will change more and more as new capacity for the generation of electric power is based on nuclear stations. The increase in demand will require new discoveries of uranium and new development of deposits and associated treatment plants. The lead-time, i.e., the time required for the commercial exploitation of new deposits, is significant if supplies are to meet demand.

Currently the world's main producers of uranium, excluding the USSR, China and Eastern Europe, about which little is known, are the United States, France, Canada and South Africa. But there is exploration, often by multinational companies, in many countries and the current picture may change abruptly.

II. *Background and demand*

Although some uranium was mined before 1939 (e.g., in Canada, Czechoslovakia and the Belgian Congo[2]), most of the present mining and ore-

[1] A *breeder reactor* is the most productive source of plutonium. It is possible by a suitable design to convert uranium in the reactor to plutonium at a rate faster than the rate of consumption of the initial input of fissionable material. *Fast-breeder reactors,* using plutonium as fuel, should be able to produce more plutonium than is used up.
[2] The Belgian Congo—Congo (Kinshasa)—became in 1971 the Republic of Zaïre.

treatment capacity resulted from the demands of nuclear weapons development and manufacture. Exploration and development between 1940 and 1950 appear to have been confined to Canada and the USA.

In the period 1951–53, the USA and the UK encouraged the development of all known uranium deposits in their allied countries and contracted to buy the output. The joint report by the European Nuclear Energy Agency (ENEA) and the International Atomic Energy Agency (IAEA) in 1969[3] shows that the cumulative total of U_3O_8 produced in Australia, Canada, South Africa and the USA rose from 42 046 to 179 580 short tons[4] between 1956 and 1960. This production exceeded both the military demand and the comparatively small civilian demand which existed in that period. As a result, stretch-out agreements were negotiated between producers and the Combined Development Agency—the joint UK/US government uranium-procurement organization—so that in most cases the purchasing commitment was maintained but production was spread over a long period. There were also some price revisions.

This led to rationalization of production, with the closure of smaller mines and ore-treatment plants, the latter in some cases being only temporarily closed down against the day when demand would again increase. Overall there has emerged a considerable gap of years between the expiration of the stretch-out agreements and the growth of demand for electrical power generation. For social and other reasons, producing countries have felt a need to sustain some production in the absence of a market, and some stockpiling has occurred. (The uranium industry in France, with its independent nuclear deterrent, appears to have followed much the same course.) For instance, in 1959—the year of highest production aggregated among the four countries mentioned—output of U_3O_8 was 40 867 short tons, compared with the civil demand for 930 tons. Production fell steadily in the 1960s but in 1969, with the inclusion of France, there was a production of 23 000 tons against a maximum civil demand for 15 500 tons.

This history of surplus production has had two consequences: an almost total cessation of exploration in the mid- or late 1950s, and a high degree of secrecy about the details, and sometimes even the existence, of contracts for the sale of uranium. The latter may be due either to the military origins of the industry or to the intense competition for the inadequate opportunities available.

[3] *Uranium Production and Short Term Demand, January 1969,* A Joint Report by the European Nuclear Energy Agency and the International Atomic Energy Agency (Paris: OECD, 1969), Table 2, p. 20.

[4] Figures for uranium resources, reserves and production refer to U_3O_8, and the basic unit adopted for commercial transactions is the pound of U_3O_8 contained in chemical concentrate. One short ton (2 000 pounds) of U_3O_8 (triuranium octoxide) equals 770 kg. uranium metal. The following figures refer to *short tons* of U_3O_3.

III. *Military demand*

An analysis of the ENEA/IAEA report of 1969, which might not be a full disclosure, shows a cumulative production up to 1967 of 354 000 tons of U_3O_8 by Australia, Canada, France, South Africa, the USA and Zaïre. To arrive at an estimate of military demand, 140 000 tons must be subtracted: 43 300 tons for the cumulative demand for power production, and 97 500 tons for estimated stockpiles in 1969. The tables in the report do not include the pre-1958 production in the then Belgian Congo, which must have been of the order of 10 000 to 25 000 tons.

A production of over 200 000 tons remains, which must be assumed to have been allocated to military purposes by France, the UK and the USA, and which undoubtedly contained an element of over-insurance or precautionary buying. It would seem that current military demand for uranium is minimal in the three Western nuclear-weapon states.

Eastern Europe

The ENEA/IAEA reports for 1969 and 1970[5] do not give world coverage since figures are not available to either of the organizations for the USSR, China or the countries of Eastern Europe, which, except for East Germany and China, are all members of the IAEA. But it is generally believed that these countries possess important resources of uranium.

In view of the uranium production undertaken for the military programmes of the three Western nuclear-weapon powers and the parallel development of the Soviet Union's military capability, production for military purposes must have been substantial in Eastern Europe.

A communiqué of the Council of Ministers of the USSR,[6] which offered help to China, Czechoslovakia, East Germany, Poland and Romania in nuclear research, specifically referred to their "supplying appropriate raw materials to the Soviet Union". It also seems likely that large deposits of uranium have been mined in the Soviet Union and that it possesses considerable reserves.

[5] *Uranium Production and Short Term Demand, January 1969, op. cit.;* and *Uranium Resources Production and Demand, September 1970,* A Joint Report by the European Nuclear Energy Agency and the International Atomic Energy Agency (Paris: OECD, 1970).

[6] Tass communiqué, 17 January 1955, cited in G. A. Modelski, *Atomic Energy in the Communist Bloc* (Melbourne, 1959). Modelski added Hungary and Bulgaria to the five countries and, in relation to all countries, identified the locations of deposits.

Czechoslovakia is the best known of the Eastern producers. Reports[7] indicate the discovery of deposits at Liberec and Dolni Rozinka. Czechoslovakia is pursuing a programme of reactor development which, as in Canada, uses natural uranium as fuel and heavy water as moderator. Reliance on this system is scarcely consistent with uncertain uranium reserves. East Germany also possesses substantial deposits.

It seems reasonable to assume that military demand is also slack in Eastern Europe. There is little sign of a large demand for nuclear fuel building up in Eastern Europe, where there are only limited plans for installing generating plants, as compared with the OECD countries.

IV. *Civil demand*

In calculating demand for uranium, research reactors can be left aside and demand is taken as a direct function of power generation.

There are difficulties in estimating nuclear power capacity over the next decade or so. The intentions notified to the IAEA by its member states show constant changes, although the sum total of capacity for 1975 has not changed much in the last few years. The main difficulties in estimating demand are the current delays in construction and commissioning and improvements announced in fuel utilization in modern light water reactors, which could have a significant effect on uranium demand. (The search for improvements in fuel utilization is continuous in relation to all types.) Another less well-defined factor is an incipient tendency to revise future power requirements downwards, which is reinforced by concern for the environment.

The ENEA/IAEA report for 1970[8] contains an estimate of the growth of nuclear generating capacity in all countries except the USSR, Eastern Europe and China for the decade 1970–80, together with a forward estimate for 1985 (see table 14.1). The report states that the reliability of the estimate lessens as the projection time increases; limits of uncertainty range from ± 4 per cent in 1972 to ± 30 per cent in 1985.

Another estimate made by the Rio Tinto Zinc Corporation (RTZ) in May 1971 differs from the ENEA/IAEA estimate for most countries and for most years (table 14.2). Nevertheless its estimates of world total capacity, while subject to the same exceptions, are within the ENEA/IAEA limits of uncertainty from 1974 onwards. The RTZ estimates for 1975 are

[7] E.g., *Financial Times*, 25 March 1969.
[8] *Uranium Resources Production and Demand, September 1970, op. cit.*

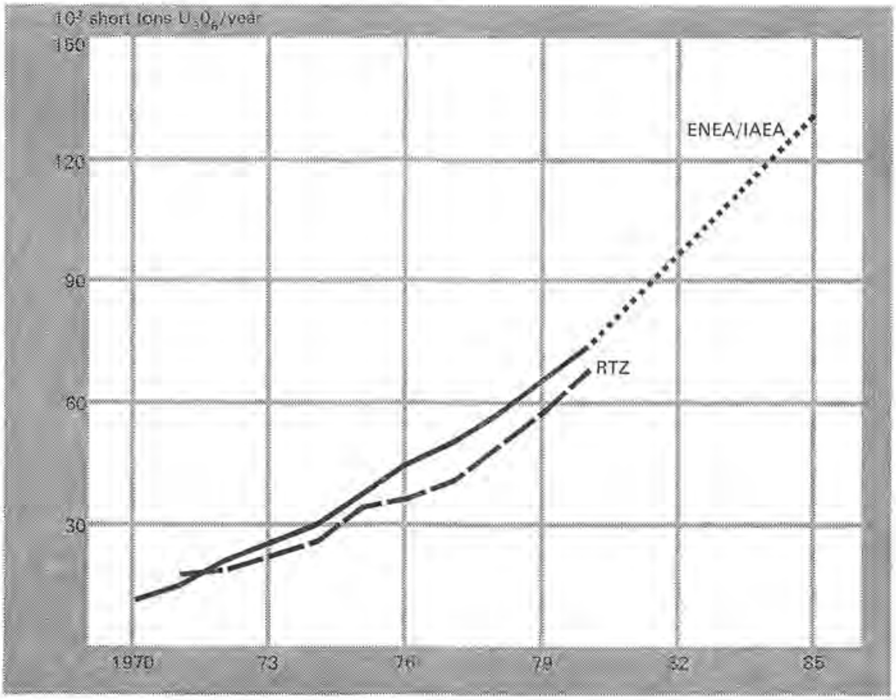
Table 14.1. Assumed growth of nuclear generating capacity used to calculate uranium demand

Gigawatts of electricity (GWe)

	End of											
Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	[1985][a]
OECD Europe												
Austria						0.6	0.6	0.6	1.2	1.2	1.8	[3.8]
Belgium	0.1	0.1	0.5	0.9	1.3	1.3	1.3	1.8	2.4	3.0	3.6	[6.6]
Denmark											0.6	[1.8]
Finland						0.4	0.4	0.4	0.8	0.8	0.8	[2.4]
France	1.5	2.0	2.6	2.6	2.6	2.6	4.1	4.9	6.7	7.6	9.2	[25.0]
FR Germany	0.8	0.9	2.2	2.5	5.9	11.1	14.3	17.0	20.0	22.5	25.0	[45.0]
Greece						0.4	0.4	0.8	0.8	1.2	1.2	[2.6]
Italy	0.6	0.6	0.6	0.6	0.6	1.4	..	..	..	..	8.0	[20.0]
Netherlands	0.1	0.1	0.1	0.5	0.5	0.5	1.2	1.2	1.2	1.2	2.0	[4.0]
Norway									0.5	0.5	0.5	[2.0]
Portugal									0.5	0.5	0.5	[1.1]
Spain	0.6	0.6	1.0	1.0	1.0	2.5	3.0	4.0	5.0	6.0	7.0	[17.0]
Sweden	0.4	0.6	0.6	1.4	2.8	3.8	4.0	4.8	5.6	6.4	7.5	[17.0]
Switzerland	0.4	0.7	1.0	1.0	1.0	1.8	1.8	2.6	2.6	3.5	3.5	[5.8]
Turkey									0.4	0.4	0.8	[2.4]
United Kingdom	5.3	5.5	7.9	9.2	10.4	11.7	14.2	17.2	20.2	23.2	26.2	[46.0]
Total OECD Europe	**9.8**	**11.1**	**16.5**	**19.7**	**26.1**	**38.7**	**49.0**	**60.3**	**73.7**	**85.0**	**99.2**	**[200.0]**
Japan	1.3	1.3	1.8	3.1	5.2	8.4	10.2	12.4	16.3	20.3	23.5	[60.0]
Total OECD Europe and Japan	**11.1**	**12.4**	**18.3**	**22.8**	**31.3**	**46.5**	**59.2**	**72.7**	**90.0**	**105.3**	**122.7**	**[260.0]**
Canada	0.2	1.0	2.0	2.5	2.5	2.5	3.3	4.7	5.5	6.8	8.0	[18.0]
USA	6.1	11.7	21.1	32.3	48.7	62.0	76.0	92.4	110.0	129.0	150.0	[277.0]
Total OECD	**17.4**	**25.1**	**41.4**	**57.6**	**82.5**	**111.0**	**138.5**	**169.8**	**205.5**	**241.1**	**280.7**	**[555.0]**
Other countr es												
Argentina				0.3	0.3	0.3	0.5	0.7	0.9	1.1	1.3	[2.5]
Australia						0.5	0.5	0.5	1.0	1.0	1.0	[2.0]
Brazil							0.5	0.5	1.0	1.0	1.5	[6.0]
India	0.6	0.6	0.8	1.3	1.8	2.3	3.2	3.7	4.6	5.1	6.4	[14.0]
Israel								0.3	0.3	0.6	0.6	[1.6]
Korea					0.6	0.6	1.2	1.2	2.0	2.7	2.7	[5.4]
Mexico						0.6	0.6	0.6	1.2	1.2	2.0	[7.5]
New Zealand									0.3	0.5	0.8	[3.1]
Pakistan		0.1	0.1	0.1	0.3	0.5	0.5	0.6	0.6	0.6	1.0	[2.6]
Philippines							0.4	0.4	0.8	0.8	1.2	[2.0]
South Africa						0.5	0.5	0.5	0.8	1.5	2.0	[4.7]
Taiwan						0.6	1.2	1.2	1.2	1.2	2.0	[2.8]
Thailand									0.4	0.4	0.4	[1.4]
Total other countries	**0.6**	**0.7**	**0.9**	**1.7**	**3.0**	**5.9**	**9.1**	**10.2**	**15.1**	**17.7**	**22.9**	**[55.0]**
World total (excl. Eastern Europe, USSR and China)	**18.0**	**26.0**	**42.0**	**59.0**	**85.0**	**118.0**	**148.0**	**180.0**	**220.0**	**260.0**	**300.0**	**[610.0]**
Uncertainty on total (± per cent)		*2*	*4*	*6*	*8*	*10*	*12*	*14*	*16*	*18*	*20*	*30*

[a] The reliability is significantly lower than for earlier years.

Chart 14.1. Estimate of annual demand for uranium[a]



[a] The estimate covers all countries except the Soviet Union, Eastern Europe and China.
Source: Tables 14.2 and 14.3.

5 per cent lower than the ENEA/IAEA estimate; for 1980, 2 per cent lower; and for 1985, 17 per cent lower.

Translating estimated nuclear generating capacity to estimated demand for uranium is beset by the following additional difficulties:

(*a*) The type and quantity of uranium required varies with the reactor type; many countries have not yet selected the types for installation in the 1970s, let alone in the 1980s, but this is not a major uncertainty.

Notes to table 14.1:

Source of the table: Uranium Resources, Production and Demand, September 1970, a joint report by the ENEA and the IAEA (Paris: OECD, 1970), p. 43.

Sources of information: Canada: Atomic Energy of Canada Limited; Denmark: Danish Atomic Energy Commission; France: Commissariat à l'Energie Atomique; West Germany: Bundesministerium für Bildung und Wissenschaft; Italy: Comitato Nazionale per l'Energia Nucleare; Japan: Power Reactor and Nuclear Fuel Development Corporation; Netherlands: KEMA, Arnhem; Portugal: Junta de Energia Nuclear; Spain: Junta de Energia Nuclear; Sweden: AB Atomenergi; Switzerland: Federal Department of the Interior; United Kingdom: UK Atomic Energy Authority, except for 1985; United States: Data on USAEC Forecasts of Nuclear Power Growth and Uranium Requirements, December 1969; other countries: Data on USAEC Forecasts of Nuclear Power Growth and Uranium Requirements, December 1969, and estimations of the Secretariats.

Table 14.2. Estimates of demand for uranium (U_3O_8), 1971-1980

Short tons

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Total
Austria	—	—	—	325	108	220	287	123	426	440	1 934
Belgium	55	406	457	129	483	509	310	608	609	605	4 171
Denmark	—	—	—	—	—	189	135	—	271	271	866
Finland	—	—	187	37	252	401	220	181	507	484	2 269
France	673	618	1 036	1 129	1 074	1 281	1 432	1 535	1 805	2 129	12 712
FR Germany	767	1 233	899	1 630	2 533	2 488	2 587	3 330	3 758	4 239	23 464
Greece	—	—	—	—	—	—	—	121	121	135	377
Ireland	—	—	—	—	—	—	185	185	60	73	503
Italy	141	142	652	584	248	619	974	982	1 113	1 346	6 801
Netherlands	239	10	10	293	377	177	312	420	430	530	2 798
Norway	—	—	—	—	—	—	—	135	135	135	405
Portugal	—	—	—	—	—	—	—	135	135	—	270
Spain	221	204	682	1 302	1 183	710	1 098	1 574	1 421	1 636	10 031
Sweden	8	1 312	529	144	1 020	1 166	1 081	1 434	1 458	1 932	10 034
Switzerland	75	123	201	190	417	765	484	463	722	705	4 145
Turkey	—	—	—	—	30	60	44	77	122	100	433
UK	2 626	3 691	3 062	2 520	4 501	4 575	4 666	4 751	5 955	7 110	43 457
Total Europe	**4 805**	**7 739**	**7 715**	**8 283**	**12 226**	**13 160**	**13 815**	**16 059**	**19 048**	**21 870**	**124 720**
Argentina	45	23	32	43	79	115	96	378	378	378	1 567
Australia	—	—	—	—	30	90	134	160	190	308	912
Brazil	—	—	—	218	73	—	231	230	201	293	1 246
Canada	277	316	426	443	530	689	756	890	1 025	1 151	6 503
Chile	—	—	—	—	144	72		181	181	51	629
Egypt	—	—	—	57	19	—	110	109	155	210	660
Hong Kong	—	—	—	—	—	—	108	103	—	73	289
India	117	113	138	157	337	276	380	479	542	624	3 163
Israel	—	—	—	—	108	54	108	163	163	219	815
Japan	1 112	1 477	1 478	3 098	3 078	2 606	3 959	5 358	3 473	7 200	34 831
Korea	—	—	170	34	144	150	77	235	234	266	1 310
Mexico	—	—	—	261	87	315	340	114	532	532	2 181
New Zealand	—	—	—	—	—	—	—	18	54	36	108
Pakistan	14	21	21	78	40	147	169	49	275	275	1 059
Philippines	—	—	—	—	144	72	103	131	235	286	1 026
South Africa	—	—	—	—	—	157	113	—	91	226	587
Taiwan	—	—	351	354	95	114	442	407	155	572	2 490
Thailand	—	—	—	—	—	157	113	—	226	226	722
Total other countries (excl. USA, Eastern Europe, USSR and China)	**6 370**	**9 689**	**10 331**	**13 026**	**17 126**	**18 174**	**21 029**	**25 119**	**29 158**	**34 796**	**184 818**
USA	11 203	9 251	11 562	13 622	16 735	18 788	20 138	24 117	23 349	33 309	187 074
World total (excl. Eastern Europe, USSR and China)	**17 573**	**18 940**	**21 893**	**26 648**	**33 861**	**36 962**	**41 167**	**49 236**	**57 507**	**68 105**	**371 892**
World total (OECD, 1970)	**15 000**	**21 000**	**26 000**	**30 000**	**37 000**	**44 000**	**50 000**	**57 000**	**65 000**	**73 000**	**448 000**

Source: Information supplied by the Rio Tinto Zinc Corporation, London.

(*b*) There is a lead-time between uranium procurement and use of the derived fuel; the ENEA/IAEA estimate is 24 months for the initial fuel loading and 16 months for replacement fuel.

(*c*) The stocks held by consumers are not known with certainty.

Table 14.3. Estimated world demand for uranium (U_3O_8)

10^3 short tons

Year	Annual demand	Cumulative demand from 1970
1970	12	12
1971	15	27
1972	21	48
1973	26	74
1974	30	104
1975	37	141
1976	44	185
1977	50	235
1978	57	292
1979	65	357
1980	73	430
[1985[a]]	[130]	[960]

[a] The reliability of the 1985 estimates is significantly less than for earlier years and, in view of the fact that no allowance has been made in producing these estimates for the re-use of plutonium in either thermal or fast reactors, the figure quoted for 1985 is more likely to represent the maximum than the mid-point of a range.

Source: Uranium Resources, Production and Demand, September 1970, a joint report by the ENEA and IAEA (Paris: OECD, 1970), p. 42.

(*d*) The extent to which plutonium will be recycled in thermal reactors is unknown and can hardly be estimated, although it could lead to what might be a major decrease in uranium consumption.

(*e*) The extent to which fast-breeder reactors will be used cannot be estimated, although their commercial introduction is probable by the early 1980s and should certainly reduce the demand for uranium by 1990.

Disregarding plutonium as a significant fuel in the estimated nuclear generating capacity, the ENEA/IAEA report for 1970 makes an estimate of world uranium demand. The Rio Tinto Zinc Corporation (RTZ) has also made an estimate until 1980 which assumes plutonium recycling (see table 14.2). RTZ estimates are consistently below the ENEA/IAEA estimates; the two are shown in chart 14.1.

Estimates of nuclear generating capacity for the countries of Eastern Europe are published by IAEA for the years up to 1977. But the capacity is not large compared with the rest of the world, being estimated for 1975 at 8 469 megawatts of electricity (MWe) for the USSR, 400 MWe for Bulgaria and 110 MWe for Czechoslovakia.

In summary, the ENEA/IAEA report for 1970 estimates the likely maximum demand for U_3O_8, as shown in table 14.3.

In comparing demand and supplies, it must be remembered that demand will continue for the life of the power station, say 20–25 years. Thus an installed capacity of 110 gigawatts[9] represents an accumulated demand of about 500 000 tons of U_3O_8 over the life of the power stations.[10]

V. *Supplies*

In assessing supplies, account must be taken of mining reserves, stockpiles, production capacity and exploration. At present only uranium in the price range of less than $10 per lb. U_3O_8 can be regarded as suitable to meet the demand for use in nuclear reactors producing electricity at competitive prices. The ENEA/IAEA report for 1970 gives figures for reserves, actual production and production capacity (see table 14.4).

Reserves[11]

Table 14.4 shows reserves (in the usual mining sense) of 840 000 tons of U_3O_8 in the price range of less than $10 per lb. as of April 1970. In addition, there are another 750 000 tons in the price range $10–15 per lb.[12]

Except in the case of South Africa, this figure of 840 000 tons does not include uranium produceable as a by-product from the mining of other minerals. The reserves of 840 000 tons will meet the cumulative demand until approximately 1984. The largest reserves—200 000 tons and over—are in Canada, South Africa and the United States. Additional resources (not yet proven as reserves) were estimated, as of April 1970, at approximately 880 000 tons, of which 510 000 tons were in the USA and 230 000 tons in Canada.

During 1970 reserves in the USA increased by a net 42 000 tons. Australia announced promising discoveries and, although it has not been

[9] 1 000 megawatts = 1 gigawatt.

[10] This is a crude estimate, since load factor, operating life, date of commissioning and type of nuclear station are all relevant. It can be assumed that the uranium demand for 100 GWE, operating at 80 per cent load factor for 20 years, is approximately 400 000 short tons of U_3O_8 (exclusive of initial charge). It is worth noting that the ENEA is to assemble an expert group on reactor usage to prepare more refined estimates of demand for the OECD area.

[11] Except where otherwise indicated, "reserves" refers to uranium in the price range up to $10 per lb. U_3O_8 on the basis of 1970 costs, and means *reserves in the mining sense*, i.e., uranium occurring in known ore deposits of such grade, quantity and configuration that it can, within the given price range, be profitably recovered with currently proven mining and processing technology and where the estimates of tonnage and grade are based on specific sample data and measurements of the deposits and on knowledge of ore-body habit.

[12] Higher cost deposits exist in several countries, notably Sweden which reports 350 000 short tons of U_3O_8 of reasonably assured resources in the price range $10–15 per lb. Part of the Swedish demand is to be met from these deposits.

Table 14.4. World uranium production and reserves (U_3O_8 below $10 per pound)

Short tons of U_3O_8

Country	Reserves as of April 1970	Actual production 1969	Production capacity planned for 1973	Production capacity attainable by 1975
Argentina	10 000	55	88	88
Australia	21 700	330	1 500	1 500
Brazil	1 000			
Canada	232 000	4 500	5 500[a]	13 000[b]
Central African Rep.	10 400		780	780
France	45 000	1 600	2 300[a]	2 300
Gabon	13 500	650	780	780
Italy	1 500		120	120
Japan	2 700		40[c]	40
Mexico	1 300	40	200	200
Niger	26 000		970[c]	1 940[d]
Portugal	9 600	103	300	300
Spain	11 000	72	550	550
South Africa	200 000	4 000	6 000	6 000
Turkey	2 300			
USA	250 000[e]	11 600	19 000	23 000
Yugoslavia	1 300			
Total	**839 000**	**22 950**	**38 138**	**50 598**
Rounded total	**840 000**	**23 000**	**38 000**	**51 000**

[a] Capacity now available.
[b] Capacity attainable by 1975, markets permitting.
[c] Capacity available by 1971.
[d] Capacity available by 1974.
[e] Does not include 90 000 short tons U_3O_8 by-product.

Source: Uranium Resources, Production and Demand, September 1970, a joint report by the ENEA and IAEA (Paris: OECD, 1970), p. 40.

proven, the latter country is expected in the near future to prove new reserves of some tens of thousands of tons of U_3O_8.

In the period between the 1969 and 1970 ENEA/IAEA reports, reserves increased from 700 000 to 840 000 tons and events in the USA and Australia show that it is probably a continuing trend.

Stockpiles

The significant stockpiles are estimated to be of the order of:

Australia	2 500 tons
Canada	9 500 tons
France	13 000 tons
South Africa	9 000 tons
UK	10 000 tons
USA	60 000 tons

It is difficult to confirm certain of these figures, some of which, e.g., the figures for France and Australia, seem high.

In addition to its stockpile of U_3O_8, the USA probably holds a large stockpile of highly enriched uranium for military purposes which potentially could be blended with depleted uranium[13] to meet fuel demands.[14] Also, such small producers as Argentina, Portugal and Spain would have small stockpiles of U_3O_8. Considerable stockpiles may be in the hands of industry. Over-supply has led to forward sales at lower prices.

Exploration

There is a substantial lag from discovery to production, which Canada estimates at 8–10 years from initiation of exploration. The ENEA/IAEA report for 1969 mentions a time lag of 4 to 5 years from discovery to production, and an even longer period in remote areas. Consequently, there is currently active exploration in the main producing countries and in other countries as well. Some features should be noted: several petroleum companies have entered the uranium field in the last few years; for example, US companies in Canada, and European oil companies in Africa. The second feature is the participation of enterprises from countries which will be substantial importers in current exploration both independently and in partnership with traditional producers. Thus West German interests are associated with exploration in Australia, Austria, Canada, Ghana, Niger, Somalia, Togo and the USA. Japanese interests are reported to be exploring in the USA and Zaïre, and Italian in Guyana, Kenya, Niger, Somalia, the USA and Zambia. In Australia eighty private companies are prospecting, many with foreign participation.

Canada has restricted by legislation participation by foreign interests in uranium production. This led in 1970 to a downturn in exploration. Australia intends to impose similar restrictions. In Canada, both exploration and production were depressed by restrictions in the USA on the import of uranium.

[13] Uranium in nature contains only 0.7 per cent of the fissionable atom U-235. Most current power reactors use uranium in which this percentage has been increased to 1.5 to 3.5 per cent. Submarine power plants and weapons manufacture require uranium enriched to over 70 per cent. The process of enrichment therefore yields as a waste product large quantities of uranium in which the content of fissionable atoms is less than occurs in nature.

[14] The *New York Times,* 18 October 1971, reported that the US AEC intends to commence selling from its stockpile of U_3O_8 in 1974. In the same issue it was reported that a study was in progress aimed at "retiring" obsolete weapons from the nuclear arsenal. When dismantled, these weapons may yield more highly enriched uranium for blending with depleted uranium.

Production and production capacity

These are shown in table 14.4. The excess of production over generating demand in 1970 is absorbed by stockpiling in producing countries and by forward sales. Nevertheless, in Canada some production capacity closed down in 1970 due to lack of sales and falling prices.

Because of lead-time, capacity limits supplies. Before new capacity is established, the pre-requisites are firm demand, assured continuity of production for 7 to 10 years, and technical and economic feasibility.

VI. *Modes of international trade in uranium*

Until the mid-1960s, uranium for the most part moved internationally in the form of "yellowcake", a concentrate containing greater than 90 per cent U_3O_8 and 60 per cent uranium metal. In the last 5 years or so, the practice has changed so that there are now several means to transfer uranium from producer to user. The most basic means of transfer is export in the form of fuel fabricated from uranium mined in the country of export. Technologically advanced industrial countries are also now offering a range of "improvement" services for uranium in the stage between the mine and the insertion of fuel elements in a reactor; these include refining, converting to fluorides, reduction to metal or dioxide, enrichment, and partial or complete fabrication of fuel elements. Thus uranium may pass through one or more countries between the country of first export and the country of final import for use. Enrichment services are primarily offered by the USA, but also by the Soviet Union and the UK, and potentially by France. At present, only nuclear-weapon states possess enrichment plants, although this situation will be altered in the next few years by the development of the gas centrifuge by the Netherlands, West Germany and the UK under a tripartite agreement, and of other processes by other countries.

Although the quantities involved in many individual transfers for "improvement" may be small, they tend to be intrinsically significant; in any event, imports for the purpose of "improvement" services and subsequent re-export complicate any collection or examination of data relating to exports and imports, particularly when the current secrecy regarding sales is taken into account. This has obvious implications for the implementation of safeguards. (For a more detailed discussion, see page 375.)

Exports

It is first necessary to deal with the question of fabricated fuel. The USA exports fuel for power reactors to India, Italy, Japan, Spain, Sweden, Switzerland and West Germany. The UK exports to Italy and Japan, and Canada to India and Pakistan. This list is not exhaustive.

In addition, there are sales of bulk uranium, sometimes long-term, and sales of smaller quantities which might lead to bulk contracts. Because of the secrecy attaching to contracts (see page 471), all that can be stated here is the countries to which the major producers export: South Africa exports to France, Japan, Sweden, Switzerland, the UK and the USA (for re-export after improvement). Canada exports to Japan, the UK and probably also to Sweden, Switzerland and West Germany. The USA probably exports to all the above-mentioned importers but mainly after improvement; some of the exports made by South Africa and Canada pass through the USA for improvement before final delivery.

All major producers, including France, appear to be interested in any sales opportunity. In March 1971 France announced an arrangement with the Soviet Union for enriching French uranium for use in an atomic power plant in Alsace in 1973–74.[15]

VII. *Conclusions*

To assure supplies of uranium to meet the estimated generating demand in the long term, new resources would have to be discovered and proved during the 1970s. Production capacity would have to be increased and both consumers and producers assured of continuous operation and adequate reserves over periods of 8 years or more.

But it seems as though there will be a shortage of uranium in the future which will inevitably hasten the development of breeder reactors. The future use of breeder reactors in many countries would have even graver implications for the proliferation of nuclear weapons. Moreover, the immense transfer in nuclear fuels within countries and between countries will make the problem of safeguards a very complex one.

[15] *New York Times*, 16 March 1971.

15. China and disarmament

I. *Introduction*

Compared with the 1960s, when the United States and the Soviet Union largely dominated the field of disarmament negotiations, in the 1970s China's attitude toward disarmament will be of increasing importance to disarmament negotiations. The Partial Test Ban Treaty, the Non-Proliferation Treaty and the treaties banning nuclearization of the sea-bed and outer space were all concluded in spite of vehement Chinese opposition, and in disregard of China's attempts to join the nuclear debate by such means as counterproposals sent to all heads of state, articles in the press, and so on.

The public Western cold war image of a reckless, irrational Chinese government, whose possession of nuclear weapons would imply grave danger to mankind, received a strong impetus from the open Sino-Soviet polemics dating from 1963. The Chinese themselves contributed to this Western image of China not by action, but by using a language without equivalent in official Western statements. Unfortunately, those Chinese arguments which, for various reasons, received almost exclusive attention in the West as well as in the Soviet Union, rather than the more comprehensive statements, were a combination of threats, poetic statements and dramatic sentences not conducive to rational interpretation, such as "the atom bomb is a paper tiger". Since 1963 the Chinese have, however, made great efforts to explain their own position in regard to various disarmament measures, and have also made their own counterproposals, which permits a description of the development of Chinese policy in this field.

The assumption that during the 1970s China will have comparatively greater influence on both the international disarmament debate and bilateral US-Soviet discussions is based on two main indicators of China's change of status in world affairs since the 1960s. First, it was possible to ignore China during the negotiations of the Test Ban Treaty, since by that time China had merely declared its intention to go nuclear and the prospects for doing so without Soviet assistance did not seem too bright, in view of China's economic difficulties in the early 1960s. But by 1970 China was already a secondary nuclear-weapon power which had demonstrated its ability to proceed with an indigenous nuclear weapons programme at an astonishing—if not alarming—speed. Secondly, the fact that the People's Republic of China assumed China's seat in the United Nations in November 1971 probably means that China will be present in future disarmament discussions conducted within or outside the UN body. It is significant that the Chinese arrival at the United Nations was immediately accompanied by speculation in the press on a future re-organization of the CCD as well as on the possibility of tripartite SALT talks.

The following discussion of China's disarmament policy is based on public Chinese statements in this field. The interpretation of Chinese *interests* is necessarily deduced from the combination of official statements and the empirical evidence of actions taken in the past, since there is no public Chinese discussion of such matters as the direction of its nuclear weapons programme. Further, China's disarmament policy, like that of any other country, is closely related to its general foreign policy. Although China's foreign policy is not analysed here, the following assumptions are implicit. The Chinese government is pursuing a consistent policy in order to achieve what it regards as China's proper rank among nations, despite shifts of emphasis on the means and other differences of opinion within the leadership. The ultimate goal is presented in vague terms, for example: "No force whatsoever can prevent the People's Republic of China from playing its great role and exerting its great influence in international affairs."[1] Foreign analyses and judgements about China's foreign policy objectives range from the ultra-rightist view of Chinese dominance of the world after it has triggered a thermonuclear war, on the one hand, to the ultra-leftist view of China as the leading force of a world revolution, on the other hand. For the purposes of this chapter, it will be enough to state that neither of these extremes is very likely, given the past conduct of China's policy which has been characterized by defensiveness and pragmatism in action, and which apparently has been designed to achieve its goals by means other than outright war against a superior enemy. A further, reasonable assumption at present seems to be that, whatever future influence China will have on world affairs, it can hardly hope to reach the same position of power in a multipolar world as the USA and the USSR enjoyed during the 1950s. This is also relevant for future Chinese influence on disarmament matters.

A study of China's position on disarmament matters reveals the following main characteristics. First, China equates the concept of arms control with control of *nuclear* arms. The possibilities of reducing conventional

[1] "China's Great Influence in the World is Irresistible", *Renmin Ribao* (*People's Daily*), 30 November 1967, in *Peking Review*, No. 50, 8 December 1967.

weapons or forces is mentioned, but always in connection with measures for nuclear disarmament. As regards chemical and biological weapons, the Chinese government has declared itself bound by the 1925 Geneva Protocol outlawing the use of these weapons, and has otherwise not shown much interest in the international debate on the problems of prohibition of production and destruction of CB weapons.

Secondly, in China, as in the USA and the USSR, the development of a plan or a programme for nuclear disarmament has been intertwined with the progress of indigenous nuclear weapons development. The following presentation of China's disarmament policy considers the Chinese attitude towards nuclear weapons, Chinese opposition to US-Soviet proposals and agreements, Chinese counterproposals and, finally, some implications for the future regarding Chinese policy in the field of disarmament.

II. *China and nuclear arms*

In 1946 Mao Tse-tung expressed the following view on nuclear weapons to US correspondent, Anna Louise Strong:

> The atom bomb is a paper tiger which the US reactionaries use to scare people. It looks terrible, but in fact it isn't. Of course, the atom bomb is a weapon of mass slaughter, but the outcome of a war is decided by the people, not by one or two new types of weapons.[2]

This opinion about nuclear weapons has been consistently repeated in official Chinese statements. It should be placed in the context of a general theme in Chinese ideology, namely, that of man's superiority over technology, rather than simply used as "proof" that the Chinese neglect the dangers of a nuclear war and have opted in favour of a national nuclear programme merely for future political gains. In fact, in ascertaining the motivations behind China's decision to "go nuclear", the issue of national security stands out as the primary motive; in other words, strategic considerations have played an important part. Furthermore, these two aspects, political and strategic, are not mutually exclusive. Obviously, a strategically useful weapon can be put to political uses. It is unreasonable to assume that a government such as China's would decide on a nuclear programme, knowing what the diversion of resources means for a country of China's size and standard of living, if it had not concluded that this programme would be profitable from all points of view.

[2] Quoted in *People of the World Unite for the Complete, Thorough, Total and Resolute Prohibition and Destruction of Nuclear Weapons* (Peking: Foreign Language Press, 1963), p. 48.

It must also be kept in mind that China is the only country which, since 1945, has repeatedly been, or considered itself to be, threatened with nuclear attack by another government. There is, in fact, enough material to show that the Chinese leadership seriously considered the risks of a US nuclear attack on China before entering the Korean War,[3] in connection with the war in Viet-Nam and Laos and, especially, during the 1958 Quemoy and Matsu crisis.[4]

Thus, the decision to "go nuclear", with Soviet aid, implied that China indeed acknowledged the importance of the new weapon:

With the emergence of atomic weapons and jet weapons, military science has registered a new development. ... We must be prepared for the suddenness of war launched by the imperialists; therefore we must be *materially* and spiritually alert.[5]

However, measured with the standards of modern warfare, it must be admitted that in the grasping of the modern military technique, and the employment of modern combat skills, our Army is still in a comparatively backward position ... Only with our understanding of the art of directing operations and combat skill demanded by modern warfare, and only with adequate ideological and *material* preparations to cope fully with a sudden incident, shall we be in the position to deal a vital blow to the enemy attacking us at any time and any place.[6]

The decision to acquire nuclear weapons was very likely taken in 1954–55.[7] In 1955 China received its first nuclear reactor from the Soviet Union, and in the Sino-Soviet polemics of 1963 it was claimed that in 1957 the Soviet Union had promised China data and a sample of a nuclear weapon.[8]

When in 1957 Mao Tse-tung gave his now famous speech in Moscow, saying that the results of a nuclear war would be the final annihilation of capitalism, this new confidence was generally related to the Soviet launching of the first satellite. In retrospect it may rather have been related to some sort of agreement or promise of Soviet aid for Chinese nuclear weapons:

It is characteristic of the situation today, I believe, that the East Wind is prevailing over the West Wind. That is to say, the forces of socialism are overwhelmingly superior to the forces of imperialism. ... At present another situation has

[3] See, for instance, Allen Whiting, *China Crosses the Yalu* (New York, 1960).

[4] See, for instance, Alice Hsieh, *Communist China's Strategy in the Nuclear Era* (New York: Rand, 1962).

[5] Liu Po-ch'eng, speech to the 2nd session of the First National People's Congress, in Hsinhua News Agency Release, Peking, 21 July 1955. (Italics added.)

[6] Yeh Chien-ying, speech to the 2nd session of the First National People's Congress, Hsinhua News Agency Release, Peking, 27 July 1955, in Alice Hsieh, *op. cit.*, p. 35. (Italics added.)

[7] See, for instance, Alice Hsieh, *op. cit.*

[8] *People of the World Unite, op. cit.*, p. 28.

to be taken into account, namely, that the war maniacs may drop atomic and hydrogen bombs everywhere. They drop them and we act after their fashion; thus there will be chaos and lives will be lost. The question has to be considered for the worst. The Political Bureau of our Party has held several sessions to discuss this question. If fighting breaks out now, China has got only hand-grenades and not atomic bombs—which the Soviet Union has.[9]

The necessity of proceeding with the nuclear weapons programme without Soviet support was conditioned by China's relationship with the Soviet Union, and is likely to have been obvious from the Chinese point of view during the 1958 Quemoy and Matsu crisis, when it became clear to the Chinese that they could not rely on the Soviet Union in case of a nuclear attack. A number of other factors, which are not analysed here, account for growing Chinese distrust of Soviet interests in aiding China, e.g., the extensive Soviet economic aid to Egypt and India from 1955, etc. Thus, the quest for independence was interrelated with the need for national security.

In the 1963 polemics with the USSR, preceding the signing of the PTB, the Chinese claimed—in rather the same tone as French statements concerning US protection of Europe—that it would not be realistic to depend on the nuclear "umbrella" of the Soviet Union.

In fighting imperialist aggression and defending its security, every socialist country has to rely in the first place on its own defence capability, and then and only then—on assistance from fraternal countries and the people of the world. For the Soviet statement to describe all the socialist countries as depending on the nuclear weapons of the Soviet Union for their survival is to strike an out-and-out great power chauvinistic note and to fly in the face of the facts. ... The real aim of the Soviet leaders is to compromise with the United States in order to seek momentary ease and to maintain a monopoly of nuclear weapons and lord it over the socialist camp.[10]

In the Sino-Soviet polemics, China also admitted its early fear of a nuclear attack, for example, in an official government statement that, following the bombing of Hiroshima and Nagasaki, "there was a kind of fear mentality among the Chinese people as well as among the peoples of other countries".[11]

By 1972 China had conducted 12 nuclear tests, including thermonuclear

[9] Quoted in *People of the World Unite, op. cit.*, p. 41.
[10] Statement by a spokesman of the Chinese government, "A comment on the Soviet Government's statement of 3 August 1963", in *People of the World Unite, op. cit.*, p. 21.
[11] Statement by a spokesman of the Chinese government, "A comment on the Soviet Government's statement of 21 August 1963", in *People of the World Unite, op. cit.*, p. 47.

and underground tests, and had launched a satellite. But the Chinese government apparently has no illusions as to the vulnerability of the Chinese nuclear force and installations, and has strongly stressed the defensiveness of the Chinese build-up. From the first nuclear explosion in October 1964, each test has been accompanied by a statement similar to the following:

China develops nuclear weapons because she is compelled to do so under imperialist nuclear threats, and she does so entirely for the purpose of defence and for breaking the imperialist nuclear monopoly and finally eliminating nuclear weapons. China's nuclear weapons are still in the experimental stage, and at present she is not yet a nuclear power, nor will she ever be a "nuclear superpower" practicing the policies of nuclear monopoly, nuclear threats and nuclear blackmail.[12]

In connection with any government's practice of a policy aimed at genuine independence, it is possible to point to motivations belonging to the category of national prestige. In the material on the Sino-Soviet conflict, there are a great number of Chinese statements suggesting hurt national pride, such as the following:

Is not China very poor and backward? Yes it is. The Soviet leaders say, how can the Chinese be qualified to manufacture nuclear weapons when they eat watery soup out of a common bowl and do not even have pants to wear?[13]

Some Chinese formulations suggest a similarity to French arguments on the matter of nuclear weapons and national prestige; they claim that non-nuclear-weapon states are reduced to second-rank status, and are bound to follow the directives of the USA and the USSR:

In the eyes of US imperialism, the countries of the world are divided into two categories: those which possess nuclear weapons and those which do not. The few nuclear powers, as a matter of course, are the masters of the world, whereas the countries which do not possess nuclear weapons are, to quote Kennedy, irresponsible and unstable, so that they are by no means qualified to possess nuclear weapons, nor can they have any say in the matter. ... It is absolutely impermissible for two or three countries to brandish their nuclear weapons at will, issue orders and commands, and lord it over the world as self-ordained nuclear overlords, while the overwhelming majority of countries are expected to kneel and obey orders meekly, as if they were nuclear slaves.[14]

[12] Statement of the government of the People's Republic of China of 30 July 1971, in Hsinhua News Agency release, 7 August 1971.
[13] Statement by a spokesman of the Chinese government, "A comment on the Soviet Government's statement of 21 August 1963", in *People of the World Unite, op. cit.*, p. 38.
[14] *People of the World Unite, op. cit.*, pp. 84–85 (translation of article in *Renmin Ribao*, 2 August 1963).

III. *China's disarmament policy*

China's opposition to US–Soviet disarmament policy

China officially supported all Soviet disarmament proposals up to 1960 when certain differences of opinion became noticeable, concerning, for example, the Soviet proposals made at the United Nations in 1959 for general and complete disarmament (GCD). While there was as yet no open quarrel between the two governments on matters of disarmament, similar to that which became public from 1963, it was obvious that the Chinese did not consider the GCD proposal to be a serious one, and the Chinese press elaborated at length that the concept of GCD was unrealistic in the absence of agreement on nuclear disarmament. The fact that in June 1960 the Socialist delegates walked out of the Ten-Nation Committee on Disarmament discussions of the GCD was attributed to Chinese pressure. During 1962 this point of view evolved into the position that support of national liberation wars must take priority over GCD talks, which was consistent with China's foreign policy approach to the third world from 1954, and that disarmament negotiations should aim at the elimination of nuclear rather than conventional weapons as a first step.

Another indication of a difference of opinion with the USSR, indicative of the future, was the official Chinese declaration in 1960 that China would be bound only by a disarmament agreement achieved with Chinese participation in the negotiations and its formal adherence.[15] This was, in fact, a notification to the United States and, chiefly, to the Soviet Union, which since late 1958 had been negotiating the Partial Test Ban Treaty, that they could not hope that China would be bound by it. In 1963 China claimed that in 1959 the USSR had cancelled its agreement to provide China with aid for a nuclear weapons programme as a concession in the PTB negotiations. In any case, the Chinese notion of a "superpower collusion" intended to contain China dates from the initiation of the PTB negotiations, which to China meant that the Soviet Union abstained from aiding China in favour of an agreement with the United States banning atmospheric nuclear tests, which were vital to the Chinese nuclear weapons development programme. The PTB also brought into the open the differences of opinion between China and the USSR on matters other than nuclear ones, marking the escalation of what was later labelled the Sino-Soviet conflict. In the

[15] See Resolution of the Standing Committee of the National People's Congress, 27 January 1960, in Hsinhua News Agency release, Peking, 21 January 1960.

1963 polemics, the Chinese did their utmost to explain why to them the PTB was nothing but a way of preserving the nuclear monopoly of the USA and the USSR, and a follow-up of Soviet policy since 1959 aimed at preventing China from becoming a nuclear-weapon power. They argued that the PTB was a first step towards a non-proliferation treaty, which would perpetuate the power of the USA and the USSR, and also that it was counterproductive to its alleged aims of disarmament:

But the Soviet Government actually regards this treaty as a step in preventing the spread of nuclear arms. While raising no objection whatever to the activity of the United States to spread nuclear arms among its allies, it does its utmost to prevent the other socialist countries and all oppressed countries from acquiring nuclear weapons. ... As was repeatedly pointed out by the Soviet Government before, the discontinuance of nuclear tests will have meaning only if it is a part of a whole disarmament programme and is one of the measures for a total ban on nuclear weapons. The tripartite treaty, however, divorces the discontinuance of nuclear tests completely from the prohibition of nuclear weapons and makes no mention whatsoever of the banning of nuclear weapons. By legalizing underground tests it relegates far into the background even a total ban on nuclear tests.[16]

The issues at stake for China were its own nuclear weapons programme and the loss of political goodwill, primarily in the third world, resulting from conducting atmospheric tests in the face of an international treaty banning such tests.

The Chinese had to find convincing arguments to oppose the widely held notion that the danger of nuclear war increases with the addition of each new member of the "nuclear club", especially since a majority of countries have, in fact, opted against indigenous nuclear weapons programmes. The Chinese position on proliferation probably also reflects the genuine conviction of the leadership that nuclear weapons are no danger *per se,* but are dangerous only in the wrong hands. This position was emphatically stated in 1963 as follows:

With regard to preventing nuclear proliferation, the Chinese Government has always maintained that the arguments of the US imperialists must not be echoed, but that a class analysis must be made. Whether or not nuclear weapons help peace depends on who possesses them. It is detrimental to peace if they are in the hands of imperialist countries; it helps peace if they are in the hands of socialist countries. It must not be said indiscriminatingly that the danger of nuclear war increases along with the increase in the number of nuclear powers. Nuclear weapons were first the monopoly of the United States. Later, the Soviet Union also came to possess them. Did the danger of nuclear war become greater

[16] "Why the Tripartite Treaty Does Only Harm and Brings No Benefit", *Renmin Ribao,* 10 August 1963, in *People of the World Unite, op. cit.,* pp. 107–08.

or less when the number of nuclear powers increased from one to two. We say it became less, not greater.[17]

As to the alleged goal of eliminating nuclear weapons, the Chinese government stated shortly after the first Chinese nuclear explosion in 1964 that only when as many Socialist states as possible break the US nuclear monopoly will there be any chance for a future agreement on the destruction of nuclear weapons:

The hope of preventing nuclear war and prohibiting nuclear weapons does not lie in consolidating the US nuclear monopoly but in breaking it. And the more thoroughly it is broken, the greater will be the possibility of completely prohibiting and thoroughly destroying nuclear weapons. Such is the dialectics of the development of things.[18]

The anticipated criticism against China for not adhering to the PTB became a reality during 1964, and Chou En-lai had to devote large portions of his speeches during his African tour to explaining and defending China's position. A comprehensive statement on China's view of nuclear weapons proliferation was also given by Chen Yi in his London *Times* interview of 1965:

A London Times correspondent . . . asked whether China was prepared to share her nuclear knowledge with any of the developing countries . . . Vice-Premier Chen Yi said: "There are two aspects to the question of nuclear cooperation. As for the peaceful use of atomic energy and the building of atomic reactors, China has already been approached by several countries, and China is ready to render them assistance; as for the request for China's help in the manufacture of atom bombs, this question is not realistic.

In my opinion, the most important task for the Afro-Asian countries today is to shake off imperialist control politically, economically and culturally and develop their own independent economy. This task is an acute struggle and its accomplishment will take quite a few years. Any country with a fair basis in industry and agriculture and in science and technology will be able to manufacture atom bombs, with or without China's assistance. China hopes that Afro-Asian countries will be able to make atom bombs themselves, and it would be better for *a greater number of countries* to come into possession of atom bombs.[19]

This statement indicates that no third world country should expect to obtain Chinese nuclear weapons; at most they could anticipate nuclear aid for civil purposes.

As the US–Soviet negotiations for the Non-Proliferation Treaty progressed in 1968, a series of Chinese statements were issued containing the

[17] Statement by a spokesman of the Chinese government, "A comment on the Soviet Government's statement of 3 August 1963", in *People of the World Unite, op. cit.*, p. 22.
[18] *Peking Review*, No. 44, 30 October 1964.
[19] *Peking Review*, No. 41, 8 October 1965. (Italics added.)

same arguments used in 1963. But emphasis was now clearly on the part played by the Soviet Union, which was accused of military collaboration with the United States directed against China:

It must be pointed out that this nuclear fraud of US imperialism and Soviet revisionism is also a component part of their anti-China plot. They not only want to fan up anti-China feelings internationally through the so-called "treaty on non-proliferation of nuclear weapons" but also want to accelerate the rigging up of an anti-China encirclement by providing their "nuclear umbrella" to India and other countries bordering China. The US imperialists and Soviet revisionists have thus taken a big step forward in their military collaboration against China.[20]

Further, China publicly supported French nuclear weapons policy on a number of occasions, enabling the conclusion to be drawn that by now China held that proliferation of nuclear weapons was desirable not only to Socialist and third world countries but actually to any country whose government opposed either the United States or the Soviet Union.

However, by 1971 China had not in practice fulfilled the worst expectations, voiced at the time of its first nuclear detonation in 1964, regarding the sharing of its nuclear knowledge. In 1965 there were occasional rumours in the West, which never materialized, e.g., of Chinese nuclear weapons being given to Egypt and Indonesia in 1965, and later to Albania. China has, to the best of our knowledge, not even given nuclear aid for civil purposes to any country. Around 1968, the cautious political exploitation of China's approaching nuclear status consisted of referring to it as a "source of inspiration" to national liberation movements in general and to the NLF in South Viet-Nam in particular:

It [China's thermonuclear weapon test] is a great inspiration and support to the heroic Vietnamese people in carrying their war against US aggression and for national salvation through to the end, and to the people of all countries in their revolutionary struggles.[21]

This might also, of course, have been intended as a warning to the United States in Viet-Nam to keep in mind the existence of Chinese nuclear weapons. So far, however, China has not openly promised any nuclear "umbrella", for instance for North Viet-Nam.

The Outer Space Treaty, concluded in 1967, as well as the Sea-Bed Treaty, concluded in 1971, were both denounced by China as further steps in the US-Soviet collaboration, designed to "divide and dominate" these areas between themselves.[22]

[20] *Peking Review*, No. 25, 13 June 1968.
[21] Hsinhua News Agency release, 28 December 1968.
[22] See, for instance, *Peking Review*, No. 7, 10 February 1967, and No. 10, 5 March 1971.

After the meeting of the US and Soviet leaders in Glassboro in 1967, China began to comment on the possibility of US–Soviet strategic arms limitation talks with increased vehemence, since this, like the PTB and the NPT, was interpreted as a political measure chiefly directed against China:

> The Johnson Administration recently yelled about constructing a so-called "anti-ballistic missile system" in an all-out agitation against China ... McNamara publicly stated that it was not necessary for the United States to go to a "profitless waste of resources" to build an anti-ballistic missile system against the Soviet Union. In addition, he urged that the United States and the Soviet Union come to an agreement on nuclear attack and "nuclear defence". All this reveals the insidious scheme of the US imperialists and the Soviet revisionists to step up their military collaboration against China. US imperialism regards socialist China as its chief enemy ... Washington not only feels perfectly at ease with nuclear weapons being in the hands of the Soviet revisionist clique but also plots with the Kremlin to oppose socialist China.[23]

The argumentation reached its peak in 1969, when for instance the following article, by no means confined to comment on the SALT talks, was published:

> The Kremlin renegades are like prostitutes who want a monument raised for their chastity ... While shouting "anti-imperialism" they are flirting and stepping up collusion with US imperialism. This is well understood by US imperialism. After Nixon declared in June that the United States would hold "strategic arms limitation talks" with Soviet revisionism at an early date, US Secretary of State Rogers at a press conference in early July openly encouraged the Soviet revisionists to be "particularly active" in "bilateral talks with the United States."[24]

In summarizing US–Soviet disarmament policy, the Chinese repeatedly presented the view that all treaties and talks had not, in fact, served the goal of disarmament but were instead "aimed at hoodwinking the world's people and covering up the intensified nuclear arms expansion and war preparations of US imperialism and social-imperialism and their nuclear war threats against the world's people".[25] French criticism of SALT, as expressed by President Pompidou, was also publicly noted in China.[26]

From 1970 there was, however, a marked restraint in the way China presented its arguments, and while US–Soviet policies were still criticized, this criticism was phrased in more general terms, without singling out specific issues.[27]

[23] *Peking Review,* No. 44, 27 October 1967. Translation of article in *Renmin Ribao,* 16 October 1967.

[24] *Peking Review,* No. 35, 29 August 1969.

[25] See, for instance, *Peking Review,* No. 13, 28 February 1969.

[26] See, for instance, "Ever-Sharpening French–US Contradictions", *Peking Review,* No. 11, 13 March 1970.

[27] *Peking Review,* No. 17, 24 April 1970.

The Chinese government has, since 1963, consistently protested against a future "superpower" label, and has stated on several occasions that China would never join a "nuclear club":

US imperialism is now calling China a "potential superpower" implying that China may also squeeze into the ranks of the superpowers some day. Thank you, American lords, but China will never accept this kind of compliment! China will never seek the so-called big-power position. We will forever stand side by side with all nations subjected to aggression, control, intervention or subversion by superpowers; we will forever stand side by side with all oppressed people and oppressed nations. The Chinese people will fight together with the people of the whole world to resolutely smash the doctrine of big-nation hegemony.[28]

On 15 June 1971, the Soviet Union proposed a conference between the five nuclear-weapon states. China's reply was negative, stating that: "The history following World War II shows that it is absolutely impossible to settle questions of nuclear disarmament by relying on negotiations only between a few big powers possessing nuclear weapons." The statement then repeated the Chinese view on the PTB, the NPT and SALT as having in no way restricted the nuclear arms race, and ended by saying that the issue of disarmament is a matter for all nations and that the disarmament discussions between the USA and the USSR would not be improved even by the inclusion of China in these talks:

The peoples of the world have long lost their confidence in the disarmament talks between the nuclear powers. They rightly hold that it is impossible to settle the question of nuclear disarmament as a whole by depending on two nuclear superpowers. *Nor can it be settled by the addition of some more nuclear powers.*[29]

This can be contrasted to China's position in 1954, when it endorsed a Soviet proposal in the United Nations calling for China's participation in negotiations between the USSR, the USA and France for a joint declaration not to use nuclear weapons and other weapons of mass destruction.

Chinese proposals for nuclear disarmament

In 1959 China proposed a nuclear-free zone in the Far East: "We advocate the establishment of an area free of atomic weapons, an area of peace, throughout the whole of East Asia and the Pacific regions."[30] When this

[28] "Down with the Doctrine of Big Nation Hegemony", in *Peking Review,* No. 5, 29 January 1971 (translation of article in *Renmin Ribao,* 23 January 1971).
[29] "Statement of the Government of the People's Republic of China, 30 July 1971", in Hsinhua News Agency release, 8 August 1971. (Italics added.)
[30] Chou En-lai, "The Report on Government Work" delivered to the 1st session of the Second National People's Congress, 18 April 1959, translated in *Current Background,* No. 559, (Hong Kong: US Consulate General, 23 April 1959).

proposal was repeated in August 1960, it included the USA; after 1963 the USSR was also mentioned. Given the political realities of the Far East, these conditions seem to indicate that China did not really expect any agreement to materialize. After the first Chinese nuclear explosion in 1964, the concept of nuclear-free zones as the first step towards disarmament was abandoned:

Many countries at present are keenly interested in the establishment of nuclear-free zones. However, to really free the nuclear-free zones from the threat of nuclear war it is first necessary for the nuclear powers to undertake not to use nuclear weapons. Otherwise, the establishment of nuclear-free zones would be impossible and even if they be set up in name, all it means is that the non-nuclear countries would be deprived of their legitimate right to develop nuclear weapons to resist the nuclear menace and be bound hand and foot, while the nuclear powers would in no way be affected in their continued production, stockpiling and even use of nuclear weapons. Consequently, the sole result would be: the larger the nuclear-free zone, the graver the US imperialist nuclear threat to the non-nuclear countries.[31]

By 1971 the proposal for a no-first-use agreement remained the basic element in an independent Chinese disarmament policy. It dates from 31 July 1963, when the Chinese government denounced the PTB and proposed the following, as adequate measures towards disarmament:

(1) All countries in the world, both nuclear and non-nuclear, solemnly declare that they will prohibit and destroy nuclear weapons completely, thoroughly, totally and resolutely. Concretely speaking, they will not use nuclear weapons, nor export, nor import, nor manufacture, nor test, nor stockpile them; and they will destroy all the existing nuclear weapons and their means of delivery in the world, and disband all the existing establishments for the research, testing and manufacture of nuclear weapons in the world.
(2) In order to fulfil the above undertakings step by step, the following measures shall be adopted first:
a. Dismantle all military bases, including nuclear bases, on foreign soil, and withdraw from abroad all nuclear weapons and their means of delivery.
b. Establish a nuclear weapon-free zone of the Asian and Pacific region, including the United States, the Soviet Union, China and Japan; a nuclear weapon-free zone of Central Europe; a nuclear weapon-free zone of Africa; and a nuclear weapon-free zone of Latin America. The countries possessing nuclear weapons shall undertake due obligations with regard to each of the nuclear-free zones.
c. Refrain from exporting and importing in any form nuclear weapons and technical data for their manufacture.
d. Cease all nuclear tests, including underground nuclear tests.
(3) A conference of the government heads of all countries of the world shall be convened to discuss the question of the complete prohibition and thorough de-

[31] "New Starting Point for Efforts to Ban Nuclear Weapons Completely", *Peking Review*, No. 48, 27 November 1964.

struction of nuclear weapons and the question of taking the above-mentioned four measures in order to realize step by step the complete prohibition and thorough destruction of nuclear weapons.[32]

Following its first nuclear explosion in 1964, China unilaterally committed itself not to use nuclear weapons first: "The Chinese government hereby solemnly declares that China will never at any time and under any circumstances be the first to use nuclear weapons."[33] In this connection, a proposal for a summit conference was also repeated; as a first step, this conference "should reach an agreement to the effect that the nuclear powers and those countries which may soon become nuclear powers undertake not to use nuclear weapons neither to use them against non-nuclear countries and nuclear-free zones, nor against each other".[34]

China made considerable efforts to bring about a discussion of this proposal. The *New York Times* reported on 22 October 1964 that Chou En-lai's letter of 2 August, containing the same text as the above-quoted statement of 31 July, was passed on to the US representatives in Warsaw. This was later substantiated by the Chinese:

Shortly after its first nuclear test, China proposed to the United States that the governments of both countries should issue a formal statement pledging that neither of them would at any time or under any circumstances be the first to use nuclear weapons. If the United States had any sincere desire for peace, it would have been easy to reach an agreement.[35]

However, the United States rejected the proposal. Other nations, including the Soviet Union, which initiated the idea of non-use of nuclear weapons as early as the 1940s, were more responsive. Admittance to the United Nations finally provided China with the opportunity of presenting its disarmament programme to a worldwide audience. China took its seat in the United Nations on 15 November 1971, and on the next day the debate was resumed on the Soviet proposal for a world disarmament conference. In his first substantive speech on disarmament, on 24 November, the Chinese delegate rejected the Soviet proposal with the following argument. The speech contained the same basic approaches as the 1963 government statement.

The two conditions demanded by China from the USA and the USSR, apparently in advance of the convening of any sort of summit conference,

[32] "Statement by the Chinese Government advocating the complete, thorough, total and resolute prohibition and destruction of nuclear weapons and proposing a conference of the government heads of all countries of the world", 31 July 1963, in *People of the World Unite, op. cit.*, pp. 5–6.
[33] In *Peking Review*, No. 42, 16 October 1964.
[34] *Ibid.*
[35] *Peking Review*, No. 1, 1 January 1965.

seem to reflect an intransigent position, designed to be impossible for those two powers to accept:

The Chinese government also maintains that in order to realize the complete prohibition and thorough destruction of nuclear weapons, the United States and the Soviet Union which possesses large quantities of nuclear weapons should, first of all, issue statements separately or jointly to undertake openly the obligations
1) not to be the first to use nuclear weapons at any time and in any circumstances and not to use nuclear weapons against non-nuclear countries and against nuclear-free zones.
2) dismantle all nuclear bases set up on the territories of other countries and withdraw all their nuclear armed forces and all nuclear weapons and means of delivery from abroad.[36]

But whereas the first point above contains the same wording as the unilateral commitment repeatedly undertaken by China, the explanatory comment by the Chinese delegate contains the following, perhaps important, modification:

In order to take the first step towards the complete prohibition and thorough destruction of nuclear weapons, one must grasp the key question and not be entangled with subsidiary issues. First and foremost, the countries possessing nuclear weapons should undertake the obligation not to be the first to use nuclear weapons against each other, and particularly not to use nuclear weapons against non-nuclear countries or nuclear-free zones. ... Otherwise, it will be totally impossible to establish nuclear-free zones or peace zones, and the danger of nuclear war will still exist.[37]

While the blanket "no-first-use" declaration has always been dismissed by the West as propaganda, the emphasis on a specific application to non-nuclear-weapon countries and nuclear-free zones may point to the possibility of China's accepting a more limited declaration. It should also be kept in mind that, while China seems to value this sort of declaration as an indication of serious intentions, China's unilateral commitment not to strike first does not imply any strategic disadvantage to China. That is to say, the argument advanced in the West—that a nuclear-weapon power must have the right to use nuclear weapons in a first strike under certain circumstances, such as a massive attack by superior conventional forces—cannot apply to China. It is hard to conceive of any circumstances that would militarily justify a nuclear first strike by China against the USA or the USSR, not to mention one against non-nuclear-weapon countries. Thus, in realistic terms, what China has undertaken is a commitment not to use

[36] Chiao Kuan-hua's speech at UN General Assembly plenary, 24 November 1971, in Hsinhua News Agency release, Stockholm, 27 November 1971, p. 21.
[37] *Ibid.*, pp. 19–20.

nuclear weapons first against non-nuclear-weapon countries, even if they are allied with the USA or the USSR. The latter is especially important for China's Asian neighbours, especially Japan and India. Consequently, China will very likely continue to press in the United Nations for the USA and the USSR to undertake a similar commitment.

The Soviet proposal for a world disarmament conference brought forth a very short and categorical explanation of why the draft resolution was unacceptable and an elaborated Chinese explanation of its view of the United Nations:

In the opinion of the Chinese delegation, the Soviet delegation's proposal for convening a world disarmament conference has neither set out a clear aim nor put forth practical steps for its attainment. If the Soviet proposal is to be acted upon, such a world disarmament conference would inevitably become a permanent club for endless discussions that solve no substantive problems, which will result in perpetual arms expansion alongside perpetual disarmament talks. ... The greater the number of the resolutions adopted, the lower the prestige of the United Nations. The time has now come to change this inglorious situation. We should endeavour to make a new start. None of us should act rashly and make hasty decisions on such a major problem as disarmament. We should consult each other fully and continue the discussions to find a way truly conducive to nuclear disarmament, and avoid discussions that lead to no solutions or decisions that are not put into effect, for this can only further disappoint the people of the world. Therefore, the Chinese delegation proposes that the Soviet draft resolution for convening a world disarmament conference not be put to the vote at this session of the General Assembly.[38]

However, this did not mean that China had dismissed the concept of a summit conference as such. The Chinese delegate stated:

As for the level of the conference, we still hold that it should be attended by the heads of government of all countries, but we are also prepared to hear and consider different opinions. As to whether it should be convened inside or outside the United Nations, this question is open for discussion and consultation among all.[39]

This, in fact, represents an elaboration of what was previously seen as a categorical Chinese demand for a summit conference, suggesting that China seriously intends to explore the matter, in informal discussions also. It is also evident that China intends to press its point that all nations should be consulted, not only as participants in a future summit conference but also as planners of the conference.

China therefore chose to support the draft resolution on the matter of a disarmament conference presented by twenty-seven nations, with Mexico and Romania as the leading sponsors. This resolution, which was adopted

[38] *Ibid.*, p. 22.
[39] *Ibid.*, pp. 21–22.

on 16 December in place of the Soviet resolution, is confined to an invitation to all states to communicate to the UN Secretary-General, before 31 August 1972, their views and suggestions on any relevant questions regarding a world conference on disarmament. While consistent with China's approach to the third world, support for this proposal was also consistent with its opposition to the USA and the USSR taking the initiative in matters of disarmament. In fact, the Soviet proposal for a world disarmament conference also suggested consultations with all countries of the world as the first step. The political rationale behind China's stand was indicated by the Chinese Ambassador to the United Nations in his speech in the closing debate. After repeating the conditions demanded of the USA and the USSR, he stated:

> Why should all this be done? Because it is none other than these two superpowers that are obdurately pushing the policies of nuclear monopoly, nuclear blackmail and nuclear threats. The world disarmament conference should in no way be convened under the nuclear threat of the superpowers.[40]

IV. *Summary and conclusions*

Whatever the real intentions of China are in regard to disarmament, they are obviously interrelated with the direction of China's nuclear weapons programme. Official Chinese statements accompanying each nuclear explosion have stressed the defensive nature of the programme. However, official statements do not necessarily reflect the real intentions of governments, and there has been much speculation about the future direction of the Chinese nuclear weapons programme. One expectation, following the launching of the Chinese satellite in 1971, concerned the development of ICBMs directed at the USA. Logically, a credible deterrent for China might mean a second-strike capability, enough to inflict considerable damage on any enemy, since China has committed itself not to strike first. On the other hand, there is the opinion that China is aiming at a nuclear force which will be considerably less than the "overkill" capability of the USA and USSR, but which will be considered sufficient to ensure that a potential enemy will conclude that the risks involved in a nuclear attack on China are too high and that it is time to open a dialogue. The situation might, in fact, soon be created in which China, though far from anything like parity with the USA and the USSR, has accumulated enough confidence through the comparatively fast progress of its nuclear weapons programme to allow it to approach or confront the USSR and the USA from a position of compara-

[40] UN Document A/PV. 2022, 16 December 1971, p. 42.

tive strength. The development of China's disarmament policy indicates that China is prepared to join discussions. It also shows that China is unlikely to commit itself to partial arms control or disarmament measures of the type concluded so far, because these are considered detrimental to China, strategically and politically, *vis-à-vis* the United States and the Soviet Union. For instance, a nuclear test ban has been dismissed by China as implying a threat to its security. Consequently, China is not likely to join any negotiating body dominated by the USA and the USSR. There is, however, reason to assume that China is willing to discuss several measures of actual nuclear disarmament, given a reorganization of present negotiating forums. By late 1971, the UN debate on the summit conference gave at least some indication of China's future behaviour. First, while China emphasized its position on disarmament as a counterweight to US–Soviet policy, it did not try to put any resolution of its own to a vote but preferred to support the twenty-seven nation draft resolution. If one of China's objectives for the future remains to be regarded as part of the third world, perhaps the leading force, China will have to operate not in isolation from, but together with, as many nations as possible.

Furthermore, whereas by 1971 the Chinese position regarding the conditions demanded of the USA and the USSR prior to the convening of any conference did seem intransigent, future events might still allow some amount of bargaining. It should be noted that China placed several conditions on its entry into the United Nations which were quietly neglected when this actually occurred. Finally, in the absence of any serious nuclear disarmament measures taken first by the USA and the USSR, the Chinese government is assumed to be continuing its nuclear weapon build-up for the same national security reasons as those advocated by the USA and the USSR.

Part IV. Developments in arms control and disarmament, 1970–1971

Chapter 16. Chemical and biological disarmament

Introduction Essential provisions of the biological disarmament convention Significance of the biological disarmament convention Prospects for chemical disarmament Reinforcement of the constraints on CW Convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction

Chapter 17. The nuclear test ban debate

Introduction Interim measures Partial measures Verification Peaceful applications of nuclear explosions Legal form of the ban Draft treaty Memorandum of the non-aligned powers Conclusions

Chapter 18. Preventing an arms race on the sea-bed

Treaty on the prohibition of the emplacement of nuclear weapons and other weapons of mass destruction on the sea-bed and the ocean floor and in the subsoil thereof

Chapter 19. The treaty for the prohibition of nuclear weapons in Latin America (Treaty of Tlatelolco)

Chapter 20. Declaration of the Indian Ocean as a zone of peace

Chapter 21. The Disarmament Decade

16. Chemical and biological disarmament

I. *Introduction*

Negotiations on chemical and biological disarmament have yielded the first, though only partial, result in the form of the prohibition of biological weapons and toxins. This was due to a major turning point in CB disarmament negotiations in the spring of 1971. The USSR and its allies, which for years had been insisting on a joint treatment of chemical and biological weapons, and had considered their prohibition an indivisible entity, revised their position. They agreed to conclude a convention providing for biological disarmament only, and thus accepted the approach advocated by the United Kingdom and the USA. Up to that moment the majority of nations had upheld the view that such a minimum solution would not be satisfactory.[1]

On 16 December 1971, the UN General Assembly commended[2] the draft convention "on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction", which had been worked out at the Conference of the Committee on Disarmament (CCD),[3] and requested the depositary governments to open the convention for signature and ratification. (For the text of the convention, see page 517.)

The main provisions of the biological convention are examined here. A discussion then follows of the significance of the document, its value and limitations, as well as of prospects for chemical disarmament. In conclusion, some suggestions are made for reinforcing the existing constraints on chemical weapons, pending the conclusion of a treaty prohibiting the possession of those weapons.

[1] The CB disarmament negotiating history is reviewed in detail in *CB Disarmament Negotiations, 1920–70,* Volume IV of the SIPRI study on *The Problem of Chemical and Biological Warfare* (Stockholm: SIPRI, 1971). The volume also reports events in 1971 which led to a separate treatment of biological weapons.

[2] UN document A/RES/2826(XXVI).

[3] UN document A/8457.

II. *Essential provisions of the biological disarmament convention*

Scope of the obligations

The convention is concerned with microbial or other biological agents and toxins (Article I).

In its report of 1969[4] the World Health Organization defined "biological agents" as those that depend for their effects on multiplication within the target organism, and are intended for use in war to cause disease or death in man, animals or plants (the target organisms). Neither this, nor any other definition, has been incorporated in the convention.

No doubts have been formally expressed as to the all-inclusive character of the biological agents prohibition. However, a clear-cut definition of the subject of the convention would make it impossible for a party ever to claim an exception to the comprehensive ban and to interpret it restrictively, for example, by relating it only to some target organisms, with the exclusion of others. A controversy similar to that over the 1925 Geneva Protocol, which some governments still consider as not banning the use of anti-plant agents, would then be definitely foreclosed.

The definition of toxins is admittedly more difficult. These poisonous substances are products of organisms; however, they are inanimate and incapable of reproducing themselves. But some toxins may also be produced by chemical synthesis, and it is conceivable that only the active site of the toxin need be synthesized, in which case the question of identity with the natural product would be hard to resolve. The language of the draft convention is meant to avoid ambiguity and to ensure that the concept of "toxins" is understood broadly: both biological and synthetically produced or modified compounds, that can now, or could in the future, be used as warfare agents, are covered by the prohibition, "whatever their origin or method of production".

The parties undertake not to develop, produce, stockpile or otherwise acquire or retain the agents and toxins specified above (Article I). However, research aimed at production of these agents or at development of new warfare agents is not banned. This omission is fraught with consequences because the prohibition to develop, produce, stockpile or otherwise acquire or retain is not absolute. It applies only to types and quantities of biological

[4] *Health Aspects of Chemical and Biological Weapons* (Geneva: World Health Organization, 1970).

agents and toxins "that have no justification for prophylactic, protective or other peaceful purposes".

While the term "prophylactic" is understood as encompassing medical activities, such as diagnosis, therapy and immunization, the term "protective", as explained by the authors of the convention,[5] covers the development of protective masks and clothing, air and water filtration systems, detection and warning devices, and decontamination equipment. Thus, research on and production of certain quantities of biological agents and toxins, over and above those needed to prevent diseases, will continue, as they will be necessary to develop the protective equipment and devices. There is also bound to be some testing in the laboratories and possibly even in the field, as well as appropriate military training.

The very maintenance of defensive preparations, which at certain stages are indistinguishable from offensive preparations, may generate suspicion, and the continued production of warfare agents contains a risk of infringement or of allegations of infringement of the provisions of the convention.

The qualification that there should be "justification" for the development, production, stockpiling or retention does not carry much weight. There are no agreed standards or criteria for the quantities of agents and toxins that may be required for different purposes, especially for military protective purposes; it is not clear who is to judge whether there exists justification for the production of any given quantity.

If countries insist on preserving their defensive preparedness, the risk inherent in the retention of some warfare agents could be considerably reduced if defensive work were internationalized to the greatest possible extent—for example, by the establishment of a special information service, or by standardization, through agreement, of protective appliances—and also if secrecy surrounding biological research were removed. This has not been provided for in the convention, but the article regarding exchange and cooperation in the use of biological substances for peaceful purposes (see below) creates premises for such future development. In no case, as was made clear in the debate, should the word "protective" be interpreted as permitting possession of biological agents or toxins for "defensive" warfare, retaliation or deterrence. This, of course, limits the amount of biological agents and toxins that countries may possess, although there is no indication at all about what the limit is.

The convention also prohibits the development, production, stockpiling, acquisition or retention of weapons, equipment or means of delivery designed to use biological agents and toxins (Article I). Research aimed at

[5] Disarmament Conference document CCD/PV.542; and UN document A/C.1/PV.1838.

production of weapons is not banned. Here there can be no justification for the omission on prophylactic, protective or other grounds, as in the case of agents.

The ban on acquisition has been strengthened by a prohibition on transfering the agents and equipment to "any recipient whatsoever"—that is, including states non-parties or international organizations, individuals or groups of individuals—and on assisting in any way in their manufacture (Article III). The importance of this non-dissemination clause has to be seen in the light of the assumed international exchange of agents and toxins for peaceful uses under Article X (see below).

The prohibitions under the convention apply "in any circumstances". The term employed makes it difficult for states adhering to the convention to formulate reservations with regard to its basic aims and there can be no doubt that the prohibitions will also be in force in time of war. The effectiveness of the provision is weakened by a clause permitting formal withdrawal from the convention (see below).

The parties undertake to destroy or divert to peaceful purposes, within nine months after the entry into force of the convention, all the prohibited agents, toxins, weapons, equipment and means of delivery (Article II). In doing so, they are obliged to observe "necessary" safety precautions and to protect not only their own population but also the "populations" of other countries and the environment in general against possible contamination.

Verification and enforcement

No verification of the destruction of stockpiles, or of their diversion to peaceful purposes, is envisaged. The parties are not even obliged to announce that they have complied with the commitment and when. However, the United States stated its intention to notify the depositary governments, and through them all the parties to the convention, of the implementation of the relevant provision.[6] (The elimination of the US arsenal of biological weapons, in accordance with the 1969 US unilateral renunciation of these weapons, was already in progress when the treaty was discussed.) The United States has promised to open the relevant biological facilities for public inspection and foreign visitors, following the destruction of stockpiles.[7]

The Soviet Union has also expressed its willingness to give appropriate notification "on the understanding that other states parties to the conven-

[6] Disarmament Conference document CCD/PV.542.
[7] *US Congressional Record-Senate,* 9 March 1971.

tion do likewise".[8] The question of inspecting biological facilities was not mentioned.

The destruction commitment will concern only very few states. Nevertheless, it would seem opportune and would add to the efficacy of the convention if, not later than nine months after its entry into force (the time prescribed for destruction), all parties formally announced that no biological warfare agent or toxin, and no prohibited weapon or equipment, was present on their territories.

The problem is more complicated when it comes to stockpiles which may be illicitly retained. It should, however, be borne in mind that, in the absence of new production and unless fully effective methods of preservation are used, the military utility of secretly stored agents will, with the passage of time, decrease.

It is generally recognized that verification of nonproduction, in the sense in which the term is normally used in disarmament negotiations, is not indispensable in the biological field, even if it were feasible. The enforcement of obligations under the convention is to be carried out through measures under national control and through some international arrangements.

Each state assumes responsibility not only for observing the convention itself, but also for preventing the prohibited activities "within the territory of such state under its jurisdiction or under its control anywhere" (Article IV), that is, by another state, private individuals or organizations. While it is not uncommon that laws are passed in accordance with constitutional processes to transpose onto the national level the commitments contracted internationally, in the case of biological weapons, considering the nature of the weapons and the relative ease with which they can be produced, these "necessary measures" to be taken by the parties acquire special significance.

On the international level, the parties undertake to consult one another and to cooperate in solving problems relating to the application of the provisions of the convention. Such consultation and cooperation may also be indirect—"through appropriate international procedures within the framework of the United Nations and in accordance with its Charter" (Article V).

A provision for direct consultation is redundant when a problem arises between friendly nations; it is inoperative when allegations of breaches are made by countries at war, or when for other reasons there is lack of cooperation between the states concerned. An indirect international procedure is more likely to be set in motion. But the language used to cover such eventualities is rather loose: the sense of the term "appropriate" is

[8] Disarmament Conference document CCD/PV.542.

vague. If it means recourse to the UN Security Council, then again a special clause seems unnecessary. According to the Charter, the UN members have a statutory right to bring any dispute or any situation which may endanger international peace and security to the attention of the Security Council and also of the UN General Assembly. A charge of violation of the biological convention, as of other disarmament agreements, would certainly fall into this category. Besides, in the special case of biological warfare, the Security Council has been assigned a special role under a separate article of the convention, within the framework of the so-called complaints procedure (see below). If "appropriate international procedures" means recourse to other UN organs, for example the Secretary-General, it is doubtful whether the latter would undertake the task of solving problems relating to the application of the convention without a well-defined mandate agreed upon in advance, and the authority for immediate action.

Another way of guaranteeing compliance has been provided through a conference to be convened with the aim of reviewing the operation of the convention and assuring that its purposes and provisions are being implemented; any new and relevant scientific and technological developments could then be taken into account (Article XII).

The parties are entitled to lodge complaints of breaches of the convention with the UN Security Council. The complaint should contain all possible evidence confirming its validity as well as a request for its consideration. Each party undertakes to cooperate in carrying out any investigation which the Security Council may initiate on the basis of the complaint received (Article VI). It is understood that in principle such investigation may include on-site inspection.

The practical value of the complaints procedure is somewhat dubious. Since there is no regular international verification of nonproduction, it is not at all apparent how it may be possible through legal means to collect evidence confirming the "validity" of a complaint as required. Even data concerning the continued production of biological agents, either qualitative or quantitative, are not to be reported. If the implication of the provision is that other, extra-legal means may be employed to collect evidence on clandestine production of prohibited agents, it should be realized that the parties are not in equal positions in this respect; many may not even possess such means.

Some countries assume that the international consultation procedure under Article V will make it possible to carry out preliminary investigations and to gather data serving as foundation for a complaint submitted to the Security Council. But here, too, it is not clear on the basis of what evidence the consultation procedure could be started. Besides, as mentioned above, no special machinery is envisaged to deal with the charges prior to their submission to the Security Council. Only the Council has under the convention a clearly expressed right to initiate investigations. Thus, each allegation, whatever its importance, may immediately become a subject of political controversy. The permanent members of the Security Council would be in a position to veto even a technical enquiry into the nature of suspected activities if the allegation is directed against them or their allies. This creates a manifest inequality of obligations—a dangerous precedent for future disarmament agreements. While it is unlikely that the great powers would give up their prerogatives under the UN Charter, and agree to a majority rule when a decision is to be taken on charges of violation, the discriminatory character of the procedure could be attenuated if an understanding is reached, or assurance given, formally or informally, that at least the initiation of investigations will not be blocked by a veto. A UN Security Council resolution containing merely a declaration of readiness to consider complaints and to take measures for their investigation, as suggested by some countries, will not make the role of the Security Council as the chief supervisor of the observance of the convention more tolerable.

In any event, and whatever the basis for a possible complaint, a complete separation of the fact-finding stage of the "complaints procedure" from the stage of political consideration and judgement by the Security Council would be more sensible and more effective. This would require a standing body of technically qualified and internationally recognized experts who could be speedily dispatched at the request of parties to carry out enquiries, in conformity with established criteria. Although a state guilty of encroachments would probably not cooperate and not permit its territory to be inspected, the very existence of an impartial mechanism, as suggested above, would constitute a deterrent against possible use and clandestine possession of the banned weapons. It would also make it easier for an innocent state under suspicion of having violated its obligations to free itself from that suspicion through invitation to inspection. In no circumstances could a refusal to allow inspection of biological laboratories be justified on grounds of military secrecy.

As it stands now, the whole system of enforcement under the convention is based on trust rather than on supervision. Even assuming that the Security Council is in a position to conclude that a breach of the convention has occurred, it still remains unclear what action will follow the conclusion, other than informing the parties of the results of the investigation. No measures against the offender have been explicitly provided for.

A separate article contains an undertaking to provide or support assistance to any party, in accordance with the UN Charter, if the Security

Council decides that such party has been exposed to danger as a result of violation of the convention (Article VII). The assistance is meant primarily as action of medical or other humanitarian or relief nature, taken at the request of the endangered party.[9] The clause is also interpreted broadly (*inter alia,* by the Soviet Union) as permitting other measures aimed at ensuring the security of the victim of aggression and the maintenance of peace, according to Chapter VII of the UN Charter.

While it is recognized that it would be for the requesting party to decide, in the first place, on the form of assistance to be provided, a confusion exists with regard to the strength of the commitment to assist. It would seem that, since assistance is to be given in accordance with the UN Charter, the relevant provision of Chapter VII of the Charter should apply; under this provision the UN members "shall join in affording mutual assistance in carrying out the measures decided upon by the Security Council". But in the understanding of the UK and the USA,[10] it would be for each party to decide whether it could or was prepared to supply the aid requested. In other words, assistance would be optional, not obligatory: it could be refused without incurring the charge of non-compliance. If this is so, one can hardly see the purpose of including a clause on the subject in the convention.

Another caveat was entered by the sponsors of the convention to the effect that states should not be precluded from rendering assistance they deemed appropriate, before a decision is taken by the UN Security Council with regard to the violation of the convention, and also on the basis of other, non-UN commitments. This further impairs the force of the provision in question as far as UN involvement is concerned.

Relationship to the Geneva Protocol

The draft convention does not contain a prohibition on the use of biological and toxin weapons. The ban is included in the 1925 Geneva Protocol prohibiting the use of asphyxiating, poisonous or other gases and of bacteriological methods of warfare. No one contests that toxins are also covered by the prohibition. The significance of the Protocol is strongly emphasized, its integrity safeguarded and its continuing validity confirmed in the text of the draft convention. All states are urged to comply strictly with

[9] It may be noted that as early as 1930 a proposal was discussed at the Preparatory Commission for the Disarmament Conference to conclude a convention for international aid, essentially of a humanitarian nature, to any country attacked with chemical or bacteriological weapons.

[10] Disarmament Conference documents CCD/PV.542 and CCD/PV.544; and UN document A/C.1/PV.1838

the principles and objectives of the Protocol (Article VIII and paragraphs 2, 3, and 4 of the preamble).

In ratifying the Geneva Protocol, many countries reserved the right to use the banned weapons against non-parties or in retaliation. It is now agreed that the reservations will become pointless, as far as biological weapons are concerned, once the convention, aimed at completely eliminating these weapons, comes into force. In fact, the convention proclaims the determination of the parties "to exclude completely the possibility of bacteriological (biological) agents and toxins being used as weapons" (paragraph 9 of the preamble). (This determination has been unnecessarily weakened by the last preambular paragraph expressing merely the conviction that no effort should be spared "to minimize" the risk of such use.) The phrase "never in any circumstances", reinforcing the prohibition under the convention (see above), is also taken as allowing no exemption from the ban on the use of biological and toxin weapons. Moreover, the procedure for investigating cases of illicit production and retention of the weapons in question, whatever its effectiveness, is clearly also applicable to cases of illicit use, since use presupposes possession.

All this, however, does not change the fact that the Geneva Protocol *is* accompanied by reservations which form an integral part of that document. According to Article VIII of the convention, nothing shall be interpreted as in any way limiting or detracting from the obligations assumed by any state under the Geneva Protocol. This may imply that the reservations—part and parcel of the obligations—will continue to subsist. Legally, they can be nullified only through a direct act of withdrawal.

To avoid misunderstandings and incompatibility with the new commitments, the countries which have attached reservations to the Geneva Protocol should declare them null and void, at least with regard to biological and toxin weapons, at the time of ratification or accession to the biological disarmament convention.[11]

Peaceful uses of biological agents

The parties undertake to facilitate and participate in an international exchange of equipment, materials and information for the use of biological agents and toxins for peaceful purposes, and to cooperate in the development of bacteriology (Article X).

[11] Belgium stated its intention to study, after the entry into force of the convention, the possibility, as far as biological weapons and toxins are concerned, of abandoning the reservations it had made in ratifying the Geneva Protocol (UN document A/C.1/PV.1841).

This is the first time a measure taken in the disarmament field provides an opportunity for the deployment of resources from military to civilian needs.[12] Besides, if an extensive international scientific exchange programme develops, it could reduce the anxiety which may be felt with regard to the absence of adequate provisions for inspection and control. But there is no built-in guarantee in the draft convention that this will actually happen.

The UN resolution commending the convention recalled the principle that the implementation of measures in the field of disarmament should release additional resources for the promotion of economic and social development, particularly in the developing countries. However, in the case of biological disarmament this principle will hardly have any significant effect.

Link with chemical disarmament

The biological disarmament convention is characterized as "a first possible step" towards the solution of the whole complex of CB disarmament (paragraph 8 of the preamble). As a matter of fact, it already covers chemically produced toxins and, according to definitions current in certain countries, even natural toxins are chemical warfare agents.[13] The parties undertake to continue negotiations with a view to reaching "early agreement" on effective measures for prohibiting the development, production and stockpiling of chemical weapons and for their destruction, and on appropriate measures concerning equipment and means of delivery (Article IX). However strong the commitment may be, it refers only to negotiations, not to disarmament. The review conference to be held five years after the entry into force of the convention, or earlier if so requested by a majority of parties, will have, among its tasks, to assure that the provisions concerning negotiations on chemical weapons are being realized. But even before then, the parties could press for chemical disarmament through consultation on problems relating to the objective of the convention (Article V), the enunciated objective being the elimination of both chemical and biological warfare agents from the arsenals of states.

[12] On 18 October 1971, the US President announced that one of the largest US facilities for research related to biological warfare, at Fort Detrick, Maryland, was being converted into a leading centre for cancer research.
[13] UN document A/7575/Rev. 1.

Entry into force and withdrawal

The convention is of unlimited duration but each party has the right to denounce it, if it decides that extraordinary events, related to the subject matter of the convention, have jeopardized the supreme interests of its country (Article XIII). The clause is patterned after previous arms limitation agreements.

In the case of biological weapons, the withdrawal provision has little, if any, justification. Apart from being a repulsive type of arm, biological and toxin weapons in their present form have, in the view of the military, little value, either as a means of offence or as a means of defence. Even if a biological attack occurred, a response in kind would be, in the opinion of many, irrational. As a form of sanction, withdrawal from the convention lacks credibility. Renunciation of biological warfare for ever, with no condition or escape clause attached, would not jeopardize the national security of any state.

The convention is to enter into force after the deposit of the instruments of ratification by twenty-two governments, including those of the USSR, the UK and the USA, as depositaries. The designation of nuclear-weapon states as depositaries of the biological convention is less substantiated than in the previously concluded treaties dealing with nuclear matters. The choice of a non-nuclear-weapon and especially non-aligned country or countries as depositaries of a convention related to non-nuclear weapons would not be less equitable; if anything, it could facilitate wider adherence to the convention.

The United States, the United Kingdom and the Soviet Union are expected to be among the first countries to ratify the convention. France stated that it would not sign it. One reason given was that, by separating the treatment of biological weapons from that of chemical weapons, the convention may weaken the scope and the authority of the 1925 Geneva Protocol with regard to the prohibition of chemical warfare. Another reason, considered even more important, was that the lack of international verification of the observance of the convention contradicts the principle that there cannot be, on the international level, true disarmament without control, a principle which, according to France, should be applied to any disarmament measure of a contractual character, albeit partial. In the autumn of 1971, France decided unilaterally to prohibit the development, production, possession, stockpiling, acquisition or granting of all biological agents which are not designed for peaceful purposes, and also to forbid incitement or assistance in this field to any state, organization or person.[14]

[14] UN document A/C.1/PV.1838.

In the absence of major substantive objections on the part of other states (China did not participate in the CB disarmament debate), and considering the low number of ratifications required, the convention should become operative rather soon.

III. *Significance of the biological disarmament convention*

The conclusion of the biological disarmament convention is conducive to allaying suspicion among states and contributes to the evolution of international relations towards closer political cooperation. The text of the convention reflects to a greater extent than some other arms control agreements the views and interests of smaller countries, both aligned and non-aligned, which actively participated in the drafting process.

In terms of disarmament, the convention is a preventive measure: it will prevent the spread of biological and toxin weapons to countries which do not possess them now; it will prevent the development of biological agents militarily more attractive than the existing ones, which may result from scientific advances modifying the conditions of their production, stockpiling and use. But the abolition of the means for biological warfare by those possessing them will also be the first real disarmament step taken during the whole post-war period, the only one involving any measure of military "sacrifice".

From the legal point of view, the convention will strengthen the force of the unilateral renunciations of biological weapons made by a number of nations in recent years. It will impose equal and identical obligations on all.

Last, but not least, it will open new prospects for international scientific cooperation in the field of peaceful uses of microbiology; the cooperation would be enhanced if at least a portion of the savings derived from biological disarmament is directed to that end.

On the other hand, it is unfortunate that a split has occurred in the treatment of chemical and biological weapons. Since the signing of the Geneva Protocol in 1925, both categories of weaponry have been dealt with inseparably in a number of international documents, and have been associated with each other in a single taboo in the public mind. The technical difficulty of drawing a boundary between chemical weapons and biological weapons adds to the artificiality of the division.

Even more regretable is the fact that, in bisecting the traditional chemical-biological unity, priority has been accorded to agents which, because of their uncontrollability and unpredictability, are of little utility and therefore judged to be militarily less important. Biological disarmament is a marginal disarmament measure compared to the banning of chemical weapons.

As described above, the draft convention also contains a number of weaknesses, deficiencies and ambiguities. None of them, however, is likely to entail great risks for the parties, in view of the nature of the weapons banned.

IV. *Prospects for chemical disarmament*

Chemical weapons are potentially attractive to the military for a number of reasons, including the fact that they are more predictable than biological weapons and can produce immediate effects—an important quality in combat. They have already been used on a large scale in wars with disastrous consequences to the attacked nations.[15]

The parties to the biological convention undertake a commitment to negotiate "in good faith" with a view to reaching agreement on effective measures for the prohibition of production and possession of chemical weapons.

Effective prohibition of chemical weapons may mean different things to different countries. For the United States it certainly implies developing reliable international verification arrangements.[16] For the Soviet Union, judging from the history of negotiations, it may mean involvement in the disarmament measure of all the militarily important states, especially the big powers.[17] These problems were simply put aside when a decision was taken to do away with biological means of warfare. The same, however, is not likely to happen soon with chemical weapons, considering the reluctance on the part of some military establishments to get rid of arms which they perceive as useful.

Nevertheless, pressure for chemical disarmament continues. In a memorandum submitted at the Conference of the Committee on Disarmament

[15] For the history of chemical warfare see *The Rise of CB Weapons,* Vol. I of the SIPRI study on *The Problem of Chemical and Biological Warfare, op. cit.*
[16] An analysis of the verification problem can be found in *The Prevention of CBW,* Vol. V of the SIPRI study on *The Problem of Chemical and Biological Warfare, op. cit.*
[17] The draft convention for chemical and biological disarmament, submitted by the Socialist countries on 23 October 1970, stipulated that, before coming into force, the convention must be ratified by all the states that are permanent members of the UN Security Council (UN document A/8136).

on 28 September 1971, the group of twelve non-aligned members of the Committee proposed guidelines for further negotiations,[18] including the following elements:

An obligation to prohibit the development, production, stockpiling, acquisition and retention of chemical agents of types and in quantities that will be defined in future agreed provisions, and weapons using such chemical agents as well as equipment or means of delivery designed to facilitate the use of such agents or weapons;

An undertaking not to assist, receive, encourage or induce any state, group of states or international organizations in the above-mentioned prohibited activities;

An undertaking to destroy or convert to peaceful uses, taking all necessary safety precautions, all chemical agents, weapons, equipment or means of delivery and facilities, specially meant for the development, production and stockpiling or for using such agents or weapons;

An undertaking to disband and not to establish anew special military or other forces for using chemical agents or weapons.

The problem of verification should be treated in accordance with the suggestions contained in the joint memorandum of the group of twelve, of 25 August 1970, namely, that verification should be based on a combination of appropriate national and international measures, which would complement and supplement each other, thereby providing an acceptable system which would ensure effective implementation of the prohibition.[19]

A clear understanding whereby future agreed provisions for the prohibition of the development, production and stockpiling of chemical weapons are not to be interpreted as in any way limiting or detracting from the obligations assumed by the parties under the Geneva Protocol of 1925;

Future agreed provisions should be implemented in a manner designed to avoid hampering the research, development, production, possession and application of chemical agents for peaceful purposes or hindering the economic or technological development of states;

An undertaking to facilitate the fullest possible exchange of chemical agents, equipment, material and scientific and technological information for the use of such chemical agents for peaceful purposes;

A recognition of the principle that a substantial portion of the savings derived from measures in the field of disarmament should be devoted to promoting economic and social development, particularly in the developing countries.

The outline of the prohibitions proposed is, thus, similar to that of the

[18] Disarmament Conference document CCD/352.
[19] Disarmament Conference document CCD/310.

biological convention. On the most sensitive issue, that of verification, the formula suggested remains vague. While there is consensus that a verification system should combine national and international undertakings, the argument concerns precisely the meaning and the extent of the latter.

The twenty-sixth UN General Assembly requested[20] the CCD to continue, as a high-priority item, negotiations with a view to reaching agreement on chemical disarmament and to take into account in its further work the above memorandum of September 1971, as well as other proposals, suggestions, working papers and expert views put forward in the CCD and in the First Committee of the UN General Assembly. Governments were urged to take all steps that may contribute to a successful outcome of the negotiations.

V. *Reinforcement of the constraints on CW*

Pending the conclusion of a chemical disarmament convention, certain measures could be taken to prevent the erosion of constraints which already exist on chemical warfare, and to reinforce them.

It appears essential to ensure general adherence to the 1925 Geneva Protocol prohibiting the use of CB weapons. Though the number of parties to the Protocol has considerably increased during the last two years, ratification or accession by some forty more countries would be needed to make the document universal. In most cases, the military potential of the states concerned matters less than the formal act of confirmation of the international rule of law. However, in the case of the United States, ratification is of material importance because the USA is the only big power not yet party to the Protocol, because it has a large arsenal of chemical weapons, and also because it interprets the scope of the Protocol restrictively and has been using chemical weapons during the war in Indo-China.

The acceptance by the USA of the prevailing international opinion that the present law prohibiting the use of chemical weapons comprehensively covers all chemical agents—including irritant agents, such as tear gas, and anti-plant agents—might facilitate negotiations on the scope of a chemical disarmament convention. A reversal of the present British stand on the question of legality of the use in war of the chemical irritant CS would also be helpful in this respect.[21]

[20] UN document A/RES 2827 A (XXVI).

[21] Canada, which had apparently held the same views as the United States and the UK, has decided to modify its position. In November 1971 Canada stated its determination not to use, at any time in the future, chemical weapons (including tear gas) in war or acquire them for use in warfare, unless these weapons should be used against Canada or its allies. This applied to all agents, whether intended against persons, animals or plants.

Another step which could strengthen the Geneva Protocol would be the withdrawal of the reservations limiting its applicability to other nations party to the Protocol, and to first use only. The prohibition of use would then become universal and absolute. For states which have succeeded to the obligations under the Geneva Protocol previously contracted on their behalf by former colonial powers, a formal act of withdrawal may not be necessary; it should be sufficient for them to notify the French government, the depositary of the Protocol, that their succession does not apply to reservations attached to the ratification.

Past experience has demonstrated the need for an agreed international procedure to verify allegations of use of chemical weapons. No such machinery has been provided for in the Geneva Protocol.

A series of measures leading more directly to chemical disarmament could also be envisaged:

States might undertake, as recommended by the UN General Assembly,[22] to refrain from further development, production or stockpiling of the most dangerous chemical agents which have no peaceful use, such as nerve gases.[23] The undertakings could be either contractual or unilateral. In the former case there may be some difficulty in drawing up a comprehensive catalogue of the agents in question; it should not, however, be impossible to establish a minimum non-controversial list using a scientific criterion or criteria to specify toxicity and some other relevant property. In the latter case, there may be no need for an agreed list; the commitments could be based on the principle of mutual example: renunciation of a specific agent or agents by one state would be reciprocated by a similar action on the part of other states. In either case, there is no reason why the methods of enforcement accepted as satisfactory to guarantee the abolition of biological and toxin weapons should not be adequate for a mere freeze of a group of the most threatening chemical agents, at least until an agreement is reached on the prohibition of *all* chemical weapons.

Chemical weapons stocked in foreign countries could be withdrawn with a concomitant undertaking not to transfer them to any recipient.

Chemical weapon-free zones could be established in different parts of the world; for example, the Treaty of Tlatelolco, prohibiting nuclear weapons in Latin America, could be expanded to include chemical weapons.

These interim or transitional steps, taken jointly or separately, could pave the way to the complete abolition of chemical weapons.

[22] UN document A/RES/2827 B (XXVI).
[23] The US representative to the CCD stated that the United States has not been producing nerve agents since mid-1968. (Disarmament Conference document CCD/PV.502.)

Appendix 16A. Convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction

The States Parties to this Convention,

Determined to act with a view to achieving effective progress towards general and complete disarmament, including the prohibition and elimination of all types of weapons of mass destruction, and convinced that the prohibition of the development, production and stockpiling of chemical and bacteriological (biological) weapons and their elimination, through effective measures, will facilitate the achievement of general and complete disarmament under strict and effective international control,

Recognizing the important significance of the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, and conscious also of the contribution which the said Protocol has already made, and continues to make, to mitigating the horrors of war,

Reaffirming their adherence to the principles and objectives of that Protocol and calling upon all States to comply with them,

Recalling that the General Assembly of the United Nations has repeatedly condemned all actions contrary to the principles and objectives of the Geneva Protocol of 17 June 1925,

Desiring to contribute to the strengthening of confidence between peoples and the general improvement of the international atmosphere,

Desiring also to contribute to the realization of the purposes and principles of the Charter of the United Nations,

Convinced of the importance and urgency of eliminating from the arsenals of States, through effective measures, such dangerous weapons of mass destruction as those using chemical or bacteriological (biological) agents,

Recognizing that an agreement on the prohibition of bacteriological (biological) and toxin weapons represents a first possible step towards the achievement of agreement on effective measures also for prohibition of the development, production and stockpiling of chemical weapons, and determined to continue negotiations to that end,

Determined, for the sake of all mankind, to exclude completely the possibility of bacteriological (biological) agents and toxins being used as weapons,

Convinced that such use would be repugnant to the conscience of mankind and that no effort should be spared to minimize this risk,

Have agreed as follows:

ARTICLE I

Each State Party to this Convention undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain:

(*a*) Microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes;

(*b*) Weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict.

ARTICLE II

Each State Party to this Convention undertakes to destroy, or to divert to peaceful purposes, as soon as possible but not later than nine months after the entry into force of the Convention, all agents, toxins, weapons, equipment and means of delivery specified in Article I of the Convention, which are in its possession or under its jurisdiction or control. In implementing the provisions of this article all necessary safety precautions shall be observed to protect populations and the environment.

ARTICLE III

Each State Party to this Convention undertakes not to transfer to any recipient whatsoever, directly or indirectly, and not in any way to assist, encourage, or induce any State, group of States or international organizations to manufacture or otherwise acquire any of the agents, toxins, weapons, equipment or means of delivery specified in Article I of the Convention.

ARTICLE IV

Each State Party to this Convention shall, in accordance with its constitutional processes, take any necessary measures to prohibit and prevent development, production, stockpiling, acquisition or retention of the agents, toxins, weapons, equipment and means of delivery specified in Article I of the Convention, within the territory of such State, under its jurisdiction or under its control anywhere.

ARTICLE V

The States Parties to this Convention undertake to consult one another and to co-operate in solving any problems which may arise in relation to the objective of, or in the application of the provisions of, this Convention. Consultations and co-operation pursuant to this article may also be undertaken through appropriate international procedures within the framework of the United Nations and in accordance with its Charter.

ARTICLE VI

1. Any State Party to this Convention which finds that any other State Party is acting in breach of obligations deriving from the provisions of this Convention may lodge a complaint with the Security Council of the United Nations. Such a complaint should include all possible evidence confirming its validity as well as a request for its consideration by the Security Council.

2. Each State Party to this Convention undertakes to co-operate in carrying out any investigation which the Security Council may initiate, in accordance with the provisions of the Charter of the United Nations, on the basis of the complaint received by the Council. The Security Council shall inform the States Parties to the Convention of the results of the investigation.

ARTICLE VII

Each State Party to this Convention undertakes to provide or support assistance, in accordance with the Charter of the United Nations, to any Party to the Convention which so requests, if the Security Council decides that such Party has been exposed to danger as a result of violation of this Convention.

ARTICLE VIII

Nothing in this Convention shall be interpreted as in any way limiting or detracting from the obligations assumed by any State under the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925.

ARTICLE IX

Each State Party to this Convention affirms the recognized objective of effective prohibition of chemical weapons and, to this end, undertakes to continue negotiations in good faith with a view to reaching early agreement on effective measures for the prohibition of their development, production and stockpiling and for their destruction, and on appropriate measures concerning equipment and means of delivery specifically designed for the production or use of chemical agents for weapons purposes.

ARTICLE X

1. The States Parties to this Convention undertake to facilitate and have the right to participate in the fullest possible exchange of equipment, materials and scientific and technological information for the use of bacteriological (biological) agents and toxins for peaceful purposes. Parties to this Convention in a position to do so shall also co-operate in contributing individually or together with other States or international organizations to this further development and application of scientific discoveries in the field of bacteriology (biology) for prevention of disease, or for other peaceful purposes.

2. This Convention shall be implemented in a manner designed to avoid hampering the economic or technological development of States Parties to the Convention or international co-operation in the field of peaceful bacteriological (biological) activities, including the international exchange of bacteriological (biological) agents and toxins and equipment for the processing, use or production of bacteriological (biological) agents and toxins for peaceful purposes in accordance with the provisions of this Convention.

ARTICLE XI

Any State Party may propose amendments to this Convention. Amendments shall enter into force for each State Party accepting the amendments upon their acceptance by a majority of the States Parties to this Convention and thereafter for each remaining State Party on the date of acceptance by it.

ARTICLE XII

Five years after the entry into force of this Convention, or earlier if it is requested by a majority of Parties to the Convention by submitting a proposal to this effect to the Depositary Governments, a conference of States Parties to the Convention shall be held at Geneva, Switzerland, to review the operation of this Convention, with a view to assuring that the purposes of the preamble and the provisions of the Convention, including the provisions concerning negotiations on chemical weapons, are being realized. Such review shall take into account any new scientific and technological developments relevant to this Convention.

ARTICLE XIII

1. This Convention shall be of unlimited duration.

2. Each State Party to this Convention shall, in exercising its national sovereignty, have the right to withdraw from the Convention if it decides that extraordinary events, related to the subject matter of this Convention, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other States Parties to the Convention and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests.

ARTICLE XIV

1. This Convention shall be open to all States for signature. Any State which does not sign the Convention before its entry into force in accordance with paragraph 3 of this article may accede to it at any time.

2. This Convention shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the Union of Soviet Socialist Republics, the United Kingdom of Great Britain and Northern Ireland and the United States of America, which are hereby designated the Depositary Governments.

3. This Convention shall enter into force after the deposit of the instruments of ratification by twenty-two Governments, including the Governments designated as Depositaries of the Convention.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Convention, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession and the date of the entry into force of this Convention, and of the receipt of other notices.

6. This Convention shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

ARTICLE XV

This Convention, the Chinese, English, French, Russian and Spanish texts of which are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Convention shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

In witness whereof the undersigned, duly authorized, have signed this Convention.

Done in . . . copies at . . ., this . . . day of . . ., . . .

17. The nuclear test ban debate[1]

I. *Introduction*

In 1969 progress towards an agreement on a comprehensive nuclear test ban was generally considered to depend on the outcome of the Strategic Arms Limitation Talks (SALT) between the United States and the Soviet Union. Subsequently, when the contents of SALT became better known, such a direct linkage proved less substantiated. There was a growing realization among the non-nuclear-weapon states—especially the non-aligned states—that, in view of the relationship of nuclear tests to the proliferation of nuclear weapons and to the continuing qualitative arms build-up, the cessation of nuclear tests was not only desirable in itself but could also stimulate progress towards other arms control measures in the nuclear field. It was also feared that nuclear testing creates radiological hazards[2] as well as risks of earth disturbances or seismic tidal waves.

For almost a decade there have been no real negotiations on a comprehensive test ban. However, the annual ritual of adopting UN resolutions which call for the suspension of nuclear weapon tests in all environments but are never heeded, was repeated.

On 14 October 1970, three nuclear explosions (one of them in the atmosphere) marked the opening of the session commemorating the twenty-fifth anniversary of the United Nations. They also marked the beginning of a new wave of pressure for a prohibition of nuclear testing. In addition, in the summer of 1971, French atmospheric tests in the Pacific provoked strong reactions from many Pacific island and littoral states. Peru even threatened to break diplomatic relations with France, should the latter persist with its programme.

A number of proposals for a comprehensive test ban were examined both in the United Nations and at the Conference of the Committee on Disarmament (CCD). Some of them indicated new approaches; others were

[1] A detailed analysis of the issues involved in a comprehensive test ban is given on pages 389–432.

[2] In the spring of 1971, the Swedish government notified the United States and the Soviet Union that radioactivity caused by their underground nuclear explosions had been detected in Sweden, and formally objected to this infringement of the Partial Test Ban Treaty.

modified versions of previous schemes. The following account reviews the main topics discussed during 1970–71 at the UN and the CCD.

II. *Interim measures*

A few states (mainly Canada, Japan and Italy) suggested that, pending a total ban, transitional steps should be taken to slow down the pace of nuclear testing and guard against the environmental risks from such testing. Proposals were made to reduce the number, possibly by quotas, as well as the scale of tests. High-yield tests, which are easily detectable and identifiable with extra-territorial means, were emphasized in this context.

The supporters of the idea of transitional steps, including the UN Secretary-General, claimed that restraints could help to reduce the dangers inherent in continued testing, generate confidence and facilitate the conclusion of a formal, comprehensive agreement. The opponents, including the USA and the USSR, asserted that the suggested approach would not remove the existing obstacles since restraints were "tied in closely" with both understanding and resolving the problem of verification (USA); and also since the observance of the quota commitment would pose problems identical to those involved in a total ban and difficulties would arise in connection with the size of quotas for various states as well as the periods of their validity (USSR).[3]

Nevertheless, at the twenty-sixth UN General Assembly the majority of UN members called for unilateral or negotiated measures of restraint that would suspend nuclear weapon testing or limit or reduce the size and number of nuclear weapon tests, pending the entry into force of a comprehensive ban "on all nuclear weapon tests in all environments by all states".[4]

III. *Partial measures*

The possibility of prohibiting underground nuclear tests above a certain level of magnitude, as a first step, was also discussed.[5] Czechoslovakia revived a particular proposal from 1964, calling for a treaty banning underground

[3] Disarmament Conference documents CCD/PV.496, CCD/PV.507, CCD/PV.517, CCD/PV.530, CCD/PV.536, and CCD/336; UN documents A/8401/Add.1, A/C.1/PV.1829, A/C.1/PV.1830, A/C.1/PV.1841, and A/C.1/PV.1847.

[4] UN document A/RES/2828C (XXVI).

[5] UN documents A/C.1/PV.1750, A/C.1/PV.1752, A/C.1/PV.1756, A/C.1/PV.1759, and A/C.1/PV.1762; Disarmament Conference documents CCD/PV.497 and CCD/PV.518.

tests above the seismological magnitude of 4.75, combined with a moratorium on explosions below that limit.[6]

To most countries the "threshold" approach did not appear to be either desirable or practicable. They asserted that such a half-measure would result in promoting the improvement of smaller nuclear warheads and the development of new, more sophisticated weapons. In addition, it was argued that a formal threshold agreement, whether defined in terms of seismic magnitude or explosion yield, could pose technical problems leading to disputes over whether the agreed limitations were being observed, even if an exact magnitude-yield ratio could be determined, which does not seem possible.[7]

IV. *Verification*

The prevailing opinion is that existing seismological means provide a high degree of guarantee against clandestine testing, and that the possibility of also using other, non-seismic means of checking would help to deter would-be violators.

A verification system providing for a set number of on-site inspections received less support than in previous years. In 1971 Ethiopia proposed that the nuclear powers should agree to having at least one on-site inspection a year as a confidence-building measure.[8] Other countries believed that inspection by invitation or upon request would provide more effective deterrence.[9] The Netherlands suggested setting up a committee or panel of impartial inspectors.[10]

First advanced in 1962, the idea of installing unmanned automatic seismic stations ("black boxes") on the territory of the nuclear powers, and possibly also near their borders, was renewed by Japan and Mexico.[11] This idea met with no definite response on the part of the nuclear powers.

Much attention was devoted to international cooperation in the exchange of seismic data, mostly due to the initiative of Canada. In June 1971 a meeting of experts was held in Geneva, within the framework of the

[6] Disarmament Conference document ENDC/144.
[7] Disarmament Conference documents CCD/PV.498, CCD/PV.502, CCD/PV.507, CCD/PV.512, CCD/PV.513, and CCD/PV.536; UN document A/C.1/PV.1831.
[8] Disarmament Conference document CCD/PV.498.
[9] Disarmament Conference document CCD/PV.513.
[10] UN. document A/C.1/PV.1751.
[11] Disarmament Conference documents CCD/PV.497, CCD/PV.504, and CCD/PV.532.

CCD, to discuss seismological methods of monitoring a comprehensive test ban.[12]

The replies to a questionnaire circulated by the UN Secretary-General[13] showed that the establishment of a system of data exchange on an assured basis could facilitate the verification of a comprehensive test ban.

The improvement of worldwide seismological capabilities was also discussed. Some countries urged that the governments in a position to do so should assist others in improving their seismic stations;[14] the United Nations invited states to provide relevant assistance.[15] It was further proposed that, before a total ban is achieved, advance notification should be given of details regarding the timing, location and magnitude of planned underground nuclear explosions in order to assist in research on seismological identification methods.[16] Egypt pointed out that a comprehensive test ban should ensure that all countries obtain seismological data of concern to them, and should also provide appropriate procedures to follow in case the data raise a doubt or reveal a violation.[17]

The United States reiterated its assertion that verification of a comprehensive test ban requires obligatory on-site inspections since seismic means alone are not always sufficient to differentiate between naturally occurring events and nuclear explosions.[18] It is noteworthy that, in an address of 26 February 1971, William C. Foster, former director of the US Arms Control and Disarmament Agency (ACDA) and former leader of the US delegation to the CCD, favoured a comprehensive test ban without inspection and stated that it was fully within the scientific competence of the

[12] The following papers were presented to the CCD: a summary of existing and potential seismic capabilities for detection and identification of underground nuclear explosions (Netherlands, CCD/323); results of a seismological study of 90 earthquakes and 33 underground nuclear explosions in Eurasia from 1968 to 1970 (Canada, CCD/327); a summary of six scientific papers and hitherto unreported research on problems related to the seismological verification of a ban on underground nuclear explosions (Sweden, CCD/329); progress made in the study of the seismic detection, location, and identification of earthquakes and explosions and the inherent limitations to seismic techniques for the verification of a comprehensive test ban treaty (United States, CCD/330); an outline of the problems of teleseismic detection in the Mediterranean area and suggestions for an international centre for coordination of research and exchange of seismic study and for the completion of the existing world network with a new centre in the Mediterranean area (Italy, CCD/331); the usefulness of ocean bottom seismographs and a universally acceptable means of determining the magnitude of seismological events (Japan, CCD/345); the seismicity of the USA, the USSR and China (Netherlands, CCD/349); and on the improvements to the existing seismic network which could result from further special studies (UK, CCD/351).

[13] UN document A/7967.

[14] UN document A/C.1/PV.1752.

[15] UN document A/RES/2663A(XXV).

[16] Disarmament Conference documents CCD/PV.507 and CCD/336.

[17] Disarmament Conference document CCD/PV.509.

[18] Disarmament Conference document CCD/PV.516; UN document A/C.1/PV.1827.

United States adequately to monitor such a ban. He added: "With our present means of instrumentation and other sources of information, it is not conceivable that the Soviets could carry out clandestine testing on a scale which could affect the strategic balance."

The Soviet Union held the view that states have at their disposal means for detecting and identifying nuclear explosions and that it is therefore impossible to test secretly. The Soviet Union favoured large-scale cooperation in the field of seismological data exchange within the context of a treaty prohibiting underground tests, and on the understanding that control of treaty observance would be exercised without international inspection, and that the evaluation of the data collected would be carried out not by an international body, but by each state on its own. The Soviet Union opposed the disclosure of underground testing programmes, which, in its view, would only "facilitate the acquisition of information by military services of other states".[19]

It was obvious to the participants in the debate that whatever verification system was eventually agreed upon, with or without on-site inspection, there would never be 100 per cent certainty that all parties were complying with a test ban. To many, the risk that some small explosions could escape detection (or identification if detected) with some potential gain (perhaps even of questionable value) to the violating party, appeared insignificant when compared to the military and political risks inherent in the continuation of underground tests without any restrictions: risks of proliferation of nuclear weapons and escalation of the arms race.

V. *Peaceful applications of nuclear explosions*

It was generally agreed that a comprehensive test ban treaty should allow nuclear explosions for peaceful purposes. Most countries felt that only the present nuclear-weapon states should retain the right to carry out such explosions. India, the strongest opponent of this approach,[20] considered it invidious for a great part of the world to become dependent on a few nuclear-weapon states for the application of nuclear explosion technology, and defended the right of each state to acquire the relevant knowledge and the freedom to apply it.[21]

[19] UN documents A/C.1/PV.1762, A/C.1/PV.1764, A/7967, and A/C.1/PV.1827; Disarmament Conference documents CCD/PV.516 and CCD/PV.536.

[20] UN document A/C.1/PV.1772.

[21] At the fourth UN Atoms-for-Peace Conference held in September 1971, a member of India's Atomic Energy Commission intimated that India was considering peaceful experiments involving atomic explosives (*International Herald Tribune*, 14 September 1971).

The whole question is closely related to the Non-Proliferation Treaty under which potential benefits from any peaceful applications of nuclear explosions should be made available to non-nuclear-weapon parties, pursuant to a special international agreement yet to be concluded.

To handle the technical modalities, the establishment of an "international service for nuclear explosions for peaceful purposes under appropriate international control" is envisaged within the framework of the International Atomic Energy Agency (IAEA). During 1970–71, the IAEA organized meetings of experts to review the technology of nuclear explosions for peaceful purposes. According to its report, it is technologically possible at present to use underground nuclear explosions on an industrial scale to stimulate gas and oil production, to prepare storage space for hydrocarbons (gas, oil and oil products) in the cavities or chimneys produced by such explosions and to seal gas and oil wells that are out of control. The IAEA concluded that: "More practical experience in the technology and availability of more data on the effect of multiple explosions will however be necessary, before the application of this technique can be economic." The IAEA also initiated studies of the character of international observation of such explosions.[22] The UN General Assembly requested the IAEA to continue its activities in this field.[23] Some non-signatories of the Non-Proliferation Treaty, for example Argentina and India,[24] considered that all states members of the IAEA, whether or not parties to the treaty, should have the right to benefit from an international service for nuclear explosions for peaceful purposes; any discrimination in this respect would—in their opinion—be contrary to the statute of the IAEA. To avoid this incompatibility, Pakistan felt that a special body should be set up to administer the explosions service and to enter into relevant agreements with states.[25]

In order to prevent nuclear explosions from being used for weapon improvement under the guise of peaceful purposes, the Netherlands and Pakistan suggested that an international body should be authorized to satisfy itself that only nuclear devices already tested were being used for peaceful applications.[26]

No progress has been recorded concerning principles governing the creation of an international régime to conduct nuclear explosions for peaceful purposes, and the legal aspects of such international regulations. There was,

[22] UN documents A/8080 and A/8384; and IAEA document GC(XV)/455.
[23] UN documents A/RES/2665(XXV) and A/RES/2829(XXVI).
[24] UN documents A/C.1/PV.1827 and A/C.1/PV.1838.
[25] UN document A/C.1/PV.1842.
[26] Disarmament Conference documents CCD/PV.512 and CCD/PV.529.

however, a demand that agreement on such explosions should be negotiated simultaneously with a treaty prohibiting underground tests.[27]

Some misgivings were expressed with regard to possible harmful effects of peaceful nuclear explosions on the human environment, especially the dangers of radioactive contamination.[28] The UN General Assembly drew attention to the invitation by the UN Scientific Committee on the Effects of Atomic Radiation to states to submit available data that would enable it to assess the effects of peaceful uses of nuclear energy on the exposure of human populations to radiation.[29]

The Netherlands suggested that a nuclear test ban be agreed with no exceptions, if it were decided that the economic benefits of peaceful explosions were so doubtful that it would be better to forego them completely rather than to run the risk of having a loophole for the continuation of the nuclear arms race.[30]

The USSR and the USA discussed the problems related to technical and theoretical aspects of applications of peaceful nuclear explosions and exchanged relevant scientific and technical information. They held talks in June 1971 in Washington, in continuation of the talks on the same subject held in April 1969 in Vienna and in February 1970 in Moscow. They considered it useful to continue such discussions in the future, concentrating on the safety problems and on separate engineering projects involving nuclear explosions.[31]

VI. *Legal form of the ban*

As regards the legal form of a comprehensive test ban agreement, three possibilities were mentioned:

1. Renegotiation of the Partial Test Ban Treaty in order to make it total: this would amount to nullifying the existing, widely accepted commitments, and is considered a risky undertaking.
2. Elaboration of a protocol to the Partial Test Ban Treaty without affecting the provisions of the latter: this would be inconvenient in view of the complicated problems of participation in, entry into force of, and amendments to the two documents.
3. Conclusion of an independent treaty prohibiting underground tests: this appears to be the most reasonable solution.

[27] Disarmament Conference document CCD/PV.504.
[28] UN document A/C.1/PV.1759; IAEA document GC(XIV)/INF/121.
[29] UN documents A/RES/2623(XXV) and A/RES/2773(XXVI).
[30] Disarmament Conference document CCD/512.
[31] Disarmament Conference document CCD/PV.536.

VII. *Draft treaty*

On 2 September 1971, Sweden submitted[32] a working paper suggesting possible provisions of a treaty banning underground nuclear weapon tests.[33] It was a revised version of the Swedish paper of 1 April 1969,[34] which took into account a number of points made in the debate.

Under the treaty proposed by Sweden, the parties would undertake "to prohibit, to prevent and not to carry out" any underground nuclear weapon test explosion, or any other underground nuclear explosion, at any place under their jurisdiction or control, subject to the following provisions:

The treaty would be fully operative for each nuclear-weapon state after a specified number of months from its entry into force, during which period nuclear weapon test explosions would be phased out in accordance with a separate protocol annexed to the treaty; the reason given for the proviso was that abrupt discontinuance of testing might create practical difficulties.

The prohibition would not apply to nuclear explosions which are carried out for construction or other peaceful purposes and take place in conformity with another protocol annexed to the treaty; the protocol dealing with this exemption would, among other things, alleviate the Partial Test Ban Treaty's rules against venting, so as to facilitate the peaceful uses of nuclear explosives.[35]

To ensure observance of the treaty, the parties would undertake:

1. To cooperate in an international exchange of seismological data in order to facilitate the detection, identification and location of underground events; provisions for such an exchange would be laid down in a third protocol annexed to the treaty. Provisions for the seismological data exchange during the phasing-out period and for peaceful explosions would be included in the first and second protocols mentioned above;
2. To cooperate in the clarification of events pertaining to the subject matter of the treaty. Each party would be entitled to make enquiries and to receive information as a result of such enquiries; to invite inspection on its territory, to be carried out in the manner prescribed by the inviting party; to make proposals for suitable methods of clarification of information deemed inadequate. The failure to cooperate in clarifying a particular event

[32] Disarmament Conference document CCD/PV.524.
[33] Disarmament Conference document CCD/348.
[34] See the *SIPRI Yearbook 1968/69*, p. 176.
[35] The PTB prohibits any nuclear explosion in any environment "if such explosion causes radioactive debris to be present outside the territorial limits of the state under whose jurisdiction or control such explosion is conducted".

might be brought to the attention of the UN Security Council and of the other parties.

To review the operation of the treaty and to assure that its provisions are being realized, a conference would be convened within a specified number of years after the entry into force of the treaty. The treaty would be of unlimited duration, but the parties would have the right to withdraw from it if they decided that their supreme interests were jeopardized.

Sweden suggested that, in its definite form, the third protocol could be worked out after the treaty had come into force and after some experience on measures for seismological verification had been acquired from the phasing-out period. The list of signatories to the treaty itself and to the protocols on the phasing-out of tests, the administration of peaceful explosions, and the development of an international seismological data system may vary.

VIII. *Memorandum of the non-aligned powers*

A memorandum of nine non-aligned members of the CCD (Burma, Egypt, Ethiopia, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia),[36] of 30 September 1971,[37] urged the conclusion of a treaty banning underground nuclear weapon tests to complement the Partial Test Ban Treaty, and stressed that both treaties should be adhered to by all nuclear-weapon states. In regard to verification, conviction was expressed that the problem could be resolved on the basis of national means, i.e., remote control, supplemented and improved upon by international cooperation and procedures, the two methods complementing each other; an adequate international exchange of seismological data from national stations should be promoted by concrete measures. Such measures, coupled with a withdrawal clause and provisions for review conferences, should ensure the required deterrence level. The memorandum further expressed the view that peaceful application of nuclear explosives must be regulated and the IAEA could play an important role in this context. The nuclear-weapon states were requested to submit their own proposals.

In a forcefully worded resolution of 16 December 1971,[38] reflecting the impatience of many nations with the lack of progress toward a CTB, the

[36] Argentina, Brazil and India—the remaining three countries of the group of twelve non-aligned CCD members—did not subscribe to the memorandum, mainly because they held different views on the question of nuclear explosions for peaceful purposes.
[37] Disarmament Conference document CCD/354.
[38] UN document A/RES/2828A(XXVI).

UN General Assembly reiterated "solemnly and most emphatically" its condemnation of all nuclear weapon tests, and urged the nuclear-weapon states to bring to a halt all such tests "at the earliest possible date and, in any case, not later than 5 August 1973" (the tenth anniversary of the signing of the Partial Test Ban Treaty).

IX. *Conclusions*

The test ban debate, including the discussion of verification, will continue, although the scientific and technological aspects of the issue have already been thoroughly explored. However, the main problem is whether, and to what extent, the various states are interested in a CTB at this time. The USA, the UK and the USSR formally assure that they are willing to conclude a treaty, though each side on its own conditions. France and China make no effort to conceal their determination to continue testing.

According to France, the cessation of nuclear tests is not disarmament; it belongs to the series of measures whose main effect is to prevent non-nuclear-weapon states from acquiring arms that nuclear-weapon states keep and continue to develop.[39] Similarly, China holds the view that, before a complete prohibition and destruction of nuclear weapons is achieved, it cannot give up its nuclear testing which is necessary for developing weapons in self-defence against "the nuclear threat of the two superpowers"; and a test ban would only consolidate the nuclear monopoly of the latter.[40]

The position of France and China makes it difficult to obtain a *universal* prohibition of nuclear testing in the foreseeable future. But it would seem fair that the lead in stopping the tests should be taken by the Soviet Union and the United States. These two advanced nuclear-weapon states have already carried out hundreds of tests, produced a generation of sophisticated nuclear weapon systems and acquired an enormous superiority in this respect over the "secondary" nuclear-weapon powers.

[39] UN document A/PV.1989.
[40] UN document A/C.1/PV.1847.

18. Preventing an arms race on the sea-bed

The draft Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil Thereof, worked out at the Conference of the Committee on Disarmament,[1] was commended by the twenty-fifth UN General Assembly in a resolution of 7 December 1970.[2] (For the text of the treaty, see page 537.)

Although the signing ceremony took place as early as 11 February 1971, by 1 January 1972 the treaty had not entered into force, despite the relatively low number of ratifications required.[3] This delay can be taken as an indication of the value attached to this arms limitation agreement by a majority of countries. Indeed, in agreeing in 1970 that the treaty should be opened for signature and ratification, a large number of UN representatives avoided committing their countries to becoming party to it. They made it clear that their affirmative votes for the resolution did not prejudge the positions which their governments would eventually adopt on the treaty. The reasons for this reserve were explained in the course of the UN debate.

Many nations, including France[4] considered the scope of the treaty prohibition to be too narrow, restricted as it is to activities of little military interest: the fixing of nuclear and other non-conventional weapons to the ocean bottom.

The treaty was also found insufficient as a denuclearization measure, since it exempted from the ban a sea-bed zone 12 miles wide. Peru considered the exemption to be "unjustifiable discrimination" in favour of the nuclear powers.[5] An amendment to enlarge the geographical extent of the prohibition to cover the entire sea-bed and ocean floor[6] was not accepted but, significantly, out of ninety-nine participating in the vote, as many as thirty-nine delegations (i.e., over a third) abstained.[7]

The provisions on verification, though rather elaborate, proved unsatis-

[1] For a detailed analysis of the draft, see the *SIPRI Yearbook 1969/70*, pages 154–84.
[2] UN document A/RES/2660(XXV).
[3] For the list of the signatories, see page 576.
[4] UN document A/C.1/PV.1754.
[5] UN document A/C.1/PV.1763.
[6] UN document A/C.1/L.528.
[7] UN document A/8198.

factory to some countries, including France and Pakistan,[8] in that no genuinely international control system was established.

Even more objectionable than these omissions were the imputed "sins of commission". It was charged, especially by the Latin American countries, that the references in the treaty to the 1958 Geneva Convention on the Territorial Sea and the Contiguous Zone were meant to set an international precedent in support of the 12-mile limit of territorial waters, which most of these countries oppose (some of them claim jurisdiction over an area as broad as 200 nautical miles), and that this was the real purpose of the great powers, rather than to promote disarmament.[9] The language of the treaty was criticized for lack of precision; Ecuador did not hesitate to call it a network of ambiguities and errors.[10]

Nevertheless, since the misgivings of coastal states have been considerably allayed by a disclaimer clause to the effect that the treaty shall not be interpreted as supporting or prejudicing the position of any party with respect to existing international conventions, or with respect to rights or claims which such state may assert, many states saw no harm in endorsing an agreement which could help to improve the international political climate, even though it covered an environment of marginal military importance. It was also appreciated that the treaty which in essence represented a bilateral self-limitation, had been negotiated and finalized multilaterally.

Consequently, and as a result of some pressure exercised by the USA and the USSR, only two delegations (El Salvador and Peru) opposed the UN General Assembly resolution, and two abstained (Ecuador and France), while nineteen delegations were absent during the voting.

The main, if not decisive, inducement to accepting the treaty was a commitment, included in it, to continue negotiations in good faith on further measures in the field of disarmament for the prevention of an arms race on the sea-bed, the ocean floor and the subsoil thereof.

No such negotiations have as yet taken place, although the Soviet Union and other Socialist countries raised the subject in the CCD and at the twenty-sixth UN General Assembly in 1971.

The United States, supported by some of its allies, has argued that there is no point in discussing measures for preventing a conventional arms race on the sea-bed, because no such race is imminent. Nevertheless, there have been reports in the US press that a new mechanical anti-submarine war-

[8] UN document A/C.1/PV.1754.
[9] UN documents A/C.1/PV.1763, A/C.1/PV.1764, and A/PV.1919.
[10] UN document A/C.1/PV.1764.

fare system is being developed, consisting of torpedoes with conventional explosive devices, to be anchored to the ocean bottom.[11]

China criticized the Sea-Bed Treaty, pointing out that it did not restrict the freedom of movement of nuclear ships and submarines and therefore did not slow down the armaments race or put an end to the "gunboat diplomacy of the superpowers".[12]

In fact, the sea-bed is only a part of the ocean environment and—for military purposes—not the most important part of it; therefore, any arms control agreement limited to the sea-bed is of no great consequence to disarmament. Moreover, there exists no uniform interpretation of the accepted principle that the sea-bed and ocean floor, and the subsoil thereof, beyond the limits of national jurisdiction, shall be reserved exclusively for peaceful purposes.[13] Under these circumstances a discussion concerning total demilitarization—i.e., a blanket prohibition of all military activities in the whole area of the sea-bed—would probably be a fruitless exercise. To be more meaningful, negotiations on future steps in the environment in question would have to centre upon well-defined areas, weapons or installations destined for military use.

Thus, for example, it might be useful to establish a sea-bed zone adjacent to the coast in which coastal states would have the exclusive right to maintain military equipment or other objects of a military nature. Such a measure would be essentially preventive: the great powers, the only ones technically capable of doing so, would be prevented from establishing, in the zone adjacent to other states, submarine bases or fortifications for military use against the territory, territorial sea or air space of other states. This zone would have to be sufficiently large—much larger than that exempted from denuclearization under the present Sea-Bed Treaty—so as to promote a real sense of security among smaller countries. In many cases the shape of the zone could be determined by the extent of the continental shelf,[14] the only region where the presence of sea-bed military installations directed against a particular country could make some sense, and where their emplacement would be less complicated than in the outlying areas. Actually, the measure may boil down to the extension of the rights of coastal states over the continental shelf, without affecting the legal status of the superjacent waters.

[11] *Washington Post,* 26 November 1971.
[12] *Le Monde,* 4 March 1971.
[13] UN document A/RES/2749(XXV).
[14] The Convention on the continental shelf, of 29 April 1958, defines "continental shelf" as (*a*) the sea-bed and subsoil of the submarine areas adjacent to the coast but outside the area of the territorial sea, to a depth of 200 metres or, beyond that limit, to where the depth of the superjacent waters admits of the exploitation of the natural resources of the said areas; (*b*) the sea-bed and subsoil of similar submarine areas adjacent to the coasts of islands.

These rights are now limited to the exploration and exploitation of the natural resources, by virtue of the 1958 Geneva Convention, which has been adhered to by only some forty countries, i.e., by less than one-third of the UN membership.

Failing a universally acceptable definition of the continental shelf and its breadth, a uniform boundary, expressed in terms of distance from the coast, could be devised specifically for arms limitation purposes.

It should be added that some states, for instance, Mexico, which regard the continental shelf as part of the national territory, consider that any emplacement of weapons thereon by any other state is already prohibited by their national legislation.

The Sea-Bed Treaty provides for a review conference to be held five years after its entry into force, in order to assure that the provisions, including the undertaking to negotiate measures for the prevention of an arms race on the sea-bed, are being realized. Given the complexities of the task, it would appear necessary to start negotiations rather soon if the parties are to live up to their commitment.

Appendix 18A. Treaty on the prohibition of the emplacement of nuclear weapons and other weapons of mass destruction on the sea-bed and the ocean floor and in the subsoil thereof

The States Parties to this Treaty,

Recognizing the common interest of mankind in the progress of the exploration and use of the sea-bed and the ocean floor for peaceful purposes,

Considering that the prevention of a nuclear arms race on the sea-bed and the ocean floor serves the interests of maintaining world peace, reduces international tensions, and strengthens friendly relations among States,

Convinced that this Treaty constitutes a step towards the exclusion of the sea-bed, the ocean floor and the subsoil thereof from the arms race,

Convinced that this Treaty constitutes a step towards a treaty on general and complete disarmament under strict and effective international control, and determined to continue negotiations to this end,

Convinced that this Treaty will further the purposes and principles of the Charter of the United Nations, in a manner consistent with the principles of international law and without infringing the freedoms of the high seas,

Have agreed as follows:

ARTICLE I

1. The States Parties to this Treaty undertake not to emplant or emplace on the sea-bed and the ocean floor and in the subsoil thereof beyond the outer limit of a sea-bed zone as defined in Article II any nuclear weapons or any other types of weapons of mass destruction as well as structures, launching installations or any other facilities specifically designed for storing, testing or using such weapons.

2. The undertakings of paragraph 1 of this Article shall also apply to the sea-bed zone referred to in the same paragraph, except that within such sea-bed zone, they shall not apply either to the coastal State or to the sea-bed beneath its territorial waters.

3. The States Parties to this Treaty undertake not to assist, encourage or induce any State to carry out activities referred to in paragraph 1 of this Article and not to participate in any other way in such actions.

ARTICLE II

For the purpose of this Treaty the outer limit of the sea-bed zone referred to in Article I shall be coterminous with the twelve-mile outer limit of the zone referred to in Part II of the Convention on the Territorial Sea and the Contiguous Zone, signed in Geneva on 29 April 1958, and shall be measured in accordance with the provisions of Part I, Section II, of this Convention and in accordance with international law.

ARTICLE III

1. In order to promote the objectives of and ensure compliance with the provisions of this Treaty, each State Party to the Treaty shall have the right to verify through observation the activities of other States Parties to the Treaty on the sea-bed and the ocean floor and in the subsoil thereof beyond the zone referred to in Article I, provided that observation does not interfere with such activities.

2. If after such observation reasonable doubts remain concerning the fulfilment of the obligations assumed under the Treaty, the State Party having such doubts and the State Party that is responsible for the activities giving rise to the doubts shall consult with a view to removing the doubts. If the doubts persist, the State Party having such doubts shall notify the other States Parties, and the Parties concerned shall co-operate on such further procedures for verification as may be agreed, including appropriate inspection of objects, structures, installations or other facilities that reasonably may be expected to be of a kind described in Article I. The Parties in the region of the activities, including any coastal State, and any other Party so requesting, shall be entitled to participate in such consultation and co-operation. After completion of the further procedures for verification, an appropriate report shall be circulated to other Parties by the Party that initiated such procedures.

3. If the State responsible for the activities giving rise to the reasonable doubts is not identifiable by observation of the object, structure, installation or other facility, the State Party having such doubts shall notify and make appropriate inquiries of States Parties in the region of the activities and of any other State Party. If it is ascertained through these inquiries that a particular State Party is responsible for the activities, that State Party shall consult and co-operate with other Parties as provided in paragraph 2 of this Article. If the identity of the State responsible for the activities cannot be ascertained through these inquiries, then further verification procedures, including inspection, may be undertaken by the inquiring State Party, which shall invite the participation of the Parties in the region

of the activities, including any coastal State, and of any other Party desiring to co-operate.

4. If consultation and co-operation pursuant to paragraphs 2 and 3 of this Article have not removed the doubts concerning the activities and there remains a serious question concerning fulfilment of the obligations assumed under this Treaty, a State Party may, in accordance with the provisions of the Charter of the United Nations, refer the matter to the Security Council, which may take action in accordance with the Charter.

5. Verification pursuant to this Article may be undertaken by any State Party using its own means, or with the full or partial assistance of any other State Party, or through appropriate international procedures within the framework of the United Nations and in accordance with its Charter.

6. Verification activities pursuant to this Treaty shall not interfere with activities of other States Parties and shall be conducted with due regard for rights recognized under international law including the freedoms of the high seas and the rights of coastal States with respect to the exploration and exploitation of their continental shelves.

ARTICLE IV

Nothing in this Treaty shall be interpreted as supporting or prejudicing the position of any State Party with respect to existing international conventions, including the 1958 Convention on the Territorial Sea and the Contiguous Zone, or with respect to rights or claims which such State Party may assert, or with respect to recognition or non-recognition of rights or claims asserted by any other State, related to waters off its coasts; including *inter alia* territorial seas and contiguous zones, or to the sea-bed and the ocean floor, including continental shelves.

ARTICLE V

The Parties to this Treaty undertake to continue negotiations in good faith concerning further measures in the field of disarmament for the prevention of an arms race on the sea-bed, the ocean floor and the subsoil thereof.

ARTICLE VI

Any State Party may propose amendments to this Treaty. Amendments shall enter into force for each State Party accepting the amendments upon their acceptance by a majority of the States Parties to the Treaty and thereafter for each remaining State Party on the date of acceptance by it.

ARTICLE VII

Five years after the entry into force of this Treaty, a conference of Parties to the Treaty shall be held in Geneva, Switzerland, in order to review the operation of this Treaty with a view to assuring that the purposes of the preamble and the provisions of the Treaty are being realized. Such review shall take into account any relevant technological developments. The review conference shall determine in accordance with the views of a majority of those Parties attending whether and when an additional review conference shall be convened.

ARTICLE VIII

Each State Party to this Treaty shall in exercising its national sovereignty have the right to withdraw from this Treaty if it decides that extraordinary events related to the subject matter of this Treaty have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other States Parties to the Treaty and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events it considers to have jeopardized its supreme interests.

ARTICLE IX

The provisions of this Treaty shall in no way affect the obligations assumed by States Parties to the Treaty under international instruments establishing zones free from nuclear weapons.

ARTICLE X

1. This Treaty shall be open for signature to all States. Any State which does not sign the Treaty before its entry into force in accordance with paragraph 3 of this Article may accede to it at any time.

2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and of accession shall be deposited with the Governments of the Union of Soviet Socialist Republics, the United Kingdom of Great Britain and Northern Ireland and the United States of America, which are hereby designated the Depositary Governments.

3. This Treaty shall enter into force after the deposit of instruments of ratification by twenty-two Governments, including the Governments designated as Depositary Governments of this Treaty.

4. For States whose instruments of ratification or accession are deposited after the entry into force of this Treaty it shall enter into force on the date of the deposit of their instruments of ratification or accession.

5. The Depositary Governments shall promptly inform the Governments of all signatory and acceding States of the date of each signature, of the date of deposit of each instrument of ratification or of accession, of the

date of the entry into force of this Treaty, and of the receipt of other notices.

6. This Treaty shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

ARTICLE XI

This Treaty, the Chinese, English, French, Russian and Spanish texts of which are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the States signatory and acceding thereto.

In witness whereof the undersigned, being duly authorized thereto, have signed this Treaty.

19. The treaty for the prohibition of nuclear weapons in Latin America (Treaty of Tlatelolco)[1]

The Treaty of Tlatelolco prohibiting nuclear weapons in Latin America, signed in 1967, is now in force for the majority of the states in the region. (For the list of these states, see page 576.) The zone of application of the treaty already includes an area of nearly 7 million square kilometres and a population of about 120 million. However, the goal set, to cover somewhat more than 20 million square kilometres (see map 7, page 548) with a population of around 280 million, and to ensure universal respect for the legal status of military denuclearization of the area, is still far from being achieved.

The two largest countries of Latin America, Argentina and Brazil—practically the only countries in the area with any nuclear weapons potential and aspirations—are not bound by its provisions. Argentina signed the treaty but did not ratify it. Brazil signed and ratified the treaty but, unlike the other parties, did not waive the requirements to be met before the treaty enters into force for it, namely, that all states in the region deposit the instruments of ratification; that additional protocols be signed and ratified by those states to which they apply (see below); and that agreements on safeguards be concluded with the International Atomic Energy Agency (IAEA).

It is unlikely that all those requirements will soon be fulfilled. But even if they were fulfilled, and Argentina and Brazil were to become parties, these two countries would still adhere to their interpretation of the basic clauses of the treaty: that they have the right to carry out nuclear explosions for peaceful purposes, that is, explosions for which one would employ devices used in nuclear weapons. An understanding to that effect was placed on record by Argentina and Brazil, as well as by Nicaragua, when they signed the treaty. This position contradicts the view taken by other signatories, notably Mexico, a view based on the interpretation of the same clauses of the treaty: that the manufacture or acquisition of nuclear explosive devices for peaceful purposes is prohibited unless or until nuclear explosive devices are developed which cannot be used as nuclear weapons—a proposition which seems hardly feasible.

[1] For the text of the treaty and a discussion of its structure, see the *SIPRI Yearbook 1969/70*, pp. 218–56.

The Non-Proliferation Treaty (NPT), signed the following year, 1968, explicitly forbids the possession by non-nuclear-weapon states of nuclear devices for any explosions; but neither Argentina nor Brazil have subscribed to the NPT.

Another point is that the Treaty of Tlatelolco does not prohibit the transit of nuclear weapons. The Preparatory Commission for the Denuclearization of Latin America affirmed that, according to the principles of international law, and in the free exercise of their sovereignty, states may grant permission for such transit in each individual case. An exception for transit is considered by some countries, non-parties to the treaty, as incompatible with the professed principle of the total absence of nuclear weapons in Latin America.

The interests of the USA and the USSR coincide on the prohibition of nuclear explosive devices to non-nuclear-weapon states. On the question of transit, however, the strategic interests of the United States in the Western hemisphere have prevailed. It is probably due to these interests that the USA has not signed (nor, for that matter, has France) Additional Protocol I to the treaty, under which the extra-continental or continental states internationally responsible, *de jure* or *de facto,* for territories lying within the limits of the zone established by the treaty, should apply to such territories the statute of military denuclearization, including IAEA safeguards. This is not to imply that it may be essential for US security to have nuclear weapons placed in the Caribbean, but the United States is apparently not prepared to renounce the option, particularly in the absence of an equivalent or similar move on the part of the Soviet Union. On the other hand, the United Kingdom and the Netherlands, which also possess territories in the Western hemisphere, have signed and ratified Additional Protocol I.

The parties to the Treaty of Tlatelolco are obliged to conclude agreements with the IAEA for the application of safeguards to their nuclear activities. These agreements should enter into force for each party not later than 24 months after the deposit of the instrument of treaty ratification. By September 1971, two years after the treaty had been in force for at least eleven states,[2] only Mexico had signed the agreement, and it may be argued that technically speaking the treaty is not yet fully operative. However, some Latin American states do not possess the nuclear technology to which safeguards could apply. Besides, the Non-Proliferation Treaty, to which a number of Latin American countries adhere and which has been

[2] In September 1969, when the treaty entered into force for eleven states, the Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL) was set up to ensure compliance with the obligations assumed by the parties.

in force since March 1970, also provides for a safeguards agreement with the IAEA. It is hardly necessary to have two agreements on the same subject; one agreement applicable to both the Treaty of Tlatelolco and the NPT would certainly suffice. The latter approach was adopted by Uruguay when it signed a safeguards agreement with the IAEA in 1971.

More important for the implementation of the Treaty of Tlatelolco is the status of Additional Protocol II, providing for an undertaking by nuclear-weapon states to respect the statute of military denuclearization of Latin America, as defined in the treaty, not to contribute to acts involving a violation of the treaty, and not to use or threaten to use nuclear weapons against the parties to the treaty.

The significance of Additional Protocol II was emphasized in UN General Assembly resolutions of 1967 and 1968, as well as in a resolution of the Conference of Non-Nuclear-Weapon States in 1968. The twenty-fifth UN Assembly expressed its conviction that the obligations under Additional Protocol II were entirely in conformity with the general obligations assumed in the UN Charter, which every member of the United Nations had undertaken to fulfil, and reiterated its appeal to the nuclear-weapon powers to sign and ratify the Protocol.[3]

The United Kingdom was the first nuclear-weapon power to sign and ratify Additional Protocol II; the United States followed suit after a period of hesitation. The ratifications by the UK and the USA were accompanied by statements of understanding and interpretative declarations (see page 591). None of the remaining nuclear-weapon states—the USSR, France and China—has indicated readiness to join the Protocol.

The position of the Soviet Union on the question of Latin American denuclearization has been rather reserved all along. Together with its allies (with the exception of Romania), the USSR abstained on the respective UN resolutions. The reasons stated[4] were that the clause concerning nuclear explosions for peaceful purposes and the absence of the prohibition to transport nuclear weapons through the territories of the contracting parties introduced elements of ambiguity. The USSR assumed that nuclear weapons would be stationed in some Latin American areas controlled by the USA and not included in the denuclearized zone, as well as inside the zone —i.e., in the Panama Canal. Cuba made a similar criticism and stated that it would consider becoming a party to the treaty only if it provided for the denuclearization and abolition of US military bases in Panama and Puerto Rico and at Guantánamo.[5]

[3] UN document A/RES/2666(XXV).
[4] UN document A/C.1/PV.1509.
[5] UN document A/C.1/PV.1508.

Moreover, the Soviet Union observed that according to the treaty the zone of its application would encompass large areas of the Atlantic and Pacific Oceans, hundreds of kilometres off the coasts of signatory states, while the limit of territorial waters has been established "in accordance with international law" at 12 nautical miles. In other words, the USSR objected to what it viewed as excessive limitation on the freedom of its navy to move or be stationed in international waters.

In reply to a letter from the Mexican Senate, the Supreme Soviet of the USSR stated that since Mexico had ratified the Non-Proliferation Treaty, and thereby made clear its position on peaceful nuclear explosions, and since it had declared its intention not to allow the transport (transit) of nuclear weapons through its territory, and extended the statute of denuclearization "to the whole territory" of Mexico, including its land, air space and territorial waters up to 12 nautical miles, the Soviet Union was ready to undertake a commitment to respect the status of Mexico as a completely nuclear-weapon-free zone. In addition, the USSR stated that if other Latin American states also "genuinely" turned their territories into completely nuclear-weapon-free zones, they too could count on the same respect from the Soviet Union for their status, and that this would be possible only if other nuclear-weapon powers also undertook the same commitments. The USSR would, however, reserve the right to reconsider its commitments "in the event of any state in respect of which the Soviet Union undertakes such a commitment perpetrating aggression or being an accomplice to aggression".[6]

Thus, the Soviet Union is using its own criteria for determining whether a given area is a nuclear-weapon-free zone, whatever the views of the parties to a multilateral treaty establishing the zone. It makes its undertaking of obligations, specified in Additional Protocol II, conditional upon the express acceptance by all the Latin American countries of the prohibition of nuclear explosive devices for peaceful purposes and also of the prohibition of the transit of nuclear weapons.

The first condition would be met only if Argentina and Brazil revised their present position on nuclear explosions. This could happen either as a consequence of some internal political changes in the two countries, or under the pressure resulting from the Non-Proliferation Treaty, or if the advantages in the field of peaceful uses of atomic energy which the Treaty of Tlatelolco may eventually offer to the parties prove sufficiently tempting. The second condition, i.e., the prohibition of transit, is even less likely to be met in the foreseeable future, considering the US interests in the region, of which the Soviet Union is aware.

[6] UN documents A/8336 and S/10250.

An additional Soviet postulate is that the same commitments should be undertaken by the other nuclear-weapon powers. Since the United Kingdom and the United States are already parties to the Protocol, this postulate applies to France and China. The approach is novel: previously, in similar cases, the requirement of reciprocity of obligations, put forward by the Soviet Union, was usually limited to the USA and the USSR.

Furthermore, the USSR seems to prefer the procedure of unilateral declarations of respect for the denuclearized status of individual states, rather than the signing of a formal, international instrument, as recommended by the United Nations.[7] This is also new: heretofore the Soviet Union had considered unilateral declarations as not binding in the strictly legal sense of the word and as not providing an adequate substitute for international agreements.[8] At the same time, the Soviet Union wishes to reserve the right to withdraw its commitment in the event of aggression, but does not qualify the latter. The United States and the United Kingdom, which in signing Additional Protocol II reserved the right to reconsider their undertakings of non-use, confined it to cases of armed attacks by a contracting party in which the latter was assisted by a *nuclear-weapon state.*

For many years the USSR has been advocating the prohibition of the use of nuclear weapons, in particular of "first use", and has proposed a convention on the subject.[9] It has been calling for the establishment of nuclear-weapon-free zones in different parts of the world, supported the idea of guarantees of non-use of nuclear weapons against non-nuclear-weapon countries during the discussion of nuclear-weapon-free zones in Europe and in Africa, and maintained that attitude in the non-proliferation debate. At one time it even proposed agreements prohibiting flights of nuclear-armed aircraft beyond national borders, and also restricting the areas of navigation for nuclear missile-carrying submarines. It is not likely that the stand of the Soviet Union on the Treaty of Tlatelolco should indicate a reversal of its traditional position, a position which it reaffirms on every occasion. If anything, the pattern of special political and military[10] relations with Cuba may provide a clue to the Soviet position.

As early as 1966, France welcomed the efforts of the Latin American countries to prevent the dissemination of nuclear weapons. It later voiced satisfaction at the conclusion of the Treaty of Tlatelolco and promised to

[7] UN document A/RES/2666(XXV).
[8] Disarmament Conference documents CCD/PV.493; CCD/PV.514.
[9] UN document A/6834.
[10] There have been persistent reports in the US press during the last year about the presence of Soviet nuclear-missile submarines in Cuban waters. It was also alleged that the USSR was preparing to build a base in Cienfuegos, Cuba to service those submarines.

study the political and legal implications of the texts proposed for its signature.[11] But these expressions of sympathy, which must be seen in the light of the French government's efforts in recent years to develop friendly relations with Latin America, have so far produced only a verbal assurance that France intends to do nothing that would infringe upon the principle of denuclearization which the countries concerned have freely adopted.[12]

Also the People's Republic of China had been viewing with "positive sympathy" the denuclearization of Latin America, but refused to associate itself with the Treaty of Tlatelolco as long as it was denied its rights in the United Nations which had commended the treaty. In the autumn of 1971, when the question of Chinese representation in the United Nations was solved, the People's Republic of China expressed support for nuclear-weapon-free zones, demanded that the countries possessing nuclear weapons should undertake not to use them against such zones, and reiterated its pledge at no time and under any circumstances to be first to use nuclear weapons.[13] It made no reference to Additional Protocol II of the Treaty of Tlatelolco, although the signing of the Protocol would be fully in line with its professed policy.

In a resolution adopted on 16 December 1971, the twenty-sixth UN General Assembly deplored the fact that not all the nuclear-weapon states had heeded the appeals which the Assembly had made previously and it urged them once again to sign and ratify Protocol II of the Treaty of Tlatelolco without further delay.[14]

An obligation to respect the denuclearized status of a zone which to a nuclear-weapon power may appear not fully denuclearized can be hedged with statements of understanding and interpretative declarations, as was the case with the ratification of Protocol II of the Treaty of Tlatelolco by the USA and the UK. But, whatever the interpretation, a refusal formally to guarantee the inviolability of the régime of absence of nuclear weapons, established at the initiative of the Latin American states, is not justified. It may undermine the credibility of the avowed positions of the nuclear-weapon powers and also adversely affect the prospects for the establishment of nuclear-weapon-free zones on other continents or areas. In undertaking to prohibit nuclear weapons in their territories, the non-nuclear-weapon states are entitled to a *quid pro quo* in the form of assurances that such weapons would not be used against them, and that the denuclearization régime would be respected.

[11] UN document A/C.1/PV. 1510.
[12] UN document A/C.1/PV. 1838.
[13] UN document A/PV. 1995.
[14] UN document A/RES/2830(XXVI).

Map 7. The zone of application of the Treaty of Tlatelolco, as of 1 January 1972[a]

[a] The zone of application of the Treaty is the whole of the territories for which the Treaty is in force (Article 4). For the purposes of the Treaty, the term "territory" includes the territorial sea, air space and any other space over which the state exercises sovereignty in accordance with its own legislation (Article 3).

SWEDISH NATIONAL MAP AND PRINTING ORGANIZATION

20. Declaration of the Indian Ocean as a zone of peace

At the initiative of Ceylon,[1] the twenty-sixth UN General Assembly discussed the question of making the Indian Ocean a zone to be used exclusively for peaceful purposes. The main features of Ceylon's proposal were that defensive and offensive armaments and military installations should be excluded from the entire high-sea area of the Indian Ocean, within limits to be specified later. Warships and ships carrying war material would have the right of transit but would not be allowed to stop except for emergency reasons of a mechanical, technical or humanitarian nature. The use of the sea-bed by submarines would also be prohibited except for reasons mentioned above. There would be a ban on naval manoeuvres, naval intelligence operations and weapon tests. Army, navy and air force bases would be prohibited in the zone.

The next step would be to exclude all foreign military bases from the territories of littoral states and, possibly, the immediate hinterland states of the Indian Ocean. The intention was also to include non-self-governing territories in the zone of peace and to have them demilitarized.

As a regional approach to disarmament, the proposal concerning the Indian Ocean goes much further than did the prohibition of nuclear weapons in Latin America (the Treaty of Tlatelolco), the Organization of African Unity's declaration of Africa as a nuclear-free zone or any other suggestion for zonal denuclearization, in that it provides for the exclusion of both nuclear and conventional weapons. It calls for total demilitarization and neutralization of the Indian Ocean.[2]

The idea of proclaiming the Indian Ocean a peace zone was formulated as early as September 1970 by the conference of heads of state or government of non-aligned countries in Lusaka; subsequently, the ministerial meeting of non-aligned countries in New York, in September 1971, agreed

[1] UN document A/8492.
[2] In a declaration of 27 November 1971, the Foreign Ministers of the countries of the Association of the South-East Asian Nations (Indonesia, Malaysia, the Philippines, Singapore and Thailand) also demanded the recognition of, and respect for, South-East Asia as a zone of peace, free from any form of interference by outside powers.

that practical effect should be given to the concept. Nevertheless, when it came to converting the accepted principle into a United Nations recommendation, several states, including some participants in the above-mentioned meetings, were not prepared to endorse the original, wide-ranging scheme.

A draft resolution on the subject,[3] submitted by Ceylon and a few other sponsors, met with a series of reservations concerning both procedural and substantive aspects of the proposal. The main objection, as stated by many countries, was that establishment of the proposed "zone of peace" would contradict existing international law on the freedom of navigation on the high seas for *all* ships; it was argued that a group of states in any given region cannot establish a separate legal régime for the high seas in that region. There were misgivings that obstacles to international commerce, fishing, installation of submarine cables and pipelines, as well as overflights, may arise, since the Indian Ocean is of concern not only to littoral states but to the entire international community. The proposed declaration was criticized for not taking account of defence arrangements in the region, as well as for the lack of exact determination of the geographical area to which it referred. The difficulties of verifying the envisaged commitments were also pointed out. Even some of those nations which obviously sympathized with the idea considered the Ceylonese proposition too ambitious and premature. They preferred a step-by-step approach similar to that adopted a few years earlier with respect to the denuclearization of Latin America: studies leading to an agreed statement by the countries in the area, and then approval by the United Nations, possibly followed by drafting a treaty and securing the cooperation of the major powers. It was feared that a declaration along the lines proposed by Ceylon might prejudge the outcome of negotiations. It should also be noted that the discussion took place in the autumn of 1971, at the time when there was a war on the Indian Sub-continent—a circumstance hardly conducive to a meeting of minds.

As a result, the original proposal was watered down, its scope restricted and its form modified.[4] Despite these changes, it was adopted by only 61 votes with 55 abstentions. The UN General Assembly resolution of 16 December 1971[5] calls upon the great powers to enter into consultations with the littoral states of the Indian Ocean with a view to halting the escalation and expansion of their military presence in the ocean, and eliminating

[3] UN document A/C.1/L.590.
[4] UN document A/C.1/L.590/Rev. 1 and Rev. 2.
[5] UN document A/RES/2832 (XXVI).

bases, military installations, logistical supply facilities, nuclear weapons and other weapons of mass destruction and any manifestation of great-power military presence "conceived in the context of great power rivalry". It also calls upon the littoral and hinterland states of the Indian Ocean, the permanent members of the Security Council and other major maritime states using that ocean, to enter into consultations with a view to ensuring that warships and military aircraft do not make use of the Indian Ocean for any threat or use of force against the sovereignty, territorial integrity and independence of any littoral or hinterland state of the ocean. Subject to the foregoing, and to the norms and principles of international law, the right to free and unimpeded use of the zone by the vessels of all nations should not be affected.

While the resolution "solemnly declares" that the Indian Ocean is designated as a zone of peace, it actually only recommends that international consultations be held; this may or may not result in bringing about such a zone. It is not even clear how these consultations should be conducted; no concrete procedure has been established to carry them through. As of now, the idea of demilitarizing the Indian Ocean is no more than a wish on the part of a group of Asian and African countries, and the resolution adopted in the United Nations is just a statement of intent.

It must be recognized that the situation in the Indian Ocean, as distinct from that in other oceans, such as the Atlantic or the Pacific, is rather favourable for the application of a policy along the lines which have been suggested. The presence of the military and naval forces of the great powers in the Indian Ocean has not, as yet, assumed really significant proportions;[6] those powers are not contiguous states; the major maritime nations are geographically remote from the area; the economic interests of the great powers are not involved in the area to such a degree as to warrant the maintenance of military and naval establishments to ensure the protection of those interests. Moreover, the peoples of the littoral and immediate hinterland states of the Indian Ocean, whatever their cultural background and specific interests, have much in common. With few exceptions, they have had a colonial past and are economically and technically underdeveloped; nearly all endorse the concept of non-alignment and share a keen desire to preserve their recently acquired sovereignty intact from disruptive external influences.

However, it should also be noted that important commercial sea routes lie across the Indian Ocean, and that the use of these routes is crucial to

[6] For information on the military presence of the great powers in the Indian Ocean, see the tables beginning on page 250.

many countries, including non-littoral states, to ensure the flow of essential supplies. It is also a fact that military strategic interests are, or may be, involved there, though these are not the interests of the states in the region.

India, a major littoral state, has insufficient resources to become a naval power; besides, its defences are directed landward rather than seaward. Similarly, other large Asian maritime nations in the Indian Ocean area (such as Pakistan and Indonesia or the states of East Africa), are not likely to acquire a significant naval capability in the foreseeable future nor to play a substantial role in world affairs beyond their immediate vicinity.

As to the position of outside powers, the most remarkable fact is the gradual, though not very sizeable, build-up of the Soviet naval presence in the Indian Ocean in recent years; this includes port agreements as well as anchorage and landing arrangements with some littoral and island countries. There may be several reasons for this development. The increased number of Soviet fishing trawlers in the Indian Ocean, the oceanographic research carried out by Soviet vessels in that area, and the expanding Soviet merchant shipping across the ocean may, in the Soviet Union's view, require a fleet capable of preventing interference. But this development may also be taken as indicating a growing role for the navy within the Soviet military establishment in promoting the Soviet Union's global strategy, while a particular aim in the Indian Ocean might be to gain more political influence to offset possible Chinese pursuits in the area. A purely military but defensive motive might be to counter the USA if it seeks to have a submarine-based nuclear force permanently stationed in the Indian Ocean. But any apprehension that Soviet presence in the Indian Ocean could constitute a threat to non-Soviet shipping, or that the USSR would be able to bring pressure on Japan and Western Europe—whose energy resources for the most part come from the Persian Gulf or the Arabian peninsula—do not seem to be well-grounded. It would not be logical for the Soviet Union to act in that way and risk its unimpeded use of the seas throughout the world. In any event, under the present circumstances, no power could achieve or even hope to achieve absolute command of the Indian Ocean such as the British Navy held during the nineteenth and early twentieth centuries.

It is significant that in June 1971, the Secretary-General of the Soviet Communist Party indicated Soviet preparedness to discuss the presence of the big powers' naval forces far from their own coasts and to solve this problem by making "an equal bargain"; he referred specifically to the Mediterranean Sea and the Indian Ocean. It would probably be false to interpret this statement as a proposal for the withdrawal of fleets, but it could imply an offer for a reciprocal limitation of military activity of the big powers in the oceans.[7]

For years US naval presence in the Indian Ocean had been kept rather low as compared to the Atlantic or the Pacific, but according to recent reports it is being expanded. US interests in the area could be described as a reflection of Soviet interests. Politically, the USA may wish to maintain whatever influence it has in the Indian Ocean and to strengthen it, as well as to respond to the increased Soviet presence there, and not to let the balance shift in favour of the USSR. Militarily, the stationing of ship-borne long-range missiles in the Indian Ocean, targeted from the south on the Soviet Union (and perhaps also on China), may be considered by some US military planners as enhancing the US strategic deterrence.

At the initiative of the USA, in October 1971, a "document of understanding" was initialed by the representatives of the USA and the USSR on the prevention of incidents at sea involving their ships and planes. There have also been reports that some discussions were held between the two powers about arranging a limit on naval armaments in the Indian Ocean.[8] All this may reduce friction caused by the juxtaposition of the two nations' navies, but it will certainly not reduce the rivalries at sea.

China has nothing to lose and everything to gain from a big power commitment to disengagement in the Indian Ocean. Although it clearly is not in a position to fill a possible future vacuum, China would be freer in its activities in the area, and would also feel less threatened militarily. This may explain why China was the only great power to vote for the declaration of the Indian Ocean as a zone of peace, while the USA and the USSR, as well as France and the UK, abstained.

As pointed out above, the big powers' military activity in the Indian Ocean has not yet reached disquieting dimensions. But precisely because this is so, steps towards the neutralization of this ocean can and should be taken now. The exclusion of the world's third largest ocean from military competition would help to avert a confrontation which could well have disastrous effects not only for the countries immediately involved, but for the world at large; it would serve the interests of the whole international community. The goal may be considered by some as hardly attainable as long as no major breakthrough occurs in relations among the great powers. Much will also depend on whether the countries in the area which are principally concerned, and which account for nearly one-third of the world's

[7] In 1968 the USSR proposed that agreement be reached for the cessation of patrols by missile-carrying submarines with nuclear missiles on board, in areas where the borders of parties to the agreement are within range of such missiles.

[8] *International Herald Tribune,* 2 February 1972.

population, can reach a consensus on the subject. And even this is not likely to be quickly achieved, considering possible divergent views which may outweigh common interests, as well as the pressure which may be brought to bear upon those countries by the great powers.

An agreement on the complete demilitarization of the Indian Ocean may be difficult to reconcile with the principle of complete freedom of the high seas. But this principle was originally devised to secure free commerce and other peaceful activities. It has been abused as a cover-up for unrestrained military activity, and for intervention and domination by powerful maritime nations. In as much as it stands in the way of disarmament, it deserves to be reconsidered, at least with regard to a part of the high seas.

21. The Disarmament Decade

The aim of the 1969 UN resolution declaring the 1970s a Disarmament Decade was to galvanize international efforts towards general and complete disarmament and to harmonize them into a purposeful plan of action. A comprehensive programme was to be agreed upon in order to provide a guideline for the negotiators. Working papers dealing with the subject were prepared by the Netherlands and Italy, as well as jointly by Mexico, Sweden and Yugoslavia.

On 1 December 1970, Ireland, Mexico, Morocco, Pakistan, Sweden and Yugoslavia officially submitted in the UN General Assembly a proposal setting out the objectives, principles, elements and phases of a comprehensive programme of disarmament; peace-keeping and security problems; as well as a procedure for implementing the programme.[1]

The document suggested that, in addition to the items under consideration, such as the prohibition of chemical and biological weapons, prevention of an arms race on the sea-bed and the banning of underground nuclear weapon tests, the following measures should be considered:

1. *Prevention and limitation of armaments*

With regard to nuclear weapons:

A moratorium or cessation of testing and deploying new strategic nuclear weapon systems;

The cessation of production of fissionable material for military purposes and the transfer of existing stocks to civilian uses;

A freeze or limitation on the deployment of all types of nuclear weapons;

The conclusion of regional agreements for the establishment of additional nuclear-weapon-free zones;

A solution of the problem concerning the prohibition of the use of, or the threat to use, nuclear weapons.

With regard to conventional armaments and armed forces:

Further prohibitions of the use for military purposes of the sea-bed and the ocean floor, and the subsoil thereof;

The establishment of ceilings on the level and types of conventional armaments and the number of armed forces;

[1] UN document A/8191.

Restrictions on the creation of foreign military bases and the stationing of troops and military equipment in foreign territories;
Convening of regional conferences at the initiative of the states of the region for the prevention and limitation of armaments.

2. *Reduction of all armaments, armed forces and military expenditures*
Gradual reductions in nuclear armaments;
Gradual reductions in conventional armaments and armed forces;
The conclusion of regional non-aggression, security and disarmament treaties at the initiative of the states concerned;
Gradual withdrawal of troops and bases from foreign territories;
Reduction in military expenditures.

3. *Elimination of armaments*
In accordance with the Joint Statement of Agreed Principles for Disarmament Negotiations of 1961 (the so-called "Zorin–McCloy Statement"), the final stage of the comprehensive programme should be the conclusion of a treaty on general and complete disarmament under effective international control, providing for the prohibition and elimination of nuclear weapons and the reduction of conventional armaments and armed forces to levels required for the maintenance of internal order and for international peace-keeping.

The document acknowledged a close inter-relationship among disarmament, international security, the peaceful settlement of disputes and an international climate of confidence. But it pointed out that progress in one category of measures should not be made dependent on progress in another.

The USA and the USSR were urged to submit revised and updated versions of their draft treaties on general and complete disarmament, which had been worked out and discussed in the early 1960s.

It proved impossible to arrive at a consensus on a disarmament programme. The UN resolution recommending that the above six-nation proposal be taken into account in the Disarmament Committee's work[2] has remained a dead letter. The USA and the USSR are obviously unwilling to tie themselves to a precise pattern of further negotiations. They are even more reluctant to be bound by priorities established by others, preferring to keep to themselves the judgement as to which measures should be dealt with and when. As a result of this approach no real progress has been recorded in arresting the arms race.

The United States and the Soviet Union proclaim that general and com-

[2] UN document A/RES/2661C (XXV).

plete disarmament is an ultimate goal to seek. At the twenty-sixth UN General Assembly they again voted for a resolution[3] urging the CCD to "resume its efforts" on the question of general and complete disarmament, but in actual fact their interest in discussing it seems to have waned.

Attempts by other states to exercise more control and influence over the disarmament talks which were in progress have also largely failed. The United Nations has not been informed about developments at SALT, except in very general terms, and has had to rely on unconfirmed press reports. The agreements signed in September 1971 on measures to reduce the risk of outbreak of nuclear war between the USA and the USSR, and on the improvement of the "hot line" between Washington and Moscow, are essentially technical and subsidiary in nature, while General Assembly appeals[4] to the USA and the USSR to agree on a moratorium on further testing and deployment of offensive and defensive strategic nuclear weapon systems, have received no response. The activities of the CCD continued to be in great part determined by the decisions of the US and Soviet co-chairmen; calls for modifying the working procedures of the Conference were ignored.

However, it was evident that the entry of China on the international stage was bound to change the structure, if not the content, of the disarmament debate. Anticipating such an evolution, the Soviet Union proposed in the spring of 1971 to convene, in the near future, a conference of the five nuclear-weapon powers to consider the whole question of nuclear disarmament. For many years France had favoured such a conference. The United Kingdom approved the idea in principle, and the United States seemed not to oppose it, recognizing that there are issues particularly appropriate for discussion among the nuclear-weapon states themselves.

The Soviet proposal has not materialized. It was rejected by China which held, in a statement of 30 July 1971, that matters affecting various countries in the world should be jointly discussed and settled by all of them and that no monopoly by a few powers should be permitted.

Subsequently, at the twenty-sixth UN General Assembly, the USSR submitted a draft resolution[5] calling for a world disarmament conference.[6]

The purpose of the conference, as explained by the Soviet Union,[7] was

[3] UN document A/RES/2825B (XXVI).
[4] UN documents A/RES/2602A (XXIV) and A/RES/2661A (XXV).
[5] UN document A/L. 631.
[6] A similar proposal was discussed and accepted by the United Nations in 1965 [UN document A/RES/2030 (XX)]. It was not put into effect because the People's Republic of China refused to participate.
[7] UN document A/PV. 1978.

to consider a wide range of problems relating to disarmament; to work out ways and means of halting and reversing the arms race; and to prohibit and eliminate nuclear and other weapons of mass destruction, their production and use. All countries, whether or not members of the UN, would be invited to participate on an equal footing. The conference to be convened periodically, once every two or three years, was not to detract from the disarmament negotiations conducted elsewhere.

The idea was welcomed by many countries, especially the non-aligned countries, which stressed, however, the need for thorough preparations and insisted that the proposed conference be held within the framework of the United Nations. France also favoured the opportunity of discussing at a world meeting the fundamental problems of disarmament, and pointed out that partial measures do not lead to disarmament, and that to attain a strategic equilibrium is not an end in itself.[8] The United States was sceptical about the usefulness of a "large and unwieldy" gathering.[9] China opposed the Soviet proposal as lacking a clear aim. It insisted that a world conference, possibly at the highest level, should discuss the question of "the complete prohibition and thorough destruction of nuclear weapons", and as the first step reach an agreement on the non-use of these weapons by nuclear-weapon countries "at any time and in any circumstances". In its view, the USA and the USSR should, first of all, issue statements, separately or jointly, undertaking an obligation not to be the first to use nuclear weapons, and not to use them against non-nuclear-weapon countries or nuclear-free zones; and to dismantle all nuclear bases set up on the territories of other countries and withdraw all their nuclear armed forces and all nuclear weapons and means of delivery from abroad.[10] Thus, according to China, some important obligations would have to be undertaken even before the conference was convened, and the conference agenda was to be formulated in such a way as to predetermine the outcome of the discussion. Such preconditions proved unacceptable to the other great powers.

As a result of informal bargaining, an agreement was reached on a resolution inviting all states to communicate to the UN Secretary-General, before 31 August 1972, their views and suggestions on any relevant questions relating to a world disarmament conference, in particular the main objectives, provisional agenda, site favoured, date and contemplated duration, procedures to be adopted for carrying out the preparatory work, and relationship to the United Nations.[11] The resolution was adopted on 16 December 1971, by acclamation.

[8] UN document A/PV. 1889.
[9] UN document A/PV. 1996.
[10] UN document A/PV. 1995.
[11] UN document A/RES/2833 (XXVI).

The history of the post-war disarmament debate has shown that, as a rule, disputes regarding the modalities of negotiations serve to cover up controversies on the substance of and approach to disarmament. The discussion on convening a world disarmament conference is no exception to that rule.

A wide international deliberative forum for disarmament matters already exists. Apart from the UN General Assembly and its First Political Committee, there is a Disarmament Commission composed of all the 132 UN members, including China. The Commission has been inactive since 1965, but could be called at any time with very few formalities; the states which are outside the UN could be invited to participate.

A negotiating body, the Geneva Conference of the Committee on Disarmament, has also been in existence for many years. All it would need to function properly would be the inclusion of China and the actual participation of France (which is a member of the Committee), as well as certain organizational reforms, such as the abolition of the institution of the US and Soviet co-chairmanship. Nevertheless, pressure for a world conference is building up. Its proponents argue that such a conference would help to focus the attention of world opinion on the problems of the arms race and the urgency of disarmament, and that it could breathe life into the stalemated talks and provide an impetus for progress. It is also expected that a new negotiating body would be set up, based on a more sound and equitable basis than the one now in existence. The main issue, however, is *what* to negotiate rather than *how* to negotiate and *where.*

The era of strict political and military US–Soviet bipolarity is gradually coming to an end. This development, desirable in itself and, in any event, unavoidable, creates a new situation in the field of disarmament. The policy of preventing the less armed from becoming more armed, or of readjusting the nuclear arsenals of the USA and the USSR without actually reducing their effectiveness, will, in the long run, not suffice. A much more imaginative policy is needed to make disarmament negotiations meaningful, whatever the negotiating forum.

22. UN General Assembly resolutions on disarmament and related matters, 1970–1971

Sea-bed and ocean floor 562
Chemical and biological weapons 563
Nuclear weapon tests 565
Nuclear safeguards 566
Strategic nuclear weapon systems 567
Latin American nuclear-free zone 567
Indian Ocean as a zone of peace 567
Military bases 568
Nuclear explosions for peaceful purposes 569
General and complete disarmament 569
Economic and social consequences of the arms race 570
Economic and social consequences of disarmament 571
Human rights in armed conflicts 571
Rule of law 572
Peace research and information about arms race and disarmament 572
World disarmament conference 573

UN member states

As of 31 December 1971, the 132 member states of the United Nations included: Afghanistan, Albania, Algeria, Argentina, Australia, Austria, Bahrain, Barbados, Belgium, Bhutan, Bolivia, Botswana, Brazil, Bulgaria, Burma, Burundi, Byelorussian Soviet Socialist Republic, Cameroon, Canada, Central African Republic, Ceylon, Chad, Chile, China, Colombia, Congo, Costa Rica, Cuba, Cyprus, Czechoslovakia, Dahomey, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Ghana, Greece, Guatemala, Guinea, Guyana, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Ivory Coast, Jamaica, Japan, Jordan, Kenya, Khmer Republic, Kuwait, Laos, Lebanon, Lesotho, Liberia, Libya, Luxembourg, Madagascar, Malawi, Malaysia, Maldive Islands, Mali, Malta, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Paraguay, People's Democratic Republic of Yemen, Peru, Philippines, Poland, Portugal, Qatar, Romania, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, Somalia, South Africa, Spain, Sudan, Swaziland, Sweden, Syria, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukrainian Soviet Socialist Republic, Union of Soviet Socialist Republics, United Arab Emirates, United Kingdom, United Republic of Tanzania, United States, Upper Volta, Uruguay, Venezuela, Yemen, Yugoslavia, Zaïre and Zambia.

[1] For states which have recently changed their names, see pages XVII–XVIII.

22. *List of United Nations General Assembly resolutions on disarmament and related matters, 1970–1971*

This list includes resolutions exclusively concerning disarmament, as well as those dealing with economic, social, colonial, legal and general political questions, but referring explicitly to disarmament matters. In the latter case, the negative votes or abstentions do not necessarily reflect the positions of states on the disarmament paragraphs of the relevant resolutions.

Only the essential parts of each resolution are given here. The text has been abridged, but the wording is close to that of the resolution.

The resolutions are grouped according to subjects, irrespective of the agenda items under which they were discussed; under each heading, the resolutions appear in the chronological order of their adoption.

In the case of roll-call, the countries are identified; in other cases, when the vote has not been recorded, the voting results are given only in figures.

Resolution no. and date of adoption	Subject and contents of resolution	Voting results
	Sea-bed and ocean floor	
2660 (XXV) 7 December 1970	Commends the Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil Thereof (the text of which is annexed to the resolution); and requests the depositary governments to open the treaty for signature and ratification.	*In favour* 104 *Against* 2: El Salvador, Peru *Abstentions* 2: Ecuador, France *Absent:* Albania, Barbados, Botswana, Burundi, Congo (Democratic Republic of), Costa Rica, Dominican Republic, Equatorial Guinea, Guinea, Haiti, Honduras, Malawi, Maldives, Nicaragua, Somalia, Southern Yemen, Sudan, Swaziland, Trinidad and Tobago
2749 (XXV) 17 December 1970 (Declaration of the principles governing the sea-bed)	Declares that the sea-bed and ocean floor, and the subsoil thereof, beyond the limits of national jurisdiction, shall be reserved exclusively for peaceful purposes, without prejudice to any measures which have been or may be agreed upon in the context of international negotiations undertaken in the field of disarmament and which may be applicable to a broader area. One or more international agreements shall be concluded as soon as possible in order to implement effectively this principle and to constitute a step towards the exclusion of the sea-bed, the ocean floor and the subsoil thereof from the arms race.	*In favour* 108 *Against* 0 *Abstentions* 14
2750 C (XXV) 17 December 1970	Decides to convene in 1973 a Conference on the Law of the Sea which would deal with the establishment of an equitable international régime—including an international machinery—for the area and the resources of the sea-bed and the ocean floor and the subsoil thereof beyond the limits of national jurisdiction, a precise definition of the area, and a broad range of related issues including those concerning the régimes of the high seas, the continental shelf, the territorial sea (including the question of its breadth and the question of international straits) and contiguous zone, fishing and conservation	*In favour* 108 *Against* 7: Bulgaria, Byelorussia, Czechoslovakia, Hungary, Poland, Ukraine, USSR *Abstentions* 6: Burma, Cuba, Mongolia, Romania, Saudi Arabia, Venezuela *Absent:* Albania, Botswana, Central African Republic, Gambia, Maldives, Pakistan[a] [a] Later announced it had intended to vote in favour.

of the living resources of the high seas (including the question of the preferential rights of coastal states), the preservation of the marine environment (including, *inter alia*, the prevention of pollution) and scientific research.

Chemical and biological weapons

2662 (XXV) 7 December 1970	Commends the following basic approach for reaching an effective solution to the problem of chemical and bacteriological (biological) methods of warfare: (a) It is urgent and important to reach agreement on the problem of chemical and bacteriological (biological) methods of warfare; (b) Both chemical and bacteriological (biological) weapons should continue to be dealt with together in taking steps towards the prohibition of their development, production and stockpiling and their effective elimination from the arsenals of all States; (c) The issue of verification is important in the field of chemical and bacteriological (biological) weapons, and verification should be based on a combination of appropriate national and international measures, which would complement and supplement each other, thereby providing an acceptable system that would ensure the effective implementation of the prohibition.	*In favour* 113 *Against* 0 *Abstentions* 2
2707 (XXV) 14 December 1970	Calls upon the government of Portugal not to use chemical and biological methods of warfare against the peoples of Angola, Mozambique and Guinea (Bissau) contrary to the generally recognized rules of international law embodied in the Geneva Protocol of 17 June 1925 and to General Assembly resolution 2603 (XXIV) of 16 December 1969. (See the *SIPRI Yearbook 1969/70*, p. 475.)	*In favour* 94 *Against* 6: Brazil, Portugal, South Africa, Spain, UK, USA *Abstentions* 16: Argentina, Australia, Austria, Belgium, Canada, Denmark, Finland, France, Italy, Luxembourg, Malawi, Netherlands, New Zealand, Norway, Paraguay, Sweden *Absent:* Bolivia, Costa Rica, Dahomey,[a] El Salvador, Honduras, Iceland, Maldives, Malta, Rwanda, Senegal,[a] Yemen [a] Later indicated it had intended to vote in favour.
2795 (XXVI) 10 December 1971	Calls upon the government of Portugal to refrain from the use of chemical substances against the peoples of Angola, Mozambique and Guinea (Bissau), as such practice is contrary to the generally recognized rules of international law embodied in the Geneva Protocol of 17 June 1925, and to General Assembly resolution 2707 (XXV) of 14 December 1970.	*In favour* 105 *Against* 8: Brazil, Costa Rica, France, Portugal, South Africa, Spain, UK, USA *Abstentions* 5: Argentina, Belgium, El Salvador, Italy, Malawi *Absent:* Bhutan, Bolivia, China, Guinea, Lebanon, Luxembourg, Maldives, Malta, Mauritius, Paraguay, Sierra Leone, Swaziland, Thailand, United Arab Emirates

Resolution no. and date of adoption	Subject and contents of resolution	Voting results
2826 (XXVI) 16 December 1971	Commends the convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction, the text of which is annexed to the resolution; and requests the depositary governments to open the convention for signature and ratification at the earliest possible date.	*In favour* 110 *Against* 0 *Abstention* 1: France *Absent:* Albania, Barbados, Bolivia, Botswana, China, El Salvador,[a] Gabon, Gambia, Haiti,[a] Iraq,[a] Lebanon, Malawi, Maldives, Mauritius, Niger, Oman, Sierra Leone, Sudan, Swaziland, Syria, United Arab Emirates [a] Later advised it had intended to vote in favour.
2827 A (XXVI) 16 December 1971	Requests the Conference of the Committee on Disarmament (CCD) to continue, as a high-priority item, negotiations with a view to reaching early agreement on effective measures for the prohibition of the development, production and stockpiling of chemical weapons and for their elimination from the arsenals of all states; Also requests the CCD to take into account in its further work the elements contained in the joint memorandum submitted on 28 September 1971 to the CCD by Argentina, Brazil, Burma, Egypt, Ethiopia, India, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia; as well as other proposals, suggestions, working papers and expert views; Urges governments to take all steps that may contribute to a successful outcome of the negotiations and that could facilitate early agreement; Calls anew for the strict observance by all states of the principles and objectives of the 1925 Geneva Protocol and invites all states that have not already done so to accede to or ratify the Protocol.	*In favour* 110 *Against* 0 *Abstention* 1: France *Absent:* Albania, Barbados, Bolivia, Botswana, Brazil, China, El Salvador,[a] Gabon, Gambia, Haiti,[a] Iraq,[a] Malawi, Maldives, Mauritius, Niger, Oman, Sierra Leone, Sudan, Swaziland, Syria, United Arab Emirates [a] Later advised it had intended to vote in favour.
2827 B (XXVI) 16 December 1971	Urges all states to undertake, pending agreement on the complete prohibition of the development, production and stockpiling of chemical weapons and on their destruction, to refrain from any further development, production or stockpiling of those chemical agents for weapons purposes which, because of their degree of toxicity, have the highest lethal effects and are not usable for peaceful purposes.	*In favour* 101 *Against* 0 *Abstentions* 10: Belgium, Canada, France, Greece, Italy, Luxembourg, Romania, Turkey, UK, USA *Absent:* Afghanistan, Albania, Barbados, Bolivia, Botswana, China, El Salvador,[a] Gabon, Gambia, Haiti,[a] Iraq,[a] Malawi, Maldives, Mauritius, Niger, Oman, Sierra Leone, Sudan, Swaziland, Syria, United Arab Emirates [a] Later advised it had intended to vote in favour.

Nuclear weapon tests

2663 A (XXV) 7 December 1970	Urges governments to consider and, wherever possible, to implement methods of improving their capability to contribute high-quality seismic data with assured international availability, and invites those governments that are in a position to do so to consider assistance in the improvement of worldwide seismological capabilities in order to facilitate, through the assured international availability of seismic data, the achievement of a comprehensive test ban.	*In favour* 102 *Against* 0 *Abstentions* 13
2663 B (XXV) 7 December 1970	Urges all states that have not done so to adhere without further delay to the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water; calls upon all nuclear-weapon states to suspend nuclear weapon tests in all environments; requests the Conference of the Committee on Disarmament to continue, as a matter of urgency, its deliberations on a treaty banning underground nuclear weapon tests and to submit to the Assembly at its twenty-sixth session a special report on the results of its deliberations.	*In favour* 112 *Against* 0 *Abstention* 1
2828 A (XXVI) 16 December 1971	Reiterates solemnly and most emphatically the condemnation of all nuclear weapon tests; urges the governments of nuclear-weapon states to bring to a halt all nuclear weapon tests at the earliest possible date and, in any case, not later than 5 August 1973.	*In favour* 74 *Against* 2: Albania, China *Abstentions* 36: Algeria, Australia, Belgium, Bulgaria, Byelorussia, Canada,[a] Central African Republic, Congo, Cuba, Czechoslovakia, Finland, France, Greece, Guinea, Hungary, Italy, Japan, Khmer Republic, Luxembourg, Madagascar, Mongolia, Netherlands, Pakistan, People's Democratic Republic of Yemen, Philippines, Poland, Portugal, Romania, South Africa, Spain, Thailand, Turkey, Ukraine, USSR, UK, USA *Absent:* Barbados, Bolivia, Botswana, Gabon, Gambia, Haiti,[a] Iraq,[b] Malawi, Maldives, Mauritania, Mauritius, Nicaragua, Niger, Oman, Panama, Sierra Leone, Sudan, Swaziland, Syria, United Arab Emirates [a] Later advised it had intended to vote in favour. [b] Later advised it had intended to abstain.
2828 B (XXVI) 16 December 1971	Appeals to the nuclear-weapon powers to desist from carrying out further nuclear and thermonuclear tests, whether underground, under water or in the earth's atmosphere; urges the nuclear powers to reach an agreement without delay on the cessation of all nuclear and thermonuclear tests; and requests the nuclear powers not to deploy such weapons of mass destruction.	*In favour* 71 *Against* 2: Albania, China *Abstentions* 38: Algeria, Argentina, Australia, Austria, Belgium, Brazil, Burma, Ceylon, Chile, Congo, Denmark, Equatorial Guinea, Ethiopia, Finland, France, Greece, Guinea, Honduras, India, Israel, Italy, Luxembourg, Madagascar, Mali, Malta, Netherlands, Norway, Peru, Portugal, Senegal, South Africa, Spain, Sweden, Uganda, UK, United Republic of Tanzania, USA, Yugoslavia

Resolution no. and date of adoption	Subject and contents of resolution	Voting results
		Absent: Barbados, Bolivia, Botswana, Egypt, Gabon, Gambia, Haiti,[a] Iceland, Iraq,[c] Malawi, Maldives, Mauritius, Niger, Oman, Panama, Sierra Leone, Sudan, Swaziland, Syria, United Arab Emirates [a] Later advised it had intended to vote in favour. [c] Later advised it had intended to abstain. Also Canada, which had voted in favour, indicated the same.
2828 C (XXVI) 16 December 1971	Urges all states that have not yet done so to adhere without further delay to the Partial Test Ban Treaty and meanwhile to refrain from testing in the environments covered by that treaty; calls upon all governments that have been conducting nuclear weapon tests, particularly those of parties to the Partial Test Ban Treaty, immediately to undertake unilateral or negotiated measures of restraint that would suspend nuclear weapon testing or limit or reduce the size and number of nuclear weapon tests, pending the early entry into force of a comprehensive ban on all nuclear weapon tests in all environments by all states; urges governments to take all possible measures to develop further, and to use more effectively, existing capabilities for the seismological identification of underground nuclear tests, in order to facilitate the monitoring of a comprehensive test ban; requests particularly governments that have been carrying out nuclear tests to take an active and constructive part in developing specific proposals for an underground test ban treaty.	*In favour* 91 *Against* 2: Albania, China *Abstentions* 21: Algeria, Argentina, Brazil, Bulgaria, Byelorussia, Ceylon, Chile, Congo, Cuba, Czechoslovakia, France, Guinea, Hungary, India, Mongolia, Poland, Romania, Ukraine, USSR, UK, USA *Absent:* Barbados, Botswana, Finland, Gabon, Gambia, Iraq,[e] Israel,[d] Malawi, Maldives, Mauritius, Niger, Oman, Peru,[e] Sierra Leone, Sudan, Swaziland, Syria, United Arab Emirates [d] Later advised it had voted in favour. [e] Later advised it had abstained.
	Nuclear safeguards	
2661 B (XXV) 7 December 1970	Noting that the International Atomic Energy Agency (IAEA) is engaged in the study of safeguards under the Treaty on the Non-Proliferation of Nuclear Weapons, requests the IAEA to pay attention also to the safeguards required with respect to new techniques for uranium enrichment.	*In favour* 107 *Against* 0 *Abstentions* 7
2763 (XXVI) 8 November 1971	Commends the work undertaken by the IAEA to meet its safeguards responsibilities.	Adopted without a vote.

2825 A (XXVI) 16 December 1971	Noting with satisfaction the success of the IAEA in drawing up detailed guidelines for the structure and content of agreements between the IAEA and states required in connection with the NPT, expresses confidence in the ability of the IAEA to meet, without delay, the obligations likely to be placed upon it in respect of the application of safeguards to nuclear material in all types of civil nuclear facilities, including uranium enrichment plants; and requests the IAEA to include in its annual report to the UN General Assembly full information on the progress of its work on the application of safeguards in connection with the NPT, including safeguards on nuclear material in uranium enrichment plants using both existing and new techniques.	*In favour* 89 *Against* 0 *Abstentions* 17
	Strategic nuclear-weapon systems	
2661 A (XXV) 7 December 1970	Urges the governments of the nuclear-weapon powers to bring about an immediate halt in the nuclear arms race and to cease all testing as well as deployment of offensive and defensive nuclear weapon systems.	*In favour* 102 *Against* 0 *Abstentions* 14: Australia, Austria, Belgium, China, Finland, France, Greece, Haiti, Italy, Luxembourg, Netherlands, Turkey, UK, USA *Absent:* Albania, Barbados, Botswana, Burundi, Costa Rica, Equatorial Guinea, Guinea, Honduras, Malawi, Maldives, Trinidad and Tobago
	Latin American nuclear-free zone	
2666 (XXV) 7 December 1970	Reaffirms the appeals addressed to the nuclear-weapon states to sign and ratify Additional Protocol II of the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco). (The accession to that Protocol entails for the nuclear-weapon states the obligations to respect the statute of denuclearization of Latin America; not to contribute to acts involving a violation of the treaty; not to use or threaten to use nuclear weapons against the parties to the Treaty.)	*In favour* 104 *Against* 0 *Abstentions* 12: Bulgaria, Byelorussia, Cuba, Czechoslovakia, France, Hungary, Mongolia, Poland, Sudan, Syria, Ukraine, USSR *Absent:* Albania, Botswana, Burundi, Costa Rica, Equatorial Guinea, Fiji, Guinea, Guyana,[b] Honduras, Malawi, Maldives [b] Later indicated it had intended to abstain.
2830 (XXVI) 16 December 1971	Notes with satisfaction that the USA deposited its instrument of ratification of Additional Protocol II of the Treaty of Tlatelolco on 12 May 1971, thus becoming a party to the Protocol, as the UK has been since 11 December 1969; deplores the fact that the other nuclear-weapon states have not yet heeded the urgent appeals which the General Assembly has made and urges them once again to sign and ratify the Protocol without further delay.	*In favour* 101 *Against* 0 *Abstentions* 12
	Indian Ocean as a zone of peace	
2832 (XXVI) 16 December 1971	Solemnly declares that the Indian Ocean, within limits to be determined, together with the air space above and the ocean floor subjacent thereto, is hereby designated for all time as a zone of peace.	*In favour* 61[f] *Against* 0 *Abstentions* 55: Argentina, Australia, Austria, Belgium, Bolivia,

Resolution no. and date of adoption	Subject and contents of resolution	Voting results
	Calls upon the great powers to enter into immediate consultations with the littoral states of the Indian Ocean with a view to: (a) halting the further escalation and expansion of their military presence in the Indian Ocean; (b) eliminating from the Indian Ocean all bases, military installations, logistical supply facilities, the disposition of nuclear weapons and weapons of mass destruction and any manifestation of great-power military presence in the Indian Ocean conceived in the context of great power rivalry. Calls upon the littoral and hinterland states of the Indian Ocean, the permanent members of the Security Council and other major maritime users of the Indian Ocean, in pursuit of the objective of establishing a system of universal collective security without military alliances and strengthening international security through regional and other cooperation, to enter into consultations with a view to the implementation of this declaration and such action as may be necessary to ensure that: (a) warships and military aircraft may not use the Indian Ocean for any threat or use of force against the sovereignty, territorial integrity and independence of any littoral or hinterland state of the Indian Ocean in contravention of the purposes and principles of the UN Charter; (b) subject to the foregoing and to the norms and principles of international law, the right to free and unimpeded use of the zone by the vessels of all nations is unaffected; (c) appropriate arrangements are made to give effect to any international agreement that may ultimately be reached for the maintenance of the Indian Ocean as a zone of peace.	Brazil, Bulgaria, Byelorussia, Canada, Central African Republic, Chile, Cuba, Czechoslovakia, Dahomey, Denmark, Dominican Republic, Fiji, Finland, France, Greece, Guatemala, Haiti, Honduras, Hungary, Ireland, Israel, Italy, Ivory Coast, Jamaica, Lesotho, Luxembourg, Madagascar, Mongolia, Netherlands, New Zealand, Norway, People's Democratic Republic of Yemen, Peru, Philippines, Poland, Portugal, Rwanda, Senegal, Singapore, South Africa, Spain, Thailand, Turkey, Ukraine, USSR, UK, USA, Upper Volta, Venezuela, Zäire *Absent:* Albania, Bahrain, Barbados, Botswana, Ecuador, Gabon, Gambia, Iraq[a], Malawi, Maldives, Mauritius, Niger, Oman, Paraguay, Sierra Leone, United Arab Emirates [a] Later advised it had intended to vote in favour. [f] Nicaragua later advised it had intended to abstain.
	Military bases	
2878 (XXVI) 20 December 1971 (Implementation of the Declaration on the granting of independence to colonial countries)	Requests the colonial powers to withdraw immediately and unconditionally their military bases and installations from colonial territories and to refrain from establishing new ones.	*In favour* 96 *Against* 5: France, Portugal, South Africa, UK, USA *Abstentions* 18: Australia, Austria, Belgium, Brazil, Canada, Denmark, Fiji, Finland, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden *Absent:* Barbados, Bhutan, Bolivia, China, Costa Rica, Gabon, Gambia, Malawi, Maldives, Mali, Mauritius, Paraguay, Qatar

	Nuclear explosions for peaceful purposes	
2665 (XXV) 7 December 1970	Having reviewed the report entitled "Establishment, within the framework of the International Atomic Energy Agency, of an international service for nuclear explosions for peaceful purposes under appropriate international control", commends the IAEA for its efforts to compile and evaluate information on the present status of the technology and to make it available on an international scale; and requests the IAEA to continue and intensify its programme in this field.	*In favour* 109 *Against* 0 *Abstentions* 5
2829 (XXVI) 16 December 1971	Requests the IAEA to study ways and means of establishing within its framework a service for nuclear explosions for peaceful purposes under appropriate international control.	*In favour* 103 *Against* 0 *Abstentions* 9
	General and complete disarmament	
2627 (XXV) 24 October 1970 (Declaration on the occasion of the twenty-fifth anniversary of the UN)	Welcomes the international agreements which have already been achieved in the limitation of armaments, especially nuclear arms. Looks forward to the early conclusion of further agreements of this kind and to moving forward from arms limitation to a reduction of armaments and disarmament everywhere, particularly in the nuclear field, with the participation of all nuclear-weapon powers. Calls upon all governments to renew their determination to make concrete progress towards the elimination of the arms race and the achievement of the final goal—general and complete disarmament under effective international control.	Adopted without vote.
2661 C (XXV) 7 December 1970	Expresses appreciation for the documents and views submitted at the Conference of the Committee on Disarmament, including the working papers on a comprehensive programme of disarmament submitted by the delegation of the Netherlands on 24 February 1970 and by the delegation of Italy on 19 August 1970, and the draft comprehensive programme of disarmament submitted by the delegations of Mexico, Sweden and Yugoslavia on 27 August 1970, and for the comprehensive programme of disarmament submitted by Ireland, Mexico, Morocco, Pakistan, Sweden and Yugoslavia to the General Assembly on 1 December 1970 (UN document A/8191). Recommends to the CCD that it take into account in its further work and its negotiations document A/8191, (for a summary of this document, see page 556), as well as other disarmament suggestions.	*In favour* 106 *Against* 0 *Abstentions* 10: Bulgaria, Byelorussia, Cuba, Czechoslovakia, France, Hungary, Mongolia, Poland, Ukraine, USSR *Absent:* Albania, Barbados, Botswana, Burundi, Costa Rica, Equatorial Guinea, Guinea, Honduras, Malawi, Maldives, Trinidad and Tobago

Resolution no. and date of adoption	Subject and contents of resolution	Voting results
2734 (XXV) 16 December 1970 (Declaration on the strengthening of international security)	Urges all states, particularly the nuclear-weapon states, to make urgent and concerted efforts within the framework of the Disarmament Decade and through other means for the cessation and reversal of the nuclear and conventional arms race at an early date, the elimination of nuclear weapons and other weapons of mass destruction and the conclusion of a treaty on general and complete disarmament under effective international control, as well as ensure that the benefits of the technology of the peaceful use of nuclear energy shall be available to all states.	*In favour* 120 *Against* 1 *Abstention* 1
2825 B (XXVI) 16 December 1971	Reaffirms the responsibility of the United Nations in the fundamental goal of the attainment of general and complete disarmament and urges the Conference of the Committee on Disarmament to resume its efforts along the lines set forth in resolution 2661 C (XXV) of 7 December 1970.	*In favour* 105 *Against* 0 *Abstentions* 4: France, Qatar, Senegal, Upper Volta[a] *Absent:* Albania, Argentina,[a] Barbados, Bhutan, Bolivia, Botswana, China, El Salvador,[a] Gabon, Gambia, Haiti,[a] Iraq,[a] Malawi, Maldives, Mauritius, Niger, Oman, Panama, Sierra Leone, Sudan, Swaziland, Syria, United Arab Emirates [a] Later advised it had intended to vote in favour.
	Economic and social consequences of the arms race	
2667 (XXV) 7 December 1970	Requests the Secretary-General to prepare, with the assistance of qualified consultant experts appointed by him, a report on the economic and social consequences of the arms race and of military expenditures.	Adopted unanimously.
2831 (XXVI) 16 December 1971	Welcomes with satisfaction the report of the Secretary-General on the consequences of the arms race and of military expenditures; recommends the widest possible publicity of the report; recommends also that the conclusions of the report should be taken into account in future disarmament negotiations; decides to keep the item entitled "Economic and social consequences of the arms race and its extremely harmful effects on world peace and security" under constant review and to place it on the provisional agenda of the twenty-eighth session of the UN General Assembly.	*In favour* 111 *Against* 1 *Abstentions* 3

Economic and social consequences of disarmament

2685 (XXV) 11 December 1970	Requests the Secretary-General to formulate suggestions with a view to establishing the link between the Disarmament Decade and the Second UN Development Decade so that an appropriate portion of the resources that are released as a consequence of progress towards general and complete disarmament would be used to increase assistance for the economic and social development of developing countries; to propose measures for the mobilization of world public opinion in support of the link between disarmament and development and thus encourage intensified negotiations aimed at progress towards general and complete disarmament under effective international control.	*In favour* 87 *Against* 9 *Abstentions* 14

Human rights in armed conflicts

2674 (XXV) 9 December 1970	Considers that air bombardments of civil populations and the use of asphyxiating, poisonous or other gases and of all analogous liquids, materials and devices, as well as bacteriological (biological) weapons, constitute a flagrant violation of the Hague Convention of 1907, the Geneva Protocol of 1925 and the Geneva Conventions of 1949.	*In favour* 77 *Against* 2: Brazil,[g] Portugal *Abstentions* 36: Argentina, Australia, Austria, Belgium, Cambodia, Canada, Central African Republic, Colombia, Costa Rica, Denmark, Dominican Republic, El Salvador, Finland, France, Guatemala, Guyana, Haiti, Honduras, Iceland, Ireland, Israel, Italy, Lesotho, Luxembourg, Malawi, Netherlands, New Zealand, Norway, Paraguay, Spain, Sweden, Thailand, UK, USA, Uruguay, Venezuela *Absent:* Albania, Bolivia, Botswana, Ceylon, Equatorial Giunea, Fiji, Laos, Maldives, Malta, Mexico, South Africa, Trinidad and Tobago [g] Later indicated it had intended to abstain. Japan, which had voted in favour, indicated the same.
2677 (XXV) 9 December 1970	Calls upon all parties to any armed conflict to observe the rules laid down in the Hague Conventions of 1899 and 1907, the Geneva Protocol of 1925, the Geneva Conventions of 1949 and other humanitarian rules applicable in armed conflicts, and invites those states which have not yet done so to adhere to those conventions; expresses the hope that the conference of government experts to be convened in 1971 by the International Committee of the Red Cross will consider further what development is required in existing humanitarian laws applicable to armed conflicts and that it will make specific recommendations in this respect.	*In favour* 111 *Against* 0 *Abstentions* 4
2852 (XXVI) 20 December 1971	Invites the International Committee of the Red Cross to continue the work that was begun with the assistance of government experts in 1971 and to devote special attention, among the questions to be taken up, to the need to ensure better application of existing rules relating to armed conflicts, particularly the Hague Conventions of	*In favour* 110 *Against* 1 *Abstentions* 5

Resolution no. and date of adoption	Subject and contents of resolution	Voting results
	1899 and 1907, the Geneva Protocol of 1925 and the four Geneva Conventions of 1949; and to the need for a reaffirmation and development of relevant rules, as well as other measures to improve the protection of the civilian population during armed conflicts, including legal restraints and restrictions on certain methods of warfare and weapons that have proved particularly perilous to civilians, as well as arrangements for humanitarian relief. Requests the Secretary-General to prepare, as soon as possible, with the help of governmental qualified consultant experts, a report on napalm and other incendiary weapons and all aspects of their possible use.	
	Rule of law	
2625 (XXV) 24 October 1970 (Declaration of principles of international law concerning friendly relations and cooperation among states)	Proclaims as a principle of international law relating to friendly relations and cooperation among states: states shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any state, or in any other manner inconsistent with the purposes of the United Nations. All states shall pursue in good faith negotiations for the early conclusion of a universal treaty on general and complete disarmament under effective international control and strive to adopt appropriate measures to reduce international tensions and strengthen confidence among states.	Adopted without vote.
	Peace research and information about arms race and disarmament	
2817 (XXVI) 14 December 1971	Requests the Secretary-General to prepare every other year an informative report on scientific works produced by national and international, governmental and non-governmental, public and private institutions, in the field of peace research; invites the governments of UN member states and the institutions referred to above to provide the Secretary-General, to the best of their ability and competence, with all the information he may require.	*In favour* 59 *Against* 7 *Abstentions* 3
2825 C (XXVI) 16 December 1971	Affirms the value of holding conferences of experts and scientists from various countries on the problems of the arms race and disarmament; expresses support for the practice of requesting the Secre-	*In favour* 110 *Against* 0 *Abstentions* 0

tary-General to prepare, with the assistance of consultant experts, authoritative reports on concrete questions relating to the arms race and disarmament; declares that progress would be promoted towards general and complete disarmament if universities and academic institutes in all countries were to establish continuing courses and seminars to study problems of the arms race.

Absent: Afghanistan, Albania, Barbados, Bolivia, Botswana, China, El Salvador,[a] Ethiopia, Gabon, Gambia, Haiti,[a] Iraq,[a] Malawi, Maldives, Mauritius, Niger, Oman, Sierra Leone, Sudan, Swaziland, Syria, United Arab Emirates

[a] Later advised it had intended to vote in favour.

World disarmament conference

2833 (XXVI)
16 December 1971

Invites all states to communicate to the Secretary-General, before 31 August 1972, their views and suggestions on any relevant questions relating to a world disarmament conference, in particular the following: main objectives, provisional agenda, site favoured, date and contemplated duration, procedures to be adopted for carrying out the preparatory work, relationship to the United Nations.

Adopted by acclamation.

23. List of states which have signed, ratified, acceded or succeeded to the treaties related to disarmament

Introduction

1. The list includes international agreements related to disarmament which were in force as at *31 December 1971,* as well as the Sea-Bed Treaty which had not entered into force by that date but was signed and ratified by several countries.

The biological disarmament convention commended by the twenty-sixth UN General Assembly, but not signed by the end of 1971, is not included in this list.

2. The relevant provisions of the treaties listed are summarized here:

The Antarctic Treaty

Prohibits any measure of a military nature in Antarctica, such as the establishment of military bases and fortifications, the carrying out of military manoeuvres, as well as the testing of any type of weapons.

Signed at Washington on 1 December 1959.

Entered into force on 23 June 1961.

The depositary government: USA.

The Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water (Partial Test Ban Treaty)

Prohibits the carrying out of any nuclear weapon test explosion, or any other nuclear explosion: (*a*) in the atmosphere; beyond its limits, including outer space; or under water, including territorial waters or high seas; or (*b*) in any other environment if such explosion causes radioactive debris to be present outside the territorial limits of the state under whose jurisdiction or control the explosion is conducted.

Signed at Moscow on 5 August 1963.

Entered into force on 10 October 1963.

The depositary governments: UK, USA, USSR.

The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty)

Prohibits the placing in orbit around the earth of any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, the installation of such weapons on celestial bodies, or stationing them in outer space in any other manner. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies are also forbidden.

Signed at London, Moscow and Washington on 27 January 1967.

Entered into force on 10 October 1967.

The depositary governments: UK, USA, USSR.

The Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco)

Prohibits the testing, use, manufacture, production or acquisition by any means, as well as the receipt, storage, installation, deployment and any form of possession of any nuclear weapons by Latin American countries.

The parties should conclude agreements with the International Atomic Energy Agency (IAEA) for the application of safeguards to their nuclear activities.

Under *Additional Protocol I,* annexed to the treaty, the extra-continental or continental states which, *de jure* or *de facto,* are internationally responsible for territories lying within the limits of the geographical zone established by the treaty (France, the Netherlands, the UK and the USA), undertake to apply the statute of military denuclearization, as defined in the treaty, to such territories.

Under *Additional Protocol II,* annexed to the treaty, the nuclear-weapon states undertake to respect the statute of military denuclearization of Latin America, as defined in the treaty; not to contribute to acts involving a violation of the treaty; and not to use or threaten to use nuclear weapons against the parties to the treaty.

Signed at Mexico City on 14 February 1967.

The treaty enters into force for each state that has ratified it when the requirements specified in the treaty have been met, i.e., that all states in the region deposit the instruments of ratification; that Additional Protocols I and II be signed and ratified by those states to which they apply (see above); and that agreements on safeguards be concluded with the IAEA.

The signatory states have the right to waive, wholly or in part, those requirements.

In 1969, when the treaty entered into force for eleven states, the Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL) was set up in accordance with the treaty provisions to ensure compliance with the obligations assumed by the parties. The first session of the General Conference of OPANAL opened on 2 September 1969.

The Additional Protocols enter into force for the states that have ratified them on the date of the deposit of their instruments of ratification.

The depositary government: Mexico.

The Treaty on the Non-Proliferation of Nuclear Weapons (Non-Proliferation Treaty)

Prohibits the transfer by nuclear-weapon states to any recipient whatsoever of nuclear weapons or other nuclear explosive devices or of control over them. Prohibits the receipt by non-nuclear-weapon states from any transferor whatsoever, as well as the manufacture or other acquisition by those states of nuclear weapons or other nuclear explosive devices.

Non-nuclear-weapon states undertake to conclude safeguards agreements with the International Atomic Energy Agency (IAEA) with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices.

Signed at London, Moscow and Washington on 1 July 1968.

Entered into force on 5 March 1970.

The depositary governments: UK, USA, USSR.

The Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil Thereof (Sea-Bed Treaty)

Prohibits emplanting or emplacement on the sea-bed and the ocean floor and in the subsoil thereof beyond the outer limit of a sea-bed zone (coterminous with the twelve-mile outer limit of the zone referred to in the 1958 Geneva Convention on the Territorial Sea and the Contiguous Zone), of any nuclear weapons or any other types of weapons of mass destruction as well as structures, launching installations or any other facilities specifically designed for storing, testing or using such weapons.

Signed at London, Moscow and Washington on 11 February 1971.

The depositary governments: UK, USA, USSR.

3. Only the dates of the signature and of the deposit of the instrument of ratification, accession or succession with the depositary government are indicated. The date of ratification by national legislative bodies is not given here.

4. Abbreviations used in the list:
S: signature
R: deposit of instruments of ratification, accession or succession
Place of signature and/or deposit of the instrument of ratification, accession or succession:
L: London
M: Moscow
W: Washington
P.I: Additional Protocol I to the Treaty of Tlatelolco
P.II: Additional Protocol II to the Treaty of Tlatelolco
S.A.: Safeguards agreement concluded with the International Atomic Energy Agency (IAEA) under the Non-Proliferation Treaty or the Treaty of Tlatelolco.

5. The footnotes at the end of the table are grouped separately for each treaty; they are numbered consecutively within each group.

23. *List of states which have signed, ratified, acceded or succeeded to the treaties related to disarmament*

	Antarctic Treaty	Partial Test Ban Treaty	Outer Space Treaty	Treaty of Tlatelolco	Non-Proliferation Treaty	Sea-Bed Treaty
Afghanistan		S: 8 Aug. 1963 LW 9 Aug. 1963 M R: 12 Mar. 1964 L 13 Mar. 1964 W 23 Mar. 1964 M	S: 27 Jan. 1967 W 30 Jan. 1967 M		S: 1 Jul. 1968 LMW R: 4 Feb. 1970 W 5 Feb. 1970 M 5 Mar. 1970 L	S: 11 Feb. 1971 LMW R: 22 Apr. 1971 M 23 Apr. 1971 L 21 May 1971 W
Algeria		S: 14 Aug. 1963 LW 19 Aug. 1963 M				
Argentina	S: 1 Dec. 1959 R: 23 Jun. 1961	S: 8 Aug. 1963 W 9 Aug. 1963 LM	S: 27 Jan. 1967 W 18 Apr. 1967 M R: 26 Mar. 1969 MW	S:[1] 27 Sep. 1967		S:[1] 3 Sep. 1971 LMW
Australia	S: 1 Dec. 1959 R: 23 Jun. 1961	S: 8 Aug. 1963 LMW R: 12 Nov. 1963 LMW	S: 27 Jan. 1967 W R: 10 Oct. 1967 LMW		S:[1] 27 Feb. 1970 LMW	S: 11 Feb. 1971 LMW
Austria		S: 11 Sep. 1963 MW 12 Sep. 1963 L R: 17 Jul. 1964 LMW	S: 20 Feb. 1967 LMW R: 26 Feb. 1968 LMW		S: 1 Jul. 1968 LMW R: 27 Jun. 1969 LMW S.A.[2] 21 Sep. 1971	S: 11 Feb. 1971 LMW
Barbados			R: 12 Sep. 1968 W	S: 18 Oct. 1968 R:[2] 25 Apr. 1969	S: 1 Jul. 1968 W	
Belgium	S: 1 Dec. 1959 R: 26 Jul. 1960	S: 8 Aug. 1963 LMW R: 1 Mar. 1966 LMW	S: 27 Jan. 1967 LM 2 Feb. 1967 W		S: 20 Aug. 1968 LMW	S: 11 Feb. 1971 LMW
Bolivia		S: 8 Aug. 1963 W 21 Aug. 1963 L 20 Sep. 1963 M R: 4 Aug. 1965 MW 25 Jan. 1966 L	S: 27 Jan. 1967 W	S: 14 Feb. 1967 R:[2] 18 Feb. 1969	S: 1 Jul. 1968 W R: 26 May 1970 W	S: 11 Feb. 1971 LMW
Botswana		R:[1] 5 Jan. 1968 M 14 Feb. 1968 L 4 Mar. 1968 W	S: 27 Jan. 1967 W		S: 1 Jul. 1968 W R: 28 Apr. 1969 L	S: 11 Feb. 1971 W

Brazil		S: 8 Aug. 1963 LW 9 Aug. 1963 M R: 15 Dec. 1964 M 15 Jan. 1965 W 4 Mar. 1965 L	S: 30 Jan. 1967 M 2 Feb. 1967 LW R:[1] 5 Mar. 1969 LMW	S:[3] 9 May 1967 R:[4] 29 Jan. 1968		S:[2] 3 Sep. 1971 LMW
Bulgaria		S: 8 Aug. 1963 LMW R: 13 Nov. 1963 W 21 Nov. 1963 M 2 Dec. 1963 L	S: 27 Jan. 1967 LMW R: 28 Mar. 1967 M 11 Apr. 1967 W 19 Apr. 1967 L		S: 1 Jul. 1968 LMW R: 5 Sep. 1969 W 18 Sep. 1969 M 3 Nov. 1969 L	S: 11 Feb. 1971 LMW R: 16 Apr. 1971 M 7 May 1971 W 26 May 1971 L
Burma		S: 14 Aug. 1963 LMW R: 15 Nov. 1963 LMW	S: 22 May 1967 LMW R: 18 Mar. 1970 LMW			S: 11 Feb. 1971 LMW
Burundi		S: 4 Oct. 1963 W	S: 27 Jan. 1967 W		R: 19 Mar. 1971 M	S: 11 Feb. 1971 MW
Byelorussian Soviet Socialist Republic		S: 8 Oct. 1963 M R:[2] 16 Dec. 1963 M	S:[2] 10 Feb. 1967 M R: 31 Oct. 1967 M			S: 3 Mar. 1971 M R: 14 Sep. 1971 M
Cameroon		S:[3] 27 Aug. 1963 W 6 Sep. 1963 L	S: 27 Jan. 1967 W		S: 17 Jul. 1968 W 18 Jul. 1968 M R: 8 Jan. 1969 W	S: 11 Nov. 1971 M
Canada		S: 8 Aug. 1963 LMW R: 28 Jan. 1964 LMW	S: 27 Jan. 1967 LMW R: 10 Oct. 1967 LMW		S: 23 Jul. 1968 LW 29 Jul. 1968 M R: 8 Jan. 1969 LMW	S: 11 Feb. 1971 LMW
Central African Republic		R: 22 Dec. 1964 W 24 Aug. 1965 L 25 Sep. 1965 M	S: 27 Jan. 1967 W		R: 25 Oct. 1970 W	S: 11 Feb. 1971 W
Ceylon		S: 22 Aug. 1963 LW 23 Aug. 1963 M R: 5 Feb. 1964 W 12 Feb. 1964 M 13 Feb. 1964 L	S: 10 Mar. 1967 L		S: 1 Jul. 1968 LMW	
Chad		S: 26 Aug. 1963 W R: 1 Mar. 1965 W			S: 1 Jul. 1968 M R: 10 Mar. 1971 W 11 Mar. 1971 M 23 Mar. 1971 L	
Chile	S: 1 Dec. 1959 R: 23 Jun. 1961	S: 8 Aug. 1963 W 9 Aug. 1963 LM R: 6 Oct. 1965 L	S: 27 Jan. 1967 W 3 Feb. 1967 L 20 Feb. 1967 M	S: 14 Feb. 1967		
Colombia		S: 16 Aug. 1963 MW 20 Aug. 1963 L	S: 27 Jan. 1967 W	S: 14 Feb. 1967	S: 1 Jul. 1968 W	S: 11 Feb. 1971 W

	Antarctic Treaty	Partial Test Ban Treaty	Outer Space Treaty	Treaty of Tlatelolco	Non-Proliferation Treaty	Sea-Bed Treaty
Congo					S: 17 Sep. 1968 L	
Costa Rica		S: 9 Aug. 1963 L 13 Aug. 1963 W 23 Aug. 1963 M R: 10 Jul. 1967 W		S: 14 Feb. 1967 R:[2] 25 Aug. 1969	S: 1 Jul. 1968 W R: 3 Mar. 1970 W	S: 11 Feb. 1971 W
Cyprus		S: 8 Aug. 1963 LMW R: 15 Apr. 1965 L 21 Apr. 1965 M 7 May 1965 W	S: 27 Jan. 1967 W 15 Feb. 1967 M 16 Feb. 1967 L		S: 1 Jul. 1968 LMW R: 10 Feb. 1970 M 16 Feb. 1970 W 5 Mar. 1970 L	S: 11 Feb. 1971 LMW R: 17 Nov. 1971 LM 30 Dec. 1971 W
Czechoslovakia	R: 14 Jun. 1962	S: 8 Aug. 1963 LMW R: 14 Oct. 1963 LM 17 Oct. 1963 W	S: 27 Jan. 1967 LMW R: 11 May 1967 L 18 May 1967 M 22 May 1967 W		S: 1 Jul. 1968 LMW R: 22 Jul. 1969 LMW	S:[3] 11 Feb. 1971 LMW
Dahomey		S:[3] 27 Aug. 1963 W 3 Sep. 1963 L 9 Oct. 1963 M R: 15 Dec. 1964 W 23 Dec. 1964 M 22 Apr. 1965 L			S: 1 Jul. 1968 W	S: 18 Mar. 1971 W
Denmark	R: 20 May 1965	S: 9 Aug. 1963 LMW R: 15 Jan. 1964 LMW	S: 27 Jan. 1967 LMW R: 10 Oct. 1967 LMW		S: 1 Jul. 1968 LMW R: 3 Jan. 1969 LMW	S: 11 Feb. 1971 LMW R: 15 Jun. 1971 LMW
Dominican Republic		S: 16 Sep. 1963 W 17 Sep. 1963 L 19 Sep. 1963 M R: 3 Jun. 1964 M 18 Jun. 1964 L 22 Jul. 1964 W	S: 27 Jan. 1967 W R: 21 Nov. 1968 W	S: 28 Jul. 1967 R:[2] 14 Jun. 1968	S: 1 Jul. 1968 W R: 24 Jul. 1971 W	S: 11 Feb. 1971 W
Ecuador		S: 27 Sep. 1963 W 1 Oct. 1963 LM R: 6 May 1964 W 8 May 1964 L 13 Nov. 1964 M	S: 27 Jan. 1967 W 16 May 1967 L 7 Jun. 1967 M R: 7 Mar. 1969 W	S: 14 Feb. 1967 R:[2] 11 Feb. 1969	S: 9 Jul. 1968 W R: 7 Mar. 1969 W	
Egypt		S:[4] 8 Aug. 1963 LMW R: 10 Jan. 1964 LMW	S: 27 Jan. 1967 MW R: 10 Oct. 1967 W 23 Jan. 1968 M		S: 1 Jul. 1968 LM	

El Salvador		S: 21 Aug. 1963 W 22 Aug. 1963 L 23 Aug. 1963 M R: 3 Dec. 1964 W 7 Dec. 1964 L 9 Feb. 1965 M	S: 27 Jan. 1967 W 15 Jan. 1969 W	S: 14 Feb. 1967 R:[2] 22 Apr. 1968	S: 1 Jul. 1968 W	
Equatorial Guinea						S: 4 Jun. 1971 W
Ethiopia		S: 9 Aug. 1963 LW 19 Sep. 1963 M	S: 27 Jan. 1967 LW 10 Feb. 1967 M		S: 5 Sep. 1968 LMW R: 5 Feb. 1970 M 5 Mar. 1970 LW	S: 11 Feb. 1971 LMW
Finland		S: 8 Aug. 1963 LMW R: 9 Jan. 1964 LMW	S: 27 Jan. 1967 LMW R: 12 Jul. 1967 LMW		S: 1 Jul. 1968 LMW R: 5 Feb. 1969 LMW SA:[3] 11 Jun. 1971	S: 11 Feb. 1971 LMW R: 8 Jun. 1971 LMW
France	S: 1 Dec. 1959 R: 16 Sep. 1960		S: 25 Sep. 1967 LMW R: 5 Aug. 1970 LMW			
Gabon		S: 10 Sep. 1963 W R: 20 Feb. 1964 W 4 Mar. 1964 L 9 Mar. 1964 M				
Gambia		R:[1] 27 Apr. 1965 MW 6 May 1965 L	S: 2 Jun. 1967 L		S: 4 Sep. 1968 L 20 Sep. 1968 W 24 Sep. 1968 M	S: 18 May 1971 L 21 May 1971 M 29 Oct. 1971 W
German Democratic Republic		S: 8 Aug. 1963 M R:[5] 30 Dec. 1963 M	S: 27 Jan. 1967 M R:[3] 2 Feb. 1967 M		S: 1 Jul. 1968 M R:[4] 31 Oct. 1969 M	S:[4] 11 Feb. 1971 M R: 27 Jul. 1971 M
Federal Republic of Germany		S: 19 Aug. 1963 LMW R:[6] 1 Dec. 1964 LW	S: 27 Jan. 1967 LMW R:[4] 10 Feb. 1971 LW		S:[1] 28 Nov. 1969 LMW	S:[5] 8 Jun. 1971 LMW
Ghana		S: 8 Aug. 1963 M 9 Aug. 1963 W 4 Sep. 1963 L R: 27 Nov. 1963 L 9 Jan. 1964 W 31 May 1965 M	S: 27 Jan. 1967 W 15 Feb. 1967 M 3 Mar. 1967 L		S: 1 Jul. 1968 MW 24 Jul. 1968 L R: 4 May 1970 L 5 May 1970 W 11 May 1970 M	S: 11 Feb. 1971 LMW
Greece		S: 8 Aug. 1963 W 9 Aug. 1963 LM R: 18 Dec. 1963 LMW	S: 27 Jan. 1967 W R: 19 Jan. 1971 L		S: 1 Jul. 1968 MW R: 11 Mar. 1970 W	S: 11 Feb. 1971 M 12 Feb. 1971 W
Guatemala		S: 23 Sep. 1963 W R:[3] 6 Jan. 1964 W		S: 14 Feb. 1967 R:[2] 6 Feb. 1970	S: 26 Jul. 1968 W R: 22 Sep. 1970 W	S: 11 Feb. 1971 W

	Antarctic Treaty	Partial Test Ban Treaty	Outer Space Treaty	Treaty of Tlatelolco	Non-Proliferation Treaty	Sea-Bed Treaty
Guinea						S: 11 Feb. 1971 MW
Guyana			S: 3 Feb. 1967 W			
Haiti		S: 9 Oct. 1963 W	S: 27 Jan. 1967 W	S: 14 Feb. 1967 R:[2] 23 May 1969	S: 1 Jul. 1968 W R: 2 Jun. 1970 W	
Holy See			S: 5 Apr. 1967 L		R:[5] 25 Feb. 1971 LMW	
Honduras		S: 8 Aug. 1963 W 15 Aug. 1963 L 16 Aug. 1963 M R: 2 Oct. 1964 W 2 Dec. 1964 L	S: 27 Jan. 1967 W	S: 14 Feb. 1967 R:[2] 23 Sep. 1968	S: 1 Jul. 1968 W	S: 11 Feb. 1971 W
Hungary		S: 8 Aug. 1963 LMW R: 21 Oct. 1963 L 22 Oct. 1963 W 23 Oct. 1963 M	S: 27 Jan. 1967 LMW R: 26 Jun. 1967 LMW		S: 1 Jul. 1968 LMW R: 27 May 1969 LMW	S: 11 Feb. 1971 LMW R: 13 Aug. 1971 LMW
Iceland		S: 12 Aug. 1963 LMW R: 24 Apr. 1964 W 29 Apr. 1964 LM	S: 27 Jan. 1967 LMW R: 5 Feb. 1968 LMW		S: 1 Jul. 1968 LMW R: 18 Jul. 1969 LMW	S: 11 Feb. 1971 LMW
India		S: 8 Aug. 1963 LMW R: 10 Oct. 1963 L 14 Oct. 1963 M 18 Oct. 1963 W	S: 3 Mar. 1967 LMW			
Indonesia		S: 23 Aug. 1963 LMW R: 20 Jan. 1964 M 27 Jan. 1964 W 8 May 1964 L	S: 27 Jan. 1967 W 30 Jan. 1967 M 14 Feb. 1967 L		S:[6] 2 Mar. 1970 LMW	
Iran		S: 8 Aug. 1963 LMW R: 5 May 1964 LMW	S: 27 Jan. 1967 L		S: 1 Jul. 1968 LMW R: 2 Feb. 1970 W 10 Feb. 1970 M 5 Mar. 1970 L	S: 11 Feb. 1971 LMW R: 26 Aug. 1971 LW 6 Sep. 1971 M
Iraq		S: 13 Aug. 1963 LMW R: 30 Nov. 1964 L 1 Dec. 1964 W 3 Dec. 1964 M	S: 27 Feb. 1967 LW 9 Mar. 1967 M R: 4 Dec. 1968 M 23 Sep. 1969 L		S: 1 Jul. 1968 M R: 29 Oct. 1969 M	S: 22 Feb. 1971 M

Ireland		S: 8 Aug. 1963 LW 9 Aug. 1963 M R: 18 Dec. 1963 LW 20 Dec. 1963 M	S: 27 Jan. 1967 LW R: 17 Jul. 1968 W 19 Jul. 1968 L		S: 1 Jul. 1968 MW 4 Jul. 1968 L R: 1 Jul. 1968 W 2 Jul. 1968 M 4 Jul. 1968 L	S: 11 Feb. 1971 LW R: 19 Aug. 1971 LW
Israel		S: 8 Aug. 1963 LMW R: 15 Jan. 1964 LW 28 Jan. 1964 M	S: 27 Jan. 1967 LMW			
Italy		S: 8 Aug. 1963 LMW R: 10 Dec. 1964 LMW	S: 27 Jan. 1967 LMW		S:[1] 28 Jan. 1969 LMW	S:[6] 11 Feb. 1971 LMW
Ivory Coast		S: 5 Sep. 1963 W R: 5 Feb. 1965 W			S: 1 Jul. 1968 W	
Jamaica		S: 13 Aug. 1963 LMW	S: 29 Jun. 1967 LMW R: 6 Aug. 1970 W 10 Aug. 1970 L 21 Aug. 1970 M	S: 26 Oct. 1967 R:[2] 26 Jun. 1969	S: 14 Apr. 1969 LMW R: 5 Mar. 1970 LMW	S: 11 Oct. 1971 LW 14 Oct. 1971 M
Japan	S: 1 Dec. 1959 R: 4 Aug. 1960	S: 14 Aug. 1963 LMW R: 15 Jun. 1964 LMW	S: 27 Jan. 1967 LMW R: 10 Oct. 1967 LMW		S:[1] 3 Feb. 1970 LMW	S: 11 Feb. 1971 LMW R: 21 Jun. 1971 LMW
Jordan		S: 12 Aug. 1963 WL 19 Aug. 1963 M R: 29 May 1964 L 7 Jul. 1964 M 10 Jul. 1964 W	S: 2 Feb. 1967 W		S: 10 Jul. 1968 W R: 11 Feb. 1970 W	S: 11 Feb. 1971 LMW R: 17 Aug. 1971 W 30 Aug. 1971 M 1 Nov. 1971 L
Kenya		R: 10 Jun. 1965 L 11 Jun. 1965 W 30 Jun. 1965 M			S: 1 Jul. 1968 W R: 11 Jun. 1970 M	
Khmer Republic						S: 11 Feb. 1971 W
Korea, South		S: 30 Aug. 1963 LW R:[3] 24 Jul. 1964 LW	S: 27 Jan. 1967 W R: 13 Oct. 1967 W		S:[7] 1 Jul. 1968 W	S:[7] 11 Feb. 1971 LW
Kuwait		S:[7] 20 Aug. 1963 LMW R: 20 May 1965 W 21 May 1965 L 17 Jun. 1965 M			S: 15 Aug. 1968 MW 22 Aug. 1968 L	
Laos		S: 12 Aug. 1963 LMW R: 10 Feb. 1965 L 12 Feb. 1965 W 7 Apr. 1965 M	S: 27 Jan. 1967 W 30 Jan. 1967 L 2 Feb. 1967 M		S: 1 Jul. 1968 LMW R: 5 Mar. 1970 LW 20 Feb. 1970 M	S: 11 Feb. 1971 LW 15 Feb. 1971 M R: 19 Oct. 1971 L 22 Oct. 1971 M 3 Nov. 1971 W

	Antarctic Treaty	Partial Test Ban Treaty	Outer Space Treaty	Treaty of Tlatelolco	Non-Proliferation Treaty	Sea-Bed Treaty
Lebanon		S: 12 Aug. 1963 W 13 Aug. 1963 LM R: 14 May 1965 W 20 May 1965 L 4 Jun. 1965 M	S: 23 Feb. 1967 LMW R: 31 Mar. 1969 LM 30 Jun. 1969 W		S: 1 Jul. 1968 LMW R: 15 Jul. 1970 LM 20 Nov. 1970 W	S: 11 Feb. 1971 LMW
Lesotho			S: 27 Jan. 1967 W		S: 9 Jul. 1969 W R: 20 May 1970 W	S: 8 Sep. 1971 W
Liberia		S: 8 Aug. 1963 W 16 Aug. 1963 L 27 Aug. 1963 M R: 19 May 1964 W 22 May 1964 L 16 Jun. 1964 M			S: 1 Jul. 1968 W R: 5 Mar. 1970 W	S: 11 Feb. 1971 W
Libya		S: 9 Aug. 1963 L 16 Aug. 1963 MW R: 15 Jul. 1968 L	R: 3 Jul. 1968 W		S: 18 Jul. 1968 L 19 Jul. 1968 W 23 Jul. 1968 M	
Luxembourg		S: 13 Aug. 1963 L 3 Sep. 1963 W 13 Sep. 1963 M R: 10 Feb. 1965 LMW	S: 27 Jan. 1967 MW 31 Jan. 1967 L		S: 14 Aug. 1968 LMW	S: 11 Feb. 1971 LMW
Madagascar		S: 23 Sep. 1963 W R: 15 Mar. 1965 W	R:[5] 22 Aug. 1968 W		S: 22 Aug. 1968 W R: 8 Oct. 1970 W	S: 14 Sep. 1971 W
Malawi		R:[1] 26 Nov. 1964 MW 7 Jan. 1965 L				
Malaysia		S: 8 Aug. 1963 W 12 Aug. 1963 L 21 Aug. 1963 M R: 15 Jul. 1964 M 16 Jul. 1964 LW	S: 20 Feb. 1967 W 21 Feb. 1967 L 3 May 1967 M		S: 1 Jul. 1968 LMW R: 5 Mar. 1970 LMW	S: 20 May 1971 LMW
Maldive Islands					S: 11 Sep. 1968 W R: 7 Apr. 1970 W	
Mali		S: 23 Aug. 1963 LMW	R: 11 Jun. 1968 M		S: 14 Jul. 1969 W 15 Jul. 1969 M R: 10 Feb. 1970 M 5 Mar. 1970 W	S: 11 Feb. 1971 W 15 Feb. 1971 M

Malta		R:[1] 25 Nov. 1964 MW 1 Dec. 1964 L			S: 17 Apr. 1969 W R: 6 Feb. 1970 W	S: 11 Feb. 1971 LW R: 4 May 1971 W
Mauritania		S: 13 Sep. 1963 W 17 Sep. 1963 L 8 Oct. 1963 M R: 6 Apr. 1964 W 15 Apr. 1964 L 28 Apr. 1964 M				
Mauritius		R:[1] 30 Apr. 1969 MW 12 May 1969 L	R: 16 Apr. 1969 W 21 Apr. 1969 L 13 May 1969 M		S: 1 Jul. 1968 W R: 8 Apr. 1969 W 14 Apr. 1969 L 25 Apr. 1969 M	S: 11 Feb. 1971 W R: 23 Apr. 1971 W 3 May 1971 L 18 May 1971 M
Mexico		S: 8 Aug. 1963 LMW R: 27 Dec. 1963 LMW	S: 27 Jan. 1967 LMW R: 31 Jan. 1968 LMW	S:[5] 14 Feb. 1967 R:[2] 20 Sep. 1967 S.A. 6 Sep. 1968	S:[8] 26 Jul. 1968 LMW R: 21 Jan. 1969 LMW	
Mongolia		S: 8 Aug. 1963 LM R: 1 Nov. 1963 M 7 Nov. 1963 L	S: 27 Jan. 1967 M R: 10 Oct. 1967 M		S: 1 Jul. 1968 M R: 14 May 1969 M	S: 11 Feb. 1971 LM R: 8 Oct. 1971 M 15 Nov. 1971 L
Morocco		S: 27 Aug. 1963 MW 30 Aug. 1963 L R: 1 Feb. 1966 L 18 Feb. 1966 M 21 Feb. 1966 W	R: 21 Dec. 1967 LM 22 Dec. 1967 W		S: 1 Jul. 1968 LMW R: 27 Nov. 1970 M 30 Nov. 1970 L 16 Dec. 1970 W	S: 11 Feb. 1971 MW 18 Feb. 1971 L R:[8] 26 Jul. 1971 L 5 Aug. 1971 W
Nepal		S: 26 Aug. 1963 LM 30 Aug. 1963 W R: 7 Oct. 1964 LMW	S: 3 Feb. 1967 MW 6 Feb. 1967 L R: 10 Oct. 1967 L 16 Oct. 1967 M 22 Nov. 1967 W		S: 1 Jul. 1968 LMW R: 5 Jan. 1970 W 9 Jan. 1970 M 3 Feb. 1970 L	S: 11 Feb. 1971 MW 24 Feb. 1971 L R: 6 Jul. 1971 L 29 Jul. 1971 M 9 Aug. 1971 W
Netherlands	R:[1] 30 Mar. 1967	S: 9 Aug. 1963 LMW R:[8] 14 Sep. 1964 LMW	S: 10 Feb. 1967 LMW R: 10 Oct. 1969 LMW	P.I.[6] S: 15 Mar. 1968 R: 26 Jul. 1971	S: 20 Aug. 1968 LMW	S: 11 Feb. 1971 LMW
New Zealand	S: 1 Dec. 1959 R: 1 Nov. 1960	S: 8 Aug. 1963 LMW R: 10 Oct. 1963 LW 16 Oct. 1963 M	S: 27 Jan. 1967 LMW R: 31 May 1968 LMW		S: 1 Jul. 1968 LMW R: 10 Sep. 1969 LMW	S: 11 Feb. 1971 LMW
Nicaragua		S: 13 Aug. 1963 LW 16 Aug. 1963 M R: 26 Jan. 1965 L 26 Feb. 1965 MW	S: 27 Jan. 1967 W 13 Feb. 1967 L	S: 15 Feb. 1967 R:[2, 7] 24 Oct. 1968	S: 1 Jul. 1968 LW	S: 11 Feb. 1971 W

	Antarctic Treaty	Partial Test Ban Treaty	Outer Space Treaty	Treaty of Tlatelolco	Non-Proliferation Treaty	Sea-Bed Treaty
Niger		S: 24 Sep. 1963 LW R: 3 Jul. 1964 M 6 Jul. 1964 L 9 Jul. 1964 W	S: 1 Feb. 1967 W R: 17 Apr. 1967 L 3 May 1967 W			S: 11 Feb. 1971 W R: 9 Aug. 1971 W
Nigeria		S: 30 Aug. 1963 M 2 Sep. 1963 L 4 Sep. 1963 W R: 17 Feb. 1967 L 25 Feb. 1967 M 28 Feb. 1967 W	R: 14 Nov. 1967 L		S: 1 Jul. 1968 LMW R: 27 Sep. 1968 L 7 Oct. 1968 W 14 Oct. 1968 M	
Norway	S: 1 Dec. 1959 R: 24 Aug. 1960	S: 9 Aug. 1963 LMW R: 21 Nov. 1963 LMW	S: 3 Feb. 1967 LMW R: 1 Jul. 1969 LMW		S: 1 Jul. 1968 LMW R: 5 Feb. 1969 LMW	S: 11 Feb. 1971 LMW R: 28 Jun. 1971 LM 29 Jun. 1971 W
Pakistan		S: 14 Aug. 1963 LMW	S: 12 Sep. 1967 LMW R: 8 Apr. 1968 LMW			
Panama		S: 20 Sep. 1963 W R: 24 Feb. 1966 W	S: 27 Jan. 1967 W	S: 14 Feb. 1967 R:[2] 11 Jun. 1971	S: 1 Jul. 1968 W	S: 11 Feb. 1971 W
Paraguay		S: 15 Aug. 1963 LW 21 Aug. 1963 M		S: 26 Apr. 1967 R:[2] 19 Mar. 1969	S: 1 Jul. 1968 W R: 4 Feb. 1970 W 5 Mar. 1970 L	S: 11 Feb. 1971 W
Peru		S: 23 Aug. 1963 LMW R: 20 Jul. 1964 W 4 Aug. 1964 L 21 Aug. 1964 M	S: 30 Jun. 1967 W	S: 14 Feb. 1967 R:[2] 4 Mar. 1969	S: 1 Jul. 1968 W R: 3 Mar. 1970 W	
Philippines		S: 8 Aug. 1963 LW 14 Aug. 1963 M R: 10 Nov. 1965 L 15 Nov. 1965 W 8 Feb. 1966 M	S: 27 Jan. 1967 LW 29 Apr. 1967 M		S: 1 Jul. 1968 W 18 Jul. 1968 M	
Poland	R: 8 Jun. 1961	S: 8 Aug. 1963 LMW R: 14 Oct. 1963 LMW	S: 27 Jan. 1967 LMW R: 30 Jan. 1968 LMW		S: 1 Jul. 1968 LMW R: 12 Jun. 1969 LMW	S: 11 Feb. 1971 LMW R: 15 Nov. 1971 LMW
Portugal		S: 9 Oct. 1963 LW				
Romania	R:[2] 15 Sep. 1971	S: 8 Aug. 1963 LMW R: 12 Dec. 1963 LMW	S: 27 Jan. 1967 LMW R: 9 Apr. 1968 LMW		S: 1 Jul. 1968 LMW R: 4 Feb. 1970 LMW	S: 11 Feb. 1971 LMW

Rwanda		S: 19 Sep. 1963 W R: 22 Oct. 1963 L 16 Dec. 1963 M 27 Dec. 1963 W	S: 27 Jan. 1967 W		S: 11 Feb. 1971 W
Saudi Arabia					S:[9]
San Marino		S: 17 Sep. 1963 W 20 Sep. 1963 L 24 Sep. 1963 M R: 3 Jul. 1964 L 9 Jul. 1964 W 27 Nov. 1964 M	S: 21 Apr. 1967 W 24 Apr. 1967 L 6 Jun. 1967 M R: 29 Oct. 1968 W 21 Nov. 1968 M 3 Feb. 1969 L	S:[7] 1 Jul. 1968 W 29 Jul. 1968 L 21 Nov. 1968 M R: 10 Aug. 1970 L 20 Aug. 1970 M 31 Aug. 1970 W	
Senegal		S: 20 Sep. 1963 W 23 Sep. 1963 L 9 Oct. 1963 M R: 6 May 1964 L 12 May 1964 M 2 Jun. 1964 W		S: 1 Jul. 1968 MW 26 Jul. 1968 L R: 17 Dec. 1970 M 22 Dec. 1970 W 15 Jan. 1971 L	S: 17 Mar. 1971 W
Sierra Leone		S: 4 Sep. 1963 L 9 Sep. 1963 M 11 Sep. 1963 W R: 21 Feb. 1964 L 4 Mar. 1964 W 29 Apr. 1964 M	S: 27 Jan. 1967 LM 16 May 1967 W R: 13 Jul. 1967 M 14 Jul. 1967 W 25 Oct. 1967 L		S: 11 Feb. 1971 L 13 Feb. 1971 M 24 Feb. 1971 W
Singapore		R:[1] 12 Jul. 1968 MW 23 Jul. 1968 L		S: 5 Feb. 1970 LMW	S: 5 May 1971 LMW
Somalia		S: 19 Aug. 1963 MW	S: 2 Feb. 1967 W	S: 1 Jul. 1968 LMW R: 5 Mar. 1970 L 12 Nov. 1970 W	
South Africa	S: 1 Dec. 1959 R: 21 Jun. 1960	R: 10 Oct. 1963 LW 22 Nov. 1963 M	S: 1 Mar. 1967 W R: 30 Sep. 1968 W 8 Oct. 1968 L		S: 11 Feb. 1971 W
Spain		S: 13 Aug. 1963 W 14 Aug. 1963 L R: 17 Dec. 1964 LW	R: 27 Nov. 1968 L 7 Dec. 1968 W		
Sudan		S: 9 Aug. 1963 LMW R: 4 Mar. 1966 LW 28 Mar. 1966 M		S: 24 Dec. 1968 M	S: 11 Feb. 1971 L 13 Feb. 1971 M

	Antarctic Treaty	Partial Test Ban Treaty	Outer Space Treaty	Treaty of Tlatelolco	Non-Proliferation Treaty	Sea-Bed Treaty
Swaziland		R: 29 May 1969 LW 3 Jun. 1969 M			S: 24 Jun. 1969 L R: 11 Dec. 1969 L 16 Dec. 1969 W 12 Jan. 1970 M	S: 11 Feb. 1971 W R: 9 Aug. 1971 W
Sweden		S: 12 Aug. 1963 LMW R: 9 Dec. 1963 LMW	S: 27 Jan. 1967 LMW R: 11 Oct. 1967 LMW		S: 19 Aug. 1968 LMW R: 9 Jan. 1970 LMW	S: 11 Feb. 1971 LMW
Switzerland		S: 26 Aug. 1963 LMW R: 16 Jan. 1964 LMW	S: 27 Jan. 1967 LW 30 Jan. 1967 M R: 18 Dec. 1969 LMW		S:[1] 27 Nov. 1969 LMW	S: 11 Feb. 1971 LMW
Syria		S: 13 Aug. 1963 LMW R: 1 Jun. 1964 LMW	R: 14 Nov. 1968 M		S: 1 Jul. 1968 M R:[7] 24 Sep. 1969 M	
Taiwan		S: 23 Aug. 1963 W R: 18 May 1964 W	S: 27 Jan. 1967 W R: 24 Jul. 1970 W		S: 1 Jul. 1968 W R: 27 Jan. 1970 W	S: 11 Feb. 1971 W
Tanzania		S: 16 Sep. 1963 L 18 Sep. 1963 W 20 Sep. 1963 M R: 6 Feb. 1964 L				S: 11 Feb. 1971 W
Thailand		S: 8 Aug. 1963 LMW R: 15 Nov. 1963 L 21 Nov. 1963 M 29 Nov. 1964 W	S: 27 Jan. 1967 LMW R: 5 Sep. 1968 L 9 Sep. 1968 M 10 Sep. 1968 W			
Togo		S: 18 Sep. 1963 W R: 7 Dec. 1964 W	S: 27 Jan. 1967 W		S: 1 Jul. 1968 W R: 26 Feb. 1970 W	S: 2 Apr. 1971 W R: 28 Jun. 1971 W
Tonga		R:[1] 22 Jun. 1971 M 7 Jul. 1971 W	R: 22 Jun. 1971 L 7 Jul. 1971 W 24 Aug. 1971 M		R:[9] 7 Jul. 1971 LW 24 Aug. 1971 M	
Trinidad & Tobago		S: 12 Aug. 1963 LW 13 Aug. 1963 M R: 14 Jul. 1964 W 16 Jul. 1964 L 6 Aug. 1964 M	S: 24 Jul. 1967 L 17 Aug. 1967 M 28 Sep. 1967 W	S: 27 Jun. 1967 R:[12] 3 Dec. 1970	S: 20 Aug. 1968 W 22 Aug. 1968 L	
Tunisia		S: 8 Aug. 1963 W 12 Aug. 1963 L 13 Aug. 1963 M R: 26 May 1965 LM 3 Jun. 1965 W	S: 27 Jan. 1967 LW 15 Feb. 1967 M R: 28 Mar. 1968 L 4 Apr. 1968 M 17 Apr. 1968 W		S: 1 Jul. 1968 LMW R: 26 Feb. 1970 LMW	S: 11 Feb. 1971 LMW R: 22 Oct. 1971 M 28 Oct. 1971 L 29 Oct. 1971 W

Turkey		S: 9 Aug. 1963 LMW R: 8 Jul. 1965 LMW	S: 27 Jan. 1967 LMW R: 27 Mar. 1968 LMW		S: 28 Jan. 1969 LMW	S: 25 Feb. 1971 LMW
Uganda		S: 29 Aug. 1963 LW R: 24 Mar. 1964 L 2 Apr. 1964 W	R: 24 Apr. 1968 W			
Ukrainian Soviet Socialist Republic		S: 8 Oct. 1963 M R:[2] 30 Dec. 1963 M	S:[2] 10 Feb. 1967 M R: 31 Oct. 1967 M			S: 3 Mar. 1971 M R: 3 Sep. 1971 M
USSR	S: 1 Dec. 1959 R: 2 Nov. 1960	S: 5 Aug. 1963 M R: 10 Oct. 1963 LMW	S: 27 Jan. 1967 LMW R: 10 Oct. 1967 LMW		S: 1 Jul. 1968 LMW R: 5 Mar. 1970 LMW	S: 11 Feb. 1971 LMW
United Kingdom	S: 1 Dec. 1959 R: 31 May 1960	S: 5 Aug. 1963 M R:[9] 10 Oct. 1963 LMW	S: 27 Jan. 1967 LMW R:[6] 10 Oct. 1967 LMW	P.I.[8] S: 20 Dec. 1967 R: 11 Dec. 1969 P. II[8] S: 20 Dec. 1967 R: 11 Dec. 1969	S: 1 Jul. 1968 LMW R:[10] 27 Nov. 1968 LW 29 Nov. 1968 M	S:[10] 11 Feb. 1971 LMW
USA	S: 1 Dec. 1959 R: 18 Aug. 1960	S: 5 Aug. 1963 M R: 10 Oct. 1963 LMW	S: 27 Jan. 1967 LMW R: 10 Oct. 1967 LMW	P. II[9] S: 1 Apr. 1968 R: 12 May 1971	S: 1 Jul. 1968 LMW R: 5 Mar. 1970 LMW	S: 11 Feb. 1971 LMW
Upper Volta		S: 30 Aug. 1963 W	S: 3 Mar. 1967 W R: 18 Jun. 1968 W		S: 25 Nov. 1968 W 11 Aug. 1969 M R: 3 Mar. 1970 W	
Uruguay		S: 12 Aug. 1963 W 27 Sep. 1963 LM R: 25 Feb. 1969 L	S: 27 Jan. 1967 W 30 Jan. 1967 M R: 31 Aug. 1970 W	S: 14 Feb. 1967 R:[2] 20 Aug. 1968 S.A.:[10] 24 Sep. 1971	S: 1 July 1968 W R: 31 Aug. 1970 W S.A.:[11] 24 Sep. 1971	S: 11 Feb. 1971 W
Venezuela		S: 16 Aug. 1963 MW 20 Aug. 1963 L R: 22 Feb. 1965 M 3 Mar. 1965 L 29 Mar. 1965 W	S: 27 Jan. 1967 W R: 3 Mar. 1970 W	S: 14 Feb. 1967 R:[2, 11] 23 Mar. 1970	S: 1 Jul. 1968 W	
Viet-Nam, South		S: 1 Oct. 1963 W	S: 27 Jan. 1967 W		S: 1 Jul. 1968 W R: 10 Sep. 1971 W	S: 11 Feb. 1971 W
Western Samoa		S: 5 Sep. 1963 L 6 Sep. 1963 MW R: 15 Jan. 1965 W 19 Jan. 1965 L 8 Feb. 1965 M				
Yemen		S: 13 Aug. 1963 M 6 Sep. 1963 W			S: 23 Sep. 1968 M	S: 23 Feb. 1971 M

	Antarctic Treaty	Partial Test Ban Treaty	Outer Space Treaty	Treaty of Tlatelolco	Non-Proliferation Treaty	Sea-Bed Treaty
Yemen (People's Democratic Republic of)					S: 14 Nov. 1968 M	S: 23 Feb. 1971 M
Yugoslavia		S: 8 Aug. 1963 LMW R: 15 Jan. 1964 L 31 Jan. 1964 M 3 Apr. 1964 W	S: 27 Jan. 1967 LMW		S: 10 Jul. 1968 LMW R:[12] 4 Mar. 1970 W 5 Mar. 1970 LM	S: 2 Mar. 1971 LMW
Zaïre		S: 9 Aug. 1963 LW 12 Aug. 1963 M R: 28 Oct. 1965 W	S: 27 Jan. 1967 W 29 Apr. 1967 M 4 May 1967 L		S: 22 Jul. 1968 W 26 Jul. 1968 M 17 Sep. 1968 L R: 4 Aug. 1970 W	
Zambia		R:[1] 11 Jan. 1965 W 8 Feb. 1965 L				

The Antarctic Treaty

[1] The Netherlands stated that the accession is also valid for Surinam and the Netherlands Antilles.

[2] Romania stated that the provisions of the first paragraph of Article XIII of the Antarctic Treaty are not in accordance with the principle according to which multilateral treaties whose object and purposes concern the international community, as a whole, should be opened for universal participation.

The Test Ban Treaty

[1] Notification of succession.

[2] The United States considers that the Byelorussian SSR and the Ukrainian SSR are already covered by the signature and deposit of ratification by the USSR.

[3] With a statement that this does not imply the recognition of any territory or régime not recognized by this state.

[4] Egypt stated that its ratification of the Treaty does not mean or imply any recognition of Israel or any treaty relations with Israel.

[5] The United States did not accept the notification of signature and deposit of ratification by the German Democratic Republic.

[6] The Federal Republic of Germany stated that the Treaty applies to Land Berlin.

[7] Kuwait stated that its signature and ratification of the Treaty does not in any way imply its recognition of Israel, nor does it oblige it to apply the provisions of the Treaty in respect of said country.

[8] The Netherlands stated that the ratification is also valid for Surinam and the Netherlands Antilles.

[9] The UK stated its view that if a régime is not recognized as the government of a state, neither signature nor the deposit of any instrument by it nor notification of any of those acts will bring about the recognition of that régime by any other state.

The Outer Space Treaty

[1] The Brazilian government interprets Article 10 of the Treaty as clearly indicating that the granting of tracking facilities by the parties to the Treaty will depend on an agreement among the interested states.

[2] The United States considers that the Byelorussian SSR and the Ukrainian SSR are already covered by the signature and deposit of ratification by the USSR.

[3] The USA stated that this did not imply recognition of the German Democratic Republic.

[4] The Federal Republic of Germany stated that the Treaty applies to Land Berlin.

[5] Madagascar acceded to the Treaty with the understanding that under Article 10 of the Treaty the state shall retain its freedom of decision with respect to the installation of foreign observation bases in its territory and shall continue to possess the right to fix, in each case, the conditions for such installation.
[6] The United Kingdom's ratification is in respect of the United Kingdom of Great Britain and Northern Ireland, the Associated States (Antigua, Dominica, Grenada, Saint Christopher–Nevis–Anguilla and Saint Lucia) and Territories under the territorial sovereignty of the United Kingdom, as well as the State of Brunei, the Kingdom of Swaziland, the Kingdom of Tonga and the British Solomon Islands Protectorate. On depositing its instrument of ratification, the United Kingdom declared that the Treaty will not be applicable in regard to Southern Rhodesia unless and until the United Kingdom informs the other depositary governments that it is in a position to ensure that the obligations imposed by the Treaty in respect of that territory can be fully implemented.

The Tlatelolco Treaty

[1] Argentina stated that it understands Article 18 as recognizing the right of the parties to carry out, by their own means or in association with third parties, explosions of nuclear devices for peaceful purposes, including explosions which involve devices similar to those used in nuclear weapons.
[2] The Treaty is in force for this country due to a declaration, annexed to the instrument of ratification in accordance with § 2 of Article 28, which waived the requirements specified in § 1 of that article, namely, that all states in the region deposit the instruments of ratification; that Additional Protocol I and Additional Protocol II be signed and ratified by those states to which they apply; and that agreements on safeguards be concluded with the IAEA.
[3] On signing the Treaty, Brazil stated that, according to its interpretation, Article 18 of the Treaty gives the signatories the right to carry out, by their own means or in association with third parties, nuclear explosions for peaceful purposes, including explosions which involve devices similar to those used in nuclear weapons.
[4] Brazil stated that it did not waive the requirements laid down in Article 28 of the Treaty. (The Treaty is therefore not yet in force for Brazil). In ratifying the Treaty, Brazil reiterated its interpretation of Article 18, which it made upon signing.
[5] In signing the Treaty, Mexico said that if technological progress makes it possible to differentiate between nuclear weapons and nuclear devices for peaceful purposes it will be necessary to amend the relevant provisions of the Treaty, according to the procedure established therein.
[6] The Netherlands stated that the Protocol shall not be interpreted as prejudicing the position of the Netherlands as regards its recognition or non-recognition of the rights of or claims to sovereignty of the parties to the Treaty, or of the grounds on which such claims are made. With respect to nuclear explosions for peaceful purposes on the territory of Surinam and the Netherland Antilles no other rules apply than those operative for the parties to the Treaty.
[7] Nicaragua stated that it reserved the right to use nuclear energy for peaceful purposes such as the removal of earth for the construction of canals, irrigation works, power plants, etc., as well as to allow the transit of atomic material through its territory.
[8] When signing and ratifying Additional Protocol I and Additional Protocol II, the United Kingdom made the following declarations of understanding:

In connection with Article 3, defining the term "territory" as including the territorial sea, air space and any other space over which the state exercises sovereignty in accordance with "its own legislation", the UK does not regard its signing or ratification of the Additional Protocols as implying recognition of any legislation which does not, in its view, comply with the relevant rules of international law.

The Treaty does not permit the parties to carry out explosions of nuclear devices for peaceful purposes unless and until advances in technology have made possible the development of devices for such explosions which are not capable of being used for weapons purposes.

Its signing and ratification could not be regarded as affecting in any way the legal status of any territory for the international relations of which the UK is responsible lying within the limits of the geographical zone established by the Treaty.

Should a party to the Treaty carry out any act of aggression with the support of a nuclear-weapon state, the UK would be free to re-consider the extent to which it could be regarded as committed by the provisions of Additional Protocol II.

In addition, the UK declared that its undertaking under Article 3 of Additional Protocol II not to use or threaten to use nuclear weapons against the parties to the Treaty extends also to territories in respect of which the undertaking under Article I of Additional Protocol I becomes effective.
[9] The United States signed and ratified Additional Protocol II with the following understandings and declarations:

In connection with Article 3 defining the term "territory" as including the territorial sea, air space and any other space over which the state exercises sovereignty in accordance with "its own legislation", the US ratification of the Protocol could not be regarded as implying recognition of any legislation which did not, in its view, comply with the relevant rules of international law.

Each of the parties retains exclusive power and legal competence, unaffected by the terms of the Treaty, to grant or deny non-parties transit and transport privileges.

As regards the undertaking not to use or threaten to use nuclear weapons against the parties, the United States would consider that an armed attack by a party, in which it was assisted by a nuclear-weapon state, would be incompatible with the party's obligations under Article 1 of the Treaty.

The definition contained in Article 5 of the Treaty is understood as encompassing all nuclear explosive devices; Articles 1 and 5 of the Treaty restrict accordingly the activities of the parties under paragraph 1 of Article 18.

Paragraph 4 of Article 18 permits, and US adherence to Protocol II will not prevent, collaboration by the USA with the parties to the Treaty for the purpose of carrying out explosions of nuclear devices for peaceful purposes in a manner consistent with a policy of not contributing to the proliferation of nuclear-weapon capabilities.

The United States will act with respect to such territories of Protocol I adherents, as are within the geographical area defined in paragraph 2 of Article 4 of the Treaty, in the same manner as Protocol II requires it to act with respect to the territories of the parties.

[10] The Safeguards Agreement was concluded in accordance with Article III of the NPT. An additional protocol provides that the safeguards under the NPT shall also apply to Uruguay's obligations under Article 13 of the Treaty of Tlatelolco.

[11] Venezuela stated that in view of the existing controversy between Venezuela on the one hand and the United Kingdom and Guyana on the other, § 2 of Article 25 of the Treaty should apply to Guyana. This paragraph provides that no political entity should be admitted, part or all of whose territory is the subject of a dispute or claim between an extra-continental country and one or more Latin American states, so long as the dispute has not been settled by peaceful means.

[12] The Treaty is not yet in force for Trinidad and Tobago; the requirements laid down in Article 28 of the Treaty have not been waived.

The Non-Proliferation Treaty

[1] A statement was made on signing the Treaty; for the summary of the statement see p. 326 for Australia; p. 343 for the Federal Republic of Germany; p. 348 for Italy; p. 320 for Japan; p. 353 for Switzerland.

[2] Together with a protocol on finance and a protocol suspending the trilateral safeguards agreement between Austria, the USA and the IAEA of 20 August 1969.

[3] Together with a protocol on finance.

[4] The United States notified its non-acceptence of notification of signature and ratification by the German Democratic Republic.

[5] On acceding to the Treaty, the Holy See stated, *inter alia*, that the Treaty will attain in full the objectives of security and peace and justify the limitations to which the states party to the Treaty submit, only if it is fully executed in every clause and with all its implications. This concerns not only the obligations to be applied immediately but also those which envisage a process of ulterior commitments. Among the latter, the Holy See considers it suitable to point out the following:

(a) The adoption of appropriate measures to ensure, on a basis of equality, that all non-nuclear-weapon states party to the Treaty will have available to them the benefits deriving from peaceful applications of nuclear technology.

(b) The pursuit of negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control.

[6] On signing the Treaty, Indonesia stated, *inter alia*, that the government of Indonesia attaches great importance to the declarations of the United States of America, the United Kingdom and the Soviet Union, affirming their intention to seek Security Council action in order to provide or support immediate assistance to any non-nuclear-weapon state party to the Treaty that is a victim of an act of aggression or an object of a threat of aggression in which nuclear weapons are used.

Of utmost importance, however, is not the action *after* a nuclear attack has been committed but the guarantees to prevent such an attack. The Indonesian government trusts that the nuclear-weapon states will study further this question of effective measures to ensure the security of the non-nuclear-weapon states.

It is in this context that the Indonesian government feels obliged to state, further, that its decision to sign the Treaty is not to be taken in any way as a decision to ratify the Treaty. Its ratification will be considered after matters of national security, which are of deep concern to the government and people of Indonesia, have been clarified to their satisfaction.

[7] A statement was made containing a disclaimer regarding the recognition of states party to the Treaty.

[8] On signing the Treaty, Mexico stated, *inter alia*, that none of the provisions of the Treaty shall be interpreted as affecting in any way whatsoever the rights and obligations of Mexico as a state party to the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco).

It is the understanding of Mexico that at the present time any nuclear explosive (device) is capable of being used as a nuclear weapon and that there is no indication that in the near future it will be possible to manufacture nuclear explosives (devices) which are not potentially nuclear weapons. However, if technological advances succeeded in modifying this situation, it would be necessary to amend the relevant provisions of the Treaty in accordance with the procedure established therein.

[9] Notification of succession.

[10] The United Kingdom recalled its view that if a régime is not recognized as the government of a state, neither signature nor the deposit of any instrument by it, nor notification of any of those acts will bring about recognition of that régime by any other state. The provisions of the Treaty shall not apply in regard to

Southern Rhodesia unless and until the government of the United Kingdom informs the other depositary governments that it is in a position to ensure that the obligations imposed by the Treaty in respect of that territory can be fully implemented.

[11] Together with a Protocol on finance and a Protocol relating to Article 13 of the Treaty of Tlatelolco.

[12] In connection with the ratification of the Treaty, Yugoslavia stated, *inter alia*, that it considered the ban on the development, manufacture and use of nuclear weapons and the destruction of all stockpiles of these weapons to be indispensable for the maintenance of stable peace and international security; it held the view that the chief responsibility for the progress in this direction rested with the nuclear-weapon powers, and expected these powers to undertake not to use nuclear weapons against the countries having renounced them as well as against non-nuclear-weapon states in general, and to refrain from the threat to use them. It also emphasized the significance it attached to the universality of the efforts relating to the realization of the NPT.

The Sea-Bed Treaty

[1] On signing the Treaty, Argentina made an interpretative declaration. It stated that it interprets the references to the freedoms of the high seas as in no way implying a pronouncement on the different positions relating to questions connected with international maritime law. It understands that the reference to the rights of exploration and exploitation by coastal states over their continental shelves was included solely because those could be the rights most frequently affected by verification procedures. Argentina precludes any possibilitiy of strengthening, through this Treaty, certain positions concerning continental shelves to the detriment of others based on different criteria.

[2] On signing the Treaty, Brazil stated that nothing in the Treaty shall be interpreted as prejudicing in any way the sovereign rights of Brazil in the area of the sea, the sea-bed and the subsoil thereof adjacent to its coast. It is the understanding of the Brazilian government that the word "observation", as it appears in paragraph 1 of Article III of the Treaty, refers only to observation that is incidental to the normal course of navigation in accordance with international law.

[3] The instrument of ratification was deposited in London and Moscow on 11 January 1972.

[4] The United States has not accepted the notification of signature by the German Democratic Republic.

[5] On signing the Treaty, the Federal Republic of Germany stated that its signature does not imply recognition of the German Democratic Republic under international law.

[6] On signing the Treaty, Italy stated, *inter alia*, that in the case of future agreements on further measures in the field of disarmament to prevent an arms race on the sea-bed and ocean floor and their subsoil, the question of the delimitation of the area within which these measures would find application shall have to be examined and solved in each instance in relation to the nature of the measures envisaged.

[7] A statement was made containing a disclaimer regarding the recognition of states party to the Treaty.

[8] The instrument of ratification was deposited in Moscow on 18 January 1972.

[9] The Treaty was signed in Washington on 7 January 1972.

[10] The United Kingdom recalls its view that if a régime is not recognized as the government of a state, neither signature nor the deposit of any instrument by it, nor notification of any of those acts, will bring about recognition of that régime by any other state.

24. Chronology of major events related to disarmament issues, September 1970 to December 1971[1]

September–December 1970

10 September The Third Conference of Heads of State or Government of Non-Aligned Countries held in Lusaka, Zambia proposes the declaration of the Indian Ocean as a zone of peace. The conference is of the opinion that a comprehensive programme of disarmament should include the following measures: measures in the field of nuclear disarmament, such as a cut-off in the production of fissionable material for weapons purposes and its transfer to peaceful uses, a halt to the production of nuclear weapons, a comprehensive test ban, reduction and destruction of stockpiles of nuclear weapons; other measures of priority in the disarmament field, such as an agreement prohibiting the development, production and stockpiling of chemical and biological weapons and their elimination from the arsenals of all nations; non-armament or confidence-building measures, such as the non-use of nuclear weapons, demilitarization of the sea-bed and the ocean floor beyond an agreed limit, and the establishment of nuclear-weapon-free zones. The participating states also feel that it may be useful to convene a world disarmament conference at an appropriate time, open for participation to all states.

21 September Five Nobel Peace Prize laureates—Lord Boyd Orr, Lester B. Pearson, René Cassin, Philip Noel-Baker and Linus Pauling—present to the United Nations a joint declaration on peace and disarmament calling on the Soviet Union and the United States to halt and reverse the nuclear arms race. As the most important first step, they suggest a moratorium on the development and deployment of new offensive and defensive strategic nuclear weapon systems, such as MIRVs and ABMs. (Ralph J. Bunche, another laureate, felt that as a member of the UN Secretariat he could not be a signatory to the Declaration, but endorsed it.)

[1] A chronology covering the period from 1945 to August 1969 can be found in the *SIPRI Yearbook 1968/69*, pp. 280–318; and a chronology for September 1969 to 3 September 1970, in the *SIPRI Yearbook 1969/70*, pp. 453–57.

19 October In a speech before the UN General Assembly, the President of Romania calls for the abolition of military blocs, the dismantling of foreign military bases, and the withdrawal of foreign troops to their national territories.

20 October In a White Paper on defence, the Japanese Defence Agency states that Japan should not acquire intercontinental ballistic missiles (ICBMs) and strategic bombers and will not at present acquire any nuclear weapons.

23 October The Soviet Union and other Socialist countries submit to the United Nations a revised draft convention on the prohibition of the development, production and stockpiling of chemical and biological weapons and on the destruction of such weapons.

24 November In a memorandum addressed to European as well as the Canadian and the United States governments, Finland proposes multilateral gatherings in Helsinki for consultations between the governments concerned and the Finnish Ministry for Foreign Affairs on the question of convening a conference on European security.

2 December The Political Consultative Committee of the Warsaw Treaty notes that adequate preconditions for holding a European conference on questions of security and cooperation already have been created. It considers that multilateral consultations with the participation of all the interested states are needed in order to reach agreement on all the questions connected with the convening of the conference. The states represented at the meeting of the Committee declare their readiness to take part in the preparatory gatherings suggested by Finland. (See 24 November.)

4 December At the North Atlantic Council meeting in ministerial session, the ministers representing countries participating in NATO's Integrated Defence Programme indicate their readiness to examine different possibilities in the field of force reductions in the Central Region of Europe, including the possible mutual and balanced reduction of stationed forces as part of an integral programme for the reduction of both stationed and indigenous forces.

7 December The Federal Republic of Germany and Poland sign a treaty reaffirming the inviolability of their existing frontiers; they agree to settle all their disputes exclusively by peaceful means and to refrain from any threat or use of force in matters affecting European and international security and in their mutual relations.

7 December The UN General Assembly adopts a resolution commending the treaty on the prohibition of the emplacement of nuclear weapons and other weapons of mass destruction on the sea-bed and the ocean floor and in the subsoil thereof, and requests the depositary governments to open the treaty for signature and ratification. The General Assembly also requests the Secretary-General to prepare a report on the economic and social consequences of the arms race and of military expenditures.

1971

4 January In reply to a letter from the Mexican Senate, the Supreme Soviet of the USSR states that the Soviet Union is ready to undertake a commitment to respect the status of Mexico as a completely nuclear-weapon-free zone. If other Latin American states also "genuinely" turned their territories into completely nuclear-weapon-free zones, they too could count on the same respect from the USSR for this status. This would be possible only if other nuclear-weapon powers also undertook the same commitments.

21 January At the conference of the heads of government of the Commonwealth countries, the Prime Minister of Ceylon proposes that the Indian Ocean be made a zone of peace.

27 January The President of the United States announces that the former biological warfare facilities at Pine Bluff Arsenal, Arkansas will be converted into a national research centre to examine the harmful effects of chemicals on mankind.

1 February In the Japanese Parliament, the Prime Minister reaffirms that his government will continue to adhere to the principles of not possessing or manufacturing nuclear weapons and not permitting them on Japanese territory.

11 February The Sea-Bed Treaty is signed at simultaneous ceremonies in London, Moscow and Washington.

19 February The Ministers for Foreign Affairs of the Warsaw Treaty countries call for a practical and constructive approach to accelerate the convening of a conference on questions of security and cooperation in Europe.

10 March The Safeguards Committee established by the Board of Governors of the International Atomic Energy Agency (IAEA) concludes its work on the structure and content of agreements between the IAEA and states, required in connection with the treaty on the non-proliferation of nuclear weapons (NPT).

10 March In a memorandum to other members of the Organization of American States, Colombia proposes that the nations of Latin America consider the problem of unnecessary military expenses and suggests that those arms which, because of their excessive cost and clearly offensive nature, are disproportionate to the needs of internal security, be eliminated by common accord. It proposes the examination of the problem of arms expenditures in Latin America by a special committee.

30 March The report of the Central Committee to the 24th Congress of the Soviet Communist Party reaffirms the readiness of the Warsaw Treaty states to annul simultaneously this treaty and NATO, or—as a first step—to dismantle their military organizations. The report includes the following proposals: to conclude treaties banning nuclear, chemical and biological weapons; to end the testing of nuclear weapons, including underground tests, by everyone and everywhere; to promote the establishment of nuclear-weapon-free zones; to bring about the nuclear disarmament of all states possessing nuclear weapons and to convene for these purposes a conference of the five nuclear powers; to convene a world conference to consider disarmament questions "to their full extent"; to dismantle foreign military bases; to reduce the armed forces and armaments in areas of dangerous military confrontation, above all in Central Europe; to reduce the probability of accidental or deliberate armed incidents; and to negotiate agreements on reducing military expenditure, in particular by the major powers.

30 March The Soviet Union and other Socialist countries submit at the Conference of the Committee on Disarmament (CCD) a draft convention on the prohibition of the development, production and stockpiling of biological weapons and toxins, and on their destruction.

15 April In a letter to the US President, the Chairman of the Senate Committee on Foreign Relations states the view of many members of the Committee that it would be in the interest of the United States to ratify the 1925 Geneva Protocol without restrictive understandings regarding the use of tear gas and herbicides. The Committee asks that the question of the interpretation of the Protocol be re-examined.

16 April Bolivia, Colombia, Costa Rica and the Dominican Republic submit a draft resolution to the General Assembly of the Organization of American States (OAS) proposing the creation of a special committee to carry out a study on the limitation of military expenditures in Latin America in proportion to the actual demands of national security.

20 April Sweden notifies the USSR that radioactivity caused by a Soviet underground nuclear explosion has been detected in Sweden, and formally objects to this infringement of the Partial Test Ban Treaty.

22 April The OAS General Assembly adopts a resolution calling for a study by the OAS Permanent Council of the meaning and scope of the proposal to eliminate unnecessary military expenditure in Latin America.

30 April Sweden notifies the United States that radioactivity caused by a US underground nuclear explosion has been detected in Sweden, and formally objects to this infringement of the Partial Test Ban Treaty.

11 May The US Senate majority leader proposes that the number of US armed forces stationed in Europe be reduced to a maximum of 150 000 troops (i.e., by about one-half) by the end of 1971.

12 May The United States deposits the instrument of ratification of Additional Protocol II of the treaty prohibiting nuclear weapons in Latin America (Treaty of Tlatelolco). The protocol contains a commitment to respect the status of military denuclearization of this area.

14 May The Secretary-General of the Soviet Communist Party reiterates the proposal for negotiations on the reduction of armed forces and armaments in Central Europe.

16 May The US Secretary of State declares that the United States favours a discussion with the Soviet Union on mutual troop reductions in Europe.

20 May The Soviet Union and the United States announce that they will concentrate this year in SALT on the limitation of the deployment of anti-ballistic missile systems (ABMs) and that, together with concluding an agreement to limit ABMs, they will agree on certain measures with respect to the limitation of offensive strategic weapons.

27 May The Soviet Union transmits to the Secretary-General of the United Nations a draft treaty concerning the moon, which provides, *inter alia,* for the prohibition of the threat or use of force or any other hostile activities on the moon; the use of the moon to carry out such activities against the earth; and the prohibition of the installation on the moon of nuclear weapons and other weapons of mass destruction, as well as other activities involving the use of the moon for military purposes.

4 June At the North Atlantic Council meeting in ministerial session, the Ministers representing countries participating in NATO's Integrated Defence Programme agree to continue and intensify explorations with the Soviet Union and also with other interested governments on the basis of the following considerations: mutual force reductions should be compatible with the vital security interests of NATO and should not operate to the military disadvantage of either side, having regard for the differences arising from geographical and other considerations; reductions should be on a basis of reciprocity, and phased and balanced as to their scope and timing; reductions should include stationed and indigenous forces and their weapons systems in the area concerned; there must be adequate verification and controls to ensure the observance of agreements on mutual and balanced force reductions. The Ministers further announce their willingness to appoint a representative to conduct such exploratory talks.

9 June A joint Romanian-Chinese communiqué on the occasion of a visit by Romania's President to China favours the withdrawal of all foreign troops from the territories of other countries, the dismantling of all foreign military bases, and the abolition of all military blocs.

11 June The Secretary-General of the Soviet Communist Party indicates that the Soviet Union is prepared to settle the problem of the presence of the big powers' naval forces far from their own coasts, specifically referring to the Mediterranean Sea and the Indian Ocean. He also states that the USSR is prepared to discuss a reduction of both foreign and national armed forces in Europe.

23 June The Soviet Union publishes the text of a note calling for a conference of the five nuclear-weapon powers to discuss nuclear disarmament questions. The message had been delivered a few days earlier in London, Paris, Peking and Washington.

13 July The US Department of Defense announces that the Army has begun the destruction of anti-personnel biological agents, munitions and toxins at Pine Bluff Arsenal in Arkansas.

30 July China formally rejects the Soviet proposal for a five-power conference and reaffirms its call for a summit conference of all states to discuss the complete prohibition and thorough destruction of nuclear weapons and, as the first step, to reach an agreement on the non-use of nuclear weapons.

5 August Australia, New Zealand, Cook Islands, Fiji, Nauru, Tonga and Western Samoa issue a joint protest against the French nuclear tests in the Pacific.

16 August Japan submits an official protest to France against the French explosion of a hydrogen bomb in the Pacific.

17 August In a cable to the President of France, the government of Peru strongly protests against the French nuclear explosions in the Pacific and demands their immediate suspension; if another explosion were to be carried out, Peru would break diplomatic relations with France as an expression of its total opposition to such acts.

1 September France formally announces the discontinuation of the current series of nuclear tests in the Pacific, stating that no further purpose would be achieved by continuing the tests.

3 September A quadripartite agreement on Berlin is signed by France, the Soviet Union, the United Kingdom and the United States. The four governments agree that there shall be no use or threat of force in the area and that disputes shall be settled solely by peaceful means.

6 September In a letter to the UN Secretary-General, the Soviet Union proposes the convening of a world disarmament conference attended by all states on an equal basis.

28 September At the CCD, Bulgaria, Canada, Czechoslovakia, Hungary, Italy, Mongolia, the Netherlands, Poland, Romania, the Soviet Union, the United Kingdom and the United States submit a draft convention on the prohibition of the development, production and stockpiling of biological and toxin weapons and on their destruction.

29 September In a joint Indian-Soviet statement, the Prime Minister of India affirms that the Indian Ocean area should be made a zone of peace.

30 September The Soviet Union and the United States sign two agreements: on measures to reduce the risk of outbreak of nuclear war between the United States and the Soviet Union; and on measures to improve the USA–USSR direct communications link.

30 September At the CCD, Burma, Egypt, Ethiopia, Mexico, Morocco, Nigeria, Pakistan, Sweden and Yugoslavia present a joint memorandum calling for a comprehensive nuclear test ban treaty.

1 October In a letter to the UN Secretary-General, Ceylon proposes that the Indian Ocean be declared a zone of peace.

6 October The North Atlantic Council approves the mandate of a representative to conduct exploratory talks with the Soviet government and other interested governments in order to explain the views of the countries appointing him on principles for mutual and balanced force reductions and on the question of a forum for eventual negotiations. He should also sound out his interlocutors with regard to the above questions.

18 October The President of the United States announces that the Army Biological Warfare Research Center at Fort Detrick, Maryland will be converted into a leading centre for cancer research.

22 October The Soviet Union and the United States initial in Moscow a "document of understanding" on the prevention of incidents at sea involving their ships and planes.

22 October The UN Secretary-General issues a report on the economic and social consequences of the arms race and military expenditures.

24 November In a joint communiqué, the Presidents of Romania and Yugoslavia call for a freeze and reduction of the military budgets of all states, the renunciation of military manoeuvres on the territories of other states, the banning of the creation of new military bases and the stationing of further nuclear weapons on foreign territories, the dismantling of foreign military bases, the withdrawal of troops within national boundaries, the creation of nuclear-free zones in different parts of the world, and the abolition of military blocs.

25 November The Canadian ambassador in Peking formally conveys Canada's concern about Chinese atmospheric testing.

27 November At the conclusion of a ministerial meeting of the Association of South East Asian Nations, Indonesia, Malaysia, the Philippines, Singapore and Thailand declare their determination to exert efforts to secure the recognition of, and respect for, South East Asia as a zone of peace, free from any form of interference by outside powers.

2 December A conference of the Foreign Ministers of the Warsaw Treaty states reaffirms the support for multilateral preparatory consultations in order to agree on the agenda of a European conference on security and cooperation, the procedure of its work, and the concrete terms and the order of convening it. The Ministers declare that their governments have decided to appoint plenipotentiary representatives to take part in multilateral consultations, and invite the other states concerned to do likewise.

14 December The press organ of the Central Committee of the Soviet Communist Party criticizes the US and British policy of striving to turn the European conference on security and cooperation into talks between the two blocs.

16 December The UN General Assembly commends the convention on the prohibition of the development, production and stockpiling of biological and toxin weapons, and on their destruction, and requests the depositary governments to open it for signature and ratification; condemns "solemnly and most emphatically" all nuclear weapon tests; urges the nuclear-weapon states which have not yet done so to sign and ratify Protocol II of the Treaty of Tlatelolco; declares that the Indian Ocean, within limits to be determined, together with the air space above and the ocean floor subjacent thereto, is designated for all time as a zone of peace; and expresses the conviction that it is desirable that careful consideration be given to the convening, following adequate preparation, of a world disarmament conference open to all states.

20 December The UN General Assembly requests the Secretary-General to prepare a report on napalm and other incendiary weapons and all aspects of their possible use.

INDEX

A

Abu Dhabi 124
Advanced Ballistic Re-entry System (ABRES) 9
Afghanistan 88–89
Africa: military expenditure 52, 64–68, 72, 82, 92–95; receipt of arms and aid 108, 110, 120–21, 129–34; military presence abroad 252, 259–60, 263, 265–67 As a nuclear-weapon-free zone 548, 550. *See also* individual countries
Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL) 543, 576
Airborne Warning and Control System (AWACS) 12
Aircraft: Soviet strategic nuclear forces 1, 11, 18; US strategic nuclear forces, 1, 10–11, 16–18
Albania 63, 70, 78, 86–87
Algeria: military expenditure 72, 92–95; receipt of arms and aid 129
Antarctica: foreign military presence in 256, 259; Antarctic Treaty 257, 574, 578–90
Anti-Ballistic Missile (ABM) 2, 11, 13, 21, 27–30, 32–34, 36, 41–42, 44–46, 48, 323, 341, 419, 421, 427, 429, 432, 594, 598. *See also* Galosh, Hardsite, Safeguard, Upstage
Anti-Submarine Warfare (ASW) 14, 41–42, 44, 46, 48, 194, 534–35
Arab-Israeli conflict 245, 424
Argentina: military expenditure 73, 96–99; receipt of arms and aid 107, 109–10, 142–43; military R&D projects 184–85, 194; and the NPT 287, 333, 356, 528; development of nuclear technology 288, 296–97, 332–33; demand for uranium 474, 476; uranium supplies 479–80; and the Treaty of Tlatelolco 333, 542–43, 545
Arms Control and Disarmament Agency (ACDA) 52, 61–62, 284, 291, 306, 399, 435, 440–41, 526
Arms trade with the third world, 1970–71, 100–10; register of arms trade, 1970–71, 124–48; sources and methods of study 111–19; value of trade 120–23
Association of South East Asian Nations 601
Atomic Energy Commission (US AEC) 152, 176, 179–80, 230–31, 291, 323, 325, 399–400, 409, 433–35, 441, 445, 448, 462–63, 465–66, 468
Australia 599; military expenditure 63, 71, 90–93; arms trade with the third world 128, 137, 139, 143; military presence abroad 267; military R&D expenditure 151–54, 156–59, 162, 165–68, 173, 220–27; military R&D projects 184–85, 191, 210; and the NPT 287, 325–27, 356; development of nuclear technology 288, 291, 296–97, 324–25, 372; demand for uranium 474, 476, 480; uranium supplies 471–72, 478–80
Austria: military expenditure 70, 86–87; military R&D expenditure 153–54, 156–59, 165–67, 174, 176, 181, 220–22; and the NPT 388; demand for uranium 474, 476, 480

B

Bahrain 124
Ballistic missiles. *See* ABM, ICBM, IRBM, Minuteman, MRBM, SLBM, SRBM
Ballistic-missile submarines. *See* Polaris, Poseidon, "Y"-class
Bangladesh 109–10, 134, 299
Beaufre (General) 283
Belgium: military expenditure 60, 82–85; military presence abroad 267; military R&D expenditure 153–54, 156–59, 165–67, 174, 178, 181, 220–29; military R&D projects 184–85; and the NPT 287, 333–37, 351–52, 356; development of nuclear technology 288, 294, 296–97, 351; demand for uranium 474, 476
Ben Gurion, David 311
Berlin 30–31, 394, 600; foreign military presence in 250, 262, 265. *See also* Germany
Biological disarmament: convention 501–13, 517–22, 594–95, 601; UN resolutions 563–64. *See also* chemical disarmament
Bolivia 96–99, 597

Brandt, Willy 339
Brazil: military expenditure 73, 96–99; receipt of arms and aid 107, 109–10, 143–44; military R&D projects 184–85, 194, 210; and the NPT 287, 290, 330–32, 356; development of nuclear technology 294, 296–97, 329–30; demand for uranium 474, 476; uranium supplies 479; and the Treaty of Tlatelolco 331, 543, 545
Brezhnev, Leonid I. 25, 30–31, 36, 429
Brunei 137
Bulgaria 69, 78, 84–85, 388, 600
Bunche, Ralph J. 594
Burma 65, 71, 91–92, 137, 531, 600
Burundi 92–95

C

Cambodia (Khmer Republic) 71, 90–91, 104–105, 110, 137
Cameroon 72, 92–95, 129
Canada 595, 600–601; military expenditure 60, 82–85; arms trade with the third world 110, 122–24, 128–30, 133, 143–44, 146; military R&D expenditure 152–54, 156–58, 162, 165–68, 173, 175–76, 178, 180–82, 195, 212, 220–29; military R&D projects 184–85, 191, 193, 208, 210, 216; military presence abroad 267; and the NPT 388; and the spread of nuclear technology 299, 307–308; and the nuclear test ban debate 524–25; demand for uranium 472–74, 476; uranium supplies 470–72, 478–80, 482
Cassin, René 594
Central African Republic 92–95, 129, 479
Ceylon 88–89, 106, 134, 550–51, 596, 600
Chad 92–95
Chagla, M.C. 303
Chemical disarmament 510, 513–16, 563–64, 594–95. *See also* biological disarmament
Chen Yi 283–84
Chile 73, 96–99, 110, 144–45, 476
China 2, 53, 599, 601; disarmament policy 483–85, 489–500; military expenditure 65, 82; arms trade with the third world 109–10, 122–23, 133, 136; military R&D projects 184–85, 189, 191–93, 207–209;
and the NPT 483, 491, 493–94; and nuclear weapons 283–84, 356, 485–88; development of nuclear technology 372; nuclear test ban 404, 429–30, 532; nuclear testing programme 406, 408, 422, 461–62, 464;
and the Disarmament Decade 558–60; and GCD 489; and Indian Ocean 553–54; and Outer Space Treaty 483, 492; and PTB 483, 487, 489, 491, 493–95; and SALT 484, 493–94; and Sea-Bed Treaty 483, 492, 535; and Treaty of Tlatelolco 544, 548–49
Chou En-lai 491, 496
Colombia 73, 96–99, 109–10, 145, 597
Comprehensive test ban (CTB) 48, 353, 359, 389–405, 408–15, 516–32, 594. *See also* detection of nuclear tests
Conference of the Committee on Disarmament (CCD) 484, 501, 513, 515, 523–32, 597
Conference of Experts (1958, Geneva) 395, 399, 423, 435, 454
Conference of Non-Nuclear-Weapon States 308, 313, 328, 352–53, 544
Congo (Brazzaville) 92–95, 110, 129
Cook Islands 599
Costa Rica 96–97, 597
Cuba 96–97, 141; Cuba crisis 390, 394–95, 426; and the Treaty of Tlatelolco 544, 546–48
Cyprus 86–89
Czechoslovakia 600; intervention in 347–48; military expenditure 69, 78, 84–85; arms trade with the third world 122–123; military R&D projects 184–85, 189, 193, 210; and the NPT 388; demand for uranium 477; uranium supplies 470, 473; and the nuclear test ban debate 524

D

Dahomey 92–95
De Gaulle, Charles 357
Denmark: military expenditure 60, 82–85; military R&D expenditure 153–54, 156–59, 165–67, 174, 176, 181, 220–29; military R&D projects 184–85; and the NPT 388; demand for uranium 474, 476
Detection of nuclear tests: underground 437–553; atmospheric and high-altitude 453–55
Disarmament: chemical and biological 501–16; chronology 594–602; and China 483–500; and the Indian Ocean 550–55; the Treaty of Tlatelolco 542–49; and SALT 23–49; the Disarmament Decade 556–60; disarmament treaties 574–93; UN resolutions 562–73
Dominican Republic 96–97, 141, 597

E

Early-warning satellite system 11, 42
East Germany: military expenditure 69,

78, 84–85; military R&D projects 184–85, 189, 194; and the NPT 388; uranium supplies 473. *See also* Berlin
Ecuador 96–99, 109, 145, 534
Egypt, Arab Republic of 600; military expenditure 64, 68, 70, 86–89; receipt of arms and aid 101, 104, 106, 124; military presence abroad 267; military R&D projects 184–85, 194–95; and the NPT 287, 313–14, 355–56, 358; development of nuclear technology 294, 296–97, 313; demand for uranium 476; and the nuclear test ban debate 526, 531
Eighteen-Nation Disarmament Committee (ENDC) 395, 398
Eisenhower, D.D. 391, 393, 399–400, 402, 406
El Salvador 96–97, 534
Ethiopia 600; military expenditure 72, 92–95; receipt of arms and aid 108, 129; and the nuclear test ban debate 525, 531
Eshkol, Levi, 311–12
Euratom and the NPT 285, 287, 296, 321, 333–37, 341, 343–45, 347–53; and safeguards 375, 384. *See also* Belgium, France, Italy, Netherlands, United Kingdom, West Germany
Europe: military expenditure 52, 59–61, 70, 82, 87; foreign military presence in 250–52, 259–60, 262–63, 265, 267, 269–71, 598; as a nuclear-weapon-free zone 548
European Economic Commission (EEC) 214, 220, 334, 336–37, 348
European Nuclear Energy Agency (ENEA) 375, 471–72, 474–80

F

Far East: military expenditure 52, 64–67, 71, 82, 90–91; receipt of arms and aid 100–102, 104–105, 108–10, 120–21, 137–41; military presence abroad 253–56, 260, 263–64, 267–69, 271. *See also* individual countries
Federov (Professor) 397
Fiji 599
Finland 595; military expenditure 70, 86–87; military R&D expenditure 153–54, 156–59, 165–66, 178, 181, 220–29; and the NPT 388; demand for uranium 474, 476
Fissionable material 285, 287, 290, 294, 297, 302, 334, 336, 339, 346–47, 358, 366–79, 387, 431
Foreign military presence of the USA, USSR, UK and France 240–75; UN resolution 568. *See also* France, United Kingdom, USA, USSR
Foster, John S., Jr. 32, 171
Foster, William C. 440, 526
Fractional Orbital Bombardment System (FOBS) 5, 8, 42, 46
France: arms trade with the third world 100–101, 103, 108–109, 122–23, 125–36, 138; military presence abroad 241–43, 246, 265-66, 271; military R&D expenditure 152–59, 161–63, 165–68, 172, 176, 178–82, 212, 216, 220–29; military R&D projects 184–85, 188–91, 193–94, 196, 207–209;
development of nuclear technology 372, 374; the spread of nuclear technology 284, 289–300, 302, 308, 310, 319, 330, 346, 352;
demand for uranium 474, 476; uranium supplies 470–72, 479–82; and the proliferation of nuclear weapons 283–84, 334, 336, 356–57; strategic nuclear forces 2, 61, 82–85;
the nuclear test ban 404, 429–30, 532, 599–600; nuclear testing programme 392, 406, 408, 422, 434, 461–62, 464, 523;
and CB disarmament 511, 516; and the Disarmament Decade 558–60; and Indian Ocean 554; and Sea-Bed Treaty 533–34, 543; and Treaty of Tlatelolco 544, 548–49

G

Gabon 92–95, 130, 479
Galosh (ABM) 21
Gandhi, Indira 107, 300–301, 305
General and Complete Disarmament (GCD) 391, 489, 569–70
Geneva Convention on the Territorial Sea and the Contiguous Zone (1958) 534, 576
Geneva Protocol of 1925, 485, 502, 508–509, 511–12, 514–16
Germany. *See* East Germany, West Germany
Ghana 72, 92–95
Gibraltar 328–29
Greece: military expenditure 60–61, 82–85; receipt of arms and aid 108–10 146–47; military presence abroad 267; military R&D expenditure 153–54, 156–59, 220–29; military R&D projects 184–85; and the NPT 388; demand for uranium 474, 476

Guatemala 96–97, 141
Guinea 92–95, 130, 267
Guyana 145

H

Haiti 96–97
Hardsite (ABM) 13
Honduras 96–97, 141
Hong Kong 90–91, 476
Hungary 69, 78, 84–85, 184–85, 388, 600

I

Iceland 153–54
India: military expenditure 64–65, 69, 71, 88–89; receipt of arms and aid 101, 105–107, 109, 135–36; military presence abroad 267; military R&D expenditure 151, 153–54, 156–59, 162, 165–68, 173–74, 178, 180–82, 217, 220–29; military R&D projects 184–85, 191, 193–94, 208–10; and the NPT 287, 301–307, 335–57, 359, 528; development of nuclear technology 288, 291, 294, 296–301; demand for uranium 474–76, 482; and the nuclear test ban debate 527
Indian Ocean: as a zone of peace 550–55, 567–68, 594, 596, 600, 602; foreign naval presence in 246, 271, 599; British naval presence 264; Soviet naval presence 240, 260–61, 553; US naval presence 252–53. *See also* South Asia
Indonesia 71, 90–91, 137, 553, 601
Intercontinental ballistic missile (ICBM) 1–2, 4–12, 15–16, 25, 27, 30, 41–42, 45–46, 49, 499
Intermediate-range ballistic missile (IRBM) 2, 6, 14, 22, 28–29
International Atomic Energy Agency (IAEA) 285, 287, 289, 301, 303, 308, 310–11, 313, 316–17, 321, 325, 331, 335–37, 341, 343–45, 348–53, 375–88, 465–67, 471–80, 528, 531, 542–44, 575–77, 596. *See also* safeguards agreements
Iran 64, 70, 86–89, 103, 107–108, 125–26, 184–85, 194
Iraq 70, 86–89, 108, 126, 388
Ireland: military expenditure 63, 70, 86–87; military R&D expenditure 153–54, 156–59, 220–23; and the NPT 388; demand for uranium 476; and the Disarmament Decade 556
Israel: military expenditure 64–68, 70, 86–89; receipt of arms and aid 101, 103–104, 126–27; military presence abroad 267; military R&D projects 184–85, 194–95, 209–10; and the NPT 287, 310–13, 355–58; development of nuclear technology 294, 296–97, 309–10; demand for uranium 474, 476
Italy: military expenditure 60, 82–85; arms trade with the third world 107, 110, 122–23, 125, 127–28, 132, 143, 147–48; military R&D expenditure 152–55, 157–59, 162, 165–67, 174, 176, 178, 180–82, 213, 220–29; military R&D projects 184–85, 191, 210; and the NPT 287, 333–37, 346–49, 355; development of nuclear technology 288, 291, 294, 296–97, 345–46; demand for uranium 474, 476, 480, 482; uranium supplies 479; and the nuclear test ban debate 524; and the Disarmament Decade 556; and biological disarmament 600
Ivory Coast 72, 92–95, 130

J

Jackson, Henry 402, 410, 433
Jamaica 141
Japan 533, 595–96, 599; military expenditure 63, 71, 90–91; arms trade with the third world 110, 122–23; military R&D expenditure 151–54, 156–59, 162, 165–68, 173–74, 176, 178, 180–82, 213, 217, 220–29; military R&D projects 184–85, 191, 208–10; and the NPT 287, 320–24, 355–59; development of nuclear technology 288–89, 291, 296–97, 317–20, 372; demand for uranium 474, 476, 480, 482; uranium supplies 479; and the nuclear test ban debate 524–25
Jarring, Gunnar 104
Jordan 70, 86–89, 127

K

Kennedy, John F. 394–96, 399, 401–402
Kenya 72, 92–95, 108, 130
Khrushchev, Nikita S. 391, 393–98
Kiesinger (Chancellor) 339
Korea. *See* North Korea, South Korea
Korean War 486
Kosygin, Alexei 24; Kosygin formula 329, 341
Kuwait 70, 86–89, 127
Kuznetsov 397

L

Laird, Melvin 26, 35, 57–60, 322–23
Laos 71, 90–91, 102, 138

Latin America: military expenditure 52, 66–67, 73, 82, 96–99; receipt of arms and aid 105, 107, 109–10, 120–21, 141–46; military presence abroad 256–57, 259, 262, 270; as a nuclear-weapon-free zone 542–49, 596. *See also* individual countries, Treaty of Tlatelolco
Launch-on-warning system 10, 14
Lebanon 70, 86–89, 108, 127
Le May, Curtis 401
Liberia 92–95, 130
Libya 64, 72, 92–95, 108, 130
Lindsay, Franklin 442
Long, Franklin 441–42
Luxembourg 60, 82–85

M

Malagasy Republic 72, 92–95
Malawi 92–95
Malaysia 65, 71, 90–91, 108–109, 138–39, 388, 601
Mali 92–95, 131
Mao Tse-tung 485–86
Mauritania 92–95
Mauritius 92–95, 131
McNamara, Robert 40, 401
Mediterranean Sea: foreign naval presence in 240, 246, 260, 270–71, 599. *See also* Europe
Medium-range ballistic missile (MRBM) 2, 6, 14, 22, 28–29
Meir, Golda 311
Mexico: military expenditure 73, 96–97; receipt of arms and aid 141; demand for uranium 474, 476; uranium supplies 479; and the nuclear test ban debate 525, 531, 600; and the Disarmament Decade 556; and the Sea-Bed Treaty 536; and the Treaty of Tlatelolco 542–43, 545
Middle East: military expenditure 52, 64, 66–67, 70, 82, 86–89; receipt of arms and aid 101, 103–104, 106–108, 120–21, 124–29; foreign military presence in 252–53, 259–60, 264, 270. *See also* individual countries
Military expenditure: trends in 1970–71, 51–73; tables of values 82–99; sources and methods of study 74–81; the economic and social consequences of military expenditure 571; UN report 276–82. *See also* under individual countries
Military R&D: the level of current military R&D expenditure 58–59, 151–82, 207–10; the size of worldwide military R&D efforts 182–207; military R&D tables 222–31; US estimates of Soviet military R&D expenditure 232–39; sources and methods of study 211–21; and SALT 44, 46–49. *See also* under individual countries
Minuteman (ICBM) 1–2, 4–9, 13, 15–16, 27, 34, 40, 44, 203
Mongolia 90–91, 600
Morocco 72, 92–95, 531, 556, 600
Moscow Treaty. *See* Partial Test Ban Treaty
Multiple Independently Targetable Re-entry Vehicle (MIRV) 2, 7–10, 13, 16–17, 27–28, 30, 34–35, 41–42, 44, 46, 48, 204, 418, 420
Multiple Re-entry Vehicle (MRV) 2, 5, 7–9, 13, 35, 46, 204

N

National Advisory Committee on Aeronautics (NACA) 231
National Aeronautics and Space Administration (NASA) 152, 179–80, 230–31, 235, 301
National Command Authority (NCA) 28–30, 33–34
Nauru 599
Nehru, Jawaharlal 304
Nepal 88–89, 136
Netherlands: military expenditure 60, 82–85; arms trade with the third world 110, 122–23, 127, 129–31, 143, 145–47; military presence abroad 267; military R&D expenditure 153–54, 156–59, 162, 165–68, 173, 178, 180–82, 220–29; military R&D projects 184–85, 191, 209–10; and the NPT 333–37, 349–51, 356, 528; development of nuclear technology 289, 294, 296–97, 349, 372–74; and the spread of nuclear technology 338; demand for uranium 474, 476; and the nuclear test ban debate 525, 529; and biological disarmament 600; and the Disarmament Decade 556; and the Treaty of Tlatelolco 543
New Zealand: 599; military expenditure 63, 71, 90–93; military presence abroad 267; and the NPT 388; demand for uranium 474, 476
Nicaragua 96–97, 141, 542
Niger 92–95, 479
Nigeria 62, 72, 92–95, 131, 531, 600; Nigerian Civil War 65
Nixon, Richard M. 24–26, 30–31, 33, 35; Nixon Doctrine 104–105, 240
Noel-Baker, Philip 594

Non-Proliferation Treaty (NPT) 24, 41, 43, 45, 48, 283–87, 290, 295, 424, 426–28, 430–32, 470, 483, 491–94, 528, 543, 545, 576, 578–94; and the attitudes of selected near-nuclear countries 298–360; and IAEA safeguards 375–77, 385–88. *See also* China, France, United Kingdom, USA, USSR, Euratom, nuclear technology
North America: foreign military presence in 256
North Atlantic Treaty Organization (NATO) 337, 394, 595, 597–99; military expenditure 52–53, 59–61, 74–76, 82–85; nuclear option in Europe 287, 334–35, 339–41, 343–45, 348, 350–51; NATO forces 28–29, 31, 36, 164, 248–49, 377; and the NPT 287
North Korea 65, 90–91, 137
North Viet-Nam: military expenditure 65, 90–91; receipt of arms and aid 110; military presence abroad 268
Norway: military expenditure 60, 82–85; military R&D expenditure 153–54, 156–59, 165–68, 174, 178, 181–82, 220–29; military R&D projects 184–85; and the NPT 388; demand for uranium 474, 476
Nuclear technology 470–82; the spread of 288–91; and the NPT 285–87; nuclear reactors 288–90, 297–98, 300, 308, 310, 313, 315, 317–20, 325, 330, 332, 335, 338, 346, 352, 366–74; for peaceful purposes 285–86, 288, 290–91, 295, 300–301, 303, 315–16, 319, 321, 325–26, 328, 330–31, 333, 341, 344–48, 352–53, 358, 376–78, 380, 385, 388, 424–25. *See also* Argentina, Australia, Belgium, Brazil, Egypt, India, Israel, Italy, the Netherlands, Pakistan, Japan, South Africa, Spain, Switzerland, West Germany, plutonium, uranium
Nuclear weapons: proliferation 1–22, 283–91, 294–96, 302; testing programmes 404–408, 417–22, 433–36; UN resolutions 565–66, 569. *See also* China, France, United Kingdom, USA, USSR, detection of nuclear tests

O

Oceania 52, 71, 82, 90–93
Oman 101, 108, 127–28
Organization for Economic Cooperation and Development (OECD) 214, 220, 375, 474, 476, 478
Organization of African Unity (OAU) 550
Organization of American States (OAS) 597–98
Orr, Lord Boyd 594
Outer Space Treaty 483, 492, 575, 578–91, 598

P

Pacific Ocean: foreign naval presence in 246, 253–56, 265, 271, 326–27, 600. *See also* Far East
Pakistan: military expenditure 64–65, 69, 71, 88–89; receipt of arms and aid 101, 105, 107, 109–10, 136–37; and the NPT 287, 308–309, 355–56, 358, 528; development of nuclear technology 294, 296–97, 307–308; demand for uranium 474, 476, 482; and the nuclear test ban debate 531, 600; and the Disarmament Decade 556; and the Indian Ocean 553; and the Sea-Bed Treaty 534
Panama 96–97, 107, 142, 544
Paraguay 96–99
Partial Test Ban Treaty (PTB) 33, 36, 48, 302, 325, 390, 400–404, 407, 432, 436, 448, 461–64, 483, 523, 529, 531–32, 574, 578–90, 598; history of negotiations 389–411; Chinese attitudes towards 487–90, 493–95
Pearson, Lester 594
Peru 523, 600; military expenditure 73, 96–99; receipt of arms and aid 107, 109–10, 145–46; and the Sea-Bed Treaty 533–34
Philippines 71, 90–91, 474, 476, 601
Plowshare programme 424, 445, 462, 468
Plutonium production 288–91, 297–98, 300, 307, 310, 312–13, 317, 319, 328, 335, 338, 346, 352, 366–70, 385
Poland 595, 600; military expenditure 69, 78, 84–85; military R&D projects 184–85, 189, 193, 210; and the NPT 388
Polaris: SLBM 2, 5, 7–9, 16–17, 20, 187; submarine 5, 21, 40, 203–204
Pollin, L. 594
Portugal: military expenditure 60, 82–85; receipt of arms and aid 110, 147; military R&D projects 184–85, 194; military presence abroad 267; demand for uranium 474, 476; uranium supplies 479–80
Portuguese Angola 147
Poseidon: SLBM 2, 7–9, 21, 420; submarine 21, 35. *See also* Polaris
Preparatory Commission for the Denuclearization of Latin America 543. *See also* Treaty of Tlatelolco
Puerto Rico 544

Q

Qatar 128
Quemoy and Matsu crisis 486–87

R

Rhodesia, Southern 72, 92–95, 131
Rio Tinto Zinc Corporation (RTZ) 473, 476–77
Rogers, William 36
Romania 595, 599–601; military expenditure 69, 78, 84–85; and the NPT 388; and the Treaty of Tlatelolco 544

S

Sadat (President) 106
Safeguard (ABM) 13, 27, 29, 33
Safeguards agreements 285, 287, 289, 295, 300, 303, 308, 310–11, 313, 316, 321, 325–26, 329, 332, 334–37, 341, 344–45, 350, 353, 375–88, 577; UN resolutions 566–67. *See also* International Atomic Energy Agency
Saudi Arabia 64, 70, 86–89, 108, 128, 267
Scientific Committee on the Effects of Atomic Radiation 529
Sea-Bed Treaty 389, 492, 533–41, 576–93; UN resolutions 562–63
Seaborg, Glenn 323
Senegal 72, 131
Sharjah 128
Shastri, Lal Bahadur 304
Short-Range Attack Missile (SRAM) 10–11, 16–17, 19, 22
Short-Range Ballistic Missile (SRBM) 22
Sierra Leone 92–95
Singapore 90–91, 108, 139, 601
Smith, Gerard 32
Somalia 72, 92–95
South Africa: military expenditure 63–64, 68, 72, 92–95; receipt of arms and aid 101, 108, 132; arms trade with the third world 127, 131–32; military R&D projects 184–85, 194, 210; and the NPT 287, 316–17, 356–57; development of nuclear technology 289, 294, 296–97, 314–16; demand for uranium 474, 476; uranium supplies 470–72, 478–79, 482
South Asia: military expenditure 52, 64–67, 71, 82, 88–89; receipt of arms and aid 120–21, 134–37; foreign military presence in 252–53, 260, 263, 267, 271. *See also* Far East
South East Asia Treaty Organization (SEATO) 242, 327
South Korea: military expenditure 71, 90–91; receipt of arms and aid 100, 105, 137, 138; military presence abroad 267
South Viet-Nam: military expenditure 71, 90–91; receipt of arms and aid 102, 104, 140–41; military presence abroad 268
Spain: military expenditure 70, 86–87; military presence abroad 267; military R&D expenditure 153–54, 156–59, 220–29; military R&D projects 184–85, 191; and the NPT 287, 328–29, 356; development of nuclear technology 288, 294, 296–97, 328; demand for uranium 474, 476, 482; uranium supplies 479–80
Strategic Arms Limitation Talks (SALT) 3–4, 23–37, 359, 426, 428, 432, 484, 493–94, 523; SALT agreements 36–37, 44–47; Soviet proposals 28, 30, 33; US proposals 27, 29, 32–33; SALT and the arms race 1–22, 40–49, 598
Strategic bombers 2, 18–19, 30, 46, 49
Strategic nuclear forces (USA and USSR): advances in 1–22; numbers of weapon systems 2, 4–7, 15–22. *See also* China, France
Strauss (Minister) 339
Submarines: numbers 15
Submarine-launched ballistic missile (SLBM) 2, 4–5, 7–9, 16, 27, 30, 42, 45, 203–204
Subsonic Cruise Armed Decoy (SCAD) 11, 17, 19
Sudan: military expenditure 65, 72, 92–95; receipt of arms and aid 132–33; military presence abroad 267
Sweden 598, 600; military expenditure 63, 70, 86–87; arms trade with the third world 111, 122–23, 145; military R&D expenditure 152–54, 156–59, 162–63, 165–68, 173, 175, 178, 180–82, 212, 216, 220–29; military R&D projects 184–85, 190–91, 208–10; demand for uranium 474, 476, 482; and the Disarmament Decade 556; and the nuclear test ban debate 531
Switzerland: military expenditure 70, 86–87; arms trade with the third world 110, 122–23; military R&D expenditure 153–54, 156–59, 166, 178, 181, 213, 220–29; military R&D projects 184–85, 191; and the NPT 287, 352–54, 356; development of nuclear technology 294, 296–97, 352; demand for uranium 474, 476, 482
Syria 70, 86–89, 129

T

Taiwan 71, 90–91, 104, 139, 474, 476
Tanzania 72, 110, 133
Test Ban Treaty. *See* Partial Test Ban Treaty
Thailand 601; military expenditure 71, 90–91; receipt of arms and aid 102, 104, 108, 140; military presence abroad 267; demand for uranium 474, 476
Thorium 290, 297, 300, 330, 377, 379, 381, 385
Togo 92–95, 133
Tonga 599
Treaty of Tlatelolco 331, 333, 387, 542–49, 575–76, 578–92, 598, 602
Trinidad and Tobago 107, 142
Tunisia 72, 92–95, 108, 133
Turkey: military expenditure 60–61, 82–85; receipt of arms and aid 110, 147–48; military presence abroad 268; military R&D expenditure 153–54, 156–57, 159, 220–29; military R&D projects 184–85; demand for uranium 474, 476; uranium supplies 479

U

Uganda 72, 92–95, 133
Undersea Long-Range Missile System (ULMS) 8, 58
UNESCO 214, 220
United Kingdom: military expenditure 60–61, 82–85; arms trade with the third world 100–101, 103, 107–108, 122–45, 147; military presence abroad 240–43, 246, 262–64, 270–71; military R&D expenditure 152–59, 161–68, 171–72, 175–82, 212, 216, 220–29; military R&D projects 184–85, 188–91, 194, 196, 207–208, 210;
development of nuclear technology 372–74; and the proliferation of nuclear weapons 284–85, 357; and the spread of nuclear technology 284, 289, 330, 349; demand for uranium 474, 476; uranium supplies 471–72, 479, 481–82; nuclear test ban 392, 396, 404, 429–30, 532; nuclear testing programme 391, 406, 408–409, 434, 461–62, 464;
and CB disarmament 501, 508, 511, 515, 600; and the Disarmament Decade 558; and the Indian Ocean 554; and the Treaty of Tlatelolco 543–44, 548
United Nations: chemical and biological disarmament 501, 505–508, 515–16; and China 484, 489, 496, 498–500; Disarmament Decade 556–60; General Assembly resolutions 561; nuclear test ban debate 390, 393–94, 523–32; report on the economic and social consequences of military expenditure 276–82; Sea-Bed Treaty discussions 533–36; UN membership 561
Upper Volta 92–95
Upstage (ABM) 13
Uranium: enriched uranium technology 289–91, 297–300, 310, 314–15, 317–19, 325, 327, 330, 335, 338, 346, 349, 352–53, 371–74, 385; supplies and stockpiles 470, 478–82; world demand 470–78. *See also* demand for and supplies, under individual countries, plutonium production
Uruguay 96–99, 146, 388, 544
USA: strategic nuclear forces 1–22, 40–43; military expenditure 52–53, 55–60, 82–85; arms trade with the third world 100–105, 122–23, 125–30, 133–34, 136–47; military presence abroad 240–44, 246–48, 250–57, 268–69, 271; military R&D 58–59; R&D expenditure 150–59, 161–71, 173–82, 212, 215–16, 218, 220–31; R&D projects 184–86, 190, 196–200, 202–10; US estimates of Soviet military R&D expenditure 232–39;
and the proliferation of nuclear weapons 284–85, 287, 356–57, 359; and the spread of nuclear technology 289, 299, 301, 310, 318, 325, 335; demand for uranium 471, 474–76; uranium supplies and stockpiles 470–72, 478–82;
nuclear testing programme 391, 405–10, 424, 433–36, 461–65, 467; and a comprehensive test ban 390–402, 405–12, 414–24, 426–29, 432, 524, 526–27, 529, 532; CB disarmament 501, 504, 508, 511, 513, 515;
disarmament efforts 595–98, 600–601; and the Disarmament Decade 557–60; Indian Ocean 554; Sea-Bed Treaty 534; Treaty of Tlatelolco 543–48
USSR: strategic nuclear forces 1–22, 40–43; military expenditure 52, 62–63, 69, 78, 82–85; arms trade with the third world 100–101, 103, 105–107, 122–24, 126–27, 129–36, 141; military presence abroad 240–44, 246–47, 259–61, 271; military R&D expenditure 151, 175, 177; R&D projects 184–85, 189, 191, 193, 195–210; R&D expenditure: US estimates of 232–39;
and the proliferation of nuclear weapons 284–85, 356, 359; and the spread of nuclear technology 308, 313; devel-

opment of nuclear technology 372; uranium supplies 472, 481-82;
and a comprehensive test ban 390-98, 403-408, 414-22, 426-29, 432, 524, 527, 529, 532; nuclear testing programme 404-10, 433-36, 461-68, CB disarmament 501, 504, 508, 511, 513;
disarmament efforts 595-96, 598-601 and the Disarmament Decade 557-60; Indian Ocean 553-54; Sea-Bed Treaty 534; Treaty of Tlatelolco 543-48

V

Vela satellite system 448-54
Venezuela 73, 96-99, 109, 146
Viet-Nam. *See* North Viet-Nam, South Viet-Nam
Viet-Nam War 52, 55-57, 245
Vorster (Prime Minister) 315-16

W

Warsaw Treaty Organization (Warsaw Pact) 29, 106, 596-97; military expenditure 52-53, 61-63, 69, 75-78, 82-85, 183-84; mutual force reduction 31, 36; nuclear forces 2; forces in Europe 247-49
West Germany 595; military expenditure 60-61, 82-85; arms trade with the third world 110, 122-23, 129, 143-48; military R&D expenditure 152-54, 156-59, 162, 164-68, 172-73, 175-78, 180-81, 212, 216, 220-29; military R&D projects 184-85, 190-91, 208-10; and the NPT 287, 333-37, 339-45, 356-57; development of nuclear technology 288, 291, 294, 296-97, 337-39, 349, 372-73; and the spread of nuclear technology 330, 332, 352; demand for uranium 474, 476, 480, 482. *See also* Berlin
Western European Union (WEU) 337-38, 344
Western Samoa 599
Wiesner (Professor) 397
World Health Organization (WHO) 502

Y

"Y"-class: SLBM 2; submarine 4-5, 7, 15, 203-204
Yemen 86-89
Yugoslavia 600-601; military expenditure 63, 70, 86-87; military R&D projects 184-85, 194-95, 209-10; and the NPT 388; uranium supplies 479; and the nuclear test ban debate 531; and the Disarmament Decade 556

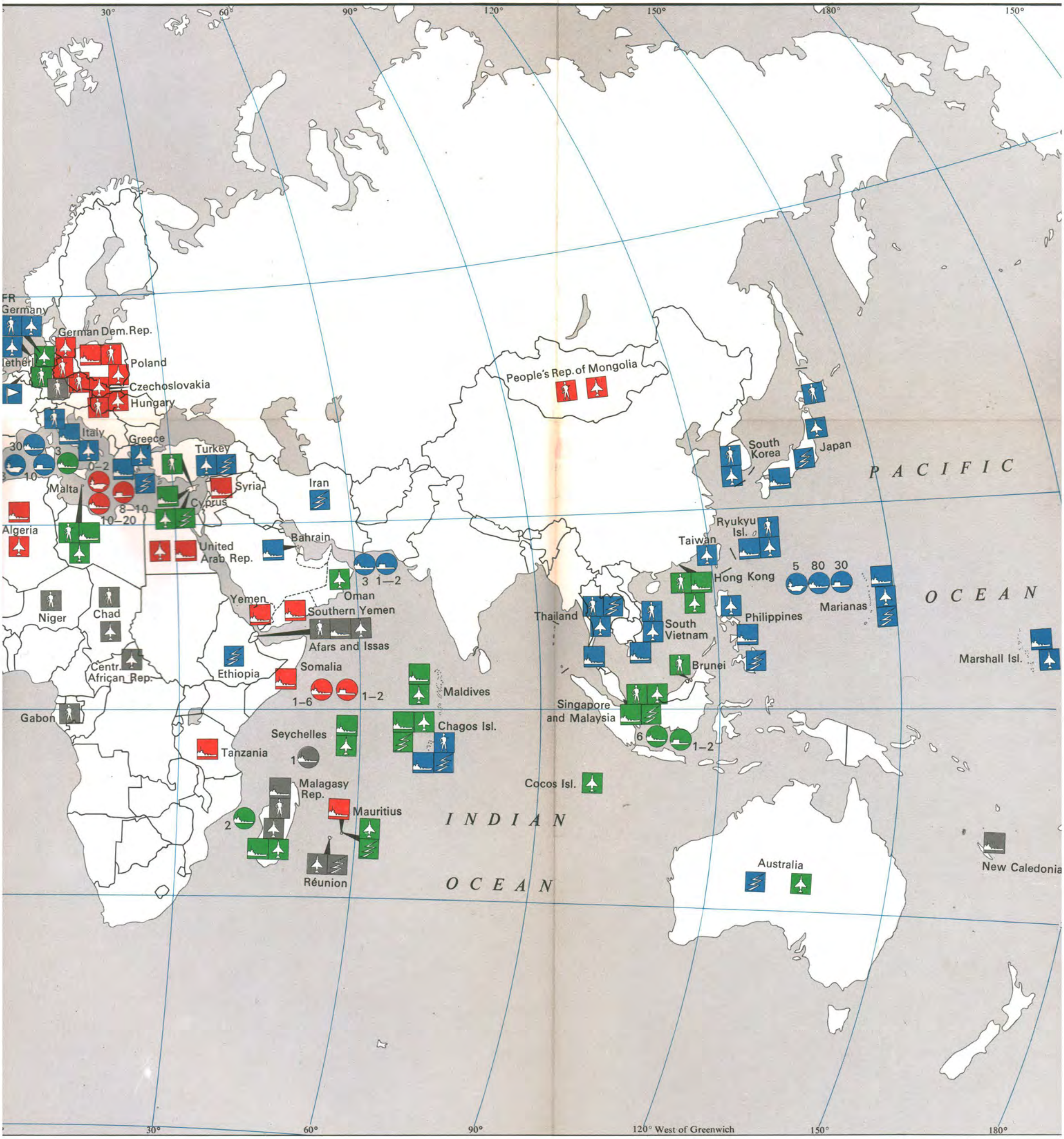
Z

Zaïre 72, 92-95, 108, 134, 388, 470, 472, 480
Zambia 72, 92-95, 134

Map 1. World map: deployment of foreign military bases and fleets by the United States, the Soviet Union, the United Kingdom and France.

Scale 1:75 0

0 500 1000 2000
0 1000 2000 4000



Army units

Naval facilities

Air Force facilities

Headquarters

Communications bases

Carriers (all types)

Major surface warships

Submarines

DEPLOYING COUNTRY

United States

Soviet Union

United Kingdom

France

000

4000 5000 statute miles

6000 8000 kilometres

SWEDISH NATIONAL MAP AND PRINTING ORGANIZATION Stockholm 1

World Armaments and Disarma

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