World Armaments and Disarmament

SIPRI *yearbook* 1977

Stockholm **I**nternational **P**eace **R**esearch **I**nstitute

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SIPRI

Stockholm International Peace Research Institute

SIPRI is an independent institute for research into problems of peace and conflict, with particular attention to disarmament and arms regulation. It was established in 1966 to commemorate Sweden's 150 years of unbroken peace.

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PREFACE

The eighth issue of the *SIPRI Yearbook* continues our analysis of the world's arms races, and the attempts to stop them, up to 31 December 1976. As in all SIPRI publications, information has been obtained from open sources only.

The nuclear arms race between the USA and the USSR could (and probably will) eventually lead to a first-strike capability. This does not necessarily mean that one side will be able to destroy completely the other's capability to inflict casualties and damage in retaliation for a first strike, but rather that this capability may be perceived to be sufficiently reduced to limit the casualties and damage to a level that might be considered acceptable for a given political goal. This level will depend on the recklessness and adventurousness of the political and military leaders in power at the time.[1]

That this perception is likely to be proved wrong, if ever put to the test, is hardly a consolation, since civilization will be destroyed in the process.

The spread of peaceful nuclear technology, and of the technical knowledge and expertise required for nuclear weapon production, is resulting in the worldwide spread of the capability to produce nuclear weapons. It is extremely unlikely that any new international measures to establish a viable non-proliferation régime will succeed where the Non-Proliferation Treaty has failed. The most that can be hoped for is that measures will be taken to slow down the rate of proliferation.

The international trade in arms is spreading worldwide the most sophisticated conventional arms. Since the October 1973 Middle East War this trade has increased at an unprecedented rate and is now virtually out of control. As a consequence, the arsenals of some third world countries are more up-to-date than are those of some industrialized countries. Many of the aircraft and missiles supplied to the third world are capable of delivering nuclear weapons.

Some of the major recipients of arms become strongly bound to the supplier state, often to an extent hardly distinguishable from that of a close ally. This dependence is considerably heightened by the knowledge that in modern war, munitions—particularly anti-tank and anti-aircraft missiles—are normally used at a very high rate. Victory may depend on the willingness of a great power to provide the massive quantities of replacements needed throughout the war. In this sense, the great power often becomes, implicitly or explicitly, the guarantor of the client state.

It is becoming increasingly realized that the Soviet-US arms race, the

[1] A longer version of this discussion appears in *Nature*, Vol. 265, 24 February 1977.

proliferation of the capability to produce nuclear weapons and the worldwide proliferation of sophisticated conventional weapons are together increasing the probability of a nuclear world war.

A war in, for example, an unstable region, involving one or more of these client states, could rapidly escalate from a conventional war to a limited nuclear war fought with the nuclear weapons of the local powers and then to the involvement of the great powers, committed to defending their clients —an involvement which might end in a general nuclear war. This end result is, of course, most likely to occur if one of the great powers perceives the chance of making a successful first strike.

While not disputing the dangers inherent in unrestrained military technology, there are those who argue that increasing cooperation between states—in, for example, economic affairs—will prevent the great powers from pursuing policies which lead to a general nuclear war. Only time will tell whether or not tendencies for cooperation will, in the next two or three decades, outweigh those for confrontation. But it is hard to be optimistic given the rapid rate at which military technology advances and the relatively slow rate at which effective bonds between states are formed. Those who are not optimistic and who are not prepared to rely on the hope that sufficiently responsible political leaders will be in power in the right countries at the crucial times to avoid a future nuclear world war have an option—to work for nuclear disarmament.

Fifteen years of arms control[2] negotiations—very active years though they have undoubtedly been—have totally disillusioned those who initially believed that the Soviet-US arms race would be stopped and disarmament achieved by a step-by-step process. In fact, since World War II the arms race has been virtually unconstrained and the only weapons destroyed by international agreement have been biological weapons—weapons of little military interest. Arms control may lead to the management of the arms race. Arms control may contribute to Soviet-US dètente. But, other than the actual negotiators and committed political leaders who soon develop a high level of "professional optimism", few now believe that the arms control approach will lead to significant disarmament.

With this experience behind us and given the present state of the world, can a far-reaching disarmament treaty—including nuclear disarmament—be

[2] Alva Myrdal has this to say about the term "arms control" in her book *The Game of Disarmament, How the United States and Russia Run the Arms Race* (New York, Pantheon Books, 1976):

"I wish it were not too late to start a boycott against the use of 'arms control' as an over-all term. It is nothing but a euphemism, serving regrettably to lead thinking and action towards the acceptance as 'arms control measures' of compromises with scant or nil disarmament effect. A further reason is that we need the term 'control' in connection with verification problems which loom large in all disarmament debates ....

"The semantic criticism against 'arms control' is also political. 'Arms control' as a synonym for 'arms regulation' is an American innovation which has come into usage only in the last decade and a half. While 'arms regulation' points in the direction of agreement to regulate, 'arms control' connotes power to control."

achieved, using the traditional methods of diplomacy and international law? SIPRI believes that it can. SIPRI also believes that unless this process is soon begun it may be too late to prevent a nuclear world war.

Attributions

Those responsible for the preparation of the *SIPRI Yearbook 1977* are as follows: Frank Barnaby (Chapter 1, sections I–III), Randall Forsberg (Appendix 1B), Sverre Lodgaard (Chapter 2), Milton Leitenberg (Chapter 3), Karlheinz Lohs (Chapter 4, sections I–III), Arthur H. Westing (Chapter 4, sections IV–V), Bhupendra Jasani (Chapter 5 and Appendices 7B and 7D), Herbert York (Appendix 5A), Richard Booth (Appendix 7A), Signe Landgren-Bäckström (Appendices 7C and 7E), and Jozef Goldblat (Chapter 1, section IV and Chapters 8 and 9).

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May 1977

Frank Barnaby
Director

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ABBREVIATIONS, CONVENTIONS AND CONVERSIONS

Abbreviations

bn	billion (one thousand million)
cm	centimetre
CY	calendar year
FY	fiscal year
h	hour
ha	hectare
kg	kilogram
km	kilometre
kt	kiloton
mi	mile
m	metre
mm	millimetre
mn	million
Mt	megaton
MWe	million watts of electricity
MWt	million watts of thermal power
nm	nautical miles
t	ton (1 000 kg)

Conventions

Particular conventions used in certain tables are given in footnotes to the respective tables. The conventions used in Part II are given in chapter 7.

..	Data not available
–	Nil or less than half the final digit shown; negligible; not applicable
()	Greater degree of uncertainty about estimate
[]	Crude estimate

Conversions

Units of length

1 millimetre=0.039 inch
1 inch=25.4 millimetres
1 metre=1.1 yards=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 tons
1 short ton=2 000 pounds=0.91 ton=0.89 long ton
1 long ton=2 240 pounds=1.1 tons=1.12 short tons
1 kiloton=1 000 tons
1 megaton=1 000 000 tons
1 kilogram=2.2 pounds
1 pound=0.45 kilogram

Part I. 1976, the year in review

Chapter 1. The main events and concerns of the year

Developments in the arsenals / Nuclear weapon proliferation / Nuclear-capable delivery systems / Disarmament / The London Club / US and Soviet strategic nuclear forces, 1968–77

Chapter 2. The increase in international nuclear transactions

Introduction / The choice of nuclear options / Commercial restrictions and the promotion of safeguards / Proliferation impact / Tables of the proliferation of nuclear power

Chapter 3. Accidents of nuclear weapon systems

Numbers of accidents / Definitions: nuclear weapon accidents and incidents / Accident reporting / Nuclear weapon safety / Categories of related events of concern / Conclusions / Tables of nuclear weapon accidents and incidents / US military service branch definitions of nuclear accidents and incidents

Chapter 4. Dioxin: a potential chemical-warfare agent

Introduction / History / Toxicology / Dioxin in the environment: four episodes / Ecological consequences / Conclusions

Chapter 5. Military satellites

Introduction / Military satellite missions and orbital characteristics / US military satellite programme / Soviet satellite programme / Military satellite programmes of other countries / Conclusions / Tables of military satellites / US air and space reconnaissance programmes

Chapter 6. Topical issues: SIPRI publications of 1976

Medical protection against chemical-warfare agents / The law of war and dubious weapons / Southern Africa, the escalation of a conflict / Ecological consequences of the Second Indochina War

1. The main events and concerns of the year

Square-bracketed numbers, thus [1], *refer to the list of references on page 18.*

I. *Developments in the arsenals*

In 1976 the world's military spending totalled about $330 bn (see appendix 7A). This sum corresponds to the entire GNP of a typical highly industrialized country with a population of 50 mn or so, and is about 25 times the amount of foreign aid to the underdeveloped countries.

About 10 per cent of military spending is for military research and development (R&D) [1]. This activity—which also absorbs more than one-half of the world's most highly qualified physical and engineering scientists—is the one which makes possible the arms race. Without military R&D, the production of weapons for replacement may continue, the size of the world's arsenals may increase, and the weapons of the small and medium powers may (because of the arms trade) eventually approach in quality those of the great powers. But in terms of the development of new, more sophisticated, more destructive and increasingly expensive weapons, the arms race would cease. In practice, however, military R&D is the hardest of all military activities to restrain. In fact, since World War II the only significant limits to developments in military technology have been the innovative capabilities of the Soviet and US societies.

Quantitatively, each of the two great powers has an enormous strategic nuclear arsenal (see appendix 1B). The USA admits to having 1 054 land-based intercontinental ballistic missiles (ICBMs), 656 submarine-launched ballistic missiles (SLBMs) on 41 strategic nuclear submarines, and about 400 strategic bombers. These strategic forces can deliver about 9 000 independently targetable nuclear warheads. The Soviet Union is reported to have about 1 500 ICBMs, about 800 SLBMs on nearly 60 strategic nuclear submarines and about 140 strategic bombers. These forces can deliver nearly 4 000 independently targetable nuclear warheads. In addition to their strategic nuclear forces, the USA and the USSR have tens of thousands of tactical nuclear weapons, most of which are considerably more powerful than the atomic bomb that destroyed Hiroshima. The types of deployed US and Soviet strategic weapon systems are shown in table 1.1.

But qualitative developments in offensive and defensive strategic weapons are probably as dangerous as, if not more so than, the size of the nuclear arsenals. These could well lead to a situation in which adventurous political and military leaders in one (or both) of the great powers may perceive a chance of "winning" a strategic nuclear war. Both the USA and

Table 1.1. Deployed US and Soviet strategic weapon systems

	Introduced	Range nm	Payload	CEP nm		Introduced	Range nm	Payload	CEP nm
ICBMs (Intercontinental ballistic missiles)									
USA Titan II	1962	6 300	1×10 Mt	0.5	*USSR* "SS-7 Saddler"	1962	6 000	1×5 Mt	2
Minuteman II	1966	6 950	1×2 Mt	0.3	"SS-8 Sasin"	1963	6 000	1×5 Mt	1.5
Minuteman III	1970	7 020	3×200 kt (MIRV)	0.2	"SS-9 Scarp"	1965	6 515	1×20 Mt	0.7
					"SS-11 mod. 1"	1966	5 650	1×1 Mt	1
					"SS-13 Savage"	1968	4 350	1×1 Mt	0.7–1
					"SS-11 mod. 3"	1973	5 650	3×200 kt (MRV)	1
					"SS-17"	1977		4×1 Mt (MIRV)	}
					"SS-18 mod. 1"	1976	5 500	1×20 Mt	} 0.3
					"SS-19"	1976	5 500	6×1 Mt (MIRV)	}
SLBMs (Submarine-launched ballistic missiles)									
USA Polaris A-3	1964	2 500	3×200 kt (MRV)	0.5–0.7	*USSR* "SS-N-5"	1963	700	1×1 Mt	
Poseidon C-3	1970	2 500	14×40 kt (MIRV)	0.3	"SS-N-6 mod. 1"	1968	1 300	1×1 Mt	1.5
					"SS-N-6 mod. 2"	1974	1 600	1×1 Mt	1.5
					"SS-N-8"	1973	4 200	1×1 Mt	0.8

	Introduced	Range nm	Payload		Introduced	Range nm	Payload
Strategic submarines							
USA With Polaris A-3	1964	. .	16×A-3	*USSR* "Hotel"-class	1960	. .	3×"SS-N-5"
With Poseidon C-3	1970	. .	16×C-3	"Yankee"-class	1968	. .	16×"SS-N-6"
				"Delta I"-class	1973	. .	12×"SS-N-8"
				"Delta II"-class	1976	. .	16×"SS-N-8"
Strategic bombers							
USA B-52C/D/E/F	1956	10 000	27 210 kg	*USSR* Mya-4 "Bison"	1955	5 255	9 070 kg
B-52 G/H	1959	10 860	34 015 kg	Tu-20 "Bear"	1956	6 775	18 140 kg
FB-111	1970	3 300	16 780 kg	Tu-. . "Backfire"	1975	(3 000)	(20 000 kg)

the USSR are improving their strategic nuclear forces (along roughly the same lines). Although the USA remains ahead of the USSR in almost all areas of military technology, the gap is closing. Because much more information is available about US weapons than about Soviet ones, a description of developments inevitably (but unfortunately) emphasizes US systems.

The most dangerous development in strategic weapons is the continuous improvement of the accuracy of warhead delivery. This accuracy is normally measured by the Circular Error Probability (CEP) which is the radius of the circle, centred on the target, within which 50 per cent of the warhead aimed at the target will fall. The guidance system of, for example, the US Minuteman III ICBM—known as the NS 20—is capable of providing a CEP of about 200 m at a range of 13 000 km and the new multiple independently targetable re-entry vehicle (MIRV) currently under development for Minuteman III—the Mark 12A—is expected to have this accuracy. The Mark 12A will be capable of destroying enemy missiles in hardened silos.

But the next generation guidance system, currently planned for the MX ICBM, the proposed replacement for the Minuteman III, is expected to provide CEPs of about 100 m. And in the generation after that, in which warheads will presumably be guided right on to their targets, CEPs as small as 30 m will probably be achieved. These warheads, likely to be available in the mid-1980s, may also be provided with a manoeuvring capability so that they can take evasive action against missile defences. Such manoeuvring independently targetable re-entry vehicles, called MARVs, will represent the ultimate in accurate ICBM delivery systems [2]. Military technology has virtually attained the theoretical maximum also in warhead design. The Minuteman III independently targetable re-entry vehicle, for example, weighs only about 100 kg and yet has an explosive power equivalent to that of 200 000 tons (200 kt) of TNT.

The MX ICBM—a $30-bn weapon system—is planned to carry a relatively large payload and to be mobile. It will probably be deployed (in the 1980s) either in hardened trenches or moved at random between a number of fixed silos. The MX missile is the US answer to the increasing vulnerability of land-based fixed ICBMs to a first strike by enemy strategic missile forces. But the probable effect of its deployment will be to provoke the Soviet Union to deploy even larger and more numerous warheads to threaten all possible MX sites.

The USSR is also developing a mobile ICBM—the SS-X-16. A mobile intermediate-range ballistic missile (IRBM)—the SS-X-20—may be derived from this ICBM. It is not known when the deployment of these missiles will begin.

The advances which have been and are being made in land-based ballistic missiles are certainly impressive but so are those made in SLBMs. The Soviet Union, for example, recently test-launched from a submarine in the White Sea one of its SS-N-18 SLBMs, which has a range of about 9 000 km.

This missile, probably equipped with three MIRVs, is likely to be operationally deployed within a few years on Soviet "Delta II"-class strategic nuclear submarines. The US equivalent is the Trident-I SLBM which will be operational before 1980 and carry up to eight MIRVs. There is no reason why SLBMs should not eventually be made as accurate as land-based ICBMs. The USA is, in fact, developing a MARV, the Mark 500 warhead, for the Trident SLBM.

The nuclear submarine remains relatively invulnerable. But large resources are being devoted by both sides to anti-submarine warfare (ASW) [3–4]. These efforts will probably eventually succeed and it therefore cannot be assumed that the submarine will retain its invulnerability. A breakthrough in ASW would, of course, be an exceedingly dangerous development with respect to world security. And so would breakthroughs in ballistic missile defence systems, such as the space-based laser and charged-particle beams now being researched.

II. *Nuclear weapon proliferation*

In 1976 there was a new surge of concern—both governmental and non-governmental—about the possible proliferation of nuclear weapons to countries which do not already have these weapons. This concern was mainly related to the continuing spread of the capability to produce fissionable material suitable for military use—specifically plutonium-239 and uranium highly enriched in uranium-235—through the spread of nuclear technology for peaceful purposes.

The 1970 Non-Proliferation Treaty (NPT) [5] lulled many into a false sense of security—politicians and non-politicians alike were convinced that the proliferation problem was thereby more or less solved. In this connection it should be remembered that during the 1960s the technical and economic barriers to the acquisition of nuclear weapons were formidable. These barriers disappeared long ago for the vast majority of countries but it has taken some time for this to be generally realized. The realization came to some at least, as a result of the 1974 Indian nuclear explosion [6], although the general reaction to this event was surprisingly muted.

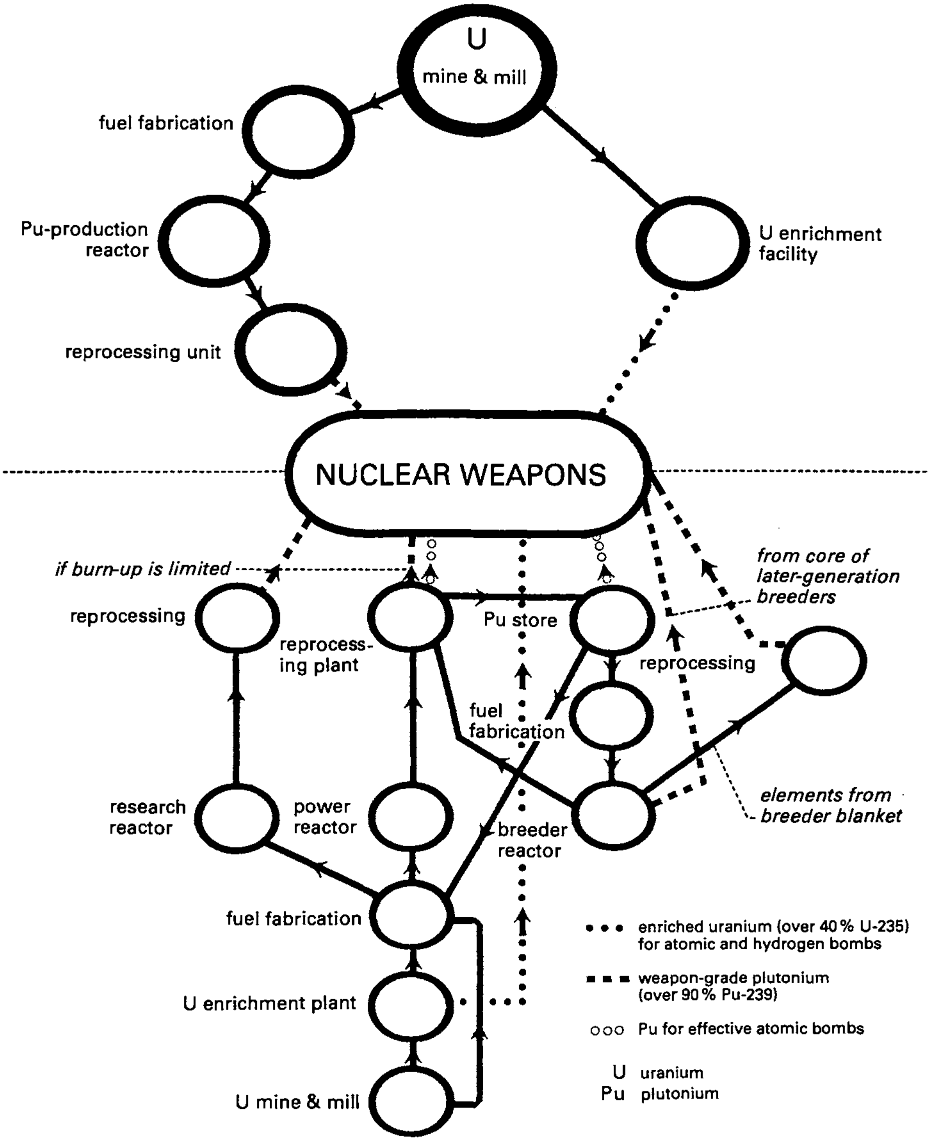
Many nuclear events preceding the Indian explosion had, of course, also passed virtually unnoticed. One example was the proliferation of uranium-enrichment technology to non-nuclear weapon countries—in particular, to FR Germany, the Netherlands and South Africa [7]. Another was the persistent rumour during the October 1973 war that nuclear weapons had spread to the Middle East—to Israel through its own efforts and to Egypt as warheads for Soviet-supplied Scud surface-to-surface missiles.

But in 1976 there was a growing general awareness of the danger of nuclear weapon proliferation and of the link between a peaceful nuclear

Figure 1.1. Routes to nuclear weapons

Direct routes

All these operations may be done under military control on a small scale and secretly at a cost of about $1 mn per atomic bomb for, say, a couple of dozen bombs.



Nuclear explosives as by-products

Nuclear explosives may be produced as by-products of a peaceful nuclear power programme. The marginal cost of so producing a nuclear explosive device may be no more than a few hundred thousand dollars.

Source: Reference [10].

Table 1.2. Summary of the nuclear status of countries having at least one nuclear reactor or one

Country	Power reactors 1976	Power reactors 1984	Uranium enrichment capability[a]	Fuel reprocessing capability[a]	Uranium resources <$30/lb[b]	Uranium producer 1976	Research reactor in operation[c]
Algeria					+		
Angola					+		
Argentina	+	+			+	+	+
Australia					+		+
Austria		+					+
Belgium	+	+		P[h]			+
Brazil		+	P	P	+		+
Bulgaria	+	+					+
Canada	+	+			+	+	+
Central African Republic					+		
Chile							+
Colombia							+
Czechoslovakia	+	+			+		+
Denmark					+		+
Egypt							+
Finland		+			+		+
France	+	+	O/C/P	O/C/P	+	+	+
Gabon					+	+	
German DR	+	+					+
Germany, FR	+	+	P[i]	O/C/P	+		+
Greece							+
Hungary		+					+
India	+	+		O/C/P	+		+
Indonesia							+
Iran		+					+
Iraq							+
Israel							+
Italy	+	+		O[j]	+	+	+
Japan	+	+	P	C/P	+	+	+
Korea, South		+			+		+
Mexico		+			+	+	+
Netherlands	+	+	O/C/P				+
Niger					+	+	
Norway							+
Pakistan	+	+		P	+		+
Philippines							+
Poland							+
Portugal					+		+
Romania		+					+
South Africa		+	O/P		+	+	+
Spain	+	+			+	+	+
Sweden	+	+			+		+
Switzerland	+	+					+
Taiwan		+					+
Thailand		+					+

element of the nuclear fuel cycle on their territory

Breeder reactor programme	NPT status[d]	NPT safeguards agreement[e]	Non-NPT safeguards agreement with IAEA[c]	Non-safeguarded nuclear facility	Member of IAEA[c]	Member of Euratom[f]	Member of NEA[g]
					+		
			+		+		
	R	*	+		+		+
	R	*	+		+		+
	R	S			+	+	+
			+		+		
	R	*			+		
	R	*			+		+
	R						
			+		+		
	S		+		+		
	R	*			+		
	R	*	+		+	+	+
	S			+	+		
	R	*	+		+		
		nw			+	+	+
	R				+		
	R	*			+		
	R	S			+	+	+
	R	*	+		+		+
	R	*			+		
+			+	+	+		
	S		+		+		
	R	*	+		+		
	R	*			+		
			+	+	+		
+	R	S			+	+	+
+	R		+		+		+
	R	*	+		+		
	R	*	+		+		
	R	S			+	+	+
					+		
	R	*			+		+
			+		+		
	R	*	+		+		
	R	*			+		
			+		+		+
	R	*	+		+		
			+	+	+		
			+	+	+		+
	R	*	+		+		+
	S		+		+		+
	R		+				
	R	*			+		

Country	Power reactors 1976	Power reactors 1984	Uranium enrichment capability[a]	Fuel reprocessing capability[a]	Uranium resources <$30/1b[b]	Uranium producer 1976	Research reactor in operation[c]
Turkey					+		+
UK	+	+	O/C/P	O/C/P	+		+
Uruguay							+
USA	+	+	O/P	C[k]/P	+	+	+
USSR	+	+	O	O	+	+	+
Venezuela							+
Yugoslavia		+			+		+
Zaire					+		+

[a] Commercial- or pilot-scale facility on country's territory: O=in operation; C=under construction; P=firmly planned.
[b] The Nuclear Energy Agency (NEA) has defined world uranium resources in two ways: first according to the type of resource in geological terms, second according to a hypothetical market price. Geologically, ore deposits are classified as *reasonably assured resources* (RAR) or *estimated additional resources* (EAR), the difference being the reliability of the geological estimate. There are three price categories (per pound U_3O_8): (*a*) less than $15; (*b*) $15 to $30; and (*c*) $30 to $100.
[c] As of 31 December 1976.
[d] As of 31 December 1976. R=ratified; S=signed.
[e] As of 31 December 1976. *=in force; S=signed; nw=nuclear weapon state.
[f] Euratom=European Atomic Energy Community.
[g] NEA=Nuclear Energy Agency of the Organization for Economic Co-operation and Development (OECD).
[h] The Eurochemic reprocessing plant in Mol has been shut down since mid-1974 and future reopening is doubtful but under consideration.
[i] Four sites are being studied by Uranit, the West German partner in URENCO, for the planned URENCO expansion.
[j] The EUREX-1 reprocessing facility at Saluggia was temporarily shut down during 1976 for modification.

programme and the capability to produce nuclear weapons. The decision by FR Germany to sell Brazil a uranium-enrichment plant and a reprocessing plant, as part of a package including eight nuclear power reactors, caused widespread comment. The news of the French sale of a reprocessing plant to Pakistan caused less, but still a good deal of comment. These two sales may have received so much publicity because they represent the first exports to non-nuclear weapon countries of plants capable of producing material in a form suitable for direct use in atomic bombs. The sharp but belated reaction of the US government to these events naturally increased interest in them. But the suspicion that this reaction was based as much on US pique at the continued French and West German success in the nuclear market-place as on the desire to hinder the proliferation of nuclear weapons was widespread. After all, the US Administration objected much more strongly to the Pakistani deal (the threat was made to cut off US economic and military aid to Pakistan) than to the Brazilian one, and the USA had itself offered not so long ago to sell nuclear power reactors to Israel and Egypt even though these states are not subject to NPT safeguards.

The announcement that South Africa was in the market for a nuclear power reactor was widely publicized, as was the decision by France to satisfy the South African demand. And the announced intentions of Cuba, Iran, Iraq and Libya, among a number of other countries, to initiate nuclear power programmes also aroused a significant amount of publicity, often

Breeder reactor programme	NPT status[d]	NPT safeguards agreement[e]	Non-NPT safeguards agreement with IAEA[c]	Non-safeguarded nuclear facility	Member of IAEA[c]	Member of Euratom[f]	Member of NEA[g]
	S		+		+		+
+	R	nw	+		+	+	+
	R	*	+		+		
+	R	nw			+		+
+	R	nw			+		
	R		+		+		
	R	*	+		+		
	R	*	+		+		

[k] Allied General Nuclear Services built a reprocessing plant in Barnwell, South Carolina, which was substantially complete at the beginning of 1976 and undergoing final non-active commissioning, but no operation licence had been issued as of 31 December 1976. See also footnote *a*, table 2.5, p. 48.

Sources: Power Reactors in Member States (Vienna, IAEA, 1976); *Power and Research Reactors in Member States* (Vienna, IAEA, 1974); *Nuclear Engineering International,* Vol. 21, Nos. 238–251, January–December 1976; *Nuclear News,* Vol. 19, Nos. 1–15, January–December 1976; *Summary of World Broadcasts, Part 2, Eastern Europe Weekly Economic Report,* EE/W859-EE/W910 (Monitoring Service of the British Broadcasting Corporation, 1976); *News Review on Science and Technology,* Institute for Defence Studies & Analyses, January–August 1976; *Uranium Resources, Production and Demand,* Joint Report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency (Organization for Economic Co-operation and Development, Paris, 1976); *Facts on Nuclear Proliferation,* a handbook prepared for the Committee on Government Operations, US Senate, by the Congressional Research Service, Library of Congress (Washington, US Printing Office, 1975) pp. 105–107 and 127–29; *Oversight Hearings on Nuclear Energy—International Proliferation of Nuclear Technology,* Hearings before the Subcommittee on Energy and the Environment of the Committee on Interior and Insular Affairs, US House of Representatives, 21, 22 and 24 July 1975 (Washington, US Government Printing Office, 1975) pp. 42–43.

proportional to the political instability of the region in which the country concerned is situated (see table 1.2).

The plutonium problem

Existing nuclear power reactors—with a total generating capacity of about 100 000 megawatts of electricity (see table 2.1)—are capable of producing about 20 000 kg of plutonium annually. About 30 per cent of this capacity is in 15 countries which do not now possess nuclear weapons (Argentina, Belgium, Bulgaria, Canada, Czechoslovakia, FR Germany, German DR, India, Italy, Japan, the Netherlands, Pakistan, Spain, Sweden and Switzerland). By the end of 1980, about 250 000 kg of commercial plutonium will be stockpiled worldwide. At this time, the world's nuclear power reactors will be capable of producing about 45 000 kg of plutonium annually, 40 per cent of it in 22 non-nuclear weapon countries (the above 15 countries plus Brazil, Finland, Hungary, Iran, Mexico, Romania and Yugoslavia).

Plutonium is an extremely potent explosive. In an atomic bomb of very modest efficiency, about 10 per cent of the plutonium is detonated to give a yield of about 20 kt for 12 kg of plutonium. The technical information required to design and manufacture a nuclear explosive device is now relatively readily available and so is the necessary expertise. Many people have direct knowledge of nuclear weapon design and this number inevitably grows continuously. Small wonder then that concern—both governmental and non-governmental—about the possiblity of the clandestine diversion of plutonium for the construction of nuclear explosives has now gone beyond the worry that governments may acquire nuclear weapons. The current concern is that terrorist organizations or even small criminal groups may do so.

At the present time, most of the world's commercial plutonium is contained in spent reactor fuel elements. The current worldwide capacity for reprocessing highly irradiated reactor fuel to remove the plutonium is relatively small. But the nuclear establishments in many countries with significant nuclear power programmes are now demanding new reprocessing plants. The main reason given for this demand is that plutonium is needed to fuel future breeder reactors. The main reason against reprocessing is that it increases the chances of the proliferation of nuclear weapons by governments and of the theft of plutonium by non-governmental groups intent on producing, or threatening to produce, nuclear explosives. The reactor fuel elements themselves are so highly radioactive that they are virtually self-protecting—handling them without very heavy and specialized equipment would be a suicidal task. The theft of fuel elements is, therefore, most unlikely.

In 1976, both President Ford and President-elect Carter proposed a moratorium on reprocessing in the USA. And France announced that it would not, in future, export reprocessing plants. But both Carter and Ford were ambiguous about future US reprocessing. A decision, one way or the other, is, however, imminent because the construction of the US reprocessing plant at Barnwell, South Carolina, has been completed. If the decision is taken to operate the plant, which is designed to handle about 1 500 tons of spent reactor fuel annually, equal to the fuel from 50 typical commercial nuclear power reactors, it will be the world's first full-scale commercial reprocessing facility for uranium oxide (as opposed to uranium metal) fuels. During the election campaign, President-elect Carter suggested that Barnwell could become a multinational reprocessing plant.

Small-scale production of fissile material for atomic bombs

A graphite- (or heavy water) moderated, natural-uranium reactor with a power of about 120 mn watts thermal (equivalent to about 40 mn watts electrical) would produce about 20 kg of plutonium-239 per year, more than enough for two atomic bombs with an explosive power equivalent to that of 20 kt of TNT. The components for such a small reactor can be easily and secretly obtained on the open market for a cost of less than $20 mn. The reactor and a small chemical reprocessing unit could be clandestinely constructed [8–9] and run. Many countries have deposits of uranium ore on their territories and thus it would normally not be difficult to obtain fuel for the reactor. This route may well be the one chosen even by countries with large peaceful nuclear power programmes, if they should decide to produce atomic bombs.

This does not, of course, mean that one should ignore the possibility of the diversion of plutonium from a peaceful nuclear power programme to military purposes. Nor does it necessarily mean that the current concern over the acquisition of nuclear power reactors, reprocessing plants or enrichment plants by new countries is misplaced. But—contrary to public opinion and often even to official statements—it does mean that a lack of access to a commercial reprocessing plant would not necessarily prevent the proliferation of nuclear weapons to countries which take the decision to acquire them directly.

The breeder reactor

The problem of controlling plutonium will be even more difficult if, and when, breeder reactors are developed to a commercially viable stage. The elements from the breeder blanket, in which uranium-238 is converted into plutonium, will normally contain weapon-grade plutonium (95–98 per cent plutonium-239). The plutonium in the spent fuel elements from the core of the reactor will normally contain about 70 per cent of plutonium-239, which is about the same concentration as the plutonium in the spent fuel elements from a typical thermal reactor. This "contaminated" plutonium would still be usable as the fissile material for atomic bombs, albeit of less than optimum efficiency. Relatively larger amounts of this plutonium would be required for a given yield and so the physical size of the weapon would be larger. More seriously, the yield of the weapon would be unpredictable because of the danger of premature detonation by the spontaneous fission of plutonium-240. But if care were taken over the design, an effective explosive device could be constructed.

The main new danger with the breeder reactor will arise from extraction of weapon-grade plutonium from the blanket elements for military purposes. The core elements will simply add to the considerable plutonium problem already created by thermal reactors. A further danger may, however, arise from second and subsequent generations of breeders because the preferred fuel for them may actually be plutonium of weapon grade.

Enriched uranium

One likely military use of highly enriched uranium (over 40 per cent uranium-235) is as the trigger for a hydrogen (thermonuclear) bomb. Highly enriched uranium is also used, with plutonium, in the more efficient atomic bombs. The spread of uranium-enrichment plants could, therefore, contribute to the proliferation of nuclear weapons [7]. Once again, attention has been mainly focussed on plants large enough for commercial use. But a small enrichment facility—a dozen or so centrifuges, for example—would be enough to produce the kilogram per year quantities of suitably enriched uranium needed for the development of a modest nuclear weapon programme. The high degree of enrichment necessary would be obtained by recycling the uranium again through the system. This technique would, in any case, also be necessary if weapon-grade uranium were produced in a commercial plant designed to provide reactor fuel for which the degree of enrichment required is normally less than 3 per cent.

Slowing down proliferation

The major suppliers of nuclear material and equipment continued to hold secret meetings in London during 1976[1] to discuss ways of making the nuclear market-place less anarchic with the object of minimizing the risk of the diversion of nuclear technology, which they are so eager to supply, to the production of nuclear explosives. The very fact that these meetings were deemed necessary at all amounts to official admission of the failure of the NPT to establish an effective non-proliferation régime. Perhaps not surprisingly, the suppliers have so far been unable to agree on a body of rules more effective than the NPT.

It should be remembered that countries in the NPT are committed to have International Atomic Energy Agency (IAEA) safeguards applied to *all* their nuclear facilities, whether indigenously constructed or imported.

The most sensible course of action, with the aim of slowing down proliferation, would be for the exporters to insist that their clients accede to the NPT, or at least subscribe to the same system of international safeguards as that which the parties to the NPT are required to take on.

The absence of commercial reprocessing and breeder reactors would not prevent proliferation but it would probably contribute to slowing it down. Until nuclear disarmament is achieved, we should make sure that the application of developments in peaceful nuclear technology which may exacerbate the situation is avoided unless it can be clearly demonstrated that the development is absolutely necessary. The use of plutonium as reactor fuel is clearly one such application.

In summary, the strengthening of the NPT along the lines discussed in the *SIPRI Yearbook 1976* [5], a moratorium on the construction of reprocessing plants and breeder reactors until the necessity for these reactors is unambiguously demonstrated, and multinational uranium-enrichment plants under IAEA safeguards are all essential steps if the spread of nuclear weapons is to be minimized.

[1] The countries involved in these meetings are Belgium, Canada, Czechoslovakia, France, FR Germany, German DR, Italy, Japan, the Netherlands, Poland, Sweden, Switzerland (observer), the UK, the USA and the USSR. See also reference [12].

III. *Nuclear-capable delivery systems*

The atomic bomb dropped on Hiroshima had an explosive yield equivalent to about 12 000 tons of TNT and it weighed about four tons. The yield-to-weight ratio—a measure of the efficiency of a bomb—was, therefore, about 3 000. (The yield-to-weight ratio of large conventional bombs is about 0.5.) A modern US nuclear warhead—the Minuteman III independently targetable re-entry vehicle, for example—has a yield of about 200 kt and weighs about 0.1 ton. The yield-to-weight ratio is, therefore, about two million—almost the maximum theoretically attainable with a thermonuclear weapon.

A new nuclear weapon power should today have little difficulty in producing an atomic bomb with a yield-to-weight ratio of about 20 000, even at an early stage in its nuclear weapon programme. Such a weapon with a yield of about 20 kt would weigh about 1 000 kg. A warhead with these characteristics could be transported by many delivery systems [10], some of which are already in the arsenals of many near-nuclear countries [11]. To take a few examples: the US A-4 Skyhawk has a maximum weapon load of about 4 500 kg, the US F-104 Starfighter of about 2 000 kg, the US F-4 Phantom of about 7 000 kg, the French Mirage V of about 4 000 kg, the British Canberra and Buccaneer of about 3 600 kg and the Soviet Ilyushin 28 of about 2 200 kg. Surface-to-surface missiles—such as the US Honest John, Lance, Pershing and Sergeant, the Soviet Scud and Frog and the Israeli Jericho—are all nuclear-capable. Moreover, the technology of a peaceful space programme could produce, as by-products, guided missiles suitable for short-, medium- and long-range ballistic delivery systems for nuclear warheads. It should also be remembered that most civilian airlines have aircraft—like the Boeing 707, for example—more sophisticated than the B-29 bomber which dropped the atomic bombs on Hiroshima and Nagasaki. These could be provided with the avionics needed to convert them into effective long-range bombers capable of delivering even very crude (and thus heavy) atomic bombs.

Recent developments in cruise missile technology could have far-reaching consequences for the proliferation of credible nuclear delivery systems —both tactical and strategic [3]. Apart from their relative invulnerability, modern cruise missiles have two important characteristics. They are very accurate and relatively cheap. A CEP of as low as a few tens of metres is now possible for a long-range cruise missile. The unit cost of new US cruise missiles is estimated at about $500 000. This is no more than the cost of a modern battle tank and 30 times less than the cost of an air-superiority fighter aircraft—like the US F-15. Less sophisticated, but still effective cruise missiles could be made for very much less cost. Because of their characteristics, many countries, underdeveloped as well as developed, may see cruise missiles as highly desirable tactical and strategic delivery systems.

Tactical cruise missiles have already been produced indigenously by a number of countries other than the USA and the USSR. The French Caisseur surface-to-surface cruise missile became operational in 1956, the British Bloodhound surface-to-air cruise missile in 1958, and the Swedish RB 08A surface-to-surface missile in 1967. More recently, Italy has developed the OTOMAT surface-to-surface anti-ship cruise missile, Britain the Sea Dart surface-to-air missile, and in FR Germany the Hydra air-to-surface anti-ship cruise missile is under development.

The main barrier to the production of strategic cruise missiles is not related to knowledge about technology but about geography. Accurate information about the contours of the terrain beneath possible flight paths and at the target is needed to be able to programme the on-board computer in order to correct accumulated errors in the inertial guidance system of the missile and to provide terminal guidance on to the target. When accurate global satellite navigational systems are available—probably within the next decade—missile guidance will become considerably easier. The acquisition of small turbofan engines and of miniaturized components for the guidance system presents no serious problem.

Most countries, including underdeveloped ones with a moderately sized defence industry producing, say, jet aircraft and missiles, could produce effective tactical cruise missiles should they choose to do so. Many of these countries could, or will soon be able to, produce cruise missiles suitable for use by them as credible strategic delivery systems. Such non-industrialized countries with well-developed defence industries include Argentina, Brazil, India, Israel and Taiwan. In collaboration with other nations, underdeveloped countries like Egypt, Indonesia, the Democratic People's Republic of Korea, the Republic of Korea and Pakistan are producing sophisticated weapons. If present trends continue, this list will quickly grow.

IV. *Disarmament*

The past year was a particularly meagre year for efforts to slow down the Soviet-US arms race and to limit armaments. The difficulties of achieving a SALT II treaty remained unresolved. In 1974, the USSR and the USA signed the Threshold Test Ban Treaty, and in 1976, a treaty governing peaceful nuclear explosions (see appendix 8B), but these have yet to be ratified. Since a threshold ban may indefinitely delay a comprehensive ban on nuclear tests it may be better for disarmament if these treaties remain unratified.

There was no real progress during the year in the Vienna talks on the mutual reduction of forces in Central Europe. The two sides agreed that reductions should be carried out by stages; that US and Soviet troop strengths would be dealt with separately from those of the remaining nine states; and that tanks and nuclear warheads, as well as aircraft and other nuclear weapon delivery vehicles, could be included in the categories of weapons to be reduced. But the controversy with regard to the scope of the reductions and the manner in which they have to be implemented remained unresolved. The negotiating situation was as follows:

NATO proposed that, in the first phase, the USSR should withdraw 68 000 troops and 1 700 tanks, while the USA would withdraw 29 000 troops, 1 000 tactical nuclear warheads, 54 F-4 aircraft and 36 Pershing surface-to-surface missile launchers. In the second phase, an equal ceiling of 900 000 would be established for NATO and Warsaw Treaty ground and air forces, with a subceiling of 700 000 for ground forces, but no separate subceilings for individual countries.

According to the Warsaw Treaty proposal, in the first phase, Soviet and US armed forces in Central Europe would be reduced by an equal percentage (approximately 2–3 per cent) of the total number of forces of both pacts in this area. Each side would also reduce 300 tanks, 54 aircraft—Soviet Fitter and US F-4; an equal number of tactical missile launchers—Soviet Scud-5 and US Pershing—together with a certain number of nuclear warheads for these means of delivery; and 36 anti-aircraft missile launchers—Soviet SAM-2 and US Nike Hercules and Hawk. All other states would reduce the number of their armed forces in Central Europe in the next phase, so that eventually all participants would have the strengths of their forces cut by an equal percentage. The reduction of troops would be carried out by complete units, together with corresponding weapons and equipment; the withdrawn Soviet and US troops would be disbanded on their national territories.

Beside the size and the method of reduction, the parties must still agree on the base figures from which the reductions are to be counted (the strength of Warsaw Treaty forces, as revealed by the USSR in June 1976, is lower than NATO estimates); determine the status of civilians performing military functions; draw a demarcation line between different arms of military service; and elaborate ways of checking compliance with the commitments undertaken.

At the beginning of 1977, a new multilateral agreement was opened for signature—a convention on environmental warfare. Originally suggested by the USA and the USSR, and subsequently negotiated at the Conference of the Committee on Disarmament (CCD), the convention prohibits military or any other hostile use of environmental modification techniques having "widespread, long-lasting or severe" effects as the means of destruction, damage or injury to states party to the convention. The term "environmental modification technique" has been defined as any technique for changing—through the deliberate manipulation of natural processes—the dynamics, composition or structure of the Earth, including its biota, lithosphere, hydrosphere, and atmosphere, or of outer space. To clarify problems relating to the application of the convention, the parties will resort to consultations, both bilateral and multilateral, which may include the services of international organizations as well as a consultative committee of experts to be convened upon request. Complaints about violations will be lodged with the UN Security Council which will act in accordance with the provisions of the UN Charter.

The following examples of phenomena that could be caused by the use of environmental modification techniques, as defined by the convention, were given during the negotiations: earthquakes; tsunamis (tidal waves); an upset in the ecological balance of a region; changes in weather patterns (clouds, precipitation, cyclones of various types and tornadic storms); changes in climate patterns; changes in ocean currents; changes in the state of the ozone layer; and changes in the state of the ionosphere. However, none of these events is likely to be caused through deliberate action for warlike purposes, that is, in such a way that the effects would be felt only by the enemy.

On the other hand, the convention seems to condone modification techniques which can produce more limited (that is, not widespread, long-lasting or severe) effects, such as precipitation modification short of changing the "weather pattern". And it is precisely these techniques that are likely to be used to influence the environment with hostile intent, especially in tactical military operations.

Not only is the non-use commitment under the convention of a partial nature, but the threshold under which the parties would retain freedom of action has been placed rather high. According to an understanding reached in the CCD, to be considered as "widespread, long-lasting or severe", the effects of the use of environmental techniques would have to encompass an area on the scale of several hundred square kilometres, last for a period of months, or approximately a season, or involve serious or significant disruption or harm to human life, natural and economic resources or other assets. No restrictions are envisaged on the development of the prohibited techniques.

Thus, the convention has no value as an arms-control undertaking and a very limited value as a law of war. In any event, it is a less urgently needed measure than a comprehensive nuclear test ban or a prohibition of chemical weapons, the two subjects unsuccessfully discussed for years in the CCD.

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Appendix 1A

The London Club

The aim of the London Club is to minimize the risk of diversion of nuclear technology, which the members are eager to supply, to the production of nuclear explosives. The Club currently has 14 members—Belgium, Canada, Czechoslovakia, France, FR Germany, German DR, Italy, Japan, the Netherlands, Poland, Sweden, the UK, the USA and the USSR. Switzerland attended the last (November 1976) series of club meetings as an observer. The founders of the Club were Canada, France, FR Germany, Japan, the UK, the USA and the USSR.

Membership of the London Club involves the agreement to adopt a set of "guidelines", finalized in November 1975, controlling the export of certain nuclear material, equipment and technology. The material and equipment concerned are defined in a "trigger" list—so called because the export of items on the list should "trigger" the application of safeguards to the nuclear material produced, processed or used in the facility for which the items are supplied. Specifically, such items should be exported by members only if covered by International Atomic Energy Agency (IAEA) safeguards, a system designed to detect (but not prevent) the diversion of nuclear material from peaceful to military purposes (see *SIPRI Yearbook 1972* for a description of the IAEA safeguards system). The London Club list is apparently a somewhat expanded version of an earlier list evolved by an older club of nuclear exporters—the 20-member Zangger Committee. This Committee, set up to interpret the safeguards clause of the Non-Proliferation Treaty (NPT), is still active and presumably the hope is that the London Club and the Zangger Committee will eventually combine. The Zangger list was incorporated in 1974 in an IAEA document known as INFCIRC/209 which is used, *inter alia,* by a number of states in relation to their NPT safeguards commitments.

The London Club trigger list includes the following nuclear materials—plutonium-239, uranium-233, uranium enriched in uranium-235 or -233, natural uranium, uranium depleted in uranium-235, and thorium—in quantities greater than specified limits. For the first three substances, and any material containing one or more of them, the limit to a given recipient country is 50 effective grams per year, for natural uranium it is 500 kg per year, and for both depleted uranium and thorium it is 1 000 kg per year.

Nuclear equipment on the trigger list includes nuclear reactors capable of producing more than 100 grams of plutonium per year, and reactor equipment such as pressure vessels, machines for loading and unloading fuel into reactors, control rods, pressure tubes for fuel elements and primary coolant, pumps for circulating liquid metal primary coolant and zirconium tubes in quantities greater than 500 kg per year.

The trigger list includes a number of non-nuclear materials used in reactors—such as deuterium and heavy water, in quantities exceeding 200 kg of deuterium atoms for each recipient country per year, and high-grade graphite in quantities exceeding 30 tons per recipient country per year. The London Club list—and here it differs from the Zangger list—includes plant for the production of heavy water, deuterium and deuterium compounds and special equipment designed for this purpose.

But perhaps the most important items of equipment on the trigger list are plants for the fabrication of fuel elements and for the reprocessing of spent reactor fuel elements, and equipment specially designed or produced for the separation of isotopes (that is, the enrichment) of uranium. Apparently, the London Club list (and this is the second difference from the Zangger list) actually defines the enrichment-plant items involved. These include gaseous diffusion barriers, gaseous diffuser housings, gas centrifuge assemblies, jet nozzle and vortex separation units, large axial or centrifugal compressors (corrosion-resistant to uranium hexafluoride) and special seals for these compressors.

The governments represented in the London Club should authorize the export of items on the trigger list only if the recipient government gives a formal assurance that the equipment or material will not be used in any nuclear explosive device, including one designed for peaceful purposes—a provision which is implicitly also in INFCIRC/209. London Club members also undertake to agree upon levels of physical protection for nuclear materials and facilities identified by the trigger list, designed to prevent the theft of fissionable material and the unauthorized use of nuclear equipment (presumably mainly with terrorists in mind). This is a new obligation.

Physical protection is a matter for the national safeguards system of the country concerned. But to implement the terms agreed upon by the members, the levels of physical protection required should be agreed on bilaterally between exporter and importer. In each case, the responsibility for the transport of trigger list items should be clearly defined.

The requirements of IAEA safeguards, assurance of nonexplosive use and physical protection should also be applied to plants built for reprocessing, uranium enrichment or heavy-water production using technology directly transferred by a member of the London Club or technology derived from transferred facilities. IAEA safeguards should apply to any facility *of the same type* as an imported facility constructed during an agreed period (apparently 20 years) in the recipient country. Thus the French-Pakistani agreement, putting the reprocessing plant recently sold by France to Pakistan under IAEA safeguards, includes the provision that any reprocessing plant of the same type as the one supplied by France, built by Pakistan in the next 20 years, will also be subject to IAEA safeguards.

"Technology" in this context apparently means technical data "in physical form" (other than that availablc in open sources) which the exporter decides is important to the design, construction, operation or maintenance of enrichment, reprocessing or heavy-water plants. It is assumed that any facility of the same type built by the importer in the 20-year period uses imported technology. The guidelines apparently do not explain what should happen after the 20-year period.

London Club members are expected to exercise restraint in exporting "sensitive technology", particularly enrichment and reprocessing facilities or technology. The guidelines suggest that exporters should encourage importers to accept multinational reprocessing and enrichment centres instead of national plants. No such multinational centres yet exist but if any are ever built the members should promote the international inspection of them.

Special controls are spelt out for the export of an enrichment facility and technology. Such a facility, or a facility based on such technology, should not be used by the recipient to produce uranium enriched to more than 20 per cent uranium-235 without the consent of the supplier, about which the IAEA should be informed. This is a noteworthy new requirement. An effective nuclear weapon based on enriched uranium would require material enriched to more than about 40 per cent.

The guidelines state that agreements with recipients of nuclear materials and equipment should, where appropriate, include arrangements for reprocessing and storage of any fissionable material usable in nuclear explosive devices. Particularly emphasized is the need to control the re-export of trigger list items and sensitive technology. Importers should give an assurance that any such re-export, or the export of trigger list items produced with the help of transferred equipment or technology, will occur only if the new recipient agrees to the same conditions as those originally accepted by the re-exporter. The supplier's consent is required for the re-export of facilities or technology for reprocessing, enrichment or heavy-water production, the export of equipment derived from these items and the re-export of heavy water or fissionable material usable in nuclear explosive devices.

The London Club guidelines are essentially a gentlemen's agreement—they do not amount to a treaty.[1] They suggest the principles which members "should" adopt rather than those which they *must* adopt. Many terms are seemingly much more loosely defined than would be acceptable in a treaty. Each member gives a "unilateral undertaking" to the other members to act according to the principles spelt out in the guidelines when considering the export of nuclear material, equipment or technology. A member is in no way legally bound to act according to the guidelines.

[1] For a further discussion of the London Club's guidelines, see chapter 2, page 29, chapter 8, page 347 and reference [12], page 19.

Presumably the only sanction for acting in a contrary way is expulsion from the Club.

In a sense, the very existence of the London Club is an admission of the failure of the NPT to establish a viable non-proliferation régime. Can the London Club succeed where the NPT has failed? One advantage of the London Club is the membership of France—a major nuclear exporter conspicuously absent from the NPT. But this hardly outweighs the disadvantage that the success of the London Club relies entirely on the continuing goodwill of its members. This is an insufficient basis to control the cutthroat competition inherent in a multibillion dollar export industry.

Perhaps even more serious is the fact that there are many actual and potential exporters of nuclear material, equipment and technology outside the London Club. It is true that a number of important near-nuclear states are outside the NPT. But the weakness of the membership of the London Club is relatively more serious than that of the NPT.

The safeguards required by London Club members are much weaker than the safeguards required by the NPT. The major difference is that parties to the NPT have to accept IAEA safeguards on all their peaceful nuclear facilities. The London Club guidelines require safeguards only on imported nuclear material, equipment and facilities or facilities derived from them. Indigenously designed and constructed facilities are not included. The London Club guidelines include, for the first time, provisions for safeguarding heavy-water production facilities and replications of transferred technology for enrichment reprocessing and heavy-water production. But these provisions, and most of the other restrictions, would be unnecessary if the entire nuclear programme of the country concerned were under IAEA safeguards. The fact that non-nuclear weapon parties to the NPT are subject to more stringent safeguards than are states outside the treaty is an absurd and intolerable discrimination.

Appendix 1B

US and Soviet strategic nuclear forces, 1968–77

Mid-year (1 July) figures

		Intro-duced	Range *nm*	Payload	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Delivery vehicles														
Strategic bombers														
USA	B-52C/D/E/F	1956	10 000	27 210 kg	281	231	231	198	149	149	116	99	83	83
	B-52G/H	1959	10 860	34 015 kg	281	281	281	281	281	281	(274)	(270)	(265)	(265)
	B-58	1960	(2 000)	5 442 kg	80	80	–	–	–	–	–	–	–	–
	FB-111	1970	3 300	16 780 kg	–	–	33	66	66	66	66	66	66	66
USSR	Mya-4 "Bison"	1955	5 255	9 070 kg	50	40	40	40	40	40	40	40	40	40
	Tu-20 "Bear"	1956	6 775	18 140 kg	100	100	100	100	100	100	100	100	100	100
	(Tu-. . "Backfire"	1975	(3 000)	(20 000 kg)	–	–	–	–	–	–	–	15	25	35)
				Bomber total: USA	**642**	**592**	**545**	**545**	**496**	**496**	**456**	**435**	**414**	**414**
				USSR	**150**	**140**	**140**	**140**	**140**	**140**	**140**	**(140)**	**(140)**	**(140)**
Strategic submarines														
USA	With Polaris A-2	1962	n.a.	16×A-2	13	13	8	8	8	8	6	3	–	–
	With Polaris A-3	1964	n.a.	16×A-3	28	28	32	26	21	13	13	13	13	11
	With Poseidon C-3	1970	n.a.	16×C-3	–	–	1	7	12	20	22	25	28	30
USSR	"Hotel"-class	1960	n.a.	3×"SS-N-5"	9	9	8	8	8	8	8	8	8	8
	"Yankee"-class	1968	n.a.	16×"SS-N-6"	(2)	(8)	(14)	(21)	(27)	(33)	34	34	34	34
	"Delta I"-class	1973	n.a.	12×"SS-N-8"	–	–	–	–	–	(1)	(8)	(11)	11	11
	"Delta II"-class	1976	n.a.	16×"SS-N-8"	–	–	–	–	–	–	–	–	(2)	(7)
				Submarine total: USA	**41**	**41**	**41**	**41**	**41**	**41**	**41**	**41**	**41**	**41**
				USSR	**11**	**17**	**22**	**29**	**35**	**42**	**50**	**53**	**55**	**60**
SLBMs (Submarine-launched ballistic missiles)														
USA	Polaris A-2	1962	1 520	1×1 Mt	208	208	128	128	128	128	96	48	–	–
	Polaris A-3	1964	2 500	3×200 kt (MRV)	448	448	512	416	336	208	208	208	208	176
	Poseidon C-3	1970	2 500	10×40 kt (MIRV)			16	112	192	320	352	400	448	480

USSR "SS-N-5"	1963	700	1×1 Mt	27	27	24	24	24	24	24	24	24	24
"SS-N-6 mod. 1"	1968	1 300	1×1 Mt }	32	128	224	336	432	528	544	544	544	544
"SS-N-6 mod. 2"	1974	1 600	3×200 kt (MRV) }										
"SS-N-8"	1973	4 200	1×1 Mt						12	96	132	164	244
			SLBM total: USA	**656**	**656**	**656**	**656**	**656**	**656**	**656**	**656**	**656**	**656**
			USSR	**59**	**155**	**248**	**360**	**456**	**564**	**664**	**700**	**732**	**812**
ICBMs (Intercontinental ballistic missiles)													
USA Titan II	1962	6 300	1×10 Mt	54	54	54	54	54	54	54	54	54	54
Minuteman I	1962	6 515	1×1 Mt	600	500	490	390	290	190	100	–	–	–
Minuteman II	1966	6 950	1×2 Mt	400	500	500	500	500	500	500	450	450	450
Minuteman III	1970	7 020	3×200 kt (MIRV)	–	–	10	110	210	310	400	550	550	550
USSR "SS-7 Saddler"	1962	6 000	1×5 Mt	200	200	200	190	190	190	190	190	130	30
"SS-8 Sasin"	1963	6 000	1×5 Mt	20	20	20	19	19	19	19	19	19	19
"SS-9 Scarp"	1965	6 515	1×20 Mt	(190)	(230)	288	288	288	288	288	288	288	263
"SS-11 mod. 1"	1966	5 650	1×1 Mt	(470)	(720)	(950)	970	970	970	970	970	870	790
"SS-13 Savage"	1968	4 350	1×1 Mt	(20)	(30)	(40)	60	60	60	60	60	60	60
"SS-11 mod. 3"	1973	5 650	3×200 kt (MRV)	–	–	–	–	–	20	40	60	60	60
"SS-18 mod. 1"	1976	5 500	1×10 Mt	–	–	–	–	–	–	–	–	25	50
"SS-19"	1976	5 000	6×1 Mt (MIRV)	–	–	–	–	–	–	–	–	100	140
"SS-17"	1977	. .	4×1 Mt (MIRV)	–	–	–	–	–	–	–	–	–	40
			ICBM total: USA	**1 054**	**1 054**	**1 054**	**1 054**	**1 054**	**1 054**	**1 054**	**1 054**	**1 054**	**1 054**
			USSR	**900**	**1 200**	**1 498**	**1 527**	**1 527**	**1 547**	**1 567**	**1 587**	**1 552**	**1 452**
			Total, bombers and missiles: USA	**2 352**	**2 302**	**2 255**	**2 255**	**2 206**	**2 206**	**2 166**	**2 145**	**2 124**	**2 124**
			USSR	**1 109**	**1 495**	**1 886**	**2 027**	**2 123**	**2 251**	**2 371**	**2 427**	**2 424**	**2 404**
Nuclear warheads													
Independently targetable warheads on missiles, SIPRI estimates													
			USA	1 710	1 710	1 874	2 938	3 858	5 210	5 678	6 410	6 842	7 130
			USSR	959	1 355	1 746	1 887	1 983	2 111	2 231	2 287	2 924	3 224
Total warheads on bombers and missiles, official US estimates													
			USA	4 200	4 200	4 000	4 600	5 700	6 784	7 650	8 500	8 400	8 500
			USSR	1 100	1 350	1 800	2 100	2 500	2 200	2 500	2 500	3 300	4 000

For sources and notes, see page 26.

Sources and notes for appendix 1B (pages 24–25)

Sources:

The main sources and methodology of this appendix are described in the *SIPRI Yearbook 1974*, pp. 106–109, where a comparable table for the decade 1965–74 appears.

The earlier table has been updated on the basis of material published in the *Annual Report* of the US Secretary of Defense for fiscal years 1976, 1977 and 1978 (Washington, US Government Printing Office, 1975, 1976, 1977) and the statements on *U.S. Military Posture* by the Chairman of the Joint Chiefs of Staff for the same three years.

A version of this table covering the years 1967–1976 which appeared in the *SIPRI Yearbook 1976*, pp. 24–27, included revised estimates of the numbers of operational US strategic submarines and SLBMs of various types, based on the dates of overhaul and conversion of each submarine given in *Jane's Fighting Ships* (London, Macdonald & Co., annual), *Ships and Aircraft of the US Fleet* (Annapolis, Naval Institute Press, recent editions), and US Senate Committee on Appropriations annual *Hearings* on naval appropriations. This revised series has been continued, based on the same sources.

The estimates of the numbers of US strategic bombers have been revised in this year's table, based on the application of a stricter definition concerning aircraft status and a review of material in the following sources: Department of Defense, *Annual Report for Fiscal Year 1962, . . ., 1968* (Washington, US Government Printing Office, 1963, 1964, 1966, 1967, 1967, 1969, 1971); Bureau of the Census, *Statistical Abstract of the United States, 1960, . . ., 1976* (Washington, US Government Printing Office, 1960, . . ., 1976); US Secretary of Defense, annual statement on the defense program and budget for fiscal years 1968–1975 (released 1967, . . ., 1974; from fiscal year 1974 on, entitled the *Annual Report* and published by the US Government Printing Office).

Notes:

General

The estimates for 1977 are planned or expected deployments. Following the practice of the official US accounts, which are the main source of this data, the estimates refer to the closing date of the current US Government fiscal year or the first day of the subsequent fiscal year. Thus, for 1977 (and, in future, subsequent years) the figures are projected not for 1 July but for 1 October, the first day of the new US fiscal year.

US delivery vehicles

Bombers

1. Definition and derivation of estimates

US bomber estimates represent the Authorized Active Inventory (AAI). This is composed of Unit Equipment (UE) aircraft—aircraft assigned to an exact, authorized number of squadrons each with an exact, authorized number of aircraft per squadron—plus an exact, 10 per cent maintenance and attrition pipeline.

For B-52s and FB-111s, the estimates have been obtained by (*a*) multiplying the official number of "active" strategic bomber squadrons (*B-52C-F:* 17, 14, 14, 12, 9, 9, 7, 6, 5, 5; *B-52G/H:* 17 through 1976, 16 in 1977; *FB-111:* 2 in 1970, 4 every year since) by the authorized number of aircraft per strategic bomber squadron, 15, yielding official UE estimates (*B-52C–F:* 225, 210, 210, 180, 135, 135, 105, 90, 75, 75; *B-52G/H:* 255 through 1976, 240 in 1977; *FB-111:* 30 in 1970, followed by 60); and (*b*) adding to each of these figures a 10 per cent support allowance.

The 10 per cent support aircraft allowance is maintained at an exact level by drawing on the pool of reserve aircraft manufactured for the purpose of replacing losses through wear and accident. In the case of the B-52G and H models, for example, the original production numbers (193 and 102, respectively) provided an inventory from which 165 Gs in 11 squadrons and 90 Hs in 6 squadrons (a total of 255 aircraft in 17 squadrons) were maintained as Unit Equipment over the period 1963–76, while 17 additional Gs and 9 additional Hs (together, 26 aircraft) were included as supporting aircraft in the AAI total, giving a current usage at any one time of 281 of the produced 295 aircraft. As various G and H model aircraft were involved in crashes or breakdowns over the years, the original 14-aircraft reserve pool from which units were taken to keep up the 10 per cent maintenance and attrition pipeline was apparently reduced to 2 units by 1972, 1 by 1973 and 0 by 1974. Subsequently, the G pipeline fell below the standard 10 per cent and by 1977, one G squadron was "deactivated" so that its aircraft could fill in the pipeline for the remaining 10 active squadrons. A corresponding cutback in bomber flight and maintenance crews was made as the squadron was deactivated.

In the case of the FB-111, of 76 aircraft produced (only 74 actually delivered, due to early crashes), 60 have apparently been maintained as UE aircraft, equipping the 4 active FB-111 squadrons with 15 aircraft each, while an additional 6 in the supporting pipeline have brought the AAI number to 66. The remaining 8 aircraft (a figure reduced by attrition to 6 by 1972 and probably 5 by 1977) have served to replenish the pipeline when necessary.

These estimates appear to be confirmed by the UE number of Short-Range Attack Missiles (SRAMs) used to equip the 17 B-52G/H squadrons and the 4 FB-111 squadrons. The "active" number of SRAMs is 1 140 (of 1 500 produced, again providing spares and a reserve pool): this figure can be obtained by allocating 4 SRAMs each to the 255 UE G and H model B-52s, for a total of 1 020, and 2 SRAMs each to the 60 UE FB-111s, adding a further 120.

The methodology of 15 aircraft per squadron plus 10 per cent for maintenance and attrition does not agree with official US estimates of the numbers of AAI or UE *B-58s*, which are almost invariably put at 2 wings of 3 squadrons each, for a total of 6 squadrons, equipped with *80* aircraft. The production quantity of B-58s was 86, preceded by an unusual 30-unit "pre-production" series, occasioned by technical difficulties with the aircraft (which also resulted in a delay of the initial operational capability of the aircraft for two years after the squadrons it was to equip had been "activated", from 1961 to 1963). It is possible that some of the 6 B-58 squadrons were understrength, and that structural difficulties with the aircraft left no serviceable units for the maintenance pipeline. Alternatively, each of the 2 wings (the standard accounting unit until a decline in wing-strength in the late 1960s led to a switch to squadron counts) may have been equipped with 40 UE aircraft, as was the practice with the earlier medium strategic bomber, the B-47, deployed in wings of 4 squadrons (the heavy bombers had 3 squadrons per wing), with 10 per squadron (as against 15 for heavy bombers). Lacking any evidence for a more precise estimate of UE and AAI B-58s, the widely cited number of 80 aircraft is given.

2. Comparability with official US figures and with estimates of Soviet bombers

In the late 1960s and early 1970s a number of B-52s (mainly and in some years exclusively D models) were maintained in "active" status after being retired from strategic bomber squadron UE status, for use in bombing raids over Vietnam. In addition, aircraft were withdrawn from the strategic squadrons or entire squadrons were withdrawn from the ready strategic forces and sent to the Pacific. Official US estimates of the numbers of active strategic bombers during this period vary considerably, as a result of including or excluding the following: non-squadron assigned B-52s on active service in Vietnam; the 10 per cent pipeline and attrition allowance (as distinct from UE numbers) for B-52s; and the reserve pool numbers of late model B-52s and FB-111s available to replenish the pipeline. Moreover, some statistics apparently follow one definition for the B-52s and another for the FB-111s (for example, the AAI for B-52s and total extant numbers for FB-111s).

In 1975 and 1976 a comparable confusion was created by the maintenance "on active duty" of B-52Ds and Fs which had been retired from authorized strategic squadrons, producing a discrepancy between "operational units" on the one hand, and "active squadrons" on the other hand, with operational units staying constant while squadrons declined. The difficulty of providing a straightforward account of the numbers of US strategic bombers was compounded when a new official statistic was published in 1976 (continued in 1977), including in the total number of bombers not only UE, 10 per cent pipeline and reserve attrition current-model aircraft, but also a small number of R&D models (3 for the USA in 1976 and 1977) and a large number of obsolete, older model aircraft in storage, of types no longer in service or in the maintenance and spares chain, phased out some or many years earlier (an estimated 120 C, E and F model B-52s, the Es retired nearly a decade ago, plus around 60 B-52Ds, the only older model still in service).

Unfortunately, published information does not permit the construction of reliable continuous series, dating back some time, of the total inventory of US bomber aircraft, including in addition to the active types, aircraft in storage or in various stages of preservation, cannibalization or modification for special tests. Since the number of Soviet strategic bombers has remained unchanged at 140 since 1968, it is possible that these aircraft are flown seldom or not at all, in which case they might be more appropriately compared with the stored rather than the active US strategic bombers. (It is unlikely that the 140 figure has been maintained through an attrition pipeline, since the entire production quantities of Mya-4, Tu-20 and "Backfire" are accounted for in the official US statistics of Soviet aircraft of these types assigned to active bomber, tanker, reconnaissance and naval duty. As a result, losses due to accident and wear show up immediately in a decline in the active aircraft estimates: they are not compensated from an unaccounted surplus attrition pipeline.)

Rather than follow the shifting definitions employed from one year to the next in the official US statistics, the US bomber estimates given here have been revised to conform to a single, consistent definition over time; and the definition chosen is that which is most common in statistics of combat capabilities—the active force. This includes most of the aircraft readily available to supplement squadron formations or replace combat losses and excludes aircraft that might need months of work to restore to operational status.

Strategic submarines and SLBMs

The numbers of US strategic submarines and the corresponding SLBMs are derived by treating all submarines under conversion as though they carry their former load until the conversion is completed (shipyard work finished), and their new load from the date of completion.

This method, the only exact procedure feasible with currently available data, differs from the official US practice of excluding from the estimates of *total force loadings* the loads that would be carried by submarines which are currently under conversion and treating submarines under conversion as though they were still under conversion until the time of their first subsequent deployment at sea. The period of conversion is generally somewhat over a year, while the first sea-deployment may lag behind shipyard completion of conversion by six months to a year. (The exact dates for tours of duty are not generally available.) Over the period 1970–78, SIPRI estimates of US missile force loadings differ from the official US estimates for the time that each of the 41 submarines undergoes conversion (18–24 months in all) by including 16 warheads per submarine before the completion of shipyard work and 160 warheads per submarine following completion of shipyard work and prior to the first tour of duty.

After estimating the average Poseidon payload at 14 warheads in the *SIPRI Yearbook 1976* series, the table reverts this year to the earlier 10-warhead per Poseidon estimate. The reason is that while there is little or no requirement for penetration aids to justify an off-loading of the maximum-capacity Poseidon payload, evidence has been published during the past year suggesting that less than expected performance of the Poseidon propulsion system probably did result in a reduction in the typical Poseidon payload, down to a level of 10 warheads, to permit the nominal range of 2 500 nm to be achieved. Each Poseidon-equipped submarine is therefore estimated to provide 160 (not 224) warheads.

Soviet delivery vehicles

The estimates of new Soviet deployments closely follow official US assessments, since US satellite observations constitute the primary source of data on Soviet activity. This may, however, result in some premature representation of Soviet ICBMs and SLBMs as operational, since US estimates for current systems include submarines in pre-deployment outfitting and sea-trials and ICBMs undergoing final launch-site preparations. The Soviet strategic submarine estimates have been adjusted to allow time for shakedowns. In the case of the estimates of Soviet ICBM deployments, US estimates of operational systems are accepted so long as evidence has appeared that work on the sites was under way for a year or more before the date on which they are considered operational.

The Soviet bomber code-named "Backfire" is included in the table only because much attention is given in the United States to this aircraft as a potential strategic delivery system. It is the only weapon system in the table not officially recognized—indeed, disavowed—by the deploying government as a strategic weapon system. Moreover, it has been publicly recognized in the US intelligence estimates as having less than intercontinental range in normal combat flight profile and as having been deployed at bases with medium-range bombers and naval aviation forces. As in the case of the Tu-20, naval aviation assigned "Backfires" are not included in this table of operational strategic forces; and the medium-range bomber assigned "Backfires" (about half of production to date), while shown individually in the table because of their prominence in debate and their (somewhat far-fetched) strategic potential, are not included in the Soviet operational strategic bomber totals.

Nuclear warheads

The SIPRI estimates of independently targetable missile warheads can generally be reconciled with the official US estimates of total bomber and missile warheads if the following steps are taken: (*a*) bomber warhead loads are based on one bomb per 8 000–10 000 kg payload, using UE aircraft for the USA and adding SRAMs (1 140 deployed over 1972–75) to the US bomber internal payload; (*b*) in the case of US SLBMs, loads on submarines under conversion are excluded altogether; and (*c*) for some years, individual MRVs (not just MIRVs) are counted separately in the force load total.

2. The increase in international nuclear transactions

I. *Introduction*

While nuclear energy forecasts have been scaled down over the past years, the growth trend in the use of nuclear power has been firmly established. Nuclear power is likely to be the fastest growing sector of the world's energy supply for many years ahead (see table 2.1). This trend has inevitably brought with it a vast increase in the amount of international transactions for the civilian use of nuclear energy.

From 1955 onwards, with the advent of the US Atoms for Peace programme, the USA, the UK and Canada concluded bilateral agreements with a number of countries. The Soviet Union has followed suit, although in a cautious manner following its dispute with China. Similarly, France and FR Germany have signed several agreements over the past two to three years, mainly with underdeveloped countries. By mid-1976, the seven original participants of the London group of suppliers had altogether about 80 bilateral governmental agreements in force with other states and another 12 among themselves.[1] These agreements promote the transfer of nuclear know-how, material and technology for research purposes and support a web of commercial transactions (see table 2.2).

The United States has been the leading country in transmitting nuclear know-how, material and equipment to others. It has provided technology and trained personnel for a large number of nuclear laboratories throughout the world. During 1955, it concluded cooperation agreements with 27 countries. By 1960, 27 US-manufactured research reactors were in operation abroad, 17 reactors were under construction, and seven were planned. Moreover, there have been relatively few restrictions in these nuclear transactions. Title to reactor-produced materials has ordinarily been with the buyer of the fuel (or with the lessee if the special nuclear material has been leased). Know-how and technical skills for reprocessing irradiated fuel have been widely distributed, on the underlying assumption that reprocessing and recycling are essential to the future of nuclear power. Separated plutonium and highly enriched uranium have been exported to non-nuclear weapon states such as Japan, South Africa and FR Germany in quantities significant for bomb production. The use of transferred materials and technology for so-called peaceful nuclear explosives is prohibited by attached notes to the agreements in only a few cases (for example, those agreements

[1] Euratom is counted here as one unit. Agreements between Euratom members (France, FR Germany and the UK) are not included in the last figure.

with Spain, Portugal and South Africa), although the USA is well known to advocate this prohibition, and the Non-Proliferation Treaty (NPT) obliges its non-nuclear members to forgo any nuclear explosive device. The note attached to the agreement with Spain, which entered into force as late as 28 June 1974, was not signed by Spain.

While the Soviet Union has been rather restrictive in its nuclear transactions, arranging for instance for the return of spent fuel, some West European countries have adopted more aggressive commercial practices. The French firm Saint Gobain Techniques Nouvelles assisted Israel in building its (assumed) reprocessing facility, and has just completed construction of a reprocessing plant in Japan—an order for which US companies were authorized to compete as well. The French agreement with Pakistan on 17 March 1976, authorizing the construction of a reprocessing plant in Pakistan, was still viable at the end of December, despite pressures exerted by the USA and others. The West German fuel cycle agreement with Brazil, signed on 27 June 1975, was substantiated during 1976 with the establishment of joint companies for uranium exploration and mining, fuel fabrication and enrichment, a technical assistance agreement for construction of a pilot reprocessing plant, and contracts for two 1 250-MWe reactors to be operational by 1983 and 1984 (with an option for six more to be completed by 1990).

The network of bilateral agreements extends far beyond the spheres of the seven major supplier countries included in table 2.2. The seven other members of the London group (Belgium, Czechoslovakia, the German Democratic Republic, Italy, the Netherlands, Poland and Sweden), had by mid-1976, about 30 agreements in force with countries outside the group, and an equal number of agreements with co-members.[2] Some third world countries have entered into a number of bilateral agreements as well, and are giving nuclear assistance to fellow underdeveloped nations. By mid-1976, India had one power agreement (with the USA) and 16 research agreements in force with other countries, eight of which were with underdeveloped nations (Romania and Spain included). Argentina had two power agreements (with Canada and the USA) and eight research agreements, five of them with other Latin American states and the others with India, Italy and Libya (see table 2.3).

The web of bilateral agreements is, however, only indicative of the wide range of international nuclear cooperation; it does not give the full picture. Some relationships are not formalized in governmental agreements and others may be kept secret. The long-lasting cooperation between FR Germany and South Africa in the field of enrichment technology is a substantive reminder in that regard. Finally, a number of transactions are carried out more or less exclusively by commercial agents.

[2] This does not include agreements between Euratom countries, except those with the UK predating British membership.

For most reactor suppliers, the share of the total output being exported is currently increasing. In 1976, 54 reactors were under construction on export orders, and another 33 were planned for export (see table 2.4). US reactor sellers faced a series of domestic cancellations in 1976 and, on the international market, Westinghouse (WEST) and General Electric (GE) are increasingly being challenged by other suppliers, primarily by the West German Kraftwerk Union (KWU) and the French Framatome (FRAM). Seven companies are now constructing reactors abroad. Among the importers are a substantial number of underdeveloped countries, embarking upon large nuclear programmes that trigger fierce competition among supplier companies.

While reactors are the economically dominant item on the international nuclear market, all essential fuel cycle elements have now entered the commercial realm. Both of the great powers are showing some restraint. The USSR does not offer reprocessing plants for sale on the international market, nor has the USA done so recently. Besides, neither of them offers reprocessing services; since 1972, the only US plants in operation have been devoted to military purposes. France, the UK and FR Germany, on the other hand, are expanding their domestic reprocessing capabilities, coordinated through United Reprocessors (see tables 2.5 and 2.6). The UK has not offered reprocessing technology for sale, but offers reprocessing services. The world's nuclear industries seem bent on separating plutonium from spent reactor fuel and on recycling it into light-water reactors and later into fast breeders. The US Atoms for Peace programme did much to encourage this development. Today, West European countries are in the forefront. By exporting reprocessing plants, by expanding their domestic reprocessing capabilities and thus paving the way for recycling, and by promoting breeder reactors normally containing plutonium-239 in concentrations of as high as 95–98 per cent in the breeder blanket (see chapter 1), they reduce the time and cost needed to adapt civilian programmes to bomb production. The implications of this may be far-reaching. If all elements of the fuel cycle are sold to Brazil, which is not a party to the NPT, and if the French reprocessing contract with non-NPT Pakistan goes through, then it may be hard to convince members of the treaty that they should refrain from buying the same elements.

Today, the last of the great-power monopolies on the international nuclear market, uranium enrichment—the technologically most demanding part of the fuel cycle, and that which is still subject to considerable secrecy—is on the point of being eroded (see table 2.7). In late 1976, the Dutch company Urenco started to operate two 0.2 mn SWU (separative work units)/year plants.[3] Eurodif's plant at Tricastin, France, is scheduled to start production by December 1978, and to be run at the full capacity of 11 mn

[3] SWU/year is the common quantitative measure of both the degree of separation of the uranium isotopes 235 and 238, and the quality of enriched material.

SWU/year from 1982 onwards. Recent projections for 1986 indicate that 12 countries will have a share in enrichment-production capacities located in eight countries (the five nuclear weapon states recognized by the NPT plus Japan, the Netherlands and South Africa). In addition, a Canadian project is in the exploratory stage; Australia, Italy and Sweden have research programmes on diffusion, centrifuge and rotating plasma techniques; and a number of countries are exploring the feasibility of laser enrichment—Australia, China, France, FR Germany, Israel, Sweden, the UK, the USA and the USSR probably being foremost among them. Apart from the Urenco plant at Almelo, the Netherlands, the only commercial contract for the construction of enrichment capacity in another country is at present the West German deal with Brazil. From a weapon proliferation point of view, however, the transfer of West German enrichment know-how to South Africa merits as much attention: a pilot plant at Valindaba, South Africa, went into operation in 1975, and a commercial plant is in an early phase of development at the same location.

II. *The choice of nuclear options*

Three main trends characterize the international nuclear market: it is *expanding* in terms of the volume and the value of the deals; it is becoming increasingly *multipolar* both on the supply side and on the part of the importers; and it is becoming more *diversified* as to items. In addition, commercial dynamics are gaining a strong momentum, stimulated by the large demand, and sustained by the highly competitive structure that has evolved on the supply side.

The new trends reflect the actions of a number of countries and companies, importers as well as suppliers. On the supply side, important roles are played by France and FR Germany. Together with Canada, these two countries have the clearest third world orientation, and they account for much of the diversification of nuclear commerce. Both of them are making extensive efforts to expand their shares of the international nuclear market and are guided more by commercial and less by other considerations than are the USA and the USSR. This coincides with developments in the arms trade sector, where the two biggest suppliers can largely afford to let their exports be directed by political considerations—due to their huge internal markets—while smaller exporters strive to secure total sales high enough for their arms industries even to survive. The European suppliers of nuclear materials and technology are thus less motivated and more poorly equipped for restraining sales of sensitive fuel cycle elements, for enforcing extensive safeguards, and for setting tough conditions to avoid military applications: they have more at stake commercially, and less political leverage in general. This is particularly relevant to FR Germany because of the restraints imposed on it after World War II. The commercial export of advanced nuclear technology appears to be a compensatory outlet for an economically vigorous but militarily restrained country. The oil crisis of 1973 and subsequent uncertainties over the supply of US enriched uranium have spurred its nuclear efforts.

Today, countries opting for nuclear power can choose among the USA, the USSR, France, FR Germany and Canada. Canada offers the Candu reactor. Besides being a commercially competitive reactor, it has some particularly attractive features for the acquisition of bomb material: it burns natural uranium, it gives a better plutonium output than light-water reactors both in quantity and quality, and fuel replacements are possible without stopping it. Argentina, India, South Korea and Pakistan—all potential nuclear weapon states—are hardly a random sample of importers. Other nations may look towards Western Europe for nuclear facilities, especially for fuel cycle elements. The structure of the market is such as to leave importers with a choice. They may increase their freedom of action by turning one way or the other: when Canada permanently cut off its nuclear sales to India in May 1976, two years after the Indian nuclear explosion, the Soviet Union agreed to sell 200 tons of heavy water to India instead. However, the two great powers are setting restraints, especially on client states. The USA has successfully opposed French sales of reprocessing plants to South Korea and Taiwan, and has shed some doubt on the realization of the French-Pakistani agreement. While the Ford Administration seemed, in essence, to accept the West German-Brazilian agreement, the new administration opposes the fuel cycle elements of the package. Taiwan built a laboratory-scale reprocessing plant at the Institute for Nuclear Energy Research, Lung Tan, which was completed in 1976, but was dismantled by the end of the year. Since then, under pressure from the USA, Taiwan has pledged not to reprocess.

III. *Commercial restrictions and the promotion of safeguards*

While the Review Conference on the Non-Proliferation Treaty held in May 1975 went largely unnoticed, a growing public interest in nuclear proliferation issues was discernible in the autumn of that year, growing even stronger during 1976. The struggle over nuclear power programmes in many developed countries drew a good deal of attention towards the relationship between nuclear power and nuclear weapons. For the most part, focus was directed at the implications of the so-called plutonium economy. During 1976, the supplier countries introduced a number of measures and engaged in a variety of actions to restrain militarily sensitive parts of international nuclear commerce.

By now, it is well known that irradiated fuel from power reactors has a plutonium-239 content high enough for use in nuclear explosives even when the reactors are run according to economic norms, although the plutonium produced in this way is far from ideal. The operating records of reactors in less developed countries (and in other countries as well) show, however, that these norms are often hypothetical. Reactors frequently operate much more irregularly than the norms prescribe, thereby producing less irradiated fuel and higher concentrations of the fissile isotope Pu-239. And having overcome the main hurdle in producing a nuclear explosive—the acquisition of fissile material—it is not a great step from there to reprocessing on a small but militarily significant scale. Reprocessing is generally acknowledged to be a relatively easy matter as compared to the construction of nuclear reactors.

While power reactors are an ordinary commercial item, sales are nevertheless at times restricted for fear of weapon proliferation. These restrictions do not, however, apply only to non-NPT members. The United States has thus been willing to provide reactors with significant plutonium outputs to several non-NPT members, but is evidently not prepared to do so with an NPT-member like Libya. By the end of 1976, there was still no US Congressional authorization of the stipulated reactor deliveries to Iran, running as high as 8 000 MWe. Soviet negotiations with Libya, which comprise an exchange of letters of 15 May 1975 concerning construction of a power plant and a research reactor in Libya and a protocol of 12 August that year on the construction of a power plant, came to a standstill in 1976. Nor were the French-Libyan negotiations in the spring of 1976 finalized by the end of the year.

If commercial recycling of plutonium becomes common, weapon-grade plutonium free of fission products will circulate widely in the nuclear fuel cycle. Plutonium in mixed plutonium and uranium oxide (Mox) fuel rods would be available in reloads at the input end of reactors: some stockpiling would be necessary, and countries fabricating Mox fuel would have even more plutonium available. Extracting plutonium from such mixed oxide fuel would be far easier than taking it out of irradiated spent uranium fuel.

Firm decisions on recycling have not yet been taken, however; on 28 October 1976, the Ford Administration announced that commercial reprocessing would be deferred, and that recycling should not proceed unless the associated risks of proliferation could be overcome. In Britain, the report on Nuclear Power and the Environment, published by the Royal Commission on Environmental Pollution in September 1976 (the Flowers Report), voiced concern over the implications of the plutonium economy, and advocated delay in the development of a first commercial-scale fast-breeder reactor. However, preparations for commercial recycling are still a major trend. Reprocessing capabilities expand and proliferate, and the first commercial delivery of reprocessed plutonium oxide took place in

1976, from the French plant at La Hague to the Swiss Bernische Kraftwerke AG (Muhleberg reactor). France, which is regarded as the leader in breeder technology, is cooperating with FR Germany and its other Euratom partners in developing and promoting the plutonium breeder on the world market. The development of reprocessing capacity and breeder reactors may considerably strengthen the overall commercial position of France and FR Germany in the years ahead—particularly *vis-à-vis* countries that are poor in natural uranium.

Separated plutonium in the form of plutonium oxide or plutonium nitrate of course lends itself most easily to bomb production. The USA, the USSR and other supplier states pressed hard during 1976 to reverse the trend towards commercialization of reprocessing plants. The USA passed a law authorizing the administration to cut off military and economic aid to countries contracting for reprocessing or enrichment plants, and the Ford Administration called upon all nations to avoid transferring or making commitments to transfer reprocessing and uranium enrichment technology and facilities for at least three years. On 16 December the French Council on External Nuclear Policy announced an embargo on all future exports of reprocessing technology, but without retroactive effect for the Pakistani agreement. However, the joint document elaborated by supplier states, adhered to by all the participants in the London Club and requiring unanimous consent in order to be changed, only asks for restraint in the transfer of sensitive facilities, technology and weapon-usable material (see appendix 1A).

The efforts to restrain international nuclear commerce so as to make civilian programmes less suited to military application go together with efforts to improve international safeguards. Japan ratified the NPT in 1976, and is in the process of negotiating the new safeguards agreements with the IAEA. The Euratom countries, which ratified the NPT immediately before the Review Conference, had still not finalized their safeguards arrangement by the end of 1976. One hundred states have now ratified the NPT.

IV. *Proliferation impact*

The recent attempts to constrain the most sensitive parts of international nuclear commerce are a reaction to the multiplication and diversification of nuclear transactions in this decade, particularly after the 1973 oil crisis. Attempts to keep civilian and military applications of nuclear energy as distinctly apart as possible are generally commendable. Some of them may, however, revive and strengthen the sense of discrimination created by the NPT, which continues to threaten the viability of the treaty. NPT members are sometimes at a disadvantage compared with non-members, even in the field of power reactor transactions. More important, a ban on future exports of reprocessing and enrichment facilities would draw new lines of legitimation for the acquisition and operation of complete fuel cycles, or important fuel cycle elements. Tables 2.5, 2.6 and 2.7 indicate where the new cut-off points might go. In addition to the discrimination between nuclear and non-nuclear weapon states embodied in the NPT, there is a noticeable tendency to discriminate between classes of non-nuclear weapon states. The promotion of multinational fuel cycle centres can hardly solve this problem. A system which denies some aspects of civilian nuclear technology to certain countries, while permitting them to others, can hardly survive for long.

By the end of 1976, at least 11 operating facilities outside the five nuclear weapon states recognized by the NPT were not subject to international or bilateral safeguards (see table 2.8). The efforts to improve and extend the coverage of safeguards notwithstanding, the possibility that the list will grow and include more countries cannot be excluded. India is a special case: it will put more unsafeguarded facilities into operation in the near future. Faced with an eventual ban on the transfer of reprocessing technology, other countries may also choose to go it alone. Know-how for reprocessing is widespread, and component parts can be bought on the international market, virtually without interference from the London Club trigger list. The cost is low: the Indian government claims to have built the reprocessing plant at Trombay (where the fissile material for the 1974 explosion was extracted) at a cost of $7 mn. Technically skilled manpower is usually the main bottleneck, but it is gradually reduced by the advent of a civilian nuclear programme. Table 2.5 contains a list of six countries where small-scale facilities have been built, indicating the existence of certain technical capabilities—although they are closed down or dismantled at present. The components for a graphite or heavy-moderated, natural uranium fuelled reactor of, for example, 180 MW thermal power (that is, 60 MWe), producing about 30 kg of weapon-grade plutonium per year, would also be available on the open market (see chapter 1). It would give enough plutonium for three atomic bombs per year and could be constructed for less than $20 mn. Indigenous construction of such facilities, free of international safeguards, may be attractive even for countries embarking upon large-scale civilian programmes—if the nuclear weapon option is a high priority.

By drawing public attention to safeguards issues and through efforts at commercial restraint, the established nuclear powers and suppliers are voicing concern over the drift of affairs. Nuclear materials and technology are more widespread than ever, and the commercial momentum has never been so strong and embracing as it is today. At best, however, their actions amount to buying time, to some interference with international commerce and national nuclear programmes which may delay weapon proliferation somewhat. Without renouncing the further exploration and promotion of safeguards and proper commercial restraints, a shift of emphasis towards questions of national security and status politics—towards the root causes of nuclear proliferation—is urgently needed. The best way to slow down nuclear proliferation would be for the nuclear weapon states to show by their actions that they are willing to downgrade the political and military role of nuclear weapons. The United States and the Soviet Union probably have to show the way, by effectuating real nuclear disarmament measures.

V. *Tables of the proliferation of nuclear power*

Conventions

Contractors

Canada	AECL	Atomic Energy of Canada Ltd.
	CGE	Canadian General Electric
France	CEA	Commissariat à l'Energie Atomique
	FRAM	Framatome
	FRAM/ACEC	FRAM—Association de Constructions Electriques de Charleroi, Belgium
FR Germany	KWU	Kraftwerk Union AG
Sweden	ASEA	ASEA-ATOM
UK	GEC	General Electric Co.
	TNPG	The Nuclear Power Group Ltd.
USA	B&W/EE/TWC	Babcock & Wilcox Co.— English Electric, UK— Taylor Woodrow Construction, UK
	GE	General Electric
	GE/TOSHIBA	GE—Tokyo Shibaura Electric Co., Japan
	GETSCO	General Electric Technical Services Co.
	GETSCO/AMN	GETSCO—Ansaldo Meccanico Nucleare, Italy
	WEN/ACEC	Westinghouse Nuclear Europe—ACEC
	WEST	Westinghouse Electric Corporation
	WEST/EI	WEST—Elletronucleare Italiana
	WEST/M	WEST—Mitsubishi, Japan
USSR	AEE	Atomenergoexport

Reactor types	BWR	– Boiling light water-moderated and -cooled
	GCR	– Gas-cooled graphite-moderated
	PWR	– Pressurized light water-moderated and -cooled
	PHWR	– Pressurized heavy water-moderated and -cooled

Table 2.1. World nuclear power capacity in operation as of 1970, 1972, 1974, 31 December 1976 and projected for 1981 and 1984

Country	Total nuclear power capacity 1970 *MWe* (net)	Number of power reactors 1970 (>20 MWe)	Total nuclear power capacity 1972 *MWe* (net)	Number of power reactors 1972 (>20 MWe)	Total nuclear power capacity 1974 *MWe* (net)	Number of power reactors 1974 (>20 MWe)	Total nuclear power capacity 1976 *MWe* (net)	Number of power reactors 1976 (>20 MWe)	Total nuclear power capacity 1981 *MWe* (net)	Number of power reactors 1981[a] (>20 MWe)	Total nuclear power capacity 1984 *MWe* (net)	Number of power reactors 1984[b] (>20 MWe)
Argentina	–	–	–	–	319	1	319	1	919	2	919	2
Austria	–	–	–	–	–	–	–	–	692	1	692	1
Belgium	11	–	11	–	11	–	1 663	3	4 481	6 (1)	6 493	8 (3)
Brazil	–	–	–	–	–	–	–	–	626	1	3 116	3 (2)
Bulgaria	–	–	–	–	432	1	837	2	1 701	4	1 701	4
Canada	229	2	2 026	6	2 535	7	2 535	7	7 254	14	10 261	19 (2)
Czechoslovakia	–	–	110	1	110	1	110	1	2 131	6 (1)	3 391	9 (4)
Finland	–	–	–	–	–	–	–	–	2 160	4	2 160	4
France	1 418	7	2 473	9	2 723	10	2 723	10	23 768	33 (2)	29 418	38 (2)
German DR	63	1	63	1	879	3	879	3	4 143	11 (2)	4 959	13 (4)
Germany, FR	902	4	2 172	6	2 189	6	4 855	8	15 822	20	35 116	36 (14)
Hungary	–	–	–	–	–	–	–	–	408	1	1 224	3 (1)
India	396	2	396	2	603	3	603	3	1 250	6	1 690	8 (1)
Iran	–	–	–	–	–	–	–	–	2 400	2	4 200	4 (2)
Italy	542	3	542	3	542	3	542	3	1 382	4	5 278	9 (4)
Japan	824	3	1 733	5	3 712	8	7 067	13	16 037	25 (1)	21 368	32 (7)
Korea, South	–	–	–	–	–	–	–	–	1 798	3	1 798	3
Mexico	–	–	–	–	–	–	–	–	–	–	1 308	2
Netherlands	52	1	52	1	499	2	499	2	499	2	499	2
Pakistan	–	–	126	1	126	1	126	1	126	1	726	2 (1)
Philippines	–	–	–	–	–	–	–	–	–	–	600	1 (1)
Romania	–	–	–	–	–	–	–	–	–	–	440	1
South Africa	–	–	–	–	–	–	–	–	–	–	1 850	2 (2)
Spain	153	1	1 073	3	1 073	3	1 073	3	10 165	13 (3)	15 091	18 (7)
Sweden	–	–	440	1	1 020	2	3 244	5	7 386	10	9 506	12 (1)
Switzerland	350	1	1 006	3	1 006	3	1 006	3	3 793	9 (6)	6 833	9 (4)
Taiwan[c]	–	–	–	–	–	–	–	–	3 108	4	4 922	6 (2)
Thailand	–	–	–	–	–	–	–	–	–	–	600	1 (1)
UK	3 462	26	4 302	28	4 302	28	4 302	28	10 710	39	10 710	39

USA	4 045	12	13 542	26	28 220	44	39 590	57	92 711	110 (2)	151 744	165 (22)
USSR	1 477	11	1 887	12	4 175	17	6 166	20	19 816	37 (2)	21 816	39 (4)[d]
Yugoslavia	-	-	-	-	-	-	-	-	632	1	1 432	2 (1)

Totals	**1970**	**1972**	**1974**	**1976**	**1981**	**1984**
No. of countries having at least 1 reactor >20 MWe	**13**	**16**	**18**	**19**	**27**	**32**
No. of reactors >20 MWe	**74**	**108**	**143**	**173**	**365**	**497**
Capacity in MWe (incl. reactors <20 MWe)	**13 924**	**31 954**	**54 481**	**78 139**	**235 918**	**361 861**

[a] The numbers in brackets indicate the number of reactors included in the total figure for reactors planned for operation in 1981 but not under construction as of 31 December 1976.

[b] The numbers in brackets indicate the number of reactors included in the total figure for reactors planned for operation in 1984 but not under construction as of 31 December 1976.

[c] Taiwan is not a member of the IAEA. The figures are taken from *Free China Weekly* and *Nuclear Engineering International*.

[d] In addition, ten 1 000-MWe reactors and two 1 500-MWe reactors were planned by the end of 1976. The schedules for these reactors have not been confirmed.

Sources: Power Reactors in Member States (Vienna, 1976, IAEA), updated with the assistance of the IAEA to 31 December 1976; *Free China Weekly*, 9 May 1976; *Nuclear Engineering International*, Vol. 21, Nos. 238–251, January–December 1976.

Table 2.2. Bilateral agreements for the peaceful utilization of nuclear energy, by main supplier country (governmental agreements in force by mid-1976)[a]

Cooperating country	Canada[b]	France	Germany, FR	Japan	UK	USA	USSR[o]
Argentina	30 Jan 1976 (P)					25 Jul 1969 (P)	
Australia				28 Jul 1972 (P)		28 May 1957 (P)	
Austria						24 Jan 1970 (P)	
Belgium					15 Mar 1966 (*)		6 Mar 1965 (R)[p]
Brazil			18 Nov 1975 (P)			20 Sep 1972 (P)	
Bulgaria							15 Jul 1966 (P)[q]
Canada				27 Jul 1960 (P)		21 Jul 1955 (P)	24 Jan 1964 (*)[d]
Chile					18 Nov 1968 (*)		
Colombia						29 Mar 1963 (R)	
Cuba							15 Sep 1967 (P)[z]
Czechoslovakia							18 Nov 1966 (P)[r]
Denmark							14 May 1968 (R)
Euratom	18 Nov 1959 (P)[c]					18 Feb 1959	
Finland	15 Aug 1976 (P)					7 Jul 1970 (P)	14 May 1969 (P)[s]
France				22 Sep 1972			20 May 1967 (R)[f]
German DR							14 Jul 1965 (P)[t]
Germany, FR							18 Jan 1974 (R)[h]
Greece					5 and 15 Apr 1968 (R)[i]	4 Aug 1955 (R)[n]	
Hungary							28 Dec 1966 (P)[u]
India		23 Jun 1965 (R)	19 May 1972 (R)			25 Oct 1963 (P)	6 Oct 1961 (R)
Indonesia		3 Apr 1969 (P)	14 Jun 1976 (*)[g]			21 Sep 1960 (R)	
Iran		26 Jun 1974 (P)	4 Jul 1976 (P)[g]			27 Apr 1957 (R)	
Iraq		18 Nov 1975 (P)					15 Apr 1975 (*)
Ireland						9 Jul 1958 (R)	
Israel						12 Jul 1955 (R)	
Italy				26 Oct 1973 (*)	12 May 1958 (P)	15 Apr 1968 (P)	22 Oct 1965 (R)
Japan	27 Jul 1960 (P)[c]	22 Sep 1972 (P)			15 Oct 1968 (P)	10 Jul 1968 (P)	
Korea, South	26 Jan 1976 (P)	19 Oct 1974 (P)				19 Mar 1973 (P)	
Kuwait					26 Jul 1975 (*)[j]		
Libya							15 May 1975 (P)[v]
Luxembourg							6 Mar 1965 (R)[p]
Netherlands							6 Mar 1965 (R)[p]
Norway					12 Jul 1957 (R)[k]	8 Jun 1967 (P)	
Pakistan	17 Mar 1976 (P)				3 Jul and 13 Oct 1964 (R)[e]		20 May 1970 (*)
Poland							20 Jun 1967 (P)[w]

Portugal						26 Jun 1974 (P)	
Philippines						19 Jul 1968 (P)	
Romania			29 Jun 1973 (P)		18 Sep 1975 (*)		26 May 1970 (P)[x]
Saudi Arabia		24 Jul 1975					
South Africa		15 Oct 1976 (P)				22 Aug 1957 (P)	
Spain	21 Apr 1976				19 Jan 1960 (P)	28 Jun 1974 (P)	
Sweden	6 Dec 1962	31 Aug 1975 (R)[e]			20 Sep 1957 (*)[i]	15 Sep 1966 (P)	12 Feb 1968 (R)[v]
Switzerland	31 Jul 1958 (P)[c]	14 May 1970 (P)				8 Aug 1966 (P)	
Taiwan						22 Jun 1972 (P)	
Thailand						27 Jun 1974 (P)	
Turkey						10 Jun 1955 (R)	
UK				15 Oct 1968 (P)		21 Jul 1955 (P)	17 Feb 1975 (*)[h]
USA	21 Jul 1955 (P)			10 Jul 1968 (P)	21 Jul 1955 (P)[m]		21 Jun 1973 (R)
USSR	24 Jan 1964 (*)[d]	20 May 1967 (R)[f]	18 Jan 1974 (P)[h]		17 Feb 1975 (*)[h]	21 Jun 1973 (R)	
Venezuela						9 Feb 1960 (P)	

[a] The agreements are divided into two categories: those providing for research co-operation, and those providing for the utilization of nuclear power. Those providing for both are listed as power agreements.

For the United States, the bilateral agreement is a fundamental mechanism for international nuclear commerce. Bilateral agreements permit US companies to deal directly with the governments and nuclear and electricity industries of the party states. Other suppliers follow other guidelines: for West German companies, the existence of governmental cooperation agreements is no strict prerequisite for commercial transactions, and Swedish firms have made commercial transactions with non-agreement as well as with agreement nations. For the Soviet Union, the distinction between the governmental and the commercial level is largely non-existent.

Euratom is an organization with important supranational characteristics, and is listed as partner to bilateral agreements, while the IAEA and other international organizations are not.

R=research agreement. P=power or research and power agreement. *=category undetermined. The dates are those for entry into force, unless otherwise noted.

[b] In December 1974, Canada undertook to renegotiate its nuclear cooperation agreements. Since then no new commercial contract for the export of uranium, nuclear technology or heavy water has been approved unless an agreement meeting the new requirements has been entered into. Agreements predating December 1974 and which were not renegotiated or subject to renegotiation by mid-1976 (like those with Australia of 7 October 1959, Iran of 7 January 1972, and Italy of 11 March 1965) are therefore not included in the list.

Pakistan and India do not meet current Canadian safeguards standards. Cooperation with these countries is cut off. The nuclear material provided under agreements with them (of 18 July 1960 and 16 December 1963, respectively) is being safeguarded by the IAEA, pursuant to related trilateral safeguards agreements.

On 22 December 1976, Canada announced new rules for nuclear exports, *inter alia* restricting transfers of nuclear materials and technology to countries accepting international safeguards on their entire nuclear programmes. The implications of the new guidelines are not taken into consideration here.

[c] Amendments being negotiated.

[d] A protocol prolonging this agreement was signed on 27 May 1973.

[e] Exchange of letters.

[f] Preceded by an agreement in the field of high energy physics (Serpuchov accelerator) of 11 October 1966, and followed by a 10-year cooperation agreement in science and technology of 27 July 1973.

[g] Date of signature.

[h] Agreement on economic, industrial and technical cooperation.

[i] Exchange of notes regarding safeguards applicable to a nuclear facility on transfer to Greece by the British AEA.

[j] Exchange of notes concerning nuclear cooperation.

[k] Exchange of notes on 26 July and 20 December 1967 prolonging the agreement.

[l] Exchange of notes on 14 February 1964, supplementing the agreement. Prolongation of the agreement, 19 September 1967. Exchange of notes in 1975, suspending part of the 1957 agreement as supplemented by the exchange of notes in 1967.

[m] Research and power. A power agreement went into force on 15 July 1966. Both agreements were due to expire (or eventually to be extended) in July 1976.

[n] Superseding research and power agreement in abeyance.

[o] The distinction between governmental framework agreements and commercial con-

tracts, valid for OECD countries, does not apply to the Soviet Union. The list thus includes initiation dates for reactor contracts listed in table 2.3. Additional information showing the types and patterns of Soviet agreements is given in notes.

[p] USSR-BENELUX. Concluded between the Belgian Atomic Energy Commission, the Stickting Reactor Center, the Netherlands, and the State Commission for Atomic Energy of the USSR.

[q] Agreement on the equipment of a nuclear power plant, followed by an agreement for the civilian utilization of nuclear energy of 27 April 1967 and a protocol concerning power plant construction of 3 March 1972.

[r] Followed by an agreement on the construction of two nuclear power plants of 30 April 1970, and an agreement on co-production of power plant equipment of 13 March 1972.

[s] Followed by an agreement on economic, industrial and technical cooperation of 20 April 1971; a protocol concerning construction of a second nuclear power plant in Finland on the same date.

[t] Agreement concerning power plant construction in the German Democratic Republic. An agreement on the civilian utilization of nuclear energy was entered into on 12 January 1970; an agreement on production and delivery of equipment on 8 December 1971; and a protocol extending the 1965 agreement on 27 April 1973.

[u] A protocol to the agreement was concluded on 3 July 1970, and an agreement on co-production of equipment for power plants on 4 November 1974.

[v] Exchange of letters concerning eventual construction of a power plant and a research reactor (preceded by an agreement on economic and technical cooperation of 4 March 1972). Another exchange of letters concerning construction of a power plant, and a protocol on cooperation in the peaceful utilization of nuclear energy were made on 30 May 1975. Another protocol on the construction of a power plant was concluded on 12 August 1975.

[w] An agreement on the construction of a power plant in Poland was concluded on 28 February 1974, and an agreement on co-production of power plant equipment on 24 April 1974.

[x] A protocol to this agreement was concluded on 30 December 1974.

[y] Protocol on cooperation in the peaceful uses of nuclear energy. An agreement on industrial, scientific and technical cooperation was concluded on 25 April 1975.

[z] Supplementary agreement on 21 November 1975.

Sources: Information extended by the Foreign Ministries or Atomic Energy Commissions of the countries included; *United States Agreements for Cooperation in Atomic Energy*, Congressional Research Service, Library of Congress, January 1976; Library catalogue of governmental agreements, IAEA. See also sources to table 2.4.

Table 2.3. Bilateral agreements for the peaceful utilization of nuclear energy, by major third world country (governmental agreements in force by mid-1976)[a]

Cooperating country	Argentina	Brazil	India	Iran	Pakistan
Afghanistan			12 Dec 1965 (R)		
Argentina			28 May 1974 (R)[b]		
Bangladesh			27 Aug 1973 (R)		
Belgium			30 Jan 1965 (R)	14 May 1963 (R)	
Bolivia	18 Feb 1971 (R)				
Canada	30 Jan 1976 (P)		([c])	7 Jan 1972 (*)	([c])
Colombia	27 Mar 1972 (R)				
Czechoslovakia			1 Jan 1967 (R)		
Denmark			18 Feb 1963 (R)		
Egypt			10 Jul 1962 (R)		
France			23 Jun 1965 (R)	26 Jun 1974 (P)	17 Mar 1976 (P)
German DR			19 Jun 1974 (R)		
Germany, FR		18 Nov 1975 (P)	19 May 1972 (R)	4 Jul 1976 (P)[d]	
Hungary			9 Oct 1961 (R)		
India	28 May 1974 (R)[b]				
Iraq			28 Mar 1974 (R)		
Italy	14 Jun 1960 (R)	19 Apr 1963 (R)		24 Sep 1966	
Libya	30 Jul 1974 (R)				
Paraguay	20 Dec 1969 (R)				
Peru	13 Jun 1969 (R)				
Philippines			14 Mar 1969 (R)		
Romania			18 Mar 1972 (R)		
Spain			27 Mar 1965 (R)		
UK					31 Jul and 13 Oct 1964 (*)[e]
USA	25 Jul 1969 (P)	20 Sep 1972 (P)	25 Oct 1963 (P)	27 Apr 1957 (R)	
USSR			6 Oct 1961 (R)		

[a] R=research agreement. P=power or research and power agreement. *=category undetermined. The dates are those for entry into force, unless otherwise noted.
[b] Date of signature. Will be valid for five years from date of ratification. Not ratified by mid-1976.
[c] See note *a* to table 2.2.
[d] Date of signature.
[e] Exchange of letters relating to the supply and use of nuclear material for peaceful research purposes.

Sources: See sources to table 2.2.

Table 2.4. International commerce in power reactors: reactors in operation, under construction or planned for export, by supplying country and main contractor, as of 31 December 1976

Supplier/ recipient country	Contractor[a]	Reactor type	Net power output *MWe*	Year of commercial operation
Canada:				
		Operating reactors		
India	AECL	PWHR	207	1973
Pakistan	CGE	PHWR	125	1972
		Reactors under construction		
Argentina	AECL	PHWR	600	1980
India	AECL	PHWR	207	1977
Korea, South	AECL	PHWR	629	1981

Supplier/ recipient country	Contractor[a]	Reactor type	Net power output MWe	Year of commercial operation
		Planned reactors		
Argentina	AECL	PHWR	600	1985
France:				
		Operating reactors		
Belgium	FRAM	PWR	870	1975
Spain	CEA	GCR	480	1972
		Reactors under construction		
Belgium	FRAM/ACEC	PWR	897	1980
Belgium	FRAM	PWR	902	1980
		Planned reactors		
Belgium	FRAM/ACEC	PWR	898	1980
Iran	FRAM	PWR	900	1982
Iran	FRAM	PWR	900	1983
South Africa	FRAM	PWR	925	1982
South Africa	FRAM	PWR	925	1984
FR Germany:				
		Operating reactors		
Argentina	KWU	PHWR	319	1974
Netherlands	KWU	PWR	447	1973
		Reactors under construction		
Austria	KWU	BWR	692	1978
Brazil	KWU	PWR	1 245	1983
Brazil	KWU	PWR	1 245	1984
Iran	KWU	PWR	1 200	1980
Iran	KWU	PWR	1 200	1981
Spain	KWU	PWR	990	1982
Switzerland	KWU	PWR	920	1978
Sweden:				
		Reactors under construction		
Finland	ASEA	BWR	660	1978
Finland	ASEA	BWR	660	1980
UK:				
		Operating reactors		
Italy	TNPG	GCR	150	1964
Japan	GEC	GCR	154	1966
USA:				
		Operating reactors		
Belgium	WEST	PWR	10.5	1962
Belgium	WEN/ACEC	PWR	392.5	1975
Belgium	WEN/ACEC	PWR	392.5	1975
Germany, FR	GE	BWR	15	1962
Germany, FR	GE	BWR	237	1967
India	GE	BWR	198	1969
India	GE	BWR	198	1969
Italy	GE	BWR	150	1964
Italy	WEST	PWR	242	1965

Supplier/ recipient country	Contractor[a]	Reactor type	Net power output *MWe*	Year of commercial operation
Japan	GE	BWR	10.3	1963
Japan	GE	BWR	340	1970
Japan	GE	BWR	439	1971
Japan	GE	BWR	760	1974
Japan	WEST/M	PWR	320	1970
Japan	WEST/M	PWR	780	1974
Netherlands	GE	BWR	51.5	1969
Spain	GE	BWR	440	1971
Spain	WEST	PWR	153	1969
Sweden	WEST	PWR	822	1975
Switzerland	GETSCO	BWR	306.2	1972
Switzerland	WEST	PWR	350	1969
Switzerland	WEST	PWR	350	1971
UK	B&W/EE/TWC	GCR	210	1966
UK	B&W/EE/TWC	GCR	210	1966
UK	B&W/EE/TWC	GCR	420	1971
UK	B&W/EE/TWC	GCR	420	1972
		Reactors under construction		
Brazil	WEST	PWR	626	1978
Italy	GETSCO/AMN	BWR	840	1977
Japan	GE	BWR	1 067	1977
Japan	GE/TOSHIBA	BWR	1 067	1979
Japan	WEST	PWR	1 120	1978
Japan	WEST	PWR	1 120	1978
Korea, South	WEST	PWR	564	1977
Korea, South	WEST	PWR	605	1981
Mexico	GE	BWR	654	1982
Mexico	GE	BWR	654	1982
Spain	GE	BWR	935	1980
Spain	WEST	PWR	900	1977
Spain	WEST	PWR	883	1977
Spain	WEST	PWR	900	1978
Spain	WEST	PWR	833	1978
Spain	WEST	PWR	881.5	1979
Spain	WEST	PWR	881.5	1979
Sweden	WEST	PWR	912	1977
Sweden	WEST	PWR	912	1979
Switzerland	GETSCO	BWR	942	1980
Switzerland	GETSCO	BWR	925	1981
Taiwan	GE	BWR	604	1977
Taiwan	GE	BWR	604	1978
Taiwan	GE	BWR	950	1980
Taiwan	GE	BWR	850	1981
Yugoslavia	WEST	PWR	632	1979
		Planned reactors		
Belgium	WEN/ACEC	PWR	1 006	1981
Belgium	WEN/ACEC	PWR	1 006	1982
Belgium	WEN/ACEC	PWR	1 006	1983
Italy	GETSCO/AMN	BWR	1 009	1982
Italy	GETSCO/AMN	BWR	1 009	1983
Italy	WEST/EI	PWR	980	1982
Italy	WEST/EI	PWR	980	1983
Philippines	WEST	PWR	600	1982
Spain	GE	BWR	938.8	1981
Spain	GE	BWR	938.8	1981
Spain	GE	BWR	900	1982
Spain	WEST	PWR	1 036	1981
Switzerland	GETSCO	BWR	1 140	1980
Taiwan	WEST	PWR	907	1983
Taiwan	WEST	PWR	907	1984

Supplier/ recipient country	Contractor[a]	Reactor type	Net power output *MWe*	Year of commercial operation
USSR:				
		Operating reactors		
Bulgaria	USSR	PWR	432	1974
Bulgaria	USSR	PWR	404.8	1975
German DR	USSR	PWR	62.5	1966
German DR	USSR	PWR	408	1974
German DR	USSR	PWR	408	1974
		Reactors under construction		
Czechoslovakia	AEE	PWR	380.5	1978
Czechoslovakia	AEE	PWR	380.5	1979
Czechoslovakia	AEE	PWR	420	1980
Czechoslovakia	AEE	PWR	420	1980
Finland	AEE	PWR	420	1977
Finland	AEE	PWR	420	1978
German DR	AEE	PWR	408	1977
German DR	AEE	PWR	408	1977
German DR	AEE	PWR	408	1979
German DR	AEE	PWR	408	1979
German DR	AEE	PWR	408	1980
German DR	AEE	PWR	408	1980
Hungary	AEE	PWR	408	1980
Hungary	AEE	PWR	408	1983
		Planned reactors		
Czechoslovakia	AEE		420	1982
Czechoslovakia	AEE		420	1982
Czechoslovakia	AEE		420	1983
Czechoslovakia	AEE		420	1984
Czechoslovakia	AEE		420	1985
Czechoslovakia	AEE		420	1985
Czechoslovakia	AEE		420	1986
German DR	AEE	PWR	408	1981
German DR	AEE	PWR	408	1981
German DR	AEE	PWR	408	1982
German DR	AEE	PWR	408	1982
Poland	AEE	PWR	408	1985
Romania	AEE	PWR	440	1983

[a] See the list of conventions on page 37.

Source: See sources to table 2.1.

Table 2.5. Fuel reprocessing capabilities, as of 31 December 1976[a]

Country	Facility	Type of fuel	Design capacity *Tons of U/year*
Existing capabilities, production scale			
Belgium	Eurochemic-Mol	Metal and UO_2, low enrichment and metal, high enrichment	75 low enriched; 1.25 high enriched (plant shut down in mid-1974[b])
France	La Hague (HAO)	Metal and UO_2, low enrichment	800
	Marcoule	Metal, low enrichment	1 000
India	Trombay[c]	Metal and UO_2, low enrichment	50
UK	British Nuclear Fuels Ltd (BNFL) Windscale Works	Metal, low enrichment[d]	2 500

Country	Facility	Type of fuel	Year available	Design capacity *Tons of U/year*
Planned capabilities, production scale				
France (CEA)[e]	La Hague	UO_2, low enrichment	1976–80	Start-up at 60 in 1976, increasing to 800 by 1980, by modification to existing plant, i.e., by extension of the above-mentioned capacity at La Hague
FR Germany (Farbenfabriken Bayer, Farbenwerke Hoechst, Gelsenberg, Nukem)[f]	KEWA (FR Germany)	UO_2, low enrichment	1987	1 400
India	Tarapur	Metal and UO_2, low enrichment		100
	Kalpakkam	UO_2		50 in 1982 increasing to 125
Japan (PNC)[g]	Tokai Mura	UO_2, low enrichment	1977	40 in 1978 increasing to 210
UK (BNFL)	Windscale (UK)	UO_2, low enrichment	1981	1 000

Country	Facility	Type of fuel	Comment
Projected capability, small-scale plants, and development projects			
Brazil[h]		UO_2, low enrichment	Small-scale
France	La Hague	Breeder (U-Pu oxide)	Pilot plant, 20 kg/day
FR Germany	WAK, Karlsruhe	Breeder, UO_2	200 kg/day pilot plant, operating
	KFA, Jülich	Graphite	2 kg/day pilot plant, scheduled to start 1977
India	Trombay	Thorium/Uranium oxide	Laboratory-scale facility, currently under reconstruction
Israel	Assumed small-scale facility	. .	. .
Italy	EUREX-1-Saluggia	UO_2 and metal	Pilot plant, in operation
	ITREC-Rotondella	Thorium/Uranium	Pilot plant, in operation
	. .	UO_2, low enrichment	800 tons/year projected operation
Pakistan[i]	. .	. .	Characteristics unknown
Sweden	. .	UO_2, low enrichment	800 tons/year plant has been considered for operation by around 1990[j]
UK	Dounreay	Advanced fuels, breeder, etc.	Pilot plant, in operation
Laboratory-scale facilities closed down or dismantled in countries other than those mentioned above			
Argentina[k]	Ezeiza Nuclear Center	Metal (research reactor fuel)	Dismantled
Canada	Chalk River	Natural oxide	Closed down
Norway	Kjeller	Metal	Closed down
Spain[k]	Juan Vigon Center	Metal	Closed down
Taiwan	Lung Tan Nuclear Energy Research Center	Metal	Dismantled
Yugoslavia[k]	Boris Kidric Institute	Metal	Closed down

[a] The Warsaw Treaty countries, the USA and Canada are not included. In the USA, no commercial facility is licensed to operate for the time being. Operating plants are devoted to military purposes.

The only US commercial plant that has ever been in operation was closed down in 1972, and its owners (Nuclear Fuel Services, Inc., of West Valley, N.Y.) have since withdrawn their application for a licence to reopen. In 1975, Allied-General Nuclear Services completed a plant in Barnwell County, S.C., with a capacity for reprocessing 1 500 tons of oxide fuel per year. In early 1976, Exxon Nuclear announced plans to build a 1 500-ton/year plant at Oakridge, Tenn. Operating licence and construction permits for these plants had not been granted as of 31 December 1976 (see President Ford's nuclear policy statement of 28 October 1976).

The reprocessing capacities of the USSR and China are not known.

[b] Consideration is being given to restarting of this plant (UO_2, low enrichment) under Belgian ownership and to expand its capacity to 300 tons of U/year.

[c] Will be modified and expanded to handle spent fuel from a 100-MWe research reactor (Super-Cirus) under construction at Trombay.

[d] A head-end facility for oxide fuel (LWR type) operated from 1970 to 1973 when it was shut down after a small release of radioactivity. This facility will probably not be modified or rebuilt.
[e] CEA=Commissariat à l'Energie Atomique. Recent estimates indicate 400 tons U/year in 1977, and full capacity by 1892. Consideration is given to the construction of new oxide reprocessing plants to be completed during the 1980s. In 1971, a loose marketing and technology exchange organization, United Reprocessors, was established among France, FR Germany and the UK, to coordinate reprocessing activities.
[f] KEWA=Kernbrennstoff-Wiederaufarbeitungsgesellschaft GmbH. Year of availability and design capacity are uncertain pending final decisions.
[g] PNC=Power Reactor and Nuclear Fuel Development Co. Built by the French company Saint Gobain Techniques Nouvelles. Initial capacity of 170 tons U/year.
[h] Part of the West German-Brazilian fuel cycle deal. A capacity of 5 kg/day has been indicated. Characteristics and time schedule probably not finalized.
[i] Planned for construction under agreement with France.
[j] In Sweden, a government study published in the beginning of 1976 asked for an immediate start of a pre-project aiming at a national reprocessing plant to be in operation in the early 1990s with a capacity of 800 tons of U/year. A higher alternative divided on two processing lines includes possibilities for reprocessing fuel from an increased aggregate of nuclear power installations in the Nordic countries after 1985. Nuclear power issues attracted unprecedented attention during the Swedish election campaign of autumn 1976, and the new government is generally bent on a lower, albeit vague, nuclear profile so far.
[k] Express interest in future construction of reprocessing plants on their territories.

Sources: Applied Atomics, Nos. 1054–1105, January–December 1976; *Nucleonics Week,* Vol. 17, Nos. 40–53, January–December 1976; *Atomwirtschaft,* Vol. 21, Nos. 1–12, January–December 1976; *Nuclear Engineering International,* Vol. 21, Nos. 238–251, January–December 1976; *Scientific American,* December 1976; Elizabeth T. McFadden, *Lists of US Reactors Exported and of Reprocessing and Enrichment Facilities Abroad,* ERDA, IAEA branch, Office of International Program Implementation, November 1975; *Uranium. Resources, Production and Demand* (including other nuclear fuel cycle data), NEA/OECD, December 1975.

Table 2.6. Reprocessing capacity for oxide fuel (LW reactor type) by 31 December 1976 and projected for 1978, 1980 and 1985[a]

Tons of U/year

Country	1976	1978	1980	1985[b]
France[c]	60	350	800	800
FR Germany[d]	–	–	–	1 400 by 1987
India[e]	100	100	225	
Italy[f]	10	10	–	–
Japan[g]		40	170	210
Pakistan[h]	–	–	–	–
UK[i]	–	–	–	1 000

[a] Warsaw Treaty countries, the USA and China are not included.
[b] By 1985, more countries than those listed here may have a capacity to reprocess oxide fuel. In the last NEA/IAEA report (see sources to table 2.5), Spain, for example, is listed as having a projected capacity of 800–1 000 tons by 1985. On the other hand, some of the countries included in the table may not proceed according to schedule.
[c] By extension of capacity at La Hague. See table 2.5.
[d] KEWA. See table 2.5.
[e] Tarapur and Kalpakkam. See table 2.5.
[f] EUREX-1. See table 2.5
[g] PNC, Tokai Mura. See table 2.5.
[h] Cf. agreement with France. Status and characteristics uncertain.
[i] BNFL, Windscale. See table 2.5.

Sources: See sources to table 2.5.

Table 2.7. Current and anticipated enrichment production capacities excluding the USSR and China, as of 31 December 1976

Country/company	Technology	Time schedule		
		1976 *Mn SWU*	1979	1986
Brazil (cf. agreement with FR Germany)	Jet nozzle	. .		
Canada (exploratory stage)[a]	Gaseous diffusion	. .		
Coredif (France, Italy, Iran, Spain, Belgium)[b]	Gaseous diffusion			5
Eurodif (France, Italy, Iran, Spain, Belgium)[c]	Diffusion		3	11
France (CEA)[d]	Diffusion	0.4	0.4	0.4
Japan (PNC)[e]	Gas centrifuge			1
South Africa (UCOR)[f]	South African process, assumed to rely on the jet-nozzle technique			5
UK (UKAEA)[g]		0.4	0.4	0.4
Urenco (FRG, UK, Netherlands)[h]	Gas centrifuge	0.1		10
USA existing plant (ERDA)[i]	Gaseous diffusion	20	26	28
new plant:[j]				
ERDA				9
Uranium Enrichment Associates	Gaseous diffusion			9
Exxon Nuclear Co.	Gas centrifuge			3
Centar Associates	Gas centrifuge	0.3–3 from 1982–89		
Garret Nuclear Corporation	Gas centrifuge	0.3–3 from 1982–89		

[a] Indicated site: James Bay, Quebec. Schedule uncertain.

[b] Site: Tricastin, France. Financed 51 per cent by Eurodif, 29 per cent by Cogema and 20 per cent by the Atomic Energy Organization of Iran. Since Iran keeps a 10 per cent share in Eurodif through Sofidif, its total share in Coredif is 25 per cent.

The decision to build the plant was announced on 13 September 1976. It is scheduled to start production by 1983/84, and reach a capacity of 5 mn SWUs by 1985. Subsequent increase of total annual capacity to 10 mn SWUs is indicated.

[c] Site: Tricastin, France. Shareholders in Eurodif are as follows: AGIP Nucleare (Italy) 12 1/2 per cent; Comitato Nazionale per l'Energia Nucleare, CNEN (Italy) 12 1/2 per cent; Cie Générale de Materiaux Nucléaires, COGEMA (France) 27.8 per cent; Empresa Nacional de Uranio S.A., ENUSA (Spain) 11.1 per cent; Société Belge pour l'enrichissement de l'uranium, SIBESI (Belgium) 11.1 per cent; and Société franco-iranienne de diffusion gazeuse, SOFIDIF (COGEMA owning 60 per cent and the Atomic Energy Organization of Iran 40 per cent) 25 per cent.

The plant is scheduled to start production by December 1978, and to be run at full capacity (11 mn SWUs) from 1982 onwards.

[d] Site: Pierrelatte. Primarily for military purposes.

[e] Site: Tokai Mura. Construction and operation of a pilot centrifuge plant is planned for 1980. Subsequent construction of a commercial plant is subject to many uncertainties.

[f] Site: Valindaba. A pilot enrichment plant has been operating since 1975. The commercial project is in an early phase of development. Schedule uncertain.

[g] Site: Capenhurst. Primarily for military purposes.

[h] Sites: Almelo, the Netherlands and Capenhurst, UK. The figure for 1976 refers to the total capacity of the three pilot plants. At the end of 1976, two 0.2 mn SWU/year plants started to operate. The capacities of the plants will be increased according to requirements, with a stipulated full production rate altogether of 10 mn SWUs in 1986.

[i] ERDA=Energy Research and Development Administration. Sites: Oak Ridge, Tenn., Paducah, Ky., and Portsmouth, Ohio. The previous annual capacity of the three plants—17 mn SWUs—is being increased by cascade improvement and uprating, aiming at a maximum capacity of 28 mn SWU/year in the beginning of the 1980s. The US Congress has authorized ERDA to build another enrichment plant (at Portsmouth, Ohio) with a maximum capacity of 9 mn SWU/year to be reached in 1985.

[j] In 1971, the government initiated an industrial participation programme, giving potential suppliers access to classified technology and the results of government-sponsored research and development efforts, with the intention of turning enrichment into a competitive commercial industry. The programme has resulted in proposals from four companies: from UEA, to reach a maximum capacity of 9 mn SWU/year at Dothan, Ala., in 1983, from Exxon Nuclear, to develop a capacity from 1 to 3 mn SWU/year over the years 1982–86, from Centar Associates and from Garret Nuclear. The realization of these proposals depends on the fate of the Nuclear Fuel Assurance Act which passed the House of Representatives in August 1976, but which was not considered by the Senate before its adjournment on 1 October.

Sources: See sources to table 2.5.

Table 2.8. Operating nuclear facilities not subject to IAEA or bilateral safeguards, as of 31 December 1976[a]

Country	Facility	Indigenous or imported	First year of operation
Egypt	Inshas	Imported (USSR)	1961
India	Apsara research reactor	Indigenous	1956
	Cirus research reactor	Imported (Canada/USA)	1960
	Zerlina research reactor	Indigenous	1961
	Purnima research reactor	Indigenous	1972
	Fuel fabrication plant at Trombay[b]	Indigenous	1960
	Trombay reprocessing plant	Indigenous	1964
Israel	Dimona research reactor	Imported (France)	1963
	Reprocessing plant (assumed)	Indigenous (in collaboration with France)[c]	. .
South Africa	Pilot enrichment plant	Indigenous (in collaboration with FRG)	1975
Spain	Vandellos power reactor	Jointly operated with France	1972

[a] Excluding the five nuclear weapon states recognized by the NPT. A previously unsafeguarded reprocessing facility in Argentina (Ezeiza Nuclear Center, laboratory scale) has been dismantled. Consideration is being given to the construction of a new reprocessing plant in this country (see table 2.5).

The unsafeguarded reprocessing facility at the Bhabha Research Centre, India, is currently closed down for reconstruction, and is therefore not included in the list.

There may be more unsafeguarded facilities than those listed here.

[b] Producing fuel for research reactors.

[c] Assistance by Saint Gobain Techniques Nouvelles.

3. Accidents of nuclear weapon systems

Square-bracketed numbers, thus [1], *refer to the list of references on page 79.*

I. *Numbers of accidents*

In the *SIPRI Yearbook of World Armaments and Disarmament 1968/69* [1a], it was demonstrated that there had been substantially more serious accidents involving US nuclear weapons than the public were aware of, and than had been previously indicated by any single source. From 1945 through March 1968, there had been at least 32 "major" accidents: those involving the complete destruction of a nuclear weapon delivery system (aircraft, missile, ship and so on) containing a nuclear weapon, and with the destruction, loss or other involvement of the nuclear warhead itself [1a]. In addition, a semi-official study completed in 1960, carried out with some access to classified information, indicated that there had further been "about 50 lesser accidents" involved in the maintenance, transport or modernization of US nuclear weapons between 1945 and 1960 [2]. A less definitive source reported that President Kennedy had been told subsequent to a 1961 investigation (following the Goldsboro, North Carolina, B-52 accident) that there had been "more than 60" accidents involving US nuclear weapons as of that date [3].

Combining the different time periods (1945 to 1960 or 1961, and 1945 to 1968) and the different categories of "major" accidents and "lesser" accidents, these numbers showed reasonably good agreement.[1] In order to provide an estimate, one could derive a monthly rate of the lesser accidents on the basis of the number given for the period up to 1960, as well as a monthly rate of the major accidents on the basis of the number of accidents having occurred by 1968. One could then project these estimates forward. Assuming that there were few or no accidents before 1950, this suggests that there have been about 125 nuclear weapon accidents, major and minor combined, between 1945 and 1976, or about one every two and a half months. In 1976 the US Office of the Secretary of Defense in fact stated that there had been a total of 97 US accidents—27 major and 70 minor—during this period. It was additionally stated that only five major US accidents had occurred in the past 11 years, the last being in 1968 [4]. The only previous official information made publicly available on this subject was released in 1968. It listed a total of only 13 major, or "Broken Arrow", accidents [5].[2]

[1] The list in the *SIPRI Yearbook 1968/69* showed 15 major US accidents as of 14 March 1961 and, with 50 lesser accidents as of 1960, this adds up to just over 60.
[2] The list also appears in a DoD communication to Charles R. Gellner by Carl Walske [6]. It is significant to note that the new information was released by the Department of Defense in response to a draft version of this chapter, which was being circulated in Washington, D.C.

Since the 1976 statement claimed a total of 27 major accidents, only five of which took place in the past 11 years, it is clear that the 1968 official statement was far from complete.

II. *Definitions: nuclear weapon accidents and incidents*

It would be useful at this point to provide the official US definitions of nuclear *accidents*—referred to above as "major"—and nuclear *incidents* —referred to above as "minor" or "lesser". The terms "accident" and "incident" will be used below.

A nuclear weapon (Broken Arrow) accident is any unexpected event involving nuclear weapons or nuclear components which results in any of the following: (*a*) accidental or unauthorized launching, firing or use, by US forces or US-supported allied forces, of a nuclear-capable weapon system which could create the risk of outbreak of war; (*b*) nuclear detonation; (*c*) non-nuclear detonation/burning of a nuclear weapon; (*d*) radioactive contamination; (*e*) seizure, theft or loss of a nuclear weapon or nuclear component, including jettisoning; and (*f*) public hazard, actual or implied.

A nuclear weapon (Bent Spear) incident is any unexpected event involving nuclear weapons or nuclear components which does not fall in the nuclear weapon accident category but which (*a*) results in evident damage to a nuclear weapon or nuclear component to the extent that major rework, complete replacement or examination or recertification by the Energy Research & Development Administration (ERDA) is required; or (*b*) requires immediate action in the interest of safety or which may result in adverse public reaction (national or international) or premature release of information.

There are slight variations in the phrasing of these definitions in the pertinent directives of each of the individual US military services (see appendix 3A).

III. *Accident reporting*

It is important to point out that subsequent portions of these US military directives and other relevant directives often stress the restriction of public information concerning a nuclear accident or incident, unless such disclosure is forced by the circumstances of the accident:

> Reports are required in the event of any accident involving nuclear weapons or material, whether or not loss or destruction results, if the circumstances become public knowledge [7].
>
> Normally the presence of either nuclear weapons or nuclear components will be neither confirmed nor denied. However, in the event of a serious accident involving a nuclear weapon, official confirmation of the presence of such weapon may be made

when it will have value for public safety or for reducing or preventing wide-spread public alarm. Such official confirmation might be needed if an accident requires evacuation of personnel, or is followed by radiation teams or other unusual activity observable by the general public which results in the generation of alarm, thus necessitating a factual, *official statement of reassurance* ...

In case such mishap occurs in a foreign country and the public interest requires announcement of the presence of a nuclear weapon or material ... [8].

It is the firm policy of the US Government to neither confirm nor deny the presence of nuclear weapons or components on board any ship, station or aircraft. The only exception is when such a confirmation or denial may be essential to public safety as to *allay public alarm* [9].

Considerable US documentation is available regarding the procedures to be followed in the case of nuclear accidents or incidents [10–17].

In the past year or two it has become obvious that the figures published in the *SIPRI Yearbook 1968/69* were probably substantially low as a representation of the total numbers of US nuclear weapon accidents, and certainly as an indication of total numbers of such accidents and incidents of all nations. This is so for a large variety of reasons, all of which independently indicate that the actual numbers of accidents were probably higher, as now turns out to be the case. Each of these reasons is discussed below.

Other delivery systems

In the *SIPRI Yearbook 1968/69* it was emphasized that the evidence that could be found for US nuclear weapon accidents almost exclusively involved long-range bomber aircraft, such as the B-36, B-47 or B-52, or large missiles. There were, and are, substantial numbers of other weapon systems deployed with nuclear weapons, but somehow no reports of accidents of these were available in the public record.

As of 30 April 1973, the stockpile of US nuclear weapons contained the following types of weapons or warheads [18a]: free-fall bombs, glide bombs, air-to-surface missiles, surface-to-surface missiles, surface-to-air missiles, tube artillery, atomic demolition munitions, depth charges, anti-submarine warfare (ASW) torpedoes and underwater-to-surface missiles.

As of 21 May 1973, the US nuclear weapon systems, of which some fraction were normally on alert, were as follows [18b]: Titan, Minuteman, Polaris, Poseidon, Pershing, B-52, FB-111, F-4, F-111, A-6, A-7, F-100 and F-104. Of these, no instance involving FB-111, F-4, F-111, A-6, A-7, F-100 or F-104 aircraft appears in any nuclear accident report. Aside from those aircraft on alert with nuclear weapons, the list of nuclear-capable aircraft is even longer. According to General Giller, there are "a number of models of aircraft which are capable of carrying these ('tactical') bombs; approximately 17 or 20" [18c]. This is far more than the number of aircraft usually considered in this role. From the 1973 Committee on Foreign Relations Staff Report, one learns that "in all, there are in NATO over 2 000 U.S. and other

NATO forward based nuclear capable aircraft" [19]. Another category of delivery systems that has by and large escaped general attention in this regard is aircraft carrier-based strike aircraft. At least through the mid-1960s, the nuclear strike mission of the aircraft carrier was substantial. In 1960, Chief of Naval Operations Arleigh Burke stated that "there were more nuclear bomb carrying planes aboard five Navy carriers in the Mediterranean and Far East than in Russia's entire heavy bomber fleet" [20]. In the following year, Secretary of Defense McNamara supplied further detail: "From the decks of a single carrier of the Forrestal class, fifty attack aircraft can be launched armed with megaton nuclear weapons. Six carriers of this class, as well as nine other attack carriers, are deployed throughout the world's oceans, and two other attack carriers are currently in maintenance" [21]. The "nine other attack carriers" carried a slightly reduced nuclear complement. In 1964, when a Polaris submarine squadron was deployed to North Pacific waters, the third carrier of the Seventh Fleet "was released from deterrent duty" in the area [22]. Although there were subsequent statements of changes in the mission priorities of the attack carrier force, there was little evidence of their reduced reliance on nuclear weapons. Certainly there have been no indications of actual reduction in nuclear weapons aboard these vessels, despite ostensible changes in mission [23].[3]

In addition, the prevalence and number of nuclear weapons on US naval vessels other than aircraft carriers is probably also substantially underappreciated. Expert testimony presented in 1974 to a Congressional committee on this point reads as follows:

> In addition to our aircraft carriers which are nuclear capable, that is, able to carry nuclear weapons, nuclear weapons are also capable of being carried and, in many cases, most cases, are carried, in frigates, destroyers, submarines, and a wide variety of other ships. Most people are not aware of that.
>
> I want to be very careful because security permits me to say only that they are capable of carrying nuclear weapons.
>
> My experience, however, has been that any ship that is *capable* of carrying nuclear weapons, *carries* nuclear weapons. They do not off-load them when they go into foreign ports such as Japan or other countries. If they are capable of carrying them, they normally keep them aboard ship at all times except when the ship is in overhaul or in for major repairs [25].

Finally, the category of air transport aircraft involved in the delivery of nuclear weapons should be mentioned. Table 2B.1 in the *SIPRI Yearbook 1968/69* indicated accidents of two such aircraft, both C-124s: one in 1959 and the second in 1965. At present the US Air Force uses three different aircraft for transporting nuclear weapons: the C-5A, the C-130 and the C-141 [26]. The US Navy uses 10, several of which are helicopters: the C-1A,

[3] One should probably also indicate the nuclear-weapon delivery capability of carrier-borne ASW aircraft—formerly the S2D and now the S2E Tracker and the SM-3A Sea King helicopter. In addition, US land-based ASW patrol aircraft such as the P-3 Orion (and before it, the P-2V Neptune) possess nuclear-weapon delivery capability [24].

C-2A, C-131, H-46, H-53, SH-3G, C-118, C-130, C-9 and CH-47. Although crashes are not uncommon for several of these aircraft types, there is no record of any of them having involved nuclear weapons in transport.

All in all, as a recent Joint Committee on Atomic Energy hearing reiterated, "the United States has now deployed in foreign countries, on [US] ships, and in [the USA], some *tens of thousands* of nuclear weapons" [18d]. This number is probably in the neighbourhood of 30000. Nuclear-weapon accident rates will be proportional to the total numbers of warheads in the force, the degree of their movement from one place to another, and their alert or readiness status. It seems very likely that accidents involving nuclear weapon carriers of types which the public and press are ordinarily unaware of as functioning in such a role simply went unreported in the public press. It was pointed out above that such public notice is not likely to take place unless circumstances force it. It does not seem reasonable to assume that major accidents occurred only in the long-range bomber category.

Other unreported US bomber accidents

Evidence was presented in the *SIPRI Yearbook 1968/69* for two nuclear weapon accidents in which the officially released government statement either omitted mention of the involvement of a nuclear weapon, or specifically denied such involvement. Both of these accidents in fact involved B-52s, and raised the obvious question of the possibility of other such instances [1b].

Nine such US nuclear-bomber accidents are reported to have taken place between 1950 and 1960, all on Canadian territory or in Canadian territorial waters, on the dates and at the locations below:

1. 13 Feb 1950	B-36	50 mi west of Hudson Hope, British Columbia
2. 18 Mar 1953[4]	B-36	Just off Grate's Cove peninsula, Newfoundland
3. 12 Feb 1955	B-47	40 mi north of Squaw Rapids, Saskatchewan
4. 1 Dec 1956	B-47	Near Nipigon, Ontario
5. 27 Apr 1957	B-57	Southwest of Cape Sable Island, Nova Scotia
6. 17 Sep 1957	B-47	50 mi south of Grand Bruit, Newfoundland
7. 24 Apr 1958	B-47	8 mi east of runway at Goose Bay, Labrador
8. 17 Dec 1959	B-47	80 mi north of Calstock, Ontario
9. 1960	B-52	Southeast of Port aux Basques, Newfoundland

None was ever reported by US authorities.[5] There is no indication of

[4] There is another report of a B-36 accident, year unknown, at 30 mi north of Argentia, Newfoundland. It is not clear if this refers to the same accident as above or whether it represents a separate accident. The two locations are about 80 mi apart.

[5] The information in the list of nine accidents is available from open Canadian public sources: from the Ministry of Transport, and from the Rescue Coordination Centres of the Canadian Department of National Defence.

whether or not any of these accidents involved nuclear weapons. However, they took place during the period that was the apparent height of US nuclear-bomber accidents which did involve nuclear weapons. (Of the B-47 accidents, one took place during the five-month period in which the 14 identified B-47 accidents occurred, five of which are specifically known to have involved nuclear weapons; see table 3.3, items 2–10.) Any, or as many, of these aircraft crashes as did involve nuclear weapons would thus fall into the major accidents category. The implication also seems likely that any additional aircraft crashes in international waters in the Atlantic (which would not have been recorded by Canadian authorities) would have gone unreported.

Submarine accidents and incidents

In recent years evidence has become available of a large number of accidents or incidents involving submarines carrying nuclear weapons. These are of at least two categories: (*a*) those involving Soviet nuclear-armed submarines [27]; and (*b*) at least nine occasions on which US submarines, "some of them armed with nuclear weapons, have collided with other vessels", apparently Soviet vessels, while within or close to Soviet territorial waters, on intelligence-gathering missions [28–32].

Aircraft-carrier fires

In recent years there have been a large number of fires aboard aircraft carriers. It is reasonable to assume that nuclear weapons were present on these vessels at the time, although there is no information to indicate whether such weapons were in any way involved.

Nuclear weapons in transit on land

Within the United States, nuclear weapons may be transported by aircraft, truck, train or naval vessel. They may be carried by aircraft, trucks or ships in manoeuvres, exercises and practice alerts. They are moved from places of manufacture to places of storage and readiness for use. Nuclear weapons have been transported in motor vehicle convoys, often in "commercial van-type trucks", by the US Army and US Navy "between storage locations and missile launch sites" in the continental United States [33]. Since there have been crashes of air cargo transport aircraft and of helicopters carrying such weapons in transit, it is not unlikely that there have been accidents of trucks carrying such weapons as well. Accident rates of surface transport systems are usually directly proportional to the amount of travel logged per year. Road transport has been used to move nuclear weapons since 1945. ERDA reportedly has 10 special vans which travelled over 1.6 mn km of US roadways in 1975, although it is ambiguous whether all of this travel was specifically logged in nuclear weapon shipments [34].[6] This ERDA truck unit reports an accident rate below the national average for such carriers, but there is nevertheless an accident rate. One accident seems to be on record, although there is no evidence that the truck was carrying nuclear weapons at the time [35a]. However, this is aside from the record of commercial vans that were chartered by the US Army and US Navy—of which there is no accounting—and which were criticized in the 1975 US Government Accounting Office report [33].

All one can say with certainty in this regard is that (*a*) nuclear weapons are transported by truck; (*b*) there appears to be no published record of such road accidents, and as of 1970 only one record of a train accident "containing weapons components" [35b][7]; (*c*) non-weapon radioactive materials are similarly shipped by road and rail transport; (*d*) there is record of numerous accidents of radioactive materials, including reactor components [37–42], in such road and rail transport; and (*e*) therefore, though it is possible that greater precaution may be taken with rail and road shipments of nuclear weapons, it is not unlikely that some accidents have occurred in such transport.

Other nuclear weapon states

The *SIPRI Yearbook 1968/69* stressed the paucity and ambiguity of information on such accidents from other nuclear weapon states—primarily the USSR, the UK and France—and pointed out that the table of accidents was totally restricted to US accidents. It seemed highly unlikely that there had been no such accidents in other nations, in view of the sizable number of US accidents and, even more so, of the factors discussed above. Obviously all three of these countries, as well as China, manufacture nuclear weapons and move them within their own territories from places of manufacture to places of storage, deployment and testing. These countries very likely have smaller complements or a smaller number of different kinds of aircraft for use in air transport of nuclear weapons, or for military nuclear use. However, no public information on numbers of accidents was available. In the interim, information has become available on both accidents and incidents of Soviet, British and French nuclear-weapon delivery systems for the several categories of systems: submarines, surface ships and aircraft. There is still no direct evidence of involvement of nuclear weapons in the case of the

[6] The number of shipments involving nuclear weapons appears to have been about 100.
[7] Other railway accidents have involved "weapon components" which were ostensibly only non-nuclear conventional explosive components. In this case the US AEC press release makes no mention whatsoever of what the components were or were not. (See reference [36].) Two other railway incidents listed involving AEC cargo are ambiguous [35c–35d].

French and British weapon systems. In the case of the Soviet systems, such evidence is explicit.[8]

It is also true for the UK and France that there are more kinds of nuclear weapon carriers deployed than is commonly realized. For example, nuclear weapons are apparently carried by French (Breguet Atlantic) and British (Shackleton and now Nimrod) ASW aircraft, and there have been crashes of both types. Of equal significance was the information released by the US Department of Defense in 1965, that

> fighter-bombers of nine North Atlantic Treaty Organization (NATO) allies, including West Germany, were armed with American nuclear warheads.
>
> The nine allies that have fighter-bombers armed with American nuclear warheads are Britain, Belgium, Canada, France, Greece, Italy, the Netherlands, West Germany and Turkey.
>
> The spokesman used the word "armed" rather than "mounted" because in some cases the allied planes have not been equipped with the required safety and control devices. The plan ultimately calls for the actual mounting of the warheads on the planes, which are on a quick reaction alert status at bases in Western Europe [43].

As recently as mid-1976, the role of nuclear-armed tactical aircraft on alert had apparently remained essentially unchanged, as is indicated by the following quotation: "The current and traditional role of nuclear tactical air power (TACAIR)—standing alert against preplanned, fixed targets—may be on the threshold of change" [44]. It remains unclear whether this referred only to US Air Force-Europe aircraft, or to NATO allied aircraft as well. In view of the extensive series of crashes of the F-104 aircraft of FR Germany, and of the fact that this aircraft was assigned a nuclear strike mission, there is thus even some possibility that nuclear weapon accidents occurred in some fraction of those crashes—as well as in crashes of aircraft of the other eight states listed above.[9] This is not as implausible as it may at first sound. Although nuclear stores for NATO allies are ostensibly in US custody, some "alert" status weapons are deployed on aircraft of US NATO allies. At the time of the Cyprus crisis it was reported, "Nuclear warheads have been removed from Greek and Turkish aircraft and placed in American custody, officials confirmed. Technical control always rests with the United States" [46]. Available information, however, indicates that these allied alert-status aircraft are not permitted to take off with air-dropped tactical

[8] It should be noted that all information regarding accidents of Soviet nuclear weapon systems, with or without the specific involvement of nuclear weapons, is provided by US sources. The USSR, as well as France, the UK and China, clearly follow official policies of not reporting such accidents unless forced to. The UK and France acknowledge accidents of the weapon system, with no reference to nuclear weapons, while the USSR neither announces nor acknowledges accidents of any sort.

[9] Questions put to West German sources concerning accidents provided the following information: "There is no official reference to a F-104 crash which involved a nuclear bomb load. It was not denied, however, that given the high ratio of nuclear missions in the past, there have been some incidents in which nuclear arms were involved in crashes. Apparently, no particular problem arose from this ammunition" [45]. Since 1970 Canadian aircraft no longer participate in the nuclear strike role.

nuclear weapons. Information is not available as to whether they ever were or are permitted to fly with air-to-air missiles containing nuclear warheads. Thus, until definitive evidence can be presented as to whether or not any of these aircraft ever crashed while nuclear-armed, these procedures and practices present yet another possible category of nuclear weapon accidents.

IV. *Nuclear weapon safety*

The above six categories of reasons would suggest substantially higher nuclear accident and incident rates, involving all the nuclear weapon states, than were reported by SIPRI in 1969. One significant countervailing factor is that the air alert status of the US long-range bomber force (B-52s) has been drastically reduced since that period, thus reducing the largest known input to the 1969 list of "major" US nuclear weapon accidents.[10] This would in part explain the greatly increased safety record regarding nuclear weapons claimed by the US Department of Defense for recent years. It would also make monthly nuclear accident and incident rates derived from the 1956–66 period incorrect if extrapolated to the present day. It seems likely that greatly increased attention is also being paid to nuclear weapon safety if some 50 of the more minor nuclear weapon incidents had taken place by 1960 but only 20 more alleged incidents have taken place between 1960 and 1976. Whether the total stockpile is greater or more widely dispersed now than before is not known. But if the numbers recently released by the US Department of Defense are correct, its safety record either was extremely poor before, or is extremely good now. Evidence of this greatly increased attention to safety is available.

Safety rules shall govern all nuclear weapon system operations wherein the nuclear weapon or warhead is vulnerable to being inadvertently or deliberately launched, prearmed, armed, fired, detonated, released, or lost. To meet this policy objective, Safety Rules shall include general provisions applicable to all nuclear weapon operations: throughout the stockpile-to-target sequence (storage, maintenance, handling, transportation, delivery, etc.) and specific provisions to provide adequate safety for unique nuclear weapon system operations (alerts, operational posturing, maneuvers, exercises, training, etc.) . . .

1. There shall be positive measures to prevent nuclear weapons involved in accidents or incidents or jettisoned weapons from producing a nuclear yield.
2. There shall be positive measures to prevent DELIBERATE prearming, arming, launching, firing or releasing of nuclear weapons, except upon execution of emergency war orders or when directed by competent authority.
3. There shall be positive measures to prevent INADVERTENT prearming, arming, launching, firing or releasing of nuclear weapons.
4. There shall be positive measures to insure adequate security of nuclear weapons, pursuant to the provisions of DOD Directive 5210, 41 [48].

[10] A demonstration of the increased activity during a special nuclear alert is provided by the record of the Cuban missile alert in October 1962. B-47 bombers were dispersed to civilian airports, and other nuclear weapon-armed systems were moved within US borders [47].

These "positive measures" comprise both technological components built into US nuclear weapons as well as management, accounting and personnel rules, and efforts clearly extend to enlisted military personnel.[11] Whether other nuclear weapon states follow similar procedures and rules, or whether they reduce the problem by less dispersion of nuclear weapons, little or no alert status, and restricted access to weapons is not known. Obviously if one does not rely on or practise a military posture of wide nuclear weapon dispersal and readiness, one does not have to rely so much on technological safeguards, human management rules or chance to operate in one's favour. Movement of US nuclear weapons is still routine and widespread, as can be demonstrated by events in 1976 in Hawaii. Members of the American Friends Service Committee were able to observe and photograph what were apparently nuclear weapon containers being driven through residential areas to military facilities, loaded into helicopters and flown over residential areas [50–59].

V. *Categories of related events of concern*

The tables which follow list both major accidents and minor incidents in the United States, the Soviet Union, France and the UK. It is likely that the totals are minimum numbers of accidents, since they are dependent first on public reports of accidents of nuclear-weapon delivery systems and second, on the thoroughness of the search in newspapers and journal records.[12] However, it is clear that the categories of accidents or incidents are bedevilled by the problem of the presence or absence of government reporting. Since every accident or incident involving a nuclear-capable delivery *system* does not necessarily take place with a nuclear weapon present—and it is probable that the majority of accidents and incidents do not—there may be entries in the lists which should not be there.

With the general increase in related information in recent years, it has become evident that the kinds of nuclear weapon accidents referred to in this chapter are only one of four somewhat related categories of events which generate concern, and to which attention should be given:

[11] "Nuclear weapons are handled daily throughout the world as a matter of routine. From a nuclear surety point of view, any time a weapon is exposed to people, there is a possibility of it being subjected to an insecure or unsafe environment . . . Air Force Regulation 122–3, 'The Air Force Nuclear Safety Certification Program', implements a safety certification requirement for combat delivery vehicles, support equipment, and procedures used to independently deliver, move, support, test, operate, monitor or maintain nuclear weapons." General routines are referred to under categories such as the Two-Man Concept, Human Reliability Program, Security, Weapon System Safety Rules, Nuclear Safety, Safeing and Sealing and Accident/Incident/Deficiency Reporting. (See entries relevant to nuclear safety in reference [49].)

[12] If Soviet and US vessels crashed and both were nuclear weapon carriers, then each vessel will be counted as a separate accident in the list of that nation's accidents; that is, both the US and the Soviet vessel will be counted separately. As we are concerned with the number of individual weapon carriers or weapons that might be in jeopardy, and if two interact in one crash, it is not double-counting to indicate each weapon carrier separately.

1. Nuclear weapon accidents proper.

2. Accidents in facilities which fabricate nuclear weapon materials or nuclear weapons, such as the 1969 fire at the US Atomic Energy Commission plant at Rocky Flats, Colorado [60–61]. Reports have also recently appeared alleging a major nuclear accident in late 1957 or early 1958 involving a plutonium production reactor or a plutonium stockpile in the Miass area of the Urals in the Soviet Union [62–63].

3. Attempts at military coups or related military actions that may involve nuclear weapons, such as the French-Algerian incident [64, 1c]. In 1970 the Subcommittee on Security Agreements and Commitments Abroad of the US Senate Committee on Foreign Relations "received reports on problems that had developed during periods of crisis within a number of countries where [US] nuclear weapons are stored" [65]. These incidents were recalled during the 1974 Cyprus crisis [47, 66–67]. There is every reason to believe that such incidents will increase in subsequent years, especially if nuclear proliferation increases [68].

4. The security of nuclear weapons against other attempts to capture them. This has received some US Congressional attention in recent years [69–71], as well as the increased attention of the US military services [72–74]. Presumably, the same matter is of concern to other nuclear weapon states as well.

Nevertheless, this chapter is restricted to the first of these categories: physical accidents and incidents of nuclear-weapon delivery systems involving nuclear weapons. One can be reasonably certain that there have been somewhat over 100 nuclear weapon accidents and incidents over the past 25 years. The tables which follow provide data on some 113 such events, with the suggestion that there may have been substantially more.

VI. *Conclusions*

It is clear that accidents and incidents involving nuclear weapons are frequent, occurring on a worldwide average of perhaps one every few months. There is no public record of what may be even more routine minor incidents on military installations, in transport, overhaul, training and so on. One incontestable fact is that nuclear weapon accidents do occur, are quite frequent worldwide, and occur to probably all the different nuclear weapon systems while these contain nuclear warheads, and in probably every kind of activity in which these weapon delivery systems take part: in silos, in the air, in harbours, under the sea-surface, on land and so on. The frequency at any particular location or on any base or ship may be low—but nuclear weapon accidents do occur.

This chapter does not address the question of the possible dangers which might or might not follow such an accident, but provides the available data on the occurrence of such accidents. It is true that in the 100 or more nuclear weapon accidents and incidents that have occurred in the post-war years, there has been no nuclear weapon detonation, but there has been very extensive radioactive contamination in several instances. A new aspect, the possibility of weapon capture and terrorism, is receiving increasingly serious attention in several government and international agencies. The presence of a nuclear weapon storage site close to a civilian population centre is questionable on at least several grounds of prudence. It would seem that preventive measures of caution, care and security—such as remote location of sites—should be of equal interest to both military and civilian administrators.

VII. *Tables of nuclear weapon accidents and incidents*

As of mid-1976, the official US figures include 27 major US nuclear weapon accidents and 70 incidents—with no specific identification of the items in either category except for the 13 major accidents identified in 1968. These numbers correlate reasonably well with the lists in the tables below. However, some of the entries may be in error, and the actual US lists may be composed of additional events not indicated here. The entries in the US major accidents list (table 3.1) which are poorly identified and unspecific (Nos. 1, 5, 23, 24, 25 and 26) are included on the strength of the original sources and a knowledge of the work of their authors. The data for the United States is supplied in three tables, with some additional relevant military aircraft accident data (see table 3.3).

Table 3.1 lists accidents in which nuclear weapons were believed to have been destroyed or seriously damaged. The 13 nuclear weapon accidents specifically identified by the Pentagon are included in this list and they are identified by source [2]. The total number of accidents listed in this group is 32.

Table 3.2 lists the incidents in which nuclear weapons were present or involved and in which they may have been placed in danger of destruction or serious damage. The total number of US incidents in this group is 59.

Table 3.3 lists a number of additional accidents or incidents which could fall into either category. In each of these events, nuclear weapons may have been present. Sufficient information is not available to confirm their presence or involvement. The total number of events listed in this group is 17.

Table 3.4 lists a total of six Soviet nuclear weapon accidents, and table 3.5, 16 Soviet incidents. Table 3.6 lists eight British nuclear weapon incidents, and finally, table 3.7 lists four French incidents.

The tables for the United Kingdom and France are the least satisfactory. On the one hand, there are no specific identifications of the involvement of nuclear weapons. On the other hand, no thorough search was made for records of British and French aircraft accidents of nuclear weapon-capable aircraft throughout the 1960s and 1970s. It is clear from a single table of British aircraft accidents for 1975 (table 3.6, source 6) that equally large tables could very likely be compiled for earlier years, indicating crashes of British F-4, Buccaneer, Scimitar, Canberra and V-bomber aircraft. Therefore, the entries listed in tables 3.6 and 3.7 are probably particularly incomplete (see also note *b* to table 3.6).

Table 3.1. US nuclear weapon accidents

Date	Weapon system	Place	Source	Remarks[a]
1. 5 Aug 1950	Unspecified	Fairfield-Suison Field, California (now Travis AFB)	[1]	Unspecified.
2. 1956	B-36 bomber	New Mexico	[2–4]	B-36 bomber dropped an atomic bomb on barren territory near Kirtland AFB, New Mexico.
3. 12 Dec 1957	B-52 bomber	Fairchild AFB, Spokane, Washington	[1, 5]	B-52 crashed on take-off. The news report at the time spoke only of "a training mission", and made no mention of a weapon.
4. 5 Feb 1958	B-47 bomber	Hunter AFB, Georgia	[2]	B-47 bomber, mid-air collision, accidentally jettisoned part of a nuclear weapon. "Weapon was in a transportable condition and not capable of a nuclear explosion."
5. 12 Feb 1958	B-47 bomber	Off Savannah, Georgia, on coast	[1]	Unspecified.
6. 5 Mar 1958	B-47 bomber	Georgia coast	[3–4]	B-47 bomber jettisoned an atomic bomb off the Georgia coast following a mid-air collision. This was listed as an "incident", not an "accident".
7. 11 Mar 1958	B-47 bomber	Florence, South Carolina	[2]	B-47 from Hunter accidentally jettisoned an unarmed nuclear weapon because of a malfunction of the plane's bomb-lock system.
8. 4 Nov 1958	B-47 bomber	Texas	[2]	B-47 crashed after take-off from Dyess AFB, Texas. The crash was the result of a fire.
9. 26 Nov 1958	B-47 bomber	Louisiana	[2]	B-47 caught fire and burned on the flight line at Chennault AFB, Louisiana.
10. 6 Jul 1959	Nuclear weapon in transit	Louisiana	[2]	C-124 transport plane carrying an unarmed nuclear weapon crashed and burned on take-off from Barksdale AFB, Louisiana.
11. 15 Oct 1959	B-52 bomber	Kentucky	[2]	B-52 bomber carrying 2 unarmed nuclear weapons collided with a KC-135 tanker plane near Glen Bean, Kentucky. Both bombs were recovered undamaged.
12. 8 Jun 1960	Bomarc surface-to-air missile	New Jersey	[3, 6]	Bomarc air-defence missile site at McGuire AFB, New Jersey, caught fire. Fire and 2 explosions severely damaged 1 of the missiles, which carried a nuclear warhead.
13. 19 Jan 1961	B-52 bomber	Monticello, Utah	[1, 7]	B-52 exploded in the air.
14. 24 Jan 1961	B-52 bomber	North Carolina	[2]	B-52 from Seymour-Johnson AFB, Goldsboro, North Carolina, carrying unarmed bombs crashed 15 mi north of the base.
15. 14 Mar 1961	B-52 bomber	California	[2]	B-52 from Beale AFB, California, on an airborne alert training flight crashed with unarmed bombs on board.
16. 4 Jun 1962	Thor ICBM	Johnston Island, US Pacific Test Range	[8]	First high-altitude (30-mi) thermonuclear explosion of the test series. Launch vehicle failure; ICBM's "thermonuclear device destroyed in flight". Warhead yield was 1 Mt.

Date	Weapon system	Place	Source	Remarks[a]
17. 20 Jun 1962	Thor ICBM	Johnston Island, US Pacific Test Range	[9]	Second high-altitude test shot fails. Thor missile and nuclear warhead again destroyed. The test was to have occurred at an altitude of 200 mi or higher. Warhead yield was again "in the one-megaton range". "A radioactive hot spot on the floor of the Pacific may mark for centuries the United States' second failure to explode a hydrogen bomb at an altitude of about 200 miles."
18. Apr 1963	Nuclear-powered attack submarine, *Thresher*	US Atlantic coastline	[10]	Submarine lost (it is unclear whether the *Thresher* had Subroc on board, which carries a nuclear warhead).
19. 13 Jan 1964	B-52 bomber	Cumberland, Maryland	[2]	B-52 from Turner AFB, Georgia, crashed near Cumberland, Maryland. It carried 2 unarmed bombs.
20. 8 Dec 1964	B-52 bomber	Indiana	[2]	B-58 Hustler bomber caught fire and burned on the flight line at Bunker Hill AFB, Indiana. It carried an unarmed bomb.
21. 12 Oct 1965	Nuclear weapon components	Ohio	[2]	C-124 transport caught fire and burned during a refuelling stop at Wright-Patterson AFB, Ohio. Nuclear weapons were not carried on the plane, but non-explosive components of nuclear systems were.
22. 17 Jan 1966	B-52 bomber	Palomares, Spain	[11–12]	A B-52 and a KC-135 refuelling tanker collided in mid-air near Palomares, Spain. B-52 crashed and 4 unarmed hydrogen bombs separated from the aircraft. One landed intact in a dry river-bed. The second and third bombs released radioactive material in the middle of a populated area. The fourth was retrieved from the ocean on 7 April after an intensive search. Some press reports indicated that this fourth weapon carried a 20-Mt warhead. Other reports credit all 4 weapons as being 1.5 Mt each in yield.
23. Unspecified	Unspecified	A North African base; Morocco (Sidi Smaine)	[1, 4]	Unspecified.
24. Unspecified	Unspecified	In the UK	[1, 4]	Unspecified.
25. Unspecified	Unspecified	Off the US Atlantic coastline	[4]	Unspecified.
26. Unspecified	Unspecified	In the Arctic	[1, 4]	Unspecified.
27. 21 Jan 1968	B-52 bomber	Thule, Greenland	[3]	Crash of B-52; 4 thermonuclear bombs lost.
28. 27 May 1968	Nuclear-powered attack submarine, *Scorpion*	Lost at sea	[13]	Undetermined; perhaps mechanical problems.
29. Unspecified	"Operational ICBM"	Unspecified	[14]	"One operational ICBM blew up on its launching pad."
30. Unspecified	"Anti-aircraft missiles"	Unspecified	[14]	"Anti-aircraft missiles have misfired several times."
31–32. Unspecified	"Nuclear-tipped missiles"	Unspecified	[14–15]	"At least" two cases in which nuclear-tipped anti-aircraft missiles were actually launched by accident.

[a] Where the phrasing used in original sources has been retained, this is indicated by quotation marks.

Sources:

1. Larus, J., *Nuclear Weapons Safety and the Common Defense* (Columbus, Ohio State University Press, 1957).
2. US Department of Defense press release, quoted in *New York Times*, 23 January 1968.
3. "Previous Atom Accidents", *New York Times*, 23 January 1968.
4. Shulman, J., "The Seventeenth Accident", *Scientist and Citizen*, Vol. 8, No. 6, April 1966 (information for the article supplied by Dr R. E. Lapp).
5. *New York Times*, 13 December 1957.
6. *New York Times*, 8 June 1960.
7. *New York Times*, 21 January 1961.
8. *New York Times*, 5 June 1962.
9. *New York Times*, 21 June 1962.
10. *Times*, 29 January 1968.
11. *Boston Globe*, 20 January 1966.
12. *US News & World Report*, 4 April 1966, pp. 66–68.
13. *Navy Magazine*, July 1968.
14. Phelps, J. B. *et al.*, *Accidental War: Some Dangers in the 1960s*, Mershon National Security Program Research Paper PR-6, 28 June 1960 (Columbus, Ohio State University).
15. *Newsweek*, 5 May 1969.

Table 3.2. US nuclear weapon incidents

Date	Weapon system	Place	Source	Remarks[a]
1. "Before 1961"	Corporal missile with nuclear warhead	Tennessee River	[1]	The missile rolled off a truck and into the Tennessee River.
2. Jan 1961	US carrier, *Saratoga*	Ionian Sea	[2]	Fire on board.
3. 3 Dec 1962	Train accident	New Mexico	[3]	A train involving a courier car and 2 box cars containing weapon components (no high explosives) derailed.
4. Early 1964	600 F-105s	. .	[4]	USAF grounded over 600 F-105s in 1964 due to propulsion problems; *followed 8 instances of major fires and explosions in F-105 aircraft.*
5. 9 Jan 1965	US Polaris submarine, *Ethan Allen*	Mediterranean	[5]	*Ethan Allen*, at periscope depth, collided with the Norwegian freighter *Octavian*. "Damage was negligible."
6. 9 Aug 1965	Titan II ICBM silo	Little Rock AFB, Arkansas	[6]	Explosion in missile silo, followed by fire.
7. 1966 (?)	Surface-to-air nuclear missile, Terrier	Jacksonville, Florida	[7]	A missile was dropped while being handled above deck of USS *Luce*, a guided missile frigate (which carries 40 Terrier missiles).
8. Oct 1966	*Oriskany*, US aircraft carrier	Off Vietnam	[8]	Fire on board.
9. Nov 1966	US aircraft carrier, *Franklin D. Roosevelt*	Off Vietnam	[8]	Fire on board.
10. 10 Nov 1966	US carrier, *Essex* and US nuclear submarine, *Nautilus*	Atlantic, off Virginia	[9–10]	The two vessels collided in a training exercise. Repairs on the *Nautilus* took over 2 months to complete.
11. "Just before Christmas", 1967	US Polaris submarine	"In northern waters"	[11]	"Damaged during maneuvers", reported from unofficial sources at Rota, Spain.
12. Jul 1967	US aircraft carrier, *Forrestal*	Off Vietnam	[12]	Fire on board.
13. 1966–67	B-52	. .	[13]	Alleged US Department of Defense report on 72 "serious failures" in B-52s in 1966–67; metal fatigue failurcs. No corroboration of this report ever found in US literature.
14. 31 Aug 1967	Polaris submarine, *Simon Bolivar*	70 mi southeast of Charleston, South Carolina	[14]	The *Simon Bolivar* collided with a target ship during torpedo practice, carrying 16 "unarmed" Polaris missiles.
15. "Just before Christmas", 1967	US Polaris submarine	In Northern waters	. .	The submarine was damaged during manoeuvres. Report was from unofficial sources and was published in the British press.
16. 1 Feb 1968	US destroyer, *Rowan*	95 mi east of Pohang, off South Korean coast	[15]	Scraped a Soviet freighter. The *Rowan* carries ASROC—a nuclear-tipped antisubmarine weapon.
17. 1 Feb 1968	A prototype US nuclear submarine, *Seawolf*	150 mi southeast of Boston	[16]	Struck sea-bed and damaged rudder.

18. 9 Apr 1968	US nuclear Polaris submarine, *Robert E. Lee*	Irish Sea	[17]	The submarine became snagged in the nets of a French trawler.
19. 15 Apr 1968	US submarine, *Scorpion*	Harbour at Naples, Italy	[18]	Collided with barge during a storm; no damage reported. However the *Scorpion* was lost at sea entirely on 27 May 1968, due to undetermined causes; possibly due to damage caused in this collision.
20. "Several months ago", 1968	US nuclear attack submarine and Soviet submarine	Unspecified	[19]	Collided with Soviet submarine; damage to US vessel. Report from Norfolk "Ledger Star". Unidentified submarine was 2 months at Rota, Spain, repairing damage.
21. 12 Jun 1968	US aircraft carrier, *Wasp*	Off Virginia capes	[20]	Collided with oiler ship *Truckee*.
22. 1968	Polaris submarine, *Von Steuben*	Unspecified	[21]	The *Von Steuben* collided with a merchant ship; the merchant ship sank.
23. Unspecified	US destroyer	Valletta Harbour, Malta	[22]	"While at anchor, a merchant ship ran into one of our destroyer types, a minor collision, but it unfortunately hit right at the spot where we had some nuclear weapons."
24. 16–17 Jun 1968	US cruiser, *Boston* and Australian destroyer, *Hobart*	Off Vietnam, Tonkin Gulf	[23–24]	US plane or planes (believed to be F-4 Phantom) sank a US patrol boat and carried out accidental missile attacks against US cruiser *Boston* and Australian guided-missile destroyer *Hobart*. *Boston* and *Hobart* carry Terrier, a surface-to-air missile with a nuclear warhead.
25. 14 Jan 1969	US nuclear carrier, *Enterprise*	75 mi south of Pearl Harbor	[12]	Explosions on board.
26. 10 Nov 1969	US Navy Corsair A-7	Mediterranean Sea, off Sicily	[25]	Aircraft crashed into the sea. Official US sources stated that it did not carry nuclear weapons; Italian sources reported that the aircraft had carried nuclear weapons.
27. 1969	Nuclear-powered attack submarine, USS *Seawolf*	65 mi east of Cape Cod	[26]	Went aground while submerged. Damage to bow and stern.
28. 10 Jan 1970	Aircraft carrier, USS *Shangri-la*	. .	. .	A fire started on an A-4 Skyhawk while on board the *Shangri-la*.
29. 30 Jan 1970	Polaris missile submarine, *Nathaniel Greene*	Charleston, South Carolina	. .	The submarine ran aground on Sullivan's Island during thick fog.
30. 10 Feb 1970	Terrier missile	On the aircraft carrier *Bon Homme Richard*	[27]	The missile became wedged in a storage magazine, where it cracked; "the weapon . . . was not believed armed at the time".
31. 28 May 1970	Polaris missile submarine, *Daniel Boone*	Off Cape Henry, Virginia	. .	The *Daniel Boone* collided with a Philippine merchant ship, the *President Quezon*. Damage to submarine was minor.
32. 13 Jun 1970	Cruiser, *Little Rock*	Off southern coast of Greece	. .	The *Little Rock*, flagship of the 6th Fleet, collided with a Greek destroyer; damage was light. *Little Rock* armed with Talos surface-to-air missiles.
33. 16 Jun 1970	Destroyer, *Eugene A. Greene*	Mediterranean	. .	Collided with a US oiler. Light damage. Destroyer armed with nuclear-tipped ASROC.
34. 4 Nov 1970	Destroyer, *Goldsborough*	8 mi NW of Taiwan	. .	Boiler explosion; 2 killed and 4 injured. Destroyer was armed with ASROC and Tartar missiles.
35. 29 Nov 1970	Polaris submarine "mother ship", *Canopus*	Holy Loch, Scotland	[28]	The *Canopus* was carrying Polaris missiles. Fire broke out. Two Polaris submarines were also moored alongside.

Date	Weapon system	Place	Source	Remarks[a]
36. 11 Apr 1972	Polaris missile submarine, *Ben Franklin*	Groton, Connecticut	. .	*Franklin* collided with tugboat. The tug sank; there was no reported damage to the submarine.
37. 6 Oct 1972	Nuclear attack submarine, *Tullibee*	150 mi off Cape Hatteras, Massachusetts	. .	Submarine collided with West German merchant ship.
38. 29 Oct 1972	Aircraft carrier, *Saratoga*	Not reported	. .	Fire aboard the aircraft carrier.
39. 13 Dec 1972	Aircraft carrier, *Ranger*	Off Vietnam coast	. .	Fire in main machinery room.
40. 21 May 1972	Nuclear attack submarine, *Sturgeon*	Near the Virgin Islands	. .	Struck bottom during dive, minor structural damage.
41. 11 Dec 1973	Aircraft carrier, *Kitty Hawk*	700 mi east of the Philippines	[29]	Fire on board.
42. 8 Jan 1974	Nuclear attack submarine, *Finback*	Norfolk, Virginia	. .	A submarine rescue ship collided with the *Finback;* minor damage.
43. 26 Jun 1974	Transport helicopter	Jones Beach, Long Island	[30–34]	A CH-47 helicopter ferrying nuclear weapons from Long Island to New Jersey made a forced landing.
44. 15 Feb 1975	Nuclear attack submarine, *Swordfish*	Near Lanai, Hawaii	[35]	The submarine struck the bottom. Reports were conflicting as to whether or not the hull was cracked.
45. 23 Oct 1975	Small nuclear warhead	Yucca Flats, Nevada nuclear test site	[36]	A canister containing a 20-kt bomb fell 40 ft down a nuclear test shaft. No radiation leakage was reported.
46–47. Nov 1975	Guided missile cruiser, USS *Belknap*	70 mi east of Sicily	[37]	After a crash with the aircraft carrier *J. F. Kennedy* during manoeuvres in the Mediterranean, the *Belknap* suffered extensive fires and ordnance explosions. Both the *Belknap* and the *J. F. Kennedy* contain nuclear weapons.
48. Dec 1975	Aircraft carrier, *Independence*	Unspecified	[38]	Collided with another ship at sea.
49. Dec 1975	Aircraft carrier, *Saratoga*	Off the Florida coast	[38]	Collided with the oiler *Mississinewa*. "The Saratoga's hull was ripped open . . .".
50–58. 1965 to 1975	US submarines[b]	Close to Soviet coast	[39–43]	"A highly technical US Navy submarine reconnaissance program, often operating within unfriendly waters, has experienced at least 9 collisions with hostile vessels in the last ten years . . . Most of the submarines carry nuclear weapons."
59. 14 Sep 1976	US destroyer, *Bordelon* and aircraft carrier, *J. F. Kennedy*	Off the coast of Scotland	[44–45]	The destroyer *Bordelon* collided with the carrier *J. F. Kennedy* during a refuelling operation.

[a] See note *a* to table 3.1.

[b] Specific identifications in this category were: (*a*) collision of the USS *Gato*, 14 or 17 November 1969, carrying nuclear weapons; (*b*) collision of the USS *Pintado*, May 1974, carrying nuclear weapons; (*c*) collision of a US submarine with a Vietnamese minesweeper, which sank; (*d*) surfacing of a US submarine under a Soviet vessel in a Soviet fleet naval exercise; (*e*) grounding of a US submarine within Soviet territorial waters; and (*f*) collision with a Soviet submarine on 31 March 1971.

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10. *Undersea Technology*, Vol. 7, No. 12, December 1966.
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16. *Daily Telegraph*, 2 February 1968.
17. *International Herald Tribune*, 12 April 1968.
18. *New York Times*, 13 June 1968.
19. *International Herald Tribune*, 3 July 1968.
20. *International Herald Tribune*, 14 June 1968.
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22. *Proliferation of Nuclear Weapons*, Hearing, Subcommittee on Military Applications, Joint Committee on Atomic Energy, US Senate, 10 September 1974.
23. *Daily Telegraph*, 19 June 1968.
24. *Daily Telegraph*, 21 June 1968.
25. *International Herald Tribune*, 11 November 1969.
26. *Naval Review* 1969, p. 304.
27. *San Francisco Chronicle*, 11 February 1970.
28. *Daily Telegraph*, 30 November 1970.
29. *International Herald Tribune*, 11 December 1973.
30. *New York Times*, 27 June 1974.
31. *New York Times*, 5 July 1974.
32. *Newsday* (Long Island Daily Press), 26 June 1974.
33. *Newsday*, 27 June 1974.
34. *Newsday*, 28 June 1974.
35. *Honolulu Star-Bulletin*, 18 February 1975.
36. *Washington Star*, 30 October 1975.
37. *Newsweek*, 8 December 1975, p. 47.
38. *Washington Post*, 2 January 1976.
39. *New York Times*, 25 May 1975.
40. *New York Times*, 4 July 1975.
41. *New York Times*, 6 July 1975.
42. *New York Times*, 20 January 1976.
43. *Village Voice*, 16 February 1976.
44. *Washington Post*, 7 October 1976.
45. *New York Times*, 15 September 1976.

Table 3.3. Possible US nuclear weapon accidents or incidents[a]

Date	Weapon system	Place	Source	Remarks[b]
1. 10 Apr 1958	B-47	12 mi south of Buffalo, N.Y.	[1]	Exploded in air while approaching a refuelling tanker.
2–10. 1 Jan to 1 May 1958	B-47	Unspecified	[1]	Fourteen B-47 accidents are reported for the 5-month period. Four of these appear in the list of major accidents, and 1 is specified and appears as item 1 above. It is impossible to know if the remaining 9 were "major" accidents, but 4 of the identified ones apparently were, permitting a good degree of suspicion concerning the others. The USAF reported that serious structural problems had developed in the B-47 after the bombers began low-level training flights. The exact nature of the crashes were not revealed. But given the fact that the USAF reported that the accidents caused a total of 34 casualties, it is likely that the accidents were serious air crashes and not merely ground handling accidents. (A Soviet source identifies accident No. 23 in table 3.1, given at an unspecified date and for an unspecified weapon system, as having also been a B-47 crash, in 1957, at the Sidi Smaine base in Morocco.)
11. Mid-1960s	"A nuclear missile" (Genie or Falcon?)	Haiphong Bay	[2]	". . . in the mid-1960s an F-102 pilot fired a nuclear missile by accident against some North Vietnamese gunboats in Haiphong Bay. The error reportedly was caused by a crossed wire in the firing safety mechanism."
12. 17 Mar 1969	B-52	Wurtsmith AFB, Michigan	. .	Bomber made an emergency landing after mid-air fire and explosion in 1 of the engines and loss of power on the right wing.
13. 3 Apr 1970	B-52	Ellsworth AFB, South Dakota	[3]	Crashed on landing.
14. Summer 1971	B-52	Lake Michigan	. .	It was reported that this B-52 crashed near the Big Rock Nuclear Power Plant at Charlevoix, Michigan. Flight training missions were resumed in late August after a new flight pattern was established which would limit B-52s from getting any closer than 5.5 mi from the nuclear plant. USAF denied that nuclear weapons were aboard the aircraft.
15. 31 Mar 1972	B-52	Near Orlando, Florida	. .	Crashed near residential area on a "routine training accident".
16. 12 Dec 1974	B-52	Near Guam	. .	-
17. 3 Sep 1975	B-52	Aiken, South Carolina	[4]	The B-52, which was officially reported not to be carrying nuclear bombs, crashed about 20 mi from Savannah River Nuclear Power Plant.

Other aircraft accidents not specifically listed:

F-4 Phantom aircraft	2 Jun 1968, Kyushu University, Japan [5]. 1968–Nov 1970, Mediterranean (4 Phantoms lost) [4]. Nov 1970, Mediterranean, from aircraft carrier *Saratoga* [6]. 27 Sep 1973, Naples [7].
F-111 aircraft[c]	28 Mar 1968 8 May 1968 30 Mar 1968 20 Jun 1975 8 Apr 1976 22 Dec 1969 22 Apr 1968
F-104 aircraft	F-104 Starfighter crashes of the West German AF now number over 100. Crashes numbers 53 through 91 took place between May 1966 and Oct 1968.
SAC aircraft	*USAF major accidents involving SAC aircraft (CY 1966–75)*

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	**Total**
B-58	1	1	2	2	–	–	–	–	–	–	**6**
B-52[d, e]	2	6	6	9	1	1	5	3	2	2	**37**
FB-111	–	–	–	0	1	1	1	0	0	1	**4**
KC-135	3	2	6	5	1	1	3	2	1	1	**25**
Other[f]	4	5	2	3	1	4	1	1	4	0	**25**
Total	**10**	**14**	**16**	**19**	**4**	**7**	**10**	**6**	**7**	**4**	**97**

[a] Listed in this table are cases where there is a possibility that nuclear weapons were present, but where the US government has not released full details as to the exact nature of the accidents or the extent of damage done to any nuclear weapons, if any were involved. In at least two cases, official statements specifically said that the aircraft were not carrying nuclear weapons.

During the late 1960s, the number of SAC bombers armed with nuclear weapons and flying airborne alert decreased. During this same period, press reports on SAC bomber accidents became ambiguous as to whether or not nuclear weapons were aboard. For the record, the last official "Broken Arrow" accident was a B-52 crash at Thule, Greenland, in January 1968, but the following list of B-52 crashes is included in the tables as possible "Broken Arrows". Vietnam-related B-52 accidents are not included.

[b] See note *a* to table 3.1.

[c] *All* F-111 aircraft were grounded due to accidents, fires, crashes and defects in June 1969, November 1969, August 1975 and August 1976.

[d] Other B-52 accidents apparently related to the bombing of Vietnam are not included in the accident lists:
19 Nov 1968, Okinawa [8].
7 Jul 1972, off Guam [9].
31 Jul 1972, Thailand [10]. This report also states that "eight other B-52s have been lost accidentally since the bombers entered the war more than seven years ago".

[e] Other more ambiguous B-52 accidents were:
12 Feb 1968, Gulf of Mexico [11].
Spring 1975 (?), Wright-Patterson AFB, Ohio [12].

[f] Includes the C-47, U-1A, T-39, UH-1 and DC-130.

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3. *Air Force Magazine*, December 1970, p. 65.
4. *Washington Post*, 3 September 1975.
5. *International Herald Tribune*, 4 June 1968.
6. *New York Sunday Times*, magazine section, 22 November 1970, p. 27.
7. *International Herald Tribune*, 28 September 1973.
8. *International Herald Tribune*, 20 November 1968.
9. *New York Times*, 9 July 1972.
10. *New York Times*, 1 August 1972.
11. *Soviet Weekly*, 9 March 1968.
12. *Air Force Magazine*, October 1975.

Table 3.4. Soviet nuclear weapon accidents

Date	Weapon system	Place	Source	Remarks[a]
1. Unspecified	Soviet airplane	Sea of Japan	[1]	"American personnel . . . recovered a nuclear weapon from a Russian airplane that crashed in the Sea of Japan."
2. 1968	Soviet ballistic-missile submarine, "G"-class	Pacific Ocean, 750 mi NW of Oahu, Hawaii	[2–8]	Submarine sank while cruising the Pacific, after a series of explosions on board. Portions of the submarine allegedly recovered by the US CIA. In some reports also alleged to have carried torpedoes with nuclear warheads.
3. 1970–71	"Nuclear (powered) submarine"	Mediterranean	[9]	"The Soviets lost a nuclear submarine in the Mediterranean four or five years ago."
4. Apr 1970	Soviet nuclear-powered submarine, "N"-class	Bay of Biscay, Eastern Atlantic	[10]	". . . was forced to the surface by an emergency and eventually sank in the Eastern Atlantic's Bay of Biscay."
			[11]	". . . the only submarine lost in the North Atlantic was off Spain in 1970 and since its loss the Soviets had stationed an electronic intelligence ship at the site around the clock" (possible contradiction with entry No. 5, below).
5. "In 1970"	Soviet nuclear-powered attack submarine, "N"-class	"Off the English coast"	[12]	"November-class subs have rarely shown their periscopes outside Soviet waters since one sank off the English coast in 1970."
6. Sep 1974	Guided-missile destroyer, "Kashin"-class	Black Sea	[13–14]	Allegedly exploded and sank.

[a] See note *a* to table 3.1.

Sources:

1. Associated Press, 20 March 1975, NBC-TV report.
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3. *New York Times*, 20 March 1976.
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9. UPI Audio Network, "Washington Window", 18–19 January 1975, R. Adm. G. LaRocque (Ret.).
10. *Washington Post*, 20 March 1975.
11. *Boston Globe Magazine*, 14 November 1976, p. 35.
12. *Time*, 2 August 1976.
13. *Washington Post*, 20 March 1975.
14. *New York Times*, 27 September 1974.

Table 3.5. Soviet nuclear weapon incidents

Date	Weapon system	Place	Source	Remarks[a]
1. Unspecified	Soviet nuclear-powered submarines (several)	In the Norwegian Sea	[1]	"None of the Soviet fleet of nuclear submarines, which may now number between 15 and 30, has been recorded as cruising far from Soviet coasts . . . Many of the Soviet submarines have broken down in the Norwegian Sea and elsewhere, relatively near the Soviet coasts, and some have been towed back to port. Some experts believe that the Soviet Union had major difficulties with its program."
2. Before 1963, unspecified	6 Soviet submarines	Unspecified	[2]	"A brief exchange between Rear Admiral I. J. Galantin, Navy Special Projects director, and Representative Daniel Flood, during hearings before a House Defense Appropriations subcommittee, revealed that at least six Soviet submarines have had to be towed back home by trawlers after they were forced to surface because of mechanical troubles."
3. Before 1962, unspecified	Soviet submarine	Gulf of Alaska	[1]	"Well before the Cuban crisis a similar breakdown occurred in a conventionally powered Soviet submarine in the Gulf of Alaska; this ship could not submerge and was escorted home by another submarine".
4. 1962	Soviet submarine	Caribbean Sea	[1]	"The Cuban crisis last fall . . . Washington now believes six Soviet submarines—all conventionally powered by diesel engines for surface cruising and electric batteries for submerged operations—were sent to the vicinity of Cuba." "One of the six experienced mechanical trouble, which prevented it from submerging except for short periods. Eventually, this submarine cruised back to the Soviet Union on the surface, escorted by a trawler."
5. 25 May 1968	Soviet Tu-16 Badger	Norwegian Sea	[3–4]	Crashed while buzzing US carrier *Essex*, after having made 4 low passes over the ship. (Category will vary depending on whether it was on ASW patrol with nuclear depth charge, or on photo-reconnaissance duty.)
6. 1965 to 1975	Soviet submarines	Unspecified	[5–6]	"At least nine collisions of US submarines in the last ten years" with other vessels while on intelligence-gathering missions. Some fraction of these other vessels were Soviet submarines; several are identified below.
7. Mid-1960s	Submarine, "E"-class	Near Vladivostok harbour	[7–8]	Collided with US submarine, "Sturgeon"-class.

Date	Weapon system	Place	Source	Remarks[a]
8. 14 or 17 Nov 1969	Soviet submarine	Barents Sea, off North Russia	[8]	Collided with US submarine, *Gato*.
9. 31 Mar 1971	Soviet submarine	"17 nautical miles off USSR coast"	[8]	Collided with US submarine, "Sturgeon"-class.
10. Mar 1972	Soviet ballistic-missile submarine, "H"-class	North Atlantic, off Newfoundland	[9]	Experienced some sort of severe problem that forced it to the surface and resulted in its being towed all the way back to the Soviet Union.
11. 4 Oct 1973	Destroyer, "Kanin"-class	North Sea	[10]	A fire amidships caused the destroyer to jettison a torpedo while near the British aircraft carrier *Hermes* during a NATO exercise.
12. May 1974	Soviet ballistic-missile submarine, "Y"-class	Near Soviet base, Petropavlovsk, Kamchatka Peninsula	[11–12]	Collided with US submarine *Pintado*, while both were submerged, and surfaced.
13. "Early this month", May 1976	Soviet nuclear-powered attack submarine	Off Murmansk	[13]	Norwegian fishing vessel snagged the fins of the Soviet submarine, which then surfaced, and was towed towards Murmansk by Soviet rescue vessels.
14. "Last week", Jul 1976	Soviet nuclear-powered attack submarine, "N"-class	Barents Sea	[14]	Norwegian fishing trawler snagged the bow of the Soviet submarine, which then surfaced, and did not resubmerge.
15. 28 Aug 1976	Soviet nuclear-powered cruise-missile submarine, "Echo"-class	Ionian Sea	[15–17]	While travelling on the surface, the Soviet submarine appears deliberately to have rammed the US frigate *Voge*.
16. 8 Oct 1976	Soviet ballistic-missile submarine, "C"-class	Sea of Okhotsk, 160 mi off the coast of Kamchatka	[18]	Japanese fishing boat snagged the conning tower of a Soviet submarine, which then surfaced, and was photographed.

[a] See note *a* to table 3.1.

Sources:

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14. *Time*, 2 August 1976.
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Table 3.6. British nuclear weapon incidents[a, b]

Date	Weapon system	Place	Source	Remarks[c]
1. Jan 1968 (?)	British Polaris submarine, *Resolution*	Off Florida coast	[1]	Developed a defect in electrical generator. Was forced to put into port in the course of Polaris test-firing programme.
2. 30 Jan 1968	RAF Vulcan	Cottesmore, Rutland, UK	[2]	Crashed; reported as not carrying nuclear weapons.
3–6. 19 Apr 1968	RAF Shackleton	Mull of Kintyre, Argyllshire, Scotland	[3]	Fourth crash in last 6 months. (Inclusion would depend on whether aircraft were on photo-reconnaissance duty or on ASW patrol with nuclear depth charges.)
7. 26 Jun 1968	Scimitar aircraft	Isle of Wight	[4]	Crashed after hitting overhead power lines.
8. Before 4 Mar 1970	British Polaris submarine, *Renown*	Unspecified	[5]	HMS *Renown* collided with the motor vessel *Moyle*.

[a] Additional British aircraft crashes for the year 1975 are listed in source [6], and include four F-4 Phantom crashes.

[b] There is the least explicit reason for the inclusion of accidents of British and French nuclear-weapon carrier systems. In no case was the involvement of nuclear weapons indicated. In some cases it was specifically denied. However, in all cases the aircraft or submarines in question are nuclear-weapon capable, and it is the policy of both Britain and France—as it is of the Soviet Union—to make no announcement concerning nuclear weapons, were they to have been involved, unless circumstances (such as a crash on land which required decontamination measures or population removal) forced it. This is the justification for compiling the lists, even though there is no evidence to support the claim that nuclear weapons were involved in any or all of these accidents. Were that to be so, several would obviously be in the "major accident" category. In the case of at least the second accident involving the British submarines, nuclear weapons were certainly on board.

[c] See note *a* to table 3.1.

Sources:

1. *Times*, 9 January 1968.
2. *Times*, 31 January 1968.
3. *Daily Telegraph*, 20 April 1968.
4. *Daily Telegraph*, 27 June 1968.
5. *Hansard*, House of Commons Report, Vol. 797, No. 72, 4 March 1970, pp. 404–405.
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Table 3.7. French nuclear weapon incidents[a, b]

Date	Weapon system	Place	Source	Remarks[c]
1. 30 Mar 1973	Mirage IV bomber	Off the coast of Biscarrosse, (Landes) France	[1]	Plane reportedly "unarmed", but crashed into the sea, reportedly "to avoid loss of life".
2. 15 May 1973	Mirage IV bomber	Luxeuil, France	[2]	Crashed on take-off.
3. 18 Jun 1973	Mirage IV bomber	Near Bellegarde, (Gard) France	[2]	Unspecified.
4. 27 Sep 1973	Mirage IV bomber	Off coast of Corsica	[2]	Crashed into the sea while on a training mission.

[a] There have also been five accidents of French conventional submarines [3]; it is not known if France deploys a torpedo with a nuclear warhead. There have also been crashes of the French ASW aircraft, the Breguet 1150 Atlantic. On 31 Jan 1972 "pacifists" broke into the "nuclear headquarters" at Mount Verdun, and made their way to the "main operating room containing radar screens, missile data".

[b] See note *b* to table 3.6.

[c] See note *a* to table 3.1.

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3. *Le Monde*, 25 October 1972.

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[13] The author would like to thank Ian Lind, Charles Zimmerman and William Flannery for their kind and generous aid in providing source material.

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Appendix 3A

US military service branch definitions of nuclear accidents and incidents

For the US Army [1]

Nuclear accident

A nuclear accident is any unplanned occurrence involving loss or destruction of, or serious damage to, nuclear weapons or their pertinent components, nuclear reactors or facilities, or other nuclear or radioactive material, which results in an actual or potential hazard to life or property.

Nuclear incident

A nuclear incident is any unexpected event involving damage to nuclear material or physically associated components which poses no immediate danger to life or property, but represents an increased risk of possible explosion or radioactive contamination. A nuclear incident is further distinguished by either the possibility of the event becoming public knowledge or having political or international implications.

For the US Navy [2]

Nuclear accident

Nuclear weapons accidents reportable under OPREP-3 PINNACLE/ BROKEN ARROW include the following:

1. Nuclear detonation other than war risk detonations or possible detonations (see PINNACLE/NUCFLASH).
2. Non-nuclear detonation or burning of a nuclear weapon.
3. Radioactive contamination.
4. Seizure, theft or loss of a nuclear weapon or nuclear component, including jettisoning.
5. Public hazard, actual or implied.

Nuclear incident

A nuclear-weapon significant incident reportable under OPREP-3 NAVY BLUE/BENT SPEAR reporting is:

An unexpected event involving war reserve nuclear weapons or nuclear components which does not fall into the category of a nuclear weapon accident but:

1. Results in evident damage to a nuclear weapon or nuclear component to the extent that major rework, complete replacement, or examination or recertification by the AEC is required; or
2. Requires immediate action in the interest of safety or which may result in adverse public reaction (national or international) or premature release of information; or
3. Has such potential consequences as to warrant the informational interest or action of the addresses listed in paragraph 3.

For the US Air Force [3]

Nuclear accident

1. The destruction of a nuclear weapon from any cause in which there is a nuclear contribution to the yield, or
2. The loss or destruction of war reserve nuclear bombs, components or warheads, or other systems employing nuclear energy, in which a nuclear reaction did not contribute to the energy released.
3. An occurrence from any cause leading to radioactive contamination of sufficient magnitude to affect the community adversely.

Nuclear incident

Explanation of the term nuclear incident:

a. Any damage to war reserve nuclear bombs or warheads from any cause which does not meet classification of accident as defined in AFR 136-9.

b. Loss or destruction of *full-scale* nuclear training items from any cause.

c. Damage to *full-scale* nuclear training bombs or warheads requiring any repair or replacement of components.

d. Loss or destruction of scaled training items when employed with nuclear weapon suspension and release systems.

e. Inadvertent release of *full-scale* or scaled training items.

f. Inadvertent release of any item using the nuclear weapon suspension and release systems (e.g., fuel tanks, pylons, bomb dispensers, etc.).

g. Damage to or failure of handling and test equipment during any phase of the stockpile-to-target sequence of a war reserve weapon or a training item.

h. Individual error or unauthorized act committed in handling, assembly, testing, loading, transporting, and, during training operations, using war reserve nuclear bombs, warheads, or training items.

i. Individual error or unauthorized act which is in violation of nuclear safety procedures or rules and which would degrade the safety of the nuclear weapon system.

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4. Dioxin: a potential chemical-warfare agent

Square-bracketed numbers, thus [1], *refer to the list of references on page 99.*

I. *Introduction*

The tragic accident that occurred in Seveso, Italy, on 10 July 1976 has reemphasized the potential utility of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (also referred to as "TCDD" or "dioxin") as a chemical-warfare agent. Dioxin, perhaps the most poisonous substance ever to have been synthesized, is only too easy to produce, maintains its integrity only too well, and can be only too readily disseminated [1–14]. It would thus seem to lend itself well to a number of hostile military purposes, both overt and covert, a potential that has already been recognized [15–16]. The aim of this chapter is to discuss the implications of employing this chemical for hostile purposes. The toxicology and thereby the human physiological effects of the compound are discussed in the first sections, whereas the subsequent sections give an account of four major occurrences of environmental dioxin contamination, and examine the ecological implications.

II. *History*

For 75 years now, dermatologists have had a clinical picture of the disease—first described by Herxheimer in 1899—known as chloracne (erroneously attributed to free chlorine, hence the name) [17]. This chronic skin eruption is characterized by persistent acne, follicular inflammation, hyperkeratosis, pustulosis and furunculosis. The external dermatological signs of its early stages are associated with pain and weakness in the lower limbs, mild paresthesia, heart complaints and psychosomatic disorders. These conditions may later be followed by severe hepatic degeneration (cirrhosis and necrosis), bronchitis, polyneuritis, encephalitis, renal and splenic damage, and multiform psychopathological-neurological delayed and permanent lesions. (For further details, see pages 89–92.)

In 1961, Bauer, Schulz and Spiegelberg made a comprehensive evaluation based on a study of 100 chloracne cases [18]. They confirmed the suspicion that dioxin—produced as a by-product in the alkaline hydrolysis of 2,3,7,8-tetrachlorobenzene to 2,4,5-trichlorophenol—was the toxic compound proper that set off the diversified sequence of poisoning. Their publication did not, at that time, receive the attention it deserved; neither did the results published earlier in 1957 by Schulz receive due attention [18].

2,4,5-Trichlorophenol itself does not cause acne, but the contaminants which may be formed in the uncontrolled production of 2,4,5-trichlorophenol are extremely potent acnegens. Dioxin and tri- and tetrachlorodibenzofuran were isolated from the contaminants formed in 2,4,5-trichlorophenol production and were demonstrated to be strongly positive acnegens when applied to rabbit ears [19]. By using the rabbit ear test, the acnegenic potency of dioxin was confirmed in 1962 [20]. In addition, this dioxin is extremely toxic in the chick embryo assay [21] and is highly embryotoxic in rats [22]. A compound related to dioxin, hexachlorodibenzo-*p*-dioxin, is known to be positive for the chick edema factor, a condition characterized by hydropericardium, ascites, and anasarca.

Dioxin and related compounds can be formed in a two-step condensation reaction from *ortho*-substituted chlorophenoxy radicals or anions [23–25]. The first route is of significance only where strongly oxidizing conditions exist, such as a reaction of chlorine with pentachlorophenol at elevated temperatures. For the second route the condensation of chlorinated phenols occurs spontaneously when their metal salts are heated to temperatures above 300°C [26]. Since this latter reaction is strongly exothermic, it proceeds to completion in a very narrow temperature range once initiated.

Trichlorophenol is manufactured in several countries in Europe and elsewhere. In the past 20 years there have been several industrial disasters in connection with its production. One case of industrial mass poisoning has been described by Goldmann [27]. In 1953, 55 people were stricken with very severe, acute chloracne as a result of a disaster in the Badische Anilin- & Soda-Fabrik AG in Ludwigshafen, FR Germany. In addition to exhibiting the typical skin eruption, 21 of these cases showed serious effects of systemic poisoning, manifested via damage to the parenchymatous organs (liver, spleen, kidneys), respiratory tract, myocardium, eyes and central nervous system. It is of interest that it was not until three years after the disaster that it was possible to pinpoint dioxin as the toxic causative; and animal experiments performed in 1961 at the site of the accident—as required by the circumstances of the case—still revealed the presence of the product in wall and plaster specimens. The unfeasibility of carrying out complete decontamination led, in 1968, to the decision to demolish the building. Animal experiments carried out in this connection at the BASF medicobiological research laboratories showed that 10 μg/kg was a lethal dose for rabbits, and that even 3 μg/kg—while nonlethal—caused liver damage. Hexachloronaphthalene—alleged until then by many to be the causative agent of chloracne, hence the name Perna Disease from *per*chlorinated *na*phthalene—is of hardly any importance as compared with dioxin, the latter being 10 000 times more potent.

In 1957 in southeastern and central USA there was an outbreak in domestic poultry of an unknown disease (causing hydropericardium, and gross kidney and liver damage) which produced substantial economic losses [28].

In this case it was a toxic impurity in the nonsaponifiable fraction of fats added to commercial chicken feed. The so-called "chick edema factor" was identified as being 1,2,3,7,8,9-hexachlorodibenzo-*p*-dioxin [29], formed in the synthesis of chlorophenols that were used as preservatives for hide-curing operations. The contaminated fat had been used in the chicken feed.

In 1963, Philips Duphar, the pharmaceuticals subsidiary of the Netherlands' Philips N.V., had an explosion involving dioxin in its Amsterdam plant. An estimated 30–200 g of the compound was released. Shortly afterwards, about 20 workers developed chloracne, and inspectors who went into the plant to examine the damage were also affected. Nine of the 18 workmen who cleaned up the area developed severe skin trouble. Three of these, along with one Philips employee, died within two years of the accident, although their deaths could not definitely be linked to exposure to dioxin. The plant was sealed off for 10 years, after which it was dismantled brick by brick. The rubble was embedded in concrete and dumped into deep water in the Atlantic Ocean near the Azores. Philips claims that none of those exposed suffered heart or kidney trouble and that no children born to families of the affected employees showed any ill effects [30–31].

Some European producers are, however, having second thoughts about continuing their production of the chemical 2,4,5-trichlorophenol. Bayer in FR Germany has decided to stop work at one of its herbicide plants pending the outcome of the evaluation of the Seveso accident (see page 94). Coalite & Chemical Products Co., the only British producer of trichlorophenol, has yet to decide whether to restart its plant. In 1968, the company had an explosion in a pilot plant and some employees developed chloracne. The company later confirmed that the chloracne was due to the presence of dioxin. Coalite has since modified its procedures so that the products of any runaway reaction automatically go into a dump tank.

In the USA, Dow Chemical, the major US manufacturer, makes trichlorophenol at Midland, Michigan for use in 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). The Midland plant is a fairly new one and extensively automated, which minimizes the possibility of worker exposure to the chemical. Thus, for example, should a safety disc rupture on a reaction vessel, it would discharge into a holding tank larger than the original reaction vessel and the reaction would be quenched with water. "We will be looking a little closer just to make sure . . . that our fail-safe systems really are", a Dow spokesman has said, but "it never even crossed our minds" to shut down trichlorophenol production [30].

Another fact has emerged in the past few years which has disclosed the potential incorrectness of all the calculations hitherto made on the actual and supposed proportion of dioxin in 2,4,5-T preparations or in crop plantations and other regions treated with chlorophenol-containing agents. Buu-Hoï and co-workers found that not only is dioxin formed as a by-product in the alkaline hydrolysis of tetrachlorobenzene to 2,4,5-trichlorophenol—the industrial precursor of 2,4,5-T—but that it is also produced by the pyrolysis of 2,4,5-T [25–26].

In 1957, Sandermann and co-workers had already reported on the possibility of this chemical reaction but could not, at that time, assess its far-reaching implications. In his comprehensive report of 1974, Sandermann gives a striking account of the entire problem of polychlorinated aromatic compounds as environmental poisons [32]; this publication also refers to a preliminary report, according to which 5 out of 30 workers employed in applying chlorinated phenoxyacetic-acid weed-killer to Swedish railway embankments [33–34] died shortly after—4 out of the 5 of cancer; it was subsequently revealed, however, that the workers had also been exposed to the herbicide amitrole (3-amino-1,2,4-triazole)—a known but neglected carcinogen. Meanwhile, it has been indicated elsewhere that the burning of brushwood treated with chlorophenol-containing herbicides may lead to the formation of dioxin [35].

Looking back on the use of herbicides by the US Army in Vietnam and recalling the fact that defoliated forests were occasionally burned by means of napalm, one begins to surmise the true extent of the impact of dioxin on the territory and people of Vietnam.

III. *Toxicology*

Dioxin is reported to be one of the most toxic chemicals known [36]. This is not to say, however, that there have not been variations in such reported toxic parameters as single oral LD_{50}s, the range of time-intervals from dosage until death, and the toxic manifestations which an animal exhibits [36–40].

Dioxin is a "cellular" poison and is much more toxic than the other chlorodibenzodioxins studied; the LD_{50}s range from 0.6 μg/kg in male guinea-pigs to 115 μg/kg in rabbits. Dogs appear to be less sensitive than rabbits. A 100 per cent mortality in rabbits treated with 10 μg/kg and in chick embryos treated with 0.05 μg/egg has been reported [21].

Death following treatment with a lethal dose of dioxin is often delayed for several weeks. Among the animals which die following treatment, approximately half the deaths occur between 13 and 18 days after treatment, with some animals dying as late as 43 days after a single oral dose. There are large differences in species susceptibility to dioxin. Moreover, in mice and rabbits, there is a marked individual difference in susceptibility to this compound which makes it difficult to conduct acute lethality studies.

Guinea-pigs are most sensitive to the lethal effects of dioxin with 90 per cent dying from a single 3 μg/kg dose. In contrast, a 100 μg/kg dose is lethal to perhaps 40 per cent of treated rats. In both species the time interval until death is similar and a large weight loss over a period of days precedes death.

Female rats appear to be more sensitive to dioxin than males. Dogs are almost 1000 times less sensitive than guinea-pigs. The cause of death is uncertain in all cases. A great range in the time interval from exposure until death has been observed.

Hepatic and cardiac lesions as well as thymic involution have been found in rats treated with dioxin [40]. Generalized subcutaneous edema, ascites, hydrothorax and hydropericardium have been observed in monkeys given toxic fat [41] which purportedly contained dioxin. These monkeys also had focal necrosis of the parenchymal cells of the liver, and gastric ulcers.

The liver is the only other organ in which microscopic changes have been consistently observed. The degree of hepatic involvement seems to be dose-dependent, but the severity of changes produced is quite variable among species. The most severe hepatic effects have been seen in rats which received a lethal dose of dioxin. These rats, which were jaundiced, show diffuse degenerative and necrotic changes in the liver [42–43].

Although degenerative and necrotic changes in the liver are also observed in guinea-pigs and mice, the magnitude of these effects is markedly diminished. To illustrate this point, hepatic changes produced at lethal dioxin levels in the rat are severe enough to be a contributing cause of death, while hepatic changes in the guinea-pig receiving a lethal dose are quite mild [42–44].

Studies on the chlorodibenzodioxins in general have led to the following conclusions: (*a*) 2,7-dichlorodibenzo-*p*-dioxin and octachlorodibenzo-*p*-dioxin have a low acute toxicity; (*b*) 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (the "dioxin" of this paper) has an unusually high toxicity; (*c*) hexachlorodibenzo-*p*-dioxin is highly toxic but less toxic than 2,3,7,8- tetrachlorodibenzo-*p*-dioxin; and (*d*) all chlorodibenzodioxins are not alike in their toxicological properties. Moreover, isomers of the same dibenzo-*p*-dioxin vary in toxicological properties, making it important to identify them specifically.

As noted already, dioxin is highly embryotoxic [22]. Isomers of a chlorodibenzodioxin can produce different degrees of toxicity. The no-effect level of dioxin for embryotoxicity was 0.03 μg/kg per day. In contrast to the high embryotoxicity of this symmetrical dioxin, 1,2,3,4-tetrachlorodibenzo-dioxin was not embryotoxic at doses as high as 800 μg/kg per day.

Previous studies reported that subcutaneous administration of dioxin at a dose level of 3 μg/kg in mice during days 6 through 15 of gestation produced pups with cleft palates and kidney anomalies [45]. It was hypothesized that the prenatal and postnatal kidney anomalies have a common etiology and that the incidence and degree of hydronephrosis are a function of dosage and length of target organ exposure [40, 46].

Another important effect of dioxin is on the immune system of animals. It has been found that dioxin at sublethal dose levels suppresses the cellmediated immunity in guinea-pigs, mice and rats [47]. Humoral immunity is slightly suppressed in the guinea-pig. The possible role of immune suppression in the death of dioxin-treated guinea-pigs and mice is discussed in view of the absence of major pathologic effects in the lymphoid system [48]. Dioxin exposure during ontogenesis of the immune system seems to be a prerequisite. One of the most important findings has been that extremely low levels of dioxin (at least in mice), while they do not produce clinical or pathological change, still have the capacity adversely to affect host defence [49]. In this connection it may be useful to look at the biochemical findings of Poland and Glover [50–51].

The results of Poland and Glover demonstrate that dioxin is a potent inducer of ALA synthetase and aryl hydrocarbon hydroxylase in the chick embryo liver. They wrote:

There is a perfect correlation between those dioxins which induce both enzymes and the toxicity data, to the extent the data are available on the various dioxins. The structure-activity relationship reveals that all dioxins which are potent inducers have halogens at three of the four lateral ring positions and at least one nonhalogenated carbon atom. The sensitivity of induction of aryl hydrocarbon hydroxylase by TCDD and other toxic dioxins suggests this response might be a very valuable screening bioassay to detect the presence of the toxic dioxins in commercial products or environmental samples. It should be emphasized that the nonspecificity of the response makes it imperative that one extract the samples tested to remove polycylic hydrocarbons, and the test is only collaborative, not definitive for TCDD and related dibenzo-*p*-dioxins [51].

Finally we turn to the question of the mechanism of toxic action produced by dioxin. Dioxin is a highly lipophilic and rather chemically unreactive molecule, which possesses remarkable biological potency with large differences in the susceptibility of different species to it. There is also an interesting structure-activity relationship among the dioxins. The oral LD_{50} values of the 2,7-dichloro and octachloro derivatives are greater than 100 000 times that of dioxin in the rat. Dioxin is remarkably slow in its toxic action leading to death. Regardless of dosage, animals die weeks after a single lethal administration of dioxin [52]. Finally dioxins are also potent inducers of aryl hydrocarbon hydroxylase activity. This enzyme complex is present and inducible in a number of tissues and is responsible for the aromatic hydroxylation of many xenobiotics.

It is useful to examine the proposed mechanism of toxicity for other aromatic or halogenated aromatic compounds that, like dioxin, are chemically relatively unreactive and highly lipophilic. Briefly, the literature can be summarized as follows. The parent compound is metabolized to a very reactive arene oxide intermediate. This intermediate may then be chemically rearranged to a phenol, be further metabolized to a dihydrodiol or glutathione conjugate, or else react chemically by covalently binding to various cellular macromolecules which act as nucleophiles.

Poland and Glover propose the following model for the toxicity of dioxin:

The parent compound enters the cell and binds to some induction-receptor or site which initiates the events which ultimately lead to the formation of more aryl hydrocarbon hydroxylase activity. TCDD is recognized by a second site in the cell, the enzyme-active center of microsomal oxygenase, and converted to a reactive metabolite, possibly an epoxide. The conversion of TCDD to its reactive metabolite is the rate-limiting step in dioxin metabolism, and this step is increased by the induction of aryl hydrocarbon hydroxylase. Some of these reactive metabolite molecules bind to cellular macromolecules producing some impairment of function which gradually produces cell death [51].

The teratogenic effect of TCDD may be a result of mutagenesis by intercalation of the parent compound into DNA or by intercalation and covalent binding of the metabolite, analogous to the acridine and aminofluorene compounds [53]. This speculative hypothesis is presented to encourage further investigations in this field.

IV. *Dioxin in the environment: four episodes*

The next question to be considered here is that of the ecological consequences of contaminating a region with dioxin, perhaps for such tactical purposes as long-term area denial, harassment or interdiction.

The information in this section is derived from the limited number of available pertinent laboratory studies as well as from the four known instances of significant environmental contamination, namely, those in South Vietnam during the 1960s, in northwestern Florida, USA also during the 1960s, in eastern Missouri, USA during May 1971, and in northern Italy during July 1976. Of these four episodes all were unintentional (and uncontrolled) and only the first two occurred in a military context. The details of these events are outlined below, followed in turn by a discussion of their ecological consequences.

South Vietnam

The widespread notoriety of dioxin stems from its inadvertent dissemination during the Second Indochina War, the first known instance of significant environmental contamination [54–55]. During that war dioxin was aerially dispensed by the USA as a contaminant of "Agent Orange", an anti-plant chemical-warfare agent consisting of approximately equal parts of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and 2,4-dichlorophenoxyacetic acid (2,4-D).

Between 1961 and 1970, but primarily (89 per cent) during the four years 1966–69, an estimated total of more than 110 kg of dioxin was applied in the above manner to approximately 1.0 mn ha of South Vietnam, that is, to 6 per cent of its land surface. Whereas the overall average dosage on the affected area thus approximated 106 mg/ha, about 690 000 ha (66 per cent) of this

Table 4.1. Rough comparison of four environmental dioxin contamination episodes

Region	Estimated amount released *kg*	Estimated area of contamination *ha*	Estimated rate of application *g/ha*	Estimated topsoil contamination *µg/kg*
South Vietnam	>110	1 000 000	0.106	0.080
Northwestern Florida	0.18	37.25	4.9	3.7
Eastern Missouri	<22	0.15	147 000	110 000
Northern Italy	>2.5	320	7.8	5.9

Sources: See text.

area received 70 mg/ha, another 230 000 ha (22 per cent) received 140 mg/ha, 80 000 ha (8 per cent) received 210 mg/ha, 30 000 ha (3 per cent) received 280 mg/ha, and the remaining 10 000 ha (1 per cent) received 350 mg/ha or more. Most of the Agent Orange spraying (90 per cent) was directed at forest lands (both upland and coastal) and the remainder at agricultural lands (primarily upland). Inasmuch as a region of 3.0 mn ha surrounding Saigon—so-called Military Region III—was the recipient of 53 per cent of the spraying, on an areal basis this region received three times as much as the nationwide average.[1]

The total population of South Vietnam at the time was approximately 17.6 mn and that of Military Region III (exclusive of Saigon) perhaps 2.4 mn. Thus on a population basis South Vietnam was *nominally* exposed to an average of 6 mg/capita, whereas the population potentially at risk in Military Region III was *nominally* exposed to an average of 25 mg/capita.

To summarize the South Vietnam episode, an estimated 110 kg or more of dioxin was applied primarily over a four-year period to 1.0 mn ha of inhabited forest and farmlands, that is, at 106 mg/ha. (In terms of the top 10 cm of the soil, and assuming a weight of 1 325 kg/m^3 for normal soil, this represents 80 ng/kg.) (See table 4.1.)

Northwestern Florida

The second known instance of significant environmental contamination with dioxin occurred at Eglin Air Force Base in northwestern Florida where the US Air Force carried out a spray equipment test programme between 1962 and 1970 [56–58]. The area of particular interest is a formerly forested, unpopulated, 37.25-ha grassland tract (Grid No. 1 of Test Area No. C-52A). Over the three-year period 1962–64, this plot was subjected to 39 540 kg of 2,4,5-T.

[1] The approximate temporal distribution of the estimated 111 kg of dioxin applied to South Vietnam is (in kg): 1961 (-), 1962 (-), 1963 (1), 1964 (2), 1965 (4), 1966 (16), 1967 (30), 1968 (22), 1969 (31) and 1970 (5). The approximate spatial distribution is (in kg): Military Region (MR) I (19), MR II (23), MR III (59), and MR IV (10). And taking their sizes into account, it is (in mg/ha): MR I (7), MR II (3), MR III (19), MR IV (3), and overall (6).

Assuming that the herbicide employed was contaminated with dioxin at an average level equal to the level found in the comparable herbicide remaining from the US operations in South Vietnam [59], then one can calculate that a total of 180 g of dioxin was applied to that area.

To summarize the northwestern Florida episode, an estimated 180 g of dioxin was applied over a three-year period to 37.25 ha of uninhabited grassland, that is, at 4.9 g/ha. (In terms of the top 10 cm of normal soil, this represents 3.7 μg/kg.) (See table 4.1.)

Eastern Missouri

The third known instance of significant environmental contamination with dioxin occurred in eastern Missouri during May 1971 [60–61]. A substantial though unknown portion of 68 m^3 of waste oil unwittingly contaminated with approximately 330 mg/kg of dioxin was spread as a dust palliative at three horse[2] farms and along one stretch of road. Assuming an oil weight of 1 000 kg/m^3, the maximum amount of dioxin involved in this episode was therefore approximately 22 kg.

Soil samples taken at the worst afflicted farm three months after the event and to a depth of perhaps 15 cm were found to contain an average of 32 mg/kg of dioxin. Based on a half-life in soil of 463 days (see page 96), one can assume that about 13 per cent of the dioxin had disappeared during the three-month interval, and that the initial concentration had thus been approximately 37 mg/kg. With the reasonable assumption that none of the dioxin had moved down out of the sampling zone during that period and further assuming a compacted soil weight of 2 650 kg/m^3, it can be calculated that the initial rate of application had been approximately 147 kg/ha. Moreover, at this rate of application, the total area of contamination could not have exceeded about 0.15 ha.

To summarize the eastern Missouri episode, a rough estimate of 22 kg or less of dioxin was applied over a period of days or weeks to perhaps 0.15 ha of inhabited farmland, that is, at perhaps 147 kg/ha. (In terms of the top 10 cm of normal soil, this represents 110 mg/kg.) (See table 4.1.)

Northern Italy

The fourth and most recent known instance of significant environmental contamination with dioxin occurred at Seveso in northern Italy during July 1976 [30–31, 62–64]. As a result of an industrial accident at a chemical plant,

[2] The scientific names of the biota mentioned in sections IV and V are: carp (*Puntius*, Cyprinidae), cat (*Felis catus*, Felidae), catfish (*Pangasius*, Shilbeidae), chicken (*Gallus gallus*, Phasianidae), cow (cattle) (*Bos taurus*, Bovidae), dog (*Canis familiaris*, Canidae), guinea-pig (*Cavia porcellus*, Caviidae), guppy (*Poecilia reticulatus*, Poeciliidae), horse (*Equus caballus*, Equidae), macaque (rhesus monkey) (*Macaca mulatta*, Cercopithecidae), prawn (*Macrobrachium*, Palaemonidae), and rabbit (*Oryctolagus cuniculus*, Leporidae).

a chemical cloud was released over the region. The cloud, containing the dioxin compound, was predominantly 2,4,5-trichlorophenol, a chemical intermediate used to produce both hexachlorophene, an antibacterial agent (used in cosmetics and soaps) and 2,4,5-T, the herbicidal compound. Dioxin is a by-product in the formation of the trichlorophenol, which was manufactured at an annual capacity of 300 tonnes at the Seveso plant. The plant produced trichlorophenol by reacting tetrachlorobenzene with potassium hydroxide in ethylene glycol. Workers were boiling off the ethylene glycol solvent in a steam-heated reaction vessel when the temperature of the reaction vessel rapidly increased and a safety disc ruptured. The reaction mixture, containing an estimated 2.5 kg or more of dioxin (together with a much larger quantity of 2,4,5-trichlorophenol) blew up into a plume 30 to 50 m high above the factory. The cloud rose into the air, cooled and came down over a cone-shaped area of inhabited farmland totalling an estimated 320 ha. The event took place over a period of only relatively few minutes.

On the basis of the level of contamination, the area has been partitioned into two zones: a Zone A of severe contamination covering about 110 ha, and a Zone B of lesser contamination covering the remaining 210 ha. As an approximation, one can assume that Zone A received a total of at least 2 kg of dioxin and that Zone B received at least 0.5 kg. Zone A may thus have received an average of 18 g/ha and Zone B 2.4 g/ha.

Both zones encompassed dairy and other farms as well as villages, with Zone A inhabited by some 700–800 people and Zone B by perhaps 3 000–4 000. Zones A and B thus received the *equivalent* of perhaps 2.7 g/capita and 0.1 g/capita, respectively.

To summarize the northern Italy episode, an estimated 2.5 kg or more of dioxin was applied over a period of hours to perhaps 230 ha of inhabited farmland, that is, at about 7.8 g/ha. (In terms of the top 10 cm of normal soil, this represents 5.9 μg/kg.) (See table 4.1.)

V. *Ecological consequences*

Ecosystem (food-chain) mobility

One of the important questions that arose as a result of the dioxin contamination in South Vietnam [54–55] was whether the poison was mobile in the ecosystem, especially whether it travelled up through those food chains culminating in man. To that end the Herbicide Assessment Commission of the American Association for the Advancement of Science (AAAS/HAC) [65] collected various commonly eaten fish and crustaceans, including indigenous carp,[2] catfish[2] and prawn,[2] downstream from forest areas of prior heavy spraying (War Zones C and D in Military Region III). All of these samples were subsequently found to contain dioxin [66]. Inasmuch as these collections were made at least several kilometres away from the spray areas and at least four months after the last spraying, these findings by AAAS/HAC do, indeed, demonstrate that when dioxin is applied to a forest at one location it is capable of entering and moving up a food chain that culminates in man.

The findings from South Vietnam of this biogeochemical cycling of dioxin have now been corroborated by both field and laboratory observations in the USA. To begin with, dioxin is taken up by vegetation, although sparingly and apparently less readily by terrestrial than aquatic plants.[3] Moreover, the US Environmental Protection Agency has found in Texas and Missouri that when 2,4,5-T (which is invariably contaminated with at least some dioxin) is used for brush control on rangelands following recommended procedures, dioxin can be recovered from the beef fat of at least some of the cattle[2] which subsequently graze on such lands [69]. In another study, the US Agricultural Research Service added dioxin in the laboratory to a model aquatic ecosystem at a level comparable to what would be supplied to the environment by currently manufactured 2,4,5-T under recommended procedures of field application [68]. The dioxin was found to be stable under these circumstances and to have been taken up and concentrated several thousandfold by the various components of two distinct aquatic food chains, the one culminating in snails and the other in fish.

Finally, it is pertinent to note here that repeated sublethal doses of dioxin appear to cumulate in the macaque or rhesus monkey[2]—or else their damage does—eventually (after 445 days) attaining a lethal level [41, 66].

Ecosystem persistence

Laboratory experiments by the US Agricultural Research Service have demonstrated that dioxin is not readily mobile in the soil and, moreover, that its half-life there is substantially longer than one year [70]. When dioxin was added to two diverse soils and incubated under continuously warm and wet conditions, between 54 and 71 per cent or more could be recovered after 350 days (independent of soil type or of initial concentration), the half-life that can be calculated from these data being 463 days.

Of greater interest here, however, are the recent investigations by the US Air Force of the northwestern Florida episode [56–58]. It has been found there that more than 12 years after the last spraying, dioxin can still be recovered from all locally collected samples of the sandy soil, wild rodents (one species) resident birds (two species), lizards (one species), fish (three species) and insects (a composite of species), despite an average annual rainfall of about 1 550 mm.

It is useful to note that the environmental residence time of dioxin appears not readily to yield to shortening via human intervention. Although the

[3] For terrestrial vegetation, see reference [67], and for aquatic vegetation, reference [68].

recent episode in northern Italy has stimulated worldwide efforts at devising practicable decontamination procedures, none appears to be forthcoming [30–31, 62–64]. The Italians are considering several alternatives. Initial rumours that flamethrowers would be brought in to destroy everything within the contaminated zone, or that the soil itself would be removed and burned somewhere, perhaps in the municipal incinerator in Milan, were unfounded: dioxin can only be broken down by incineration at very high temperatures (indeed an expert commission has recommended building a 1 200°C incinerator to destroy the vegetation and buildings from the contaminated area) and incineration at lower temperatures such as those in municipal incinerators or generated by flamethrowers would only vaporize dioxin and help to spread it even further into the environment. Another scheme being discussed would be permanently to isolate the most contaminated area, Zone A, probably by fencing it off, and turn it into a scientific observation area to study the long-term effects of dioxin exposure on the land and living things.

Another decontamination method that could be tried in the region is the use of agents such as Carbitol (mono- and diethyl ethers of diethylene glycol) to accelerate photodegradation [30–31]. Other approaches include the introduction of selected soil microorganisms, flooding to increase anaerobic metabolism, or the use of "catch" plants to reduce residues. Using chemical agents to increase photodegradation seems to some to be the most promising of these approaches.

The human ecosystem

To date, no human mortality has been unequivocally attributable to environmental contamination with dioxin. On the other hand, a number of serious and refractory human illnesses, especially among children, have been unambiguously attributed to such poisoning (see [60–61]). One now awaits with some trepidation the possible revelation in northern Italy of delayed effects among those exposed as well as among those *in utero* at the time of exposure. (Indeed, 20 or more pregnancies have been therapeutically terminated in northern Italy to avoid the possibility of giving birth to malformed offspring.)

The Italian episode is too recent to permit judgement of whether environmental dioxin contamination results in human neonatal problems. On the other hand, hospital records (such as they were) had been examined by AAAS/HAC in South Vietnam with this question in mind [71]. In Tay Ninh Hospital, serving the most heavily sprayed area of South Vietnam (War Zone C in Military Region III), it was found, by an examination of records of all of the 7 336 births during 1968–70, that during the height of the spray period, the number of stillbirths per thousand live births was 77, a rate roughly twice as high as in comparable unsprayed regions or times. As to specific terata, the records of the Saigon Children's Hospital revealed that the relative incidence of only two sorts of birth anomalies went up during the heavy spray period, namely of spina bifida and pure cleft palate, in each case more than trebling. Spina bifida rose from a normal proportion of 0.7 per cent (the relative incidence among the 2781 defective live births during 1959–66) to one of 2.1 per cent during the heavy spray period (the relative incidence among the 1205 defective live births during 1967–68). Similarly, pure cleft palate rose from a normal proportion of 0.8 per cent to one of 3.0 per cent during the heavy spray period.

Similar birth data were collected by the US Department of Defense independently of AAAS/HAC [72]. Calculations using those data show that the frequencies of stillbirths and birth anomalies (hydatidiform moles and other congenital malformations) throughout South Vietnam (exclusive of the unsprayed Saigon region) were greater during the period of heavy spraying than before it. For example, there were 34 stillbirths per 1000 live births during the pre- or light-spray period (among the 58038 total births examined during 1960–66), this value rising to 38 during the period of heavy spraying (among the 105698 births examined during 1967–70).

Three points must be stressed here. First, no statistical analysis is available of the various sets of data from South Vietnam summarized above. Second, even under the best of conditions such data can only suggest but not demonstrate a cause-and-effect relationship. Third, the pertinent demographic and epidemiological records of South Vietnam were at the time incomplete and also inadequate in other ways. In fact, precisely that facet of the population most likely to have been subjected to spray injury was also the one most likely to have been under-represented in the relevant statistics.[4]

VI. *Conclusions*

It is abundantly clear that dioxin is an exceedingly toxic and stable substance, that it can be readily incorporated into an ecosystem within which it becomes distributed to the various living and non-living components, and that once thus incorporated it is extraordinarily persistent and virtually impossible to remove. It thus becomes additionally evident that dioxin could be employed for hostile purposes in order to make some large area of enemy territory irreversibly uninhabitable for an extended period of time (a use, one might add, that has been similarly suggested for plutonium).

The ecological impact of applying dioxin to an area at a militarily effective level would be substantial. The birds and other wildlife resident at the time would be virtually, if not entirely, destroyed. And for some time to come the

[4] The group not included in the statistics employed here has been studied in part by Tung [73] and Rose and Rose [74].

wildlife migrating or immigrating into the area (an area in no obvious way dangerous to them) would also be placed in severe jeopardy. With the heterotrophic component of the affected ecosystems thus decimated, major ecological imbalances would result.[5]

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5. Military satellites

Square-bracketed numbers, thus [1], *refer to the list of references on page 177.*

I. *Introduction*

The remarkable achievements of the space probes—the spectacular photographs of and data from the Moon, Mars, Jupiter, Venus and Mercury, and the recent landing on Mars—have distracted people's attention from other equally remarkable but much less well-known accomplishments of man's use of artificial Earth satellites. In addition to satellites launched for scientific exploration and for investigating applications in support of the economy, other satellites are launched to fulfil military objectives. Man's military technological genius has devised satellites to enable him, for example, to communicate simultaneously with armed forces which are close by as well as with those which may be thousands of kilometres away. Satellites can be used to predict weather in order to facilitate bombing raids and accurately to navigate lethal arms to their targets. With the aid of reconnaissance satellites, military targets can be recognized and their geographical positions accurately determined using geodetic satellites.

In recent years, about 60 per cent of both the US and the Soviet satellites launched into the Earth's orbit have been military satellites. In the USA, the main portion of the space programme is conducted by a civilian organization, the National Aeronautics and Space Administration (NASA). The remaining major segment is operated by the Department of Defense with the United States Air Force (USAF) as its executive agent, with emphasis on supplying military support or R&D associated with military support. Much less is known about the Soviet system. The Soviet Academy of Sciences, however, plays a role in planning part of the Soviet programme.

In addition to reconnaissance satellites, a wide variety of other satellites have been launched by the two big powers. Each state employs so-called early-warning satellites for advance warning of the launching of enemy missiles. Considerable developments are being made in navigation, communications and meteorological satellites, and meteorological and geodetic satellites are launched regularly. Both powers have carried out programmes related to the development of satellites capable of intercepting and destroying other satellites in orbit.

In the section to follow, various military missions for which satellites are used and the orbital characteristics of the different types of military satellites will be described. In sections III and IV, the military satellite programmes of the USA and the USSR are described. In section V, the most recently launched Chinese satellites are considered, and the military satellite programmes of other countries are described. Section VI gives the conclusions to be drawn from what is known about these satellite programmes. In appendix 5A, a short history of events leading up to the development of reconnaissance satellites in the USA is given.

Tables of the launches and orbital characteristics of the satellites are presented in section VII of this chapter. Where a country's satellite launches have been covered in previous SIPRI Yearbooks, only the launches for 1976 are given; in the case of launches not previously recorded in the SIPRI Yearbooks, the entire satellite programme is recorded in the tables.

II. *Military satellite missions and orbital characteristics*

Many factors influence the selection of a specific satellite orbit for a given mission. The military missions which can suitably be performed by satellites and the orbital parameters which satisfy the requirements for such missions are briefly discussed below for each type of satellite currently in use.

Photographic reconnaissance satellites

A satellite usually follows an elliptical orbit and its motion round the Earth is complicated by the rotation and shape of the planet. However, these complicating phenomena have been effectively used to make observations from space. For example, the Earth rotates round its axis approximately once every 1 440 min. If the period[1] of a satellite is chosen carefully, then the satellite ground tracks[2] will repeat each day. Alternatively, a period can be chosen to result in a gradual shift of the ground tracks each day so that complete coverage of a larger area of interest can be made. Each day the ground track over a particular area will shift westward by about 22.5° at every sixteenth orbit if the period is close to 90 min.

There are two effects which cause further shifts in the ground tracks. First, the orbital period of a satellite varies because of, for example, the Earth's atmosphere. Second, because of the rotation of the Earth round its axis, the Earth bulges out at the equator and is flattened at its poles. This deviation of the Earth's shape from a perfect sphere causes the plane of the satellite orbit to rotate round the Earth's axis and also causes the ellipse to turn in its own plane by up to 5° per day. The rotation of the orbital plane round the Earth's axis can amount to as much as 10° per day.

For reconnaissance satellites the second effect is often used so that they

[1] The time required for a satellite to go round the Earth once is called its period.
[2] The ground track is defined as the projected path traced out by a satellite over the surface of the Earth.

pass over a region of interest on the Earth at the same time of day throughout the active lifetime of the satellite. Thus the reconnaissance photography always refers to the same local time so that changes in activity in the region can be compared from day to day. This is done by placing a satellite in a Sun-synchronous orbit in which the satellite is orbited with an inclination of almost 90°. The plane of the satellite orbit contains both the Earth and the Sun. To maintain the Sun-synchronous orbit, the plane of the satellite orbit has to be rotated 360/365 or 0.986° per day. If the satellite is in just the right orbit, the Earth's equatorial bulge will deflect the orbital plane by this amount.

The orbital inclination determines the range of latitudes over which the satellite travels on each revolution. Therefore, the choice of a particular orbital inclination depends on where the area of interest is and how closely it is to be observed. Another factor which might influence the choice of orbital inclination is economics. If a satellite is launched eastwards from any place along the equator, it already has an initial velocity of 1 700 km/h because of the Earth's rotation. Less power is thus required from a rocket to put a satellite in orbit with an orbital inclination of considerably smaller value than 90°.

The changes in ground tracks discussed above are slow and it often takes a long time before a satellite is correctly positioned over an area of interest. Satellites are therefore often manoeuvred from a ground station on the Earth in order more quickly to bring them over a specific region.

Whether an object can be detected from a satellite depends upon a number of factors, among which are the characteristics of the camera carried by the satellite, the type of film used, the contrast between the object being photographed and its surroundings, the shadow it casts and the satellite's altitude. The latter varies from perigee to apogee.[3] For achieving good photography, it is advantageous to have a low satellite altitude, but with a low altitude the drag of the Earth's atmosphere reduces the lifetime of the satellite. In the case of US satellites, they usually descend to heights of about 150 km over the target area and then ascend to altitudes of about 400–500 km. In this way the effects of atmospheric drag on the satellite are minimized. (For more detailed analyses of photographic reconnaissance satellite orbits and the image quality of photographs obtained from such satellites, see *SIPRI Yearbook 1975* [1].)

Electronic reconnaissance satellites

The primary function of electronic-reconnaissance or ferret satellites is to pinpoint the locations of air-defence and missile-defence radars usually located along the borders of a country. These satellites also determine the

[3] When the orbital path of a satellite is elliptical, the shortest distance between the Earth and the satellite is called the perigee height, and the longest distance the apogee height.

signal characteristics and detection range of such radars so that, with a knowledge of their location, the penetration of enemy air defences by strategic bombers can be efficiently planned.

It is essential to know the characteristics of each basic type of enemy radar so that the electronic countermeasure (ECM) equipment carried by bomber aircraft can be suitably designed. The purpose of such ECM instruments is to interfere with enemy air-defence radars. The interference may consist of generating spurious signals which create an illusion in enemy radar systems of several bombers, thereby confusing enemy anti-aircraft missiles. Details such as the operating frequency of enemy radar and the speed at which its antennas rotate, the rate at which it transmits successive pulses and the length of time each pulse lasts, are measured. ECM equipment carried by the bombers must also be designed to cope with enemy electronic counter-countermeasures (ECCM).

These satellites are also used to locate military radio stations and to eavesdrop on military communications.

The ideal altitude for electronic reconnaissance satellites is slightly higher than that for photographic reconnaissance satellites. However, the altitude for an electronic reconnaissance satellite should not be so high that its sensitivity is significantly reduced. It is true that the higher the satellite, the longer its lifetime, but a high altitude reduces the payload that the launch vehicle can carry. In view of these factors, the most commonly chosen altitude for most electronic reconnaissance satellites is in the range of 300–400 km, at which altitude the satellite's lifetime is from several months to many years. However, the useful lifetime is in fact determined by the lifetime of the satellite's batteries and solar cells as well as that of its complex electronic receivers and tape recorders.

Navigation satellites

Signals are transmitted from navigation satellites on very stable frequencies, providing a constant reference frequency, a navigation message as well as timing signals. A navigation message describes the satellite's position as a function of time. An updated navigation message and time corrections are periodically transmitted from the ground stations to the satellite. By receiving these signals during a single pass, a navigator can accurately calculate his position.

In order to determine his position, the navigator must relate it to the known position of the satellite in its orbit. In practice the position and velocity of a navigator in space are determined from simultaneous observations made by the navigator of the range and range rate (the rate at which the distance between the navigator and the satellite changes) at any given time relative to the known positions and velocities of three navigation satellites.

Radio signals received from a moving satellite appear higher in frequency as the satellite approaches the navigator and lower in frequency as the satellite recedes from the observer. The difference between the observed frequency and the known transmitter frequency is known as the Doppler shift. The Doppler shift is a measure of relative motion of the satellite and the navigator or the relative position when the relative motions are integrated. In the Doppler technique, the frequencies received from the satellites are compared with those generated in the navigator's equipment so that the shift in frequency due to the satellite's motion is determined.

The observation time is usually about 15 min and the oscillator frequency is sufficiently stable to give accurate readings. A number of other factors affect the accuracy of the system, such as: (*a*) the instrument and measurement noise in the form of local and satellite oscillator phase jitter, or navigator's clock error; (*b*) uncertainties in the geopotential model used in generating the orbit; (*c*) incorrectly modelled surface forces such as drag and radiation pressure acting on the satellites; (*d*) ephemeris rounding error (the last digit in the ephemeris is rounded); and (*e*) uncorrected propagation effects—ionospheric and tropospheric effects.

The root sum square (rss) of all the errors lies in the range of 18–35 m. Experiments indicate that the rss range is 27–37 m with a maximum error of 77 m [2].

Two other main sources of error result from refraction of the signal radiation transmitted by satellites. The greater of the two is due to the ionosphere. The wavelength of radiation passing through the ionosphere is somewhat distorted due to interaction with free electrons and ions. The amount of distortion of the wavelength is approximately inversely proportional to the square of the transmitted frequency. The path length of the transmitted signal through the ionosphere changes because of the satellite's motion round the Earth. The rate of change of the path length causes an ionospheric refraction frequency shift error in the received signal. It has been shown, however, that this can be corrected if the Doppler measurements are made at two different frequencies [3]; US Transit satellites, for instance, transmit coherent signals at both 150 and 400 MHz.

If only one frequency is used for transmission, for example 400 MHz, the total magnitude of the errors caused by the factors enumerated above varies from very small to 200–500 m, because the density of the ionosphere varies from less dense at night to highly dense during daytime. The density also depends on sunspot activity and location with respect to the magnetism of the equator where the ionosphere is most dense. Using a high frequency results in a maximum error of 242 m and an rss error of 88 m [2].

The second type of error is introduced by the troposphere. As the signal radiation passes through the Earth's atmosphere, the signal wavelength is compressed because the speed of propagation is reduced. This effect is directly proportional to transmission frequency and therefore cannot be detected in the same manner as ionospheric refraction. The effect of tropospheric refraction can be reduced in two ways: in one method, the effect is compensated by using knowledge of temperature, pressure and humidity; in the second method, the tropospheric effects are reduced by disregarding any data obtained close to the horizon. Above 5°–10° of elevation, the tropospheric error is many times smaller than that at the horizon.

Communications satellites

For long-distance communications, the use of satellites as relay stations allows large parts of the Earth's surface to be covered. With such a system, the satellite transponder (receiver-amplifier-transmitter) replaces several intermediate repeaters which are necessary for long-distance communications in a conventional Earth-bound microwave system.

Communications satellites can be classified into two broad categories by their electromagnetic and orbital characteristics. In the first category, there are both passive and active satellites. A passive satellite, which may be a large metallic skin balloon construction, acts only as a reflector of radio waves. One serious disadvantage with such a system is that the reflected signal is very weak by the time it reaches the terminal on Earth. Thus, passive satellites are not commonly used in a communications system and they are now only of historical interest. An active satellite, on the other hand, carries a transponder system which receives communications signals transmitted from ground stations, amplifies them and retransmits them to other Earth stations.

In addition to the transponder, a communications satellite also has a system for transmitting a beacon signal to allow the Earth terminal antenna to locate and track the satellite. This signal may be generated within the satellite. Sometimes a beacon signal is produced by converting the frequency of a signal transmitted by the Earth terminal. Often, however, the beacon and telemetry functions are combined by modulating the telemetry information on to the beacon signal. The transponder in the US Defense Satellite Communications System (DSCS) Phase I satellites is a double-frequency conversion repeater, transmitting at 7.3 GHz and receiving at 8.0 GHz [4].

If a repeater is operated on the same frequency band for both input and output signals, these signals can be isolated by using different frequency bands for each type of signal. The frequency conversion is usually achieved by using either single conversion or double conversion. The choice depends on the required input-to-output power gain and the channel bandwidth [5]. If the bandwidth is large, a single conversion may be adequate. Where the input and output operating frequencies are high and a narrow bandwidth is desired, a double-conversion transponder may be needed.

The transponder is sometimes designed to include signal processing. The input radio-frequency (RF) signal is demodulated and the baseband signal is then modulated on to the output RF carrier. For military satellites, such a system can improve protection against jamming [4].

In the second category, communications satellites can be divided into three general types according to their orbital characteristics: synchronous, semisynchronous and nonsynchronous.

A synchronous satellite, orbiting at an altitude of about 35 900 km with the same period as the Earth's period of rotation about its own axis, will appear stationary with respect to the Earth if its orbital inclination is zero.

A nonsynchronous satellite has an altitude other than 35 900 km and orbits round the Earth with a period which depends on its altitude. This type of satellite is therefore visible from a given point on the Earth during only a part of its orbit; the duration and frequency of the visibility will depend on the orbital characteristics and on the positions of the Earth terminals. From some terminals, there may be good visibility during only some orbits, while from other terminals, the satellites may not be seen at all. Therefore, many nonsynchronous satellites are needed for continuous coverage of the Earth.

The total area of the Earth covered by a satellite at any time is bounded by a circle the radius of which is a function of the satellite altitude and the minimum allowable Earth antenna-elevation angle. In the case of an equatorial synchronous satellite, the Earth coverage area is fixed, whereas for a nonsynchronous satellite in a circular orbit the coverage area is circular, fixed in size and moving continuously over the Earth's surface.

It is important that at an Earth terminal the duration of visibility of a satellite is long. This duration increases as the satellite's altitude increases and also as the satellite orbital plane moves closer to the Earth terminal. At any altitude a direct overhead pass results in the longest duration of visibility. If a communications satellite does not have information-storage capability, the satellite must be able to be seen by two Earth terminals simultaneously to establish a link. This makes a nonsynchronous satellite system more complex than a synchronous one.

Communications satellites in the United States are placed in circular orbits at heights of about 40 000 km so that the effects of atmospheric drag are minimized. These satellites have an orbital inclination of nearly 0° so that their orbital period is about 24 h and they therefore follow the Earth's rotation, hovering over one spot above the Earth. An important advantage of such a synchronous equatorial orbit for long-distance communications satellites is that they can be tracked by an almost stationary aerial rather than by a rapidly moving one. Since the signals have to travel at least 72 000 km, however, sensitive radio receivers have to be used. On the other hand, a satellite in such an orbit can be seen from about one-third of the Earth's surface.

One disadvantage of such an orbit for countries situated far from the equator is that, for latitudes north of 70° N, the satellite is below the horizon and therefore unusable. The Soviet Union therefore chose for its Molniya communications satellites a semisynchronous orbit with a 12-h period and with perigee and apogee heights of about 500 km and 40 000 km, respectively. The apogee is over the northern hemisphere so that the satellite spends most of its time in orbit in high northern latitudes. One effect of the Earth's flattening at the poles and bulging at the equator is to cause the satellite orbit to turn in its own plane. However, if the orbital inclination is 63.4°, then the orbit remains stationary and will have a stable perigee. The orbital inclination of Soviet Molniya satellites is about 65° so that the movement of the apogee is negligible throughout the active lifetime of the satellite.

Since these satellites travel at high altitudes (about 40 000 km) there are marked effects of the gravitational forces of the Sun and the Moon. The satellites have to make small manoeuvres to stay in their correct positions. Moreover, as there is a sudden change in the gravitational field of the Earth in the mid-Atlantic region, satellites in the equatorial synchronous orbit have to be corrected so that they remain stationary over this region. Ideal positions for synchronous satellites are over the Pacific and Indian Oceans.

The selection of a particular orbit must also be subject to any limitations on the sensors the satellite carries. For a communications satellite, an important limitation of radio systems is the restriction on range imposed by transmission power limits. Satellite weight is nearly proportional to power so that more satellites can be launched with a given vehicle if the power requirements are low or if the satellite can be placed in a high-altitude orbit. Moreover, low power tends to reduce interference.

Below an altitude of about 1 600 km, an active communications satellite provides adequate service with omnidirectional antennas and relatively simple subsystems. For intercontinental communications, the lowest useful altitude is about 3 200 km. But at such altitudes and with circular orbits, hundreds of satellites would be required for significant coverage. The number of satellites necessary can be reduced if they are orbited above ca. 8 000 km. For high-quality communications, active-repeater satellites (see section III) need to be used, for which a minimum altitude of 16 000 km is necessary [5]. The best altitude is one at which the smallest number of satellites is required for worldwide coverage.

For global coverage, the cost of construction of ground stations is inversely proportional to the satellite altitude. More stations are required for point-to-point worldwide communications for satellites at low altitudes. A minimum number of ground stations are required for satellites in 24-h orbits (that is, in synchronous orbits).

Weather satellites

The US and the Soviet weather, or meteorological, satellites are launched into quite different orbits from those considered so far. A circular orbit is usually used with satellite altitudes between 500 km and 1 500 km—altitudes low enough for cloud details to be seen and high enough for wide views which overlap on successive revolutions to be photographed. US weather satellites are orbited in near-polar orbits so that each satellite can obtain a complete picture of the globe every 24 h.

Special orbital inclinations are often chosen, for example, for the US Nimbus satellite, to ensure that the satellites pass over the same area at the same time of day throughout their orbital lifetimes so that the photographs taken of weather conditions always refer to the same local time. Such an orbit is achieved if the precession[4] turns the orbital plane counterclockwise as seen from the north at the same rate at which the Earth rotates round the Sun. This means that the orbital plane remains stationary with respect to the Sun. An orbital inclination of about 100° produces the required precession of 0.98°/day, an orbital inclination not far from that used for meteorological purposes.

Examples of some of the orbits discussed above are shown in figure 5.1.

Geodetic satellites

Geodesy is the branch of applied mathematics that deals with the shape of the Earth, its gravitational field and the exact positions of points on the Earth's surface.

Accurate knowledge of the shape of the Earth and of the precise whereabouts of points on the Earth are important for mapping purposes. The Earth's gravitational field is far from uniform, since large sections of the Earth's crust have different densities. If the effects of the Earth's shape and its non-uniform gravitational field are neglected, then considerable errors may be introduced in the computations of trajectories and in the inertial guidance systems of missiles and aircraft.

The astrogeodetic method can connect all points of a land mass on to a consistent geodetic system of points, but it cannot span the oceans unless the land masses are close together. Geodetic satellites have been developed for this purpose and are employed by the armed forces, who use maps with grids accurately to locate specific places. Accurate knowledge of the relative positions of these grids and knowledge of the Earth's gravitational field became particularly important when long-range ballistic missiles were developed.

The orbital path of a satellite is an imperfect geometrical shape. The satellite weaves sideways and up and down as it moves in its orbit. These small orbital perturbations, ranging from a few centimetres to several metres, can be detected by Earth-based tracking stations and are measured

[4] Because the Earth is flattened at the poles and bulges at the equator, it causes the orbit of a satellite to turn round the Earth's axis while keeping its inclination constant. This effect is known as precession.

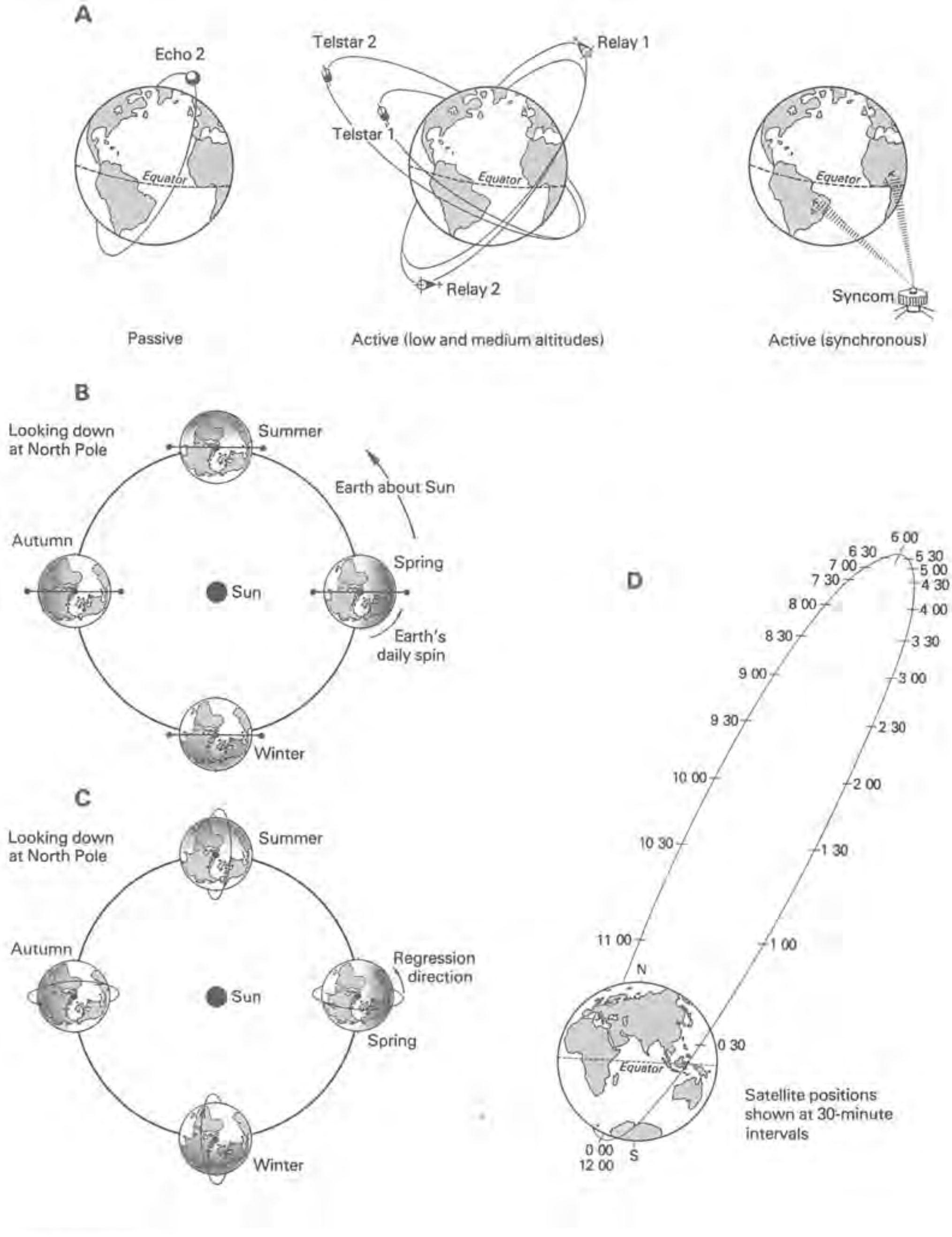
Figure 5.1. Four types of satellite orbit

A. Three orbits used by US communications satellites.

B. A 90°-inclination orbit, fixed in inertial space. The satellite can observe the bright side of the Earth for only part of the year.

C. A 97°—101°-inclination orbit chosen to regress at the proper rate so that the satellite can observe the bright side of the Earth throughout the year.

D. The 63°-inclination orbit used by Soviet Molniya communications satellites.



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to determine the shape and the distribution of the gravitational field of the Earth.

The positions of places located at great distances from each other on the surface of the Earth can be determined using satellites in one of the following three ways. In one method, known as the geometric-optical satellite system, the moving satellite is photographed against a star background simultaneously from two ground stations. This fixes a pair of directions from the two ground stations to the satellite and a plane which contains these directions and an as yet unknown straight line joining the two stations. Similar planes containing such a line will be defined for many satellite positions so that the direction from a known station to an unknown station can be computed. By repeating this determination of directions from known to unknown stations, a worldwide network of stations can be formed, comparable to a huge triangulation net.

In a second method, the position of a satellite is determined by measuring three simultaneous distances from three known ground stations. After three satellite positions have been determined, an unknown ground station is fixed in relation to them and its position in relation to the known ground stations can then be computed. This is comparable to triangulation in three dimensions.

In the third method—a dynamic satellite system—the orbit of the satellite is determined first from equations of motion which relate the satellite's position to the centre of the Earth and include the orbit's perturbations due to an estimate of the Earth's irregular gravitational field. One type of dynamic satellite system is the Doppler system. The Doppler satellite is tracked from a ground station and its nearest distance is deduced from the Doppler effect of its approach and departure. By tracking several satellites, the position of the ground station is linked to their orbits and in turn to the centre of the Earth, yielding geocentric coordinates. If two ground points are thus linked to the same geocentric coordinate system, their positions relative to each other can be computed.

A satellite used for these purposes should have a minimum perigee height of 700–1 000 km so that effects of atmospheric drag are minimized. The orbital inclination should be such that observations at higher latitudes are also possible. An inclination of 55°–70° would make the satellite accessible to most areas of interest. If, however, a satellite is used to measure the Earth's gravitational field, various other orbital inclinations are preferable.

The eccentricity[5] of the satellite's orbit should be 0.05 or less, so that geometrical problems become simpler. Such an eccentricity would ensure an almost circular orbit which would keep the satellite within an accurate observing range. For dynamical applications, larger eccentricity, of the order of 0.2, is desirable to produce a measurable motion of the perigee [6].

[5] The eccentricity of an ellipse is defined as the ratio of the distance between the centre and focus of the ellipse to its semimajor axis.

III. *US military satellite programme*

The use of artificial Earth satellites for reconnaissance purposes was recognized in the United States as long ago as 1946. During the 1950s, US aerial and space reconnaissance programmes were developed (see appendix 5A), and on 10 August 1960 the first US reconnaissance satellite, Discoverer 13, was launched from the Western Test Range (WTR) at the Vandenberg Air Force Base, Point Arguello, about 204 km northwest of Los Angeles. This satellite ejected a capsule containing the first film to have returned to Earth and been recovered. The US military satellite programme has developed considerably since the launch of Discoverer 13.

Electronic-reconnaissance, navigation, communications, geodetic, early-warning and weather satellites have also been developed and used on a routine basis in the United States. Ocean-surveillance satellites have also recently been developed and launched. During the early 1960s, development of the technology and possibly some hardware for interceptor/destructor satellite systems was considered in a number of United States Air Force (USAF) and United States Navy (USN) satellite programmes. Most of these, however, were either cancelled or suspended, but interest in such systems has recently been revived.

The US military satellite programmes are briefly described below.

Photographic reconnaissance satellites

Initially, Agena photographic reconnaissance satellites with close-look types of mission were launched using Atlas launchers (see table 5.1); from mid-1966, Agena D satellites have been launched using Titan-3B rockets. Although both these launchers are the same size, the payloads put into orbit differ: 1 500–2 000 kg for Atlas and about 4 500 kg for the Titan-3B launchers [7]. The increased payload capability allows larger film packs, longer focal-length cameras and a larger number of film-recovery capsules to be used.

A close-look satellite is usually launched about four to eight weeks after an area-surveillance satellite has been launched. This has led to the development under Program 467 (or LASP—Low Altitude Surveillance Platform) of the third type, the new-generation Big Bird satellite, designed to perform both the area-surveillance and the close-look types of mission. Big Bird satellites are launched using Titan-3D rockets which can place a payload of some 13 600 kg into low Earth orbit. The vehicle consists basically of two Titan core stages with two five-segment, strap-on solid boosters three metres in diameter. The satellite has its own propulsion system for orbital adjustments during flight.

The use of area-surveillance and close-look satellites by the USA has decreased. In 1976 only three photographic reconnaissance satellites were launched. Of these, one was the large Big Bird satellite and the remaining two were close-look Agena satellites.

The characteristics of the US photographic reconnaissance satellites launched during 1976 are given in table 5.2.

Electronic reconnaissance satellites

Since October 1972, Big Bird satellites have carried electronic reconnaissance satellites into orbit; at a later stage these satellites were ejected into independent orbits with much greater perigee heights. In 1976, only one such satellite was orbited. Its orbital characteristics are given in table 5.3.

Early-warning satellites

A missile early-warning satellite was successfully launched from the Eastern Test Range (ETR) at Cape Kennedy, 28° 28′N, 80° 31′W, halfway down Florida's eastern coastline, on 14 December 1975. However, the satellite equipment developed a fault. As a result, on 26 June 1976 another early-warning satellite, the only one launched that year, was sent up from ETR. The orbital characteristics of this satellite are given in table 5.4.

Ocean-surveillance satellites

The US Navy recently launched its first prototype ocean-surveillance satellite into a near-circular orbit, using an Atlas rocket. Designed to monitor surface ships, this satellite was built by the Naval Research Laboratory and code-named Whitecloud. The satellite contains a number of sensors, including passive infrared and millimetre-wave radiometers as well as rapid-frequency antennas for detecting shipborne radar and communications signals [8]. The satellite also carried three small sub-satellites which are now orbiting the Earth in near-circular orbits similar to that of the main satellite. Each of these sub-satellites is believed to carry an infrared/millimetre sensor so that, together with the main satellite, a large part of the ocean surface is covered. The sub-satellites are believed to transmit their data to the parent satellite for processing and relay to the Earth stations [9].

The orbital parameters of these satellites are given in table 5.5.

Navigation satellites

Military operations which involve moving weapon systems such as aircraft, missiles or ships require knowledge of their position, velocity and direction. These requirements are being fulfilled by navigation satellites. Potentially the technology offers a continuous worldwide navigation capability with high accuracy.

Military navigation satellites have been proposed for three altitudes: low altitude (900–2700 km), medium altitude (13000–20000 km) and synchronous altitude (22000–48000 km). At these altitudes the orbital periods of the satellites are 100–150 min, 8–12 h and 24 h, respectively. All the US navigation satellites launched up to 1974 have been of the low-altitude type. The present system uses the Doppler technique to determine the navigator's position. At low altitudes the Doppler shift recorded by the navigator is more pronounced than at medium or synchronous altitudes because of the greater difference in velocity between the satellite and the navigator. In this technique the satellite transmits two types of signals. A radio wave is transmitted on two carrier frequencies—about 150 MHz and about 400 MHz. The satellite also transmits in code the latest information about its own orbit. The latter is recorded in the memory of the satellite's computer each time it passes over a ground station.

The US Navy was initially concerned with the development of navigation satellites under the Navy Navigation Satellite System (NNSS) programme. On 17 September 1959, Transit 1A, the first of a series of satellites using the Doppler technique for navigation, was launched using a Thor rocket with an Able upper stage; the satellite failed to orbit, however. Until November 1961, Thor/Able rockets were used to launch Transit satellites from Cape Kennedy but at the end of 1962 Scout launchers were introduced and the satellites were launched from Vandenberg AFB. These four-stage vehicles are relatively inexpensive and were used to launch small payloads on a wide variety of missions. The Transit satellite was designed basically as an aid to navigation for missile submarines, but towards the end of 1964 secrecy descended over the programme and the designation Transit ceased to be used.

A second set of satellites in the NNSS programme are the TIMATION (Time Navigation) satellites. Navigation using these satellites is based on the measurement of time a radio signal takes to travel from the satellite to the navigator's receiving equipment. Three such experimental satellites have been launched so far: one in May 1967 (TIMATION I, 1967–53F), one in 1969 (TIMATION II, 1969–82B) and one in 1974 (TIMATION III, 1974–54A). They are sometimes called Navigation Technology Satellites (NTS).

A Defense Navigation Satellite Development Program is also under consideration by the US Air Force. The proposed demonstration satellite system would consist of four satellites, the centre one at a synchronous altitude and the remaining three in inclined elliptical orbits having periods of 24 h. USAF navigation technology is in some respects similar to that developed by the USN. In both systems, for example, the position of the navigator is determined by making simultaneous measurements of distance (range) from the navigator to each of several satellites. But the differences between the two systems lie in the orbital configuration and satellite altitude. The USN orbits its satellites in polar orbits at medium altitude. Only three satellites are needed to give global coverage but the navigator can only determine his position intermittently and in two dimensions. However, a total of 27 satellites would provide continuous global coverage in three dimensions, including the altitude. In contrast, the USAF plans to have a combination of satellites in geosynchronous and semisynchronous orbits. In this case a minimum of four or five satellites are needed in a regional constellation and a total of 20 satellites, five in each regional constellation, are needed to cover the Earth. Moreover, USN satellites such as TIMATION have an accurate crystal oscillator on board so that each spacecraft operates autonomously except for periodic updating of its orbital parameters and its clock from several ground stations situated in various regions of the Earth. In the case of the USAF programme, the satellites are used as intermediate transmitters of signals originating at a central ground station for each regional constellation. For determining the position of each satellite in orbit, several additional small ground terminals would be required for each regional constellation.

Although the desirability of a joint services programme for the development of a satellite navigation system which would provide accurate navigation capability to ground-based, airborne or shipborne weapon systems was recognized for some time, it was not until mid-1974 that such a programme was initiated. A new system, called the Global Positioning System or the Navstar, was planned.

The Navstar system will consist of 24 satellites grouped equally into three rings situated in circular orbits, at altitudes of about 20 000 km with 12-h periods and at orbital inclinations of 63°. It is expected that with such a system a navigator will be able to obtain continuous position fixes in three dimensions to within about 10 m and will be able to determine his velocity to within about 6 cm/s [10]. The system is designed particularly with weapon delivery systems in mind. For example, it will very accurately navigate ICBMs to their targets. It is envisaged for use with nuclear weapons and for synchronizing the automated battlefield [11].

The Navstar system is expected to become operational in 1984. A Navigation Technology Satellite, NTS-1, was launched on 14 July 1974 from ETR to test techniques under consideration for use in the Navstar system. The satellite was equipped to transmit on two frequencies, 35 MHz and 1 580 MHz, so that an evaluation of dual-frequency operation could be made, particularly from the point of view of improving navigational accuracy. The satellite also carried a quartz crystal oscillator and a rubidium atomic clock [12]. However, tests of these clocks and other experiments have had limited success because of satellite stabilization problems [13]. In early 1977, NTS-2 will be launched to test advanced atomic and crystal frequency standards for use in the Navstar system [14]. Future developments include caesium atomic clocks and hardened satellites to minimize vulnerability to both nuclear and non-nuclear attacks. The possibility of using Navstar for navigating other spacecraft in geosynchronous or elliptical orbits is also being considered [15]. The orbital characteristics of these US navigation satellites are shown in table 5.6.

Communications satellites

The US Deparment of Defense (DoD) has basically two independent types of communications satellite systems forming a part of the World-Wide Military Command and Control System (WWMCCS). These are often called strategic and tactical communications satellite systems. The first system carries high data-rate strategic command and control signals over long distances, using large ground and shipboard terminals. Moreover, intelligence data, high-priority warning and special communications are also transmitted by such systems. In the tactical system, satellites are employed to transmit command and control communications essential to military forces. This type of system can only process low data-rate communications.

The concept of the communications satellite system began in 1958 with Project SCORE (Signal Communication by Orbiting Relay Equipment) when the USAF orbited an Atlas ICBM-type burnt-out rocket stage equipped with two-way radio equipment which transmitted taped messages for 12 days. The SCORE satellite was followed by Echo passive satellites in 1960 and 1964. This latter type of satellite requires ground-station transmitters of much higher power than those required for active satellites. An active satellite, Courier, was also launched in 1960.

After a long series of studies, the Initial Defense Communication Satellite Project (IDCSP) was established towards the end of 1964 by the USAF [16]. Under this programme two types of systems were suggested. In one it was planned to use Atlas-Agena boosters to place a number of satellites at a time into approximately 11 000-km random polar orbits. In a second system, only a few synchronous-altitude satellites would be placed in equatorial orbits. In the latter case, only two satellites would be launched at a time using Titan 3C rockets. After a successful Titan 3C launch in June 1965, however, the Atlas-Agena project was cancelled and in June 1966, seven IDCSP satellites were launched in near-synchronous orbit using a single Titan 3C rocket. The IDCSP was renamed the Initial Defense Satellite Communication System (IDSCS). While the IDSCS provided limited operational capability between widely separated fixed terminals, the LES (Lincoln Experimental Satellite) series of satellites demonstrated advances in technology which allowed communications between aircraft, ships, mobile ground terminals and large fixed installations [16].

The second phase of the DSCS system is a high-capacity, super-high frequency (SHF) system which provides protection from jammed voice and data links for the WWMCCS. This system also provides such protection for the worldwide Diplomatic Telecommunication Service, as well as providing transmission of some surveillance, intelligence and early-warning data. Under this programme the USAF has launched two satellites in 1971, two in late 1973 and two in May 1975.

It has been argued that a reliable satellite communications system for command, control and communications of US strategic nuclear forces must be able to withstand severe physical and jamming attacks during wartime if the strategic nuclear force is to be a credible deterrent [17]. Considerable effort has been spent on this question under the Air Force Satellite Communication (AFSATCOM) programme; two experimental satellites, LES 8 and 9, were launched in 1975 to demonstrate and validate the necessary technology. The AFSATCOM will use short, low-speed (teletype) messages for force execution, report-back and force redirection. The use of such messages together with suitable anti-jamming techniques will allow for relatively simple UHF low-power terminals aboard operational vehicles.

The first regularly operating satellite telecommunication service in the world was demonstrated by the USN in January 1960, a service which still continues. As further advances in the field of UHF and higher frequency propagation and their applications to communications satellites were made, the USN expanded its programme to use man-made satellites for communications. With this technique, transmission of signals became relatively insensitive to atmospheric and solar disturbances. In 1970, the USN evaluated its satellite communications programme by testing Tacsat 1 (Tactical Satellite) and LES 6 [18]. The latter satellite is still in orbit, providing limited operational use.

In 1975, the USN leased a satellite from the Communications Satellite Corporation [18] until various other satellites become operational. It is planned that, beginning in late 1976 and over a period of one year, the USA will launch three or four geostationary satellites. These satellites will be called the Fleet Satellite Communication (FLTSATCOM) which will provide communication by digitalized voice, teleprinter and other techniques. Moreover, these satellites will be able to pass computer-to-computer data thus providing real-time readiness, for example, of ocean surveillance and combat direction. The FLTSATCOM will operate at UHF but, unlike the DSCS, it will have relatively small capacity. These satellites are expected to be launched some time in 1977. Orbital data of these satellites are shown in table 5.7.

Weather satellites

The US Army, Navy and industry began to study weather satellite technology in the early 1950s—in particular, the Radio Corporation of America (RCA) applied to meteorology the experience it had gained in studying television-equipped satellites for the Air Force. But it was not until early

1973 that the USAF first acknowledged that it had been operating its own weather satellites [19]. In the early 1960s, the USAF relied upon cloud-cover photographs obtained from the civilian RCA-built TIROS satellite. However, civilian and military meteorological requirements are very different: the military require high-resolution cloud-cover photographs over specific geographical regions, whereas the civilian requirement is for low resolution but for wider area coverage. The military therefore embarked on a separate weather-satellite programme. Very little is known about this USAF programme, designated Program 417 [20], but its requirement was to develop a weather reconnaissance satellite. It has been reported that the first experimental military weather satellite built by RCA was launched into polar orbit from Vandenberg AFB on 18 January 1965 using the Thor/Altair rocket [19]. The satellite weighed 73 kg and carried a payload of vidicon cameras.[6] More advanced weather satellites have subsequently been launched from Vandenberg AFB. On average, two or three satellites have been launched each year to secure global coverage for military forces around the world.

The satellites, communication links and terminal equipment have been considerably improved. The USAF weather satellites provide very high-resolution visible and infrared photographs of cloud cover of all parts of the world twice daily. The resolution of the satellite sensors is between 0.6 km and about 4 km [19]. Measurements of vertical profiles of atmospheric temperature are continuously being made so that an adequate global distribution of upper-air temperature data becomes available. This would potentially improve and expand the capabilities of military weather services.

There are two large, fixed, weather satellite-data receiving terminals in the United States: one at Fairchild AFB (Washington) and the other at Loring AFB (Maine). Weather data are first stored on tape recorders aboard the satellite and are then transmitted to remote overseas ground stations. The data are then relayed to the two ground terminals via relay satellites. From these terminals the data are immediately transmitted to the USAF Global Weather Central at Offutt AFB (Nebraska). The photographic images can be converted to digital data and processed by computers so that observations, analyses and forecasts can be generated automatically. Final output is distributed through the USAF Automated Weather Network directly to military installations around the world. The Air Force also has tactical air transportable data-acquisition terminals in vans which can be flown to any part of the world and set up within hours to receive data from the satellites.

The USAF has developed a second-generation satellite—the Block 5D

[6] The vidicon camera is the satellite television camera system whose main component is a layer of photoconductive material. The image of an object is formed on this layer, and is then converted into electrical signals.

Integrated Spacecraft—to provide increased meteorological capability. This new satellite was designed and built by RCA.

Since 1973, the USN has also participated in the military weather-satellite programme. Under the USAF/USN programme, tests—consisting in installing two data-receiving and -processing terminals on two ships—were conducted during 1972 and 1973 to determine the ability of ships at sea to receive real-time weather data from satellites in polar and Sun-synchronous orbits [21]. The USN is planning to install a complex data-processing centre at its Fleet Numerical Weather Central (Monterey, California) where all the weather data and photographs will be processed. At present the navy can receive, at Monterey, data directly from the USAF satellites or indirectly from the USAF Global Weather Central [22].

It is possible that the military may also use the two Synchronous Meteorological Satellites (SMS-1 and SMS-2) in geostationary orbits over the equator: they provide cloud-cover photographs at 30-min intervals on a continuous basis. The planned operational lifetime of the satellites is five years.

Orbital characteristics of these satellites are given in table 5.8.

Interceptor/destructor satellites

Although no information is available on actual tests of a satellite interceptor/destructor system in the USA, it is known that at least a limited capability to intercept hostile satellites exists. The US system uses missiles based on Johnston and Kwajalein islands in the Pacific Ocean [23]. Programmes have been initiated to investigate the possibility of orbital interceptors, but information on such programmes is of a fragmentary nature.

USAF Program 437 considered the satellite inspector system, but it was reported that this programme had been merged into Program 922, which investigated the feasibility of a direct-ascent anti-satellite system. It was reported that an attempt was made in 1971 to launch such a satellite system, but that it failed [24].

The US Army also considered a satellite interceptor/destructor system, using Zeus and Nike X missiles, under its Program 505.

Another programme, Project 706 or Project SAINT (Satellite Inspector Technique), was conceived in 1960 to demonstrate a military rendezvous with unknown or unidentified spacecraft in Earth orbit. The initial launch of such a system was to have been made in 1962 by an Atlas-Agena B rocket but the project was abandoned before the flight took place [23, 25].

Other USAF programmes related to anti-satellite operations were the PRIOR programme and RMU (Remote Maneuvering Unit). The latter programme was related to Project SAINT and consisted in investigations of systems to detect, intercept, inspect and destroy hostile satellites. The system would have used television and radio command links.

Some of these programmes were concerned with inspector satellites. Programme Skipper, an anti-satellite weapon system, was a concept involving vertically launched space mines. This study programme was mainly concerned with satellite destruction systems and was associated with the USN Early Spring programme.

Although there appear to have been no US inspector/destructor flights corresponding to Soviet experiments in this field, the Gemini flights (1965–66) successfully demonstrated the US inspector/destructor capability. Gemini 3, launched on 23 March 1965, successfully carried out manned orbital manoeuvres. Gemini 6 and 7 were launched on 15 December and 4 December, respectively. On 15 December a successful rendezvous between the two satellites was carried out in space. Gemini 8, launched on 16 March 1966, docked with the Agena target vehicle on the same day. The Gemini programme was conducted by NASA, but the Department of Defense also played a major role in this programme [26]. The DoD was interested in the satellite rendezvous technique, particularly with a non-cooperative satellite.

Recently the USAF has shown interest in the development of small ground- and air-launched anti-satellite interceptors, consisting of a non-explosive interceptor guided by a long-wavelength infrared homing system to its target satellite, which would be destroyed by collision [27].

Geodetic satellites

The early attempts in 1958 and 1959 to launch geodetic satellites were unsuccessful (see table 5.9). However, on 31 October 1962, ANNA 1B was successfully orbited after ANNA 1A had failed. Nearly all satellites are of value from the point of view of geodesy. For example, the most useful of the non-geodetic satellites were the Echo communications satellites which were easy to see with optical instruments. Pageos was another balloon satellite orbited by NASA in 1966 specifically for geodetic work.

To help make truly simultaneous observations, flashing lights were installed on several geodetic satellites. The lights flash in coded sequences so that widely separated stations can compare time exposure photographs taken against the background of the fixed stars. The DoD satellite ANNA 1B carried the first optical beacon into orbit in 1962. GEOS A (Explorer 29), launched on 6 November by NASA, also carried a flashing light.

Radio beacons of various types are carried by many satellites to aid in tracking them. NASA's Explorer 22 and 27 satellites carried both laser reflectors for tracking as well as radio beacons which combined the tracking functions with signals for ionospheric research. GEOS B (Explorer 36), launched on 11 January 1968, carried, in addition to the necessary geodetic instruments, C-band radar transponders to determine whether or not C-band radar tracking stations can track with sufficient accuracy for geodetic work [28].

On 1 January 1972, management responsibility for all DoD geodetic and gravimetric programmes was transferred from the Defense Intelligence Agency to the newly established Defense Mapping Agency [17].

IV. *Soviet satellite programme*

During the mid-1960s the Soviet space programme began to proliferate. Here only some of the military satellite programmes are discussed. From 1962 onwards, most of the Soviet satellites have been designated Cosmos plus a serial number. The Cosmos series covers a variety of missions and it is only through the study of repetitive patterns in orbits, the kind of debris associated with the flights, the types of signals they transmit, and the timing of the satellite launches that it has been possible to classify most of the individual satellites by their various missions.

Eight types of Soviet satellites will be briefly discussed: photographic reconnaissance satellites, electronic reconnaissance satellites, ocean-surveillance satellites, navigation satellites, communications satellites, fractional orbital bombardment systems and the satellite interceptor and destructor system.

Photographic reconnaissance satellites

In the Cosmos series, the Soviet Union has continued to launch 12- and 13-day photographic reconnaissance satellites. An interesting satellite which might belong to this series was Cosmos 758. It was launched from Plesetsk and exploded after only four days in orbit. This satellite might have been part of the Soviet Satellite Intercept tests or it might have been exploded intentionally after a mission failure [29]. It is possible that the satellite was on a photographic reconnaissance mission and carried a high-resolution camera [30]. It is difficult to be certain about this satellite because it was orbited at 67°—an unusual orbital inclination for a Soviet reconnaissance satellite. Two additional such satellites, Cosmos 805 and Cosmos 844, were recently launched. The former transmitted on a new frequency, manoeuvred during flight and was recovered after 20 days [31]; the latter exploded after three days. Certainly Cosmos 758 marked the beginning of a new programme. These satellites may be the first of the Soviet long-lived photographic reconnaissance satellite programme.

The orbital characteristics of these satellites are given in table 5.10.

Electronic reconnaissance satellites

The Soviet Union has continued to launch electronic reconnaissance satellites with orbital inclinations of 71° and 74° and with orbital periods of 92 min and 95 min, respectively.

The orbital parameters of these satellites are shown in table 5.11.

Ocean-surveillance satellites

Launch vehicle type F-1-m has been used to orbit two types of satellites. Those in the first group belong to the interceptor/destructor satellites which will be described below. A second group of satellites launched by this vehicle are believed to be the ocean-surveillance satellites. An important feature of these satellites is that they perform ocean-surveillance missions while in orbits with perigee and apogee heights of about 250 km and 260 km, respectively. After a few weeks, the satellites eject several objects and are then manoeuvred into new parking orbits at greater perigee and apogee heights of about 870 km and 930 km, respectively.

The first of such flights was performed by Cosmos 198, launched on 27 December 1967. In 1970, Cosmos 367 was launched and moved to its higher orbit so rapidly that only the higher orbital parameters were announced [32]. The true nature of these satellites was not learned until 1974 when the US Navy announced that the Soviet Union had been developing an ocean-surveillance satellite system [33].

Orbital characteristics of the Soviet ocean-surveillance satellites are given in table 5.12.

Early-warning satellites

Early-warning satellites are ideally suited for learning of the launch of intercontinental ballistic missiles with nuclear warheads, and it is therefore reasonable to assume that the Soviet Union has also developed such a satellite system. It has been suggested that vehicle type A-2-e has been used to orbit early-warning satellites into 12-h orbits from Plesetsk [32].

It seems that the recently launched Cosmos 775 is probably the first Soviet early-warning satellite in synchronous orbit [34]. This satellite was launched using the type D-1-e vehicle from Tyuratam. It was placed in a synchronous orbit, the plane of which was inclined at 0.03° to the equatorial plane. The perigee and apogee heights of the satellite were 35 737 km and 36 220 km, respectively. The satellite was placed into a position over the Atlantic Ocean where it could observe any US submarine-launched ballistic missiles (SLBMs).

The details of the orbital characteristics of these satellites are shown in table 5.13.

Navigation satellites

Analyses of Soviet satellite orbital data and monitoring of their telemetry signals have identified satellites which are probably used for navigation purposes. Moreover, identification of such satellites is particularly facilitated if a group of satellites with similar orbital parameters also have a geometrical relationship which allows complete global coverage.

The Kettering Group calculated the values of the right ascension of the ascending node[7] of satellites with orbital inclinations of about 74°. These satellites were chosen because they had orbital characteristics similar to those of the US Transit navigation satellites. The Group showed that the satellites (with 74° inclination and 104-min period) launched during 1970–72 had orbital planes spaced at 120° intervals [35]. Analyses of the right ascension of ascending nodes show that Cosmos 475 and 489 replaced Cosmos 385 and 422 at intervals of about one year, indicating that the useful lifetime of the payload is about one year. These satellites formed a three-satellite navigation system.

On 16 August 1972, Cosmos 514 was launched into an orbit with very similar characteristics to those described above, except that its orbital inclination was 82.97°. Subsequently, Cosmos 627 and 689 replaced Cosmos 514 and 574, respectively, and Cosmos 586 was replaced by Cosmos 628 and 663. This new set of satellites provide the same kind of global coverage as those at a 74° inclination but their orbital planes are now spaced at 60° rather than 120° intervals [36]. These satellites formed a six-satellite navigation system. It was found that these navigation satellites transmit on 150 MHz and 400 MHz, frequencies also used by the US navigation satellites [36].

Cosmos 778 was launched on 4 November 1975. The orbital plane of this satellite and that of Cosmos 726 were 30° apart. This was the beginning of the new set in which the orbital spacing of the navigation satellites is 30°. Cosmos 789, launched on 20 January 1976, also belonged to this new system of satellites [37].

The orbital characteristics of all the Soviet navigation satellites are given in table 5.14.

Communications satellites

It is impossible precisely to determine how extensively the Soviet armed forces use civilian satellites for military purposes. The civilian and military Soviet communications satellite programmes are carried out by the Molniya satellites. However, with the increasing number of Molniya satellites, it is very likely that the Soviet military use these satellites for their purposes, particularly since domestic television coverage has not been expanded through use of the extra channels available. By the end of 1975, for example, the Molniya 1 series (begun in 1965) consisted of 33 satellites; the Molniya 2 series (from 1971) consisted of 15 satellites; and the Molniya 3 series (from 1974) consisted of three satellites.

[7] The points of intersection of the orbit with the celestial equator are called the nodes. If a terrestrial sidereal rectangular coordinate system (X,Y,Z) has the origin at the centre of the Earth, then the angle between the line joining a node and the X-axis is the right ascension of the ascending node. The X-axis is oriented towards the vernal equinox or the first point of Aries. The equatorial plane of the Earth is inclined to the plane of the Earth's orbit about the Sun. The line of intersection of these two planes is called the line of the vernal equinox leading to the first point of Aries.

Unlike the US satellites, Soviet spacecraft carry large payloads, of at least 1 000 kg, and have about 10 times the power output of the US Early Bird satellite of the same period. In the Soviet space programme the basic launch vehicle is the 1957 ICBM, the SS-6 Sapwood, to which are added one or more upper stages, depending on the mission. For the Molniya flights, the vehicle consists of a 1 1/2-stage booster with a second-generation upper stage plus an escape stage; the vehicle has been designated the A-2-e.

The Soviet Union places communications satellites in orbits with periods of about 12 h, with perigees of about 500 km in the southern hemisphere and apogees of about 40 000 km in the northern hemisphere. If three such satellites are orbited 120° apart in a plane, each satellite will provide about nine hours of coverage per day over the Soviet Union. Because of the orbital inclination of 62.8°, the satellite not only provides excellent coverage at northern latitudes but also provides visibility simultaneously on passes through the apogee across the polar regions. The satellites with orbital planes 120° apart were superseded by those with orbital planes spaced 90° apart. This constituted a four-satellite communications system. During 1976 Molniya 1 satellites have been placed in between Molniya 2 and 3. This leads to the speculation that Molniya 1 series are military communications satellites [31].

Molniya satellites make two orbits daily, one of which is over the Soviet Union and the other over North America. The orbital parameters are optimized so that the longest communication period occurs over the region between Moscow and Vladivostok. The first Molniya satellite was a cylinder which carried six solar battery panels and had two parabolic aerials mounted on it. The antennas are folded during launch and automatically open out after the carrier rocket has separated out. Radio-electronic equipment is carried inside the cylinder. During the entire flight the satellite is oriented with its solar batteries facing the Sun, and under operational conditions one of the aerials is directed towards the Earth and follows it very accurately. The second aerial is kept in reserve. The satellite can handle a television programme, a large number of telephone conversations, still pictures and telegraph communications, and can relay other forms of information.

It has been the intention of the Soviet Union for some time to use 24-h synchronous satellites, which have been used regularly by the United States. The first Soviet synchronous satellite, Cosmos 637, was orbited in 1974. Later that year, Molniya 1S was placed in an equatorial synchronous orbit and it was not until the end of 1975 that a new series of such synchronous satellites began with the launch of Statsionar 1 (Raduga).

The formation of the Soviet communications network using synchronous orbits probably began with the launch of Statsionar 1. It is possible that the Soviet Union is planning to launch at least an 11-satellite network into synchronous orbit by about 1980 since it informed the Frequency Registration Board of the International Telecommunications Union that it plans to launch the Statsionar-T satellite for domestic television communications, and Statsionar 2 and 3 for overall Soviet and European communications. It has been announced that Statsionar 4–10 may be launched in 1978–80 [38]. The orbital location of Statsionar-T will be 99°E longitude with the Earth-to-satellite link within 6.2 GHz ± 12 MHz and the satellite-to-Earth link within the range 714 MHz ± 12 MHz. Statsionar 2 is located at 35°E longitude, over the eastern part of Africa, for communications services to Europe and the Western part of the Soviet Union. The Earth-to-satellite link will be in the frequency range 5.75–6.2 GHz and that from satellite-to-Earth will be 3.42–3.87 GHz. The system is designed for telephone, telegraph and phototelegraph communications and for sound and television broadcasting. Statsionar 3 is similar to Statsionar 2 except that it will serve the whole of the Soviet Union (apart from the extreme north and Kamchatka). It will be positioned at 85°E longitude over the southern part of India [39]. Statsionars 4–10 are planned to operate in the 4 GHz and 6 GHz frequency bands used by Intelsat satellites. Statsionar 4 will be placed at 14°W longitude, Statsionar 5 at 58°E longitude and Statsionar 10 at 170°W longitude. Statsionar 8 and 9, at 25°W longitude and 45°E longitude, respectively, will reinforce northern hemispheric coverage while Statsionar 6 and 7, at 85°E longitude and 140°E longitude, respectively, would primarily cover the domestic telecommunications services [40].

The orbital characteristics of Soviet communications satellites are given in table 5.15.

Weather satellites

Although two or three weather satellites are launched per year by the United States, many more Soviet weather satellites are launched because of their short active lifetimes of about six months. The Soviet weather-satellite programme began in 1963 with component testing of some of the satellites in the Cosmos series. For example, Cosmos 45 (launched in 1964), Cosmos 65 and Cosmos 92 (launched in 1965) were recoverable satellites and had meteorological missions. Initially experimental meteorology satellites, Cosmos 14 and 23 were launched from Kapustin Yar using the Sandal IRBM with an upper stage (B-1). The first known meteorological satellite, Cosmos 122, was launched from Tyuratam on 25 June 1966. Cosmos 122 could observe the dark side of the Earth and photograph it using infrared sensors [41]. This was the last meteorological satellite to be launched into a 65° orbit from Tyuratam.

The third Molniya 1 communications satellite also transmitted photographs of the cloud cover over the Earth. The routine use of satellites for monitoring weather began in 1969. The new series of satellites, called Meteor, carried equipment providing photographs with higher resolution than those obtained from the US TIROS satellites. However, the coverage was not as complete as that obtained by the US satellites [42]. A series of new improved Meteor satellites, Meteor 2, will replace the Meteor 1s. The first of these, a test Meteor 2-1, was launched on 11 July 1975 from Plesetsk. Meteor 2 satellites will carry improved visible and infrared scanning radiometers for imagery as well as for temperature measurements. It has been reported that the image resolution from these satellites will be comparable with that obtained by US weather satellites [43].

The early Cosmos weather satellites and the Meteor satellites have been launched using the Vostok type of standard launch vehicle (A-1). Meteor satellites have been launched from Plesetsk at an orbital inclination of 81°.

The orbital characteristics of the Soviet weather satellites are given in table 5.16.

Fractional orbital bombardment systems

A fractional orbital bombardment system (FOBS) is designed to place a weapon in orbit and, at a given point, before it has completed its first revolution round the Earth, the weapon is slowed down by a retrorocket and caused to drop on to its target.

In November 1967 a new large rocket, the Scarp SS-9, was paraded in Moscow and was reported to be capable of intercontinental and orbital launching. The SS-9 is bottle-shaped and about 34 m in length. It consists of a large first stage about 3 m in diameter topped by a tapered section and then a smaller portion about 1 m in diameter. When used for space flights, it is possible that four stages are involved, in which case the total length may be about 47 m. If used as an ICBM, the SS-9 is capable of carrying a 20- to 25-Mt warhead weighing about 4 500 kg, but its use in FOBS would reduce the size of the warhead to 10 Mt and its weight to about 3 200 kg [44]. The rocket system is designated F-l-r if designed for FOBS, where "r" symbolizes the retrofire fourth stage which drives the warhead back to Earth, leaving the rest of the system in orbit.

An advantage to the Soviet Union of FOBS for delivering nuclear warheads would be that the US warning time would be reduced. Secondly, US defences could be penetrated from the south, the least defended front. It must be noted that these tests did not constitute violations of the treaty and resolution banning weapons of mass destruction from orbit, both because they did not complete one full orbit and in all likelihood did not carry an actual warhead while undergoing tests, and also because they did not cross the US mainland.

In 1966 two Cosmos flights, Cosmos U1 and U2, were detected but they were not announced by the Soviet Union. It was not until 1967 and 1971 that it became apparent that these were the beginning of the FOBS. All such subsequent flights, beginning with Cosmos 139 launched on 25 January

1967, were announced by the Soviet Union under the Cosmos series; their perigees and apogees were given but not their orbital periods. This was presumably because the payload part never completed a full orbit since the retrorocket fired, bringing the payload back to Earth to strike a target in the Soviet Union.

It is interesting to note that the variation in launch times of the 1967 FOBS flights were such that the payloads were fairly consistently recovered at local dusk. This suggests that the tests were probably also used to practise detecting low-orbit missiles [41]. At this particular time of day, conditions are such that spurious echoes appear on a radar screen.

These satellites and their orbital characteristics are given in table 5.17.

Interceptor/destructor satellites

On 30 October 1967, Cosmos 186 (launched on 27 October using a Soyuz booster) rendezvoused and docked with Cosmos 188 (launched on 30 October), as Cosmos 212 later did with Cosmos 213. While this demonstrated the Soviet capability to manoeuvre satellites to rendezvous with another friendly satellite, a number of experiments have been carried out by the Soviet Union to develop this capability to rendezvous with an unfriendly satellite and to destroy it. In such experiments, a manoeuvrable satellite was launched to intercept and inspect a target satellite in orbit. Initially the interceptor satellite flew close to the target, made a high-speed close inspection of it, and then moved away before exploding .

Actual tests of the interceptor/destructor satellite system seem to have started with the launch of Cosmos 217 on 24 April 1968. This satellite was to have been a target satellite but it exploded when it began to make orbital manoeuvres. The "m" stage may possibly have caused the failure [45].

It was not until six months later, on 19 October 1968, that Cosmos 248 in the series was launched. This delay may well have been caused by the failure of Cosmos 217. Soon after its launch, Cosmos 248 manoeuvred from its lower altitude to an intermediate altitude of about 500 km into a nearly circular orbit. Cosmos 249 was launched on the following day. The satellite, with its "m" stage separated from the carrier-rocket, passed very close to the target satellite, Cosmos 248, as it went into a much higher eccentric orbit. After Cosmos 249 had moved away from Cosmos 248, it was exploded. About a week and a half later, Cosmos 252 was launched on 1 November and it also followed a mission almost identical to that of Cosmos 249. Such tests were carried out periodically until 1971.

In 1971, however, a new procedure was introduced. The interceptor approached and flew close to the target at a considerably lower speed. The interceptor was in almost the same orbit as that of the target. After such a prolonged inspection, the interceptor was brought down to a lower orbit and allowed to decay. So far no target satellite has been destroyed by an interceptor satellite.

In the initial experiments, interceptor/destructor satellites and target satellites were launched using a rocket system similar to that used for the FOBS. The rocket system is designated F-1-m where "m" symbolizes the manoeuvring stage. Until 1971, both these types of satellites were launched from Tyuratam. A new pattern emerged on 9 February 1971 when a target Cosmos 394 satellite was launched from Plesetsk using a C-1 (Skean intermediate-range ballistic missile [IRBM] plus an upper stage) vehicle. On 25 February an interceptor/destructor Cosmos 397 satellite was launched from Tyuratam using an F-1-m vehicle. Two more such pairs of satellites were launched in 1971 and, after about four years, another pair of satellites were launched in early February 1976.

Orbital characteristics of these satellites are given in table 5.18.

Geodetic satellites

Although the Soviet Union is known to have an interest in geodesy and mapping, it is difficult to learn from open sources which of the Cosmos satellites are intended for geodetic missions. It would be surprising if geodetic satellites were not used by the Soviet Union, since geodetic data are essential for accurate ICBM targeting due to the fact that the gravitational fields around launch and target areas can affect the accuracy with which the re-entry vehicle reaches its target. Since the missile fields in the Soviet Union are spread over a wide geographical area, the use of geodetic satellites becomes almost essential.

It has recently been suggested that a number of Soviet satellites believed to be navigation satellites may be on geodetic missions [32]. These satellites have been placed in 1200- to 1400-km orbits with orbital inclinations of about 74° and periods of about 109 and 113 min. Cosmos 800 and 842, which at first sight would appear to belong to the 105-min navigation satellite subset, are flying with their orbital planes diametrically opposed to those of the navigation satellite system and may also be geodetic in purpose [46]. Recently, the orbital inclinations of these satellites have been changed to about 83° with orbital periods of about 109 min. The satellites are launched from Plesetsk using an SS-5 vehicle (C-1 or Skean IRBM plus upper stage).

Table 5.19 gives the orbital characteristics of these geodetic satellites.

V. *Military satellite programmes of other countries*

The People's Republic of China

The People's Republic of China launched three satellites in 1975. It was reported that one of these satellites, China 4, ejected a capsule which was recovered. In 1976 two satellites, China 6 and China 7, were launched. The latter satellite was placed in an orbit similar to that of China 4. The satellite was reported to have been recovered [47], but there is some doubt as to whether it was in fact the satellite or part of its payload.

Orbital characteristics of the satellite are shown in table 5.20.

British communications satellites

On 19 September 1966, as a result of a request from the British government, it was agreed between the USA and the UK that the USAF would procure a synchronous communications satellite for the UK. It was agreed that the USAF would launch the satellite into the required orbit and then turn the command and control over to the UK. On 22 November 1969, using a Delta rocket, Skynet 1 was launched into a synchronous orbit. A standby was launched on 19 August 1970 but the satellite failed to achieve the required orbit. These two satellites were to have provided the UK with military satellite communications for three to five years and the satellites were to have been replaced by two other satellites at the end of 1973. However, Skynet 2 failed in January 1973 and Skynet 1 ceased to function in January 1972.

It was not until 23 November 1974 that Skynet 2B was successfully launched into a synchronous orbit from Cape Kennedy (ETR). This was the first military communications satellite mainly to be built by a British company. Skynet 2A, launched on 17 January 1974, failed to enter synchronous orbit because the second stage of the Delta launch vehicle failed. Skynet 2B is stationed over the Seychelles in the Indian Ocean and will provide communications in an area bounded by Norway, the Antarctic, Western Australia and the Atlantic out to about 23° W.

Communications are carried out over two channel bandwidths, one at 20 MHz and the other at 2 MHz. When a signal is received by the satellite, it is converted to an intermediate frequency of 70 MHz and divided into two channels. Signals in each channel are separately amplified and limited and then recombined. A beacon signal fed into the system is used for tracking the satellite. The finally combined communication and beacon signal is transmitted back to Earth. Such a double conversion provides protection against interference.

The orbital characteristics of the British satellites are given in table 5.21.

NATO communications satellites

On 20 March 1970, using a Thor/Delta launcher, NATO put its first communications satellite into a near equatorial synchronous orbit . The satellite was launched by the United States from Cape Kennedy. It was positioned over the East Atlantic, linking the capital cities of the NATO countries. The USAF was responsible for producing and launching the satellite as well as for initially controlling it in orbit.

In late 1966 the United States offered other NATO countries the opportunity of exploring the potential of satellites for tactical military communications. This resulted in a meeting of representatives of seven NATO countries, held in June 1967 at the US Army Satellite Communications Agency, to consider the extent of participation. Criteria for NATO participation in the US programme were formulated at later meetings in Bonn. In November 1967 an understanding was reached among the seven countries (Belgium, Canada, the Federal Republic of Germany, Italy, the Netherlands, the USA and the UK) officially sponsoring a cooperative programme for tactical satellite communications (TACSATCOM). In this cooperative programme, the satellite was to be built and launched by the United States and special ground terminals were to be built by the participants. This programme resulted in the launching of LES 5 (on 1 July 1967) and LES 6 (on 26 September 1968) [48].

The second back-up satellite, NATO 2, was launched from Cape Kennedy on 3 February 1971, again using a Thor/Delta launcher. The initial testing of the satellite's communications system was carried out by the USAF Space and Missiles Systems Organization (SAMSO). More detailed testing was done by the Signals Research and Development Establishment in the UK and then by the SHAPE Technical Centre at The Hague [49].

NATO 2 covers an area from the eastern coast of North America to the eastern boundary of Turkey. The communications system is basically designed to operate with only one satellite, the other being a standby satellite. The most recent NATO satellite to be launched is the first of three NATO 3 satellites: NATO 3A, launched from Cape Kennedy on 22 April 1976, is the largest communications satellite developed for NATO.

The orbital characteristics of these satellites are given in table 5.22.

French satellite programme

France is the third nation, after the United States and the Soviet Union, to have launched its own satellite with its own rocket. Although most of the French space programme is for peaceful purposes and although the 1975 budget for the French national space agency, Centre National d'Etudes Spatiales (CNES), has shown a continuation of the shift in emphasis from national to European programmes, in 1973 France announced interest in developing military reconnaissance satellites. The then French Defence Minister, Michel Debré, reported that the Defence Ministry was studying the possibility of developing a military reconnaissance satellite [50]. He emphasized, however, that it would be a long-term project which would not be implemented until sometime between 1980 and 1985.

At an exhibition at Le Bourget in 1975, the armed forces and the CNES for the first time publicly admitted interest in photographic and electronic reconnaissance and communications satellites. The exhibition displayed, among other things, satellite systems for investigation of the Earth's resources as well as some of the other above-mentioned systems. Some details of certain of these satellites were discussed at the exhibition. For example, it was pointed out that the photographic reconnaissance satellite would use a recoverable capsule containing the exposed films, and cost estimates for some satellites have been given. According to a study carried out by Aérospatiale-Thomson-CSF, the cost of a French communications satellite would be approximately $750 mn – $1 bn, and the cost of an electronic reconnaissance satellite would be about twice this amount [51].

It has been reported that in 1977 the armed forces technical services will carry out military space communications technology experiments using the French-West German communications satellite Symphonie. Two Symphonie satellites (see table 5.23) have been launched by NASA using Thor/Delta rockets. These experiments are planned in collaboration with the Service Central des Télécommunications et de l'Informatique, the Direction Technique des Constructions et Armes Navales and the Direction Technique des Engins (DTEN) [52]. This project is called Sextius.

Although some have argued that France needs a military communications satellite more urgently than a photographic reconnaissance satellite [53], the French Minister of Defence, Yvon Bourges, asked the CNES and DTEN to submit plans for a military photographic reconnaissance satellite programme to the French Parliament in March–April 1976 [54]. The satellites will be launched mainly into polar or near-polar orbits with perigee heights of about 300 km or 1200 km, and will weigh about 350 kg. The higher-altitude satellites will presumably be Earth resources satellites. These satellites will be launched using the Ariane rocket. It is planned that after the feasibility study, the armed forces will submit tenders in 1979 and launch a satellite by about 1985. The first system is expected to become operational in 1986. The satellite may be launched from the Kourou launch site in French Guyana.

In addition to the interest shown in reconnaissance and communications satellites, France has already launched, either in collaboration with the United States or on its own, a number of meteorological and geodetic satellites. The first French geodetic satellite was launched in February 1966 using the Diamant A launcher. France's first meteorological satellite, EOLE, was launched in 1971 by the United States using the Scout rocket.

The orbital characteristics of the French satellites are given in table 5.23.

VI. *Conclusions*

Since 1972, the number of photographic reconnaissance satellites launched annually by the United States and the Soviet Union has been steady at about

5 and 35, respectively. At least half the number of photographic reconnaissance satellites of either state carry high-resolution cameras to perform close-look missions. The longer orbital lifetimes of US photographic reconnaissance satellites have enabled the United States to perform its reconnaissance activities from space with only a small number of satellites. In 1976, for example, the United States launched only three photographic reconnaissance satellites, compared with 34 for the Soviet Union. The US Big Bird satellite was launched on 8 July 1976, and was still in orbit after more than 160 days.

It can be seen from the sections above that space technology is well on the way to developing satellites for navigating lethal arms to targets with high accuracy and satellites for predicting weather conditions in order to facilitate bombing. Reconnaissance satellites are used to recognize targets, whose geographical positions are accurately determined by the use of geodetic satellites. The latter perform the additional task of accurately mapping the Earth's terrain so that missiles and aircraft can be navigated to targets using the terrain contour matching system.

By mid-1976, the United States had spent about $85 bn on such military and civilian space programmes [23]. About 60 per cent of all US space flights are military-oriented and about one-third of the total sum is spent on military space activities. In the United States, budget requests give detailed requirements for navigation, communications, geodetic, early-warning and weather satellites, whereas no specific item is mentioned for surveillance satellites, presumably because these requests are contained in a classified part of the budget. No comparable information is available from the Soviet space budget but it may not be very different from the US efforts; again, the military-oriented satellites form a similar fraction of total Soviet space activities.

The extensive use of surveillance and early-warning satellites has become an important part of US strategic doctrine. With the development of other types of satellites, there seems to be a trend toward developing new doctrines, such as that of flexible response. This would emphasize limited nuclear war-fighting capabilities at various levels. In this new strategy, space technology provides better centralized command and control of military forces via, for example, effective communications satellites. In a limited exchange of nuclear weapons, it is necessary to obtain a damage assessment for making a prompt response; it is evident from earlier discussions that reconnaissance satellites have this capability. It should be noted that precise target information is required in the current counterforce doctrine for fighting limited nuclear war—again a requirement fulfilled by reconnaissance satellites.

The importance of military satellites is further emphasized by the fact that considerable efforts are being made to increase their survivability. This includes research into anti-jamming devices, protection against the effects of nuclear blast and increased surveillance of space by ground- and space-based sensors. Such a detection system can serve as a warning against satellite attacks.

Of the various types of satellites deployed, navigation and geodetic satellites may well revolutionize strategic and tactical warfare. With the aid of such satellites, it will be possible to guide a missile to within a few metres of its target anywhere in the world, thereby acquiring unprecedented accuracies.

Finally, it is important not to forget the useful role satellites play in verifying some arms-control agreements and in monitoring the world's trouble spots. Whereas these aspects are well publicized, what is generally not known is the extent to which this new technology is being used to militarize space. The most disturbing aspect of advances in space technology is that they are beginning to give rise to new doctrines—doctrines which may well condition man to believe that limited nuclear wars can be fought and won.

VII. *Tables of military satellites*

Conventions

. .	Information not available
–	None
?	Uncertainty about the satellite designation or other data

Abbreviations and acronyms

US launchers:

A	Atlas
A-1/2	One and one-half stage booster with either first- or second-generation upper stage
A-A	Agena A
A-B	Agena B
A-D	Agena D
Bu II	Burner II
LT	Long Tank
LTTA	Long Tank Thrust Augmented
LTTAT	Long Tank Thrust Augmented Thor
LTTD	Long Tank Thor Delta
T-3A	Titan-3A
T-3B	Titan-3B
T-3C	Titan-3C
T-3D	Titan-3D
TAD	Thrust Augmented Delta

TAID	Thrust Augmented Improved Delta
TAT	Thrust Augmented Thor
Th	Thor

Soviet launchers:

A-2	Vostok up-rated second stage
A-2-e	One and one-half stage booster with second-generation upper stage plus escape stage
B-1	Modified Sandal intermediate-range missile with added upper stage
C-1	Skean intermediate-range missile plus upper stage
D-1-e	Proton booster plus upper and escape stages
F-1-m	SS-9 Scarp missile with orbital and manoeuvrable stages
F-1-r	Scrag or Scarp booster with orbital and re-entry stages

US launch sites:

ETR	Eastern Test Range (Cape Kennedy, Florida)
WTR	Western Test Range (Vandenberg AFB, California)
WI	Wallops Island (Virginia)

Soviet launch sites:

KY	Kapustin Yar
PL	Plesetsk
TT	Tyuratam

Other:

AMS	Advanced Meteorological Satellite
ANNA	Army, Navy, NASA, Air Force
ARPA	Advanced Research Projects Agency
ATS	Applications Technology Satellite
Comstar	Owned by Comsat General Corp.
CSC	Communications Satellite Corporation
DATS	Daspun Antenna Test Satellite
DMSP	Data Meteorological Satellite Program
DSCS	Defense Satellite Communications System
ESSA	Environmental Science Service Administration
GEOS	Geodynamic Experimental Ocean Service Administration
GOES	Geostationary Operational Environmental Satellite
IDCSP	Initial Defense Communication Satellite Program
Intelsat	International Telecommunications Satellite Consortium
ITOS	Improved TIROS Operational Satellite
Lageos	Laser Geodynamic Satellite
LES	Lincoln Experimental Satellite
Marisat	Marine Communications Satellite

NASA	National Aeronautics & Space Administration
NOAA	National Oceans & Atmosphere Administration
NOSS	Navy Ocean Surveillance Satellite
NTS	Navigation Technology Satellite
OV	Orbiting Vehicle
Pageos	Passive Geodetic Satellite
SDS	Satellite Data System
Secor	Sequential Collation of Range
SMS	Synchronous Meteorological Satellite
Syncom	Synchronous Communications Satellite
TACSAT	Tactical Communications Satellite
TIP	Transit Improvement Program
TIROS	Television Infrared Observation Satellite
USAF	US Air Force
USN	US Navy
WU	Western Union

Table 5.1. US photographic reconnaissance satellites and their launchers, 1959–76

	Area-surveillance satellites					Close-look satellites				Big Bird satellites
Year	Th/A-A	Th/A-B	Th/A-D	TAT/ A-D	LTTAT/ A-D	Atlas/ A-A	Atlas/ A-B	Atlas/ A-D	Titan-3B/A-D	Titan-3D
1959	6									
1960	4	2								
1961		11				1	1			
1962		14	6				6			
1963			8	7				4		
1964			4	11				9		
1965				13				8		
1966				8				12	3	
1967				3	6			3	6	
1968					8				8	
1969					6				6	
1970					4				5	
1971					2				4	1
1972					2				3	3
1973									3	2
1974									3	2
1975									2	2
1976									2	2

Table 5.2. US photographic reconnaissance satellites launched in 1976

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *days*	Whether film capsule recovered
USAF (1976-27A)	WTR T-3B/A-D	22 Mar 1814	96.40	89.25	125	347	57	. .
USAF (1976-65A)	WTR T-3D	8 Jul 1843	97.00	88.54	159	242	158	. .
USAF (1976-94A)	WTR T-3B/A-D	15 Sep 1858	96.39	89.18	135	330	51	. .
USAF (1976-125A)	WTR T-3D	19 Dec 1829	96.95	92.37	247	533	5 months (expected)	. .

[a] The designation of each satellite is recognized internationally and is given by the World Warning Agency on behalf of the Committee on Space Research.

Table 5.3. US electronic reconnaissance or ferret satellites launched in 1976

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
USAF (1976-65C)	WTR T-3D	8 Jul 1843	96.38	97.34	628	632	60.00

[a] See footnote *a* to table 5.2.

Table 5.4. US early-warning satellites launched in 1976

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
USAF (1976-59A)	ETR T-3C	26 Jun 0307	0.5	1 433.3	35 620	35 860	$>10^6$

[a] See footnote *a* to table 5.2.

Table 5.5. US ocean-surveillance satellites launched in 1976

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
USN NOSS (1976-38A)	WTR Atlas	30 Apr 1912	63.46	107.47	1 092	1 128	1 600
USN SSU-1 (1976-38C)	WTR Atlas	30 Apr 1912	63.44	107.49	1 093	1 129	1 600
USN SSU-2 (1976-38D)	WTR Atlas	30 Apr 1912	63.43	107.50	1 093	1 130	1 600
USN SSU-3 (1976-38J)	WTR Atlas	30 Apr 1912	63.45	107.49	1 083	1 139	1 600

[a] See footnote *a* to table 5.2.

Table 5.6. US navigation satellites launched during 1959–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
		1959					
ARPA Transit 1A –	ETR Th/Able	17 Sep . .	Failed to orbit				
		1960					
ARPA Transit 1B (1960-γ2)	ETR Th/Able Star	13 Apr 1200	51.28	95.81	373	748	2 730.75 days
USN Transit 2A (1960-η1)	ETR Th/Able Star	22 Jun 0600	66.69	101.66	628	1 047	150
USN Transit 3A –	ETR Th/Able Star	30 Nov . .	Failed to orbit				
		1961					
USN Transit 3B (1961-η1)	ETR Th/Able Star	22 Feb 0350	28.38	96.22	167	1 002	36.38 days
USN Transit 4A (1961-o1)	ETR Th/Able Star	29 Jun 0419	66.81	103.82	881	998	600
USN Transit 4B (1961-αη1)	ETR Th/Able Star	15 Nov 2219	32.43	105.63	956	1 104	1 000
		1962					
USN Transit 5A (1962-βψ1)	WTR Scout	19 Dec 0126	90.74	99.11	698	723	50
		1963					
USAF –	WTR Scout	. . . .	Failed to orbit				
USN Transit (1963-22A)	WTR Scout	16 Jun 0155	89.97	99.67	724	757	50
USAF/USN Transit 5B ? (1963-38B)	WTR Th/Able Star	28 Sep 2010	89.90	107.42	1 075	1 127	1 000
USAF/USN Transit (1963-49B)	WTR Th/Able Star	5 Dec 2150	89.98	107.15	1 067	1 112	1 000
		1964					
USN –	WTR Th/Able Star	21 Apr . .	Failed to orbit				
USN Transit (1964-26A)	WTR Scout	4 Jun 0350	90.42	103.12	854	956	200
USAF/USN Transit ? (1964-63B)	WTR Th/Able Star	6 Oct 1702	89.92	106.65	1 055	1 085	1 000

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli- nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
USAF/USN Transit (1964-83D)	WTR Th/Able Star	13 Dec 0014	89.86	106.33	1 025	1 084	1 000
		1965					
USAF/USN Transit ? (1965-17A)	WTR Th/Able Star	11 Mar 1341	89.97	95.19	211	890	94.72 days
USN Transit ? (1965-48A)	WTR Th/Able Star	24 Jun 2234	90.00	106.92	1 024	1 144	1 000
USN Transit (1965-65F)	WTR Th/Able Star	13 Aug 2248	90.01	108.19	1 089	1 194	1 000
USN Transit ? (1965-109A)	WTR Scout	22 Dec 0434	89.11	105.09	909	1 080	1 000
		1966					
USN Transit ? (1966-05A)	WTR Scout	28 Jan 1702	89.78	105.99	861	1 217	1 000
USN Transit ? (1966-24A)	WTR Scout	26 Mar 0336	89.73	105.37	891	1 128	300
USN Transit ? (1966-41A)	WTR Scout	19 May 0224	90.00	103.48	863	980	200
USN Transit ? (1966-76A)	WTR Scout	18 Aug 0224	88.86	106.85	1 056	1 101	1 000
		1967					
USN – (1967-34A)	WTR Scout	14 Apr 0322	90.23	106.60	1 053	1 083	1 000
USN – (1967-48A)	WTR Scout	18 May 0907	89.57	107.04	1 074	1 105	1 000
USN – (1967-92A)	WTR Scout	25 Sep 0824	89.28	106.81	1 041	1 116	1 000
		1968					
USAF – (1968-12A)	WTR Scout	2 Mar 0350	89.99	107.00	1 035	1 139	1 000
		1970					
USN Navy Naviga- tion Satellite 19 (1970-67A)	WTR Scout	27 Aug 1326	90.02	107.04	955	1 221	1 300

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli- nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
		1972					
USAF Triad 1 (1972-69A)	WTR Scout	2 Sep 1746	90.14	100.68	716	863	90
		1973					
USN Navy Naviga- tion Satellite 20 (1973-81A)	WTR Scout	30 Oct 0043	90.18	105.62	895	1 149	900
		1974					
USAF NTS 1 (Timation 3) (1974-54A)	WTR Atlas Burner	14 Jul 0517	125.08	468.40	13 445	13 767	300 000
		1975					
USAF Triad 2 (TIP 2) (1975-99A)	WTR Scout	12 Oct 0643	90.74	95.34	362	705	4
		1976					
USAF TIP 3 (1976-89A)	WTR Scout	1 Sep 2107	90.31	96.02	348	789	4

[a] See footnote *a* to table 5.2. Uncertainty about the full designation of the USN Transit satellites is indicated by a question mark. After 1966 the Transit designation ceased to be used, but it is assumed that USN satellites launched after 1966 belonged to this "Transit" series.

Table 5.7. US communications satellites launched during 1958–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli- nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
		1958					
ARPA Score (1958-ξ)	ETR Atlas B	18 Dec 2324	32.3	101.47	185	1 484	33.6 days
		1960					
NASA Echo A-10	ETR Delta	13 May . .	Failed to orbit				
NASA Echo 1 (1960-21)	ETR Delta	12 Aug 0936	47.22	118.22	1 524	1 684	2 841.63 days
ARPA Courier 1A	ETR Th/Able Star	18 Aug . .	Failed to orbit				
USA Courier 1B (1960-ν1)	ETR Th/Able Star	4 Oct 1746	28.33	106.85	938	1 237	1 000 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
		1961					
USN Lofti (1961-η)	ETR Th/Able Star	22 Feb 0350	28.38	96.22	167	1 002	36.38 days
		1962					
NASA Telstar 1 (1962-αε1)	ETR Delta	10 Jul 0838	44.79	157.65	952	5 632	10 000 years
NASA Relay 1 (1962-βv2)	ETR Delta	13 Dec 2331	47.45	184.71	1 345	7 398	50 000 years
		1963					
NASA Syncom 1 (1963-04A)	ETR Delta	14 Feb 0517	33.30	1 425.5	34 392	36 739	>10^6 years
NASA Telstar 2 (1963-13A)	ETR Delta	7 May 1131	42.73	225.05	974	10 803	200 000 years
USAF/USN Lofti 2A (1963-21B)	WTR Th/A-D	15 Jun 1438	69.87	95.71	171	925	32.8 days
NASA Syncom 2 (1963-31A)	ETR Delta	26 Jul 1428	33.05	1 454.0	35 584	36 693	>10^6 years
		1964					
NASA Relay 2 (1964-03A)	ETR Delta	21 Jan 2107	46.32	194.60	2 091	7 411	10^6 years
NASA Echo 2 (1964-04A)	WTR Th/A-B	25 Jan 1355	81.50	108.95	1 029	1 316	1 960.17 days
NASA Syncom 3 (1964-47A)	ETR TAD	19 Aug 1214	0.10	1 407.8	34 191	36 271	>10^6 years
		1965					
USAF LES 1 (1965-08C)	ETR T-3A	11 Feb 1717	32.15	145.55	2 774	2 811	50 000 years
CSC/NASA (Intelsat 1A) Early Bird (1965-28A)	ETR TAD	6 Apr 2346	0.13	1 436.95	35 003	36 606	>10^6 years
USAF LES 2 (1965-34B)	ETR T-3A	6 May 1214	32.10	309.85	2 784	14 798	500 000 years
USAF LES 4 (1965-108B)	ETR T-3C	21 Dec 1536	26.60	589.24	189	33 632	10 years
USAF LES 3 (1965-108D)	ETR T-3C	21 Dec 1536	26.46	581.41	195	33 177	836 days
		1966					
USAF IDCSP 1 (1966-53B)	ETR T-3C	16 Jun 1355	0.086	1 334.7	33 656	33 897	>10^6 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
USAF IDCSP 2 (1966-53C)	ETR T-3C	16 Jun 1353	0.081	1 335.3	33 668	33 909	>10^6 years
USAF IDCSP 3 (1966-53D)	ETR T-3C	16 Jun 1353	0.121	1 336.6	33 695	33 936	>10^6 years
USAF IDCSP 4 (1966-53E)	ETR T-3C	16 Jun 1353	0.183	1 338.6	33 696	34 018	>10^6 years
USAF IDCSP 5 (1966-53F)	ETR T-3C	16 Jun 1353	0.042	1 340.8	33 699	34 102	>10^6 years
USAF IDCSP 6 (1966-53G)	ETR T-3C	16 Jun 1353	0.058	1 344.0	33 722	34 206	>10^6 years
USAF IDCSP 7 (1966-53H)	ETR T-3C	16 Jun 1353	0.040	1 347.6	33 712	34 359	>10^6 years
USAF IDCSP (8 satellites) –	ETR T-3C	26 Aug . .	Failed to orbit				
CSC/NASA Intelsat 2A (1966-96A)	ETR TAD	26 Oct 2324	26.43	669.8	289	37 656	10^6 years
USAF OV4 1R (1966-99B)	ETR T-3C	3 Nov 1355	32.84	90.30	291	298	62.56 days
USAF OV4 1T (1966-99D)	ETR T-3C	3 Nov 1355	32.83	90.59	294	321	68.6 days
NASA ATS 1 (1966-110A)	ETR A/A-D	7 Dec 0210	0.23	1 465.89	35 852	36 887	>10^6 years
		1967					
CSC/NASA Intelsat 2B (1967-01A)	ETR TAD	11 Jan 1048	2.14	1 448.5	35 563	36 496	>10^6 years
USAF IDCSP 8 (1967-03A)	ETR T-3C	18 Jan 1424	0.07	1 329.6	33 557	33 800	>10^6 years
USAF IDCSP 9 (1967-03B)	ETR T-3C	18 Jan 1424	0.05	1 330.0	33 526	33 846	>10^6 years
USAF IDCSP 10 (1967-03C)	ETR T-3C	18 Jan 1424	0.06	1 330.7	33 579	33 819	>10^6 years
USAF IDCSP 11 (1967-03D)	ETR T-3C	18 Jan 1424	0.07	1 332.1	33 606	33 847	>10^6 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli-nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
USAF IDCSP 12 (1967-03E)	ETR T-3C	18 Jan 1424	0.03	1 334.2	33 608	33 929	>10^6 years
USAF IDCSP 13 (1967-03F)	ETR T-3C	18 Jan 1424	0.06	1 335.5	33 656	33 978	>10^6 years
USAF IDCSP 14 (1967-03G)	ETR T-3C	18 Jan 1424	0.03	1 339.5	33 675	34 077	>10^6 years
USAF IDCSP 15 (1967-03H)	ETR T-3C	18 Jan 1424	0.05	1 343.0	33 665	34 229	>10^6 years
CSC/NASA Intelsat 2C (1967-26A)	ETR TAD	23 Mar 0126	1.37	1 434	35 687	35 771	>10^6 years
NASA ATS 2 (1967-31A)	ETR A/A-D	6 Apr 0322	28.40	218.9	178	11 124	880.81 days
USAF IDCSP 16 (1967-66A)	ETR T-3C	1 Jul 1312	7.18	1 308.9	32 906	33 528	>10^6 years
USAF IDCSP 17 (1967-66B)	ETR T-3C	1 Jul 1312	7.22	1 309.8	33 006	33 548	>10^6 years
USAF IDCSP 18 (1967-66C)	ETR T-3C	1 Jul 1312	7.20	1 311.6	33 079	33 555	>10^6 years
USAF DATS 1 (1967-66D)	ETR T-3C	1 Jul 1312	7.10	1 313.6	33 156	33 553	>10^6 years
USAF LES 5 (1967-66E)	ETR T-3C	1 Jul 1312	6.8	1 316.2	33 178	33 636	>10^6 years
CSC/NASA Intelsat 2D (1967-94A)	ETR TAD	25 Sep 0043	0.93	1 438.3	35 747	35 913	>10^6 years
NASA ATS 3 (1967-111A)	ETR A/A-D	5 Nov 2331	0.53	1 444.9	35 791	36 130	>10^6 years
		1968					
USAF IDCSP 19 (1968-50A)	ETR T-3C	13 Jun 1410	0.19	1 335.7	33 758	33 841	>10^6 years
USAF IDCSP 20 (1968-50B)	ETR T-3C	13 Jun 1410	0.11	1 335.5	33 725	33 863	>10^6 years
USAF IDCSP 21 (1968-50C)	ETR T-3C	13 Jun 1410	0.10	1 335.9	33 699	33 907	>10^6 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
USAF IDCSP 22 (1968-50D)	ETR T-3C	13 Jun 1410	0.10	1 338.0	33 737	33 954	>10[6] years
USAF IDCSP 23 (1968-50E)	ETR T-3C	13 Jun 1410	0.19	1 339.6	33 721	34 035	>10[6] years
USAF IDCSP 24 (1968-50F)	ETR T-3C	13 Jun 1410	0.16	1 342.0	33 724	34 126	>10[6] years
USAF IDCSP 25 (1968-50G)	ETR T-3C	13 Jun 1410	0.17	1 345.2	33 721	34 256	>10[6] years
USAF IDCSP 26 (1968-50H)	ETR T-3C	13 Jun 1410	0.13	1 350.6	33 752	34 443	>10[6] years
NASA ATS 4 (1968-68A)	ETR Atlas/ Centaur	10 Aug 2234	29.04	93.92	219	726	67.72 days
CSC/NASA Intelsat 3A –	ETR LT/Delta	18 Sep . .	Failed to orbit				
USAF LES 6 (1968-81D)	ETR T-3C	26 Sep 0735	3.0	1 431.0	35 597	35 785	>10[6] years
CSC/NASA Intelsat 3B (1968-116A)	ETR LT/Delta	19 Dec 0029	0.7	1 436	35 770	35 790	>10[6] years
		1969					
CSC/NASA Intelsat 3C (1969-11A)	ETR LTTA/Delta	6 Feb 0043	1.34	1 436.4	35 782	35 808	>10[6] years
USAF Tacsat 1 (1969-13A)	ETR T-3C	9 Feb 2107	0.8	1 436	35 768	35 803	>10[6] years
CSC/NASA Intelsat 3D (1969-45A)	ETR LTTA/Delta	22 May 0155	28.5	640.9	396	36 093	20 years
CSC/NASA Intelsat 3E (1969-64A)	ETR LTTA/Delta	26 Jul 0210	30.33	146.42	271	5 397	20 years
NASA ATS 5 (1969-69A)	ETR ATLAS/ Centaur	12 Aug 1102	2.6	1 463.8	35 760	36 894	>10[6] years
		1970					
CSC/NASA Intelsat 3F (1970-03A)	ETR LTTA/Delta	15 Jan 0014	0.9	1 436.1	35 773	35 801	>10[6] years
CSC/NASA Intelsat 3G (1970-32A)	ETR LTTA/Delta	23 Apr 0043	0.21	1 436.2	35 772	35 805	>10[6] years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
CSC/NASA Intelsat 3H (1970-55A)	ETR LTTA/Delta	23 Jul 2317	13.3	1 043	19 400	36 030	>10[6] years
		1971					
CSC/NASA Intelsat 4A (1971-06A)	ETR Atlas/ Centaur	26 Jan 0043	0.55	1 436.1	35 779	35 794	>10[6] years
USAF[b] (1971-21A)	WTR T-3B/A-D	21 Mar 0350	63.19	596.1	390	33 800	5 years
USAF DSCS 1 (1971-95A)	ETR T-3C	3 Nov 0307	2.70	1 435.2	35 065	36 475	>10[6] years
USAF DSCS 2 (1971-95B)	ETR T-3C	3 Nov 0307	2.28	1 438.0	35 349	36 299	>10[6] years
CSC/NASA Intelsat 4B (1971-116A)	ETR Atlas/ Centaur	20 Dec 0112	0.4	1 436.2	35 749	35 828	>10[6] years
		1972					
CSC/NASA Intelsat 4C (1972-03A)	ETR Atlas/ Centaur	23 Jan 0014	0.4	1 436.1	35 781	35 794	>10[6] years
CSC/NASA Intelsat 4D (1972-41A)	ETR Atlas/ Centaur	13 Jun 2150	0.15	1 436.2	35 782	35 794	>10[6] years
		1973					
USAF[c] (1973-56A)	WTR T-3B/A-D	21 Aug 1605	63.29	705.68	460	39 296	10 years
CSC/NASA Intelsat 4E (1973-58A)	ETR Atlas/ Centaur	23 Aug 2324	0.4	1 432.7	35 539	35 927	>10[6] years
USAF DSCS 3 (1973-100A)	ETR T-3C	14 Dec 0000	2.5	1 436.0	35 790	35 791	>10[6] years
USAF DSCS 4 (1973-100B)	ETR T-3C	14 Dec 0000	2.5	1 436.0	35 797	35 801	>10[6] years
		1974					
WU/NASA Westar 1 (1974-22A)	ETR LTT/Delta	13 Apr 2331	0.0	1 435.4	35 761	35 770	>10[6] years
NASA ATS 6 (1974-39A)	ETR T-3C	30 May 1258	1.6	1 436.1	35 781	35 791	>10[6] years
WU/NASA Westar 2 (1974-75A)	ETR LTT/Delta	10 Oct 2248	0.4	1 432.7	35 710	35 734	>10[6] years
CSC/NASA Intelsat 4F (1974-93A)	ETR Atlas/ Centaur	21 Nov 2346	1.77	1 436.2	35 775	35 801	>10[6] years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli- nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
		1975					
CSC/NASA Intelsat 4F-6 –	ETR –	20 Feb . .	Failed to orbit				
USAF SDS 1 (1975-17A)	WTR T-3B/A-D	10 Mar 0448	63.5	702.0	295	39 337	10 years
USAF DSCS 5-6[d] (1975-40A)	ETR T-3C	20 May 1410	28.58	88.34	150	249	6 days
CSC/NASA Intelsat 4G (1975-42A)	ETR Atlas/ Centaur	22 May 2248	0.4	1 436.2	35 780	35 795	>10⁶ years
CSC/NASA Intelsat 4A (F-1) (1975-91A)	ETR Atlas/ Centaur	26 Sep 0014	0.4	1 436.2	35 780	35 795	>10⁶ years
RAC/NASA Satcom 1 (1975-117A)	ETR Uprated Th/Delta	13 Dec 0155	0.3	1 439.7	35 625	36 086	>10⁶ years
		1976					
CSC/NASA Intelsat 4A (F-2) (1976-10A)	ETR Atlas/ Centaur	30 Jan 0000	0.40	1 436.1	35 752	35 819	>10⁶ years
NASA Marisat 1 (1976-17A)	ETR Uprated Th/Delta	19 Feb 2234	2.40	1 436.6	35 703	35 867	>10⁶ years
USAF LES 8 (1976-23A)	ETR T-3C	15 Mar 0126	25.00	1 436.1	35 787	35 787	>10⁶ years
USAF LES 9 (1976-23B)	ETR T-3C	15 Mar 0126	25.00	1 436.1	35 787	35 787	>10⁶ years
RCA/NASA Satcom 2 (1976-29A)	ETR Uprated Th/Delta	26 Mar 2234	0.00	1 436.2	35 785	35 789	>10⁶ years
NASA Comstar 1A (1976-42A)	ETR Atlas/ Centaur	13 May 2234	1.00	1 436.2	35 780	35 794	>10⁶ years
USAF SDS 2 ? (1976-50A)	WTR T-3B/A-D	2 Jun . .	63.3 ?	703.8 ?	380 ?	39 315 ?	10 years ?
NASA Marisat 2 (1976-53A)	ETR Uprated Th/Delta	10 Jun 0014	2.50	1 436.6	35 788	35 807	>10⁶ years
NASA Comstar 1B (1976-73A)	ETR Atlas/ Centaur	22 Jul 2248	1.0	1 436.2	35 780	35 795	>10⁶ years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
USAF SDS 3 ? (1976-80A)	WTR T-3B/A-D	6 Aug . .	63.3	703.8	380	39 315	10 years
NASA Marisat 3 (1976-101A)	ETR Uprated Th/Delta	14 Oct 2248	2.6	1 436.2	35 051	36 525	>10^6 years

[a] See footnote *a* to table 5.2.
[b] Payload may have later injected itself into an inclined synchronous orbit. First launch of this type.
[c] First such launch was in 1971. Orbit similar to Soviet communications satellites.
[d] Failed to reach equatorial synchronous orbits.

Table 5.8. US weather satellites launched during 1960–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
		1960					
NASA TIROS 1 (1960-β2)	ETR Th/Able	1 Apr 1146	48.4	99.16	693	750	60
NASA TIROS 2 (1970-π1)	ETR Delta	23 Nov 1117	48.5	98.20	619	732	60
		1961					
NASA TIROS 3 (1961-ρ1)	ETR Delta	12 Jul 1019	47.9	100.33	735	820	100
		1962					
NASA TIROS 4 (1962-β1)	ETR Delta	8 Feb 1229	48.30	100.31	712	840	100
USAF –	WTR Scout	23 May . .	Failed to orbit				
NASA TIROS 5 (1962-αα1)	ETR Delta	19 Jun 1214	58.08	100.44	588	974	80
USAF (1962-α01)	WTR Scout	23 Aug 1146	98.66	99.59	620	858	40
NASA TIROS 6 (1962-αψ1)	ETR Delta	18 Sep 0853	58.32	98.73	686	713	60
		1963					
USAF (1963-5A)	WTR Scout	19 Feb 0434	100.48	97.79	505	791	20

Satellite name and designation[a]	Launch site and vehicle	Launch date and time GMT	Orbital inclina-tion deg	Period min	Perigee height km	Apogee height km	Lifetime years
NASA TIROS 7 (1963-24A)	ETR Delta	19 Jun 0950	58.23	97.40	621	649	50
USAF –	WTR Scout	27 Sep . .	Failed to orbit				
NASA TIROS 8 (1963-54A)	ETR Delta	21 Dec 0922	58.48	99.33	691	765	60
		1964					
USAF (1964-2B)	WTR Th/A-D	19 Jan 1048	99.04	101.31	801	830	300
USAF (1964-2C)	WTR Th/A-D	19 Jan 1048	99.07	101.32	811	825	300
USAF (1964-31A)	WTR Th/A-D	18 Jun 0448	99.84	101.64	828	842	500
USAF (1964-31B)	WTR Th/A-D	18 Jun 0448	99.83	101.64	828	842	500
NASA Nimbus 1 (1964-52A)	WTR Th/A-B	28 Aug 0755	98.66	98.42	429	937	15
		1965					
USAF (1965-3A)	WTR Th/Altair	19 Jan 0502	98.78	97.68	471	822	20
NASA TIROS 9 (1965-04A)	ETR Delta	22 Jan 0755	96.40	119.23	705	2 582	1 000
USAF (1965-21A)	WTR Th/Altair	18 Mar 0448	99.12	97.68	525	764	30
USAF (1965-38A)	WTR Th/Altair	20 May 1634	98.69	100.06	567	953	30
NASA TIROS 10 (1965-51A)	ETR Delta	2 Jul 0405	98.65	100.76	751	837	80
USAF (1965-72A)	WTR Th/Altair	10 Sep 0448	98.65	101.93	649	1 054	80
		1966					
USAF –	WTR Th/Altair	6 Jan . .	Failed to orbit				
ESSA 1 (TIROS 11) (1966-08A)	ETR TAD	3 Feb 0735	97.91	100.35	702	845	70
ESSA 2 (1966-16A)	ETR TAD	28 Feb 1355	101.00	113.57	1 356	1 418	10 000
USAF (1966-26A)	WTR Th/Altair	31 Mar 0434	98.60	100.56	634	933	50
NASA Nimbus 2 (1966-40A)	WTR TAT/A-B	15 May 0755	100.35	108.15	1 103	1 179	800

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
USAF (1966-82A)	WTR Th/Bu II	16 Sep 0434	98.46	100.86	705	891	50
ESSA 3 (1966-87A)	WTR TAD	2 Oct 1033	101.06	114.60	1 383	1 493	10 000
		1967					
ESSA 4 (1967-06A)	WTR TAD	26 Jan 1731	102.00	113.48	1 328	1 443	10 000
USAF (1967-10A)	WTR Th/Bu II	8 Feb 0755	98.84	101.55	796	868	70
ESSA 5 (1967-36A)	WTR TAD	20 Apr 1117	101.97	113.63	1 361	1 423	10 000
USAF (1967-80A)	WTR Th/Bu II	23 Aug 0448	98.97	102.20	834	892	100
USAF (1967-96A)	WTR Th/Bu II	11 Oct 0755	99.16	100.18	667	866	80
ESSA 6 (1967-114A)	WTR TAD	10 Nov 1800	102.12	114.82	1 410	1 488	10 000
		1968					
NASA/USA Nimbus B/ Secor 10 –	WTR Thorad/A-D	18 May . .	Failed to orbit				
USAF (1968-42A)	WTR Th/Bu II	23 May 0434	98.94	102.19	817	904	100
ESSA 7 (TIROS 17) (1968-69A)	WTR LT/Delta	16 Aug 1131	101.72	114.98	1 432	1 476	10 000
USAF (1968-92A)	WTR Th/Bu II	23 Oct 0434	99.00	101.45	797	855	100
ESSA 8 (1968-114A)	WTR LT/Delta	15 Dec 1717	101.90	114.70	1 410	1 473	10 000
		1969					
ESSA 9 (1969-16A)	ETR TAID	26 Feb 0735	101.79	115.28	1 427	1 508	10 000
NASA Nimbus 3 (1969-37A)	WTR Thorad/A-D	14 Apr 0755	99.91	107.40	1 075	1 135	800
USAF (1969-62A)	WTR Th/Bu II	23 Jul 0434	98.80	101.36	788	856	80
		1970					
NASA ITOS 1 (1970-08A)	WTR LTTA/Delta	23 Jan 1131	102.00	115.10	1 436	1 482	10 000
USAF (1970-12A)	WTR Th/Bu II	11 Feb 0838	98.71	101.39	773	874	80
NASA Nimbus 4 (1970-25A)	WTR Thorad/A-D	8 Apr 0824	99.89	107.29	1 095	1 100	1 200

Satellite name and designation[a]	Launch site and vehicle	Launch date and time GMT	Orbital inclination deg	Period min	Perigee height km	Apogee height km	Lifetime years
USAF (1970-70A)	WTR Th/Bu II	3 Sep 0838	98.73	101.30	764	874	80
NASA NOAA 1 (ITOS) (1970-106A)	WTR LTTA/Delta	11 Dec 1131	101.94	114.93	1 429	1 473	10 000
		1971					
USAF (1971-12A)	WTR Th/Bu II	17 Feb 0350	98.83	100.86	763	833	80
USAF (1971-87A)	WTR Th/Bu II	14 Oct 0936	98.96	101.68	796	877	80
ITOS B (1971-91A)	WTR LTTA/Delta	21 Oct 1507	Failed to orbit[b]				
		1972					
USAF (1972-18A)	WTR Th/Bu II	24 Mar 0853	98.80	101.83	803	885	100
NASA NOAA 2 (1972-82A)	WTR LTTA/Delta	15 Oct 1717	101.77	115.01	1 451	1 458	10 000
USAF (1972-89A)	WTR Th/Bu II	9 Nov 0502	98.65	101.80	813	872	80
NASA Nimbus 5 (1972-97A)	WTR Uprated Th/Delta	11 Dec 0755	99.95	107.25	1 089	1 102	1 600
		1973					
NASA ITOS-E –	WTR Delta	16 Jul . .	Failed to orbit				
USAF (1973-54A)	WTR Th/Bu II	17 Aug 0448	98.86	101.58	811	852	80
NASA NOAA 3 (1973-86A)	WTR Uprated Th/Delta	6 Nov 1702	102.08	116.12	1 500	1 509	10 000
		1974					
USAF (1974-15A)	WTR Th/Bu II	16 Mar 0810	98.94	101.54	782	877	80
NASA SMS 1[c] (1974-33A)	ETR LTTD	17 May 0936	1.90	1 436.0	35 741	35 830	$>10^6$
USAF (1974-63A)	WTR Th/Bu II	9 Aug 0322	98.86	101.76	806	875	80
NASA NOAA 4 (1974-89A)	WTR Two-stage Th/Delta	15 Nov 1717	101.75	115.00	1 447	1 462	10 000
		1975					
NASA SMS 2 (1975-11A)	ETR Uprated Th/Delta	6 Feb 2248	1.10	1 456.4	35 680	36 685	$>10^6$

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
USAF DMSP (1975-43A)	WTR Th/Bu II	24 May 0322	98.93	102.00	813	892	80
NASA Nimbus 6 (1975-52A)	WTR Uprated Th/Delta	12 Jun 0810	99.96	107.30	1 092	1 104	1 600
NASA GOES 1(SMS-3) (1975-100A)	ETR Delta	16 Oct 2234	1.00	1 435.9	35 770	35 770	>10[6]
		1976					
USAF (1976-16A)	WTR Th/Bu II	19 Feb 0755	98.87	88.97	90	355	0.67 day
NASA NOAA 5 (1976-77A)	ETR Two-stage Th/Delta	29 Jul 1702	102.10	116.34	1 509	1 522	10 000
USAF AMS 1 (1976-91A)	WTR Th/Bu II	11 Sep 0810	98.70	101.60	818	848	80

[a] See footnote *a* to table 5.2.
[b] The satellite failed to achieve the planned orbit.
[c] First synchronous meteorological satellite (SMS).

Table 5.9. US geodetic satellites launched during 1958–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
		1958					
NASA Beacon 1 –	ETR Jupiter C	23 Oct . .	Failed to orbit				
		1959					
NASA Beacon 2 –	ETR Juno II	14 Aug . .	Failed to orbit				
		1962					
USN ANNA 1A –	ETR Th/Able Star	10 May . .	Failed to orbit				
USN ANNA 1B (1962-βμ1)	ETR Th/Able Star	31 Oct 0810	50.14	107.84	1 077	1 182	3 000
		1964					
USA/USN Secor 1B (1964-01C)	WTR TAT/A-D	11 Jan 2010	69.89	103.46	904	933	1 500

Satellite name and designation[a]	Launch site and vehicle	Launch date and time GMT	Orbital inclination deg	Period min	Perigee height km	Apogee height km	Lifetime years
NASA Beacon –	ETR Delta	19 Mar . .	Failed to orbit				
NASA Beacon B Explorer 22 (1964-64A)	WTR Scout	10 Oct 0307	79.69	104.82	889	1 081	2 000
		1965					
USA/USN/ USAF Secor 3 (1965-16E)	WTR Th/A-D	9 Mar 1829	70.08	103.51	909	938	1 000
USA/USN Secor 2 (1965-17B)	WTR Th/Able Star	11 Mar 1341	89.98	97.85	296	1 014	1 081.76 days
USA/USAF Secor 4 (1965-27B)	WTR Atlas/A-D	3 Apr 2122	90.03	111.58	1 282	1 313	5 000
NASA Beacon C Explorer 27 (1965-32A)	WI Scout	29 Apr 1424	41.19	107.78	941	1 317	3 000
USA/NASA Secor 5 (1965-63B)	WI Scout	10 Aug 1800	69.26	122.24	1 140	2 423	10 000
NASA (GEOS 1) Explorer 29 (1965-89A)	ETR TAD	6 Nov 1843	59.38	120.30	1 115	2 277	50 000
		1966					
USA/USAF Secor 6 (1966-51B)	WTR Atlas/A-D	9 Jun 2010	90.05	125.13	168	3 648	391.7 days
NASA Pageos 1 (1966-56A)	WTR TAT/A-D	24 Jun 0014	87.14	181.43	4 207	4 271	50
USA/USAF Secor 7 (1966-77B)	WTR Atlas/A-D	19 Aug 1926	90.11	167.59	3 680	3 700	100 000
USAF Secor 8 (1966-89B)	WTR Atlas/A-D	5 Oct 2248	90.19	167.63	3 676	3 706	100 000
		1967					
USA/USN Secor 9 (1967-65A)	WTR Th/Bu II	29 Jun 2107	89.91	172.2	3 803	3 947	100 000
		1968					
NASA (GEOS 2) Explorer 36 (1968-2A)	WTR TAID	11 Jan 1619	105.80	112.28	1 084	1 577	10 000

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli-nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
NASA/USA Secor 10 –	WTR Thorad/A-D	18 May . .	Failed to orbit				
USA Secor 11 –	WTR Atlas/Bu II	16 Aug . .	Failed to orbit				
USA Secor 12 –	WTR Atlas/Bu II	16 Aug . .	Failed to orbit				
USA Secor 13 (1969-37B)	WTR Thorad/A-D	**1969** 14 Apr 0755	99.93	107.36	1 075	1 130	2 000
NASA/USA Topo 1 (1970-25B)	WTR Thorad/A-D	**1970** 8 Apr 0824	99.76	107.09	1 064	1 111	2 000
NASA (GEOS 3) Explorer 53 (1975-27A)	WTR Uprated Th/Delta	**1975** 10 Apr 0000	114.96	101.82	839	853	200
NASA Lageos (1976-39A)	WTR Th/Delta	**1976** 4 May 0755	109.86	225.41	5 837	5 945	>10

[a] See footnote *a* to table 5.2.

Table 5.10. Soviet photographic reconnaissance satellites launched in 1976

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclina-tion *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *days*	Whether recovered[b]
Cosmos 788[c] (1976-02A)	PL A-2	7 Jan 1536	62.81	89.53	183	321	12.60	Yes
Cosmos 799[d] (1976-09A)	TT A-2	29 Jan 0838	71.40	89.64	205	306	11.80	?
Cosmos 802[c] (1976-13A)	TT A-2	11 Feb 0853	64.99	89.56	172	334	13.84	Yes
Cosmos 805[f] (1976-18A)	PL A-2	20 Feb 1410	67.13	89.72	171	351	19.60	?
Cosmos 806[c,g] (1976-20A)	TT A-2	10 Mar 0810	71.37	89.65	178	334	12.89	Yes
Cosmos 809[d] (1976-25A)	TT A-2	18 Mar 0922	65.03	89.55	205	300	11.88	Yes

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *days*	Whether recovered[b]
Cosmos 810[c] (1976-28A)	PL A-2	26 Mar 1507	62.82	89.67	181	338	12.70	?
Cosmos 811[c] (1976-30A)	PL A-2	31 Mar 1258	72.85	89.95	206	338	11.80	?[h]
Cosmos 813[d] (1976-33A)	PL A-2	9 Apr 0838	81.34	88.98	210	236	11.85	Yes
Cosmos 815[c] (1976-36A)	PL A-2	28 Apr 0936	81.33	89.01	218	231	12.90	?[h]
Cosmos 817[c] (1976-40A)	TT A-2	5 May 0755	64.99	89.47	173	324	12.90	?
Cosmos 819[d] (1976-45A)	TT A-2	20 May 0658	65.00	89.44	202	293	11.90	?
Cosmos 820[c] (1976-46A)	PL A-2	21 May 0658	81.36	88.78	209	217	11.80	?
Cosmos 821[c] (1976-48A)	PL A-2	26 May 0907	72.83	89.69	204	314	12.80	?
Cosmos 824[c] (1976-52A)	TT A-2	8 Jun 0712	71.37	89.82	204	325	12.90	?
Cosmos 833[c] (1976-55A)	PL A-2	16 Jun 1312	62.82	89.44	180	316	12.60	?[h]
Cosmos 834[d] (1976-58A)	PL A-2	24 Jun 0712	81.37	89.05	216	237	11.90	?
Cosmos 835[c] (1976-60A)	TT A-2	29 Jun 0726	64.96	89.41	174	317	12.84	Yes[h]
Cosmos 840[d] (1976-68A)	PL A-2	14 Jul 0907	72.87	89.73	203	319	11.80	?
Cosmos 844[f] (1976-72A)	PL A-2	22 Jul 1550	67.15	89.76	172	353	3.00	?[i]
Cosmos 847[c] (1976-79A)	PL A-2	4 Aug 1326	62.82	89.50	181	321	12.61	Yes
Cosmos 848[e] (1976-82A)	PL A-2	12 Aug 1341	62.80	89.57	206	303	12.62	?
Cosmos 852[c] (1976-86A)	TT A-2	28 Aug 0907	64.99	89.54	173	332	12.85	Yes
Cosmos 854[c] (1976-90A)	PL A-2	3 Sep 0922	81.35	89.27	167	308	12.85	Yes
Cosmos 855[c] (1976-95A)	PL A-2	21 Sep 1146	72.88	89.96	202	341	11.8	Yes[h]
Cosmos 856[e] (1976-96A)	TT A-2	22 Sep 0936	65.01	89.53	203	300	12.9	Yes[h]
Cosmos 857[c] (1976-97A)	PL A-2	24 Sep 1507	62.80	89.50	179	323	12.6	Yes
Cosmos 859[c] (1976-99A)	TT A-2	10 Oct 0936	65.00	89.60	173	337	10.9	?
Cosmos 863[c] (1976-106A)	PL A-2	25 Oct 1438	62.81	89.74	178	348	10.6	Yes
Cosmos 865[e] (1976-109A)	PL A-2	1 Nov 1131	72.88	89.81	203	326	11.8	Yes

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclina-tion *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *days*	Whether recovered[b]
Cosmos 866[c] (1976-110A)	TT A-2	11 Nov 1048	64.98	89.16	180	287	11.9	?
Cosmos 867[c] (1976-111A)	PL A-2	23 Nov 1634	62.83	92.07	352	401	12.64	Yes
Comos 879[d] (1976-119A)	PL A-2	9 Dec 1005	81.37	88.90	213	225	12.80	Yes
Cosmos 884[c] (1976-123A)	TT A-2	17 Dec 0936	65.01	89.34	166	319	11.90	Yes

[a] See footnote *a* to table 5.2.
[b] *Yes* indicates that recovery signals were monitored by the Kettering Group.
[c] Manoeuvrable satellites—two tone.
[d] Non-manoeuvrable satellites—pulse duration modulation.
[e] Non-manoeuvrable satellites—pulse duration modulation—also scientific missions.
[f] May be a fourth generation of satellites with longer orbital lifetimes.
[g] Second-generation satellites carrying low-resolution cameras.
[h] Satellite ejected capsule.
[i] Satellite exploded.

Table 5.11. Possible Soviet electronic reconnaissance satellites launched in 1976

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli-nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
Cosmos 787 (1976-01A)	PL C-1	6 Jan 0502	74.03	95.30	518	547	10 years
Cosmos 790 (1976-07A)	PL C-1	22 Jan 2234	74.04	95.25	511	549	10 years
Cosmos 801 (1976-12A)	PL B-1	5 Feb 1435	70.95	95.28	268	796	2 years
Cosmos 812 (1976-31A)	PL C-1	6 Apr 0419	74.03	95.21	508	548	10 years
Cosmos 818 (1976-44A)	PL B-1	18 May 1102	71.05	92.08	271	481	7 months
Cosmos 845 (1976-75A)	PL C-1	27 Jul 0531	74.06	95.25	514	546	10 years
Cosmos 849 (1976-83A)	PL B-1	18 Aug 0936	70.97	95.95	264	865	18 months
Cosmos 850 (1976-84A)	PL B-1	26 Aug 1102	70.94	92.20	272	493	6 months
Cosmos 870 (1976-115A)	PL C-1	2 Dec 0014	74.00	95.26	513	548	10 years

[a] See footnote *a* to table 5.2.

Table 5.12. Possible Soviet ocean-surveillance satellites launched in 1976

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli-nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
Cosmos 860 (1976-103A)	TT F-1-m	17 Oct 1814	65.04 64.70[b]	89.66 104.33[b]	252 919[b]	265 1 008[b]	600
Cosmos 861 (1976-104A)	TT F-1-m	21 Oct 1702	64.96 64.8[b]	89.65 104.3[b]	251 919[b]	265 1 005[b]	600

[a] See footnote *a* to table 5.2.
[b] Final orbit.

Table 5.13. Possible Soviet early-warning satellites launched during 1967–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclina-tion *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
		1967					
Cosmos 159[b] (1967-46A)	TT . .	16 May 2150	51.60	1 174.2	350	60 637	20
Cosmos 174[c] (1967-82A)	TT . .	31 Aug 0755	64.85	715.0	430	39 796	487 days
		1968					
Cosmos 260[c] (1968-115A)	TT A-1/2	16 Dec 0922	64.93	712.36	518	39 570	4.40
		1972					
Cosmos 520 (1972-72A)	PL A-2-e	19 Sep 1926	62.89	715.02	750	39 470	5.00
		1973					
Cosmos 606 (1973-84A)	PL A-2-e	2 Nov 1258	62.91	709.92	657	39 310	15.00
		1974					
Cosmos 665 (1974-50A)	PL A-2-e	29 Jun 1605	62.82	710.65	625	39 378	15.75
		1975					
Cosmos 706 (1975-07A)	PL A-2-e	30 Jan 1507	62.85	710.55	623	39 824	30.00
Cosmos 775 (1975-97A)	TT D-1-e	8 Oct 0029	0.03	1 445.9	35 737	36 220	$>10^6$
		1976					
Cosmos 862 (1976-105A)	PL A-2-e	22 Oct 0922	62.81	712.32	571	39 516	15

[a] See footnote *a* to table 5.2.
[b] The satellite could have been a precursor test of manned spacecraft.
[c] Possible Molniya failure.

Table 5.14. Soviet navigation satellites launched during 1970–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
		1970					
Cosmos 385 (1970-108A)	PL C-1	12 Dec 1258	74.02	104.75	978	986	1 200
		1971					
Cosmos 422 (1971-46A)	PL C-1	22 May 0043	74.03	105.10	988	1 010	1 200
Cosmos 465 (1971-111A)	PL C-1	15 Dec 0434	74.03	104.94	970	1 012	1 200
		1972					
Cosmos 475 (1972-09A)	TT C-1	25 Feb 0936	74.08	104.81	970	1 000	1 200
Cosmos 489 (1972-35A)	PL C-1	6 May 1117	74.02	104.82	969	1 002	1 200
Cosmos 514 (1972-62A)	PL C-1	16 Aug 1522	82.97	104.43	958	975	1 200
		1973					
Cosmos 574 (1973-42A)	PL C-1	20 Jun 0614	82.94	105.14	985	1 014	1 400
Cosmos 586 (1973-65A)	PL C-1	14 Sep 0029	82.94	104.89	971	1 009	1 200
Cosmos 627 (1973-109A)	PL C-1	29 Dec 0405	82.95	105.08	974	1 019	1 200
		1974					
Cosmos 628 (1974-01A)	PL C-1	17 Jan 1005	82.96	104.87	958	1 016	1 200
Cosmos 663 (1974-48A)	PL C-1	27 Jun 1536	82.95	104.88	972	1 007	1 200
Cosmos 689 (1974-79A)	PL C-1	18 Oct 2234	82.94	105.12	981	1 017	1 200
Cosmos 700 (1974-105A)	PL C-1	26 Dec 1200	82.96	104.80	966	999	1 200
		1975					
Cosmos 726 (1975-28A)	PL C-1	11 Apr 0755	82.99	104.65	956	996	1 200
Cosmos 729 (1975-34A)	PL C-1	22 Apr 2107	82.97	105.05	980	1 011	1 200
Cosmos 755 (1975-74A)	PL C-1	14 Aug 1326	82.90	105.00	974	1 013	1 200
Cosmos 778 (1975-103A)	PL C-1	4 Nov 1005	82.96	104.95	978	1 004	1 200
		1976					
Cosmos 789 (1976-05A)	PL C-1	20 Jan 1702	82.97	105.05	975	1 016	1 200
Cosmos 800 (1976-11A)	PL C-1	3 Feb 0810	82.97	105.13	984	1 015	1 200

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
Cosmos 823 (1976-51A)	PL C-1	2 Jun 2234	82.96	105.04	980	1 011	1 200
Cosmos 842 (1976-70A)	PL C-1	21 Jul 1019	82.98	104.96	972	1 011	1 200
Cosmos 846 (1976-78A)	PL C-1	29 Jul 1955	82.92	104.81	954	1 015	1 200
Cosmos 864 (1976-108A)	PL C-1	29 Oct 1243	82.94	104.90	966	1 011	1 200
Cosmos 883 (1976-122A)	PL C-1	15 Dec 1355	82.95	104.86	961	1 012	1 200
Cosmos 887 (1976-128A)	PL C-1	28 Dec 0735	82.94	104.84	954	1 018	1 200

[a] See footnote *a* to table 5.2.

Table 5.15. Possible Soviet communications satellites launched during 1964–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
		1964					
Cosmos 41[b] (1964-49D)	TT A-2-e	22 Aug 0712	64.88	714.58	426	39 771	46 years
Cosmos 42[c] (1964-50A)	KY B-1	22 Aug 1102	48.97	97.91	224	1 098	345.21 days
Cosmos 43[c] (1964-50C)	KY B-1	22 Aug 1102	48.96	98.00	227	1 100	492.37 days
		1965					
Molniya 1-1 (1965-30A)	TT A-2-e	23 Apr 0155	65.50	707.29	538	39 300	14 years
Cosmos 80[d] (1965-70A)	TT C-1	3 Sep 1355	55.98	114.97	1 357	1 555	10^4 years
Cosmos 81[d] (1965-70B)	TT C-1	3 Sep 1355	56.05	115.29	1 384	1 557	10^4 years
Cosmos 82[d] (1965-70C)	TT C-1	3 Sep 1355	56.04	115.65	1 408	1 565	10^4 years
Cosmos 83[d] (1965-70D)	TT C-1	3 Sep 1355	56.03	116.01	1 441	1 567	10^4 years
Cosmos 84[d] (1965-70E)	TT C-1	3 Sep 1355	56.03	116.33	1 466	1 576	10^4 years
Molniya 1-2 (1965-80A)	TT A-2-e	14 Oct 1938	65.19	718.84	481	39 935	518 days
Cosmos 103[e] (1965-112A)	TT C-1	28 Dec 1229	56.07	96.95	594	636	60 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
		1966					
Molniya 1-3 (1966-35A)	TT A-2-e	25 Apr 0712	65.04	710.41	506	39 492	6.5 years
Molniya 1-4 (1966-92A)	TT A-2-e	20 Oct 0755	65.35	714.40	505	39 685	692.02 days
		1967					
Cosmos 151[e] (1967-27A)	TT C-1	24 Mar 1146	56.07	97.14	596	652	50 years
Cosmos 158[e] (1967-45A)	PL C-1	15 May 1102	74.03	100.40	738	822	200 years
Molniya 1-5 (1967-52A)	TT A-2-e	24 May 2248	64.87	710.40	1 188	38 807	4.5 years
Molniya 1-6 (1967-95A)	TT A-2-e	3 Oct 0502	64.96	718.03	502	39 868	518.76 days
Molniya 1-7 (1967-101A)	TT A-2-e	22 Oct 0838	65.00	715.00	508	39 710	801 days
		1968					
Molniya 1-8 (1968-35A)	TT A-2-e	21 Apr 0419	64.85	713.12	391	39 738	5.5 years
Molniya 1-9 (1968-57A)	TT A-2-e	5 Jul 1522	65.05	713.80	401	39 803	2.1 years
Cosmos 236[e] (1968-70A)	TT C-1	27 Aug 1131	56.07	96.83	588	630	50 years
Molniya 1-10 (1968-85A)	TT A-2-e	5 Oct 0029	64.87	712.00	436	39 633	6.5 years
		1969					
Molniya 1-11 (1969-35A)	TT A-2-e	11 Apr 0238	64.94	713.50	404	39 741	1 832 days
Molniya 1-12 (1969-61A)	TT A-2-e	22 Jul 1258	64.90	710.94	499	39 519	696 days
		1970					
Molniya 1-13 (1970-13A)	PL A-2-e	19 Feb 1858	65.44	703.13	461	39 170	5.5 years
Cosmos 336[f] (1970-36A)	PL C-1	25 Apr 1702	74.04	115.49	1 464	1 490	10^4 years
Cosmos 337[f] (1970-36B)	PL C-1	25 Apr 1702	74.05	116.27	1 470	1 554	10^4 years
Cosmos 338[f] (1970-36C)	PL C-1	25 Apr 1702	74.03	115.89	1 472	1 518	10^4 years
Cosmos 339[f] (1970-36D)	PL C-1	25 Apr 1702	74.04	115.10	1 446	1 472	9 000 years
Cosmos 340[f] (1970-36E)	PL C-1	25 Apr 1702	74.04	114.70	1 409	1 473	8 000 years
Cosmos 341[f] (1970-36F)	PL C-1	25 Apr 1702	74.04	113.97	1 345	1 471	6 000 years
Cosmos 342[f] (1970-36G)	PL C-1	25 Apr 1702	74.04	113.62	1 313	1 471	5 000 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
Cosmos 343[f] (1970-36H)	PL C-1	25 Apr 1702	72.02	114.32	1 374	1 474	7 000 years
Molniya 1-14 (1970-49A)	PL A-2-e	26 Jun 0322	65.37	704.70	448	39 260	5.5 years
Molniya 1-15 (1970-77A)	PL A-2-e	29 Sep 0824	65.50	706.18	480	39 300	5.5 years
Cosmos 372[e] (1970-86A)	PL C-1	16 Oct 1507	74.06	100.80	785	806	100 years
Molniya 1-16 (1970-101A)	PL A-2-e	27 Nov 1550	65.48	707.09	471	39 350	5.3 years
Molniya 1-17 (1970-114A)	TT A-2-e	25 Dec 0350	64.99	711.80	495	39 565	31 months
		1971					
Cosmos 407[e] (1971-35A)	PL C-1	23 Apr 1131	74.06	100.99	791	819	120 years
Cosmos 411[f] (1971-41A)	PL C-1	7 May 1424	74.03	113.91	1 318	1 492	5 000 years
Cosmos 412[f] (1971-41B)	PL C-1	7 May 1424	74.04	116.20	1 482	1 537	10^4 years
Cosmos 413[f] (1971-41C)	PL C-1	7 May 1424	74.04	115.84	1 476	1 509	10^4 years
Cosmos 414[f] (1971-41D)	PL C-1	7 May 1424	74.02	115.16	1 428	1 496	9 000 years
Cosmos 415[f] (1971-41E)	PL C-1	7 May 1424	74.01	115.50	1 452	1 503	9 000 years
Cosmos 416[f] (1971-41F)	PL C-1	7 May 1424	74.02	114.54	1 373	1 494	7 000 years
Cosmos 417[f] (1971-41G)	PL C-1	7 May 1424	74.01	114.23	1 344	1 495	6 000 years
Cosmos 418[f] (1971-41H)	PL C-1	7 May 1424	74.01	114.85	1 401	1 495	8 000 years
Molniya 1-18 (1971-64A)	PL A-2-e	28 Jul 0336	65.37	704.99	468	39 254	6 years
Cosmos 444[f] (1971-86A)	PL C-1	13 Oct 1341	74.03	114.16	1 324	1 509	6 000 years
Cosmos 445[f] (1971-86B)	PL C-1	13 Oct 1341	74.03	114.53	1 353	1 513	7 000 years
Cosmos 446[f] (1971-86C)	PL C-1	13 Oct 1341	74.03	114.88	1 384	1 513	8 000 years
Cosmos 447[f] (1971-86D)	PL C-1	13 Oct 1341	74.03	115.21	1 414	1 515	9 000 years
Cosmos 448[f] (1971-86E)	PL C-1	13 Oct 1314	74.03	115.58	1 441	1 522	9 000 years
Cosmos 449[f] (1971-86F)	PL C-1	13 Oct 1341	74.04	116.33	1 484	1 544	10^4 years
Cosmos 450[f] (1971-86G)	PL C-1	13 Oct 1341	74.03	115.94	1 465	1 530	10^4 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
Cosmos 451[f] (1971-86H)	PL C-1	13 Oct 1314	74.03	116.73	1 492	1 574	10^4 years
Molniya 2-1 (1971-100A)	PL A-2-e	24 Nov 0936	65.47	712.03	517	39 554	28 months
Cosmos 468[e] (1971-114A)	PL C-1	17 Dec 1258	74.03	100.83	786	809	120 years
Molniya 1-19 (1971-115A)	PL A-2-e	19 Dec 2324	65.42	703.28	499	39 139	5.5 years
		1972					
Molniya 1-20 (1972-25A)	PL A-2-e	4 Apr 2038	65.60	705.35	480	39 260	666 days
Molniya 2-2 (1972-37A)	PL A-2-e	19 May 1438	65.42	705.11	440	39 290	5 years
Cosmos 494[e] (1972-43A)	PL C-1	23 Jun 0922	74.06	100.83	790	804	120 years
Cosmos 504[f] (1972-57A)	PL C-1	20 Jun 1800	74.02	114.03	1 324	1 498	5 000 years
Cosmos 505[f] (1972-57B)	PL C-1	20 Jun 1800	74.03	114.37	1 354	1 498	6 000 years
Cosmos 506[f] (1972-57C)	PL C-1	20 Jun 1800	74.02	114.70	1 384	1 498	7 000 years
Cosmos 507[f] (1972-57D)	PL C-1	20 Jun 1800	74.02	115.03	1 414	1 498	8 000 years
Cosmos 508[f] (1972-57E)	PL C-1	20 Jun 1800	74.02	115.37	1 446	1 497	9 000 years
Cosmos 509[f] (1972-57F)	PL C-1	20 Jun 1800	74.02	115.73	1 475	1 501	10^4 years
Cosmos 510[f] (1972-57G)	PL C-1	20 Jun 1800	74.02	116.10	1 497	1 512	10^4 years
Cosmos 511[f] (1972-57H)	PL C-1	20 Jun 1800	74.03	116.48	1 496	1 548	10^4 years
Molniya 2-3 (1972-75A)	PL A-2-e	30 Sep 2024	65.63	703.20	392	39 240	5.5 years
Molniya 1-21 (1972-81A)	PL A-2-e	14 Oct 0614	65.30	706.18	480	39 300	5.1 years
Cosmos 528[f] (1972-87A)	PL C-1	1 Nov 0155	74.03	114.21	1 368	1 471	7 000 years
Cosmos 529[f] (1972-87B)	PL C-1	1 Nov 0155	74.03	114.61	1 404	1 470	8 000 years
Cosmos 530[f] (1972-87C)	PL C-1	1 Nov 0155	74.03	113.85	1 336	1 469	6 000 years
Cosmos 531[f] (1972-87D)	PL C-1	1 Nov 0155	74.03	114.83	1 423	1 471	9 000 years
Cosmos 532[f] (1972-87E)	PL C-1	1 Nov 0155	74.04	113.49	1 302	1 470	4 000 years
Cosmos 533[f] (1972-87F)	PL C-1	1 Nov 0155	74.03	113.68	1 319	1 470	5 000 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time GMT	Orbital inclination deg	Period min	Perigee height km	Apogee height km	Lifetime
Cosmos 534[f] (1972-87G)	PL C-1	1 Nov 0155	74.04	114.03	1 351	1 470	6 000 years
Cosmos 535[f] (1972-87H)	PL C-1	1 Nov 0155	74.04	114.42	1 385	1 472	8 000 years
Molniya 1-22 (1972-95A)	TT A-2-e	2 Dec 0448	65.01	717.70	555	39 797	2.1 years
Molniya 2-4 (1972-98A)	PL A-2-e	12 Dec 0658	65.26	706.48	495	39 300	1.7 years
Cosmos 540[e] (1972-104A)	PL C-1	25 Dec 2324	74.08	100.79	781	810	120 years
		1973					
Molniya 1-23 (1973-07A)	TT A-2-e	3 Feb 0600	65.00	703.15	470	39 164	4.0 years
Molniya 2-5 (1973-18A)	PL A-2-e	5 Apr 1117	65.49	702.19	477	39 107	6.5 years
Cosmos 564[f] (1973-37A)	PL C-1	8 Jun 1536	74.03	114.68	1 395	1 484	8 000 years
Cosmos 565[f] (1973-37B)	PL C-1	8 Jun 1536	74.03	115.36	1 450	1 492	9 000 years
Cosmos 566[f] (1973-37C)	PL C-1	8 Jun 1536	74.01	115.12	1 435	1 485	9 000 years
Cosmos 567[f] (1973-37D)	PL C-1	8 Jun 1536	74.01	114.88	1 414	1 486	9 000 years
Cosmos 568[f] (1973-37E)	PL C-1	8 Jun 1536	74.02	114.43	1 378	1 482	8 000 years
Cosmos 569[f] (1973-37F)	PL C-1	8 Jun 1536	74.02	114.23	1 359	1 482	7 000 years
Cosmos 570[f] (1973-37G)	PL C-1	8 Jun 1536	74.02	114.03	1 341	1 481	6 000 years
Cosmos 571[f] (1973-37H)	PL C-1	8 Jun 1536	74.03	114.81	1 321	1 481	6 000 years
Molniya 2-6 (1973-45A)	PL A-2-e	11 Jun 1445	65.41	705.06	441	39 285	5.0 years
Molniya 1-24 (1973-61A)	PL A-2-e	30 Aug 0014	65.47	717.77	463	39 893	5.5 years
Cosmos 588[f] (1973-69A)	PL C-1	2 Oct 2150	74.00	115.37	1 451	1 494	10^4 years
Cosmos 589[f] (1973-69B)	PL C-1	2 Oct 2150	74.01	114.95	1 419	1 487	9 000 years
Cosmos 590[f] (1973-69C)	PL C-1	2 Oct 2150	74.00	115.15	1 438	1 486	10^4 years
Cosmos 591[f] (1973-69D)	PL C-1	2 Oct 2150	74.00	114.20	1 349	1 488	6 000 years
Cosmos 592[f] (1973-69E)	PL C-1	2 Oct 2150	74.00	114.01	1 333	1 486	6 000 years
Cosmos 593[f] (1973-69F)	PL C-1	2 Oct 2150	74.00	114.39	1 366	1 487	7 000 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time GMT	Orbital inclination deg	Period min	Perigee height km	Apogee height km	Lifetime
Cosmos 594[f] (1973-69G)	PL C-1	2 Oct 2150	74.01	114.57	1 382	1 488	8 000 years
Cosmos 595[f] (1973-69H)	PL C-1	2 Oct 2150	74.00	114.77	1 402	1 486	8 000 years
Molniya 2-7 (1973-76A)	PL A-2-e	19 Oct 1033	62.84	717.93	509	39 855	9.00 years
Molniya 1-25 (1973-89A)	TT A-2-e	14 Nov 2038	64.92	702.37	454	39 197	6.00 years
Molniya 1-26 (1973-97A)	PL A-2-e	30 Nov 1312	62.89	740.03	619	40 829	11.50 years
Cosmos 614[e] (1973-98A)	PL C-1	4 Dec 1507	74.06	100.66	770	805	120 years
Cosmos 617[f] (1973-104A)	PL C-1	19 Dec 0936	74.03	114.04	1 336	1 436	5 000 years
Cosmos 618[f] (1973-104B)	PL C-1	19 Dec 0936	74.02	115.28	1 446	1 486	9 000 years
Cosmos 619[f] (1973-104C)	PL C-1	19 Dec 0936	74.02	115.06	1 423	1 493	9 000 years
Cosmos 620[f] (1973-104D)	PL C-1	19 Dec 0936	74.01	115.51	1 461	1 495	10^4 years
Cosmos 621[f] (1973-104E)	PL C-1	19 Dec 0936	74.03	114.84	1 410	1 485	8 000 years
Cosmos 622[f] (1973-104F)	PL C-1	19 Dec 0936	74.01	114.44	1 371	1 487	7 000 years
Cosmos 623[f] (1973-104G)	PL C-1	19 Dec 0936	74.02	114.63	1 389	1 487	7 000 years
Cosmos 624[f] (1973-104H)	PL C-1	19 Dec 0936	74.02	114.24	1 366	1 474	6 000 years
Molniya 2-8 (1973-106A)	PL A-2-e	25 Dec 1117	62.89	736.95	488	40 809	10.50 years
		1974					
Molniya 1-27 (1974-23A)	PL A-2-e	20 Apr 2053	62.86	737.63	624	40 707	13.00 years
Cosmos 641[f] (1974-24A)	PL C-1	23 Apr 1410	74.01	114.60	1 389	1 484	7 000 years
Cosmos 642[f] (1974-24B)	PL C-1	23 Apr 1410	74.01	113.83	1 321	1 483	4 000 years
Cosmos 643[f] (1974-24C)	PL C-1	23 Apr 1410	74.01	114.22	1 355	1 484	6 000 years
Cosmos 644[f] (1974-24D)	PL C-1	23 Apr 1410	74.02	114.02	1 336	1 484	5 000 years
Cosmos 645[f] (1974-24E)	PL C-1	23 Apr 1410	74.02	114.40	1 370	1 485	7 000 years
Cosmos 646[f] (1974-24F)	PL C-1	23 Apr 1410	74.01	114.81	1 405	1 487	8 000 years
Cosmos 647[f] (1974-24G)	PL C-1	23 Apr 1410	74.01	115.00	1 424	1 486	9 000 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
Cosmos 648[f] (1974-24H)	PL C-1	23 Apr 1410	74.01	115.23	1 440	1 490	10^4 years
Molniya 2-9 (1974-26A)	PL A-2-e	26 Apr 1424	62.89	737.04	600	40 702	100 years
Molniya 2-10 (1974-56A)	PL A-2-e	23 Jul 0126	62.89	737.59	604	40 726	19 years
Molniya 1-S-1[g] (1974-60A)	TT D-1-e	29 Jul 1200	0.07	1 436.20	35 787	35 790	$>10^6$ years
Cosmos 676[e] (1974-71A)	PL C-1	11 Sep 1746	74.05	101.01	796	816	120 years
Cosmos 677[f] (1974-72A)	PL C-1	19 Sep 1438	74.03	114.53	1 399	1 469	7 000 years
Cosmos 678[f] (1974-72B)	PL C-1	19 Sep 1438	74.03	116.03	1 468	1 535	10^4 years
Cosmos 679[f] (1974-72C)	PL C-1	19 Sep 1438	74.02	115.78	1 468	1 513	10^4 years
Cosmos 680[f] (1974-72D)	PL C-1	19 Sep 1438	74.03	115.58	1 468	1 494	10^4 years
Cosmos 681[f] (1974-72E)	PL C-1	19 Sep 1438	74.03	115.35	1 468	1 474	9 000 years
Cosmos 682[f] (1974-72F)	PL C-1	19 Sep 1438	74.03	115.15	1 455	1 468	9 000 years
Cosmos 683[f] (1974-72G)	PL C-1	19 Sep 1438	74.03	114.95	1 436	1 469	9 000 years
Cosmos 684[f] (1974-72H)	PL C-1	19 Sep 1438	74.02	114.74	1 418	1 468	8 000 years
Molniya 1-28 (1974-81A)	PL A-2-e	24 Oct 1243	62.82	736.37	656	40 614	14.5 years
Molniya 3-1 (1974-92A)	PL A-2-e	21 Nov 1033	62.82	737.26	625	40 685	11.00 years
Molniya 2-11 (1974-102A)	PL A-2-e	21 Dec 0224	62.90	736.77	659	40 629	14.00 years
		1975					
Molniya 2-12 (1975-09A)	PL A-2-e	6 Feb 0448	62.78	736.85	634	40 660	10.00 years
Cosmos 711[f] (1975-16A)	PL C-1	28 Feb 1355	74.00	115.53	1 462	1 496	10^4 years
Cosmos 712[f] (1975-16B)	PL C-1	28 Feb 1355	74.00	114.95	1 413	1 492	8 000 years
Cosmos 713[f] (1975-16C)	PL C-1	28 Feb 1355	74.00	114.75	1 398	1 490	7 000 years
Cosmos 714[f] (1975-16D)	PL C-1	28 Feb 1355	74.00	115.33	1 446	1 494	9 000 years
Cosmos 715[f] (1975-16E)	PL C-1	28 Feb 1355	74.00	115.75	1 470	1 508	10^4 years
Cosmos 716[f] (1975-16F)	PL C-1	28 Feb 1355	74.00	115.96	1 480	1 517	10^4 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclina-tion *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
Cosmos 717[f] (1975-16G)	PL C-1	28 Feb 1355	74.00	116.21	1 481	1 538	10^4 years
Cosmos 718[f] (1975-16H)	PL C-1	28 Feb 1355	74.01	115.14	1 430	1 492	9 000 years
Molniya 3-2 (1975-29A)	PL A-2-e	14 Apr 1800	62.86	736.35	608	40 661	12.00 years
Molniya 1-29 (1975-36A)	PL A-2-e	29 Apr 1033	62.83	736.47	430	40 852	100 years
Cosmos 732[f] (1975-45A)	PL C-1	28 May 0029	74.02	114.65	1 405	1 472	7 000 years
Cosmos 733[f] (1975-45B)	PL C-1	28 May 0029	74.00	116.30	1 472	1 555	10^4 years
Cosmos 734[f] (1975-45C)	PL C-1	28 May 0029	74.01	115.10	1 445	1 473	9 000 years
Cosmos 735[f] (1975-45D)	PL C-1	28 May 0029	74.02	115.33	1 462	1 477	9 000 years
Cosmos 736[f] (1975-45E)	PL C-1	28 May 0029	74.02	115.55	1 471	1 489	10^4 years
Cosmos 737[f] (1975-45F)	PL C-1	28 May 0029	74.02	116.04	1 471	1 532	10^4 years
Cosmos 738[f] (1975-45G)	PL C-1	28 May 0029	74.02	115.80	1 469	1 512	10^4 years
Cosmos 739[f] (1975-45H)	PL C-1	28 May 0029	74.01	114.88	1 425	1 473	8 000 years
Molniya 1-30 (1975-49A)	PL A-2-e	5 Jun 0141	62.82	736.82	435	40 857	12.00 years
Molniya 2-13 (1975-63A)	PL A-2-e	8 Jul 0502	62.87	736.87	432	40 862	100 years
Molniya 1-31 (1975-79A)	PL A-2-e	2 Sep 1312	62.90	736.78	623	40 667	10 years
Molniya 2-14 (1975-81A)	PL A-2-e	9 Sep 0029	62.81	736.50	439	40 837	15 years
Cosmos 761[f] (1975-86A)	PL C-1	17 Sep 0712	73.99	114.74	1 402	1 484	7 000 years
Cosmos 762[f] (1975-86B)	PL C-1	17 Sep 0712	74.00	115.19	1 440	1 487	9 000 years
Cosmos 763[f] (1975-86C)	PL C-1	17 Sep 0712	74.00	115.86	1 476	1 512	10^4 years
Cosmos 764[f] (1975-86D)	PL C-1	17 Sep 0712	74.00	116.09	1 481	1 528	10^4 years
Cosmos 765[f] (1975-86E)	PL C-1	17 Sep 0712	74.00	116.36	1 480	1 553	10^4 years
Cosmos 766[f] (1975-86F)	PL C-1	17 Sep 0712	74.00	114.97	1 421	1 486	8 000 years
Cosmos 767[f] (1975-86G)	PL C-1	17 Sep 0712	74.00	115.41	1 457	1 490	9 000 years
Cosmos 768[f] (1975-86H)	PL C-1	17 Sep 0712	74.00	115.63	1 474	1 493	10^4 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
Cosmos 773[e] (1975-94A)	PL C-1	30 Sep 1843	74.06	100.87	791	808	120 years
Molniya 3-3 (1975-105A)	PL A-2-e	14 Nov 1912	62.90	737.26	523	40 790	12 years
Cosmos 783[e] (1975-112A)	PL C-1	28 Nov 0014	74.06	100.99	795	815	120 years
Molniya 2-15 (1975-121A)	PL A-2-e	17 Dec 1117	62.81	736.01	431	40 821	10 years
Statsionar 1 (Raduga 1) (1975-123A)	TT D-1-e	22 Dec 1312	0.10	1 434	35 800	35 800	>10^6 years
Molniya 3-4 (1975-125A)	PL A-2-e	27 Dec 1033	62.81	735.10	443	40 764	10.5 years
		1976					
Molniya 1-32 (1976-06A)	PL A-2-e	22 Jan 1146	62.91	717.74	476	39 579	10 years
Cosmos 791 (1976-08A)	PL C-1	28 Jan 1033	74.05	114.81	1 402	1 490	8 000 years
Cosmos 792 (1976-08B)	PL C-1	28 Jan 1033	74.06	115.23	1 436	1 494	9 000 years
Cosmos 793 (1976-08C)	PL C-1	28 Jan 1033	74.06	115.02	1 418	1 494	8 000 years
Cosmos 794 (1976-08D)	PL C-1	28 Jan 1033	74.06	115.44	1 452	1 497	4 000 years
Cosmos 795 (1976-08E)	PL C-1	28 Jan 1033	74.05	115.66	1 467	1 503	10^4 years
Cosmos 796 (1976-08F)	PL C-1	28 Jan 1033	74.04	115.90	1 474	1 518	10^4 years
Cosmos 797 (1976-08G)	PL C-1	28 Jan 1033	74.05	116.13	1 480	1 533	10^4 years
Cosmos 798 (1976-08H)	PL C-1	28 Jan 1033	74.05	116.40	1 481	1 557	10^4 years
Molniya 1-33 (1976-21A)	PL A-2-e	11 Mar 1955	62.84	734.41	491	40 682	12 years
Molniya 1-34 (1976-26A)	PL A-2-e	19 Mar 1938	62.93	696.52	416	38 882	12 years
Molniya 3-5 (1976-41A)	PL A-2-e	12 May 1800	62.81	736.64	625	40 657	10 years
Cosmos 825 (1976-54A)	PL C-1	15 Jun 1312	73.99	114.74	1 397	1 489	7 000 years
Cosmos 826 (1976-54B)	PL C-1	15 Jun 1312	74.00	116.33	1 484	1 546	10^4 years
Cosmos 827 (1976-54C)	PL C-1	15 Jun 1312	74.00	114.96	1 415	1 491	8 000 years
Cosmos 828 (1976-54D)	PL C-1	15 Jun 1312	73.99	115.18	1 435	1 491	9 000 years
Cosmos 829 (1976-54E)	PL C-1	15 Jun 1312	74.00	115.39	1 453	1 492	9 000 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclina-tion *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
Cosmos 830 (1976-54F)	PL C-1	15 Jun 1312	74.00	115.61	1 471	1 495	10^4 years
Cosmos 831 (1976-54G)	PL C-1	15 Jun 1312	74.00	115.85	1 477	1 510	10^4 years
Cosmos 832 (1976-54H)	PL C-1	15 Jun 1312	74.00	116.07	1 484	1 523	10^4 years
Cosmos 836 (1976-61A)	PL C-1	29 Jun 0810	74.06	100.98	791	818	120 years
Cosmos 837[h] (1976-62A)	PL A-2-e	1 Jul 0810	62.75	98.51	438	936	8 years
Cosmos 841 (1976-69A)	PL C-1	15 Jul 1312	74.05	100.83	787	808	120 years
Molniya 1-35 (1976-74A)	PL A-2-e	23 Jul 1550	63.01	700.93	476	39 045	10 years
Cosmos 853[h] (1976-88D)	PL A-2-e	1 Sep 0322	62.81	91.68	242	473	3 months
Statsionar 1B (Raduga 2) (1976-92A)	TT D-1-e	11 Sep 1829	0.30	1 440	35 900	35 900	$>10^6$ years
Cosmos 858 (1976-98A)	PL C-1	29 Sep 0712	74.06	100.93	792	813	120 years
Statsionar 1C (Ekran) (1976-107A)	TT D-1-e	26 Oct 1453	0.2	1 437	35 852	35 850	$>10^6$ years
Molniya 3-6 (1976-127A)	PL A-2-e	28 Dec 0643	62.81	716.97	544	39 773	10 years

[a] See footnote *a* to table 5.2.
[b] Precursor to Molniya 1.
[c] Dual launch.
[d] Quintuple launch.
[e] See reference [44].
[f] Octuple launch.
[g] The first stationary Molniya satellite.
[h] May be a failed Molniya satellite.

Table 5.16. Soviet weather satellites launched during 1963–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli-nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
		1963					
Cosmos 14[b] (1963-10A)	KY B-1	13 Apr 1102	48.95	92.10	252	499	137.6 days
Cosmos 23[b] (1963-50A)	KY B-1	13 Dec 1355	49.00	92.90	240	613	104.48 days

Satellite name and designation[a]	Launch site and vehicle	Launch date and time GMT	Orbital incli-nation deg	Period min	Perigee height km	Apogee height km	Lifetime
		1964					
Cosmos 44[c] (1964-53A)	TT A-1	28 Aug 1619	65.04	99.48	615	857	100 years
Cosmos 45[d] (1964-55A)	TT A-2	13 Sep 0950	64.89	89.68	207	313	4.9 days
		1965					
Cosmos 58[c] (1965-14A)	TT A-1	26 Feb 0502	65.00	96.78	563	647	50 years
Cosmos 65[d] (1965-29A)	TT A-2	17 Apr 0950	65.00	89.75	207	319	7.94 days
Cosmos 92[d] (1965-83A)	TT A-2	16 Oct 0810	64.97	89.85	201	334	7.94 days
Cosmos 100[c] (1965-106A)	TT A-1	17 Dec 0224	65.00	97.58	630	658	60 years
		1966					
Cosmos 118[c] (1966-38A)	TT A-1	11 May 1410	65.00	97.13	587	657	60 years
Cosmos 122 (1966-57A)	TT A-1	25 Jun 1019	65.14	97.12	550	690	50 years
		1967					
Cosmos 144 (1967-18A)	PL A-1	28 Feb 1438	81.25	96.88	574	644	50 years
Cosmos 149[e] (1967-24A)	KY B-1	21 Mar 1005	48.40	89.76	245	285	17.28 days
Cosmos 156 (1967-39A)	PL A-1	27 Apr 1243	81.23	97.20	593	635	50 years
Cosmos 184 (1967-102A)	PL A-1	24 Oct 2324	81.19	97.16	600	638	60 years
		1968					
Cosmos 206 (1968-19A)	PL A-1	14 Mar 0936	81.23	97.08	598	640	60 years
Cosmos 226 (1968-49A)	PL A-1	12 Jun 1312	81.24	96.87	579	639	60 years
		1969					
Meteor 1 (1969-29A)	PL A-1	26 Mar 1229	81.20	97.96	633	687	60 years
Meteor 2 (1969-84A)	PL A-1	6 Oct 0141	81.26	97.70	613	681	60 years
		1970					
Cosmos 320[e] (1970-05A)	KY B-1	16 Jan 1102	48.40	90.18	247	326	24.67 days
Meteor 3 (1970-19A)	PL A-1	17 Mar 1117	81.18	96.42	537	635	50 years
Meteor 4 (1970-37A)	PL A-1	28 Apr 1048	81.23	98.12	625	710	60 years
Meteor 5 (1970-47A)	PL A-1	23 Jun 1424	81.23	102.16	831	888	400 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli-nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
Meteor 6 (1970-85A)	PL A-1	15 Oct 1131	81.21	97.49	626	648	60 years
Cosmos 389 (1970-113A)	PL A-1	18 Dec 1619	81.19	98.06	642	687	60 years
		1971					
Meteor 7 (1971-03A)	PL A-1	20 Jan 1133	81.21	97.60	629	656	60 years
Meteor 8 (1971-31A)	PL A-1	17 Apr 1146	81.24	97.17	610	633	60 years
Meteor 9 (1971-59A)	PL A-1	16 Jul 0141	81.19	97.29	614	642	60 years
Meteor 10 (1971-120A)	PL A-1	29 Dec 1048	81.25	102.66	878	889	500 years
		1972					
Cosmos 476 (1972-11A)	PL A-1	1 Mar 1117	81.23	97.24	617	633	60 years
Meteor 11 (1972-22A)	PL A-1	30 Mar 1410	81.23	102.59	868	891	500 years
Meteor 12 (1972-49A)	PL A-1	30 Jun 1858	81.22	102.95	889	905	500 years
Meteor 13 (1972-85A)	PL A-1	26 Oct 2248	81.27	102.57	867	891	500 years
Cosmos 542 (1972-106A)	PL A-1	28 Dec 1102	81.22	96.38	527	641	29 years
		1973					
Meteor 14 (1973-15A)	PL A-1	20 Mar 1117	81.27	102.64	873	892	500 years
Meteor 15 (1973-34A)	PL A-1	29 May 1039	81.22	102.48	853	896	500 years
Cosmos 604 (1973-80A)	PL A-1	29 Oct 1410	81.23	97.25	615	631	60 years
		1974					
Meteor 16 (1974-11A)	PL A-1	5 Mar 1146	81.23	102.23	832	894	500 years
Meteor 17 (1974-25A)	PL A-1	24 Apr 1200	81.23	102.58	865	894	500 years
Meteor 18 (1974-52A)	PL A-1	9 Jul 1438	81.23	102.57	865	893	500 years
Cosmos 673 (1974-66A)	PL A-1	16 Aug 0350	81.21	97.17	607	637	60 years
Meteor 19 (1974-83A)	PL A-1	28 Oct 1019	81.18	102.48	843	907	500 years
Meteor 20 (1974-99A)	PL A-1	17 Dec 1146	81.24	102.38	842	897	500 years
		1975					
Meteor 21 (1975-23A)	PL A-1	1 Apr 1229	81.21	102.59	867	893	500 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
Cosmos 744 (1975-56A)	PL A-1	20 Jun 0658	81.25	97.11	602	635	60 years
Meteor 2-01[e] (1975-64A)	PL A-1	11 Jul 0419	81.29	102.48	858	891	500 years
Cosmos 756 (1975-76A)	PL A-1	22 Aug 0210	81.24	97.29	622	634	60 years
Meteor 22 (1975-87A)	PL A-1	18 Sep 0029	81.26	102.36	838	901	500 years
Meteor 23 (1975-124A)	PL A-1	25 Dec 1858	81.26	102.42	842	902	500 years
		1976					
Cosmos 808 (1976-24A)	PL A-1	16 Mar 1731	81.25	97.10	602	634	60 years
Meteor 24 (1976-32A)	PL A-1	7 Apr 1312	81.26	102.33	843	893	500 years
Meteor 25 (1976-43A)	PL A-1	15 May 1341	81.24	102.39	846	895	500 years
Cosmos 851 (1976-85A)	PL A-1	27 Aug 1438	81.20	96.78	568	637	50 years
Meteor 26 (1976-102A)	PL A-1	15 Oct 2324	81.27	102.48	857	892	500 years

[a] See footnote *a* to table 5.2.
[b] Test of meteorological instruments.
[c] Precursor to weather satellite.
[d] Observation and meteorological test. Satellite recovered.
[e] Experimental weather satellite.

Table 5.17. Soviet fractional-orbital bombardment systems launched during 1966–71

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital inclination *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *days*
		1966					
Cosmos U.1 (1966-88A)	TT F-1-r	17 Sep 2234	49.63	96.08	163	1 046	54.95
Cosmos U.2 (1966-101A)	TT F-1-r	2 Nov 0043	49.58	94.50	140	855	15
		1967					
Cosmos 139 (1967-05A)	TT F-1-r	25 Jan 1355	49.7	87.97	144	210	0.06
Cosmos 160 (1967-47A)	TT F-1-r	17 May 1605	49.66	87.58	137	177	0.8
Cosmos 169 (1967-69A)	TT F-1-r	17 Jul 1648	49.68	87.78	135	200	0.06

Satellite name and designation[a]	Launch site and vehicle	Launch date and time GMT	Orbital incli-nation deg	Period min	Perigee height km	Apogee height km	Lifetime days
Cosmos 170 (1967-74A)	TT F-1-r	31 Jul 1648	49.46	88.19	121	252	0.06
Cosmos 171 (1967-77A)	TT F-1-r	8 Aug 1605	49.60	87.58	138	177	0.06
Cosmos 178 (1967-89A)	TT F-1-r	19 Sep 1453	49.65	88.39	138	258	0.06
Cosmos 179 (1967-91A)	TT F-1-r	22 Sep 1410	49.57	87.87	139	207	0.06
Cosmos 183 (1967-99A)	TT F-1-r	18 Oct 1326	49.63	88.90	130	315	0.07
Cosmos 187 (1967-106A)	TT F-1-r	28 Oct 1312	49.63	88.88	143	301	0.07
		1968					
Cosmos 218 (1968-37A)	TT F-1-r	25 Apr 0043	49.56	87.28	123	162	0.07
Cosmos 244 (1968-82A)	TT F-1-r	20 Oct 1341	49.57	87.33	134	158	0.06
		1969					
Cosmos 298 (1969-77A)	TT F-1-r	15 Sep 1605	49.60	87.31	127	162	0.06
		1970					
Cosmos 354 (1970-56A)	TT F-1-r	28 Jul 2248	49.62	87.54	134	178	0.06
Cosmos 365 (1970-76A)	TT F-1-r	25 Sep 1410	49.66	87.49	133	174	0.06
		1971					
Cosmos 433 (1971-68A)	TT F-1-r	8 Aug 2346	49.41	88.54	112	299	0.06

[a] See footnote *a* to table 5.2.

Table 5.18. Possible Soviet inspector/destructor satellites launched during 1967–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time GMT	Orbital incli-nation deg	Period min	Perigee height km	Apogee height km	Lifetime
		1967					
Cosmos 185[b] (1967-104A)	TT F-1-m	27 Oct 0224	64.09 64.00	98.67 97.46	518 493	873 784	445.61 days
		1968					
Cosmos 217[c] (1968-36A)	TT F-1-m	24 Apr 1605	62.24 62.26	88.50 87.65	144 140	262 179	2 days
Cosmos 248[c] (1968-90A)	TT F-1-m	19 Oct 0419	62.25	94.80	475	543	10 years
Cosmos 249[d] (1968-91A)	TT F-1-m	20 Oct 0405	62.35	112.13	493	2 157	100 years

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli-nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
Cosmos 252[d] (1968-97A)	TT F-1-m	1 Nov 0029	62.32	112.45	531	2 149	200 years
		1969					
Cosmos 291[c] (1969-66A)	TT F-1-m	6 Aug 0546	62.24	91.46	147	548	33.70 days
Cosmos 316[e] (1969-108A)	TT F-1-m	23 Dec 0922	49.50 49.48	102.82 95.20	152 138	1 638 926	248.46 days
		1970					
Cosmos 373[c] (1970-87A)	TT F-1-m	20 Oct 0546	62.93 62.92	94.77 94.83	472 466	544 556	10 years
Cosmos 374[f] (1970-89A)	TT F-1-m	23 Oct 0419	62.95	112.26	521	2 141	150 years
Cosmos 375[f] (1970-91A)	TT F-1-m	30 Oct 0210	62.82	111.82	528	2 098	150 years
		1971					
Cosmos 394[c] (1971-10A)	PL C-1	9 Feb 1858	65.84	96.54	572	614	40 years
Cosmos 397[g] (1971-15A)	TT F-1-m	25 Feb 1117	65.73	113.51	574	2 202	150 years
Cosmos 400[c] (1971-20A)	PL C-1	18 Mar 2150	65.83	104.99	983	1 006	1 200 years
Cosmos 404[h] (1971-27A)	TT F-1-m	21 Apr 1424	65.74 65.15	103.12 94.22	802 169	1 010 799	<0.4 day
Cosmos 459[c] (1971-102A)	PL C-1	29 Nov 1731	65.81	89.34	224	260	27.92 days
Cosmos 462[i] (1971-106A)	TT F-1-m	3 Dec 1312	65.75 65.75 65.75	105.43 103.06 98.80	230 212 220	1 800 1 595 1 185	3 years
		1976					
Cosmos 803[c] (1976-14A)	PL C-1	12 Feb 1258	65.85	96.39	554	618	40 years
Cosmos 804[j] (1976-15A)	TT F-1-m	16 Feb 0824	65.15 65.56	93.08 96.38	149 556	703 615	<0.65 day
Cosmos 814[j] (1976-34A)	TT F-1-m	13 Apr 1717	65.07	90.48	118	480	<0.28 day
Cosmos 839[c] (1976-67A)	PL C-1	8 Jul 2107	65.86	116.88	984	2 098	4 000 years
Comos 843[k] (1976-71A)	TT F-1-m	21 Jul 1522	65.08	89.27	132	346	<0.36 day
Comos 880[c] (1976-120A)	PL C-1	9 Dec 2010	65.85	96.44	560	617	30 years
Cosmos 886[l] (1976-126A)	TT F-1-m	27 Dec 1243	65.85 65.84	102.96 114.79	531 594	1 265 2 295	–

[a] See footnote *a* to table 5.2.
[b] Manoeuvrable satellite. Intercept test.
[c] Target satellite.
[d] Manoeuvrable satellite, passed near Cosmos 248. Satellite exploded.

[e] Manoeuvrable satellite. May be related to FOBS system.
[f] Manoeuvrable satellite, passed near Cosmos 373. Satellite exploded.
[g] Manoeuvrable satellite, passed near Cosmos 394. Satellite exploded.
[h] Manoeuvrable satellite, passed near Cosmos 400. Satellite did not explode but decayed naturally.
[i] Manoeuvrable satellite, passed near Cosmos 459. Satellite exploded.
[j] Manoeuvrable satellite, passed near Cosmos 803 and was probably recovered.
[k] Manoeuvrable satellite, probably failed.
[l] Manoeuvrable satellite, passed near Cosmos 880. Satellite exploded.

Table 5.19. Possible Soviet geodetic satellites launched during 1968–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli-nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
		1968					
Cosmos 203 (1968-11A)	PL C-1	20 Feb 1605	74.06	109.22	1 178	1 208	3 000
Cosmos 256 (1968-106A)	PL C-1	30 Nov 1200	74.05	109.45	1 175	1 227	3 000
		1969					
Cosmos 272 (1969-24A)	PL C-1	17 Mar 1648	73.99	109.35	1 181	1 211	3 000
Cosmos 312 (1969-103A)	PL C-1	24 Nov 1648	74.03	108.60	1 144	1 179	2 500
		1971					
Cosmos 409 (1971-38A)	PL C-1	28 Apr 1438	74.01	109.36	1 177	1 216	3 000
Cosmos 457 (1971-99A)	PL C-1	20 Nov 1800	74.04	109.50	1 185	1 221	3 000
		1972					
Cosmos 480 (1972-19A)	PL C-1	25 Mar 0224	82.97	109.21	1 175	1 203	3 000
Cosmos 539 (1972-102A)	PL C-1	21 Dec 0155	74.02	112.98	1 343	1 383	5 000
		1973					
Cosmos 585 (1973-64A)	PL C-1	8 Sep 0141	73.99	113.63	1 368	1 416	6 000
		1974					
Cosmos 650 (1974-28A)	PL C-1	29 Apr 1702	74.04	113.49	1 369	1 402	6 000
Cosmos 675 (1974-69A)	PL C-1	29 Aug 1453	74.04	113.70	1 365	1 426	5 000
		1975					
Cosmos 708 (1975-12A)	PL C-1	12 Feb 0322	69.23	113.58	1 369	1 413	6 000
Cosmos 770 (1975-89A)	PL C-1	24 Sep 1200	82.94	109.21	1 169	1 210	3 000
		1976					
Cosmos 807 (1976-22A)	PL C-1	12 Mar 1326	82.97	109.13	396	1 973	35

[a] See footnote *a* to table 5.2.

Table 5.20. Possible photographic reconnaissance satellite launched in 1976 by the People's Republic of China

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli- nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime	Whether recovered
China 7 (1976-117A)	Shuang- Cheng- Tzu	7 Dec 0430	59.45	91.08	172	489	4 days	Yes

[a] See footnote *a* to table 5.2.

Table 5.21. British military satellites, launched during 1969–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli- nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime
Communications satellites							
		1969					
UK/NASA Skynet 1[b] (1969-101A)	ETR Delta	22 Nov 0043	2.40	1 407.8	34 702	35 838	$>10^6$ years
		1970					
UK/NASA Skynet 2[c] (1970-62A)	ETR TAT/Delta	19 Aug 1214	28.04	636.5	270	36 041	Uncertain
		1974					
UK/NASA Skynet 2A (1974-02A)	ETR Th/Delta	17 Jan 0141	37.60	121.48	96	3 406	6 days
UK/NASA Skynet 2B (1974-94A)	ETR Uprated Th/Delta	23 Nov 0029	2.30 1.90[d]	1 469.5 1 436.2[d]	36 255 35 784[d]	36 621 35 794[d]	$>10^6$ years
Meteorological satellites							
		1971					
Prospero (1971-93A)	Woomera Black Arrow	28 Oct 0141	82.06	106.53	547	1 582	150 years

[a] See footnote *a* to table 5.2.
[b] First synchronous military defence communications satellite placed over the Indian Ocean.
[c] A standby satellite to Skynet 1, which failed to achieve the required orbit.
[d] Final orbit.

Table 5.22. NATO communications satellites launched during 1970–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli-nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
		1970					
US/NATO 1	ETR	20 Mar	25.81	656.9	281	37 048	$>10^6$
(1970-21A)	TAT/Delta	2346	2.8[b]	1 403.4[b]	34 429[b]	35 860[b]	
		1971					
US/NATO 2	ETR	3 Feb	27.83	587.5	299	33 420	$>10^6$
(1971-09A)	TAT/Delta	0141	2.8[b]	1 403.4[b]	34 429[b]	35 860[b]	
		1976					
US/NATO 3A	ETR	22 Apr	26.99	630.89	177	35 902	$>10^6$
(1976-35A)	TAT/Delta	2053	2.7[b]	1 426.2[b]	35 778[b]	35 797[b]	

[a] See footnote *a* to table 5.2.
[b] Final orbit.

Table 5.23. French satellites with possible military applications, launched during 1966–76

Satellite name and designation[a]	Launch site and vehicle	Launch date and time *GMT*	Orbital incli-nation *deg*	Period *min*	Perigee height *km*	Apogee height *km*	Lifetime *years*
Communications satellites							
		1974					
Symphonie 1	ETR	19 Dec	0.20	1 436.10	35 768	35 806	$>10^6$
(1974-101A)	Delta	0258					
		1975					
Symphonie 2	ETR	27 Aug	0.10	1 436.10	35 776	35 797	$>10^6$
(1975-77A)	Delta	0141					
Geodetic satellites							
		1966					
Diapason 1	Hammaguir	17 Feb	34.03	118.51	499	2 738	200
(1966-13A)	Diamant A	0838					
		1967					
Diademe 1	Hammaguir	8 Feb	40.02	104.66	557	1 411	100
(1967-11A)	Diamant A	0930					
Diademe 2	Hammaguir	15 Feb	39.45	110.01	591	1 881	200
(1967-14A)	Diamant A	1053					
		1970					
PEOLE 1	Kourou	12 Dec	15.00	97.17	517	747	20
(1970-109A)	Diamant B	1258					
		1975					
Starlette[b]	Kourou	6 Feb	49.82	104.51	807	1 141	2 000
(1975-10A)	Diamant B.P4	1634					
Meteorological satellites							
		1971					
Eole 1	WI	16 Aug	50.16	100.62	677	904	80
(1971-71A)	Scout	1843					

[a] See footnote *a* to table 5.2.
[b] Satellite de Taille Adaptée avec Réflecteurs Laser pour les Etudes de la Terre.

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Appendix 5A

US air and space reconnaissance programmes

Square-bracketed numbers, thus [1], *refer to the list of references on page 187.*

During the early Eisenhower years (1953–55) the development of two different systems for conducting overhead reconnaissance was initiated. One of these systems was the U-2, a very high-flying aircraft. The other was the Agena satellite system, a rocket-powered platform designed to launch and support military payloads having a variety of purposes, including reconnaissance and surveillance. Both of these programmes were conducted under an especially thick cloak of secrecy—key parts were conducted as so-called black programmes—and these devices came to the attention of the general public and the US Congress as a whole only long after they were in regular use. In addition, the United States also carried out a programme to develop and fly a very small satellite as part of its contribution to the International Geophysical Year (IGY) in 1957–58. From the beginning this last programme was given much publicity, and it became deeply impressed on the public consciousness, especially after the October 1957 launch of the Soviet Sputnik. As a result, the IGY satellite programme—that is, space exploration for its own sake—is generally regarded as the main root from which the current US space programme grew. As we shall see, however, that is not in fact the case: the highly classified military rocket and satellite programmes of the mid-1950s provided the largest part of the industrial technological base underlying the US space programme of the 1960s and 1970s, and the military provided a substantial majority of the programme leadership as well.

The U-2[1]

The idea of aerial reconnaissance of enemy territory during wartime is as old as artificial flight itself [2], but the idea of conducting peace-time aerial reconnaissance to gather strategic intelligence, the idea that led to the U-2, only came to be seriously considered at the highest levels of the US government towards the end of the Truman Administration, during the Korean War. In 1951–52 several closely connected and influential individuals, or-

[1] There is little official information available on the origins and early years of the U-2 programme. This section is therefore based chiefly on recent interviews and correspondence with many of the principal people involved, including Richard Bissell, James R. Killian, Jr., Bernard A. Schriever, Edward M. Purcess, Bruce Billings, Amrom Katz and George B. Kistiakowsky. Also used was the transcript of a press conference originally given by Bissell in 1966 but initially withheld from publication for security reasons. It was eventually published in large part in the *Los Angeles Times* [1], but even then was buried in a larger story about the art of photo-interpretation.

ganizations and *ad hoc* study groups took up the idea, expanded on it and promoted it with higher governmental authorities. One such group was the Air Force Development Planning Office, then headed by General Bernard A. Schriever. Among his assistants was Richard Leghorn, then an Air Force officer, and long interested in aerial reconnaissance. Leghorn is considered by many as the principal author of the postwar doctrines and ideas concerning tactical and strategic reconnaissance by means of overflight. His specific task in Schriever's office seems to have been to work out a plan for conducting such reconnaissance. Among those whom Leghorn consulted in these matters while still at the Air Force headquarters was Amrom Katz, since 1940 a civilian scientist working for the Air Force on aerial reconnaissance techniques. In 1954 Katz moved to the RAND Corporation where he participated in the work of that organization on reconnaissance satellites, and at the beginning of the second Nixon Administration he became a senior official in the Arms Control and Disarmament Agency (ACDA), much of whose own action programme depends on reconnaissance techniques.

During this same period, in May 1951, the Air Force arranged for a special *ad hoc* study of the problem known as Beacon Hill. This study brought together for the first time in this connection several of the men who would for many years thereafter play key roles in these activities, including Edwin Land, founder and president of the Polaroid Corporation; James Baker, an astronomer and an exceptional designer of optical equipment; and Allen Donovan, an aeronautics engineer. The Beacon Hill study made use of a number of sources, in particular work done at a Boston University laboratory that had for some time been doing state-of-the-art work related to aerial reconnaissance. (Leghorn was also involved in this programme.) The year-long study is said to have produced a "great report" on the subject of cameras for taking high-altitude pictures.

A third group that was active on the same subject during that same critical period was the Air Force Scientific Advisory Board's Panel on Physical Sciences. Established in 1951, this panel later became known as the Intelligence Systems Panel (1953–55) and then the Reconnaissance Panel (1955–62). There was, as is very often the case, a considerable overlap in its membership with the other groups working in the field. Thus, the Panel's first chairman was George Kistiakowsky (later, science adviser to President Eisenhower), the second was James Baker, the third was Carl Overhage, and Land and Donovan were members from the beginning.

Finally, as a result of all these studies, the Air Force took steps to set in motion a project to develop suitable cameras and the special aircraft needed to fly them.[2] At the request of the Air Force, four companies submitted

[2] According to the NASA historian Eugene Emme, at least one project involving reconnaissance overflights of the socialist bloc predated the U-2 promotion. This project apparently had the code-name "Moby Dick" and utilized very high-altitude balloon-borne cameras, but was never effective.

proposals for developing very high-flying aircraft appropriate for such a purpose. In addition, Lockheed submitted an unsolicited proposal, drawn up by Clarence L. Johnson, which comprised what was essentially a single-engine jet-powered glider. The Air Force at first rejected the Johnson design, and authorized work on prototypes of two of the others. But before such work could proceed very far, a new factor intervened and resulted in important changes in the plans.

This new factor was the Technological Capabilities Panel (TCP), sometimes also referred to as the "Surprise Attack Panel". Organized in March 1954 by the Science Advisory Committee of the White House Office of Defense Mobilization at the direct request of President Eisenhower, the TCP was charged with an overall review of the entire military research and development (R&D) programme [3].[3] The director of the Panel was James R. Killian, Jr. of the Massachusetts Institute of Technology, one of the members of the parent committee. The actual detailed work of the TCP was done primarily by three subpanels. The first two of these dealt with strategic weapons and air defence and are not of direct concern for this discussion. Subpanel Three, however, was chaired by the ubiquitous Edwin Land, and had as its main purpose a review of the need for and the means of gathering technological intelligence. This subpanel, which again included James Baker among its members, concluded that the Lockheed proposal—that is, C. L. Johnson's U-2—was in fact the best, and they successfully urged that it, rather than one of the more conventional and more elaborate alternatives, be adopted for this purpose. They were attracted by the notion that the U-2 was a "mosquito", manifestly less hostile than something bigger. Contrary to Air Force thinking, they insisted that it be unarmed. Johnson himself made a good impression on the subpanel, and they backed the U-2 in part for this reason also.

The United States Intelligence Board (USIB), then the highest coordinating board for US intelligence activities, endorsed the project in November 1954. After a private meeting with Killian and Land, and with the Board's endorsement in hand, Eisenhower gave final approval shortly thereafter. Because he wanted the project to be primarily a civilian rather than a military operation, he also decided to assign management and administrative responsibility entirely outside the then standard organizational mechanisms, to the Central Intelligence Agency (CIA). Even so, because of the expertise and facilities it possessed, the Air Force was inevitably also involved, and Trevor Gardner, Assistant Secretary of the Air Force for R&D, became the Air Force official responsible. The selection of Gardner meant that the project would most likely go forward with all possible speed. He was a young, energetic, intelligent and brash engineering executive who

[3] The TCP report itself, issued in February 1955, has only recently been declassified but in a sanitized version.

firmly believed that not enough was being done to adapt the fruits of modern technology to the needs of US national security. In fact, one of the main stimuli behind the formation of the TCP in the first place was Gardner's concern that the United States was not doing enough in this area. Since entering the Pentagon in 1953, he had become deeply involved in advancing the missile development programme, and the U-2 presented him with yet another opportunity to put his ideas into practice. In early December, CIA Director Allen Dulles informed Richard Bissell of his staff that the U-2 programme would be his direct responsibility, and in mid-December Bissell and Gardner met for the first time to work out the details. The programme was conducted with a high degree of informality, and the contractors for the project—Lockheed for the aircraft, Pratt and Whitney for the engines, and Hycon and Perkin Elmer for the cameras—assumed an unusually central role in its planning and development. A small group under Land's leadership also continued to provide guidance throughout the U-2 project and has continued to play a similar role in regard to all the follow-on programmes. Lockheed went to work immediately after the Bissell-Gardner meeting, and the first U-2 flight took place in August 1955, substantially less than a year after Eisenhower approved the programme [4].[4]

Beginning in late June 1956, a series of six U-2 flights overflew European USSR, including Moscow and Leningrad. Following these first six flights, there was a brief pause resulting from a secret diplomatic protest by the USSR, but the flights were resumed soon thereafter.[5]

Later, U-2 flights were launched from Turkey and Pakistan in order to photograph the missile development activities taking place at Kapustin Yar in southern USSR, Tyuratam in Kazakhstan and Sarishagan in Central Asia, and to observe what was going on at the nuclear test range near Semipalatinsk. These and the earlier flights demonstrated that the U-2 had sufficient range and covered enough area to provide valuable input about the development status of the Soviet missile programme. At the same time, however, they showed that it was impossible for the aircraft to give adequate information about deployment of Soviet missiles. On balance, therefore, the U-2 data was unable to allay growing concerns in Washington about the Soviet missile programme [5]. Moreover, it greatly stimulated the government's desire to obtain more and better intelligence information which in turn served to promote the development and deployment of certain

[4] The case of the U-2, it should be added, is an example (an extreme one to be sure) of an organizational style characteristic of the Eisenhower Administration. It seems that the R&D phase of almost every major strategic system approved by the President—for example, the Atlas-Titan and Polaris systems—was removed from the conventional service structure.

[5] In this connection, it should be recalled that Eisenhower had proposed that the USA and the USSR conduct limited but open overflights of each other's territory as a means of reducing the political tensions created by the growing fears of surprise attack. Eisenhower put forward this idea, known as the Open Skies proposal, at the Geneva Summit Conference of July 1955 (fully six months after approval of the U-2 project), but it was summarily rejected by Khrushchev.

follow-on systems, most notably reconnaissance satellites, even before the downing of Gary Powers's U-2 aircraft in 1960 signalled the end of that phase of the U-2 programme.

WS 117L/Agena: the reconnaissance satellite system[6]

From the time the notion of orbiting artificial satellites was first introduced into military circles in the United States at the end of World War II, the value of using such satellites as military observation posts was realized. In fact, studies made by the RAND Corporation (initially a unit of the Douglas Aircraft Company known as Project Rand) during the Truman Administration not only demonstrated (on paper) the feasibility of space reconnaissance but also offered fairly accurate estimates concerning the dimensions and other parameters of the necessary hardware.[7] No programme for the development of such a system was initiated during the Truman years, however, mainly because the great cost of developing and building the rocket boosters needed to put the satellites into orbit simply could not be justified on the basis of this application alone.

Early in the Eisenhower Administration this situation changed radically. The thermonuclear breakthrough, the US military's "New Look" at strategy, and John Foster Dulles's doctrine of massive retaliation coupled with the persistence of Trevor Gardner, General Bernard Schriever, John Von Neumann, Edward Teller and others led to the initiation of several closely related programmes for the development of rockets suitable for launching satellites larger than those described by RAND (225 kg and above) as being adequate for space reconnaissance.

On 1 March 1954, just a month after the Strategic Missile Evaluation Committee chaired by John Von Neumann had submitted its report to the Air Force urging the development of the first ICBM (Atlas), RAND issued a report on "Project FEED BACK", the then current name for the reconnaissance satellite proposal. This report, edited by James E. Lipp and Robert M. Salter, described the total system in some detail, confirmed the validity and feasibility of the concept, and estimated that the development of a complete satellite system based on the existing state of the art would require seven years and cost $165 mn.

As a result of this combination of events—the publication of RAND's Project FEED BACK report, the initiation of a "highest priority" programme to develop the Atlas missile, and the growing attention being given to the importance of reconnaissance by such influential groups as the Air

[6] The US reconnaissance satellite system has had several different code-names during its history, including Pied Piper, Weapon System 117L or WS 117L, Big Brother and Samos.
[7] The first of these RAND reports appeared in 1946 [6]. For a discussion of this and other reports, see references [7a, 8].

Staff, the TCP,[8] and the Air Force Science Advisory Board—the Air Force decided to go ahead with the programme. On 16 March 1955, they issued General Operational Requirement 80, a formal so-called requirements document calling for the development of a reconnaissance satellite. Lockheed, RCA and Martin participated in the design competition that followed.

Lockheed Missiles and Space Division had already been interested in this project for some time. In order to strengthen its hand in the competition, Lockheed recruited a number of key people from RAND. The RAND people themselves saw the move as providing the opportunity to work on the actual design and construction of the systems they had long been studying, an opportunity which, by its nature, RAND itself could never provide. Among those who joined Lockheed and who had long been deeply involved in the RAND satellite studies were Louis Ridenour, L. Eugene Root (who shortly after became President of Lockheed Missiles and Space Company [LMSC]), Robert Salter and James Lipp. Salter had been the author or a co-author of almost every major RAND report on the subject. Accordingly, he was able to formulate for Lockheed a proposal for a satellite system which in effect incorporated almost everything the Air Force knew and thought about the subject.[9]

Not surprisingly, then, the USAF considered Lockheed's proposal the most satisfactory of those submitted and on 29 October 1956 that firm was awarded a letter contract making it the prime contractor on what became known formally as Weapons System 117L. The Air Force Ballistic Missile Division (AFBMD) under General Schriever's command was given responsibility for managing the project. The Ramo-Wooldridge organization and the Von Neumann committee, which were involved in all other AFBMD programmes, were left out of the management loop in this case. At about the time the contract was awarded and "the money really started coming in", Salter was shunted aside and John H. Carter, formerly a Colonel on Schriever's staff at AFBMD, became the programme director. In addition to a reconnaissance payload, the original 1945 contract also included the development of a system for conducting round-the-clock overhead surveillance of all large rocket launches by means of detection of the large amounts of infrared radiation emitted by such rockets during take-off. This particular

[8] The TCP subpanel did not like certain specific engineering details of the RAND proposal and apparently did not endorse it *per se,* but the TCP's general endorsement of overhead reconnaissance was a very positive factor in promoting its acceptance. The authors of the report repeatedly stressed above all other considerations the need to apply the "creative resources of science, engineering, and technology" to the reconnaissance field. "We *must*," they maintained, "find ways to increase the number of hard facts upon which our intelligence estimates are based, to provide better strategic warning to minimize surprise in the kind of attack, and to reduce the danger of gross overestimation or gross underestimation of the threat" [3a].

[9] As one former Lockheed official put it, "Salter's central role since the beginning enabled him to write a proposal in a form which allowed the Air Force to tear off the Lockheed covers, substitute their own covers, and label it the ARDC [Air Research and Development Command] Development Plan" [9].

subsystem became known as Midas and, after a somewhat fitful development programme, is today in service as one of the major components of the US missile early-warning system.

Since the Atlas alone could not put a significant payload into orbit,[10] a major component of the Lockheed programme involved the development of a new additional rocket stage designed to sit atop the Atlas to provide the final push for getting the payload into orbit. This stage is known as the Agena. The first version was about 6 m long, 1.5 m in diameter, and was powered by a Bell Aerosystems rocket engine capable of generating 6 800 kg of thrust. Fully fuelled, it weighed 3 855 kg but its orbital weight (without fuel) was only about 800 kg [10].[11] The Agena was the first large rocket whose engines were designed to be stopped and restarted in space, an absolute essential for providing any sort of capability to manoeuvre. This innovation, in turn, has allowed Lockheed to boast of many "firsts" achieved by various models of Agena spacecraft since 1959. They were, they said, the "first to achieve a circular orbit, to achieve a polar orbit, to be stabilised in all three axes in orbit, to be controlled in orbit by ground command, to return a man-made object from space, to propel themselves from one orbit to another, to propel spacecraft on successful Mars and Venus flyby missions, to achieve a rendezvous and docking by spacecraft in orbit, and to provide propulsion power in space for another spacecraft" [11].

On 28 February 1959 this Agena stage, sitting as a second stage on top of a Thor booster, launched the very first US satellite having a weight (590 kg) at all comparable to the early Soviet Sputniks.[12] (By then, other less capable US systems, designed specifically for the purposes of the International Geophysical Year, had launched very small (14-kg) payloads beginning on 31 January 1958.) The payload, carried into orbit by that first successful Agena launch, was known as Discoverer 1. Because of a total communications failure, there has always been some doubt about exactly what happened in this case. In any event, Discoverer 2 was launched just six weeks later, on 13 April, and it did successfully attain its main objective. The stated purpose of Discoverer was to investigate various techniques necessary for the exploitation of space flight, including manoeuvring in space and return of its capsule to Earth. On 10 August 1960, Discoverer 13 was successfully returned to Earth and its capsule was recovered near Hawaii by an Air Force task group. It was followed in turn by many others in succeed-

[10] That is, the large-scale, super-precise optics required for obtaining suitable pictures from approximately 100–150 km overhead. Such equipment could not be usefully packaged in a satellite with a weight under 500 kg.

[11] Klass [7b] gives slightly different figures for weights: launching weight—3 625 kg; weight in orbit—590 kg.

[12] In December 1958 an entire Atlas was placed in orbit. This isolated event, known as "Project Score", was carried out very largely for propaganda purposes. The gross weight was indeed large (3 855 kg) but its so-called useful payload was a very small communications-relay package hastily arranged for the purpose. It was never followed by any descendants, and it is more usefully thought of as a rather peculiar Atlas test than as a part of the US satellite programme.

ing years. It has been almost universally assumed that Discoverer's real purpose was photo-reconnaissance, but US authorities have never officially confirmed that assumption.

The first attempt to launch the more powerful Atlas-Agena combination was made on 26 February 1960, but it failed because of a malfunction at the time the Agena stage separated from the Atlas. A second attempt on 24 May was successful and put a 2270-kg Midas satellite into orbit, and on 31 January 1961 the Atlas-Agena combination was used to launch successfully a new heavier reconnaissance satellite known as Samos 2 [12]. From these dates onward, the Agena stage and its descendants, placed on top of the Thor, Atlas and Titan boosters, have provided the means for launching practically all US military satellites and most large civilian satellites as well. The only major exception is the Saturn system used in connection with the Apollo programme, but even that huge rocket derived the enormous thrust needed for its first stage from engines whose development was originally started under the aegis of the Air Force missile and space programmes and only later transferred to NASA.

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6. Topical issues: SIPRI publications of 1976

I. *Medical protection against chemical-warfare agents*[1]

There are three basic lines of defence against attack by chemical-warfare agents. First, there are the physical protection methods: if people can be shielded from the contaminated environment by masks, special clothing, skin-barrier ointments or shelters, they will not succumb to CW attack. Second, there are chemical countermeasures—decontamination methods that can be used to destroy environmental contaminants before they do any harm. Finally, there are medical countermeasures, such as antidotes to counter the effects of poisons that have entered the body. Certainly, no one of these lines of defence will be perfect or foolproof, but together they can be expected to blunt most forms of CW attack. In fact, 100 per cent protection is not necessarily the objective: what is needed is a level of protection that is sufficiently high to render CW attack uneconomical or otherwise unattractive to an attacker.

Physical means of protection against chemical warfare, as well as chemical countermeasures, have been developed to a high level of sophistication, but a number of problems still remain. In many countries research and development work in this field is continuing and the level of protection provided for individual soldiers is being continuously improved, but in all armies the level of protection provided still leaves ground troops vulnerable to some form of CW attack, and no army yet has the capability for keeping its soldiers continuously protected while on combat duty.

At present, the possibilities for effective medical treatment of chemical-warfare casualties are also limited: prophylaxis is possible only against certain protein agents such as some toxins, and very few specific antidotes are available for the multitude of different CW agents, so that, for the most part, medical treatment is merely supportive and palliative. But there is one important exception—the therapy of organophosphorus nerve-agent poisoning. This has now been refined to the stage where the simpler forms of treatment can be administered, using special autoinjectors, by a layman—even by the poisoned individual.

The SIPRI book *Medical Protection against Chemical-Warfare Agents* contains the proceedings of an international symposium organized by the

[1] *Medical Protection against Chemical-Warfare Agents* (Stockholm, Almqvist & Wiksell, 1976, Stockholm International Peace Research Institute), 166 pages, 47 tables, 27 figures, 1 plate. ISBN 91-2200044-5.

Yugoslav Toxicological Society in cooperation with SIPRI. Thirty-one scientists—toxicologists, pharmacologists, and biochemists as well as disarmament experts—from 13 countries met to review the present state of knowledge of medical treatment of organophosphorus poisoning, to discuss the work that is currently under way in this field and to assess the possibilities for further progress in solving some of the problems that still remain, with special reference to the problem of protection against chemical-warfare agents.

Organophosphorus poisoning and existing methods of treatment

The principal mode of action of the nerve agents is to inactivate an enzyme in the body called acetylcholinesterase, which is essential for the normal functioning of the nervous system. Nerve impulses are transmitted between nerve fibres and between nerve endings and various organs and muscles by the compound acetylcholine. Once acetylcholine has performed its function, it is destroyed by acetylcholinesterase, thus leaving the nerve fibres or endings free to transmit further impulses. The action of the nerve agents is to inhibit acetylcholinesterase so that it is unable to break down the acetylcholine, with the result that acetylcholine accumulates and nerve function is blocked. Death from nerve-agent poisoning is most likely to be caused by acute oxygen deprivation following paralysis of the respiratory muscles or inhibition of the central respiratory centres, aggravated by severe cardiovascular failure.

Treatment of nerve-agent poisoning consists of the use of cholinolytic drugs—atropine or related drugs—that block the effects of excess acetylcholine, and oxime-type drugs that restore the activity of acetylcholinesterase inhibited by some types of nerve agent. But this treatment is by no means completely adequate. Atropine cannot prevent paralysis of the respiratory muscles (although oximes may do so if the dose of nerve agent has not been too large), and so artificial respiration may be essential, which in mass-casualty situations would be virtually impossible. Oximes are not effective against all types of nerve agent, the most important example being their lack of effect against poisoning by soman. And as yet there is no effective prophylactic treatment against nerve-agent poisoning, although oximes and certain other compounds do offer a fair measure of promise for nerve-agent prophylaxis.

In practical terms, this means that, although atropine and the oximes are the best forms of treatment currently available, in the case of chemical-warfare attack with organophosphorus nerve agents, adequate medical protection of troops on the battlefield would, to say the least, be extremely difficult, and such protection of civilian populations would certainly be impossible. It is thus important to ask whether current research is likely to offer solutions to these problems.

Current research on treatment of organophosphorus poisoning

There are two basic approaches to developing improved methods of medical protection against organophosphorus poisoning: to try to improve existing treatment methods, or to try to find completely new means of dealing with the problem effectively. If a more effective treatment is found, it will probably be some combination of existing and novel methods.

Research aimed at improving existing treatment methods includes attempts to find other cholinolytic drugs or oximes that are more effective than the currently used ones or that will be therapeutically effective against a wider range of organophosphorus compounds than are the present ones. A few cholinolytics other than atropine have been investigated, and in some cases have been found to be more effective than atropine, probably because they have a higher central-nervous-system activity. But often these other drugs have undesirable side-effects, and on the basis of results to date, there seems to be little, if any, justification for substituting any of these other cholinolytics for atropine.

Among the oximes, a large number of new compounds have been synthesized and tested for therapeutic efficiency. Some of the oximes that have been prepared and tested in animal experiments certainly seem to combine low toxicity with significant therapeutic effect, and thus seem worthy of further study. And further such pharmaceutical screening tests may perhaps result in the discovery of a highly effective drug. But, as was the case with the cholinolytics, the results that are available to date would hardly justify abandoning the three oximes currently in general use—obidoxime, pralidoxime and trimedoxime—for one of these new ones.

A number of researchers have been investigating ways in which the therapeutic effectiveness of the existing drug treatment with atropine and oximes can be increased. One possible way might be to add to the standard drug treatment other drugs that might in some way enable atropine and the oximes to act more effectively. For example, one of the limitations to the effectiveness of oximes is that they are excreted from the body rather quickly, and hence can only exert their biochemical effect for a limited period. Repeated administration of drugs is not always a suitable solution to this problem. However, it has been shown that some compounds—thiamine (vitamin B_1) was investigated in one study—can significantly increase the retention time of an oxime in the body. It might be useful to investigate other chemicals in this context. But it is still not clear how high a concentration of an oxime must be present in the blood for how long in order to give effective therapeutic effect.

It is clear that there are numerous problems associated with therapeutic treatment—administration of drugs *after* exposure to the poisons. Some workers have therefore been investigating the possibilities of prophylactic treatment against organophosphorus intoxication—that is, treatment administered *before* exposure to the poison. One approach in this direction is the prophylactic use of therapeutically active oximes. The aim in these studies is to design oximes with prolonged biological half-lives which might therefore be suitable as prophylactic agents. Although the results so far have unfortunately not been very promising, the studies are still in an early stage. Some compounds have been found which show some potential as prophylactic agents, and it is to be hoped that after more investigation, effective prophylaxis will become a reality.

While it may be possible to improve the effectiveness of the existing methods of therapy, and while it may even be possible to develop adequate prophylactic measures against organophosphorus poisoning, it will probably not be possible to solve all of the problems of treatment that exist at the moment. Other researchers have therefore been studying alternative means of medical treatment in an effort to find ways to overcome the limitations of the standard oxime and atropine therapy.

One of the outstanding problems is the lack of response of soman poisoning to oxime therapy. Some workers have been able to demonstrate that drugs other than oximes, and even in some cases some oximes, may have therapeutic effects against soman. But it seems that this antidotal effect is probably not based on enzyme reactivation, and the exact biochemical mechanisms of action have not yet been made clear.

Among the central effects and symptoms of organophosphorus poisoning, convulsions seem to play a major role in the mechanism of death. Oximes cannot be used to treat these symptoms, and many of the normal anticonvulsant drugs were also found to be ineffective. However, some benzodiazepines, for example diazepam, when used in conjunction with atropine and obidoxime, were found to be able to control convulsions in rats and rabbits poisoned with sarin or soman.

Probably one of the most promising research efforts described at the symposium concerns using drugs to reverse the respiratory paralysis that results from organophosphorus poisoning: at present, respiratory paralysis can only be treated with artificial respiration. The work so far reported shows that the use of the compounds 3-chloro-2,5,6-trimethylbenzoic acid (U23223) and 9-anthroic acid (ANCA), in combination with atropine, can prevent the respiratory paralysis caused by DFP and paraoxon in rats. More important, it has also been shown that when applied to soman intoxication, such treatment can postpone the onset of respiratory paralysis for about two and a half hours. While this delay is not a complete answer to the problem—the respiratory failure will still occur at the end of the delay period, and subsequent administration of more of the compounds only gives a very short additional delay—it could be extremely valuable in that it would provide the time needed to move a poisoned patient to a medical facility where artificial respiration could be given. There are also indications from preliminary experiments that ANCA treatment is able to prevent the respiratory paralysis resulting from intoxication by sarin, a chemical-warfare agent that causes a respiratory paralysis of shorter duration than that produced by soman. If such a treatment is developed to the point where it is effective and efficient in humans, one of the major problems of organophosphorus intoxication and its treatment, namely, restoring breathing in a poisoned patient without artificial respiration, may be in sight of being solved.

The need for further research

The research that is being carried out on the problems of treating organophosphorus poisoning is certainly producing valuable results, and the present methods of treatment may be considerably improved. For example, there is a good chance that a drug, probably not an oxime, will be found which is effective against soman poisoning; there are drugs which seem to be able to counter some of the central effects of organophosphorus poisoning that are not responsive to oxime therapy; and there is promise that the problem of respiratory failure may be overcome with a new drug treatment. However, when one examines these advances in the context of mass casualties, for example, those that will almost certainly result from a chemical-warfare attack with organophosphorus nerve agents, the prospects are rather less promising. Even if some of the new drugs could be incorporated into military autoinjectors, all that can realistically be said of the new methods of treatment is that they will provide more time than do the existing treatment methods to move poisoned individuals to medical facilities.

The SIPRI book *Medical Protection against Chemical-Warfare Agents* concludes that some form of international cooperation would be valuable in solving the problem of therapy of organophosphorus poisoning. Two broad areas in which cooperation might be beneficial are identified. First, there seems to be a need for standardization among scientists working on these issues. For example, toxicity determinations, cholinesterase-activity determinations and methods for evaluating therapeutic methods are all carried out in different ways in different laboratories and in different countries. The result is that it is often difficult to make valid comparisons of results from different sources.

The other area in which international cooperation would be useful is the dissemination of information. A central data bank that could collect and distribute information relating to the problem of organophosphorus poisoning and therapy would be valuable in this context.

In summary, it can be said that, with the techniques and drugs available at the moment, adequate medical protection against organophosphorus nerve agents used in war is not feasible. However, it is probably not unrealistic to conclude that if the research currently under way is continued, and especially if there is some form of international cooperation of research efforts, reasonably effective, even if not 100 per cent, protection may become feasible in the not too distant future.

II. *The law of war and dubious weapons*[2]

Many SIPRI publications have described the impact of technology on armaments, drawing attention to the disastrous influence of technology on military strategies and postures. In fact, technology appears to be one of the dominant factors of the arms race.

The tendency to use militarily all available means of destruction shows that in this field, as in many others, man is increasingly the slave of technology rather than its master. And attempts to counteract this tendency by agreements on freezing armaments or on disarmament have had very limited results.

But another approach to constrain and mitigate the use of force concerns the rules governing not the manufacture and possession of arms, but their *use*. From the beginning, the Red Cross—in which the International Committee of the Red Cross (ICRC) and affiliated national societies (Red Crescent, Red Lion and Sim) cooperate—has been active in this field. Initially its objective was to alleviate the suffering of those who had become the victims of war. Later on, it extended its interest to an examination of the means and methods of warfare which lead to such suffering, and attempts were made to adopt laws of warfare which would restrict such means and methods.

In the past decade the ICRC has intensified its struggle for strengthening and further developing the humanitarian laws of warfare. It felt the need for a reaffirmation of the traditional principles because of the emergence of the concept of total warfare. But it also recognized that a progressive development of the laws of war was vital, in view of the military impact of technology and of changing social and political realities. It not only took up questions of the protection of victims, but also supported initiatives limiting the use of certain weapons. It succeeded in organizing, with the support of the United Nations, the "Diplomatic Conference on the Reaffirmation and Development of International Humanitarian Law applicable in Armed Conflicts", four sessions of which were held in 1974, 1975, 1976 and 1977. The Diplomatic Conference had before it two "Draft Additional Protocols to the Geneva Conventions of August 12, 1949". In the first Protocol the ICRC has formulated proposals relating to the protection of victims of international armed conflicts. The second Protocol deals with the protection of victims of non-international armed conflicts.

[2] *The Law of War and Dubious Weapons* (Stockholm, Almqvist & Wiksell, 1976, Stockholm International Peace Research Institute), 78 pages. ISBN 91-85114-31-6.

One of the topics in the Protocols concerns the means of combat—the question of whether or not new weapons are in conformity with the principles of the laws of warfare. Technology has produced numerous new weapons, including weapons of mass destruction, and recent armed conflicts have shown the devastating effects of some of them. This strengthened the conviction that governments should honour the pledge expressed in the St Petersburg Declaration of 1868, in which it was suggested that new scientific improvements in arms should lead to negotiations and to understanding in order "to conciliate the necessities of war with the laws of humanity".

In the Draft Protocols, the ICRC proposed general principles concerning weapons, to be applied by the High Contracting Parties. The Diplomatic Conference decided, at Committee level, not only to formulate these principles, but also to discuss specific weapons which might be considered to be "dubious weapons", and to determine whether their use, totally or partially, should be prohibited. It decided to concentrate its discussions on specific conventional weapons, and to omit specific weapons of mass destruction, such as nuclear or biological weapons.

In view of these developments, an attempt is made in the SIPRI publication *The Law of War and Dubious Weapons* to answer the question: What are the legal principles to be applied with respect to "dubious weapons"? It is important to re-examine the present state of the law of armed conflict with respect to the means of combat, because every state has the obligation to determine whether the employment of a specific weapon would, under some or all circumstances, be prohibited by the international law of armed conflict. For this reason, the legality or illegality of the use of new conventional as well as of non-conventional weapons is discussed in this book.

Three questions concerning the legality of the use in war of "dubious weapons" are considered: Are the traditional principles of the law of war still valid? Should the progressive development of the laws of war be based on the recognition and inclusion of new principles? Does the application of the principles of the laws of war to certain new types of weapons—nuclear, chemical and biological, incendiary and fragmentation weapons, small-calibre high-velocity bullets and so on—lead to the conclusion that all use of these weapons or any specific use of these weapons is illegal?

After examining the traditional principles, the conclusions are reached that the relevant principles underlying the rules of traditional international law concerning the means of combat can be summarized as follows: (*a*) the prohibition of superfluous injury, (*b*) respect for civilians, (*c*) the principle that the demands of humanity may prevail over the demands of warfare, and (*d*) the principle that the demands of peace (including cease-fires and armistices) may prevail over the demands of warfare (prohibition of treachery).

Three factors, all linked with the great changes induced by industrialization and technological weapon development, are mainly responsible for the attitude that the traditional distinction between civilians and members of the armed forces has ceased to have any great significance and that the civilian population may be made the legitimate object of military attack: (*a*) the growing importance of armaments and the arms industry, (*b*) the development of the doctrine of deterrence, and (*c*) the concept of "coercive warfare".

After examining the traditional principles and stressing the need for their reaffirmation, the question is considered of whether—in view of technological developments in weaponry—new principles with respect to the laws of war concerning the prohibition of specific weapons should be added to the traditional ones, and it is concluded that they should be clearly and expressly recognized. It is suggested, however, that these new principles are in essence only the consequences of principles already applied in the traditional rules of warfare.

The application of the principles of the law of war to new "dubious weapons" is examined: nuclear, biological and chemical, incendiary, small-calibre high-velocity, fragmentation and delayed-action weapons (including booby traps). Although the ICRC Diplomatic Conference does not deal with the first three categories, a short analysis of the legal position of all seven categories is given.

It can be concluded that, although during the discussion at the Diplomatic Conference it appeared that widely divergent views existed concerning the effects of specific weapons, and that in military circles there exists a certain reluctance to accept a prohibition with respect to the use of specific weapons or to specific use of weapons, mankind should not be made the slave of technology and should put a stop to the development of increasingly sophisticated means of destruction. It is also concluded that the most crucial task of the law of armed conflicts will be to prohibit in the near future, before it is too late, the use of weapons of mass destruction, especially nuclear weapons.

III. *Southern Africa, the escalation of a conflict*[3]

Over the past 20 years a general pattern of conflict escalation, from reformism to armed revolution, has been developing in Southern Africa. African resistance to white rule, in the form of local wars against the intruders, began when the first European colonizers arrived on the continent. Opposition resurged among the African population after World War II, in the form of reformist demands, which prevailed until the end of the 1950s. But

[3] *Southern Africa, The Escalation of a Conflict* (Stockholm, Almqvist & Wiksell; New York and London, Praeger, 1976, Stockholm International Peace Research Institute), 235 pages, 2 tables, 2 charts, 3 plates. ISBN 91-2200051-8.

starting in 1960—the year of the Sharpeville massacre and the beginning of the arms build-up in the Republic of South Africa—the prospect of armed revolution became a reality in Southern Africa.

This political and military conflict involves six nations and territories directly: Namibia, the Republic of South Africa and Rhodesia; the former Portuguese colonies of Angola and Mozambique in Southern Africa; and one country in West Africa—Guinea-Bissau.

South Africa is usually described as the bastion of white supremacy in the area. Since 1960 it has increased its military strength in all fields—manpower, equipment and arms production. Its military expenditure between 1963 and 1973 exceeded that of all the other African nations combined, with the exception of Egypt. In addition, South Africa now belongs to the "near nuclear" countries and could develop a nuclear bomb if it should decide to do so.

Rhodesia's military establishment has often been regarded as an auxiliary force to South Africa's in the event of a future large-scale conflict between the white-ruled states in Southern Africa and hostile external or internal forces. It possesses considerable military strength compared, for example, with Zambia or Tanzania.

With the fall of the Caetano colonial regime, the wars in the Portuguese colonies ended in April 1974. By November 1975 the last Portuguese colony in Africa had become independent. This signalled the beginning of a process of change that would affect Southern Africa as a whole and that would also provoke changes in the future approach of foreign powers in the region.

In the SIPRI book *Southern Africa, The Escalation of a Conflict,* a study of the conflict determinants—that is, the combination of factors that may be decisive in a situation where a local or limited political and military conflict such as that occurring in Southern Africa, threatens to escalate into general war—leads to the conclusion that the ultimate cause of tension in Southern Africa lies in the conditions imposed on the black population by the minority white ruling class. One finds an overall common pattern of conflict escalation. In Portuguese Africa, the increasingly brutal measures undertake to suppress all manifestations of African nationalism made reformism impossible in effect. The outlawing of nationalistic organizations in Rhodesia, Namibia and South Africa and the legislative measures undertaken to bar black African aspirations to share political power might also usher revolution into these countries. The Portuguese colonial regime's unresponsiveness to African nationalist demands led to armed warfare as the sole means of realizing these demands. The pattern is being repeated—as yet on a smaller scale—in Rhodesia, Namibia and South Africa.

The most influential factor for the outcome of African nationalism may well be the emergence of a unified nationalist movement under a strong leadership. In this context, the role played by outside supporters of the black nationalists must be taken into account: the provision of military supplies, foreign training and access to bases in friendly countries was of crucial importance to the liberation movements in Angola, Guinea-Bissau and Mozambique. It is concluded that the Republic of South Africa will not be able to continue to exist as the sole white-ruled state on the African continent, due to the fact that, inspired by the example of Portuguese Africa, opposition to the regime is growing inside the country. The main issue for the future is how apartheid will be abolished—by peaceful means or violent, that is, through a civil war or a major war involving other African states or even non-African powers. It seems unlikely that any Western government could take seriously the South African argument that the preservation of the apartheid system is vital to the survival of the "free world". The real purpose of any foreign action in a future large-scale crisis—presumably a situation of civil insurrection combined with guerrilla attacks—would be the protection of financial interests. Such intervention would substantiate the claims of South Africa regarding its importance as a supplier of raw materials such as uranium and gold to the West. One additional pretext for Western aid to South Africa might be the need to counter a perceived Soviet threat in the Indian Ocean, but, after the experience of Indochina, it is difficult to envisage any course of events that might lead to direct military intervention by the Western powers. Some kind of indirect intervention to protect the white regime is, however, far more plausible, such as the foreign investments made in Angola which have played and still play an important role for the competing nationalist movements. It remains a fact that political denunciations have not and will not have any profound consequences for the South African government as long as economic relations with Western countries remain intact.

In the last instance, the key to the future will lie with the black population in the countries concerned. The miserable conditions under which the blacks in Southern Africa live cannot be expected to produce a revolutionary movement unless a way is found to canalize black African demands and unify and organize the separate groups. If this fails to occur, the individuals affected will remain second-class citizens dominated by the rules of apartheid. Furthermore, should African opposition to the prevailing system inside these countries exhaust itself, it will not be possible for outside parties to influence the South African government towards any relaxation of apartheid.

There is also the possibility that a certain liberalization within South Africa may neutralize black opposition and make it settle for less than complete equality with the whites. This would ultimately lead to the development of a socio-economically differentiated society in which apartheid had given way, but in which non-whites would still remain second-class citizens though they would possess the same political rights as whites. This alternative represents more wishful thinking on the part of the privileged class, however, than a realistic assessment of actual conditions. What is at stake is not merely the issue of changing the apartheid system, but how to change it and for the benefit of whom. It is doubtful, considering the poverty and misery imposed on the blacks, that they will be content with limited reforms designed to bolster the economy. It is far more probable that they will seek to eliminate completely the doctrine and practices of white racial supremacy.

Thus, unless substantial concessions are made by the white ruling class, it appears inevitable that South Africa will experience some major upheaval in the not too distant future. Such a conflict may easily escalate, perhaps even transforming Southern Africa into the next international battlefield.

IV. *Ecological consequences of the Second Indochina War*[4]

The Second Indochina War was the first in modern history in which environmental disruption was an intentional and substantial component of the strategy of one of the belligerent powers. In an attempt to subdue a largely guerrilla opponent, the USA pioneered a variety of hostile techniques causing widespread environmental disruption which were aimed at denying its enemy concealment, freedom of movement, and local sources of food and other supplies.

The three ecologically most destructive techniques of the Second Indochina War were (*a*) the massive and sustained expenditure of high-explosive munitions (ca. 14 mn tons of bombs, shells and the like), (*b*) the profligate dissemination of chemical anti-plant agents (ca. 55 000 tons of herbicides), and (*c*) the large-scale employment of heavy landclearing tractors (ca. 200 so-called Rome ploughs).

Although no portion of Indochina seems to have been exempt from military punishment, the diverse mutilations of the landscape were for the most part directed against the 17 mn ha of largely rural South Vietnam. Indeed, South Vietnam was subjected to 71 per cent of the total high-explosive munitions used and to virtually all of the herbicidal attacks and Rome-plough landclearing. US hostilities against the rest of Indochina, mounted largely from the air, were in large measure ancillary to those against South Vietnam (with the 29 per cent as yet unaccounted for munitions distributed as follows: Laos, 16 per cent; North Vietnam, 8 per cent; and Cambodia, 5 per cent).

In the SIPRI book *Ecological Consequences of the Second Indochina War*, the damage to the forests of South Vietnam from bombs and shells is presented in two categories: complete obliteration and severe damage. The first category consists of that forest land which was converted to craters by

[4] *Ecological Consequences of the Second Indochina War* (Stockholm, Almqvist & Wiksell, 1976, Stockholm International Peace Research Institute), 119 pages, 17 tables, 2 maps. ISBN 91-22000-63-3.

the high-explosive munitions. Such crater-obliterated forest areas have been calculated to add up to about 104 000 ha. Next there is the forest land which was subjected to flying metal fragments (shrapnel). If one uses the zone subjected to such abuse at an intensity sufficient to be lethal to 50 per cent or more of the exposed personnel, then the area in question amounts to about 4.9 mn ha. This last defined area is one in which many of the trees are injured by shrapnel, an event that in turn leads to fungal entry and decay, inevitably followed by a significant proportion of tree mortality.

The damage to South Vietnam's forests from chemical anti-plant agents is also best presented in two categories: virtually complete obliteration and partial damage. The first category consists of that forest land sprayed four or more times if an upland area, but only once if a lowland mangrove area (mangrove being an oddly sensitive forest type). This category of virtual obliteration covers about 202 000 ha, 51 000 of which is upland and 151 000 of which is mangrove. The second category, that of partial damage, consists of upland forests sprayed one to three times. This area has been calculated to cover some 1.3 mn ha. The first of these categories is estimated to have experienced between 85 and 100 per cent tree mortality whereas the second category experienced between 10 and 50 per cent.

The damage to South Vietnam's forests from Rome ploughs need be represented in but one category, that of essentially complete obliteration. This category of complete tree removal and topsoil disturbance amounts to some 325 000 ha.

Combining the several separate damage estimates presented above through the use of simple addition would inflate the extent of damage since some of the areas were subjected to more than one category of insult. The summations are therefore reduced by 10 per cent to account for such overlap. Thus, complete or essentially complete devastation comes to an estimated 568 000 ha, representing 5 per cent of the forest lands of South Vietnam (or 3 per cent of the entire region). The partially (severely) damaged forest lands were estimated to be at least an additional 5.6 mn ha, representing 54 per cent of the forest lands of South Vietnam (or 32 per cent of the entire region). These values do not, of course, take into account a variety of additional abuses to the land—both hostile and non-hostile—that resulted from the massive US military presence in Indochina.

Estimates regarding the rate of ecological recovery from the environmental damage outlined above are confounded by the pre-war status of the damaged areas, by the range of habitats involved, by the variety of abuses inflicted, and by the character and extent of subsequent human manipulations of the areas. Nonetheless, it can be suggested that those areas designated as having been partially damaged will, if left to their own devices, recover over a period of one to several decades. Conversely, in order for those areas designated as having been obliterated to regain a semblance of their pre-war status, time spans of several to many decades are involved.

Indeed, in the special case of the mangrove habitat—where the annihilation represents 30 per cent or more of the entire type—the period of recovery is now expected to be in excess of one century. Moreover, an estimated 10 mn large bomb craters (craters with a volume averaging about 67 cubic metres) can be considered to have become a permanent feature of the regional geomorphology.

Among the ecological lessons to be learned from the military tactics employed during the Second Indochina War are: (*a*) that the vegetation can be severely damaged or even destroyed with relative ease over extensive areas—and, of course, with it the ecosystems for which it provides the basis; (*b*) that natural, agricultural and industrial-crop plant communities are all similarly vulnerable; and (*c*) that the ecological impact of such actions is likely to be of long duration.

Part II. Developments in world armaments

Chapter 7. Sources and methods for the world armaments data

Purpose of the data / Sources / Definitions and restrictions / Methodology in the appendices / World military expenditure, 1976 / Registers of indigenous and licensed production of major weapons in industrialized countries, 1976 / Register of arms trade with industrialized countries, 1976 / Registers of indigenous and licensed production of major weapons and small arms in third world countries, 1976 / Register of arms trade with third world countries, 1976

7. Sources and methods for the world armaments data

Square-bracketed numbers, thus [1], *refer to the list of references on page 220.*

This chapter describes the sources and methods used in the preparation of the appendices on military expenditure, arms production and arms trade (appendices 7A to 7E). Only the main points are noted here. Further details on the arms production registers are given in the SIPRI Yearbook 1974 and on the arms trade registers in the SIPRI Yearbook 1973. The five appendices are updated versions of those which appeared in the SIPRI Yearbook 1976.

I. *Purpose of the data*

Together, the military expenditure tables and the arms production and trade registers form the nucleus of a comprehensive, quantitative and qualitative survey of world armaments. The purpose of the military expenditure estimates is to provide an indication of the overall volume of military activity in different countries, and of the resources absorbed by this activity. The arms production and trade registers show the origin, flow, costs and main characteristics with regard to the technical sophistication of the major weapons now being acquired in all countries. The main purpose of including small arms, military electronics and aero-engines in the arms production registers for the third world is to illustrate the level of technology acquired. An analysis of the trade in arms and in arms production technology will be presented in the forthcoming SIPRI publication *The Global Arms Trade,* which will also include a complete set of country registers of arms imports for the period 1945–77, as well as some coverage of the transfer of small arms.

Countries and time period covered

The appendices cover all the countries in the world.

The tables of military expenditure data, appendix 7A, are presented by region in the following order: NATO (North Atlantic Treaty Organization), WTO (Warsaw Treaty Organization), Other Europe, Middle East, South Asia, Far East, Oceania, Africa, Central America and South America. The individual countries are listed alphabetically within each of these regions.

Appendix 7B, arms production in the industrialized countries, includes register I, the indigenous arms production, and register II, the licensed production. Both registers in appendix 7B list the industrialized countries by region (NATO, WTO, Other Europe and Other Developed, the latter comprising Australia, China, Japan and New Zealand).

Appendix 7C, the arms trade with industrialized countries, lists the recipient countries in alphabetical order.

Appendix 7D, arms production in third world countries, includes register I, the indigenous production of major arms; register II, the licensed production of major arms; and register III, both the indigenous and licensed production of small arms. All three registers list the third world countries in alphabetical order.

Appendix 7E, the arms trade with third world countries, lists the recipient countries in alphabetical order. Tables 7E.1 and 7E.2—aggregate tables of the values of arms imports by the third world and of exports by supplier countries—are presented by region corresponding to the regions employed in the military expenditure tables. (Aggregate tables of the values of arms imports by the industrialized countries will be presented in the forthcoming SIPRI publication on the global arms trade.)

The absence of a country or an entire region from one or another of the arms production or trade registers means that no activity of the type indicated has been found for that area.

The arms production registers include only the items believed to have been actually in production or under development during the calendar year 1976. The arms trade registers cover items on order or delivered in 1976.

In the case of the military expenditure series it should be noted that in this edition of the *Yearbook* the figure for the most recent year is generally a budget estimate; and the figures for all the preceding years are, in general, final figures for actual outlays in that year. The degree of uncertainty relating to figures derives from the fact that contingencies may result in actual expenditures which differ—occasionally very widely—from the budgeted amounts; and government accounting procedures can require a considerable time after the closing of the fiscal year to arrive at a final figure for the total amount paid out during that period.

The military expenditure estimates refer to the calendar year in all cases. For countries where the government fiscal year differs from the calendar year, conversion to a calendar-year basis is made on the assumption of an even rate of expenditure throughout the fiscal year.

II. *Sources*

The sources of the data presented in the appendices are of five general types: official national documents; journals and periodicals; newspapers; books, monographs and annual reference works; and documents issued by international and intergovernmental organizations. The common criterion for all these sources is that they are open sources, available to the general public.

The official national documents include budgets; parliamentary or congressional proceedings, reports and hearings; statistics, White Papers, annual reports and other documents issued by governments and agencies; and statements by government officials and spokesmen. These and the journals, periodicals and newspapers contain information relating to both military expenditure and weapon production and trade. Comparatively few books or monographs are used, since the information in such works is generally too dated. An exception is annual reference works, which contain up-to-date information. The main official international documents used are those containing information relating to military expenditures. There are no surveys published by international or intergovernmental organizations on weapon production or trade.

The fact that different sources may give conflicting information on the same item necessitates an evaluation of the reliability of all the sources prior to entering the item in the arms *trade* registers in particular. In future, a reliability index of the most frequently used sources will be made by mathematically weighting the sources to facilitate their use in compiling the SIPRI data.

The following list shows a selection of the periodical publications which are regularly perused for relevant data:

Journals and periodicals

Aerospace International (Bonn-Duisdorf)
Africa Research Bulletin (Exeter, UK)
Air Actualités (Paris)
Air et Cosmos (Paris)
Air Force Magazine (Washington)
Air International (Bromley, UK)
Arab Report and Record (London)
Armament Data Sheets (London, Aviation Studies Atlantic)
Armed Forces Journal (Washington)
Armies and Weapons (Genoa)
Asian Recorder (New Delhi)
Aviation Week and Space Technology (New York)
Campaign against Arms Trade, Newsletter (London)
Congressional Quarterly Weekly Report (Washington)
Défense Conjoncture (Neuilly, France)
Défense Interarmées (Neuilly, France)
Defense Monitor (Washington)
Défense Nationale (Paris)
Economist (London)
Facts and Reports (Amsterdam)
Far Eastern Economic Review (Hong Kong)
Flight International (London)
Flying Review International (London)
Forces Armées Françaises (Paris)
IDSA News Review on China, Mongolia and the Koreas (New Delhi, Institute for Defence Studies & Analyses)

IDSA News Review on Japan, South East Asia and Australasia (New Delhi, Institute for Defence Studies & Analyses)
IDSA News Review on South Asia (New Delhi, Institute for Defence Studies & Analyses)
IDSA News Review on West Asia (New Delhi, Institute for Defence Studies & Analyses)
IMF Survey (Washington, International Monetary Fund)
Interavia (Geneva)
Interavia Airletter (Geneva)
Interavia Data (Geneva)
International Affairs (London)
International Air Forces and Military Aircraft Directory (Stapleford, UK, Aviation Advisory Services)
International Defense Business (Washington)
International Defense Review (Geneva)
International Financial Statistics (Washington, International Monetary Fund)
International Market Report (Washington)
Keesing's Contemporary Archives (Bristol)
Latin America (London)
Latin America Economic Report (London)
Milavnews (Stapleford, UK, Aviation Advisory Services)
Missiles and Rockets (Washington)
Monthly Bulletin of Statistics (New York, United Nations)
Monthly Bulletin of Statistics, The Republic of China (Taipei)
NACLA's Latin America & Empire Report (New York)
National Defense (Washington)
Nato Review (Brussels)
New Times (Moscow)
Österreichische Militärische Zeitschrift (Vienna)
Official Price List (London, Aviation Studies Atlantic)
Quarterly National Accounts Bulletin (Paris, OECD)
Soldat und Technik (Frankfurt)
US Naval Institute Proceedings (Annapolis, Md.)
Wehrtechnik (Bonn-Duisdorf)
3.Welt Magazin (Bonn)

Newspapers

Anti-Apartheid News (London)
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 (Zurich)
New York Times (New York)
Pravda (Moscow)
Rand Daily Mail (Johannesburg)
Standard Tanzania (Dar-es-Salaam)
Sunday Times (London)
Svenska Dagbladet (Stockholm)
Times (London)

Annual reference publications

For data on military expenditure, gross domestic product or net material product:

Africa (London, Africa Journal Ltd)
Africa Contemporary Record (London, Rex Collings)
Africa Guide (Saffron Walden, UK, Africa Guide Company)
Africa South of the Sahara (London, Europa Publications)
AID Economic Data Book: Africa, ... Far East, ... Latin America, ... Near East and South Asia (Washington, United States Agency for International Development)
Asia Yearbook (Hong Kong, Far Eastern Economic Review Ltd)
Europa Year Book—A World Survey (London, Europa Publications)
Far East and Australasia (London, Europa Publications)
Far Eastern Economic Review Yearbook (Hong Kong, Far Eastern Economic Review Ltd)
Middle East and North Africa (London, Europa Publications)
Military Balance (London, International Institute for Strategic Studies)
"Defence Expenditures of NATO Countries", NATO press release (Brussels, NATO)
Sivard, R. L., *World Military and Social Expenditures 1976* (Leesburg, Virginia, 1976, WMSE Publications)
Statesman's Year-Book (London, Macmillan)
Statistical Yearbook (New York, United Nations)
World Military Expenditures and Arms Transfers (Washington, United States Arms Control and Disarmament Agency)[1]
Yearbook of National Accounts Statistics (New York, United Nations)

For data on weapon production and trade:

"Aerospace Forecast and Inventory", annually in *Aviation Week and Space Technology* (New York, McGraw-Hill)
International Air Forces and Military Aircraft Directory (Stapleford, UK, Aviation Advisory Services)
Jane's All the World's Aircraft (London, Macdonald & Co.)
Jane's Fighting Ships (London, Macdonald & Co.)
Jane's Infantry Weapons (London, Macdonald & Co.)
Jane's Weapon Systems (London, Macdonald & Co.)
"Military Aircraft of the World", annually in *Flight International* (London, IPC Transport Press)

[1] This source was previously called *World Military Expenditures and Arms Trade*, and before that, *World Military Expenditures*.

III. *Definitions and restrictions*

The military expenditure estimates are intended to show the amount of money actually spent (outlays) for military purposes. It should be noted that in many countries there are alternative series for funds budgeted, appropriated (set aside) or obligated (committed to be spent). Since our objective is to show the volume of activity, series for actual expenditures have been chosen in preference to these alternatives. Even with this series, there may be some misrepresentation of the volume of activity—particularly for the United States and to a lesser extent for other major arms-producing countries—since payment for arms procurement may lag behind the actual production work. The expenditure series has the advantage, however, of being the only final measure of the actual amount of resources consumed.

Military expenditures are defined to include weapon 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 and payments on war debts.

For calculating the ratio of military expenditure to national product, either gross domestic product (GDP) at purchasers' values or net material product (NMP) has been used, following the practice of the individual countries in identifying national product. GDP is defined as "the final expenditure on goods and services, in purchasers' values, *less* the c.i.f. [cost, insurance, freight] value of imports of goods and services" [1]. NMP is defined as "the net (of depreciation) total amount of goods and productive series produced in a year expressed at realized prices" [2]. The ratio of military expenditure to national product will generally be higher when NMP is used, since this measure excludes a variety of services which are included in GDP.

The arms production and trade registers cover primarily the four categories of "major weapons"—that is, aircraft, missiles, ships and armoured vehicles. Strictly speaking, all of these except missiles are potential "weapon platforms", while missiles are part of "weapon systems". However, our use of the term "weapon" or "major weapon" by and large conforms with general practice. The great majority of the aircraft, ships and armoured vehicles entered in the registers are armed: as such they constitute either the central component of a weapon system which is generally identified by reference to that platform or a major unitary fighting system. For the production of indigenously designed weapons and for licensed production in developed countries (appendix 7B), only the *armed* ships and armoured vehicles are included. However, all aircraft—even unarmed transport and utility planes—are covered. The reason for the different treatment of aircraft is twofold. First, most aircraft can easily be converted to carry armaments and to form effective fighting platforms. This is not equally true of unarmed armoured vehicles and support ships. Second, the technology required to produce aircraft of any kind is generally more advanced than that required for armoured vehicles and ships which may not differ significantly from their widely produced civilian counterparts. Coverage of the arms imports by all countries (appendices 7C and 7E) and licensed production in third world countries (appendix 7D) is extended to include unarmed ships and armoured vehicles as well as unarmed aircraft, the criterion for inclusion simply being delivery to the armed forces of the country concerned. This results in the listing of a very small number of items of the type not included in the indigenous production register.

In the appendix on arms production in third world countries, a separate register of the production of small arms—that is, pistols, rifles, machine-guns, and so on—is presented this year in order, as explained above, to give a better indication of the level of weapon technology reached in these countries.

As a result of the exclusion of small arms, ammunition and artillery, the coverage of arms imports by third world countries is estimated to reflect only about one-half of the total procurement of military equipment in this region. In the case of the developed countries, which are generally equipped with more sophisticated weaponry, the proportion is probably considerably higher. One main aspect of the procurement activity in all countries, which is not reflected in the registers, is that associated with infrastructure and support equipment, such as land-based radar systems, communication networks, data-processing facilities, and so on. The satellite systems produced by the United States and the Soviet Union for the purposes of reconnaissance, navigation and communication constitute the most advanced and expensive type of support equipment not covered by the registers: funds for the development and production of space systems are estimated to account for about 5 per cent of the annual US budget for procurement of weapons and equipment.

IV. *Military expenditure tables (appendix 7A)*

The estimates of the military expenditures of NATO countries are taken from official NATO data, the figures for Warsaw Treaty Organization countries other than the USSR are from national budgets, and the estimates for the remaining countries in the world are in general taken from the United Nations *Statistical Yearbook*. The figures for the Soviet Union are SIPRI estimates, the methodology of which was explained in the *SIPRI Yearbook 1974* [3]. For many countries, the estimates for the most recent years are based on budget figures derived from newspapers and journals and other sources described above.

In order to provide time series estimates of total world military expenditure at constant prices, two operations must be performed. First, all national expenditure must be converted into a common currency: the most widely used unit for such a purpose is the US dollar, which SIPRI has also adopted. For this purpose it is necessary to use constant exchange rates, preferably those prevailing in a recent year. Second, it is necessary to adjust for the effect of changes in the level of prices.

For most countries we have used the official exchange rate in 1973 or, if this fluctuated during the year, the weighted average rate. For the Warsaw Treaty Organization countries, special purchasing power parities were used because these yielded more reasonable expenditure relationships both within the WTO and between these countries and the rest of the world. For WTO countries other than the USSR, and for Albania, purchasing power parities calculated by Benoit and Lubell were used [4]. For the USSR, SIPRI estimates of the rouble:dollar purchasing power parity have been calculated [3]. Since the 1974 SIPRI study, there has been a significant change of opinion in the US intelligence community concerning the volume of resources devoted to defence in the USSR. Throughout the 1950s and 1960s the open literature on this subject, both official and unofficial, had two general characteristics. First, it was assumed that the official Soviet defence budget was not comprehensive and that additional military expenditure was included in the allocation to "Science" and in the general residuals (unallocated expenditures) to be found in the State budget. Second, there was a widely held view that, because the military sector was a high-priority recipient of resources, its efficiency was relatively great. This meant that the rouble:dollar conversion ratios for military activities were relatively low, or that a relatively small number of roubles would translate into a relatively large number of dollars. This body of literature was reviewed and forms the basis of the SIPRI estimate of the dollar-equivalent of Soviet military expenditure [3].

The prevailing opinion in official US agencies[2] is new in at least two respects [5]. First, the "residuals" approach to estimating Soviet military expenditure appears to have been abandoned. Second, it is now felt that the relative efficiency of the military sector in the Soviet Union has been greatly overestimated in the past. The latter reassessment does not affect calculations of the dollar-equivalent of Soviet military expenditure. These estimates are now prepared, primarily by the US Central Intelligence Agency, by directly costing the Soviet military apparatus—manpower, procurement, operations, and so on—at US prices. However, the new assessment has a major impact on estimates of Soviet military expenditure in rouble terms. Estimates of expenditure in roubles—computed by applying rouble:dollar conversion ratios to the estimated dollar-equivalent of Soviet military expenditure—have increased by a factor of about 2. Similarly, current estimates of the percentage of Soviet GNP devoted to military purposes

[2] The Central Intelligence Agency (CIA), the Defense Intelligence Agency (DIA) and the Office of Net Assessment, Department of Defense.

(around 11–13 per cent) are nearly double those advanced in the latter half of the 1960s (6–8 per cent).

So far no detailed explanation of this change of opinion has been made public. Nor, as far as is known, have any unofficial studies appeared that confirm the official view. If such confirmation becomes available, SIPRI would review its present method of estimating the dollar-equivalent of Soviet military expenditure.

The adjustment for changes in prices was made by applying the consumer price index in each country. In many countries this is the only price index available: as an index of the general movement of prices, it is a reasonable one for showing the trend in the resources absorbed by the military, in constant prices. For further detail on this point, the reader is referred to the *SIPRI Yearbook 1972* [6].

V. *Registers of indigenously designed and licence-produced weapons in development or production (appendices 7B and 7D)*

Arrangement and classification of entries

Within the four broad categories of major weapons (aircraft, missiles, ships and armoured vehicles), the systems produced by each country are arranged by function. Thus aircraft are presented as follows: bombers, fighters, strike aircraft, other combat aircraft (for example, maritime patrol), reconnaissance aircraft and other electronic equipment platforms, transports, trainers, utility planes, armed helicopters, transport helicopters and utility helicopters. For all these categories, except bombers, other combat aircraft, reconnaissance aircraft and armed helicopters, there is a further subdivision between heavier and lighter types.[3] In the case of missile systems, a set of abbreviated descriptions of the launching platform and target is employed, and entries are listed first by launching platform (fixed land-based, towed, mobile, portable, fixed-wing aircraft, helicopter, ship, submarine) and, within these groups, by target (fixed land-based, tank, missile, fixed-wing aircraft, helicopter, ship, submarine). For ships, the following descriptive categories were evolved on the basis of the nomenclature employed by the majority of countries: strategic submarines (equipped with long-range strategic missiles), hunter-killer (counter-submarine) submarines (fast, nuclear-powered submarines without anti-ship missiles), anti-shipping submarines (equipped with anti-ship missiles), ordinary submarines, coastal

[3] In the case of transport aircraft, the following apply: heavy (over 200 000 kg), medium (50 000–200 000 kg), ordinary (10 000–30 000 kg). For fighter and strike aircraft, light types are defined as those weighing less than 11 000 kg. Most unarmed helicopters fall into one of the following categories: heavy lift (over 50 000 kg), medium transport (ca. 20 000 kg), transport (ca. 6 000–7 000 kg), utility (2 000–5 000 kg) or light utility (under 2 000 kg).

submarines, aircraft carriers (over 30 000 tons displacement), cruisers (7 000–25 000 tons), destroyers (3 500–6 999 tons), frigates or escorts (1 300–3 499 tons), corvettes (500–1 299 tons) and patrol boats or missile boats (below 500 tons). In the few cases where national descriptive designations radically depart from the scheme—for example, the French use of "corvette" for a 3 000-ton ship—these standardized descriptions have been inserted in square brackets in place of the official one.

An attempt has been made to place newer systems first and older ones second, within the various functional groupings.

Aircraft, ship and armoured vehicle armaments

No attempt has been made to describe the armaments carried on the combat aircraft since, in general, these are not only too numerous for the space available but also variable (that is, most combat aircraft can carry a variety of alternative weapon loads). For armoured vehicles, the main armament is indicated in the first of the columns of standardized data. In the case of ships, symbols indicating the nature and number of all armaments except the limited-capability anti-submarine mortars and rocket launchers are shown directly after the description. The order in which ship armaments are listed is as follows: missiles (ship-to-ship, ship-to-air, ship-to-submarine, submarine-to-submarine, submarine-to-surface), guns, anti-submarine torpedo tubes or torpedo launchers and ordinary torpedo tubes.

System specifications

The data on speed, weight and range are maximum values in all cases. In some cases these values are dependent on a number of variables. For example, in the case of aircraft the figure given for speed is the maximum speed under optimal conditions, which generally means that the aircraft carries no external payload and is flying at or near its maximum altitude.

Programme history

The dates given for design, prototype test and production are initial dates only, except for data pertaining to the Soviet Union, where little official data relating to weapon system developments are published. In the case of the USSR, the dates shown in the prototype test column generally refer to the time when a system was first reported to have been observed. In most cases these dates probably postdate initial prototype tests by one to two years.

Numbers to be produced

For the industrialized countries, an attempt has been made to divide the total planned production number of each system, or the number on order, between units to be manufactured for domestic military acquisition and units manufactured for export. When such data were available, the numbers to be procured for domestic acquisition are shown first, followed by a stroke and then the numbers for export. When a figure for total production was available but it was not known whether any of this production was intended for export, or what proportion was intended for export, a single figure appears.

For the third world countries, an attempt has been made to show the number planned for production, followed by a stroke and then the number produced to date.

Financial data

Data on research and development (R&D) costs refer to the total amount of money spent—or planned to be spent—on the development of the system over a period of years. Data on unit prices are average figures for the cost of an equipped item, excluding prorated R&D costs, spares and associated ground equipment.

The financial data should be used with great caution: they are intended to indicate general orders of magnitude only. It has not been possible to obtain standardized information, and in some cases the R&D costs and average unit prices have been calculated on a constant-price basis, with reference to some year in the early 1970s, while in the other cases the figures represent actual funds expended over a period of years, with no allowance made for inflation. Projected costs for systems to be produced later in the 1970s have an even greater element of uncertainty added to the noncomparability arising from the fact that some figures are based on price levels in the early 1970s while others are computed on the basis of projected price levels.

Foreign-designed components

The final column of the register of indigenously designed weapons produced in the industrialized countries shows the use of foreign-designed power plants (engines), armaments or electronic components, with the exporting country indicated in brackets. Occasionally a foreign-designed component can be the result of a collaborative effort by the two or more countries. Such cases are entered as follows: PP (Fr.+UK). Similarly, a weapon system may incorporate electronic components or armaments designed and/or produced in more than one foreign country. Such cases are entered as follows: Ar (USA, It.) or E (UK, Switz.).

Weapon production in the third world

The registers for the third world (appendix 7D) are arranged differently from those for the industrialized countries. There are two reasons for this. First, the volume of weapon production activity in most third world countries is comparatively small. Second, one of the main points which these registers attempt to illuminate is the degree of self-sufficiency in weapon design and production which individual third world countries have achieved.

For these reasons the third world arms production registers are arranged by country rather than by type of major weapon or small arm, and for each country all weapon development and/or production activity is listed. This necessitated some changes in the column headings. In addition, the column headings have been changed to permit the recording of more details on the degree of indigenization of a given weapon production programme. This information is also used to value the arms trade component of weapons produced under licence.

VI. *Arms trade registers (appendices 7C and 7E)*

The descriptive terminology used in appendices 7C and 7E differs slightly from that employed in appendices 7B and 7D, and generally follows the practice used in previous SIPRI registers of the arms trade.

Value of the arms trade

The SIPRI values of the arms trade do not correspond to current prices paid for the weapons but are estimates constructed as a trend-measuring device, as follows.

Over the post-war period, an enormous variety of weapons has been supplied to the third world. One way of providing a single measure of this heterogeneous flow is to put it into monetary terms which reflect both the quantity and also the quality of the weapons transferred. The "actual" prices paid are inadequate for this purpose, even if they were known in all instances, first because of the wide range of financial arrangements that have evolved for arms transactions. The United States, for example, has donated large quantities of armaments to many countries and, in most cases, has valued these grants for its own accounting purposes at one-third of the acquisition cost of the particular item of equipment. Depending on the condition of the equipment, this procedure may understate or overstate the true value of the transaction. For some arms transactions, mostly those involving the Soviet Union, payment has been made indirectly in the form of raw materials or under credit terms not comparable with Western practice. Sales at discount prices are also difficult to evaluate. Weapons transferred free of charge or on lease as well as those produced under licence would not be included at all if an attempt were made to use actual prices to measure the trend in arms transfers.

From a financial point of view, the arms trade is complex and the available official or semi-official data is far from sufficiently detailed and comprehensive to form the basis for a reliable and consistent assessment of the value of the arms trade over time. In addition, of course, some important suppliers release no information whatsoever.

Because of these circumstances, SIPRI undertook to value the arms trade independently by constructing a price list (based on prices in 1968) of all the major weapons transferred to the third world, and by using this to value every transaction recorded. (For a full description of the methodology, see *The Arms Trade with the Third World* [7].) The transactions recorded were confined to major weapons because this is the only component of the arms trade which can be documented comprehensively from open sources. This is a limitation, but statistically not so serious that the SIPRI data collection cannot be used as a reliable arms trade sample, since, for example, in fiscal year 1973, major weapons accounted for 56 per cent of the total value of goods and services provided under the US Foreign Military Sales and Military Assistance programmes. The remaining 44 per cent was composed of ammunition, communications equipment, other equipment, construction, repair and rehabilitation, supply operations, training and other services.

Meaning of the SIPRI values

The SIPRI arms trade values represent an attempt to measure the quantity of resources transferred to the third world in the form of major weapon systems. To the extent that major weapons account for a fairly stable share of the total trade, the SIPRI values can be used also as an index of the trend in the total value of military goods and services transferred to the third world. There is good reason to assume that major weapons have taken up a fairly stable share of the total trade in weapons and related equipment, at least in the past. The comprehensive nature of some of the larger arms deals concluded in recent years, particularly with Middle East countries, suggests that such items as technical assistance, electronic equipment and logistical facilities will account for a growing share of the financial value of the arms trade over the next few years.

Other considerations

Three other considerations must be taken into account in reconciling the SIPRI estimates of the value of arms trade with the third world and the official figures published by, for example, the United States. First, the official figures refer to total arms exports, a large percentage of which are exports to other industrialized countries. Second, the official figures refer to the total value of contracts signed during the year; the weapons and equipment involved may not actually be delivered until several years after the contract has been signed. The SIPRI values are based only on major weapons that have been physically transferred in a given year. As an example, foreign military sales by the USA in fiscal year 1973 amounted to $3.6 bn but actual deliveries under this programme in that year amounted to less than half this sum, or about $1.4 bn. When the contract value of a particular deal is made public, this information is included in the register but the figures are not used in estimating the annual value of weapons transactions. Finally, the SIPRI values are expressed in constant prices. The original price list, based on 1968, has been inflated to reflect 1975 price levels.

VII. *Conventions and abbreviations*

The following conventions and abbreviations are used in the tables and registers of world armaments data in the appendices below:

Conventions

. .	Information not available
( )	Uncertain data or SIPRI estimate. For military expenditure: estimates based on budget figures or using an estimated consumer price index, or both. For GDP, NMP data: where sources other than *National Account Statistics* are used
[ ]	For military expenditure: rough estimate
<	Less than the number given
>	More than the number given
~	Approximate number
–	Nil
1969–	1969 and subsequent years
n.a.	Not applicable
†	For military expenditure: year of independence
I	For military expenditure: GDP figures used for years after this symbol are not *strictly* comparable with those for preceding years

Abbreviations

A	Attack
A/A	Anti-aircraft
AAM	Air-to-air missile
ABM	Anti-ballistic missile
AC	Armoured car
AD	Air defence
AEW	Airborne early warning
AF	Air Force

aircr	Fixed-wing aircraft
ALBM	Air-launched ballistic missile
ALCM	Air-launched cruise missile
APC	Armoured personnel carrier
approx	Approximately
Ar	Armament
ARM	Anti-radar missile
A/S	Anti-submarine
A/SM	Anti-submarine missile
ASM	Air-to-surface missile
A/S TT	Anti-submarine torpedo tubes
ASW	Anti-submarine warfare
A/T	Anti-tank
ATM	Anti-tank missile
AWACS	Airborne warning and control system
B	Bomber
batt	battery
carr-b or land-b	Aircraft carrier-based or land-based
COIN	Counterinsurgency
com.&con.	Command and control
Co-prod	Co-production
CVR(T)	Combat vehicle reconnaissance (tracked)
D	Diesel
Displ	Displacement of naval vessels, in tons
E	Electronic equipment
ECM	Electronic countermeasures
E-d	Computer/data processing equipment
E-f	Fire-control system (for armaments)
E-g	Guidance system (for missiles)
E-n	Navigation equipment
E-r	Radar
E-s	Sonar
ELINT	Electronic intelligence
Ex-Im	Export-Import Bank
F	Fighter
FAC	Fast attack craft
FB	Fighter-bomber
fixed	Fixed land-based
FROG	Free rocket over ground

GT	Gas turbine
HE	High explosive
hel	Helicopter
I	Interceptor
ICBM	Intercontinental ballistic missile (range >5 500 km)
Imp	Imported
Indig	Indigenization
IR	Infrared
IRBM	Intermediate-range ballistic missile (range 2 750–5 500 km)
J	Jet
kt	Kiloton (1 000 tons of TNT equivalent)
L	Licence
LOH	Light observation helicopter
LP	Liquid propellant
LRCM	Long-range cruise missile
MAP	(US) Military Assistance Program
MBT	Main battle tank (heavy, medium)
MG	Machine-gun
MIRV	Multiple independently targetable re-entry vehicle
miss	Missile
Mk	Mark
mobile	Mobile ground-based
Mod	Model
MRBM	Medium-range ballistic missile (range 1 100–2 750 km)
MRV	Multiple re-entry vehicle
MSBS	Mer-sol balistique stratégique
Mt	Megaton (1 000 000 tons of TNT equivalent)
N	Nuclear
P	Piston
PBV	Post boost vehicle
portable	Portable (man-carried)
PP	Power plant
recce	Reconnaissance
Req	Requirement

RL	Rocket launcher
RV	Re-entry vehicle
S	Solid propellant
SAM	Surface- or Ship-to-air missile
SAR	Search and rescue/sea-air rescue
ShAM	Ship-to-air missile
ShShM	Ship-to-ship missile
ShSuM	Ship-to-submarine missile
SL	Storable liquid
SLAM	Submarine-launched air missile
SLBM	Submarine-launched ballistic missile
SLCM	Ship- or Submarine-launched cruise missile
SP	Self-propelled ground-based
Sqds	Squadrons
Srs	Series
SSM	Surface-to-surface missile
ST	Steam turbine
STOL	Short take-off and landing
sub	Submarine
SuShM	Submarine-to-ship-missile
SuSuM	Submarine-to-submarine missile
t	Ton
TF	Turbofan
TOW	Tube-launched, optically-tracked, wire-guided
towed	Towed ground-based
TP	Turboprop
transp	Transport
TS	Turboshaft
TT	Torpedo tube
U.c.	Unit cost
USAF	United States Air Force
USN	United States Navy
vers	Version
VG	Variable geometry
VIP	Very important person
V/STOL	Vertical or short take-off and landing
VTOL	Vertical take-off and landing

References

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2. Wilczynski, J., "The Economics of Socialism", in C. Charter, ed., *Studies in Economics,* Number 2 (London, George Allen and Unwin, 1967;).
3. *World Armaments and Disarmament, SIPRI Yearbook 1974* (Stockholm, Almqvist & Wiksell, 1974, Stockholm International Peace Research Institute), appendix 8B, pp. 172–204.
4. Benoit, E. and Lubell, H., "The World Burden of National Defense", in E. Benoit, ed., *Disarmament and World Economic Interdependence* (Oslo, Universitetsförlaget, 1967).
5. *Allocation of Resources in the Soviet Union and China—1976,* Hearings before the Subcommittee on Priorities and Economy in Government of the Joint Economic Committee of the Congress of the United States (Washington, US Government Printing Office, 24 May and 15 June 1976), esp. pp. 4, 17–24, 41–43.
6. *World Armaments and Disarmament, SIPRI Yearbook 1972* (Stockholm, Almqvist & Wiksell, 1972, Stockholm International Peace Research Institute), pp. 78–79.
7. *The Arms Trade with the Third World* (Stockholm, Almqvist & Wiksell, 1971, Stockholm International Peace Research Institute), pp. 785–92.

Appendix 7A

World military expenditure, 1976

For sources and methods, see chapter 7. For conventions, see page 216.

Table 7A.1. World summary: constant price figures

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
USA	68 234	69 584	69 622	70 004	68 130	70 937	76 943	75 824	73 326	72 928
Other NATO	29 245	29 817	27 301	29 830	31 050	32 241	35 397	36 697	37 241	37 157
Total NATO	**97 479**	**99 401**	**96 923**	**99 834**	**99 180**	**103 178**	**112 340**	**112 521**	**110 567**	**110 085**
USSR	31 600	31 300	30 500	36 000	32 700	40 800	44 600	48 900	46 700	44 900
Other WTO[a]	2 600	2 700	2 900	3 000	2 958	3 250	4 147	4 469	4 471	4 598
Total WTO	**34 200**	**34 000**	**33 400**	**33 000**	**35 658**	**44 050**	**48 747**	**53 369**	**51 171**	**49 498**
Other Europe	2 880	3 160	3 225	3 300	3 300	3 546	3 867	3 999	4 226	4 256
Middle East	975	1 025	1 225	1 325	1 340	1 440	1 600	1 785	2 065	2 370
South Asia	975	1 100	1 100	1 075	1 090	1 150	1 494	2 317	2 287	2 364
Far East (excl China)	2 725	2 900	3 100	3 275	3 375	3 525	3 740	3 926	4 249	4 770
China	[9 100]	[9 800]	[9 100]	[10 100]	[10 100]	[11 800]	[13 700]	[15 500]	[18 400]	[19 400]
Oceania	1 058	974	976	1 024	1 018	1 006	1 039	1 166	1 356	1 559
Africa (excl Egypt)	260	300	275	325	390	575	860	961	1 149	1 323
Central America	300	350	375	400	435	459	509	545	580	571
South America	2 340	2 515	2 600	2 135	2 200	2 139	2 168	2 256	2 204	2 649
World total	**152 292**	**155 525**	**152 299**	**155 793**	**158 086**	**172 868**	**190 064**	**198 345**	**198 254**	**198 845**

[a] At current prices and Benoit-Lubell exchange rates.

Table 7A.2. NATO: constant price figures

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
North America:										
Canada	3 099	2 903	2 703	2 524	2 512	2 584	2 689	2 502	2 604	2 325
USA	68 234	69 584	69 622	70 004	68 130	70 937	76 943	75 824	73 326	72 928
Europe:										
Belgium	771	806	799	807	824	834	888	920	981	957
Denmark	360	379	370	361	404	411	502	508	524	556
France	7 639	7 929	7 321	7 469	7 699	7 935	8 229	8 087	8 311	8 446
FR Germany	4 600	5 566	4 141	6 611	7 148	7 535	9 562	10 749	10 301	10 180
Greece	281	247	242	251	266	258	262	268	279	302
Italy	1 924	1 991	2 033	2 121	2 204	2 279	2 500	2 787	2 853	2 961
Luxembourg	16	17	17	16	10	11	14	13	17	17
Netherlands	1 448	1 352	1 190	1 060	1 168	1 360	1 447	1 466	1 595	1 554
Norway	352	373	348	368	350	381	421	438	444	515
Portugal	217	223	229	257	266	427	485	474	517	517
Turkey	386	375	387	445	469	506	532	541	585	621
UK	8 152	7 656	7 521	7 530	7 730	7 720	7 866	7 944	8 230	8 206
Total NATO	**97 479**	**99 401**	**96 923**	**99 834**	**99 180**	**103 178**	**112 340**	**112 521**	**110 567**	**110 085**
Total NATO (excl USA)	**29 245**	**29 817**	**27 301**	**29 830**	**31 050**	**32 241**	**35 397**	**36 697**	**37 241**	**37 157**
Total NATO Europe	**26 146**	**26 914**	**24 598**	**27 306**	**28 538**	**29 657**	**32 708**	**34 195**	**34 637**	**34 832**

US $ mn, at 1973 prices and 1973 exchange rates (Final column, X, at current prices and exchange rates)

1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1975X
86 993	100 363	103 077	98 698	89 065	82 111	82 469	78 358	77 383	75 068	77 373	*90 948*
37 325	38 980	37 806	37 638	38 385	40 412	42 619	43 326	44 543	45 651	46 859	*58 194*
124 318	**139 343**	**140 883**	**136 336**	**127 450**	**122 523**	**125 088**	**121 684**	**121 926**	**120 719**	**124 232**	*149 142*
47 000	50 800	58 600	62 200	63 000	63 000	63 000	63 000	61 900	61 100	61 100	*61 000*
4 833	5 252	6 387	7 012	7 498	7 974	8 240	8 808	9 444	10 207	11 007	*10 207*
51 833	**56 052**	**64 987**	**69 212**	**70 498**	**70 974**	**71 240**	**71 808**	**71 344**	**71 307**	**72 107**	*71 307*
4 422	4 420	4 560	4 740	4 864	4 983	5 288	5 382	5 650	5 658	5 900	*7 761*
2 830	3 700	4 450	5 140	6 175	6 425	8 820	11 468	15 737	19 875	21 835	*25 164*
2 313	2 101	2 176	2 312	2 403	2 856	3 100	2 775	2 611	2 804	3 210	*3 638*
4 862	5 348	5 949	6 387	6 917	7 589	8 005	8 032	8 200	8 250	8 700	*10 855*
[21 800]	[21 800]	[22 800]	[24 600]	[27 200]	[28 200]	[27 300]	[27 300]	[27 300]	[27 300]	[27 300]	*[32 300]*
1 779	1 937	2 101	2 129	2 125	2 125	2 131	2 102	2 177	2 157	2 097	*2 597*
1 382	1 712	1 984	2 376	2 514	2 776	2 869	3 096	3 676	4 550	5 200	*6 039*
614	659	738	718	754	771	791	812	811	900	950	*1 105*
2 687	3 170	3 006	3 149	3 230	3 700	3 781	4 003	3 550	4 700	4 500	*4 417*
218 840	**240 242**	**253 634**	**257 099**	**254 130**	**252 922**	**258 413**	**258 462**	**262 982**	**268 220**	**276 031**	*314 325*

US $ mn, at 1973 prices and 1973 exchange rates (Final column, X, at current prices and exchange rates)

1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1975X
2 386	2 562	2 415	2 276	2 392	2 403	2 409	2 408	2 582	2 546	2 723	*3 074*
86 993	100 363	103 077	98 698	89 065	82 111	82 469	78 358	77 383	75 068	77 373	*90 948*
977	1 019	1 066	1 067	1 136	1 152	1 215	1 259	1 311	1 417	1 480	*1 854*
548	547	584	574	563	617	613	583	638	693	722	*914*
8 688	9 155	9 164	8 738	8 835	8 947	9 173	9 513	9 437	9 903	10 379	*13 034*
9 869	10 264	9 112	9 992	10 108	10 823	11 576	12 027	12 558	12 496	12 312	*15 198*
327	422	492	557	603	638	680	679	650	1 043	(1 211)	*1 360*
3 204	3 128	3 187	3 124	3 293	3 726	4 114	4 107	4 110	3 825	3 735	*4 744*
17	14	12	12	13	13	14	15	17	18	17	*22*
1 515	1 677	1 659	1 732	1 788	1 871	1 933	1 967	2 053	2 158	2 120	*2 851*
512	528	559	590	592	607	606	611	627	681	677	*908*
545	669	705	653	714	747	737	681	816	561	433	*774*
603	608	643	631	675	790	821	862	943	(1 516)	(1 908)	*2 113*
8 134	8 387	8 208	7 692	7 673	8 078	8 728	8 614	8 801	8 794	9 142	*11 348*
124 318	**139 343**	**140 883**	**136 336**	**127 450**	**122 523**	**125 088**	**121 684**	**121 926**	**120 719**	**124 232**	*149 142*
37 325	**38 980**	**37 806**	**37 638**	**38 385**	**40 412**	**42 619**	**43 326**	**44 543**	**45 651**	**46 859**	*58 194*
34 939	**36 418**	**35 391**	**35 362**	**35 993**	**38 009**	**40 210**	**40 918**	**41 961**	**43 105**	**44 136**	*55 120*

Table 7A.3. NATO: current price figures

	Currency	1956	1957	1958	1959	1960	1961	1962	1963	1964
North America:										
Canada	*mn dollars*	1 888	1 829	1 740	1 642	1 654	1 716	1 810	1 712	1 813
USA	*mn dollars*	41 513	44 159	45 096	45 833	45 380	47 808	52 398	52 295	51 213
Europe										
Belgium	*mn francs*	17 887	19 232	19 254	19 658	20 209	20 641	22 341	23 596	26 241
Denmark	*mn kroner*	936	1 012	988	986	1 113	1 180	1 551	1 651	1 764
France	*mn francs*	14 690	15 600	16 569	17 926	19 162	20 395	22 184	22 849	24 280
FR Germany	*mn marks*	7 211	8 962	6 853	11 087	12 115	13 175	17 233	19 924	19 553
Greece	*mn drachmas*	4 939	4 477	4 469	4 735	5 110	5 034	5 102	5 385	5 647
Italy	*bn lire*	584	611	647	667	710	749	861	1 031	1 118
Luxembourg	*mn francs*	395	439	429	402	263	290	355	348	462
Netherlands	*mn guilders*	1 854	1 845	1 656	1 505	1 728	2 013	2 186	2 307	2 661
Norway	*mn kroner*	967	1 049	1 024	1 107	1 058	1 179	1 371	1 465	1 570
Portugal	*mn escudos*	2 297	2 391	2 485	2 820	3 023	4 922	5 744	5 724	6 451
Turkey	*mn liras*	1 159	1 266	1 470	2 153	2 410	2 718	2 980	3 157	3 443
UK	*mn pounds*	1 615	1 568	1 593	1 595	1 657	1 709	1 814	1 870	2 000

Table 7A.4. NATO: military expenditure as a percentage of gross domestic product

	1956	1957	1958	1959	1960	1961	1962	1963	1964
North America:									
Canada	*6.1*	*5.6*	*5.2*	*4.6*	*4.3*	*4.3*	*4.2*	*3.7*	*3.6*
USA	*9.8*	*9.9*	*10.0*	*9.4*	*8.9*	*9.1*	*9.3*	*8.8*	*8.0*
Europe:									
Belgium	*3.7*	*3.8*	*3.7*	*3.7*	*3.6*	*3.4*	*3.5*	*3.4*	*3.4*
Denmark	*3.0*	*3.1*	*2.9*	*2.6*	*2.7*	*2.6*	*3.0*	*3.0*	*2.8*
France	*7.7*	*7.3*	*6.8*	*6.6*	*6.4*	*6.2*	*6.0*	*5.6*	*5.3*
FR Germany	*3.6*	*4.1*	*3.0*	*4.4*	*4.0*	*4.0*	*4.8*	*5.2*	*4.6*
Greece	*6.0*	*5.1*	*4.8*	*4.9*	*4.9*	*4.3*	*4.0*	*3.9*	*3.6*
Italy	*3.6*	*3.5*	*3.4*	*3.3*	*3.3*	*3.1*	*3.2*	*3.3*	*3.3*
Luxembourg	*1.9*	*1.9*	*1.9*	*1.8*	*1.0*	*1.2*	*1.3*	*1.2*	*1.4*
Netherlands	*5.7*	*5.2*	*4.7*	*4.0*	*4.1*	*4.5*	*4.5*	*4.4*	*4.3*
Norway	*3.5*	*3.6*	*3.5*	*3.6*	*3.2*	*3.3*	*3.6*	*3.5*	*3.4*
Portugal	*4.0*	*4.0*	*4.0*	*4.3*	*4.2*	*6.4*	*7.0*	*6.5*	*6.7*
Turkey	*4.7*	*4.1*	*3.8*	*4.5*	*5.1*	*5.5*	*5.1*	*4.7*	*4.8*
UK	*7.8*	*7.2*	*7.0*	*6.7*	*6.5*	*6.3*	*6.4*	*6.2*	*6.1*

Table 7A.5. WTO: current price figures

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Bulgaria	. .	133	149	141	154	187	222	256	224	198
Czechoslovakia	1 071	1 094	1 047	1 035	1 033	1 119	1 276	1 274	1 202	1 191
German DR	. .	. .	487	. .	295	295	796	826	855	914
Hungary	. .	110	. .	144	179	194	283	374	355	332
Poland	754	634	704	898	937	1 069	1 154	1 300	1 374	1 461
Romania	. .	405	381	365	360	386	416	439	461	502
USSR[a]	31 600	31 300	30 500	33 000	32 700	40 800	44 600	48 900	46 700	44 900
Total WTO	**[34 200]**	**[34 000]**	**[33 400]**	**36 000**	**35 658**	**44 050**	**48 747**	**53 369**	**51 171**	**49 498**

[a] At SIPRI estimated exchange rates (see *SIPRI Yearbook 1974*, pp. 191 ff.).

Local currency, current prices

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
1 659	1 766	1 965	1 927	1 899	2 061	2 131	2 238	2 405	2 862	3 127	3 595
51 827	63 572	75 448	80 732	81 443	77 854	74 862	77 639	78 358	85 906	90 948	99 083
26 606	28 169	30 396	32 676	33 892	37 502	39 670	44 140	48 941	57 395	69 936	79 445
1 974	2 080	2 249	2 591	2 640	2 757	3 195	3 386	3 520	4 439	5 281	5 974
25 300	26 732	28 912	30 264	30 696	32 672	34 907	37 992	42 284	47 705	55 955	64 100
19 915	20 254	21 408	19 310	21 577	22 573	25 450	28 720	31 908	35 644	37 589	38 823
6 290	7 168	9 390	11 003	12 762	14 208	15 480	17 211	19 866	24 126	43 917	(57 090)
1 212	1 342	1 359	1 403	1 412	1 562	1 852	2 162	2 392	2 852	3 104	3 526
477	497	413	374	391	416	442	517	601	710	836	900
2 714	2 790	3 200	3 280	3 682	3 968	4 466	4 974	5 465	6 254	7 246	7 713
1 897	1 947	2 097	2 300	2 502	2 774	3 022	3 239	3 505	3 938	4 771	5 220
6 680	7 393	9 575	10 692	10 779	12 538	14 699	16 046	16 736	25 108	19 898	18 500
3 821	3 996	4 596	5 159	5 395	6 237	8 487	9 961	12 192	15 831	(30 570)	(43 610)
2 091	2 153	2 276	2 332	2 303	2 444	2 815	3 258	3 512	4 160	5 165	6 188

Per cent

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
3.0	*2.8*	*2.9*	*2.6*	*2.4*	*2.4*	*2.3*	*2.1*	*2.0*	*2.0*	. .
7.5	*8.4*	*9.4*	*9.2*	*8.6*	*7.8*	*7.0*	*6.6*	*6.0*	*6.1*	. .
3.2	*3.1*	*3.1*	*3.2*	*2.9*	*2.9*	*2.8*	*2.8*	*2.8*	*2.8*	*3.1*
2.8	*2.7*	*2.7*	*2.8*	*2.5*	*2.4*	*2.5*	*2.3*	*2.1*	*2.4*	*2.6*
5.2	*5.0*	*5.0*	*4.8*	*4.2*	*4.2*	*4.0*	*3.9*	*3.8*	*3.7*	. .
4.3	*4.1*	*4.3*	*3.6*	*3.6*	*3.3*	*3.3*	*3.4*	*3.4*	*3.6*	*3.6*
3.6	*3.7*	*4.3*	*4.7*	*4.8*	*4.8*	*4.7*	*4.6*	*4.1*	*4.2*	*6.5*
3.3	*3.4*	*3.1*	*3.0*	*2.7*	*2.7*	*2.9*	*3.1*	*3.0*	*2.9*	. .
1.4	*1.4*	*1.2*	*1.0*	*0.9*	*0.8*	*0.8*	*0.9*	*0.8*	*0.9*	. .
3.9	*3.7*	*4.0*	*3.7*	*3.6*	*3.5*	*3.4*	*3.4*	*3.3*	*3.4*	*3.5*
3.7	*3.5*	*3.5*	*3.6*	*3.6*	*3.5*	*3.4*	*3.3*	*3.1*	*3.1*	*3.2*
6.2	*6.3*	*7.3*	*7.4*	*6.8*	*7.1*	*7.4*	*7.0*	*6.0*	*7.4*	*5.3*
5.0	*4.4*	*4.5*	*4.6*	*4.4*	*4.3*	*4.5*	*4.3*	*4.1*	*3.9*	*5.9*
5.9	*5.7*	*5.7*	*5.4*	*5.0*	*4.8*	*5.0*	*5.2*	*4.9*	*5.1*	*5.0*

US $ mn, at Benoit-Lubell exchange rates

1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
207	213	228	260	279	305	337	364	416	472	453
1 275	1 457	1 552	1 679	1 755	1 876	1 976	2 071	2 126	2 271	2 400
944	1 062	1 711	1 858	2 006	2 124	2 242	2 457	2 625	2 821	3 019
301	313	381	440	567	570	543	547	609	649	707
1 584	1 661	1 905	2 105	2 142	2 312	2 324	2 538	2 745	2 965	3 325
522	546	610	670	749	787	818	831	923	1 029	1 103
47 000	50 800	58 600	62 200	63 000	63 000	63 000	63 000	61 900	61 100	61 100
51 833	**56 052**	**64 987**	**69 212**	**70 498**	**70 974**	**71 240**	**71 808**	**71 344**	**71 307**	**72 107**

Table 7A.6. WTO: current price figures

	Currency	1956	1957	1958	1959	1960	1961	1962	1963	1964
Bulgaria	*mn leva*	. .	154	173	163	179	217	258	297	260
Czechoslovakia	*mn korunas*	9 100	9 300	8 900	8 800	8 783	9 512	10 845	10 829	10 217
German DR	*mn marks*	. .	. .	1 650	. .	1 000	1 000	2 700	2 800	2 900
Hungary	*mn forints*	. .	1 912	. .	2 500	3 100	3 376	4 913	6 500	6 163
Poland	*mn zlotys*	12 000	10 100	11 200	14 300	14 920	17 019	18 378	20 695	21 881
Romania	*mn lei*	. .	3 817	3 597	3 446	3 639	3 639	3 924	4 143	4 346
USSR	*mn roubles*	9 730	9 672	9 400	9 370	11 600	11 600	12 700	13 900	13 300

Table 7A.7. WTO: military expenditure as a percentage of net material product

	1956	1957	1958	1959	1960	1961	1962	1963	1964
Bulgaria	. .	*4.8*	*5.0*	*3.9*	*4.0*	*4.6*	*5.0*	*5.2*	*3.1*
Czechoslovakia	*6.8*	*6.6*	*6.0*	*5.8*	*5.4*	*5.6*	*6.2*	*6.3*	*6.1*
German DR	. .	. .	*2.7*	. .	*(1.4)*	*(1.4)*	*(3.6)*	*(3.6)*	*(3.6)*
Hungary	. .	*1.8*	. .	*2.0*	*2.2*	*2.3*	*3.1*	*3.9*	*3.6*
Poland	*4.8*	*3.4*	*3.5*	*4.1*	*4.0*	*4.1*	*4.3*	*4.5*	*4.4*
USSR[a]	*9.1*	*8.6*	*7.4*	*6.9*	*6.4*	*7.6*	*7.7*	*8.2*	*7.3*

[a] An alternative series for the Soviet Union shows the SIPRI estimates of the dollar-equivalent of Soviet military expenditure as a percentage of official Soviet estimates of the dollar-equivalent of Soviet National Income for 1962–73:

	1962	1963	1964
	22.5	*23.4*	*20.2*

Table 7A.8. Other Europe: constant price figures

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Albania[a]	. .	. .	. .	. .	. .	58	65	66	68	70
Austria	95	157	180	178	165	160	168	205	259	214
Finland	112	109	113	134	141	163	229	181	179	182
Ireland	44	43	42	44	47	49	50	51	57	58
Spain	520	552	494	463	548	558	651	670	681	675
Sweden	1 130	1 157	1 169	1 218	1 198	1 258	1 352	1 441	1 516	1 608
Switzerland	389	518	556	536	503	587	648	676	732	738
Yugoslavia	593	580	623	674	642	713	704	709	734	711
Total Other Europe	**[2 880]**	**[3 160]**	**[3 225]**	**[3 300]**	**[3 300]**	**3 546**	**3 867**	**3 999**	**4 226**	**4 256**

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

Table 7A.9. Other Europe: current price figures

	Currency	1956	1957	1958	1959	1960	1961	1962	1963	1964
Albania	*mn leks*	. .	. .	. .	. .	. .	[240]	[270]	[275]	282
Austria	*mn schillings*	1 001	1 714	1 986	1 989	1 893	1 890	2 076	2 608	3 408
Finland	*mn markkaa*	170	184	206	246	267	314	460	383	417
Ireland	*mn pounds*	7.9	8.1	8.3	8.6	9.2	9.9	10.5	10.8	12.9
Spain	*mn pesetas*	9 330	10 881	11 067	11 115	13 375	13 935	17 173	19 218	20 920
Sweden	*mn kronor*	2 389	2 557	2 706	2 820	2 898	3 107	3 500	3 839	4 173
Switzerland	*mn francs*	682	930	1 009	972	924	1 096	1 264	1 362	1 521
Yugoslavia	*mn new dinars*	1 580	1 590	1 785	1 956	2 077	2 477	1 701	2 862	3 321

Local currency, current prices

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
230	240	247	264	302	324	354	391	422	483	548	525
10 125	10 841	12 385	13 189	14 268	14 919	15 943	16 800	17 600	18 071	19 300	20 400
3 100	3 200	3 600	5 800	6 300	6 800	7 200	7 600	8 328	8 900	9 564	10 233
5 757	5 219	5 433	6 611	7 644	9 848	9 891	9 430	9 489	10 564	11 258	12 275
23 255	25 213	26 438	30 332	33 519	34 100	36 800	37 000	40 400	43 700	47 200	52 928
4 735	4 927	5 146	5 751	6 319	7 067	7 424	7 710	7 835	8 700	9 700	10 400
12 800	13 400	14 500	16 700	17 700	17 900	17 900	17 900	17 900	17 600	17 400	17 400

Per cent

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
3.5	*3.3*	*3.1*	*3.1*	*3.2*	*3.1*	*3.4*	*3.5*	*3.5*	*3.7*	. .
5.9 ▮	*5.5*	*5.3*	*4.8*	*4.9*	*4.8*	*5.0*	*4.9*	*4.9*	*4.7*	*4.8*
(3.6)	*(3.6)*	*3.9*	*(5.9)*	*(6.1)*	*(6.3)*	*(6.3)*	*(6.3)*	*(6.6)*	*(6.7)*	. .
3.4	*2.8*	*2.6*	*2.9*	*3.0*	*3.6*	*3.4*	*3.0*	*2.7*	*2.9*	. .
4.4	*4.4*	*4.4*	*4.5*	*4.8* ▮	*4.6*	*4.3*	*3.9*	*3.8*	*3.6*	*3.5*
6.6	*6.5*	*6.4*	*6.8*	*6.8*	*6.2*	*5.9*	*5.7*	*5.3*	*5.0*	. .

18.1	. .	*17.3*	*18.0*	*17.4*	*16.5*	*15.4*	*14.8*	*13.1*	*11.6*	*10.7*

US $ mn, at 1973 prices and 1973 exchange rates (Final column, X, at current prices and exchange rates)

1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1975X
66	66	81	105	115	140	143	142	147	153	189	*153*
245	249	249	257	254	244	260	263	294	287	(318)	*379*
180	175	201	183	194	211	241	244	248	258	(252)	*379*
56	57	58	61	69	76	90	95	98	116	. .	*147*
797	862	893	927	945	977	1 062	1 161	1 169	1 078	(1 285)	*1 472*
1 622	1 580	1 583	1 667	1 711	1 739	1 786	1 791	1 806	1 809	(1 755)	*2 286*
776	757	721	769	791	823	838	812	809	761	(811)	*1 084*
680	674	764	771	785	773	868	874	1 079	1 196	(1 165)	*1 861*
4 422	**4 420**	**4 560**	**4 740**	**4 864**	**4 983**	**5 288**	**5 382**	**5 650**	**5 658**	**[5 900]**	*7 761*

Local currency, current prices

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
288	272	272	335	435	475	580	590	589	610	635	783
2 957	3 474	3 661	3 775	4 006	4 135	4 166	4 712	5 130	6 277	6 646	7 922
446	456	471	589	549	597	692	847	956	1 140	1 398	1 552
14.0	13.7	14.4	15.5	17.3	21.3	25.5	33.1	38.8	46.7	67.0	. .
23 471	29 407	33 850	36 780	39 016	42 067	47 019	55 368	67 467	78 600	84 749	119 223
4 646	4 990	5 072	5 176	5 596	6 150	6 714	7 306	7 823	8 665	9 530	10 220
1 586	1 746	1 770	1 726	1 889	2 014	2 232	2 425	2 556	2 795	2 804	3 041
4 305	5 070	5 382	6 406	6 980	7 864	8 948	11 716	14 108	21 100	29 495	. .

Table 7A.10. Other Europe: military expenditure as a percentage of gross domestic product

	1956	1957	1958	1959	1960	1961	1962	1963	1964
Austria	*0.8*	*1.3*	*1.5*	*1.4*	*1.2*	*1.0*	*1.1*	*1.3*	*1.5*
Finland	*1.5*	*1.5*	*1.6*	*1.7*	*1.7*	*1.8*	*2.4*	*1.9*	*1.8*
Ireland	*1.5*	*1.5*	*1.5*	*1.4*	*1.4*	*1.4*	*1.4*	*1.3*	*1.4*
Spain	*2.2*	*2.2*	*1.9*	*1.8*	*2.2*	*2.0*	*2.1*	*2.0*	*1.9*
Sweden	*4.7*	*4.6*	*4.7*	*4.6*	*4.0*	*4.0*	*4.1*	*4.2*	*4.1*
Switzerland	*2.4*	*3.0*	*3.2*	*2.9*	*2.5*	*2.7*	*2.8*	*2.7*	*2.8*
Yugoslavia[a]	*9.9*	*7.9*	*9.0*	*8.0*	*7.2*	*7.4*	*7.2*	*6.2*	*5.4*

[a] Percentage of gross material product.

Table 7A.11. Middle East: constant price figures

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Bahrain[a]	..	..	..	..	..	..	..	..	..	..
Cyprus	..	..	..	..	..	..	..	..	10	12
Egypt	348	314	[293]	[297]	[320]	[353]	[400]	447	560	607
Iran	168	203	326	364	290	290	287	292	323	434
Iraq	128	140	150	176	201	210	224	261	299	366
Israel	86	122	137	153	182	182	205	254	332	363
Jordan	67	67	80	100	93	91	98	98	97	98
Kuwait	..	..	..	..	..	[32]	[35]	41	38	58
Lebanon	23	22	25	23	24	29	41	34	37	43
Oman	..	..	..	..	..	..	..	..	..	..
Saudi Arabia	..	..	..	..	..	[129]	[165]	207	202	212
Syria	67	56	[100]	98	98	101	114	119	131	143
United Arab Emirates	..	..	..	..	..	..	..	..	..	..
Yemen[a]	..	..	..	..	..	..	..	..	..	..
Yemen, Democratic[a]	..	..	..	..	..	..	..	..	..	..
Total Middle East	[975]	[1 025]	[1 225]	[1 325]	[1 340]	[1 440]	[1 600]	[1 785]	[2 065]	[2 370]

[a] At current prices and 1973 exchange rates.
[b] 1974.

Table 7A.12. Middle East: current price figures

	Currency	1956	1957	1958	1959	1960	1961	1962	1963	1964
Bahrain	*mn dinars*	..	..	..	..	..	..	..	..	..
Cyprus	*mn pounds*	..	..	..	..	..	..	..	..	2.7
Egypt	*mn pounds*	83	78	[73]	[74]	[80]	[89]	[98]	110	143
Iran	*mn rials*	6 205	7 960	12 771	15 699	13 756	14 183	14 156	14 487	16 606
Iraq	*mn dinars*	25.8	29.7	31.0	35.8	42.4	44.8	48.2	58.3	66.1
Israel	*mn pounds*	122	183	212	243	294	313	386	511	700
Jordan	*mn dinars*	12.8	13.4	15.9	20.1	19.1	18.9	20.6	21.1	21.1
Kuwait	*mn dinars*	..	..	..	..	..	6.1	6.8	7.9	7.1
Lebanon	*mn pounds*	38.0	39.1	45.6	43.0	47.8	56.4	80.6	68.9	76.6
Oman	*mn rials*	..	..	..	..	..	..	..	..	..
Saudi Arabia	*mn riyals*	..	..	..	..	..	331	428	541	531
Syria	*mn pounds*	161	140	[234]	237	251	261	279	297	346
United Arab Emirates	*mn dirhams*	..	..	..	..	..	..	..	..	..
Yemen	*mn rials*	..	..	..	..	..	..	..	..	..
Yemen, Democratic	*mn dinars*	..	..	..	..	..	..	..	..	..

Per cent

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1.2	*1.3*	*1.3*	*1.2*	*1.2*	*1.1*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
1.7	*1.6*	*1.6*	*1.7*	*1.4*	*1.4*	*1.5*	*1.5*	*1.4*	*1.4*	*1.4*
1.4	*1.3*	*1.3*	*1.2*	*1.2*	*1.3*	*1.4*	*1.5*	*1.5*	*1.6*	..
1.8	*2.0*	*2.1*	*2.0*	*1.9*	*1.6*	*1.6*	*1.6*	*1.6*	*1.6*	*1.5*
4.1	*4.1*	*3.8*	*3.7*	*3.6*	*3.6*	*3.7*	*3.7*	*3.6*	*3.5*	*3.3*
2.7	*2.7*	*2.6*	*2.4*	*2.4*	*2.3*	*2.3*	*2.1*	*2.0*	*2.1*	..
5.4	*5.1*	*5.2*	*5.7*	*5.3*	*5.0*	*4.4*	*4.8*	*4.6*	*5.2*	..

US $ mn, at 1973 prices and 1973 exchange rates (Final column, X, at current prices and exchange rates)

1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1975X
..	..	..	..	..	..	..	5	7	14	..	*14*
10	11	10	9	10	11	10	10	18	..	..	*20*[b]
625	869	897	1 012	1 529	1 756	1 719	2 818	2 804	4 382	(4 080)	*5 367*
598	752	852	759	958	944	1 328	1 823	4 077	5 568	(5 713)	*7 289*
374	361	439	536	548	557	538	747	2 062	1 573	..	*1 884*
461	710	1 228	1 715	1 949	1 930	3 735	3 781	3 545	2 795	2 941	*3 576*
116	121	170	185	143	150	117	131	114	127	(103)	*173*
61	94	106	114	116	113	114	[375]	[547]	[572]	(221)	*[723]*
50	55	62	60	60	61	87	95	104	(104)	[104]	*140*
..	..	..	..	..	51	86	124	378	[599]	[593]	*730*
386	562	419	455	513	569	760	1 079	1 464	(3 459)	(5 690)	*4 377*
117	130	201	208	253	214	249	394	468	516	(628)	*714*
..	..	..	..	..	..	16	21	62	..	..	*72*[b]
..	5	9	12	16	20	26	35	50	58	..	*58*
..	..	[24]	23	23	26	28	30	[37]	..	..	*37*[b]
[2 830]	**[3 700]**	**[4 450]**	**[5 140]**	**[6 175]**	**[6 425]**	**[8 820]**	**11 468**	**15 737**	**[19 875]**	**[21 835]**	***25 164***

Local currency, current prices

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
..	..	..	..	..	..	..	..	1.8	2.8	5.6	..
3.3	2.8	3.1	2.7	2.7	3.0	3.5	3.4	3.5	(7.3)	..	..
178	200	280	300	350	549	650	650	1 111	1 225	2 100	2 250
22 826	31 365	40 030	45 734	42 160	54 120	55 575	83 200	125 400	319 900	493 500	559 860
80.6	83.9	83.8	104.1	134.3	143.2	150.8	153.3	223.1	667.3	557.9	..
825	1 131	1 772	3 129	4 481	5 399	5 990	13 080	15 879	20 810	22 850	31 700
21.5	26.0	27.4	38.4	45.2	37.4	40.7	34.5	42.4	44.2	55.2	51.0
10.9	12.5	19.4	22.6	23.8	24.0	27.8	31.3	[112.0]	[185.0]	[210.0]	88.3
90.1	105.9	121.9	135.9	139.1	138.4	142.3	212.9	246.7	300.2	314.9	327.0
..	..	..	..	..	..	16	28	43	144	252	275
561	1 050	1 579	1 224	1 396	1 655	1 925	2 657	3 983	5 932	15 395	27 800
365	316	366	587	600	763	676	793	1 505	2 061	2 640	3 690
..	..	..	..	..	..	..	64	90	285	..	..
..	..	25	39	57	74	92	121	162	225	265	..
..	..	..	[8.2]	8.1	8.1	8.9	9.6	10.3	[12.7]	..	..

Table 7A.13. Middle East: military expenditure as a percentage of gross domestic product

	1956	1957	1958	1959	1960	1961	1962	1963	1964
Cyprus	. .	. .	. .	. .	. .	. .	. .	. .	*2.4*
Egypt	. .	. .	. .	. .	*5.6*	*6.0*	*6.1*	*6.2*	*7.0*
Iran	. .	. .	. .	. .	*4.2*	*4.2*	*3.9*	*3.7*	*3.9*
Iraq	*5.7*	*6.5*	*6.0*	*6.7*	*7.1*	*6.9*	*6.9*	*8.3*	*7.9*
Israel	*4.6*	*5.9*	*5.9*	*5.9*	*6.6*	*5.9*	*6.1*	*6.7*	*8.0*
Jordan	. .	. .	. .	*21.5*	*19.4*	*15.7*	*17.3*	*16.3*	*14.2*
Kuwait	. .	. .	. .	. .	. .	. .	. .	*1.2*	*1.0*
Lebanon	. .	. .	. .	. .	. .	. .	. .	. .	*2.4*
Saudi Arabia	. .	. .	. .	. .	. .	. .	. .	*6.0*	*5.4*
Syria	. .	. .	. .	. .	. .	. .	. .	*7.5*	*7.5*
Yemen	. .	. .	. .	. .	. .	. .	. .	. .	. .
Yemen, Democratic	. .	. .	. .	. .	. .	. .	. .	. .	. .

Table 7A.14. South Asia: constant price figures

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Afghanistan	. .	. .	. .	. .	. .	. .	[43]	[55]	46	44
Bangladesh	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
India	760	914	905	844	848	911	1 256	2 055	2 011	1 961
Nepal	. .	. .	. .	. .	[4]	[4]	[5]	5	4	4
Pakistan	174	144	150	176	184	182	173	188	212	341
Sri Lanka	9	12	16	18	18	18	17	14	14	14
Total South Asia	**[975]**	**[1 100]**	**[1 100]**	**[1 075]**	**[1 090]**	**[1 150]**	**1 494**	**2 317**	**2 287**	**2 364**

Table 7A.15. South Asia: current price figures

	Currency	1956	1957	1958	1959	1960	1961	1962	1963	1964
Afghanistan	*mn afghanis*	. .	. .	. .	. .	[628]	[650]	[650]	[810]	909
Bangladesh	*mn takas*	. .	. .	. .	. .	. .	. .	. .	. .	. .
India	*mn rupees*	2 110	2 665	2 797	2 699	2 774	3 046	4 336	7 306	8 084
Nepal	*mn rupees*	. .	. .	. .	. .	[16.2]	[19.4]	[22.4]	23.7	25.5
Pakistan	*mn rupees*	793	718	771	878	978	984	938	1 029	1 208
Sri Lanka	*mn rupees*	33	46	66	72	71	73	68	60	60

Table 7A.16. South Asia: military expenditure as a percentage of gross domestic product

	1956	1957	1958	1959	1960	1961	1962	1963	1964
India	[*1.7*]	[*2.1*]	[*2.0*]	[*1.9*]	[*1.9*]	*1.9*	*2.6*	*3.8*	*3.6*
Nepal	. .	. .	. .	. .	. .	. .	. .	. .	. .
Pakistan	[*3.1*]	[*2.5*]	[*2.6*]	[*2.8*]	*2.8*	*2.6*	*2.4*	*2.4*	*2.6*
Sri Lanka	*0.6*	*0.8*	*1.1*	*1.1*	*1.1*	*1.1*	*1.0*	*0.8*	*0.8*

Per cent

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
2.4	1.8	1.8	1.5	1.3	1.3	1.3	1.1	1.0	2.4
7.7	8.2	11.2	11.5	12.4	18.0	20.1	19.2	31.4	32.2
4.7	5.9	6.8	6.8	5.6	6.3	5.4	6.6	6.7	. .
8.8	8.5	8.4	9.2	11.4	11.2	10.3	. .	[11.1]	. .
8.0	10.0	15.0	21.8	26.7	27.5	24.2	40.8	38.1	34.8
12.8	15.2	14.1	20.5	20.6	17.8	18.2	13.9	16.1	14.7
1.5	1.5	2.2	2.4	2.4	2.5	2.2	2.1	[5.7]	[6.3]
2.6	2.7	3.2	3.2	3.0	2.8	2.6	3.3	[3.3]	. .
5.0	8.3	11.3	8.0	8.4	8.2	7.5	7.7	5.7	. .
7.9	6.7	5.8	10.6	10.0	11.9	9.1	8.9	16.0	14.2
. .	. .	. .	. .	2.6	3.1	3.2	3.6	4.4	4.4
. .	. .	. .	. .	14.3	13.7	. .	. .	. .	. .

US $ mn, at 1973 prices and 1973 exchange rates (Final column, X, at current prices and exchange rates)

1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1975X
43	37	32	34	30	24	29	39	38	68	[92]	83
. .	. .	. .	. .	. .	. .†	62	70	59	49	[59]	60
1 852	1 718	1 788	1 892	1 949	2 320	2 449	2 165	2 047	2 232	2 572	2 792
5	6	6	6	7	7	7	8	8	9	. .	11
398	324	333	363	396	474	525	470	435	427	456	671
15	16	17	17	21	31	28	23	24	19	21	21
2 313	**2 101**	**2 176**	**2 312**	**2 403**	**2 856**	**3 100**	**2 775**	**2 611**	**2 804**	**[3 210]**	*3 638*

Local currency, current prices

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
1 023	1 088	1 177	1 273	1 322	1 361	1 360	1 467	1 774	1 925	(3 725)	(5 250)
. .	. .	. .	. .	. .	. .	. .	332	545	700	730	(790)
8 651	9 027	9 535	10 170	10 840	11 747	14 438	16 206	16 737	20 380	23 468	25 105
28.3	35.2	41.9	45.9	51	58	66	72	82	99	125	. .
2 059	2 575	2 240	2 307	2 588	2 975	3 730	1 350	4 695	5 622	6 663	7 505
62	65	69	78	85	113	172	162	145	170	147	160

Per cent

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
3.6	3.4	3.1	3.1	3.0	3.0	3.4	3.5	3.3	. .
[0.4]	[0.5]	0.6	0.6	0.6	0.6	0.7	0.7	0.7	. .
4.0	4.5	3.5	3.4	3.5	[3.7]	[4.4]	7.2	6.2	. .
0.8	0.8	0.8	0.7	0.7	0.8	1.3	1.1	0.8	0.8

Table 7A.17. Far East: constant price figures

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Brunei[a]	. .	. .	. .	. .	. .	. .	. .	. .†	4	12
Burma	(121)	(121)	(135)	(153)	(142)	(131)	(141)	(161)	(154)	168
Hong Kong	. .	. .	. .	. .	. .	. .	11	11	10	18
Indonesia	214	268	336	341	401	445	313	216	169	151
Japan	1 289	1 270	1 287	1 312	1 302	1 349	1 476	1 570	1 727	1 788
Kampuchea, Democratic (Cambodia)	. .	. .	. .	[66]	[55]	56	58	56	59	55
Korea, North[a]	. .	. .	. .	. .	. .	225	250	280	300	350
Korea, South	113	146	172	180	178	185	213	177	167	175
Laos	. .	. .	. .	. .	. .	. .	43	27	21	27
Malaysia	78	81	85	75	69	58	59	79	110	155
Mongolia[a]	. .	. .	. .	. .	. .	[18]	[18]	[18]	[18]	[18]
Philippines	62	64	66	69	68	70	68	68	65	65
Singapore	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .†
Taiwan	187	206	257	291	270	251	268	324	394	442
Thailand	60	109	92	98	96	101	106	109	116	124
Vietnam, North[a]	. .	. .	. .	. .	. .	[340]	[390]	[485]	[585]	[620]
Vietnam, South	. .	. .	181	179	226	233	326	345	350	602
Total Far East	**[2 725]**	**[2 900]**	**[3 100]**	**[3 275]**	**[3 375]**	**[3 525]**	**3 740**	**3 926**	**4 249**	**4 770**

[a] At current prices and 1973 exchange rates.
[b] 1973.
[c] 1974.

Table 7A.18. Far East: current price figures

	Currency	1956	1957	1958	1959	1960	1961	1962	1963	1964
Brunei	*mn dollars*	. .	. .	. .	. .	. .	. .	. .	. .	8.7
Burma	*mn kyats*	357	378	406	411	426	408	432	478	466
Hong Kong	*mn dollars*	. .	. .	. .	. .	. .	. .	33	34	34
Indonesia	*mn new rupiahs*	4.4	6.1	11.1	14.1	21.7	31.7	59.8	92.4	145
Japan	*bn yen*	150	152	154	159	163	178	208	238	272
Kampuchea, Democratic (Cambodia)	*mn riels*	. .	. .	. .	[1 655]	[1 495]	1 610	1 736	1 764	1 899
Korea, North	*mn won*	. .	. .	. .	. .	. .	[565]	[625]	[700]	[750]
Korea, South	*bn won*	7.1	11.3	12.8	14.0	14.8	16.7	20.5	20.5	24.9
Laos	*mn kip*	. .	. .	. .	. .	. .	. .	2 712	3 312	4 935
Malaysia	*mn dollars*	148.1	160.6	166.2	142.3	131.3	110.9	112.0	154.9	216.5
Mongolia	*mn tugriks*	. .	. .	. .	. .	. .	[60]	[60]	[60]	[60]
Philippines	*mn pesos*	162	169	182	187	193	201	208	219	227
Singapore	*mn dollars*	. .	. .	. .	. .	. .	. .	. .	. .	. .
Taiwan	*bn dollars*	3.2	3.8	4.8	6.0	6.6	6.6	7.2	8.9	10.8
Thailand	*mn baht*	817	1 567	1 390	1 420	1 378	1 473	1 580	1 643	1 778
Vietnam, South	*bn piastres*	. .	. .	6.0	6.1	[7.6]	8.3	12.0	13.6	14.3

US $ mn, at 1973 prices and 1973 exchange rates (Final column, X, at current prices and exchange rates)

1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1975X
13	11	11	8	21	16	[15]	15	24	55	..	*56*
131	129	125	145	161	162	146	151	104	92	[89]	*117*
20	24	24	24	25	27	29	22	24	20	30	*39*
104	226	292	339	359	405	456	430	(610)	(645)	..	*1 080*
1 911	2 045	2 184	2 376	2 605	2 885	3 227	3 406	3 461	3 478	3 556	*4 413*
56	61	62	67	143	143	189	113	..	..	..	*113*[b]
350	470	673	716	717	753	500	511	624	753	822	*675*
214	238	281	324	334	394	442	456	594	570	998	*730*
27	26	24	24	25	26	22	21	17	..	..	*25*[c]
191	177	184	179	243	273	269	280	262	342	(300)	*423*
[18]	[24]	[30]	[40]	[45]	51	58	64	112	112	123	*112*
71	78	89	100	113	105	115	206	256	273	256	*390*
..	42	64	128	162	206	218	205	197	223	267	*288*
523	534	579	[575]	577	697	764	819	(575)	(585)	..	*(916)*
134	154	185	217	252	298	309	300	289	325	374	*425*
[640]	[630]	[630]	[585]	[585]	[585]	[585]	[520]	[520]	..	..	*[520]*[c]
459	479	512	540	550	563	661	513	434	..	..	*533*[c]
4 862	**5 348**	**5 949**	**6 387**	**6 917**	**7 589**	**8 005**	**8 032**	**[8 200]**	**[8 250]**	**[8 700]**	*10 855*

Local currency, current prices

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
29.3	32.3	27.9	27.5	19.4	51.0	38.0	[37.5]	37.0	59.3	134.0	..
511	502	486	498	545	582	599	581	739	647	754	883
57	67	84	88	89	100	112	(128)	(112)	(143)	(123)	(191)
522	3 700	21 600	63 100	86 000	102 200	120 475	144 450	178 525	(356 000)	(448 800)	..
300	337	375	422	483	570	669	783	924	1 167	1 312	1 469
1 846	1 851	2 025	2 154	2 478	5 966	10 206	16 956	26 073	..	..	..
[880]	[880]	1 180	(1 690)	1 798	(1 800)	1 890	1 254	1 282	1 568	1 890	2 065
29.9	40.7	50.0	65.4	84.9	101.6	136.1	170.7	181.4	294.0	353.2	706.1
7 391	8 463	8 531	8 511	8 672	9 131	9 375	10 330	12 732	15 071	..	..
303.1	379.5	366.6	379.3	367.3	510	581	591	681	747	1 019	(925)
[60]	[60]	[80]	[100]	[130]	[150]	169	(191)	213	372	373	407
237	270	318	365	421	500	572	728	1 398	2 435	2 841	2 901
..	..	79	123	244	311	402	434	503	591	686	808
12.1	14.6	15.4	17.8	[18.5]	19.3	24.0	27.1	31.4	(32.5)	(34.8)	..
1 921	2 151	2 575	3 152	3 769	4 420	5 319	5 738	6 238	7 400	8 662	10 419
28.5	35.2	52.8	72.0	92.0	128.3	155.2	228.3	255.8	336.0	..	..

Table 7A.19. Far East: military expenditure as a percentage of gross domestic product

	1956	1957	1958	1959	1960	1961	1962	1963	1964
Burma	*6.0*	*6.0*	*6.4*	*6.1*	*6.0*	*5.6*	*6.3*	*6.4*	*6.5*
Hong Kong	. .	. .	. .	. .	. .	. .	*0.5*	*0.4*	*0.4*
Indonesia	. .	. .	. .	. .	*5.4*	*6.3*	*4.6*	*2.9*	*2.0*
Japan	*1.5*	*1.4*	*1.3*	*1.2*	*1.1*	*0.9*	*1.0*	*1.0*	*0.9*
Kampuchea, Democratic (Cambodia)	. .	. .	. .	. .	. .	. .	*7.5*	*6.9*	*7.1*
Korea, South	*4.7*	*5.8*	*6.2*	*6.4*	*6.0*	*5.7*	*5.9*	*4.2*	*3.6*
Malaysia	*2.9*	*3.1*	*3.4*	*2.6*	*2.2*	*1.9*	*1.8*	*2.4*	*3.1*
Philippines	*1.6*	*1.6*	*1.6*	*1.5*	*1.5*	*1.4*	*1.3*	*1.2*	*1.1*
Singapore	. .	. .	. .	. .	. .	. .	. .	. .	. .
Taiwan	*9.3*	*9.4*	*10.7*	*11.6*	*10.5*	*9.4*	*9.4*	*10.2*	*10.6*
Thailand	*2.1*	*3.4*	*2.9*	*2.8*	*2.6*	*2.5*	*2.5*	*2.4*	*2.4*
Vietnam, South	. .	. .	. .	. .	*9.2*	*9.7*	*12.7*	*13.4*	*12.3*

Table 7A.20. Oceania: constant price figures

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Australia	918	840	845	887	877	875	912	1 034	1 201	1 387
Fiji	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
New Zealand	140	134	131	137	141	131	127	132	155	172
Total Oceania	**1 058.0**	**974.0**	**976.0**	**1 024.0**	**1 018.0**	**1 006.0**	**1 039.0**	**1 166.0**	**1 356.0**	**1 559.0**

[a] 1974.

Table 7A.21. Oceania: current price figures

	Currency	1956	1957	1958	1959	1960	1961	1962	1963	1964
Australia	*mn dollars*	372	351	357	383	392	401	417	475	565
Fiji	*mn dollars*	. .	. .	. .	. .	. .	. .	. .	. .	. .
New Zealand	*mn dollars*	50	49	50	54	56	53	53	56	68

Table 7A.22. Oceania: military expenditure as a percentage of gross domestic product

	1956	1957	1958	1959	1960	1961	1962	1963	1964
Australia	*3.4*	*3.0*	*3.0*	*2.9*	*2.8*	*2.7*	*2.7*	*2.8*	*3.0*
Fiji	. .	. .	. .	. .	. .	. .	. .	. .	. .
New Zealand	*2.4*	*2.2*	*2.2*	*2.2*	*2.1*	*1.9*	*1.8*	*1.8*	*2.0*

Per cent

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
6.6	6.5	5.7	5.3	5.4	5.7	5.7	5.3	5.9	..	..
0.5	0.6	0.7	0.7	0.6	0.5	0.5	0.5	0.4	0.4	..
2.2	1.2	2.5	3.0	3.2	3.1	3.3	3.2	2.6	3.6	..
0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.9	..
6.1	5.9	..	..	5.6	..	..	..	..	..	..
3.7	4.0	4.1	4.2	4.1	3.9	4.3	4.4	3.7	4.3	3.8
4.0	4.8	4.5	4.5	3.8	5.1	5.5	5.2	4.7	4.4	..
1.1	1.1	1.2	1.2	1.2	1.2	1.1	1.3	2.0	2.4	2.5
..	..	2.1	2.9	4.9	5.4	5.9	5.3	4.9	4.7	5.0
10.6	11.5	10.5	10.4	[9.4]	8.5	9.2	8.8	8.1	6.2	6.2
2.3	2.1	2.4	2.7	2.9	3.3	3.7	3.5	2.9	2.7	2.9
19.9	16.0	15.8	20.1	17.2	16.5	16.2	20.9	16.4	..	..

US $ mn, at 1973 prices and 1973 exchange rates (Final column, X, at current prices and exchange rates)

1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1975X
1 597	1 767	1 920	1 941	1 919	1 932	1 936	1 912	1 982	1 963	1 932	2 380
..	..	0.5	0.5	0.6	0.6	0.7	0.9	1.0	..	..	1[a]
182	170	180	187	205	192	194	189	194	193	164	216
1 779.0	**1 937.0**	**2 100.5**	**2 128.5**	**2 124.6**	**2 124.6**	**2 130.7**	**2 101.9**	**2 177.0**	[2 157.0]	[2 097.0]	2 597

Local currency, current prices

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
678	804	918	1 025	1 065	1 094	1 169	1 240	1 340	1 599	1 822	2 016
..	..	..	0.3	0.3	0.4	0.4	0.5	0.7	0.9	..	..
78	85	84	93	101	118	122	132	139	159	181	181

Per cent

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
3.4	3.7	3.9	4.0	3.7	3.5	3.4	3.2	2.9	2.9
..	..	..	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2.1	2.1	2.0	2.2	2.1	2.2	1.9	1.8	1.6	1.7

Table 7A.23. Africa: constant price figures

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Algeria	. .	. .	. .	. .	. .	. .	[115]†	137	146	166
Benin (Dahomey)[a]	. .	. .	. .	. .	. .†	(2.1)	(2.9)	(3.4)	(4.0)	4.4
Burundi	. .	. .	. .	. .	. .	. .	(1.6)†	(1.8)	(2.0)	3.0
Cameroon	. .	. .	. .	. .	18†	23	28	24	23	24
Central African Republic	. .	. .	. .	. .	. .†	2.1	2.0	1.9	3.9	3.4
Chad	. .	. .	. .	. .	. .†	0.1	2.5	2.7	3.0	5.2
Congo	. .	. .	. .	. .	. .†	3.7	6.4	(6.5)	7.7	7.3
Ethiopia	. .	. .	. .	(25)	30	(33)	36	48	62	66
Gabon	. .	. .	. .	. .	. .†	1.7	2.5	3.8	3.0	4.3
Ghana	16	20†	20	21	34	47	46	42	38	33
Guinea[a]	. .	. .	. .†	. .	. .	5	7	7	8	13
Ivory Coast	. .	. .	. .	. .	. .†	6	14	13	17	20
Kenya	7.8	8.4	7.5	6.6	3.7	1.2	0.8	2.7†	8.1	13
Liberia	. .	. .	. .	. .	. .	. .	. .	(4.2)	4.1	4.3
Libya	. .	. .	. .	(8)	(7)	(9)	(21)	(23)	25	32
Malagasy Rep.	. .	. .	. .	. .	3†	14	15	14	14	15
Malawi	. .	. .	. .	. .	. .	. .	. .	. .	(1.1)†	1.2
Mali[a]	. .	. .	. .	. .	. .†	[4.6]	[4.8]	[5.2]	[5.4]	5.1
Mauritania	. .	. .	. .	. .	. .†	[4.0]	[5.9]	7.0	3.3	3.4
Morocco	44†	60	70	69	70	80	85	112	100	88
Niger	. .	. .	. .	. .	. .†	2.4	3.9	6.4	(7.2)	10.1
Nigeria	10	13	25	30	34†	35	41	52	58	68
Rhodesia, S.	. .	. .	. .	. .	. .	. .	. .	. .†	21	25
Rwanda	. .	. .	. .	. .	. .	. .	. .†	[2.6]	[2.9]	3.4
Senegal	. .	. .	. .	. .	. .†	8	11	18	23	22
Sierra Leone	. .	. .	. .	. .	3.0	2.5†	2.7	2.9	2.9	3.0
Somalia	. .	. .	. .	. .	. .†	5.2	5.9	7.1	7.6	6.4
South Africa	123	130	96	91	103	163	263	267	374	384
Sudan	17†	23	26	29	33	33	38	42	54	66
Tanzania	. .	. .	. .	. .	. .	. .†	2	4	7	10
Togo	. .	. .	. .	. .	. .†	(0.4)	(0.9)	1.4	(4.0)	(4.3)
Tunisia	5†	8	14	22	25	28	22	23	27	22
Uganda	5	4	4	4	2	0.3	2†	6	11	19
Upper Volta	. .	. .	. .	. .	(2.4)†	(2.8)	(7.8)	(8.0)	(8.0)	(5.3)
Zaire	. .	. .	. .	. .	. . †	. .	. .	39	52	134
Zambia	. .	. .	10	. .	13	20	21	22	11 †	29
Total Africa	**[260.0]**	**[300.0]**	**[275.0]**	**[325.0]**	**[390.0]**	**[575.0]**	**[860.0]**	**960.6**	**1 149.2**	**1 323.1**

[a] At current prices and 1973 exchange rates.
[b] 1974.

US $ mn, at 1973 prices and 1973 exchange rates (Final column, X, at current prices and exchange rates)

1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1975X
160	156	150	142	134	130	128	132	192	[205]	[232]	*259*
4.0	4.4	4.4	4.9	5.3	5.7	[6.0]	6.2	(6.3)	. .	. .	*6*[b]
3.1	3.4	3.5	3.4	3.9	3.8	4.2	(6.0)	6.9	. .	. .	*8*[b]
26	28	29	31	31	32	35	(38)	(39)	. .	. .	*(40)*[b]
3.6	4.9	6.3	8.1	7.2	7.3	6.1	7.1	6.7	. .	. .	*7*[b]
8.6	(11.4)	(11.5)	12.7	17.9	19.0	(18.5)	17.7	(21.7)	. .	. .	*23*[b]
10.8	12.1	11.2	12.4	16.7	17.7	16.7	17.7	19.3	. .	. .	*19*[b]
60	51	48	47	42	44	49	49	60	70	. .	*81*
4.2	4.1	4.0	5.9	6.5	7.4	7.8	9.3	10.1	11.1	. .	*17*
32	51	57	53	47	45	38	41	53	. .	. .	*68*[b]
16	17	17	17	[22]	[20]	[21]	20	[19]	. .	. .	*[19]*[b]
19	21	22	22	24	26	27	27	30	33	31	*46*
17	20	20	19	21	26	33	39	38	35	33	*47*
4.2	4.7	3.9	4.1	4.7	5.3	4.5	3.7	3.1	. .	. .	*4*[b]
60	171	270	413	[455]	[647]	[667]	[887]	[948]	[1 020]	. .	*1 233*
16	17	18	18	18	19	17	21	18	. .	. .	*21*[b]
1.5	1.8	1.8	1.6	1.8	1.9	2.0	3.0	3.8	. .	. .	*4*[b]
5.3	5.7	5.8	6.6	7.7	7.2	9.5	10.6	(9.5)	. .	. .	*9*[b]
3.2	3.3	3.5	3.6	3.6	3.5	[3.8]	5.7	[7.7]	20.1	[30.0]	*28*
92	99	116	125	118	126	140	181	149	142	(375)	*207*
4.4	5.2	5.8	5.5	5.8	6.1	5.0	(4.6)	(5.0)	. .	. .	*5*[b]
58	201	344	562	570	470	504	380	624	1 195	(1 227)	*1 964*
24	27	28	28	33	36	35	47	110	122	(152)	*143*
7.1	5.7	4.9	4.4	5.0	5.1	5.9	8.3	7.3	. .	. .	*8*[b]
22	24	25	22	24	25	25	20	20	20	24	*32*
2.7	2.6	3.1	3.7	4.2	4.1	4.1	(3.9)	(4.0)	. .	. .	*4*[b]
8.2	9.7	10.4	10.4	12.9	13.2	15.4	16.1	13.3	. .	. .	*16*[b]
416	469	467	481	460	511	518	633	830	1 010	1 282	*1 179*
72	72	88	96	124	143	129	112	91	79	. .	*123*
13	16	15	19	31	39	42	46	43	(34)	. .	*49*
3.3	3.7	3.9	4.0	4.4	4.6	4.9	5.6	6.3	6.5	. .	*9*
25	23	28	27	30	31	35	36	33	41	74	*51*
25	28	35	36	38	65	82	51	30	. .	. .	*49*
(5.8)	(5.7)	(5.8)	(6.0)	(6.5)	(6.6)	(6.0)	(6.3)	[6.6]	. .	. .	*7*
121	102	83	96	136	129	116	130	123	. .	. .	*158*
28	31	34	25	42	93	108	74	(88)	. .	. .	*96*[b]
1 382.0	**1 712.4**	**1 983.8**	**2 376.3**	**2 514.1**	**2 775.5**	**2 869.4**	**3 095.8**	**3 675.6**	**[4 550.0]**	**[5 200.0]**	*6 039*

Table 7A.24. Africa: current price figures

	Currency	1956	1957	1958	1959	1960	1961	1962	1963	1964
Algeria	*mn dinars*	. .	. .	. .	. .	. .	. .	320	390	425
Benin (Dahomey)	*mn francs*	. .	. .	. .	. .	. .	(480)	(655)	(765)	(905)
Burundi	*mn francs*	. .	. .	. .	. .	. .	. .	86	100	119
Cameroon	*mn francs*	. .	. .	. .	. .	2 185	2 840	3 550	3 350	3 450
Central African Republic	*mn francs*	. .	. .	. .	. .	. .	250	250	250	580
Chad	*mn francs*	. .	. .	. .	. .	. .	7	319	367	441
Congo	*mn francs*	. .	. .	. .	. .	. .	500	915	990	1 235
Ethiopia	*mn dollars*	. .	. .	. .	33	41	46	50	68	90
Gabon	*mn francs*	. .	. .	. .	. .	. .	245	370	620	500
Ghana	*mn cedis*	6.7	8.3	8.5	9.1	14.9	21.9	23.4	21.9	22.2
Guinea	*mn syli*	. .	. .	. .	. .	. .	100	150	150	157
Ivory Coast	*mn francs*	. .	. .	. .	. .	. .	990	2 148	1 976	2 742
Kenya	*mn pounds*	1.8	2.0	1.8	1.6	0.9	0.3	0.2	0.7	2.1
Liberia	*mn dollars*	. .	. .	. .	. .	. .	. .	. .	2.6	2.6
Libya	*mn dinars*	. .	. .	. .	1.4	1.4	1.8	4.2	4.7	5.4
Malagasy Rep.	*mn francs*	. .	. .	. .	. .	396	2 094	2 266	2 211	2 334
Malawi	*mn kwachas*	. .	. .	. .	. .	. .	. .	. .	. .	0.7
Mali	*mn francs*	. .	. .	. .	. .	. .	[2 020]	[2 130]	[2 330]	[2 400]
Mauritania	*mn ouguiyas*	. .	. .	. .	. .	. .	[100]	[150]	197	99
Morocco	*mn dirhams*	116	165	198	198	210	244	272	379	354
Niger	*mn francs*	. .	. .	. .	. .	. .	315	488	(855)	(1 010)
Nigeria	*mn naira*	3	4	8	10	12	13	16	20	23.4
Rhodesia, S.	*mn dollars*	. .	. .	. .	. .	. .	. .	. .	. .	10.2
Rwanda	*mn francs*	. .	. .	. .	. .	. .	. .	. .	130	[180]
Senegal	*mn francs*	. .	. .	. .	. .	. .	1 100	1 725	2 840	3 800
Sierra Leone	*mn leones*	. .	. .	. .	. .	1.5	1.3	1.4	1.5	1.7
Somalia	*mn shillings*	. .	. .	. .	. .	. .	23	26	32	39
South Africa	*mn rand*	48	52	40	38	44	71	116	119	171
Sudan	*mn pounds*	3.0	4.1	5.0	5.4	6.1	6.8	7.9	9.2	12.2
Tanzania	*mn shillings*	. .	. .	. .	. .	. .	. .	10	17	33
Togo	*mn francs*	. .	. .	. .	. .	. .	66	144	229	682
Tunisia	*mn dinars*	1.4	2.5	4.4	6.6	7.4	8.6	6.6	7.1	8.6
Uganda	*mn shillings*	15	15	14	14	8	1	5	20	39
Upper Volta	*mn francs*	. .	. .	. .	. .	311	403	1 201	1 294	1 313
Zaire	*mn zaïres*	. .	. .	. .	. .	. .	. .	. .	3.3	6.1
Zambia	*mn kwachas*	. .	. .	3.4	. .	4.8	7.2	7.8	8.0	4.2

Local currency, current prices

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
490	490	490	490	490	488	491	500	545	874	1 030	1 288
995	900	1 000	1 000	1 100	1 200	1 300	[1 350]	1 412	(1 425)	..	..
182	200	212	237	235	273	276	315	476	637	..	..
3 700	4 050	4 500	4 800	5 150	5 500	5 800	6 850	8 255	(9 475)	..	..
547	588	827	1 109	1 451	1 351	1 468	1 312	1 616	1 667	..	..
820	1 426	(1 950)	(2 000)	2 275	3 500	3 925	(3 950)	4 010	(5 410)	..	..
1 235	1 910	2 218	2 130	2 336	(3 200)	(3 530)	(3 655)	4 010	4 610	..	..
107	109	93	87	86	86	90	94	102	136	170	..
740	740	740	740	1 130	1 285	1 514	1 682	2 107	2 556	3 612	..
25.4	25.5	39.0	47.2	46.8	43.1	42.7	40.0	47.9	77.9	..	..
275	325	345	350	360	[445]	[415]	[425]	416	400	..	..
3 162	3 260	3 600	4 000	4 185	4 900	5 335	5 425	6 025	(7 870)	9 834	10 458
3.5	4.7	5.7	5.8	5.6	6.1	7.9	10.6	13.6	15.3	16.6	17.4
2.8	2.8	3.3	2.8	3.3	3.8	4.3	3.8	3.7	3.7	..	..
7.3	15.0	43.0	71.0	[118]	[130]	[180]	[185]	[265]	[305]	[365]	..
2 644	2 800	2 990	3 220	3 380	3 370	3 840	3 625	4 660	5 000	..	..
0.8	1.0	1.1	1.1	1.0	1.2	1.4	1.5	2.4	3.5	..	..
2 260	2 365	2 540	2 565	2 950	3 400	3 175	4 200	4 685	(4 220)	..	..
104	100	108	117	125	135	142	[165]	[265]	[400]	1 200	(2 000)
320	332	356	419	464	444	493	568	765	815	840	(2 385)
1 480	710	855	915	960	1 025	1 120	1 010	(1 050)	(1 160)	..	..
28	26	87	150	270	310	290	320	250	480	1 210	1 495
12.6	12.6	14.1	15.3	15.4	18.2	20.2	20.2	28.5	71	86	119
220	480	391	357	329	401	430	511	757	731	..	..
3 750	3 800	4 050	4 300	960	4 461	4 678	4 969	4 461	5 225	6 907	8 823
1.8	1.7	1.7	2.1	2.6	3.1	3.0	3.2	(3.2)	(3.7)	..	..
37	46	54	60	64	80	81	92	102	100	..	..
182	204	238	241	256	257	303	327	438	641	885	1 251
14.6	16.1	17.9	19.6	24.1	32.5	38.0	38.4	39.1	39.9	43.0	..
51	68	83	83	103	175	233	266	325	362	(365)	..
678	584	629	670	735	830	948	1 063	1 261	1 604	1 960	..
7.4	8.8	8.4	10.5	10.5	11.8	12.6	14.6	15.8	15.2	20.5	39.0
77	102	120	142	163	190	376	462	360	350	..	..
860	960	910	930	1 045	1 160	1 205	1 230	1 420	1 670	..	..
15.3	15.9	18.3	23	30	48	48	50	65	79	..	..
12.0	12.6	14.6	17.9	13.3	23	54	66	48	(62)	..	..

Table 7A.25. Africa: military expenditure as a percentage of gross domestic product

	1956	1957	1958	1959	1960	1961	1962	1963	1964
Algeria	. .	. .	. .	. .	. .	. .	[2.7]	(3.1)	3.2
Benin (Dahomey)	. .	. .	. .	. .	. .	(1.3)	(1.7)	(1.9)	(2.1)
Burundi	. .	. .	. .	. .	. .	. .	. .	(1.4)	. .
Cameroon	. .	. .	. .	. .	. .	. .	[2.5]	2.2	2.1
Central African Republic	. .	. .	. .	. .	. .	0.7	0.7	0.7	1.5
Chad	. .	. .	. .	. .	. .	. .	0.1	0.6	0.7
Congo	. .	. .	. .	. .	. .	[1.5]	[2.6]	(2.7)	[3.2]
Ethiopia	. .	. .	. .	. .	1.7	1.9	1.9	2.4	2.9
Gabon	. .	. .	. .	. .	. .	0.7	0.9	1.4	1.0
Ghana	0.9	1.1	1.1	1.0	1.6	2.1	2.1	1.8	1.6
Guinea	. .	. .	. .	. .	. .	[2.0]	[2.7]	(2.7)	. .
Ivory Coast	. .	. .	. .	. .	. .	0.6	1.3	1.0	1.1
Kenya	0.9	1.0	0.8	0.7	0.4	0.1	0.1	[0.2]	0.6
Liberia	. .	. .	. .	. .	. .	. .	. .	0.9	0.9
Libya	. .	. .	. .	. .	. .	. .	2.4	1.9	1.4
Malagasy Rep.	. .	. .	. .	. .	0.3	[1.5]	1.5	(1.5)	1.5
Malawi	. .	. .	. .	. .	. .	. .	. .	. .	0.5
Mali	. .	. .	. .	. .	. .	. .	. .	. .	[2.8]
Mauritania	. .	. .	. .	. .	. .	[2.3]	[3.1]	3.6	1.4
Morocco	1.7	2.3	2.4	2.4	2.3	2.7	2.6	3.2	2.8
Niger	. .	. .	. .	. .	. .	0.6	0.8	1.3	1.5
Nigeria	0.2	0.2 ▮	0.4	0.5	0.5	0.5	0.6	0.7	0.7
Rhodesia, S.	. .	. .	. .	. .	. .	. .	. .	. .	1.5
Rwanda	. .	. .	. .	. .	. .	. .	. .	. .	. .
Senegal	. .	. .	. .	. .	. .	0.7	1.1	1.6	2.0
Sierra Leone	. .	. .	. .	. .	. .	. .	[0.7]	[0.7]	0.7
Somalia	. .	. .	. .	. .	. .	. .	. .	(2.7)	. .
South Africa	1.1	1.1	0.8	0.8 ▮	0.8	1.3	2.0	1.8	2.4
Sudan	1.0	1.2	1.5	1.5	1.6	1.7	1.8	2.0	2.6
Tanzania	. .	. .	. .	. .	. .	. .	0.2	0.3 ▮	0.6
Togo	. .	. .	. .	. .	. .	[0.2]	[0.5]	0.7	1.8
Tunisia	. .	. .	. .	. .	2.2	2.3	1.8	1.6	1.9
Uganda	0.5	0.5	0.5	0.5	0.2[b]	0.03	0.2	0.4[b]	0.8
Upper Volta	. .	. .	. .	. .	(0.7)	[0.8]	[2.3]	(2.4)	[2.4]
Zaire	. .	. .	. .	. .	. .	. .	. .	1.7	3.1
Zambia	. .	. .	1.2	. .	1.1	1.8	1.9	1.9	0.9 ▮

[a] GDP figure used excludes the three Eastern states.
[b] GDP at factor cost.

Per cent

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
3.5	3.2	3.0	2.6	2.4	2.1	2.1	1.8	1.8	1.8	. .
2.2	1.9	2.1	2.0	2.1	2.1	2.1	[2.0]	2.0	1.8	. .
1.4	. .	. .	(1.5)	(1.4)	(1.5)	(1.5)	(1.5)	(2.1)	2.4	. .
2.1	2.2	2.2	2.0	2.0	1.8	1.8	1.9	2.0	. .	. .
(1.3)	(1.3)	1.8	2.2	[2.7]	2.4	2.6	(2.1)	(2.6)	. .	. .
. .	. .	(3.4)	3.4	(3.3)	4.7	(5.2)	(5.3)	5.2	. .	. .
[2.9]	[4.2]	[4.6]	(4.0)	(4.0)	(5.0)	[5.1]	(4.3)	4.0	. .	. .
3.2	3.1	2.5	2.2	2.0	1.9	1.9	1.9	1.9	. .	. .
1.5	1.3	1.3	1.0	1.3	1.4	[1.4]	1.6	1.3	1.0	. .
1.6	1.7	2.6	2.8	2.3	1.9	1.7	1.4	(1.4)	. .	. .
. .	. .	. .	(4.9)	(4.6)	. .	. .	. .	. .	. .	. .
1.3	1.3	1.3	1.2	1.1	1.2	1.2	1.1	1.1	1.1	. .
1.0	1.1	1.3	1.2	1.1	1.1	1.2	1.5	1.6	1.5	1.4
0.9	0.9	0.9	0.7	0.9	0.9	1.0	0.8	0.7	0.5	. .
1.4	2.3	5.5	6.4	[9.3]	[9.8]	[11.1]	[10.3]	[12.1]	[8.4]	. .
1.6	1.5	1.6	1.5	1.5	1.4	1.4	1.3	1.6	. .	. .
0.4	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.6	. .
. .	. .	. .	. .	2.2	. .	1.9	(2.4)	(2.6)	(2.1)	. .
(1.4)	[1.2]	[1.2]	1.2	(1.3)	[1.3]	[1.3]	1.6	2.6	. .	. .
2.4	2.6	2.6	2.7	2.9	2.6	2.7	2.8	3.6	3.1	. .
2.0	0.7	0.9	1.0	1.0	0.9	. .	. .	. .	. .	. .
0.8	0.7	2.8[a]	5.2[a]	7.5[a]	5.9	4.2	4.2	2.8	3.7	. .
1.7	1.7	1.7	1.8	1.5	1.7	1.6	1.5	1.9	2.4	. .
. .	. .	2.6	2.2	1.8	2.0	2.1	2.4	3.3	. .	. .
2.0	1.8	2.0	2.0	1.8	1.9	1.9	1.7	1.9	1.9	. .
0.7	0.6	0.6	0.7	0.8	0.9	0.8	0.9	0.7	0.7	. .
. .	. .	. .	. .	(3.9)	. .	. .	. .	. .	. .	. .
2.3	2.4	2.5	2.4	2.2	2.1	2.4	2.1	2.3	2.9	. .
3.0	3.2	3.3	3.4	4.1	5.2	5.5	. .	. .	. .	. .
0.8	1.0	1.1	1.1	1.2	1.9	2.4	2.4	2.6	(2.6)	. .
1.6	1.1	1.1	1.1	1.1	1.1	1.2	1.2	. .	. .	. .
1.4	1.6	1.4	1.7	1.5	1.6	1.4	1.3	1.3	1.0	1.2
1.3	1.7	1.9	1.9	2.0	2.0	3.6	. .	. .	. .	. .
1.5	1.6	. .	1.2	. .	1.3	. .	. .	. .	. .	. .
5.6	5.2	5.9	3.2	3.3	5.0	4.7	4.6	4.4	4.5	. .
1.8	1.6	1.6	1.7	1.0	1.8	4.6	5.0	2.9	3.4	. .

Table 7A.26. Central America: constant price figures

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Costa Rica	7.2	8.1	7.7	7.7	7.8	7.5	7.7	7.6	7.2	7.9
Cuba[a]	. .	. .	. .	. .	. .	207	237	252	262	252
Dominican Rep.	. .	. .	51	63	51	50	48	46	49	47
El Salvador	8.2	9.4	8.7	7.2	7.1	7.4	10.3	10.8	10.6	10.8
Guatemala	11	11	12	12	12	11	11	12	16	18
Haiti	9	10	12	12	12	13	13	12	12	11
Honduras	6.6	6.5	6.5	6.5	5.9	10.1	10.1	10.4	7.8	7.5
Jamaica	. .	. .	. .	. .	. .	. .	1.4†	5.9	6.1	6.3
Mexico	103	122	120	120	132	141	158	173	194	195
Nicaragua	. .	. .	. .	. .	. .	11	12	12	11	11
Panama	. .	. .	. .	. .	. .	(0.5)	0.6	0.6	0.6	0.7
Trinidad and Tobago	. .	. .	. .	. .	. .	. .	. .†	2.7	4.0	3.4
Total Central America	**[300.0]**	**[350.0]**	**[375.0]**	**[400.0]**	**[435.0]**	**458.5**	**509.1**	**545.0**	**580.3**	**570.6**

[a] At current prices and 1973 exchange rates.
[b] 1974.

Table 7A.27. Central America: current price figures

	Currency	1956	1957	1958	1959	1960	1961	1962	1963	1964
Costa Rica	*mn colones*	(28.9)	(32.7)	(31.8)	32.0	32.9	32.6	34.3	35.0	34.2
Cuba	*mn pesos*	. .	. .	. .	. .	. .	175	200	213	221
Dominican Republic	*mn pesos*	. .	. .	34.5	42.6	33.4	31.6	33.1	34.0	37.0
El Salvador	*mn colones*	17.4	19.2	19.0	15.6	15.3	15.5	21.7	23.0	23.0
Guatemala	*mn quetzales*	8.8	9.3	9.8	9.8	9.4	9.2	9.3	10.2	12.7
Haiti	*mn gourdes*	27.2	29.7	35.0	34.4	33.3	35.5	35.7	36.2	38.8
Honduras	*mn lempiras*	9.3	8.9	[9.1]	9.3	8.2	14.4	14.5	15.4	12.0
Jamaica	*mn dollars*	. .	. .	. .	. .	. .	. .	0.7	3.0	3.2
Mexico	*mn pesos*	632	792	862	883	1 021	1 111	1 258	1 388	1 589
Nicaragua	*mn córdobas*	. .	. .	. .	. .	. .	49.2	53.2	54.3	53.2
Panama	*mn balboas*	. .	. .	. .	. .	. .	. .	0.5	0.5	0.5
Trinidad and Tobago	*mn dollars*	. .	. .	. .	. .	. .	. .	. .	3.3	4.9

Table 7A.28. Central America: military expenditure as a percentage of gross domestic product

	1956	1957	1958	1959	1960	1961	1962	1963	1964
Costa Rica	*1.3*	*1.4*	*1.3*	*1.2*	*1.2*	*1.1*	*1.1*	*1.0*	*0.9*
Cuba[a]	. .	. .	. .	. .	. .	. .	*6.6*	*6.2*	*5.3*
Dominican Republic	. .	. .	*4.8*	*6.1*	*4.6*	*4.5*	*3.7*	*3.4*	*3.4*
El Salvador	. .	. .	*1.4*	*1.2*	*1.1*	*1.1*	*1.4*	*1.4*	*1.2*
Guatemala	*1.0*	*1.0*	*0.9*	*0.9*	*0.9*	*0.9*	*0.8*	*0.8*	*1.0*
Haiti	. .	. .	. .	. .	*2.4*	*2.6*	*2.6*	*2.4*	*2.3*
Honduras	*1.4*	*1.3*	[*1.3*]	*1.2*	*1.2*	*2.0*	*1.9*	*1.9*	*1.3*
Jamaica	. .	. .	. .	. .	. .	. .	*0.1*	*0.5*	*0.5*
Mexico	*0.6*	*0.7*	*0.7*	*0.6*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*
Nicaragua	. .	. .	. .	. .	. .	*1.9*	*1.9*	*1.8*	*1.5*
Panama	. .	. .	. .	. .	. .	. .	*0.1*	*0.1*	*0.1*
Trinidad and Tobago	. .	. .	. .	. .	. .	. .	. .	*0.3*	*0.4*

[a] Percentage of gross material product.

US $ mn, at 1973 prices and 1973 exchange rates (Final column, X, at current prices and exchange rates)

1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1975X
8.8	9.0	11.7	12.7	5.6	7.3	7.3	8.1	7.5	..	..	8[b]
252	296	355	296	343	343	316	320	[314]	..	..	320[b]
44	42	43	42	40	40	40	37	42	[55]	68	71
11.1	11.1	13.1	32.0	10.8	12.9	13.3	14.8	22.3	..	..	26[b]
18	20	19	18	33	21	22	21	22	..	..	26[b]
10	10	10	10	10	9	10	8	7	8	..	10
8.7	9.4	8.1	16.8	9.7	12.5	16.2	15.9	14.8	..	..	17[b]
6.4	6.7	6.9	6.0	6.6	7.8	8.1	12.9	13.8	..	..	18[b]
238	236	254	267	273	294	332	353	342	408	..	581
13	14	13	13	15	15	19	15	20	..	..	22[b]
0.6	1.0	1.1	1.5	1.8	3.3	2.1	2.1	1.8	..	..	2[b]
3.3	3.4	3.2	3.3	5.0	5.0	4.7	4.2	3.4	..	..	4[b]
613.9	**658.6**	**738.1**	**718.3**	**753.5**	**770.8**	**790.7**	**812.0**	**810.6**	**[900.0]**	**[950.0]**	**1 105**

Local currency, current prices

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
37.2	41.6	42.8	58.0	64.5	30.1	39.9	42.0	53.3	(64.9)	..	..
213	213	250	300	250	290	290	267	270	265	..	..
35.0	32.4	31.2	32.5	31.0	31.3	31.9	34.4	36.6	47.6	[71.0]	95.3
23.6	23.9	24.3	29.5	71.8	24.9	29.9	31.3	37.0	65.2	..	..
14.3	14.7	16.3	15.7	15.6	28.7	18.5	19.5	20.7	26.0	..	..
36.8	35.4	35.8	35.6	35.2	35.8	36.6	39.1	39.9	42.3	50.9	..
12.0	14.1	15.4	13.6	28.9	17.2	22.8	31.1	31.7	33.3	..	..
3.4	3.5	3.8	4.1	3.8	4.6	5.7	6.3	11.7	[16.0]	..	..
1 651	2 100	2 148	2 355	2 560	2 750	3 125	3 700	4 409	5 292	7 292	..
57.2	65.9	72.4	70.9	72.2	85.8	86.8	112.9	107.4	155.9	..	..
0.6	0.5	0.8	0.9	1.3	1.6	2.9	2.0	2.0	(2.1)	..	..
4.3	4.3	4.5	4.6	4.9	7.5	7.8	8.0	8.2	(8.2)	..	..

Per cent

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
0.9	*1.0*	*0.9*	*1.1*	*1.1*	*0.5*	*0.6*	*0.5*	*0.5*	*0.5*
5.1	*5.3*	*6.1*	*6.9*	*6.0*	*6.9*	*6.0*	*4.4*	*4.0*	*3.6*
3.7	*3.1*	*2.8*	*2.8*	*2.3*	*2.1*	*1.9*	*1.7*	*1.6*	..
1.2	*1.1*	*1.1*	*1.3*	*3.0*	*1.0*	*1.1*	*1.1*	*1.1*	*1.7*
1.1	*1.1*	*1.1*	*1.0*	*0.9*	*1.5*	*0.9*	*0.9*	*0.8*	*0.8*
2.1	*1.9*	*1.9*	*1.9*	*1.8*	*1.7*	*1.6*	*1.6*	*1.2*	..
1.2	*1.3*	*1.3*	*1.0*	*2.2*	*1.2*	*1.5*	*1.9*	*1.8*	*1.7*
0.5	*0.5*	*0.5*	*0.5*	*0.4*	*0.4*	*0.4*	*0.4*	*0.7*	*0.7*
0.7	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*	*0.7*
1.4	*1.6*	*1.6*	*1.5*	*1.4*	*1.5*	*1.4*	*1.7*	*1.3*	*1.5*
0.1	*0.1*	*0.1*	*0.1*	*0.1*	*0.2*	*0.3*	*0.2*	*0.1*	*0.1*
0.3	*0.3*	*0.3*	*0.3*	*0.3*	*0.4*	*0.4*	*0.4*	*0.3*	*0.2*

Table 7A.29. South America: constant price figures

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Argentina	1 170	1 230	1 275	1 009	1 114	1 084	1 044	1 046	964	1 072
Bolivia	4	4	[4]	[5]	[6]	7	7	15	15	17
Brazil	669	755	770	620	574	519	554	544	583	863
Chile	128	137	128	103	110	112	113	103	97	110
Colombia	77	69	63	52	59	70	111	122	115	126
Ecuador	25	24	23	20	27	26	25	22	25	28
Guyana	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Paraguay	. .	. .	. .	. .	. .	9	9	10	10	11
Peru	122	110	125	111	108	128	127	175	171	170
Uruguay	. .	. .	. .	. .	. .	29	30	42	41	46
Venezuela	119	160	184	178	161	155	148	177	183	206
Total South America	**[2 340]**	**[2 515]**	**[2 600]**	**[2 135]**	**[2 200]**	**2 139**	**2 168**	**2 256**	**2 204.0**	**2 649.0**

[a] 1974.

Table 7A.30. South America: current price figures

	Currency	1956	1957	1958	1959	1960	1961	1962	1963	1964
Argentina	*mn new pesos*	54	71	98	171	236	263	325	402	452
Bolivia	*mn pesos*	10	24	[26]	[35]	[49]	58	61	137	147
Brazil	*mn cruzeiros*	26	35	41	44	55	70	114	194	388
Chile	*mn escudos*	52	73	82	91	109	119	135	179	245
Colombia	*mn pesos*	283	289	306	272	317	410	664	965	1 072
Ecuador	*mn sucres*	298	289	282	247	336	336	329	307	370
Guyana	*mn dollars*	. .	. .	. .	. .	. .	. .	. .	. .	. .
Paraguay	*mn guaraníes*	. .	. .	. .	. .	. .	[750]	[750]	[860]	[840]
Peru	*mn soles*	1 066	1 039	1 265	1 259	1 340	[1 687]	[1 785]	2 614	2 824
Uruguay	*mn old pesos*	. .	. .	. .	. .	. .	187	221	365	509
Venezuela	*mn bolivares*	381	496	601	607	540	533	509	613	650

Table 7A.31. South America: military expenditure as a percentage of gross domestic product

	1956	1957	1958	1959	1960	1961	1962	1963	1964
Argentina	*2.5*	*2.6*	*2.5*	*2.3*	*2.3*	*2.2*	*2.2*	*2.1*	*1.8*
Bolivia	*0.4*	*0.8*	[*0.8*]	[*0.9*]	[*1.1*]	*1.2*	*1.1*	*2.4*	*2.3*
Brazil	*2.6*	*2.9*	*2.8*	*2.2*	*2.0*	*1.7*	*1.7*	*1.6*	*1.7*
Chile	*3.1*	*3.2*	*2.7*	*2.2*	*2.6*	*2.5*	*2.4*	*2.1*	*1.9*
Colombia	*1.9*	*1.6*	*1.5*	*1.2*	*1.2*	*1.3*	*1.9*	*2.2*	*2.0*
Ecuador	*2.6*	*2.4*	*2.3*	*1.9*	*2.4*	*2.2*	*2.0*	*1.8*	*1.9*
Guyana	. .	. .	. .	. .	. .	. .	. .	. .	. .
Paraguay	. .	. .	. .	. .	. .	[*1.9*]	[*1.7*]	[*1.8*]	[*1.6*]
Peru	*3.2*	*2.9*	*3.1*	*2.7*	*2.4*	[*2.6*]	[*2.4*]	*3.2*	*2.9*
Uruguay	. .	. .	. .	. .	. .	*1.1*	*1.2*	*1.6*	*1.6*
Venezuela	*1.9*	*2.1*	*2.4*	*2.4*	*2.1*	*2.0*	*1.7*	*1.9*	*1.8*

US $ mn, at 1973 prices and 1973 exchange rates (Final column, X, at current prices and exchange rates)

1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1975X
1 208	1 316	1 112	1 183	1 232	1 103	1 114	956	1 288	2 122	1 886	*1 413*
16	15	13	11	14	13	18	21	24	30	37	*52*
736	1 013	1 017	1 119	1 056	1 444	1 514	1 767	1 071	1 211	1 318	*1 474*
135	143	152	169	232	237	285	450	263	. .	. .	*182*[a]
127	130	171	99	121	223	116	104	100	92	. .	*109*
26	28	31	40	41	36	42	47	57	61	66	*87*
1.2†	2.5	2.3	2.7	4.2	3.6	3.6	4.0	5.9	. .	. .	*7*[a]
12	13	13	14	16	11	19	17	17	19	. .	*25*
169	215	215	230	226	275	258	263	220	301	. .	*419*
44	52	39	53	59	77	99	70	[82]	. .	. .	*[105]*[a]
213	242	241	228	229	277	312	304	422	453	329	*544*
2 687.2	**3 169.5**	**3 006.3**	**3 148.7**	**3 230.2**	**3 699.6**	**3 780.6**	**4 003.0**	**3 549.9**	**[4 700.0]**	**[4 500.0]**	*4 417*

Local currency, current prices

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
647	962	1 354	1 329	1 521	1 800	2 170	3 474	4 780	7 997	37 268	180 379
178	175	179	168	144	197	187	272	418	787	1 041	1 360
924	1 157	2 066	2 574	3 492	3 926	6 498	8 033	10 831	8 202	12 070	18 335
358	542	681	917	1 319	2 405	2 951	6 314	45 230	159 700	. .	. .
1 218	1 467	1 627	2 263	1 437	1 885	3 789	2 255	2 479	2 950	3 410	. .
428	413	456	527	714	767	742	933	1 163	1 770	[2 180]	2 592
. .	1.9	4.3	4.0	4.7	7.6	6.7	7.0	8.4	14.5	. .	. .
[975]	1 132	1 226	1 292	1 414	1 514	1 075	2 131	2 165	2 662	3 173	. .
3 286	3 575	4 994	5 957	6 769	6 960	9 055	9 125	10 193	9 932	16 860	. .
900	1 500	3 300	5 600	9 300	11 900	19 400	43 964	61 100	[127 075]	. .	. .
742	782	885	894	867	891	1 113	1 290	1 309	1 969	2 329	. .

Per cent

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1.8	*1.2*	*2.3*	*1.9*	*1.9*	*1.9*	*1.6*	*1.6*	*1.3*	. .	. .
2.5	*2.2*	*2.0*	*1.6*	*1.3*	*1.6*	*1.4*	*1.8*	*1.9*	*2.1*	*2.4*
2.5	*2.2*	*2.9*	*2.6*	*2.6*	*1.9*	*2.4*	*2.2*	*2.3*	*1.2*	*1.3*
2.0	*2.2*	*2.0*	*2.0*	*2.0*	*2.5*	*2.3*	*2.6*	*3.6*	*1.6*	. .
2.0	*2.0*	*2.0*	*2.3*	*1.3*	*1.4*	*2.5*	*1.2*	*1.0*	*0.9*	. .
1.9	*1.7*	*1.7*	*1.8*	*2.2*	*2.3*	*1.8*	*2.0*	*1.8*	*1.9*	[2.0]
. .	*0.5*	*1.0*	*0.9*	*0.9*	*1.4*	*1.2*	*1.2*	*1.3*	*1.6*	. .
[*1.7*]	*1.9*	*2.0*	*2.0*	*2.0*	*2.0*	*1.3*	*2.2*	*1.7*	*1.6*	*1.7*
2.9	*2.6*	*3.2*	*3.2*	*3.2*	*2.9*	*3.4*	*3.1*	*2.8*	*2.2*	*3.0*
1.7	*1.5*	*1.9*	*1.5*	*1.8*	*1.9*	*2.6*	*3.5*	*2.4*	. .	. .
2.0	*2.0*	*2.1*	*2.0*	*1.9*	*1.7*	*1.9*	*2.0*	*1.7*	*1.5*	*1.9*

Appendix 7B

Registers of indigenous and licensed production of major weapons in industrialized countries, 1976

I. Register of indigenously designed major weapons in development or production in industrialized countries, 1976

For sources and methods, see chapter 7. For conventions, see page 216.

Part 1. *Aircraft*

Country	Designation, description	Power plant	Weight *max takeoff wt, kg*	Speed *km/h* or *Mach no.*	Year design begun	Year of prototype flight	Year in production	Number: domestic/ export or total	R&D cost *$ mn*	Unit price *$ mn*	Foreign-designed Power plant, Electronics or Armaments
NATO											
Canada	*DHC-5D Buffalo* STOL transp[a]	TP	22 316	420	. .	1975	1974	. .[b]	. .	. .	PP (USA)
	DHC-6 Twin Otter STOL transp	TP	5 670	338	1964	1965	(1965)	. ./452[c]	. .	. .	–
France	*Delta Mirage 2000* fighter[d]	TF	9 070[e]	~M 3	1975	(1978)	. .	. .[f]	. .	. .	. .
	Mirage F1 fighter	TJ	14 900	M 2.2	1964	1966	1972[g]	146/186[h]	. .	~6	E-r (UK) Ar (USA
	F1-E multi-mission aircr	TF	15 550	M 2.2	1973	1974	. .	. .	. .	(5.8)	Ar (USA)
	Mirage III interceptor, ground attack or recce	TJ	13 500	M 2.2	Mid-1950s	1956	1958	406[i]/~325	. .	. .	E-r (UK)
	Mirage 5 ground attack vers	TJ	13 500	M 2.2	. .	1967	1969	68[j]/~262[k]	. .	. .	. .
	Mirage 50 multi-mission fighter	TJ	13 500	>M 2	. .	(1975)	. .	–/17[l]	. .	. .	. .
	Super Etendard multi-role carr-b	TJ	11 500	M 1	. .	1974	. .	52[m]/–	. .	10.5[n]	E-n (USA)
	Atlantic Mk II martitime patrol	TP	43 500	658	1970	. .	. .	. .[o]	. .	. .	PP (UK)
	Alouette III SA.319 Astazon light utility hel	TS	2 200	210	. .	1967	. .	. .[p]	. .	. .	–
	SA 360 Dauphin utility hel	TS	2 800	315	. .	1972	1975	27[q]/1	. .	. .	–
	SA 365 Dauphin twin-engine vers	TS	3 000	315	. .	1975	1977	. .	. .	. .	–
	SA 315B Lama light utility hel	TS	1 950	120	1968	1969	. .	. ./184	. .	0.22	–
	SA 321G Super Frelon[r] anti-sub vers	TS	13 000	275	. .	1962	. .	~15[s]/66[t]	. .	. .	–

FR Germany	*Do 24/72* rescue flying boat	TP	18 600	416	1973	. .	. .[u]	. .	. .	. .	PP (USA)
	AM-C 111 STOL transp	TP	6 800	415	. .	. .[v]	. .	. .	. .	. .	PP (Can)
	Do 28 D-2 STOL transp	P	3 842	325	. .	1966	1968	121/. .	. .	. .	PP (USA)
	AWI 2 Fantrainer trainer	. .[w]	1 350	320	. .	1977	. .	. .	. .	. .	–
	Bo 105 utility hel	TS	2 300	270	1962	1966	1971	307[x]/54[y]	. .	. .	PP (USA)
International: FRG (42.5%) UK (42.5%) It. (15%)	*Panavia MRCA* multi-purpose aircr	TF	17 240–18 145	M 2.2	1969	1974[z]	1976[aa]	40/. .	3 200[ab]	10.6[ab]	E-r (USA)
Fr. (50%) UK (50%)	*Jaguar, Sepecat* strike fighter/trainer	TF	15 500	M 1.5	1964	1969	1972	~260[ac]/. .	. .	. .	. .
	Jaguar International export vers	TF	. .	. .	. .	. .	1975	–/24	. .	. .	. .
Fr. (50%) FRG (50%)	*Alpha-Jet* multi-purpose aircr	TF	7 000	991	1969	1973	1976	140[ad]/. .[ae]	. .	5.1[af]	. .
Fr., UK[ag]	*SA 330 Puma* medium tactical transp hel	TS	7 000	273	. .	1965	1968	170[ah]/. .	. .	. .	. .
	Lynx WG.13 multi-purpose hel	TS	4 309	273	1968	1971	1974	119/>25	. .	. .	. .
	SA 341 Gazelle light utility hel[ai]	TS	1 800	310	. .	1967	1971	309[aj]/. .	. .	. .	. .
Italy	*MB.326 E* trainer/light strike	TJ	4 350	. .	. .	. .	. .	12[ak]/. .	. .	. .	PP (UK)
	MB.326 GB, K, L trainer/light strike	TJ	5 216	M 0.82	. .	1967	. .	. ./65	. .	~1.3	PP (UK)
	MB.339 trainer/light strike	TJ	5 895	M 0.82	(1974)	1976	. .	100/. .	. .	~1.6	PP (UK)
	G222 transp	TP	26 500	540	. .	1970	1974	44/3	. .	. .	PP (USA)
	PD-808 526 light transp/ECM	TJ	8 165	852	. .	1964	. .	25[al]/. .	. .	. .	PP (UK)
	SF 260 MX/W/SW trainer/light strike surveillance	P	1 200	340	. .	1970	. .	20/170	. .	. .	PP (USA)
	SM 1019 E STOL light utility	TP	1 450	313	1969	1969	1974	40[am]/. .	. .	. .	PP (USA)
	A 109 multi-purpose hel	TS	2 450	311	. .	1971	. .	5[an]/. .	. .	. .	PP (USA)
	P166-DL3 multi-purpose utility	TP	4 300	417	. .	1976	. .	. .	. .	. .	PP (USA)
Netherlands	*F.27 400M/500M* recce/transp	TP	20 410	480	. .	1965[ao]	. .	. ./11[ap]	. .	. .	PP (UK)
	maritime patrol vers	TP	20 410	427	1975	1976	. .	. .	. .	. .	PP (UK) E (USA, Can.)
UK	*Buccaneer S Mk 2* strike/recce	TF	28 123	M 0.85	. .	1963	1964	46[aq]/. .	. .	. .	Ar (Fr.)[ar]
	Harrier V/STOL strike/recce	TF	11 340	~M 1.3	. .	1966	1968	125/118	. .	. .	–
	Sea Harrier V/STOL strike/recce	TF	11 340	M 0.9	1975	. .	1977	25/. .	. .	. .	–
	Strikemaster light strike/trainer	TJ	5 215	760	. .	1967	. .	. ./134[as]	. .	. .	–
	Nimrod maritime recce	TF	87 090	926	1964	1967	1968	50[at]/–	. .	. .	–
	AEW vers	TF	87 090	926	1973	1977	. .	. .	. .	. .	. .
	HS 748 Andover transp	TP	23 133	452	1957	1960	1961	31/24	. .	. .	–
	Coastguarder maritime patrol	TP	23 133	452	(1973)	1977	. .	. .	. .	. .	. .
	SD3-M STOL transp	TP	10 886	367	. .	1974	. .	. .	. .	. .	PP (Can.)

Country	Designation, description	Power plant	Weight *max takeoff wt, kg*	Speed *km/h* or *Mach no.*	Year design begun	Year of proto-type flight	Year in pro-duction	Number: domestic/ export or total	R&D cost $ *mn*	Unit price $ *mn*	Foreign-designed Power plant, Electronics or Armaments
	Skyvan Srs 3M STOL light transp	TP	6 577	327	. .	1970	1970	–/50	. .	. .	PP (USA)
	Hawk trainer/light strike	TF	7 375	M 1.16	(1971)	–[au]	1976	175/50[av]	. .	~2	PP (UK+Fr.)
	Defender ground support/recce/ transp	P	2 993	283	. .	1971	1972	. ./37[aw]	. .	. .	PP (USA)
	Trislander M transp/maritime patrol	P	4 536	290	1970	1970	1970	. .	. .	. .	PP (USA)
	Jetstream 200 trainer	TP	5 700	454	. .	1973[ax]	1972	26/–	. .	. .	PP (Fr.)
	Bulldog 120 primary trainer	P	1 066	241	1968	1969	(1971)	139/150[ay]	. .	. .	PP (USA)
	200 light strike vers	P	1 179	278	1974	1976	. .	. .	. .	. .	PP (USA)
USA	*B-1* strategic bomber	TF	176 810	~M 2.0	1970	1974	. .	244/–	22 900[a]	93.8	–
	F-111 F fighter-bomber	TF	41 500	M 2.2	. .	. .	. .	106[b]/–	. .	. .	–
	F-15A Eagle fighter	TF	25 401	1 482	1965	1972	1974	749[c]/25	. .	16.7	–
	F-14A Tomcat[d] fighter/strike carr-b	TF	33 724	M 2.4	. .	1970	. .	408[e]/80	. .	20.4	–
	F-18 light fighter/strike carr-b	TJ	19 960	M 1.8	1974	1978	. .	800/–	1 430	5.8	–
	F-16 light fighter/strike	TF	14 968	>M 2.0	1974	1976	. .	650/348[f]	. .	3.9	E-f (UK)
	XFV-12A V/STOL light fighter carr-b	TF	8 845	>M 2.0	1973	1976	–	. .	. .	. .	–
	AV-8B[g] V/STOL strike carr-b	TF	13 154–13 608	. .	1975	1978	1981	342/–	350[h]–400	~5	PP (UK)
	F-4 Phantom strike/recce	TJ	24 765	>M 2.2	. .	1958	. .	–/820[i]	. .	. .	–
	F-5E/F Tiger II light fighter										
	F-5E Tiger II light fighter	TJ	11 192	M 1.63	1970	1972	1973	54[j]/606	. .	. .	–
	F-5F Tiger II two-seat vers	TJ	11 192	M 1.55	1970	1972	1973	. ./66	. .	. .	–
	F-5B Freedom Fighter light fighter	TJ	9 298	M 1.34	. .	1964	. .	. ./82	. .	. .	–
	A-10A strike	TF	21 500	722	1970	1972	1975	739[k]/. .	. .	. .	–
	A-7 Corsair II strike										
	A-7E Corsair II strike carr-b vers	TF	19 050	1 123	. .	1968	1968	666/–	. .	. .	PP (UK)
	A-7D AF vers	TF	19 050	1 123	. .	1968	1968	669/110[l]	. .	. .	PP (UK)
	A-7H export vers	TF	19 050	1 123	. .	1975	. .	–/60[m]	. .	. .	PP (UK)
	A-6 Intruder strike carr/land-b										
	A-6E Intruder strike carr/land-b	TJ	26 580	1 035	. .	1970	. .	318[n]/. .	. .	. .	–
	EA-6B Prowler ECM vers	TJ	29 483	1 055	1966	1968	1969	77/. .	. .	. .	–
	A-4 Skyhawk strike carr/land-b										
	A-4M Skyhawk II strike carr/land-b	TJ	11 113	1 040	. .	1970	1970	74/36	. .	. .	–
	A-4N Skyhawk II improved export vers	TJ	11 113	1 040	. .	1972	1972	. .	. .	. .	–
	A-37B Dragonfly light strike COIN	TJ	6 350	816	1967	1967	(1968)	250/88	. .	. .	–

OV-10 E/F Bronco light strike	TP	6 563	452	. .	1973	(1974)	–/80	. .	. .	–
P-3 Orion ASW patrol										
P-3C Orion ASW patrol	TP	61 235	761	. .	1968	1968	132[o]/31	. .	. .	–
P-3F Orion export 3C vers, simpler electronics	TP	61 235	761	. .	. .	1973	–/34	. .	. .	–
S-3A Viking ASW carr-b	TF	23 831	834	1969	1972	1972	179[p]/–	. .	. .	–
US-3A Viking carr-b transp vers	TF	21 592	834	(1975)	1976	. .	30/. .	. .	. .	–
E-4 AABNCP-Advanced Airborne National Command Post com. & con.										
E-4A initial vers	TF	351 530	. .	. .	1973	(1974)	3/–	. .	. .	–
E-4B with advanced equipment	TF	351 530	. .	. .	1976	. .	6/–	~353[q]	. .	–
E-3A AWACS-Airborne Warning and Control System AEW/com. & con.	TF	147 421	926	. .	1972	1975	34/–	. .	79	–
E-2C Hawkeye AEW carr-b	TP	23 391	602	. .	1971	1971	83[r]/9	. .	18	–
AMST-Advanced Medium STOL Transp										
YC-14 prototype	TF	107 500	811	1972	1976	. .	. .	. .	. .	–
C-130 Hercules medium transp										
C-130H current standard vers	TP	79 380	620	. .	1964	1965	422[s]	. .	. .	–
EC-130Q airborne comm. relay	TP	79 380	620	. .	. .	. .	10/–	. .	. .	–
KC-130R/H tanker	TP	. .	. .	. .	. .	1973	8/31	. .	. .	–
T-37C basic jet trainer	TJ	3 402	612	. .	. .	. .	–/>250	. .	. .	–
T-2D/E Buckeye jet trainer carr/ land-b	TJ	5 977	840	. .	1968	1968	–/72	. .	. .	–
T-34C Mentor basic trainer	TP	1 938	414	. .	. .	1975	~400[t]/12	. .	0.4	PP (Can.)
T-41D primary trainer	P	1 156	246	1963	. .	. .	238/5	. .	. .	–
F33A/C trainer	P	1 542	322	. .	1959	(1960)	–/55[u]	. .	. .	–
C-12/Huron light transp	TP	5 670	536	1970	1972	1973	92/–	. .	~0.6	PP (Can.)
AAH-Advanced Attack Hel										
YAH-64[v] prototype	TS	7 892	307	1973	1975	1981	536/–	. .	. .	–
AH-1 attack hel										
AH-1S Cobra/TOW	TS	4 309	352	. .	1973	1974	346[w]/–	. .	. .	–
AH-1J Sea Cobra	TS	4 535	333	. .	. .	. .	. ./202	. .	. .	–
UTTAS-Utility Tactical Transp Aircr System										
YUH-60A medium transp hel prototype	TS	9 707	318	1972	1974	. .	1 311[x]/–	. .	. .	–
H-53 multi-purpose hel										
CH-53E shipborne heavy lift	TS	31 638	315	1971	1974	1976	. ./–	. .	. .	–
RH-53D mine countermeasure	TS	22 680	315	1970	1972	1972	30/6	. .	. .	–
CH-47C Chinook transp hel	TS	20 865	–	. .	1967	1968	. .	. .	. .	–
Bell Model 214 Huey Plus utility hel	TS	6 803	241	1970	1974	1974	. ./365[y]	. .	–	–
UH-1 Iroquois utility hel										
UH-1N current production vers	TS	5 080	203	1968	. .	1969	258/20[z]	. .	. .	PP (Can.)
UH-1H current production vers	TS	3 660	204	. .	. .	1967	1 255/9	. .	. .	–

Country	Designation, description	Power plant	Weight *max takeoff wt, kg*	Speed *km/h* or *Mach no.*	Year design begun	Year of proto-type flight	Year in pro-duction	Number: domestic/ export or total	R&D cost *$ mn*	Unit price *$ mn*	Foreign-designed Power plant, Electronics or Armaments
	Lamps Mk III Light Airborne Multi-Purpose System hel	TS	5 805	265	1972	1978	1979	~200[aa]/–	. .	. .	–
	XV-15 Bell Model 301 tilt rotor research hel	TS	6 804	612	1973	1977	. .	. .	~29	. .	–
	Bell Model 209 Sea Cobra multi-purpose hel	TS	6 350	333	. .	1976	1976	16/–	. .	0.4	PP (Can.)
	OH-58 A/B Kiowa armed light recce hel	TS	1 360	188	1968	. .	. .	. ./12	. .	. .	–
	Hughes 500 M light recce and ASW hel	TS	1 360	244	. .	. .	. .	. ./100[ab]	. .	. .	–
	Bell Model 206 JetRanger multi-purpose light hel	TS	1 451	225	. .	. .	. .	–/12	. .	. .	–
	S-72 RSRA Rotor Systems Research Aircraft high speed multi-purpose research hel	TS	11 884	555	. .	1976	. .	. .	. .	. .	–
Warsaw Treaty Organization											
Czechoslovakia	*L-39 Albatross* combat trainer	TF	4 600	750	. .	1968	1972	. .	. .	. .	PP (USSR)
	L-39Z light strike vers	TF	4 535	750	. .	. .	. .	. .	. .	. .	PP (USSR)
Poland	*TS-11 Iskra* trainer	TJ	3 800	722	. .	1960	1962	>300/. .	. .	. .	–
	Iskra 100 ground attack	TJ	. .	. .	. .	1972	. .	. ./90	. .	. .	–
	Iskra 200 current production vers	TJ	3 840	720	. .	. .	. .	. .	. .	. .	–
	Mi-2M utility hel	TS	3 700	210	1968	1974	. .	. .	. .	. .	PP (USSR)
USSR	*(Tu-26) "Backfire-B"* bomber	TF	127 000	>M 2	(1969)	(1971)	(1973)	>50/. .	. .	. .	–
	MiG-25 "Foxbat A" fighter	TJ	35 000	M 2.8	. .	1965	(1970)	. ./–	. .	. .	–
	"Foxbat B" recce vers	TJ	35 000	M 3.2	. .	. .	(1969)	. ./–	. .	. .	–
	MiG-23 "Flogger" VG fighter										
	"Flogger A" initial vers	TJ	. .	M 2	. .	1967	(1970)	>500[a]/~85	. .	. .	–
	"Flogger B" fighter/strike vers	TJ	12 700–15 000	M 2.3	. .	. .	. .	. .	. .	. .	–
	"Flogger C" two-seat vers	TJ	12 700–15 000	M 2.3	. .	. .	. .	. .	. .	. .	–
	MiG-27 "Flogger D" multi-role fighter	TJ	17 750	M 1.5	. .	. .	. .	. .	. .	. .	–
	Tu-22 "Blinder" interceptor vers	TJ	83 900	M 1.3	. .	. .	(1973)	~250[b]/12	. .	. .	–
	Su-19 "Fencer" multi-role combat	TJ	30 850	>M 2	. .	(1970)	(1973)	. ./–	. .	. .	–
	Su-15 "Flagon"[c] fighter	TJ	16 000	M 2.5	. .	1967	(1968)	~650/. .	. .	. .	–

	Su-17 "Fitter C" STOL strike	TJ	19 000	M 2.17	. .	1967	(1970)	. ./–	. .	. .	–
	Su-20 export vers	TJ	. .	. .	. .	. .	. .	. ./36	. .	. .	–
	MiG-21 "Fishbed"[d] interceptor strike recce	TJ	10 400	M 2.0	. .	(1955)	(1958)	2 000/ >2 118	. .	. .	–
	Tu-95 "Bear"[e] strategic bomber maritime recce	TP	154 220	805	. .	1954	. .	>150/. .	. .	. .	–
	Yak-36 "Forger" VTOL strike										
	"Forger-A" ASW strike vers	. .	10 000	~M 1.3	. .	. .	. .	~12[f]/–	. .	. .	–
	"Forger-B" training vers	. .	. .	. .	. .	. .	. .	. ./–	. .	. .	–
	Il-38 "May" ASW	TP	(60 000)	645	. .	1967	(1970)	. ./4	. .	. .	–
	Il-76 "Candid" medium transp	TF	157 000	850	. .	1971	1973	. ./–	. .	. .	–
	Mi-24 "Hind A, B" attack hel	TS	8 400	310	. .	(1971)	(1973)	(100)/. .	. .	. .	–
	Mi-12 "Homer" heavy lift hel	TS	105 000	260	. .	1969	(1972)	. ./–	. .	. .	–
	Mi-6 "Hook" heavy lift hel	TS	42 500	300	. .	1957	. .	>500	. .	. .	–
	Mi-8 "Hip" transp	TS	12 000	260	. .	(1960)	. .	>1 000/ ~300	. .	. .	–
	Ka-25 "Hormone" ASW/transp hel	T	7 300	220	. .	1961	(1964)	(300)/(9)	. .	. .	–
Other Europe											
Finland	*Leko-70* primary trainer	P	1 200	240	1973	1975	. .	30/. .	. .	. .	PP (USA)
International: Yug., Rom.	*Orao (Eagle)* light strike/trainer	TJ	9 000	1 100	1971	1974	(1977)	400/. .	. .	. .	PP (UK)
Spain	*C-101* trainer/light strike	TF	4 700	M 0.8	1975	1977	. .	60/. .	22[g]	. .	PP (USA)
	T12 Aviocar STOL light transport	TP	6 300	445	1968	1971	1973	34/31	. .	. .	PP (USA)
Sweden[h]	*System 37 Viggen* fighter/strike										
	JA 37 single-seat interceptor	TF	17 000	M 2	1968	1974	1974	30[i]/–	. .	. .	PP (USA, Swe.) E-d, E-n (USA)
	AJ 37 strike/recce	TF	15 000/ 20 500	M 2	1962	1971[j]	1971	120[k]/–	. .	. .	PP (USA, Swe.)
	SAAB 35X Draken[l] fighter/strike/ recce	TJ	16 000	M 2	. .	1955	. .	>600[m]	. .	. .	PP (UK)
	SAAB Supporter light utility	P	1 200	260	. .	1972	. .	. ./77	. .	. .	PP (USA)
Switzerland	*PC-6/B2-H2 Turbo-Porter* STOL light utility	TP	2 770	260	1957	1959	. .	>360[n]	. .	. .	PP (Can.)
	PC-7 Turbo-Trainer trainer	TP	2 700	460	. .	. .	. .	. .	. .	. .	PP (Can.)
Yugoslavia	*J-1 Jastreb* light strike	TP	5 100	820	. .	. .	. .	. .	. .	. .	PP (UK)
	J-1-E export attack vers	TP	5 100	820	. .	. .	. .	. .	. .	. .	PP (UK)
	RJ-1 recce vers	TP	5 100	820	. .	1976	. .	. .	. .	. .	PP (UK)
	TJ-1 trainer vers	TP	4 350	820	. .	1974	. .	. .	. .	. .	PP (UK)
	G2-A Galeb jet trainer	TJ	4 300	756	1957	1961	1963	. .	. .	. .	PP (UK)
	G2-A-E export vers	TJ	4 300	756	. .	1974	1975	. .	. .	. .	PP (UK)

Country	Designation, description	Power plant	Weight *max takeoff wt, kg*	Speed *km/h* or *Mach no.*	Year design begun	Year of proto-type flight	Year in pro-duction	Number: domestic/ export or total	R&D cost *$ mn*	Unit price *$ mn*	Foreign-designed Power plant, Electronics or Armaments
Other Developed											
Australia	*N22 Nomad* STOL utility	TP	3 855	311	1965	1971	1974	12/18	. .	. .	PP (USA)
	N24 stretched vers	TP	3 855	311	. .	1975	. .	6/. .	. .	. .	PP (USA)
China[o]	*F-9* fighter	TJ	10 700	M 1– M 1.56	. .	. .	. .	. .	. .	. .	PP (USSR)
	F-6 (Improved MiG-19) light fighter	TJ	8 780	1 452	. .	1961	1961	~1 500	. .	. .	. .
	. . hel[p]	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Japan	*T-2* advanced trainer	TF	9 675	M 1.6	1967	1971	1974	59/. .	. .	. .	PP (Fr., UK) E-n (UK)
	F-1 Kai light strike vers	TF	13 614	M 1.6	1973	1975	1977	68[q]/. .	. .	. .	PP (Fr., UK)
	PS-1 ASW flying boat	TP	43 000	547	1959	1967	. .	22/. .	. .	. .	PP (USA)
	US-1 rescue vers	TP	45 000	481	1970	1974	. .	9/. .	. .	. .	PP (USA)
	C-1 transport	TF	38 700	806	1966	1970	1973	24/. .	. .	. .	PP (USA)
	MU-2J	TP	4 900	462	. .	1970	. .	117/. .	. .	. .	PP (USA)
	MU-2K utility	TP	4 500	462	. .	1971	. .	88/. .	. .	. .	PP (USA)
	KM-2B trainer	P	1 510	413	. .	1974	. .	62/. .	. .	. .	PP (USA)
	P-2J ASW maritime patrol	TP	34 019	402	1961	1966	. .	83/. .	. .	. .	PP (USA)
	KH-7 utility hel	TS	2 700	. .	1974	. .	. .	. .	. .	. .	PP (USA)
New Zealand	*CT-4* trainer	P	1 088	286	. .	1972	. .	13/14	. .	. .	PP (USA)

NATO, excluding the USA

[a] The DHC-5D can also be used for assault missions.

[b] Nineteen DHC-5Ds are being built and plans for 24 more are progressing.

[c] By January 1975, 452 DHC-6s had been sold—50 to the military, including eight to the Canadian Armed Forces.

[d] The development programme of Delta Mirage 2000, the aircraft based largely on the Mirage III, and planned to replace it, has taken over from an earlier programme concerning the Super Mirage. Full details of the aircraft and the development programme have not been released so far.

[e] The weight is for the aircraft in the interception configuration.

[f] The French Air Force has a requirement for up to 200 Mirage 2000s and it has been reported that they will buy 127 aircraft.

[g] The present total production rate is 6/month.

[h] The export figure of 186 aircraft includes F1-B, -C, -E and -G models. South Africa has ordered 32 F1-As, some of which will be assembled locally.

[i] All aircraft have been delivered.

[j] This includes 18 prototype and pre-production models.

[k] Seventeen Mirage 5s are currently being delivered to Zaire and options for 28 more are held.

[l] The Mirage 50 is basically the Mirage III with a more powerful SNECMA Altar 9k 50 engine.

[m] Under the main procurement confirmed for 1977, the Navy has ordered 14 Super Etendards as a follow-on to 10 in 1974, 20 in 1975 and 6 in 1976. Two prototypes have also been produced.

[n] The unit price for the batch of 14 ordered for procurement in 1977.

[o] There are plans to procure 42 Atlantic Mk IIs during 1977–82. Plans to cooperate with some or all of the old partners in the Mk I programme have not materialized yet.

[p] Total sales of the Alouette III series are now close to 1400. Most Alouette IIIs built today are SA 319s.

[q] This includes two prototypes.

[r] The Super Frelon was developed as an anti-submarine helicopter with the USA providing technical assistance.
[s] For the French Navy.
[t] About 100 are on order. The SA 321H military export is to Israel, South Africa, Libya and other Middle Eastern countries. Sixteen maritime Super Frelons were ordered by China and are now being delivered.
[u] A decision to begin production has not yet been made.
[v] Construction of the prototype has started.
[w] Wankel engine.
[x] A further order for 227 of the militarized version of the Bo 105 is expected.
[y] Thirty have been ordered for the Netherlands Army.
[z] Nine prototype aircraft have been built.
[aa] The six pre-production aircraft are all expected to fly by late-1977. One of these left the factory in October 1976. The total programme is set at 809 units but only 40 units have been authorized.
[ab] These figures are at late-1975 price levels and they are for West German aircraft. The unit cost to the UK of the standard strike model is estimated at $8.5 mn in 1976–77 prices.
[ac] The Anglo-French order is for 402 aircraft, of which about 260 have been delivered.
[ad] France and FR Germany plan to build 400 aircraft.
[ae] Thirty-three aircraft have been bought by Belgium, and Turkey and Egypt have shown interest in 60 and about 120 aircraft, respectively.
[af] Based on a statement made in the West German Parliament. The maximum unit cost has been set at $5.1 mn at late-1974 price levels.
[ag] Puma and Gazelle are predominantly of French design; Lynx is predominantly of British design. All three aircraft are co-produced by the two countries.
[ah] The French Army and Air Force have received 130 and production of the remaining 40 ordered for the RAF was completed in 1972. A total of 169 were ordered by the French forces. Total sales of all seven versions were 459, which includes about 23 civilian units. Ninety are being built under licence in Romania.
[ai] The production of the Gazelles is divided between Aérospatiale and Westland at a ratio of about 60 : 40.
[aj] Of the 166 ordered by the French Army, about 75 may be the SA 342 version. The UK has increased its planned procurement from 143 to 202.
[ak] Six of these are converted from MB.326s.
[al] Production of the PD-808 was due to be completed by late-1975.
[am] The Italian Army has issued a letter of intent for a total of 100 aircraft.
[an] The Italian Army is expected to buy 80 A 109s.
[ao] First flight of the F27 500M took place in 1967.
[ap] This includes several F27 600s.
[aq] Delivery was due to be completed in 1976.
[ar] The S Mk 2A is built without Martel missile capability and the S Mk 2B is to carry Martels.
[as] Between 10 and 12 more were reported to have been ordered by Saudi Arabia.
[at] Forty-eight MR Mk 1s are being refitted with new communications equipment and advanced tactical sensor and navigation systems. These aircraft will be registered as MR Mk 2.
[au] There are no separate prototypes but one pre-production Hawk flew in 1974 and the first five production aircraft are allocated to the development programme.
[av] The Finnish government has signed a letter of intent to purchase at least 50 aircraft.
[aw] Thirty-seven aircraft had been sold by the end of 1975.
[ax] No prototype for series 200. The first of these flew in 1973. All 26 aircraft have been delivered to the RAF.
[ay] These include series 100. By early-August 1976, 270 aircraft had been delivered.

USA

[a] Total programme cost, including R&D.
[b] A total of 562 aircraft in the F-111 and FB-111 series were built.
[c] 100 were delivered to the USAF by mid-1976.
[d] The F-14B is the same aircraft as the F-14A, except that it is powered by an advanced engine.
[e] By August 1978, 216 aircraft were completed for the US Navy and 16 for the Iranian Air Force.
[f] Includes options on 42 aircraft by three of the four European consortium nations: Belgium, Denmark and the Netherlands. In addition to these, sales include 72 aircraft to Spain and 160 to Iran.
[g] The AV-8B will be built under licence from Hawker Siddeley and McDonnell Douglas will probably contract out some production work in the UK.
[h] Cost in FY 1975 dollars and unit cost is based on production of 336 aircraft.
[i] Variants of the F-4 are in the process of being delivered to FR Germany (180), Iran (200), Israel (200), Japan (128), South Korea (72) and Turkey (40) with a further order of possibly 40 more.
[j] By August 1976, 500 F-5Es were delivered to the USAF for subsequent overseas delivery. Kenya will also acquire 12 F-5s.
[k] Procurement of 95 aircraft has been authorized for FY 1976 and by the end of July 1976, a total of 17 aircraft were delivered.
[l] The sale of 110 A-7Ds to Pakistan will be made if it agrees not to purchase the nuclear reprocessing plant from France.
[m] Deliveries of 60 to Greece are now complete.
[n] A total of 119 have been converted from A-6As, and 58 have been built as A-6Es.
[o] Total P-3C production is 561 aircraft.
[p] 101 aircraft have been delivered.
[q] Estimated R&D costs, including test and evaluation to the end of 1981.
[r] The US Navy has ordered 51 units, 32 of which have been delivered.
[s] This includes C-130Hs or variants ordered or delivered by mid-1976.
[t] Of the required number of about 400 units, contracts for 116 have been received.
[u] Some of these were delivered during 1975.

[v] The YAH-64 was selected as the winner in the AAH competition between itself and Bell Model 409 YAH-63. The US Army has stated a requirement for 536 AAHs.

[w] Apart from the production of 305 new AH-1Ss, 290 HueyCobras are to be converted to AH-1Q/S status.

[x] This includes the US Army's requirement of 1 107 UTTAS helicopters and the US Navy's potential requirement for 204 UTTAS-derived Lamps Mk 3 aircraft which would carry ASW weapons. The US Army decided to award a production contract for YUH-60A. The initial Army contract calls for 15 UH-60As plus options for an additional 353 aircraft.

[y] Fifty-seven of the 365 ordered by Iran had been delivered by mid-1976.

[z] A Canadian order for 50 was completed in 1972 but this order had an option on 20 more.

[aa] The US Navy has about 102 Mk 1 Lamps. The Mk 2 version has been eliminated from the Navy's plan and the Mk 3 is in the development stage. The US Navy's eventual requirement is about 200 Lamps.

[ab] Thirty-four of these will be made in the USA and the rest will be assembled in South Korea. 500 Ms are also built under licence in Argentina and in Italy.

WTO/Other Europe/Other Developed

[a] This includes all versions to the Soviet Air Force.

[b] These include Blinder A, B, C and D versions.

[c] "Flagon-A" was the initial production model and "Flagon-B", a STOL aircraft, is at the development stage. "Flagon-E" is the improved version with new engines and avionics.

[d] Several versions have been produced.

[e] Several versions have been produced.

[f] About 10–12 appear to be deployed by the Soviet Navy at Kiev.

[g] This includes the cost of construction of six prototype aircraft.

[h] The Saab Model 105 is no longer in production, but its successor is under study.

[i] Thirty of the planned total procurement of 150 aircraft were ordered in 1974.

[j] First production AJ37.

[k] This includes SK37 and SH37 versions.

[l] Current version of Draken J35.

[m] More than 600 Drakens of various types have been built for Sweden, Denmark and Finland. Some of the models are partly assembled in Finland.

[n] More than 360 of all the models of the PC-6s had been built by April 1976.

[o] Aircraft of Soviet origin are shown with the Soviet designation in brackets. They are listed as indigenous weapons, because China has been almost totally isolated from Soviet technology since 1960.

[p] It has been confirmed that at least one type of helicopter is being produced at present in China. However, it is not clear whether this is completely of Chinese design or whether it is based on the Soviet Mi-4.

[q] Of the 68 planned, 26 have been ordered.

Part 2. *Missiles*

Country	Designation, description	Power plant	Warhead weight *kg* (if nuclear, *kt* or *Mt*)	Range *km*	Year design begun	Year of proto-type flight	Year in pro-duction	Number: domestic/ export or total	R&D cost $ *mn*	Unit price $ *mn*	Foreign-designed Power plant, Electronics or Armaments
NATO											
France	*S-3* fixed-to-fixed	S	(1.2 Mt)	3 000	1973	. .	. .	(27)/–	. .	. .	. .
	Pluton mobile-to-fixed	S	25 and 15 kt	120	. .	1969	1973	120/–	. .	. .	–
	Harpon mobile/aircr-to-fixed/tank	S	2.6	3	. .	. .	. .	. .	. .	. .	–
	SS/AS-11 mobile/aircr-to-fixed/tank	S	2.6	3	. .	. .	(1958)	170 000	. .	. .	–
	SS/AS-12 mobile/aircr-to-fixed/tank	S	30	8	. .	. .	(1962)	. .	. .	. .	–
	R.440 Crotale mobile/ship-to-aircr	S	15	8.5	1964	1965	1968	16/. .	. .	. .	–
	AS-15 mobile/aircr-to-ship	. .	. .	15	. .	. .	. .	. .	. .	. .	–
	AS-20 aircr-to-fixed/ship	S	30	7.4	. .	. .	. .	>8 000	. .	. .	–
	AS-30 aircr-to-fixed/ship	S	230	12	. .	. .	. .	~3 200	. .	. .	–
	AS-30L lighter vers	S	115	. .	. .	. .	. .	. .	. .	. .	–
	R.530 aircr-to-aircr	S	27	18	1958	. .	(1963)	4 000[a]	. .	. .	–
	Super 530 aircr-to-aircr	S	HE	>11	1971	1973	(1977)	1 000/–	. .	. .	–
	R.550 Magic aircr-to-aircr	S	HE	10	1968	1972	1974	~6 000[b]	. .	. .	–
	Hirondelle system[c] ship-to-aircr miss	S	HE	(40)	1971	. .	(1977)	. .	. .	. .	–
	Exocet anti-shipping										
	MM-38 ship-to-ship	S	~200	>42	(1967)	. .	1972	. .[d]	. .	. .	E-d (UK)
	AM-39 aircr/hel-to-ship	S	. .	70	. .	1973	1975	. .[d]	. .	. .	. .
	MM-39 ship-to-ship development	S	165	>50	. .	. .	. .	. .	. .	. .	. .
	MM-40 long-range vers	S	165	>70	. .	. .	(1977)	. .	. .	. .	. .
	SM-39	S	. .	50	. .	. .	. .	. .	. .	. .	. .
	Malafon ship-to-ship	S	. .	13	1956	1962	. .	. .	. .	. .	. .
	M-2 sub-to-fixed	S	500 kt	3 000	. .	. .	1973	(48)/–	. .	. .	. .
	M-20 sub-to-fixed	S	1 Mt	>3 000	. .	1976	. .	. .	. .	. .	. .
	M-4 (MIRV) sub-to-fixed	S	(3–5)× 150 kt	~4 000	. .	. .	(1979)	(96)/–	. .	. .	. .
	Matra AM 15[e] anti-ship	S	. .	15	. .	. .	. .	. .	. .	. .	. .
	AS-15[e] anti-ship	S	. .	15	. .	. .	. .	. .	. .	. .	. .

Country	Designation, description	Power plant	Warhead weight kg (if nuclear, kt or Mt)	Range km	Year design begun	Year of proto-type flight	Year in pro-duction	Number: domestic/ export or total	R&D cost $ mn	Unit price $ mn	Foreign-designed Power plant, Electronics or Armaments
FR Germany	*Cobra 2000* portable-to-tank	S	2.7	2	1957	. .	1960	>170 000	. .	. .	PP (Switz.)
	Mamba portable-to-tank	S	2.7	2	. .	1972	1974	. .	. .	. .	. .
	AS.34 Kormoran aircr-to-ship	S	160	40	1964	1970	(1974)	350/–	. .	. .	E-g (Fr.)
International: FRG, Fr.	*HOT* mobile/hel-to-tank	S	6	4	1964	1971	1975	6 000	. .	. .	. .
	Milan portable-to-tank	S	3	2	1963	. .	1972	10 000[f]	. .	. .	. .
	Roland[g] mobile-to-aircr										
	I clear weather vers	S	6.5	6.5	1964	(1968)	1974	. .	10 800[h]	. .	. .
	II all weather vers	S	6.5	6.5	1964	(1975)	(1976)	. .	. .	. .	. .
Fr., UK	*Martel* aircr-to-fixed										
	AS.37 anti-radar vers	S	HE	~60	(1960)	(1966)	1973	. .	. .	. .	. .
	AJ.168 TV-guided vers	S	HE	~60	(1960)	(1966)	1973	. .	. .	. .	. .
Bel., Den., It., Neth., Nor., USA	*Sea Sparrow System*[i] ship-to-aircr/ miss	S	(30)	22.2	1969	1972	1973	100/4	(35)	. .	. .
Fr., It.	*OTOMAT* ship/aircr-to-ship										
	I initial vers	TJ	65.8	>80	1969	1971	. .	560[j]	. .	. .	. .
	II longer-range vers	TJ	. .	~100	1969	1974	(1975)	. .	. .	. .	. .
	III Téséo[k] extended range vers	TJ	. .	20	. .	. .	. .	. .	. .	. .	. .
Italy	*Spada System*[l] fixed-to-aircr	S	HE	31.5	. .	1974	–	. .	. .	. .	. .
	Indigo mobile-to-aircr	S	21	~10	1962	1963	. .	. .	. .	. .	E-f (Switz.)
	Sparviero portable-to-tank	S	4	3	1966	. .	. .	–	. .	. .	. .
	Aspide-1A aircr/fixed-to-aircr	S	(30)	31.5	1969	1974	(1977)	. .	. .	. .	. .
	Airtos aircr-to-ship	S	35	11	(1969)	(1974)	. .	. .	. .	. .	. .
	Marte system[m] hel-to-ship	S	70	20	1969	(1975)	–	. .	. .	. .	. .
	Albatros system[n] ship-to-aircr miss	S	HE	. .	1966	(1970)	1973	10/. .	. .	. .	. .
	Sea Killer ship/hel-to-ship										
	II current vers	S	70	25	1965	1969	. .	–/. .	. .	. .	E-f (Switz.)
	III[o] under development	S	150	45	(1972)	. .	–	. .	. .	. .	. .
Norway	*Penguin* ship-to-ship										
	Mk.1 initial vers	S	120	>20	1961	. .	1969	. .	(60)	. .	. .
	Mk.2 longer-range	S	120	(30)	. .	. .	–	. .	. .	. .	. .

UK	*Swingfire* mobile-to-tank	S	HE	4	1958	..	(1968)	..	..	..	..
	Beeswing infantry vers	S	HE	4	1958	..	(1968)	..	..	..	..
	Golfswing Mk 2 infantry vers	S	HE	4	1958	..	..	..	..	..	..
	Vigilant portable-to-tank	S	>5	1.4	1956	(1957)	1960	>15 000	2.5	..	..
	Rapier mobile-to-aircr	S	HE	(6)	1963	..	1967	..	..	..	..
	Tigercat towed/fixed-to-aircr	S	HE	5	..	..	(1969)	..	..	..	..
	Blowpipe portable-to-aircr	S	HE	..	1966	..	(1973)	..	..	..	..
	XJ521 UK Sparrow[p] aircr-to-aircr	S	HE	..	1973	1975	1977	..	..	..	Ar (USA)
	SRAAM (QC 434) aircr-to-aircr	S	10	..	1972	..	–	..	..	..	..
	Red Top aircr-to-aircr	S	31	>12	1957	..	(1962)	..	..	..	..
	Sea Skua CL834 aircr-to-ship	S	~20	(15)	(1970)	..	–	..	..	..	..
	Sea Dart ship-to-aircr	S/L	HE	80	(1962)	(1965)	1970	..	..	..	..
	Seacat ship-to-aircr	S	HE	4.75	1958	1962	(1962)	..	..	..	..
	Sea Wolf ship-to-miss/aircr/ship	S	(14)	..	1967	1975	..	..	..	..	..
USA	*LGM-30G Minuteman 3* MIRV fixed-to-fixed	S	~3×200 kt	13 000	1966	1968	1970	610[a]/–	..	~5.4	–
	BGM-71A TOW[b] fixed/hel-to-tank	S	HE	3.75	1962	1968	1969	~200 000	156	..	–
	Site Defense fixed-to-miss	S[c]	N	~50	1971	..	..	. ./–	1 310	..	–
	Safeguard system fixed-to-miss										
	XLIM-49A Spartan high altitude	S	N-Mt	>185	1965	1968	1970	. .[d]/–	..	..	–
	Sprint low altitude	S	N-kt	~40	1963	1965	1970	. .[d]/–	..	..	–
	MGM-52C Lance SP/towed-to-fixed	SL	N/HE	120	1963	1965	1971	360[e]/. .	447.5	0.34	–
	SAM-D mobile-to-aircr	S	N/HE	..	1965	1970	(1981)	..	~6 000[f]	(26)	–
	MIM-23B Improved Hawk mobile-to-aircr	S	HE	40	1964	1971	1972	..	155	0.1	–
	MIM-72A/Chaparral mobile-to-aircr	S	HE	16.1	1964	1965	1966	..	143	0.75	–
	FGM-77A Dragon portable-to-tank	S	HE	1	1968	1971	1973	30 000–40 000	119	..	–
	FIM-92A Stinger portable-to-aircr	S	3	1	1972	1974	..	445/. .	(120)	0.11	–
	AGM-69A SRAM aircr-to-fixed	S	~200 kt	222	1966	1969	1971	1 500[g]/–	..	(0.35)	–
	AGM-86A ALCM aircr-to-fixed	TF	N-kt	1 300	1974	1976	(1979)	3 000/–	393	(0.5)	–
	AGM-62B Walleye II aircr-to-fixed	–[h]	907	..	1968	(1973)	(1974)	150[i]/–	..	(0.29)	–
	AGM-88 HARM aircr-to-(fixed) radar	S	HE	18.5	1972	1975	(1980)	2 935/–	126.8	0.08	–
	AGM-78 Standard ARM[j] aircr-to-(fixed) radar	S	100	25	1966	1967	1968	..	..	0.12	–
	AGM-45A Shrike aircr-to-(fixed) radar	S	HE	16	1962	..	1963	24 030[k]	..	0.37	–
	AGM-65 Maverick aircr-to-fixed/tank										
	AGM-65A standard vers	S	59	20	1966	1969	1972	15 000/ 3 500[l]	..	0.4	–
	AGM-65B scene-magnification	S	59	..	..	1977	..	2 000/. .	..	0.2	–
	AGM-65C laser guided	S	59	..	(1972)	1973	1978	5 000/. .	56.2	..	–
	AGM-65D imaging IR	S	59	..	1976	..	1981	8 940/. .	117.4	..	–

Country	Designation, description	Power plant	Warhead weight *kg* (if nuclear, *kt* or *Mt*)	Range *km*	Year design begun	Year of proto-type flight	Year in pro-duction	Number: domestic/ export or total	R&D cost $ *mn*	Unit price $ *mn*	Foreign-designed Power plant, Electronics or Armaments
	Hellfire aircr-to-fixed/tank	S	HE	5.6	1974	1976	1979	. .	122.6	. .	–
	SRAAM aircr-to-aircr	S	HE	. .	1975	. .	. .	. .	. .	. .	–
	AIM-54 Phoenix aircr-to-aircr/miss	S	HE	165	1962	1966	1971	2 495/694	416	0.52[m]	–
	AIM-9 Sidewinder IR/IC aircr-to-aircr										
	9L new IR vers	S	. .	(3.7)	1972	1975	1976	1 510[n]/. .	52	0.05	–
	9H current production vers	S	(3.5)	(3.7)	1968	. .	1971	4 720/. .	. .	(0.03)	–
	AIM-7 Sparrow III aircr-to-aircr										
	AIM-7F latest vers	S	30	>44	1968	1972	1975	2 310[o]/. .	128.5	(0.05)	–
	AGM-53 Condor aircr-to-ship/fixed	S	286	111	1963	1970	. .	983[p]/. .	282	(0.44)	–
	Standard I ship-to-aircr/miss/ship										
	RIM-67A ER – Extended range	S	HE	55	1964	1965	1966	2 160[q]/. .	. .	(0.1)	–
	RIM-66A MR – Medium range	S	HE	18	1964	1965	1966	3 892[q]/. .	. .	(0.1)	–
	Standard Missile II ship-to-aircr/miss/ship	S	HE	(100)	1970	1972	1976	22[r]/. .	115	0.12	–
	Harpoon anti-shipping										
	AGM-84A aircr-to-ship	TJ-S	232	>100	1968	1972	1975	791[s]/571	320	0.45	–
	RGM 84A-1 ship-to-ship	TS-S	HE	110	1968	1970	1975	. .	. .	. .	–
	UUM-84 Capoon sub-to-ship	TS-S	HE	. .	1970	1974	. .	. .	. .	. .	–
	RUR-5A Asroc ship-to-sub	S	N/HE	10	1955	. .	1959	. .	. .	. .	–
	UGM-93 Trident MIRV sub-to-fixed										
	UGM-93A (1–4) initial vers	S	N	>7 400	(1971)	. .	1979	48[t]/–	2 926	10.8	–
	Trident II (D-5) longer-range	S	N	10 000	(1972)	. .	. .	. ./–	1 380	. .	–
	UGM-73A Poseidon MIRV sub-to-fixed	S	(10×4 kt)	4 630	1965	1968	1969	. ./–	. .	5.6	–
	SLCM[u] sub/ship-to-fixed										
	YBGM-110 competitive prototype	TF	N[v]	3 700[w]	1972	. .	(1980)	~1 200/–	585	0.8	–
	YBGM-109 competitive prototype	TF	N[v]	3 700[w]	1972	1976	(1980)	. .	. .	~0.91	–
	UUM-44A Subroc sub-to-sub	S	N	56	1958	1964	1965	. ./–	. .	. .	–
Warsaw Treaty Organization											
USSR	*"SS-18"* MIRV fixed-to-fixed	SL	N, 6–8 MIRV	9 250	. .	1972	(1974)	(40)[a]/–	. .	. .	–
	"SS-19" MIRV fixed-to-fixed	L	N, 6 MIRV	10 190	. .	1973	(1974)	(100)/–	. .	. .	–
	"SS-17" MIRV fixed-to-fixed	SL	N, 4 MIRV	>9 000	. .	1972	(1975)	(30)/–	. .	. .	–

	"SS-X16" fixed/(mobile)-to-fixed	S	>1 Mt	>8 000	..	1972	..	../–	..	..	–
	"SS-X20" MIRV fixed/(mobile)-to-fixed	S	N	4 630	..	1974	..	../–	..	..	–
	"SS-12 Scaleboard" mobile-to-fixed	..	(1 Mt)	800	..	..	(1968)	..	..	..	–
	"SS-1C Scud B" mobile-to-fixed	L	N/HE	280	..	..	(1962)	..	..	..	–
	"Sagger AT-3" mobile-to-tank	S	11.5	3	..	(1965)	..	..	..	..	–
	"SA-5 Gammon" fixed-to-aircr	S	..	250	..	(1963)	(1966)	../–	..	..	–
	"SA-8 Gecko" mobile-to-aircr	..	..	6.1	..	(1973)	(1975)	..	..	..	–
	"SA-9 Gaskin" mobile-to-aircr	S	..	~5	..	..	(1974)	..	..	..	–
	"SA-6 Gainful" mobile-to-aircr	S	80	60[b]	..	1967	(1970)	..	..	..	–
	"SA-2 Guideline" mobile-to-aircr	SL	130[c]	50	..	1967	..	..	..	..	–
	"SA-3 Goa" mobile-to-aircr	S	HE	30	..	..	(1960)	..	..	..	–
	"SA-7 Grail" portable/mobile-to-aircr	S	1.8	3.5[d]	..	..	(1966)	..	..	..	–
	"AS-7 Kerry" aircr-to-fixed/tank	(S)	HE	..	..	..	(1975)	..	..	..	–
	"AS-6" aircr-to-ship/fixed	S	N	740[e]	..	..	(1970)	..	..	..	–
	"AS-5 Kelt" aircr-to-ship/fixed	L	..	>180	..	..	(1968)	..	..	..	–
	"AA.6 Acrid" aircr-to-aircr	S	(100)	37	..	..	(1973)	..	..	..	–
	"SS-NX-13" sub-to-ship/fixed	..	(N)	(750)	..	1973	..	..	..	..	–
	"SS-N-12"[f] ship-to-ship/fixed	..	..	555	..	..	..	..	..	..	–
	"SS-N-11"[g] ship-to-ship	S	..	(54)	..	..	(1968)	..	..	..	–
	"SS-N-10"[h] ship-to-ship	..	..	(54)	..	..	(1968)	..	..	..	–
	"SS-N-9"[i] ship-to-ship	S	..	(275)	..	..	..	..	..	..	–
	"SS-NX-17"[j] ship-to-ship	S	..	..	..	1975	..	..	..	..	–
	"SS-NX-18"[k] ship-to-ship	L	(>9 260)	..	..	1975	..	..	..	..	–
	"SA-N-4"[l] ship-to-hel	..	..	(37)	..	(1969)	..	..	..	..	–
	"SA-N-3 Goblet"[m] ship-to-aircr	S	HE	(30)	..	1967	..	..	..	..	–
	"SS-N-8"[n] sub-to-fixed	SL	(1 Mt)	7 780	..	..	(1973)	../–	..	..	–
	"SS-N-6 Mod 3"[o] MRV sub-to-fixed	SL	(1 Mt) 3 MRV	2 960	..	..	(1967)	../–	..	..	–
	"SS-N-7"[p] sub-to-ship	S	HE	(55)	..	1967	(1968)	../–	..	..	–
Other Europe											
Sweden	*RBS 70* mobile-to-aircr	S	HE	5	1969	(1973)	1976	..	20	..	..
	RB 53 Bantam anti-tank	S	1.9	2	1956	..	1963	..	..	..	..
	RB 05A[a] aircr-to-ship/fixed	L	HE	..	1960	(1968)	1971	..	..	..	..
	RB 04E aircr-to-ship	S	200–250	..	1968	..	1973	..	..	..	E-g (Fr.)
Other Developed											
Australia	*Ikara* ship-to-ship	S	HE	(20)[b]	..	..	1961	..	..	..	..
Japan	*Kam-9* mobile/ship-to-tank/ship	S	HE	3	1964	..	..	..	..	..	..
	ASM-1 aircr-to-fixed/ship	S	140	45	1973	(1977)	(1980)	(68)/–	(32)	..	..
	AAM-2 aircr-to-aircr	S	HE	..	..	1968	(1975)	../–	..	..	..

Country	Designation, description	Power plant	Warhead weight kg (if nuclear, kt or Mt)	Range km	Year design begun	Year of proto-type flight	Year in pro-duction	Number: domestic/ export or total	R&D cost $ mn	Unit price $ mn	Foreign-designed Power plant, Electronics or Armaments
China	*"CSS-3"* fixed-to-fixed	L	(3 Mt)	(5 500)	. .	1976	. .	. ./–	. .	. .	. .
	"CSS-2"[c] fixed-to-fixed	SL	(1 Mt)	(2 780)	. .	. .	(1971)	(30)/–	. .	. .	. .
	"CSA-1" (SA-2)[d] mobile-to-aircr	S/L	(130)	(40)	. .	. .	. .	. ./–	. .	. .	. .
	"CSS-N-1" (SSN-2) ship-to-ship	S	HE	42	. .	. .	. .	. ./–	. .	. .	. .
	"CSS-X-4" fixed-to-fixed	. .	. .	11 000	. .	1976[e]	. .	. .	. .	. .	. .

NATO, excluding the USA

[a] Production of R530s is expected to cease in 1978.

[b] Main procurement in 1977 is confirmed and includes among other items, the delivery of 250 R550s to the French Air Force.

[c] With Super 530 missile.

[d] More than 1 000 of these different versions of Exocet have been ordered.

[e] New radio-controlled missiles.

[f] The UK will acquire 5 000 missiles in 1977/88. The ultimate requirement is 50 000 units which may be produced under licence in the UK. This will make the UK the third partner.

[g] In early-1975, the US Army awarded a $108-mn contract to Hughes Aircraft Co. for development of the US system. The Roland system will be adapted and produced under licence with the Boeing Aerospace Co.

[h] These also include the Roland II.

[i] In the USA the system is referred to as the "improved point defense surface missile system" and it uses the RIM-7H Sparrow missile.

[j] These include both the type I and type II. Negotiations have reached an advanced stage for the purchase by Egypt of about 300 units.

[k] This is an extended-range version which is under development for coastal defence purposes.

[l] The system is designed to employ semi-active homing missiles, particularly the Aspide-1A missile now in advanced development.

[m] The system uses Sea Killer Mk 2 missiles.

[n] The system uses either Sparrow RIM-7H or Aspide-1A missiles.

[o] For use against large vessels.

[p] XJ521 Skyflash is designated to replace the current AIM-7E Sparrow.

USA

[a] This includes an additional 60 Minuteman 3s, each of which will have three W-78 350-kt nuclear warheads. The remaining 550 already deployed will also be equipped with W-78s.

[b] TOW=Tube-launched, Optically-tracked, Wire-guided.

[c] SDM (Site Defense of Minuteman) is an ABM system which includes essentially phased-array radar, a computer subsystem and an improved version of the Sprint missile, Sprint II. The missile is in the advanced design stage but the system integration testing with the prototype radar and data processor is only scheduled to begin in 1977.

[d] In its final operational capability, the Safeguard system consists of 30 Spartan and 70 Sprint missiles.

[e] A $32.4-mn order from the US Army was received to produce 360 Lance non-nuclear missiles.

[f] US Army estimate of the total cost of the SAM programme.

[g] All 1 500 SRAMs have been delivered. Further orders depend on the future of the B-1.

[h] Unpowered, guided (Smart) bomb.

[i] Conversion of Walleye I missiles to the new type is proceeding.

[j] AGM-78D-2 is the current version.

[k] Total production between 1965 and 1977. Current production versions are the AGM-45-7A and AGM-45-9, and version AGM-45-10 is under development.

[l] This includes 2 850 Mavericks delivered to Iran and 650 Mavericks ordered by Saudi Arabia.

[m] This includes R&D costs.

[n] Projected procurement in FY 1976 for the USAF and the USN. The subsequent yearly procurement rate is expected to be 750 for the USN and 1 000 for the USAF. The USA will cooperate with FR Germany in the production of AIM-9Ls. The latter has agreed to cancel development of its Dornier Viper air-to-air missile.

[o] Planned procurement for FY 1976.

[p] Funds for the Condor missile programme were denied.

[q] Numbers of missiles of the two types on US ships by mid-1975. A total of 1 400 were deployed on foreign ships.

[r] Pilot production of 22 missiles started in 1976.
[s] A total of 231 Harpoons were acquired in FY 1976; planned procurements for 1977 and 1978 are 245 and 315 respectively.
[t] Appropriation for procurement in FY 1977 of 48 missiles was granted.
[u] SLCM=Sea-Launched Cruise Missile. The programme is a counterpart of the ALCM (Air-Launched Cruise Missile). The tactical model will have a range of 555 km or more and is likely to be armed with a conventional warhead for anti-shipping.
[v] For land attack. The weapon would be armed with a nuclear warhead in the 250-kt yield range.
[w] A US Navy variant has a reduced range of about 1 850 km; about half that of the submarine-launched version. When launched from the B-52, the missile will have a range of about 2 960 km.

WTO

[a] Forty SS-18s are probably deployed which could carry eight MIRVs, but at present they carry only a single warhead. A further 260 may be deployed by the end of the programme.
[b] Maximum range at high altitude; at low altitude it is 35 km.
[c] Various warheads have been reported. A somewhat larger missile with a larger warhead was seen in Moscow in 1967. This is believed to have been a nuclear warhead.
[d] The missile can engage targets at heights of between 0.5 km and 1.5 km.
[e] Maximum range at high altitude; at sea level it is 250 km.
[f] It is reported that the Soviet aircraft carrier "Kiev" is equipped with SS-N-12 missiles.
[g] Deployed on Osa-3 patrol boats.
[h] Deployed on Kresta 2 missile ship and "Krivak"-class destroyer.
[i] Deployed on "Nanuchka"-class missile gunboat, and "Juliet"-class submarine.
[j] The first Soviet SLBM using a solid propellant and a PBV for deployment on RVs may have a MIRV capability.
[k] The missile, with a PBV can probably deliver three MIRVs. The missile is in some respects similar to the SS-N-8 but it is believed to be larger, and to have a more sophisticated guidance system. The missile was successfully launched from a submarine in 1976.
[l] Deployed on "Kara"-, "Krivak"-, "Nanuchka"- and "Grisha"-class vessels.
[m] Deployed on the two "Moskva" helicopter carriers, six "Kresta II" cruisers, and on a "Kara"-class ship.
[n] Deployed on nine "Delta"-class submarines.
[o] Deployed on "Yankee"-class submarines.
[p] Deployed on "Charlie"- and possibly "Papa"-class submarines.

Other Europe/Other Developed

[a] Development of RB 05B has been halted following a decision by Sweden to procure the AGM-65 A/B Maverick missile.
[b] Range is determined more by the effective range of the sonar than by the Ikara missile itself.
[c] The CCS-2 IRBMs are currently deployed and the number is expected to remain the same.
[d] The CSA-1, a Chinese version of the Soviet SA-2 missile, is the basic operational SAM system.
[e] The CSS-X-4, China's only full-range ICBM, began trials in 1976. This missile is in the same class as the US TITAN and Soviet SS-9.

Country	Class, description, armaments	Power plant	Displacement *tons*[a]	Speed *knots*	Year of first ship: Laid down	Year of first ship: Launched	Year of first ship: Commissioned or completed	Number: domestic/ export or total	Aircraft capacity	Unit price *$ mn*	Foreign-designed Power plant, Electronics or Armaments
NATO											
Belgium	*E71* frigate ShShM, SAM, A/S TT 100 mm	GT	2 340	28	1947	. .	1976	4/–	–	. .	PP (UK) Ar. (NATO+Fr.) E-r (Neth.+USA)
Denmark	*"KV 72"*[b] corvettes ShShM, 76 mm, 40 mm	D	1 000	>30	. .	. .	. .	3/–	–	. .	PP (USA)
	Willemoes missile boat ShShM, 76 mm or 57 mm, TT	GT	220	40	(1974)	. .	1975	10/–	–	. .	PP (UK)
France	(*Le Redoutable*) strategic sub 16 SLBM, TT	N	9 000	25	1964	1967	1971	5[c]/–	–	(230)	–
	Agosta patrol sub 4A/S TT	D	1 725	20	1972	1974	1976	4/2	–	. .	–
	Type F67 destroyer ShShM, ShSuM, 3×100 mm, 2A/S TT	GT	5 745	31	1970	1972	1974	3[d]/–	2A/S hel	. .	Ar-hel (UK+Fr.)
	Type C70 destroyer A/S vers ShShM, SAM, 100 mm, 10TT	GT	4 100	30	1974	1975	1978	18/–	2A/S hel	. .	PP (UK) Ar-hel (UK+Fr.)
	A/A vers SAM, 2×20 mm	GT	4 100	30	. .	. .	. .	6/–	. .	. .	PP (UK) Ar (USA)
	Type A60 "Avisos" corvette 100 mm, 2×20 mm, A/S TT	D	1 170	24	1972	1973	1975	12/2[e]	–	. .	–
	PR 72S missile boat ShShM, 76 mm, 2×20 mm	D	536	28	(1975)	. .	. .	–/10	–	. .	Ar (It.+Fr.)
	PR 72 patrol boat 76 mm, 40 mm	D	445	28	(1974)	1975	1976	–/4	–	. .	Ar (It., Swe.)
	La Combattante II missile boat ShShM	D	255	40	. .	1971	1972	–/6	–	. .	–
	La Combattante III missile boat ShShM, 2×76 mm, 2A/S TT	D	418	32	1975	. .	1976	–/4	–	. .	–
	Trident missile boat ShShM, 40 mm	D	130	25	1973	(1975)	1977	30/–	–	. .	–
	L'Andacieux patrol boat	D	250	. .	. .	. .	1976	–/1	–	. .	–
	P92 patrol boat 2×20 mm	D	90	29	. .	. .	1975	–/20	–	. .	–
FR Germany	*Type 209* patrol sub 8TT	D	1 290	22	1971	1973	1974	–/15[f]	–	. .	E-f (Neth.)
	Type 143 missile boat ShShM, 76 mm, 2TT	D	378	38	1972	1974	1975	10/–	–	(27)[g]	E-f (Neth.) Ar (Fr., It.)
	. . missile boat, ShShM, 76 mm, 40 mm	D	230	40	. .	. .	. .	–/6	–	. .	Ar (Israel)

International:											
FRG, It., USA	*PHM-Patrol Hydrofoil Missile* ShShM, 76 mm	GT	221	>40	1973	1974	1976	(24)[h]	–	(39)	E-r (Neth.)
FRG, Nor.	*Type 210* coastal sub	D	750	. .	. .	. .	. .	21[i]	–	. .	. .
Italy	*Sauro* patrol sub 6TT	D	1 631	20	1974	1977	1977	2/–	–	. .	. .
	Lupo frigate ShShM, 127 mm, 4× 40 mm, 6TT	GT	2 700	35	1974	1976	1977	4/10[j]	1 hel	. .	PP (USA) Ar (NATO)
Netherlands	*Tromp* destroyer SA, 2×120 mm	GT	5 400	30	1971	1973	1975	2/–	1A/S hel	. .	PP (UK) Ar (USA, NATO)
	Kortenaer frigate ShShM, SA, 76 mm, 4A/S TT	GT	3 500	30	1975	1976	1978	13/–	1A/S hel	87	PP (UK) Ar (USA, NATO)
Norway	*"Hawk"* missile boat AS, 40 mm, 4TT	D	150	35	. .	. .	. .	14/–	–	. .	PP (FRG)
	Jägaren missile boat ShShM, 57 mm, 4TT	D	140	35	. .	. .	1972	–/17	–	(5)	PP (FRG)
UK	*Swiftsure* attack sub 5A/S TT	N	4 500	30	1969	1971	1973	6/–	–	(75)	. .
	Oberon patrol sub	D	2 410	17	1957	1959	1961	–/14[k]	–	(12)	. .
	Invincible A/S cruiser SA/ShShM	GT	19 500	28	1973	. .	(1979)	2/–	10 hel (5 V/ STOL)	269	. .
	Sheffield destroyer SA/ShShM, 115 mm	GT	3 500	30	1970	1971	1976	9/–	1A/S hel	41.3	. .
	Vosper Mk 10 destroyer ShShM, 2× 115 mm, AS, 2A/S TT	GT	3 800	30	1972	1974	1976	–/6[l]	1A/S hel	(45)	E-r (Neth., It.)
	Weapon frigate ShShM, SA, 2× 40 mm, 6A/S TT	GT	4 000	>30	1975	1976	(1978)	3/–	2A/S hel	30.5	Ar (Fr.)
	Amazon frigate ShShM, SA, 115 mm, 6TT	GT	2 500	32	1969	1971	1974	8/–	1A/S hel	21.5	Ar (Fr.)
	Brecon minesweeper/mine-hunter	D	725	. .	. .	. .	1978	2/–	–	7.9	–
	Island patrol boat 40 mm	D	1 250	. .	. .	. .	1976	5/–	. .	. .	–
	Logistic Landing Craft	D	1 413	. .	. .	. .	1977	3/–	. .	. .	–
	VT-2 missile hovercraft ShShM	GT	(100)	(60)	(1974)	. .	. .	. .	–	. .	. .
USA	*Trident* strategic sub SLBM[m]	N	18 700	30	1976	1977	1978	10/–	–	729.7[n]	–
	Los Angeles attack sub SuSuM, 4A/S TT	N	6 900	40	1972	1974	1976	39[o]/–	–	320	–
	Nimitz aircraft carrier SA	N	93 400	>30	1968	1972	1975	3/–	~100	(1 881)	–
	Virginia cruiser SA, ShSuM, 2× 127 mm, 6A/S TT	N	11 000	>30	1972	1974	1976	4/–	2 hel	(368)[p]	–
	Spruance destroyer SA, ShSuM, 2× 127 mm, 6A/S TT	GT	7 800	>30	1972	1973	1975	30/4	1 hel	(100)	–
	Perry frigate ShShM, SA, 76 mm, 6A/S TT	GT	3 605	>28	1975	1976	1977	50/2	2 hel	(143.4)[q]	E-f (Neth.) Ar (It.)

Country	Class, description, armaments	Power plant	Displacement *tons*[a]	Speed *knots*	Year of first ship: Laid down	Year of first ship: Launched	Year of first ship: Commissioned or completed	Number: domestic/ export or total	Aircraft capacity	Unit price *$ mn*	Foreign-designed Power plant, Electronics or Armaments
	SES-Surface Effect Ship air cushion frigate ShShM, SA	GT	3 000	>80	(1978)[r]	. .	. .	. .	2 hel	602[s]	–
	Tarawa amphibious assault SA, 3×127 mm	T	39 300	~24	1971	1973	1976	5/–	~30 hel	230	–
	AALC-Amphibious Assault Landing Craft	GT	(160)	(50)	. .	1975	. .	. .	–	82[t]	–
Warsaw Treaty Organization											
German DR	*Kondor II* coastal minesweeper 6×25 mm	D	280	21	. .	. .	(1971)	30/–	–	. .	. .
Poland	*Wisla* patrol boat 2×30 mm, 4TT	D	70	30	. .	. .	. .	12/–	–	. .	. .
USSR	*"Delta II"* strategic sub (16) SLBM	N	. .	. .	(1973)	1976	. .	(4)/–	–	. .	–
	"Delta" strategic sub (12) SLBM	N	10 000	25	. .	1972	1973	10/–	–	. .	–
	"Papa" patrol sub SuShM, TT	N	. .	. .	. .	(1971)	(1974)	1/–	–	. .	–
	"Charlie" patrol sub 8 SuShM, 8TT	N	5 100	~30	. .	1967	1968	12/–	–	. .	–
	"Charlie II"[u] patrol sub	N	. .	. .	. .	. .	. .	2/–	–	. .	–
	"Victor" patrol sub 8TT	N	5 100	>30	. .	(1966)	(1968)	18/–	–	. .	–
	"Victor II" patrol sub	N	6 000	. .	. .	. .	. .	1/–	–	. .	–
	"Tango" patrol sub	D	2 500	. .	. .	. .	(1974)	3/–	–	. .	–
	"Kara" cruiser SA, ShShM, 4×76 mm, 4×30 mm, 10TT	GT	10 000	~34	. .	. .	(1973)	(5)/–	1 hel	. .	–
	"Kresta II" cruiser SA, ShShM, 4×57 mm, 8×30 mm, 10TT	ST	8 000	33	1968	. .	. .	(10)/–	1 hel	. .	–
	"Kiev" A/S aircraft carrier ShShM, A/S TT, 4×76 mm	. .	40 000	>30	. .	. .	. .	(3)/–	25 V/STOL, 25 hel	. .	–
	"Krivak" destroyer SA, ShShM, 4×76 mm, 8TT	GT	3 900	38	. .	. .	(1971)	11/–	–	. .	–
	"Grisha" corvette SA, 2×57 mm, 4A/S TT	GT	900	30	. .	1970	1972	18/–	–	. .	–
	"Nanuchka" corvette SA, ShShM, 2×57 mm	D	850	30	. .	1971	. .	14/–	–	. .	–
	"Turya" hydrofoil patrol boat 2×57 mm, 4TT	D	230	40	. .	. .	1973	17/–	–	. .	–

Other Europe											
Spain	*Baleares* frigate SA, ShSuM, 127 mm, 4A/S TT	T	4 177	28	1968	1970	1973	5[v]/–	–	. .	E-r, E-s (USA) Ar (USA)
	F.80 frigate SA, 76 mm, 6A/S TT	D	1 400	25	1974	1975	1976	10/–	–	. .	PP (FRG) E-R (Neth.) E-s (USA) Ar (NATO, It.)
Sweden	*Näcken* patrol sub 8TT	D	1 125	20	. .	. .	1977	3/–	–	(20)	. .
	Spica II patrol boat 57 mm, 6TT	GT	230	(35)	. .	1972	1973	12/–	–	(8)	PP (UK)
Yugoslavia	. . missile boat ShShM, 57 mm	GT	240	40	(1973)	. .	. .	10/–	–	. .	PP (UK), Ar (Fr.)
Other developed											
China	*Han* patrol sub	(N)	. .	. .	(1971)	(1974)	. .	(2)/–	–	. .	. .
	Ming patrol sub 6TT	D	(1 500)	. .	(1971)	. .	(1975)	2/–	–	. .	. .
	"Romeo" patrol sub 6TT	D	1 600	14	. .	. .	(1971)	36/–	–	. .	. .
	Luta destroyer ShShM, 4×130 mm, 8×57 mm, 8×25 mm	T	3 750	>32	. .	. .	1971	7/–	–	. .	. .
	Kiangtung frigate SA, 4×100 mm, 8×37 mm	D	1 800	(28)	1971	1973	1974	2[w]/–	–	. .	. .
	Hainan corvette 2×50 mm, 4×57 mm, 4×25 mm	D	500	~25	1963	. .	. .	15/–	–	. .	. .
	Hola missile boat ShShM, 4×30 mm	D	200	32	(1972)	. .	(1974)	(53)[x]/–	–	. .	. .
	Hoku missile boat ShShM, 2×25 mm	D	80	40	(1973)	. .	(1974)	(50)[y]/–	–	. .	. .
	Shanghai patrol boat guns, TT	D	155	30	1960	. .	. .	255/65	–	. .	. .
Japan	*Uzushio* patrol sub 6TT	D	1 850	20	1968	1970	1971	8/–	–	. .	. .
	Haruna destroyer ShSuM, 2×127 mm, 2×35 mm, 6A/S TT	T	5 200	32	1976	. .	1980	2/–	3A/S hel	. .	Ar (USA)
	Tachikaze destroyer SA ShSuM, 2×127 mm, 3A/S TT	T	3 850	33	1973	1974	1976	2/–	–	. .	Ar (USA)
	Yamagumo destroyer ShSuM, 4×76 mm, 6A/S TT	D	2 100	27	1972	1973	1974	6/–	–	. .	Ar (USA)
	Chikugo escort ShSuM, 2×76 mm, 2×40 mm, 8A/S TT	D	1 500	25	1968	1970	1970	12/–	–	. .	. .
	Miura amphibious craft 2×76 mm, 2×40 mm	D	2 000	14	1973	1974	1975	3/–	–	. .	–
	Atsumi amphibious 4×40 mm	D	1 550	13	1971	1972	1972	3/–	–	. .	–

[a] For submarines, the displacement and speed are given when the ship is submerged.
[b] Three are under construction. Designed to replace "Triton"-class.
[c] The fourth submarine in this class was launched in 1976 and the fifth is being built. Plans to build a sixth were cancelled in early 1976. M-20 nuclear warheads are to be fitted on MSBS missiles carried by Le Foudroyant.
[d] The last ship, De Grasse, was commissioned in November 1976.

[e] The South African Navy is to buy two ships which will be taken from the French Navy's own 14-ship building programme.
[f] Nine of these ships are already commissioned and the remainder are either under construction or on order.
[g] Including development costs and subsystem.
[h] The US Navy's programme to construct 30 PHMs has been reduced to only five units now planned. The Federal Republic of Germany plans to build up to 12 ships and Italy up to seven.
[i] A development project is in hand by the Norwegian and West German Navies to replace the Type 205 (FRG) and Type 207 (Norway) in the 1980s.
[j] Four vessels have been ordered by Peru, two of which will be built in Peru.
[k] Of the 13 British, three Canadian and two Chilean ships, all are commissioned; two are under construction for Australia and two for Brazil.
[l] Two multi-purpose versions, armed with French Exocet anti-ship missiles, are being built in Brazil with material and technical assistance from the UK.
[m] The Trident submarines are each capable of carrying 24 MIRV missiles. The missile launch tubes have been designed to accommodate the larger Trident II missiles as a follow-on to the Trident I missile.
[n] Appropriation for the fifth Trident submarine.
[o] Twenty-eight of these have been authorized up to FY 1976. An additional 11 are planned to be built at the rate of two units a year at least until the early 1980s.
[p] Estimated cost in FY 1976 of the proposed fifth ship. This ship has however not been funded.
[q] This is the estimated cost per ship in FY 1977.
[r] The US Navy plans to develop a prototype SES and to produce a vessel by 1981. Construction will begin in FY 1978.
[s] Estimated programme costs up to the construction of one prototype.
[t] R&D costs, including two prototypes.
[u] An enlarged version of the "Charlie"-class.
[v] The last one was commissioned in 1976.
[w] Further construction has apparently been delayed or suspended.
[x] "Hola" is a modified version of the Soviet "Osa", seven of which were transferred directly from the Soviet Union.
[y] "Hoku" is a modified version of the Soviet "Komar", 10 of which were ordered from the Soviet Union.

Part 4. *Armoured vehicles*

Country	Designation, description	Main armament *mm*	Combat weight *tons*	Road speed *km/h*	Year design begun	Year of prototype test	Year in production	Number: domestic/ export or total	R&D cost *$ mn*	Unit price *$ mn*	Foreign-designed Power plant, Electronics or Armaments
NATO											
France	*AMX-30* main battle tank	105	36	65	1957	1962	1966	(1 000)/ (850)	. .	. .	–
	A/A vers, guns	30	. .	. .	. .	. .	. .	. .	. .	. .	–
	A/A vers, missiles	–	. .	. .	(1974)	. .	1978	–/. .	. .	. .	–
	AMX-13 light tank	105	15	64	. .	. .	. .	. ./~4 000[a]	. .	. .	–
	VXB-170A Berliet amphibious armoured personnel carrier	20	15.5	85	1965	1969	1973	600/. .	. .	. .	–
	AMX-10P amphibious armoured personnel carrier	20	13.8	65	(1965)	1969	1973	. ./250	. .	. .	–
	AMX-10 anti-tank	105	. .	. .	. .	. .	. .[b]	. .	. .	. .	–
	AMX-10RC recce vers	105	15	85	. .	(1973)	(1977)	. .	. .	. .	–
	VAB Saviem forward armoured vehicle	. .	12.9	90	(1969)	1973	. .	1 000[c]/. .	. .	. .	–
	M-3 Panhard armoured personnel carrier	. .	5.8	100	. .	1969	1971	700/3 300	. .	. .	–
	M-3 VDA A/A vers	22	. .	. .	. .	(1973)	(1976)	. .	. .	. .	–
	M-3 anti-tank, missile	. .	. .	. .	. .	. .	(1976)	–/. .[d]	. .	. .	–
	AML-245 armoured car	. .[e]	4.8–5.5	100	. .	1960	(1960)	(4 000)[f]	. .	. .	–
	H-90 current vers	90	. .	. .	. .	. .	. .	. .	. .	. .	–
	HS-30 current vers	30	. .	. .	. .	. .	. .	. .	. .	. .	–
FR Germany	*Leopard II* main battle tank	105 or 120	50.5	68	(1966)	1973	(1978)	. .	. .	. .	E-f (USA)
	Leopard I main battle tank	105	42.2	65	1957	. .	1965	2 437/1 388	(25)	0.72	Ar (UK)
	Gepard anti-aircraft tank system	35	45.1	65	1966	1969	1976	420/150	. .	1.7	Ar, E-f, Er (Switz.)
	Marder armoured personnel carrier	20	28.2	70	1959	. .	1970	2 516[g]/–	. .	0.39	. .
	Spähpanzer-2 Luchs armoured car	20	19	100	1965	1968	1975	408/. .	. .	. .	. .
	UR 416 armoured personnel carrier	. .[h]	6.3	80	. .	1973	. .	. ./(106)	. .	. .	. .
International: FRG, UK	*FMBT-80* main battle tank	(120)[i]	. .	. .	1972	. .	. .	. .	. .	. .	. .

Country	Designation, description	Main arma-ment mm	Combat weight tons	Road speed km/h	Year design begun	Year of proto-type test	Year in pro-duction	Number: domestic/ export or total	R&D cost $ mn	Unit price $ mn	Foreign-designed Power plant, Electronics or Armaments
Italy	*Type 6616* armoured recce car	20	7.4	95	. .	1973	. .	. .	. .	. .	Ar (Fr.)
UK	*Chieftain* main battle tank	120	53.8	48	(1958)	1959	1965	(800)/1950[j]	. .	0.67	. .
	Scorpion light tank	76	7.8	87	1964	. .	1974	>2 000[k]	. .	(0.2)	–
	FV721 Fox armoured car	30	6.4	104	1965/66	1967	1973	. ./(300)	. .	. .	–
USA	*XM-1* main battle tank	(105)	63.8	80	1972	(1976)	. .	3 312/–	35.6[l]	1.3	–
	M-60 main battle tank	105	. .	48	1956	1959	. .	1 600[m]/–	. .	0.52	–
	M-60A1 current vers	. .	48	48	. .	. .	1962	22 400[n]/–	. .	0.59	–
	M-60A2	152	58	48	1964	1965	1966	540[o]/. .	. .	. .	–
	M-60A3 improved vehicle	. .	. .	. .	. .	. .	1977	. .	. .	(0.17)	–
	XM-723 MICV-Mechanised Infantry Combat Vehicle	20–30	19.5	74	(1972)	1974	. .	1 200/. .	67	0.22	–
	M113A1[p] armoured personnel carrier	12.7	11.2	68	. .	1964	(1965)	1 200[q]/. .	. .	. .	–
	V-150 Commando armoured car	. .[r]	9.6	89	. .	1971	. .	–/. .	. .	. .	–
	M-48 main battle tank	90	47.6	48.3	1950	1951	(1951)	. .[s]/421[t]	. .	. .	–
Warsaw Treaty Organization											
Czechoslovakia	*SKOT-2A (OT-64)* amphibious armoured personnel carrier	14.5	14.8	95	1959	. .	(1963)	. .	. .	. .	–
Hungary	*FUG-70* amphibious scout car	14.5	7	100	. .	. .	(1970)	. .	. .	. .	–
USSR	*T-70* main battle tank	(122)	(40)	. .	. .	. .	1970–71	. ./–	. .	. .	–
	T-62 main battle tank	115	37.5	55	. .	. .	1961–62	. .	. .	. .	–
	BMD amphibious light tank	73	9	60	. .	. .	(1970)	. ./–	. .	. .	–
	BMP-1 infantry combat vehicle	73	12	60	. .	(1967)	. .	. .	. .	. .	–
	M-1970 armoured personnel carrier	7.62	10	55	. .	. .	. .	. .	. .	. .	–
	BRDM-2 (BTR-40P) recce car	7.62	5.6	80	. .	(1966)	. .	. .	. .	. .	–
	ZSU-23-4 anti-aircraft vehicle	23	14.5	44	. .	. .	1965	. .	. .	. .	–
Other Europe											
Austria	*Panzerjäger K* anti-tank vehicle	105	17	65	1965	(1968)	(1974)	~120/. .	. .	. .	Ar (Fr.)
Sweden	*Ikv 91* light tank	90	15.5	69	1968	(1970)	1973	. ./–	. .	. .	. .
	Pbv 302 (improved) armoured personnel carrier	20	13.5	65	. .	. .	. .	. ./–	. .	. .	. .

Switzerland	*Pz 68* main battle tank	105	39	55	(1968)	. .	(1970)	(280)/–	. .	(0.4)	PP (FRG) Ar (UK)
	Tornado 2 infantry combat vehicle	20 or 25	21	70	1967	1968	–[u]	–/. .	. .	. .	. .
Yugoslavia	*M60* armoured personnel carrier	12.7	9.5	45	. .	(1965)	(. .)	. ./–	. .	. .	. .
Other Developed											
China	*T-59 (T-54)*[v] main battle tank	100	36.5	48	. .	. .	(1963)	. .	. .	. .	–
	T-63 (light) tank	85	. .	. .	. .	. .	. .	. .	. .	. .	–
	T-60 (PT-76) light amphibious tank	84	(14)	. .	. .	. .	. .	. .	. .	. .	–
	M-1967 armoured personnel carrier	12.7	10	. .	. .	. .	(1967)	. .	. .	. .	–
Japan	*STB-6* main battle tank	105	38	53	1962	1968/69	1974	(280)/–	. .	(0.7)	Ar (UK)
	Type 73 amphibious infantry combat vehicle	12.7	13.3	60	. .	. .	(1974)	. ./–	. .	. .	. .

[a] Total of all versions exported. Argentina has also assembled AMX-13s.
[b] Under development.
[c] Under test by the French Army which has placed an initial order for more than 1 000.
[d] At least one export order has been finalized.
[e] Various types of armament used. Latest in the series is a version with the new 60-mm mortar.
[f] This is a total of all versions. A large number have been built under licence in South Africa.
[g] This includes a further production of 340 units.
[h] Missile vehicle is armed with TOW or Cobra anti-tank missiles and a reconnaissance vehicle is mounted with 20-mm cannon and 90-mm recoilless rifles.
[i] FR Germany has been invited to submit its Leopard II in the US XM-1 competition. The USA, FR Germany and the UK have not resolved the question of a common gun for the FMBT-80 and the winner of the Leopard II-XM-1 competition.
[j] The export order is from Iran only, which is also providing the funding for extensive modifications to the Chieftain.
[k] It is expected that Iran will increase its existing order for 250 Scorpions to 360.
[l] Final appropriation for R&D.
[m] Proposed US inventory of M-60s between 1975 and 1989.
[n] Proposed US inventory of M-60 Als and M-60 A2s.
[o] Proposed inventory between 1975 and 1989.
[p] There are two versions available, one upon which the six-barrel Vulcan gun can be mounted and the other on which a TOW missile can be mounted.
[q] The House Appropriation Committee had approved $89.4 mn for 1 200 of the US Army's M-113s.
[r] Various types up to 90 mm can be fitted.
[s] Proposed inventories of various models are as follows: M-48A1/A2C—2 800 units in 1975 to be reduced to zero by 1989; M48A3—400 units between 1975 and 1985 to be reduced to zero by 1980; and M-48A5-increasing the inventory to 1 200 by 1989.
[t] M-48A1 sold to the Republic of Korea.
[u] Development continuing. Enlarged version (24 tons) called "Taifun"; version with 90-mm anti-tank gun called "Gepard". Intended for export and/or licensed production.
[v] Vehicles of Soviet origin are shown with Soviet designation in brackets. They are listed as indigenous because China has been almost totally isolated from Soviet technology since 1960.

II. Register of licensed production of major weapons in industrialized countries, 1976

For sources and methods, see chapter 7. For conventions, see page 216.

Part 1. *Aircraft*

Licensee	Licenser	Year of licence	Designation, description	Power plant	Weight *max takeoff wt, kg*	Speed *km/h* or *Mach no.*	Nature of licence, technical changes by licensee	Year in production	Number: domestic/ export or total	Unit price $ *mn*
NATO										
Italy	USA	(1966)	*F-104S* fighter/strike	TJ	14 060	M 2.2	Mainly indigenous manufacture	1968	205/18[a]	. .
		1968	*CH-47C* transp hel	TS	17 463	286	Partial indigenous manufacture	1970	26/44[b]	. .
		1965	*SH-3D* A/S hel	TS	9 525	267	Indigneous manufacture except radar	1967	. .[c]	. .
		. .	*AB 214B* utility hel	TS	7 257	241	. .	. .	. .	. .
		. .	*AB 212A* A/S hel	TS	5 079	196	Indigenously developed A/S version of US aircraft	1975	28/. .[d]	. .
			AB 212 AWW Above Water Warfare	TS	. .	. .	Under development	. .	. .	. .
		. .	*AB 204AS* A/S hel	TS	4 310	167	Indigenously developed A/S version of US aircraft	. .	. .	. .
		. .	*AB 205A-1* utility hel	TS	4 310	222	Indigenous manufacture	1969	. .	. .
		1961	*AB 206B-1* utility hel	TS	1 519	222	Indigenous manufacture	1971	. .	. .
		. .	*NH-500M*[e] light hel	TS	1 360	244	Assembly of wholly indigenously produced NH-500 is expected to start in 1977	1973	. .	. .
UK	USA	1966	*SH-3 Sea King* A/S hel	TS	9 525	208	Indigenous manufacture, British engines and avionics	1969	13/33	. .
			Commando transp ver	TS	9 525	208	. .	1972	. ./34	. .
USA	Switzerland	(1965)	*AU-23A Peacemaker* COIN aircraft	TP	2 767	280	Military version of Porter developed in the USA	(1970)	. ./20	. .
Warsaw Treaty Organization										
Romania	UK	1968	*Islander* light transp	P	2 993	273	Indigneous manufacture	1969	315[f]	. .
	France	1971	*Alouette III* utility hel	TS	2 250	220	Assembly, some indigenous manufacture	1971	50/–	. .

Other Europe

Spain	FR Germany	. .	*CASA 223K1* trainer	P	821	249	Indigneous manufacture	1972	–/50[g]	
Yugoslavia	UK, France	1971	*Gazelle* light utility hel	TS	1 800	264	Assembly, eight pattern aircraft were supplied	1973	122	. .

Other Developed

Australia	USA	1971	*B206B-1* utility hel	TS	1 451	225	Some indigenous manufacture	1973	56/–	. .
Japan	USA	1969	*F-4EJ* fighter/bomber	TJ	24 765	>M 2	Mainly indigneous manufacture	1972	158/–	~11.25
		1959	*P-2J* maritime patrol	TP	34 019	402	Indigenous manufacture, substantial modification of US design	1969	82[h]/–	. .
		(1962)	*SH-3A* A/S hel	TS	18 044	166	Mainly indigenous manufacture	. .	67/–	. .
		(1961)	*KV-107II/IIIA* transp hel	TS	19 000	270	Indigenous manufacture	(1962)	. .	. .
		(1961)	*B205A-1* utility hel	TS	9 500	204	Indigenous manufacture	(1972)	(55)/–	. .
		1967	*OH-65* light hel	TS	1 225	216	Assembly	1969	135/–	. .
		. .	*TH-55J* light hel	P	1 670	138	. .	1974	48/–	. .
		(1976)	*AH-1*[i] attack hel	TS	9 500	352	Initially locally assembled	. .	32/–	. .

Licensee	Licenser	Year of licence	Designation, description	Power plant	Warhead weight *kg* (if nuclear, *kt* or *Mt*)	Range *km*	Nature of licence, technical changes by licensee	Year in production	Number: domestic/ export or total	Unit price $ *mn*
NATO										
International:										
European NATO Consortium (leader, FRG)	USA	. .	*AIM-9 Sidewinder* aircr-to-aircr	S	. .	. .	FRG secured the right to produce AIM-9L	. .	. .	. .
European NATO Consortium (leader, Nor.)	USA	. .	*AGM-12B Bullpup* aircr-to-ship/fixed	LP	113	~11	. .	. .	. .	. .
Italy	USA	. .	*AIM-7 Sparrow III* aircr/ship-to-aircr/miss	S	30	(25)	Indigenous manufacture	. .[j]	. .	. .
Turkey	FR Germany	. .	*Cobra 2000* portable-to-tank	S	2.7	2	. .	. .	. .	. .
UK	FRG/ France	1976	*"Milan"* anti-tank	S	HE	2	Initially subsystems purchased from FRG and France will be assembled in UK and by mid-1979 all-British Milan will be built		(50 000)[k]/ . .	. .
USA	FRG/ France	(1975)	Roland SAM	S	HE	6.5	. .	. .	. .	. .
Other Europe										
Yugoslavia	USSR	. .	*"Sagger"* portable/mobile-to-tank	S	11.5	3	. .	. .	. .	. .
Other Developed										
Japan	USA	1972	*MIM-14C Nike Hercules* fixed-to-aircr	S	HE	>140	Non-nuclear version	(1973)	(36)/–	(3.0)
		1972	*MIM-23 Hawk* mobile-to-aircr	S	HE	>11	. .	(1973)	(30)/–	(2.5)
		. .	*AIM-7 Sparrow III* aircr-to-aircr	S	30	(25)	. .	(1973)	600/–	. .

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Part 3. *Ships*

Licensee	Licenser	Year of licence	Class, description	Displacement *tons*	Speed *knots*	Nature of licence, technical changes by licensee	Year of first ship: Laid down	Year of first ship: Launched	Year of first ship: Commissioned or completed	Number: domestic/ export or total	Unit price *$ mn*
NATO											
Turkey	FR Germany	. .	*Jaguar III* missile boat ShShM	(400)	(38)	–	. .	. .	(1974)	3/–	. .
Other Europe											
Spain	France	. .	*Agosta* patrol sub 4A/S TT	1 725	20	Some French assistance	1975	. .	1979	2[1]/–	. .

Part 4. *Armoured vehicles*

Licensee	Licenser	Year of licence	Designation, description	Main armament *mm*	Combat weight *tons*	Road speed *km/h*	Nature of licence, technical changes by licensee	Year in production	Number: domestic/export or total	Unit price *$ mn*
NATO										
Belgium	UK	. .	*Scorpion* light tank	76	7.8	87	Substantial indigenous manufacture	(1973)	(700)[m]/–	. .
	FR Germany	1972	*Kanone JPZ4-5* anti-tank	90	26	70	Assembly	(1974)	80/–	0.37
Italy	FR Germany	. .	*Leopard* main battle tank	105	42.2	65	Indigenous manufacture	(1973)	600/–	. .
	USA	1963	*M113* armoured personnel carrier	–	10.7	64	Indigenous manufacture	. .	~3 600/1 620	. .
Warsaw Treaty Organization										
Czechoslovakia	USSR	. .	*T-62* main battle tank	115	15	62	Probably indigenous manufacture	. .	. .	. .
Hungary	Czechoslovakia	. .	*OT-64* armoured personnel carrier	14.5	12.8	95	. .	. .	. .[n]/–	. .
Poland	USSR	. .	*T-62* main battle tank	115	37.5	55	. .	. .	. .	. .
	Czechoslovakia	. .	*OT-64* armoured personnel carrier	14.5	12.8	95	. .	. .	. .[n]/–	. .
Other Europe										
Spain	France	1972	*AMX-30* main battle tank	105	36	65	Assembly	(1974)	180/–	. .

[a] Turkey has received 18 and holds an option on four more.
[b] Since deliveries to Iran are behind schedule, 26 units will be built in the USA.
[c] The status of the production programme is unclear. It is probably nearing completion. It is reported that Syria may buy 12 units.
[d] Two hundred units of various versions have been sold.
[e] An ASW version is being considered.
[f] A total of 114 had been completed by 1973. The production was scheduled to increase to 40 and 50 in 1974 and 1975, respectively.
[g] Of these, 37 or more had been delivered. Syria is planning a follow-on order of 16.
[h] Sixty-two were delivered by March 1976.
[i] Japan has decided to produce AH-1 helicopters under licence.
[j] The AIM-7E will eventually be replaced by the Aspide-1A missile. Manufacturing licences have been granted to Italy by FR Germany.
[k] The UK will initially purchase 5 000 missiles from France.
[l] Two more are under consideration.
[m] This includes both the "Scorpion" and a version armed with an anti-tank missile known as "Striker".
[n] Production may be complete.

Appendix 7C

Register of arms trade with industrialized countries, 1976

For sources and methods, see chapter 7. For conventions, see page 216.

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
Australia	France	1	"Improved Durance"-class	Fleet replenishment ship	$74.6 mn; navy order imminent	(1977)	(1982)
	FR Germany	87	Leopard 1A3	Tank			
		6	. .	Armoured recovery vehicle	$47 mn	May 1975	1976–77
		5	. .	Bridge-layer			
		14	Leopard 1A3	Tank	$17.4 mn; replacing Centurion; new 5-year defence programme	1976	(1977)
	New Zealand	37	NZAI CT-4 Airtrainer	Trainer	$3.5 mn	1973	1975–76
	UK	100	BAC Rapier	SAM	$44 mn incl 20 launchers and special radar equipment; new 5-year defence programme	1975	1978–81
		2	"Oberon"-class	Patrol submarine	$64 mn; displ: 1 610 t; in addition to 4 previously acquired; Australian designation "Oxley"-class	Oct 1971	1977
		1	Wessex AS Mk 31	Helicopter carrier	With 7 helicopters; brings total to 4	. .	Feb 1976
		1	Vosper Thornycroft "Harrier Carrier"	Aircraft carrier	Req: 3 for navy; 2 to be built in Australia	Jan (1977)	(1983)
	UK/USA	10	Westland/Sikorsky SH-3D Sea King	ASW helicopter	$3.1 mn; order cut from 20; for navy	1972	1975–76
	USA	6	Grumman S-2E Tracker	ASW aircraft	$1.2 mn incl spares, freight; surplus; option on 12 more	1976	1977
		12	Lockheed C-130H Hercules	Transport aircraft	$115 mn; to replace C-130A	1975	1978
		8	Lockheed P-3C Orion	Long-range maritime patrol aircraft	Offset orders for Australian industry	Jun 1975	1977–78
		2	Lockheed P-3C Orion	Long-range maritime patrol aircraft	$31 mn	1976	1979

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
		. .	McDonnell Douglas RGM-84A Harpoon	ShShM	To arm 2 new "Perry"-class frigates	1976	1981–82
		2	FFG-7, "Perry"-class	Patrol frigate	U.c.: $266 mn; displ: 3 400 t; arms: Harpoon ShShM	1976	1981–82
Austria	Israel	20–24	IAI Kfir	Fighter-bomber aircraft	U.c.: $5 mn excl spares; competitor Viggen u.c.: $8 mn; decision expected Jan 1977	(1977)	. .
	Switzerland	12	Pilatus PC-6 Turbo Porter	STOL utility transp aircr		Apr 1975	Aug 1976–Feb 1977
	USA	12	Bell 206B JetRanger	Helicopter	For observation and liaison	1975	1976
Belgium	France	. .	Aérospatiale MM-38 Exocet	ShShM	To arm 4 new "E-71"-class frigates to be completed 1976–78; 4 launchers/ship	1976	(1977–)
	France/FR Germany	33	Dassault-Breguet/Dornier Alpha Jet 1B	Trainer aircraft		Sep 1975	1978–80
	FR Germany	80	Rheinstahl JPK 90	Tank destroyer	$29.7 mn incl spares and training	1972	1975–76
	FR Germany/ Switzerland	55	Gepard 35-mm	A/A tank	Arms: SP gun; developed by Oerlikon-Contraves, Switzerland	1973	1976
	Italy	22	SIAI-Marchetti SF-260	Trainer aircraft	For light strike role	1976	. .
	Italy/USA	. .	Selenia/Raytheon Sea Sparrow	ShAM	Incl 4 launchers; arming 4 new E-71 frigates under construction in Belgium; completed 1976–78	. .	(Dec 1976–78)
	UK	12	Fairey/Britten-Norman BN-2 Islander	STOL transport aircraft	$3.6 mn; for army; to replace Dornier Do-27B	Nov 1975	1976–77
		3	Hawker Siddeley HS 748	Transport aircraft	$7 mn; to replace Douglas C-54/C-47; option on 2 more	1974	Aug 1976
		(500)	BAC Swingfire	ATM	Arming FV 102 striker AC	1973	. .
	UK/USA	5	Westland/Sikorsky SH-3D Sea King Mk 48	SAR helicopter	$14 mn	1974	1976
	USA	116	General Dynamics F-16	Light-weight fighter aircr	$850 mn incl 12 two-seat F-16Bs; co-production scheme; arms: 2× Sidewinder AAM, 4×Sparrow AAM	Jul 1976	1979–

		6	Swearingen Merlin 3A	Light turboprop transport aircraft	$8.6 mn; for liaison and survey; replacing Pembroke	Sep 1975	1976
		. .	Raytheon AIM-9L Sidewinder	AAM	Arming 102 F-16s	Jul 1976	1979–
		. .	Raytheon AIM-7E Sparrow	AAM	Arming 102 F-16s	Jul 1976	1979–
		. .	LTV Lance	SSM	With non-nuclear warhead	May 1975	1976–77
Bulgaria	Czechoslovakia	(50)	Aero L-39	Trainer aircraft	Adopted as standard basic jet trainer for WTO countries except Poland; to replace 150 L-29s	1972	(1977–)
		(500)	BMP-76 (BMP-1)	APC	Replacing BTR-50P	. .	(1975–76)
		. .	T-62	Tank	Bulgaria has a small number; first units delivered 1969	. .	(1975–76)
		. .	ZSU-23-4 Shilka	SP A/A gun		. .	(1975–76)
Canada	FR Germany	8	Biber	Bridge-laying tank	$187 mn incl Leopard and Taurus tanks; for Canadian troops in FR Germany	1976	1978
		128	Leopard C-1	Tank	$187 mn incl Biber and Taurus tanks; offset orders in Canada up to 40% of total price within 10 years; training in FR Germany; 85 tanks to replace Centurion for Canadian troops in Europe	1976	1978–
		8	Taurus	Tank	$187 mn incl Biber and Leopard tanks; for Canadian troops in FR Germany	1976	1978
	UK	. .	Short Blowpipe	Infantry SAM	$28 mn; 100 launchers	1973	1975–76
	USA	18	Lockheed P-3C Orion	Long-range patrol aircr	$1.1 bn incl ground training equipment, maintenance trainers, simulators, ASW computer, data centre; offset orders in Canada; u.c.: $21.2 mn	Jul 1976	1980–81
		. .	Hughes BGM-71 TOW	ATM	$30 mn incl 150 launchers and support equipment	1973	1975–76
China	France	13	Aérospatiale SA-321 Super Frelon	SAR helicopter		1973	1975–76
	FR Germany	4	MBB Bo 105	Helicopter	U.c.: $600 000; order signed by National Machinery Import and Export Company; option on 16 more	Jun 1976	Dec 1976–

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
Czecho-slovakia	USSR	. .	T-62	Tank	Has small number	. .	(1975–76)
		. .	BMP-76 (BMP-1)	APC	Replacing 85 BMPs and OT-65s	. .	(1975–)
		. .	ZSU-23-4 Shilka	SP A/A gun		. .	(1975–)
Denmark	FR Germany	120	Leopard 1A3	Tank	$85 mn; to replace Centurion	1974	1977–80
	Italy/USA	. .	Selenia/Raytheon Sea Sparrow	ShAM	Arming 6 newly constructed "KV 72"-class	(1975)	. .
	Sweden	5	Saab-Scania TF-35 Draken	Trainer aircraft	$14.2 mn; brings total to 51	1973	1976
		32	Saab-MFI T-17 Supporter	Light trainer aircraft	$4.2 mn; offset orders; replacing Chipmunks	Jan 1975	1975–77
	USA	48	General Dynamics F-16	Light-weight fighter aircraft	$440 mn excl armaments; complete costs expected to be much higher; offsets orders in Denmark; to be produced by British-Belgian company Fairey; option on 10 more until 31 May 1978	Jul 1976	1979–
		20	McDonnell Douglas RGM-84A Harpoon	ShShM	$9.7 mn	Dec 1975	(1977–)
Finland	Sweden	15	Saab-Scania J35 Draken	Strike/trainer aircraft	$15 mn incl special equipment and simulators; refurbished ex-Swedish AF; 6 J35Bs training in 1976	Jan 1976	Jun 1976–79
	UK	30–50	Hawker Siddeley HS Hawk	Strike/trainer aircraft	$123 mn; letter of intent signed; negotiating for offset orders; licensed production planned; selected in favour of Saab Draken	(Mid-1977)	(1979–)
	USSR	. .	SAM-3	SAM	Negotiating, incl training; firm order expected	(1977)	(1978)
		. .	SAM-6	SAM	See above	(1977)	(1978)
France	USA	1	McDonnell Douglas Super 62 DC-8	Transport aircraft	$11.2 mn; for transport and liaison	1975	1976
German DR	Czechoslovakia	. .	Aero L-39	Trainer aircraft	Adopted as standard basic jet trainer for WTO countries except Poland; to replace 20 L-29, Yak, MiG-15	(1972)	(1977–)

		..	Zlin 43	Light trainer aircraft		(1975)	1976
	USSR	..	T-62	Tank	First units delivered 1969	..	(1975–76)
		..	BMP-76	APC	Replacing BTR-50P	..	(1975–76)
		..	ZSU-23-4 Shilka	SP A/A gun		..	(1975–76)
FR Germany	France	..	Aérospatiale AS.30	ASM		1975	1975–76
		200	Aérospatiale MM-38 Exocet	ShShM	To arm 6 S.143 patrol boats	1973	1976–80
		150	Aérospatiale MM-38 Exocet	ShShM	To arm 30 patrol boats and 4 destroyers	Aug 1976	1977–79
	France/UK	6	Aérospatiale/Westland SA-330 Puma	Helicopter	Option on 2 more	1976	..
	Switzerland	12	Pilatus Turbo Porter	STOL transport aircraft	Brings total to 24	1975	1976–77
	UK/France	12	Westland/Aérospatiale WG-13 Lynx	ASW helicopter	$84.3 mn; for 6 Type 122 frigates; navy order	1976	1977–85
	UK/Italy	..	FN-70	155-mm howitzer	To replace all old types by 1977; army order	(1975)	1976–77
	USA	12	Bell 206B JetRanger	Light observation hel	$2.8 mn; brings total to 24	1976	(1977)
		3	Bell 212	SAR helicopter	$1 mn; to replace Bell UH-1H for SAR	Mar 1976	(1977)
		..	General Dynamics RIM-66A Standard	SAM	To replace Tartar	..	1976–77
		..	Hughes AGM-65A Maverick	AAM	Arming F-40; see licensed production register	1969	1972–76
		4 000	Hughes BGM-71 TOW	ATM	$33 mn incl 175 launchers	1976	(1976–77)
		175	LTV MGM-52 Lance	SSM	Incl 26 launchers; with non-nuclear warhead; army order	1974	1976–77
		..	McDonnell Douglas RGM-84A Harpoon	ShShM	To arm F.122 frigates and "Adams"-class destroyers	1976	..
		500	Raytheon AIM-9L Sidewinder	AAM	$43 mn; incl support equipment; contract not finalized; to update 175 F-4Fs over next 5 years	1976	(1977–82)
		..	Raytheon AIM-7 Sparrow	AAM	$155.2 mn incl electronic equipment, 105-mm cannon; sale announced by DoD; contract not finalized	1976	..
		..	Raytheon Patriot	SAM	Selected to succeed improved Hawk	(1977)	..
		300	M-113	APC		(1975)	(1976–77)
		..	..	Destroyer	Sale approved by US Senate 5 Aug 1976; ex-WW II	1976	(1977)
		10	Type 162	Fast-attack missile boat	Displ: 202 t; under construction by Boeing, Seattle; arms: 4×Exocet ShShM	May 1975	..

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
Greece	Canada	3	Canadair CL-215	Amphibious transp/ bomber aircraft	U.c.: $3 mn; brings total to 5	1975	Apr 1976
	France	4	Aérospatiale Alouette III	Helicopter	Navy order for ASW	1975	Mar 1976
		40	Dassault Mirage F-1C	Fighter aircraft	$295 mn	. .	Aug 1975–77
		. .	Aérospatiale SS.12 M	ShShM	Arming 2 new missile boats completed 1975–76	1974	1975–76
		. .	Aérospatiale MM-38 Exocet	ShShM	Arming total of 14 Combattante II/III missile boats	1976	. .
		120	AMX-30	Tank		1974	Mar 1975–76
		(100	. .	APC		1974	1975–76)
		6	Combattante II	Missile boat	$64 mn; displ: 300 t; arms: 4×Exocet ShShM; 4 to be produced in Greece (see licensed production register); brings total to 14	Dec 1976	. .
		4	Combattante III	Missile boat	Displ: 332 t; arms: Penguin ShShM	1974	1978–
		2	. .	Missile boat	Displ: 115 t; arms: SS.12 ShShM	1974	1975–76
	France/ FR Germany	. .	Euromissile Milan	ATM		1975	1975–76
	FR Germany	7	"Jaguar"-class	Fast torpedo boat	Displ: 160 t; completed 1958	1974	1975–76
		4	Improved Type 209	Submarine	$66 mn; displ: 1 000 t; NATO MAP	Oct 1975	1977–78
	Israel	~20	Nord 2501 Noratlas	Transport aircraft	Negotiating; surplus ex-IAF; firm order expected	(1977)	(1977)
	Italy/USA	. .	Selenia Aspide/Sea Sparrow	ShShM	First to be delivered with Italian-built Sea Sparrow; later with Aspide ShShM	1976	. .
	Norway	. .	Kongsberg Penguin	ShShM	Arming Combattante III missile boats	1976	1978–
	USA	35	Bell UH-1H Iroquois	Utility helicopter	$27.5 mn; FMS sale announced 26 Jan 1977	1976	. .
		8	Lockheed C-130H Hercules	Transport aircraft	U.c.: $5.8 mn incl spares	1975	1976
		60	LTV A-7H Corsair	Strike aircraft	$259.2 mn incl spares and training	1974	1975–77
		2	McDonnell Douglas F-4E Phantom	Fighter aircraft	Replacement; in addition to 38 previously delivered; arms: Maverick AAM	1976	1976
		8	McDonnell Douglas RF-4E Phantom	Fighter/recce aircraft	$91 mn incl spares and support equipment; arms: Maverick AAM	Dec 1975	1976

		40	Rockwell T-2E Buckeye	Trainer aircraft	$55 mn	1974	1976–77
		. .	Hughes AGM-65A Maverick	AAM	Arming F-4E and RF-4E	1975–76	1976
		. .	Hughes BGM-71 TOW	ATM		(1974)	1974–76
		300	Raytheon AIM-9J-1 Sidewinder	AAM	$7.5 mn; FMS sale announced 25 Jan 1977; (arming 38 F-4Es, 8 RF-4Es)	1976	1977–
		2	FFG-7, "Oliver H. Perry"-class	Frigate	To be financed through US grant aid funds; firm order expected	(1977)	. .
		7	. .	Destroyer	See above	(1977)	. .
		1	"Gearing"-class	Destroyer	Displ: 2 425 t; completed 1945	1975	1976
		2	"Asheville"-class	Large patrol boat	Displ: 225 t; completed 1969	1975	Jun 1976
Hungary	Czechoslovakia	. .	Aero L-39	Trainer aircraft	Adopted as standard basic jet trainer for WTO countries except Poland; to replace L-29	(1972)	(1977–)
		. .	BMP-76 (BMP-1)	APC	To replace BTR-50	. .	(1975–76)
		. .	ZSU-23-4 Shilka	SP A/A gun		. .	(1975–76)
Iceland	Netherlands/ FR Germany	1	Fokker/VFW F.27 Friendship Mk 200	Transport aircraft	For SAR and maritime patrol	Sep 1975	Nov 1976
Ireland	Italy	10	SIAI-Marchetti SF-260 W Warrior	Ground attack/trainer aircr	For primary training and coastal patrol	1976	Nov 1976– Feb 1977
	UK	4	Short Skyvan 3M	Light transport aircraft	$2.2 mn; order imminent	(1977)	. .
Italy	USA	40	McDonnell Douglas F-4E Phantom	Fighter aircraft	$125 mn credit incl spares and training; arms: AAM, ASM; firm order expected	(1977)	. .
		. .	General Dynamics RIM-66A Standard	SAM		. .	(1976–)
		5 000	Hughes BGM-71 TOW	ATM	$51.5 mn incl 130 launchers	1972	1974–76
Japan	USA	1	Beechcraft C90 King Air	Trainer aircraft	Funded for FY 1977; navy order for instrument training	Mar 1975	1977
		1	Bell AH-1S	Assault helicopter	$3.2 mn; funded for FY 1977; army order; delivery 1979 for evaluation; licensed production planned to start 1983	1976	1979
		5	Grumman E-2C Hawkeye	AEW aircraft	Order reduced from 15; to be contracted after Apr 1977; funding to be sought in FY 1978 budget	(1977)	(1979)

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
		2	Sikorsky RH-53D	Minesweeping helicopter	Funded for FY 1977; navy order	1976	1977
		80	General Dynamics RIM-60A Standard	ShShM	Arming 2 new "Tachikaze"-class destroyers under construction	(1975)	(1976–77)
		..	McDonnell Douglas RGM-84A Harpoon	ShShM	Navy order; arming ships and helicopters	1976	..
		..	Raytheon RIM-7H Sea Sparrow	ShShM	Arming 2 new "Haruna"-class destroyers	(1975)	1980–81
Netherlands	France/ FR Germany	20	Euromissile Milan	ATM	Bought for evaluation; competing with Dragon	1976	1976
	FR Germany	30	MBB Bo-105C	Light observation hel	$24 mn	1974	Jul 1975–76
	FR Germany/ Switzerland	95	Krauss Maffei/ Oerlikon-Contraves Gepard	A/A tank	$86 mn for first 60; with 35-mm SP gun	1973	1977–
	Italy/USA	..	Selenia/Raytheon Sea Sparrow	ShAM	Arming 13 new Kortenaer frigates	(1974)	1978–84
	UK/France	8	Westland Aérospatiale WG-13 Lynx	ASW helicopter	$16.4 mn; to replace Agusta Bell	Nov 1974	Nov 1976–77
		10	Westland Aérospatiale WG-13 Lynx	ASW helicopter	Uprated version	1976	1977
		8	Westland/Aérospatiale WG-13 Lynx	ASW helicopter	$8.6 mn; uprated version	Feb 1976	1978–
		..	General Dynamics RIM-66A Standard	ShShM	Arming new "Tromp"-class destroyers	..	Sep 1976
		..	Hughes BGM-71 TOW	ATM	Third contract	1975	(1976)
		20	McDonnell Douglas Dragon	ATM	Bought for evaluation; competing with Milan	1976	1976
		1 batt	LTV MGM-52 Lance	SSM	$35 mn; with non-nuclear warhead	May 1975	1978
		12	McDonnell Douglas RGM-84A Harpoon	ShShM	$4 mn; arming new frigates; order may be increased to $160 mn	1976	1978
		~840	Raytheon AIM-9J-1 Sidewinder	AAM	$21.2 mn incl 40 training vers; FMS sale	1976	(1977–)
		850	M-113 Al	APC	$230 mn	1975	1977–78
New Zealand	UK	10	Hawker Siddeley Andover	Tactical transport aircraft	$14.3 mn; incl spares and support equipment; ex-RAF surplus stocks; to replace Bristol 170 and C-47	1976	Dec 1976– Jan 1977

Norway	(Sweden	1	. .	Inshore minesweeper	Displ: 130 t	. .	. .)
	Italy/USA	. .	Selenia/Raytheon Sea Sparrow	ShAM	Arming 13 new Kortenaer frigates	(1974)	1978–84
	USA/ Netherlands	72	General Dynamics F-16	Light-weight fighter aircr	$1 bn excl spares, arms and support equipment; cost escalated and now equals total defence budget for FY 1977; co-production scheme; planes to be assembled by Fokker-VFW	Jul 1976	1979–
	USA/ FR Germany-France	900	Euromissile Roland	SAM	$109.2 mn incl 40 launchers; licensed production in USA	1976	1981–
	USA	. .	M-113A1	APC	Production for new order started 1976	1976	(1977–)
Poland	USSR	. .	BMP-76 (BMP-1)	APC	To replace BTR-50P	. .	(1975–76)
		. .	ZSU-23-4 Shilka	SP A/A gun		. .	(1975–76)
Portugal	France	. .	Aérospatiale MM-38 Exocet	ShShM	Incl 30 launchers; arming 10 "João Coutinho"-class frigates	1976	(1977–)
	FR Germany	6	Fiat G.91T	Trainer aircraft	Incl support equipment and training; ex-Luftwaffe surplus; for NATO brigade	1975	1976
		14	Fiat G.91R	Light strike aircraft			
		. .	Lockheed F-104G Starfighter	Fighter aircraft	Small number; ex-Luftwaffe surplus	(1975)	1976
		24	CASA C.212 Aviocar	STOL transport aircraft	$34.5 mn incl 2 C.212B trainers	1974	1975–76
	USA	6	T-38 Talon	Trainer aircraft	Ex-USAF	1976	Jan 1977
		2	Lockheed C-130H Hercules	Transport aircraft	Incl spares and technical support	Sep 1976	Aug–Sep 1977
		5	M-48	Tank	Lease; for NATO brigade	(1975)	1976
		20	. .	AC	For NATO brigade	(1975)	1976
Romania	Czechoslovakia	. .	Aero L-39	Trainer aircraft	Adopted as standard basic jet trainer for WTO countries except Poland; to replace L-29	(1972)	(1977–)
	USSR	. .	T-62	Tank	Adopted as successor to T-54/55	(1969)	(1977–)
		. .	BMP-76	APC	To replace BTR-50P	. .	(1975–76)
		. .	ZSU-23-4 Shilka	SP A/A gun		. .	(1975–76)
Spain	France	15	Dassault Mirage F-1C	Fighter aircraft	$91.5 mn	(1974)	1975–76
		. .	Thomson-CSF/Matra Crotale	Naval ShAM	Selected by navy in preference to Sea Sparrow; for 10 "F-80"-class frigates under construction since 1974	(1976)	. .

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
		..	Matra R.550 Magic	AAM	Arming 15 F-1Cs	(1974)	1975–76
	FR Germany	1	"Barcelo"-class	Patrol boat	Displ: 139 t; 5 more to be licence-produced 1976–77	1973	1976
	Italy	8	Agusta Bell 212	ASW helicopter	Contract being finalized	(1977)	(1977–)
	UK/USA	6	Hawker Siddeley HS Harrier AV-8A	V/STOL fighter aircraft	$30 mn; 5 more planned; US Marine Corps acting as procurement agent for Spain	1973	1976
		2	Hawker Siddeley HS Harrier TAV-8A	V/STOL trainer aircr			
	USA	18	Beech F-33C Bonanza	Trainer aircraft	Brings total to 30	1975	1976
		12	Bell AH-1G HueyCobra	Helicopter	Navy order; brings total to 20	1974	1976
		(15)	Bell UH-1H Iroquois	Helicopter	For AF and army	..	1976
		6	Boeing-Vertol CH-47 C Chinook	Helicopter	Army order; for heavy transport; brings total to 12	Feb 1976	1977
		72	General Dynamics F-16	Light-weight fighter aircr	USAF leased 42 F-4Es pending delivery of F-16	1976	(1980–)
		5	Lockheed C-130H Hercules	Transport aircraft	Brings total to 9	1975	1976
		3	Lockheed KC-130H Hercules	Tanker/transport aircraft		1975	1976
		42	McDonnell Douglas F-4E Phantom	Fighter aircraft	$53 mn; ex-USAF lease for 5 years, pending delivery of F-16; arms: Maverick AAM	1976	1977–
		12	Sikorsky SH-3D Sea King	ASW helicopter		1974	..
		1 batt	Raytheon MIM-23B Improved Hawk	SAM		1975	1976
		..	Tartar	ShShM	Arming 5 DEG-7 destroyers	1975	(1977–)
		80	General Dynamics RIM-66A Standard	ShShM	Arming 5 "Baleares"-class frigates	1968	1973–76
		..	Hughes AGM-65A Maverick	ASM	$23.6 mn; arming 42 F-4Es on lease	1976	1977–
		..	Raytheon AIM-9J-1 Sidewinder	AAM	$23 mn	1976	1977–
		..	M-113 A1	APC	Production for new order started 1976	1976	1977–
		1	AF-56	Store ship	Ex-USN	1975	Apr 1976
Sweden	France/ FR Germany	..	Euromissile Milan	ATM	Small number bought for evaluation	1975	1976
	Norway	..	Kongsberg Penguin	ShShM	Arming 16 new "Jägaren"-class patrol boats under construction	1975	(1977–)

		16	"Jägaren"-class	Patrol boat	$33.7 mn for hulls; arms: Penguin ShShM; Sweden to supply guns and electronics	1975	(1977–80)
	USA	. .	Hughes AGM-65A Maverick	ASM	U.c.: $40 000; total: $20.5 mn; arming AJ-37 Viggen	Feb 1976	1978–
		. .	Hughes BGM-71 TOW	ATM	Small number bought for evaluation	Oct 1975	1976
		. .	Raytheon MIM-23B Improved Hawk	SAM	$39 mn; for updating of "Robot 67" system	1976	1980–83
Switzerland	Sweden	. .	Bofors Bantam	ATM	Standard equipment in Swiss Army since 1967	(1965)	1967–
	USA	72	Northrop F-5E/F	Fighter aircraft	$460 mn incl 6 F-5Fs; ordered despite failure to arrange $10.6 mn worth of offset agreements	1976	1979–80
		. .	McDonnell Douglas Dragon	ATM	$200 mn; army order to be signed in 1977 if funding provided; licensed production of all components except missile	(1977)	
Turkey	FR Germany	193	Leopard A2	Tank	$221 mn; FRG credit; 50% to be paid over next 5 years	1976	(1977–)
		1	Lürssen-type	Fast missile boat	Displ: 400 t; 3 more being licence-produced	1973	1976
		7	"Jaguar"-class	Fast attack torpedo boat	Displ: 160 t; completed (1962); arms: 2×Bofors guns	1975	1975–76
		5	"Vegesack"-class	Coastal minesweeper	Displ: 262 t; completed 1960; ex-FRG; French design; arms: 8×Harpoon ShShM	(1975)	1975–76
		1	Type 209	Submarine	Displ: 990 t; in addition to 2 previously acquired; 2 more to be licence-produced	1974	1978
	FR Germany/ France	6 520	Euromissile Milan	ATM	$253 mn incl 438 launchers; FRG credit; army order	1976	(1977–)
	Italy/USA	22	Aeritalia/Lockheed F-104S Starfighter	Fighter/interceptor aircr	Brings total to 40; arms: Sparrow AAM	1975	1976
		56	Agusta Bell 205	Helicopter	Army order for commando units	1976	(1977–)
		3	Agusta Bell 212	ASW helicopter	$4 mn; navy order	1975	(1977)
		200	Selenia/Raytheon AIM-7E Sparrow	AAM	FY 1976 funding; arming 40 F-4Es	1975	1976–

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
	Norway	. .	Kongsberg Penguin	ShShM	Firm navy order expected	(1977)	. .
		. .	. .	ATM	$13 mn; sale approved by Norwegian Foreign Ministry; firm order expected	(1977)	. .
	USA	40	General Dynamics F-16	Light-weight fighter aircr	Initial batch of 40 to be contracted in 1977; requirement: >100 from 1980	(1977)	(1980–)
		40	McDonnell Douglas F-4E Phantom	. .	$464 mn incl spares and training; Ex-Im Bank loan; agreement reached in exchange for re-opening of 20 US bases in Turkey; arms: Sparrow AAM	1976	1977–
		. .	Hughes AGM-65A Maverick	ASM	U.c.: $40 000; arming F-4E	1976	1977–
		. .	Hughes BGM-71 TOW	ATM	Incl in US sales list presented Jun 1976 for Congressional approval	1974	(1977–)
		33	McDonnell Douglas RGM-84A Harpoon	ShShM	Arming 4 new "Lürssen"-type missile boats	1976	Feb 1977
		. .	Raytheon AIM-7 Sparrow 3	AAM	Incl spares; included in US sales list presented Jun 1976 for Congressional approval; arming F-4E and F-104S	1975	1977–
		. .	M-113 A1	APC	Production for new order started 1976	1976	1977–
		2	"Guppy III"-class	Submarine	Displ: 1975 t; completed 1945–46; ex-USN; delivery upheld under US embargo 1975–Apr 1976	1974	(1977)
	USSR	60	Mil Mi-8	Helicopter	Army order	1975	(1977–)
UK	France	300	Aérospatiale MM-38 Exocet	ShShM	First fitted into 4 "County"-class cruisers 1973; being refitted into 4 "Amazon"-class, 3 "Weapon"-class and 8 "Leander"-class destroyers 1976–78	Jun 1971	1973–75
		. .	Aérospatiale MM-40 Exocet	ShShM	Arming 6 "Sheffield"-class frigates	(1976)	1977

	France/FR Germany	5 000	Euromissile Milan	ATM	Incl 300 guidance and sighting systems; licensed production of total of 50 000 to begin 1979	Oct 1976	1977–78
	USA	..	LTV MGM-52 Lance	SSM	$128 mn; with non-nuclear warhead; to replace Honest John in all NATO countries	1974	1976–77
		..	McDonnell Douglas RGM-84A Harpoon	ShShM	$6 mn	Dec 1975	..
USA	Canada	2	DHC-6 Twin Otter	Transport aircraft	Army order; for liaison and recce	1976	1976
	UK	12	Hawker Siddeley HS Harrier AV-8	V/STOL fighter aircr			
		8	Hawker Siddeley HS Harrier TAV-8	V/STOL trainer aircr	$112 mn; brings total to 110	1973	1975–76
		342	Hawker Siddeley HS Harrier AV-8B	V/STOL fighter aircr		1976	..
USSR	Czechoslovakia	..	Aero L-39	Trainer aircraft	Adopted as standard basic jet trainer for WTO countries except Poland; replacing L-29	(1972)	1973–
		..	OT-64 SKOT	APC	Reportedly being bought	..	(1975–76)
	Finland	2	..	Cable ship	Displ: 6 000 t	Jul 1974	..
	Poland	1	"Ropuchka"-type	Tank-landing ship	New construction; 113 m	..	1976
Yugoslavia	France	..	Aérospatiale MM-38 Exocet	ShShM	Arming 10 new missile boats under construction in Yugoslavia	(1974)	(1977–)
	USA	4	Lockheed T-33A	Advanced jet trainer aircr	Limited MAP; delivered via FR Germany	(1975)	1976

Appendix 7D

Registers of indigenous and licensed production of major weapons and small arms in third world countries, 1976

I. Register of indigenously designed major weapons in development or production in third world countries, 1976

For sources and methods, see chapter 7. For conventions, see page 216.

Country	Designation, description	Power plant	Arma-ment	Date design begun	Date in pro-duction	Produc-tion rate	Status of programme, other information	No. planned/ produced	Unit price $ *mn*
Argentina	*IA-58 Pucará* COIN combat	TP (Fr.)	MG (Belg.); cannon (Switz.)	1966	1972	1/month	Req: 70; ordered: 30 for AF; Bolivia reportedly considering buying 18; interest shown by AFs of Peru, Libya and S. Africa	. ./5	. .
	IA-60 Pucará jet attack vers	J	. .	. .	. .	. .	Developing	. .	. .
	Trainer	TF (Fr.)	. .	. .	. .	. .	Based on Pucará airframe; speed: Mach 0.73; developing	. .	. .
	Cicaré CH-111 Colibrí hel	P (USA)	–	1973	. .	. .	For AF training; first flight early 1976	. .	. .
	Survey ship	. .	. .	. .	1974	. .	Displ: 1 960 t	1/. .	. .
Bangladesh	*"Pabna"*-class riverine patrol craft	D	40/60 Bofors gun	. .	. .	. .	Displ: 69.5 t; commissioned first in Jul 1972, second Jun 1972 and third Nov 1974	. ./3	. .
Brazil	*Aerotec T-23 Uirapuru* primary trainer	P (USA)	–	1965	1968	4/month	For export to Nigeria: 40	. .	0.02

	EMB-110C Bandeirante light transp	TP (Can.)	–	1965	1973	4/month	EMB-110 versions ordered: 60 for AF, 3 for Chilean Navy, 5 for Uruguayan AF	. .	. .
	EMB-110A Bandeirante navaid checking and calibration vers	TP (Can.)	–	. .	. .	. .	AF received 2 in May	. .	. .
	EMB-110B aerial photographic vers	TP (Can.)	–	. .	. .	. .	Ordered: 6 for AF	. .	. .
	EMB-110K freighter vers	TP (Can.)	–	. .	. .	. .	Ordered: 20 for AF	. .	. .
	EMB-111 maritime surveillance	TP (Can.)	ASM	1973	(1974)	. .	Ordered: 16 for AF	>16/. .	. .
	Neiva N-621A Universal II T-25 trainer	P (USA)	Light bombs, rockets	1972	(1975)	–	Likely to enter production soon at a rate of 2/month	. .	. .
	Type X-40 miss	. .	. .	. .	(1975)	. .	Seen during military parade; range: 60 km	. .	. .
	EE-9 Cascavel COIN APC/armed recce	D (FRG)	MG, 90-mm cannon	1970	1975	. .	In production for Brazilian Army; ordered: 20 by Qatar	. .	. .
	EE-11 Urutu APC	D (FRG)	MGs, cannons, various calibres	1970	(1972)	. .	In production for Brazilian Army and Marines	. .	. .
	River transp	D	–	. .	1975–76	. .	Displ: 150 t; speed: 14 knots	. ./4	. .
	Submarine	. .	. .	. .	. .	. .	Planning	. .	. .
	Electronics	–	–	. .	(1970)	. .	. .	. .	. .
	Turbojet engines	–	–	1970	. .	. .	Developing	. .	. .
Egypt	Defence industry	–	–	. .	. .	. .	Four-country agreement signed on joint Arab arms industry 29 Apr 1975; initial funds: $1 bn	. .	. .
India	*HAL HJT-16 MkI Kiran* jet trainer/ground attack	TJ (L:UK)	7.62-mm MG, rockets	1961	1968	25/year	Req: 180 for AF and Navy	180/100	Export 1972: 0.4
	HAL HJT-16 MkII Kiran jet trainer/ground attack	TJ (L:UK)	Nose-mounted integral MG, avionics	1974	. .	–	Flight test expected in Oct 1976	. .	. .

Country	Designation, description	Power plant	Arma-ment	Date design begun	Date in pro-duction	Produc-tion rate	Status of programme, other information	No. planned/ produced	Unit price $ *mn*
	HAL HF-24 Marut MkI light fighter-bomber	TJ (L:UK)	Aden guns (UK), rockets, bombs	1956	1963	. .	Production continues	214/145	Export 1973: 1.4
	HAL HF-24 Marut MkI T tandem trainer vers	TJ (L:UK)	Aden guns (UK), rockets, bombs	1967	1974	. .	Req: 10 for AF	10/10	. .
	HAL HF-73 Marut MkIII strike/fighter	TJ (L:UK)	. .	1969	–	–	Development progressing; prototype flight 1980	–	–
	HAL HAC-33 light STOL transp	TP (L:UK)	. .	Design complet-ed 1974	–	–	Req: "large number" for AF and Navy	–	Est. cost: 0.3
	HAL HPT-32 basic trainer	P (USA)	. .	Design complet-ed 1974	–	–	Scheduled to replace AF HT-2 from 1981–82; flight test was expected for Nov 1976	–	Est. cost: 0.08 on pro-duction run of 50
	Ship-to-ship miss	. .	. .	. .	. .	. .	Successfully tested in Dec 1975	. .	. .
	Main battle tank	. .	. .	(1970)	. .	. .	Design: Avadi R&D Dept.	–	–
	APC	. .	. .	. .	. .	. .	Large-scale production planned; prototype trials 1973	. .	. .
	Large patrol boat	. .	. .	1974	. .	. .	Under construction in Calcutta	. .	. .
	Nuclear-powered submarine	N	. .	1974	–	–	Planning; design to be completed 1980	. .	. .
	Aero-engines	J	–	1965	(1976)	. .	In production for HJT-16 Kiran at HAL, Bangalore, R&D	. .	. .
	Electronics	. .	. .	1965	. .	. .	Bharat Electronics; HAL Lucknow: avionics	. .	. .
	Target drones	. .	. .	(1970)	. .	. .	Testing: Jul 1974; speed: Mach 1.4	. .	. .
	Unguided rockets	. .	. .	. .	. .	. .	. .	. .	. .

Indonesia	*Lipnur LT-200* 2-seat light trainer (Pazmany PL-2 derivative)	TP (USA)	–	. .	. .	. .	First 2 prototypes Sep 1973; production in hand; being evaluated by Taiwan, S. Korea, Japan, USA	–/50	. .
	"*Mawar*"-class large patrol craft	D	A/A guns	. .	(1973)	. .	Displ: 147 t; speed: 21 knots; more to be built	5/3	. .
Israel	*IAI-201 Arava* STOL military transp	TP (Can.)	MG	1966	1972	4/month	In production for home and export requirements; 50 sold mostly to L. American countries	>100/. .	0.7
	IAI "Kfir" combat aircr Mach 2.2 (Mirage III/5 development)	TJ (USA)	DEFA cannon, Rafael Shafrir AAM	1968	Early 1974	3–4/month	Req: 200 for AF; interest shown by Austria, Mexico, Singapore, Taiwan and others	>250/. .	4.5
	IAI "Kfir C-2" fighter/ground attack Mach 2.3	TJ (USA)	DEFA cannon, Rafael Shafrir AAM	. .	. .	. .	Offered for export	150/24	6.25
	IAI "Kfir 5" fighter-bomber	. .	. .	Design complet-ed 1975	. .	. .	IAI is working on a considerably more advanced vers on the lines of Mirage 2000	. .	. .
	IAI-1123 Westwind light transp	TJ (USA)	–	. .	1971	2/month	E: USA; 36 sold so far; production scheduled to stop with 36th aircraft		1.1
	IAI-1124 Westwind executive jet	TF (USA)	–	. .	1975	2/month	. .	. ./17	1.6
	IAI-1124-N naval patrol/SAR	. .	. .	. .	. .	. .	Israel is seeking support for this new vers	. .	3
	Jericho fixed-to-fixed miss	S	Warhead HE/N	1966	. .	. .	Tested at range of 500 km in 1975	. .	. .
	Rafael Shafrir air-to-air miss, IR-homing	S	11 kg	1965	1969	. .	Range: 5 km; sales made to several overseas customers incl Taiwan	. .	0.02
	Gabriel ship-to-ship miss, vers I and II	S	180 kg	1966	I: 1970; II: 1974	. .	Mk I range: 14 mi; Mk 2 range: 26 mi; sold to Singapore, S. Africa, Argentina	. .	. .
	Ship-to-ship miss	. .	. .	(1975)	. .	. .	Engine currently being produced with almost double range of Gabriel	. .	. .

Country	Designation, description	Power plant	Arma-ment	Date design begun	Date in pro-duction	Produc-tion rate	Status of programme, other information	No. planned/ produced	Unit price $ *mn*
	Luz air-to-surface miss	. .	. .	(1970)	. .	. .	Developing; TV-guided	. .	. .
	"*Katyusha*" artillery rocket	. .	. .	–	1971	. .	Israeli vers of captured Soviet rocket	. .	. .
	Ze'ev short-range unguided artillery rocket, 2 vers	. .	170 kg; 70 kg	. .	(1973)	. .	Ranges: ~1 km, 4.5 km; used in Oct 1973 war	. .	. .
	RBY-MkI armoured recce/COIN "*Rabix*" AC vehicle	G (USA)	Light MG	. .	. .	. .	3.6 t; first displayed in 1975; trials successfully completed	. .	. .
	Sabra medium tank	D (USA)	Gun (UK)	(1969)	1971	. .	40 t; entered service in 1972	. .	. .
	Main battle tank	. .	. .	1975	. .	. .	. .	. .	. .
	"*Reshef*"-class fast miss boat	D	Gabriel SSM	. .	1973	2/year	Displ: 415 t; production continues for 7 more for Israel and 6 for S. Africa	>30/12	25
	New hel-carrying miss ship	. .	Gabriel SSM	. .	. .	. .	Displ: 850 t; developing	. .	. .
	Soltam L-33 155-mm self-prop gun	. .	7.62-mm A/A gun	. .	1973	. .	41 t; mounted on Sherman chassis	. .	. .
	Avionics and electronics	–	–	. .	1960	. .	Tadiran largest electronics producer; exports: $70 mn/ year	. .	. .
	Engines	–	–	. .	1969	. .	Bet-Shemesh plant; IAI Bedek Aviation	. .	. .
	Napalm	–	–	. .	(1951)	. .	First used in 1956 war; also used in 1967 war	. .	. .
Korea, North	"*Najin*"-class frigate	D	. .	. .	1971	. .	Larger vers of "Sariwan"-class built in 1960s	. ./3	. .
Korea, South	Helicopter	. .	. .	. .	. .	. .	S. Korea is planning to set up its own helicopter industry	. .	. .

	Medium-range ballistic miss	. .	. .	. .	. .	. .	S. Korea has purchased all the plant and equipment of Lockheed Propulsion division; this is indicative of a desire to develop its own missiles	. .	. .
Kuwait	Rockets	. .	–	. .	1974	. .	Operated with a special guiding device; further development planned	. .	. .
Nepal	Munitions	–	–	. .	. .	. .	Factory completed 1975	. .	. .
Pakistan	Shipbuilding	–	–	(1974)	. .	. .	Karachi shipyard constructing 8 ships for Saudi Arabia and Abu Dhabi	8/. .	. .
Peru	Aircraft industry	–	–	1975	. .	. .	Construction of helicopters will be given priority	. .	. .
	"*Parinas*"-class tanker	D	. .	. .	1975	. .	Displ: 13 600 t full load; laid down in 1974	. ./2	. .
	Fleet tanker	D	. .	. .	. .	. .	Displ: 25 000 t; to be completed in 1977	. .	. .
Philippines	Aircraft industry	–	–	1975	. .	. .	AF is planning to manufacture a 3-seat light basic trainer	. .	. .
	Bong-Bong II unguided artillery rocket	. .	. .	1972	. .	. .	R&D financing from President Marcos's social welfare fund; test-fired 1972	. .	. .
	Shipbuilding	–	–	. .	. .	. .	Government is planning to build 44- to 50-m gunboats; equipment will be foreign	. .	. .
Singapore	Shipbuilding	–	–	. .	. .	. .	Vosper Thornycroft, Singapore, and other companies produce ships of various types; 25 000 people are employed in this industry	. .	. .

Country	Designation, description	Power plant	Arma-ment	Date design begun	Date in pro-duction	Produc-tion rate	Status of programme, other information	No. planned/ produced	Unit price $ *mn*
	Electronics	–	–	1974	. .	. .	Singapore Electronics and Eng. Pte. Ltd: precision equipment for military aircraft	. .	. .
South Africa	Tank	. .	. .	. .	1976	. .	Government announced it is ready to start series production of indigenous tanks	. .	. .
	Mine-clearing vehicle	–	–	. .	1973	. .	No further information since 1973	. .	. .
	"*Whiplash*" air-to-air miss, IR-homing	S	Warhead: HE	1966	1972	. .	Range: 550 km	. .	. .
	Electronics	–	–	. .	. .	. .	. .	. .	. .
	Engines	–	–	(1968)	. .	. .	Local engine on Eland II AC	. .	. .
	Napalm	–	–	. .	1968	. .	Manufactured entirely of local materials	. .	. .
	Chemical weapons: nerve gas, tear gas	–	–	1960	. .	. .	Self-sufficiency achieved since large investments in arms industries	. .	. .
Taiwan	*XT-CH-IB Chunghsing* medium trainer	TP (USA)	. .	1970	. .	. .	First flight 1974; an initial batch of 30 to be produced in 1977–78	>30/2	. .
	Jet trainer	. .	. .	. .	–	–	Planning	. .	. .
	XC-2 tactical transp	TP (USA)	. .	1973	. .	. .	Construction of prototype began in 1976; max speed: 546 km/h	. .	. .
	Medium-range surface-to-surface miss	. .	Warhead: HE	(1973)	. .	. .	Range: 960 km; developing	. .	. .
	Patrol boat	. .	. .	. .	(1974)	. .	. .	14/. .	. .
	Electronics	–	–	. .	1960	. .	R & D at 4 major institutes	. .	. .

Venezuela	Aircraft industry	–	–	–	–	–	To be established with foreign aid; will probably begin with licensed production	. .	. .
	Shipbuilding industry	–	–	–	–	–	3 major shipyards to be built	. .	. .

Note: The following countries have shipbuilding industries, but there is no specific information on current projects: Burma, Cameroon, Chile, Colombia, Congo, Cuba, Dominican Republic, Egypt, Gabon, Guyana, Ivory Coast, S. Korea, Mexico, Syria, Thailand and Vietnam.

II. Register of licensed production of major weapons in third world countries, 1976[a]

For sources and methods, see chapter 7. For conventions, see page 216.

Licensee	Licenser	Designation, description	Power plant	Arma-ment	Date of licence	Date in produc-tion	Produc-tion rate	Status of programme, other information	No. planned/ produced	Unit price $ *mn*
Argen-tina	USA	*FMA Cessna A182* monoplane	P (Imp: USA)	. .	1965	. .	. .	. .	. ./150	. .
		FMA Cessna A150 trainer	P (Imp: USA)	–	1971	. .	. .	. .	. ./40	. .
		Chincul Piper Cherokee light plane	P (Imp: USA)	–	1971	1973	. .	Single-engined; assembly from knocked-down parts	1 000/. .	. .
		Chincul Piper Seneca light plane	P (Imp: USA)	–	1971	1973	. .	Twin-engined; assembly from knocked-down parts	340/. .	. .
		Raca Hughes Model 500 hel	T (Imp: USA)	–	1973	. .	. .	Assembly from knocked-down parts; by Jan 1975, 25 Model 500s had been ordered, of which 8 had been delivered; others in the 500 series are 500C and 500M	120/20 (by early 1976)	. .
	FR Ger-many	*Type 148* fast miss boat	D (Imp: FRG)	Triple launcher for Gabriel SSM; 76-mm and 40-mm guns; 2 21-in torpedo tubes (or 8 mines)	1970	1971	. .	Displ: 234 t; speed: 30 knots; 2 ordered, of which 1 is being built in Argentina and 1 in FRG	. .	. .

Licensee	Licenser	Designation, description	Power plant	Armament	Date of licence	Date in production	Production rate	Status of programme, other information	No. planned/ produced	Unit price $ *mn*
	UK	*Type 42* destroyer	GT (Imp: UK)	Sea Dart SSM (Imp: UK); 1 hel (Imp: UK); 1 4.5-in automatic gun and 2 20-mm Oerlikon guns (Imp: Switz.)	1970	1971	. .	Displ: 3 500 t; speed: 30 knots; 1 built in UK and commissioned Nov 1975; 1 being built in Argentina, expected commissioning in 1976	. ./1	~45
		Type 21 frigate, "Amazon"-class	GT (Imp: UK)	Exocet SSM; Seawolf SSM and A/S hel (Imp: UK); 1 4.5-in Mk 8 and 2 20-mm Oerlikon guns	1975	. .	. .	Displ: 2 500 t; speed: 34 knots; preliminary agreement reached in 1975 for building 6 frigates at Argentinian shipbuilding yard	6/. .	. .
Brazil	Italy	*EMB AT 26 Xavante* armed trainer/COIN (MB.326B)	TJ (Imp: UK)	AS. 11/12 ASM (Imp: Fr.); MG (Imp: It., Switz., UK)	1970	Nov 1971	30/year	Brazilian content increasing; only basic elements still from Italy; licence extended to 1978 for more production; first order for 112, second for 40; option on 30 more	152/94	Aug 1972: 0.6
		EMB-330 armed trainer	. .	. .	. .	. .	. .	Seems to have fallen short of BAF's expectation in terms of performance and combat capability; project seems to have been abandoned	. .	. .
		EMB MB.326K light strike/COIN	TJ (Imp: UK)	. .	(1975)	. .	. .	Eventually to replace Xavante production	. .	. .
		EMB-340 light strike	TF (Imp: UK)	. .	. .	. .	. .	Joint development by EMBRAER and Aermacchi proposed	. .	. .
		(Audi SH-4 Silvercraft utility hel) (SIAI Marchetti SH-4)	P (Imp: USA)	–	Sep 1973	–	. .	No further information since 1974	100/. .	. .

	France/ FR Germany	*Roland* SAM	S	Warhead: HE	. .	. .	. .	Brazil holds partial licence	. .	. .
	USA	*EMB-810 Seneca* light plane	P (Imp: USA)	–	1974	1975	4/month	Assembly started mid-1975; E: USA; no royalties paid on aircr built for sale in Brazil; production of EMB planes was expected to more than double in 1976	. ./217	. .
		EMB-720 Minvano light plane	P (Imp: USA)	–	1974	1975	3/month	22 produced in 1975	. ./. .	. .
		EMB-710 Carioca light plane	P (Imp: USA)	–	1974	1975	10/month	32 produced in 1975	. ./. .	. .
		EMB-711 Corisco light plane	P (Imp: USA)	–	1974	1975	10/month	57 produced in 1975	. ./. .	. .
		EMB-820 Navajo light plane	P (Imp: USA)	–	1974	1975	4/month	7 produced in 1975	. ./. .	. .
	FR Germany	*MB 2000 Cobra* anti-tank miss	S	Warhead: HE	1973	1975	. .	. .	. .	. .
	UK	"*Niteroi*"-class destroyer	GT (Imp: UK); D (Imp: FRG)	Exocet SSM (Imp: Fr.); Seacat SAM (Imp: UK); Ikara ASM (Imp: Australia); 1 Lynx hel (Imp: UK); Vickers gun (Imp: UK); Bofors RL/ gun (Imp: Sweden)	1970	. .	. .	Displ: 3 800 t; first launched in UK Feb 1974, in Brazil Sep 1974; completion 1976–80; 2 being built in Brazil, 4 in UK	6/1	45
Colombia	USA	*Cessna* utility light plane, various types	P (Imp: USA)	–	(1971)	1972	200/year planned for 1976	Planned to manufacture complete airframe by end-1976	. .	. .
	Italy	*Midget* experimental assault sub	D	TT	1971	1972	2 commissioned 1972, 2 in 1974	Displ: 70 t; speed: 6 knots; assembly completed	. ./4	. .
Egypt	UK/ France	*Westland-Aérospatiale WG-13 Lynx* hel	TS (Imp: UK)	. .	(1975)	–	. .	Plans to build these helicopters temporarily abandoned	. .	1.65

Licensee	Licenser	Designation, description	Power plant	Arma- ment	Date of licence	Date in produc- tion	Produc- tion rate	Status of programme, other information	No. planned/ produced	Unit price $ *mn*
	UK	*HS Hawk* trainer/attack	TF (Imp: UK)	. .	(1975)	–	–	Production plans temporarily abandoned	. .	. .
		BAC Golfswing anti-tank miss	S	Warhead: HE	Late (1975)	. .	. .	Vehicle-mounted vers of Swingfire; also to be supplied to Saudi Arabia	~10 000/. .	. .
	France	*Crotale* SAM	S	Warhead: HE	. .	. .	. .	Egypt plans to sell licence-produced Crotales to Saudi Arabia, Kuwait and Belgium	. .	. .
India	Czecho-slovakia	*OT-62/64(2A)* APC	. .	. .	1970	. .	. .	Czech vers of BTR-50	. .	. .
	France	*Dassault-Breguet Mirage F1* fighter	. .	. .	. .	–	–	HAL has been offered licensed production; initially F1 is to be assembled; manufacture of sophisticated components later to go up to 100%	~250/–	. .
		HAL SA-315 Cheetah high-altitude hel (Aérospatiale SA-315 Lama)	TS (L: Fr.)	SS.11 ATM (L: Fr.)	Sep 1970	1972	. .	38 delivered by Feb 1976; delivery of aircr with completely locally built materials started in 1976; E: USA	100/. .	. .
		HAL SA-316B Chetak general-purpose hel (Aérospatiale Alouette III)	TS (L: Fr.)	SS.11 ATM (L: Fr.)	1962	1965	. .	Manufactured from local raw materials; ordered: 219	219/174	. .
		Bharat SS.11 ATM	S	Warhead: HE	1970	1971	. .	Complete production rights handed over 1974	. .	. .
	UK	*HAL Ajeet* light-weight fighter/ground attack (Gnat MkII)	TJ (L: UK)	Aden cannon (Imp: UK)	1973	1976	. .	Req: 100 for AF; first prototype flew 1975; first delivered Dec 1976	100/. .	2.5
		Ajeet trainer vers	TJ (L: UK)	. .	1973	(1978)	. .	2 prototypes to be completed 1977; first flight 1977	. .	. .

		HAL HS-748 transp	TP (L: UK)	–	. .	1959	. .	Production to be completed in 1977; 24 for Indian Airlines and 55 for IAF	79/66	1.5
		Vijayanta medium battle tank	D (Imp: UK)	105-mm gun	1965	1967	~100/year	Indig: 95% by 1977	. .	. .
		"*Leander*"-class ASW frigate	T (Imp: UK)	1 Wasp hel (Imp: UK); 2 Seacat SAM launchers (Imp: UK)	1965	1973	. .	Displ: 2 450 t; speed: 30 knots; fourth commissioned in 1976	6/4	. .
	USSR	*MiG-21M* fighter/ground attack, Mach 2.0	TJ (Imp: USSR)	Atoll AAM (L: USSR)	1970	1973	. .	Indig: ~90%	150/~15	. .
		Bharat K-13A Atoll air-to-air miss	S	Warhead: HE	1964	1969	. .	IR missile for HAL MiG-21 fighter	. ./>600	. .
	Switzer-land	Electronics	–	–	1975	. .	. .	Contraves fire-control radar for L-70 A/A gun	. .	. .
Indonesia	FR Ger-many	*MBB Bo 105* hel	TS (USA)	. .	1976	1976	2–3/month	. .	>50/16	. .
	Spain	*Casa C-212* light STOL transp	TP (USA)	–	(1975)	. .	. .	3 C-212A military vers ordered by Indonesian AF; 6 assembled by end-1976	. ./6	. .
	USA	*Lipnur LT-200* light trainer	P (USA)	–	. .	. .	. .	About 30 LT-200s will be ordered for various agencies, incl Indonesian AF; 6 are pre-production aircr; first 2 prototypes flight-tested in Nov 1974; construction of 2 modified and improved pre-production aircr began in Dec 1974	36/. .	. .
Iran	USA	*Bell 214A* utility hel	TS (Imp: Can.)	. .	. .	(1976)	. .	Ordered: 400; initially to be assembled but later also produced in Iran	400/. .	. .
		Bell 209 AH-1J armed hel	TS (Imp: Can.)	XM-197 gun	. .	(1976)	. .	Assembly has started in Shiraz	. .	. .
		Hughes TOW anti-tank miss	S	Warhead: HE	. .	–	–	TOW to be assembled in Shiraz	. ./–	. .

Licensee	Licenser	Designation, description	Power plant	Arma-ment	Date of licence	Date in produc-tion	Produc-tion rate	Status of programme, other information	No. planned/ produced	Unit price $ *mn*
		Electronics	–	–	1974	. .	. .	Iranian government has acquired licence to produce several types of electronic equipment	. .	. .
	UK	*BAC Rapier* SAM	S	Warhead: HE	1975	–	–	A joint company, Irano-British Dynamics, will start producing Rapier SAMs under licence in 1977	. ./–	. .
		Chieftain main battle tank	. .	. .	. .	–	–	Ordered: 1 600; Iran is negotiating for licence to produce part of total order	. ./–	. .
Israel	USA	*General Dynamics F-16* fighter	. .	. .	. .	–	–	Israel negotiating for 250 F-16s, most of which for production under licence	250/. .	6.1
		"*Dabur*"-class coastal patrol boat (developed from US "Swift"-class boats)	D	Armament varies; MG, 20-mm cannon most common	. .	. .	. .	Displ: 35 t; speed: 22 knots; production continuing	. ./25	. .
	France	*Defa* 30-mm aircr cannon	–	–	. .	. .	. .	Israel has modified Defa; for equipping Kfir combat aircr	. .	. .
		Engines	–	–	. .	. .	. .	Bet-Shemesh Engines Ltd manufactures aircr engines under licence from Turbomeca	. .	. .
Korea, North	China	*Chinese "Romeo"*-class sub	D	TT	. .	. .	. .	Displ: 1 600 t; speed: 14 knots; production continuing	. ./2	. .
	USSR	Aircraft industry	–	–	. .	–	–	Established with Soviet assistance for licensed production of MiG-21 starting in 1978	. ./–	. .

		"*P-6*"-class fast attack torpedo boat	D	TT	..	..	..	Displ: 66 t; speed: 30 knots; growing number being built locally	..	..
Korea, South	USA	*Hughes 500 MD* hel	T (USA)	..	1976	..	..	66 of the 100 to be assembled in S. Korea	100/. .	..
		Pazmany PL-2 light plane	P (USA)	–	..	..	..	Korean AF built 1 prototype in 1971 for flight-testing; later completed 3 more for evaluation as trainer aircr	..	..
		PSMM multi-mission patrol and attack ship	GT (Imp: USA)	Standard ShShM; 1 76-mm 50-cal and 1 40-mm A/A gun; 2 0.50-cal MGs	..	(1975)	..	Displ: 250 t; first of 4 PSMMs was reported under construction in S. Korea; all were planned to be commissioned during 1976–77	7/(3)	..
		CPIC-type coastal patrol boat	GT	(Harpoon) ShShM	(1974)	..	..	Displ: 70 t; under construction	>4/. .	..
Mexico	Israel	*Arava* STOL transp	TP (Imp: Can.)	MG	..	–	–	Negotiating for establishment of a national aircr industry in which Israel will hold 10% share; Arava to be assembled there	–	..
		IAI "Kfir" fighter/ground attack	TP (Imp: Can.)	DEFA cannon, Rafael Shafrir AAM	..	–	–	Negotiations are ongoing for licensed production; order of ~100 needed to make project viable	–	..
	UK	"*Azteca*"-class large patrol boat	..	..	1976	(1977)	..	Displ: 130 t; in addition to 21 purchased 1974–76; plans to acquire total of 80	10/. .	..
Pakistan	China	.. SAM system	–	–	(1975)	–	–	..	. ./–	..
	France	*Dhamial Alouette III* hel	TS (Imp: Fr.)	..	1968	1972	1/month	Assembly of imported components; all 3 services receiving	. ./60	..
		Dassault-Breguet Mirage F1 fighter	TJ (Imp: Fr.)	..	..	–	–	Negotiations still not finalized	. ./–	..

Licensee	Licenser	Designation, description	Power plant	Arma-ment	Date of licence	Date in produc-tion	Produc-tion rate	Status of programme, other information	No. planned/ produced	Unit price $ *mn*
	FR Germany	*MBB Bo 810 Cobra 2000* anti-tank miss	S	Warhead: 2.7 kg	1963	(1964)	. .	Indig: 100%; production continues	. .	. .
	USA	*Cessna T-41D* primary trainer	P (Imp: USA)	–	1975	(1976)	50/year	Cessna has agreed to licensed production for Kiyuski International, a private Pakistani company	. ./–	. .
		Breda Nardi Hughes 500 LOH hel	. .	. .	1975	(1976)	50/year planned	Agreement signed with Italy for production in Pakistan; E: Middle East	. ./–	. .
		Cessna 0-1 Bird Dog light plane	. .	. .	. .	1970	1/month	Indig: 60%; no licence acquired	. .	. .
Peru	Italy	"*Modified Lupo*"-class guided-miss frigate	GT & D (Imp: It.)	2 OTOMAT SSM (Imp: It.); 1 ASW hel	1974	First laid down Aug 1974	. .	Displ: 2 500 t; speed: 35 knots; 2 to be built in Italy, 2 in Peru	4/. .	. .
Philippines	FR Germany	*PADC MBB Bo 105* hel	TS (Imp: USA)	. .	1974	1974	. .	Assembly continues for 28 helicopters	38/19	. .
	Italy	*XT-001* primary trainer	P (Imp: USA)	–	(1975)	. .	. .	Prototype flew in 1975, virtually a duplicate of Italian SF.260MP	. .	. .
	UK	*BN Islander* light transp	P (Imp: USA)	–	1974	1974	. .	Phases 1 and 2 completed end-1975 with 20 aircr; 20 units being assembled from knocked-down components during phase 3; phase 4 will include production of sub-assemblies and aircr components for 60 units	100/(24)	. .
Singapore	FR Germany	*Lürssen Vegesack "TNC 48"*-class fast attack miss boat	D (Imp: FRG)	Gabriel SSM (Imp: Isr.); 1 57-mm and 1 4-mm gun	. .	1973	2/year	Displ: 230 t; 4 built and commissioned in Singapore; 3 ordered by Thailand in 1973, 2 of which commissioned in	. ./6	. .

								Aug and Nov 1976 and there is an unconfirmed report of a fourth ordered; displ for the last 4: 260 t		
	UK	Costal patrol craft	D	20-mm guns, MG	. .	. .	. .	Displ: 25–82 t; 33 patrol craft delivered during past 5 years to customers incl Brunei, Hong Kong, Kuwait, Malaysia and Sabah	. ./33	. .
South Africa	France	*Atlas Mirage F1-CZ/A2* fighter	TJ (Imp: Fr.)	AAM, ASM	1971	1977–78	. .	Ordered: 48; preparations for production continuing; 32 to be assembled	100/. .	. .
		Eland armoured car (Panhard AML 60/90)	D	60-mm, 90-mm cannon	1965	1967	100/year	Indig: ~100%; second-generation development locally	. ./~1 000	. .
	France/ FR Germany	(*"João-Coutinho"*-class frigate)	. .	Gabriel ShShM	Feb 1975	. .	. .	Announced as indigenous construction but perhaps originally to have been built in Portugal	6/–	. .
	Israel	*"Reshef"*-class fast miss craft	D	Gabriel SSM (Imp: Isr.)	Late 1974	(1975)	. .	Displ: 430 t; speed: 30 knots; 3 under construction in Haifa, 1 in S. Africa	6/–	18 with missiles
	Italy	*Atlas Impala I* armed trainer/COIN (MB.326M)	TJ (Imp: UK)	MG, rockets	1965	1967	. .	Indig: 70%; exported; production completed	. ./300	0.4
		Atlas AM-3C "Bosbok" monoplane	P (Imp: It.)	MG, rockets	1971	1975	. .	Most if not all assembled by Atlas	40/40	. .
		Atlas Impala II light strike (MB.326K)	TJ (Imp: UK)	MG, rockets	1973	1975	. .	Ordered: 100; production in hand	. .	0.6
		AFIC RSA-200 Falcon civil/military light plane	P (Imp: USA)	–	1965	1967	. .	Production temporarily suspended	. .	. .
	Italy/ USA	*C4M Kudu* (AL-60/ AM-3C derivative) STOL, light observation transp	P (Imp. It.)	–	(1974)	1975	. .	Ordered: 37	. .	. .

Licensee	Licenser	Designation, description	Power plant	Armament	Date of licence	Date in production	Production rate	Status of programme, other information	No. planned/ produced	Unit price $ *mn*
Taiwan	USA	*Bell 205 UH-1H* utility hel	TS (Imp: USA)	. .	1969	(1972)	1/month	Assembly of 118 nearing completion	118/~100	. .
		Northrop F-5E Tiger II fighter	TJ	AIM-9 Sidewinder AAM	1973	1974	4/month by end-1976	Production started with knocked-down parts from USA but now proportion of locally manufactured components is progressively increasing	160/~35	. .
		Sidewinder AIM-9 AAM	S	. .	. .	. .	. .	Construction and production	. .	. .
Venezuela	Italy	Coastal patrol craft	D	. .	Mar 1973	1974	. .	Ordered: 21; 11 to be built in Venezuela	21/10	. .

[a] The values of the licence-produced weapons are included in the tables of values of the arms trade, pages 306–309, estimated at 100 per cent of the import value.

III. Register of indigenous and licensed production of small arms in third world countries, 1976

For sources and methods, see chapter 7. For conventions, see page 216.

	Indigenous production		Licensed production	
Country	Type	Status of programme, other information	Type	Status of programme, other information
Argentina	105-mm anti-armour cannon, grenade	In production	Pistol, sub-machine-gun, rifle, machine-gun, grenade, mortar	Licensers: Belgium, France, FR Germany, Switzerland, USA; the Fabrica Militar and Fabricaciones Militares manufacture most of the small arms required by Argentina
Brazil	–	–	Sub-machine-gun, rifle	Licensers: Denmark, FR Germany
Chile	–	–	Rifle, light machine-gun	Licenser: Belgium

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India	–	–	Pistol, machine-gun, grenade, rifle, anti-tank weapon, anti-aircraft gun	Licensers: Belgium, UK, France, USSR; India produces most of its small arms requirement locally
Indonesia	–	–	Pistol, rifle, machine-gun	Licensers: Belgium, Italy; some earlier Soviet weapons are copied and produced
Iran	–	–	Pistol, machine-gun	Licenser: FR Germany; Iran is devoting large effort to entering arms production and there are programmes to expand small arms production
Israel	Sub-machine-gun *Uzi*, grenade, mortar, anti-tank weapon	Israel designs and produces many small arms; E: many countries	Grenade	Licenser: USA
Korea, North	–	–	Pistol, rifle, machine-gun	Licensers: China, USSR; many Soviet and Chinese small arms are manufactured in N. Korea
Korea, South	–	–	Rifle	USA supplies most S. Korean requirements; some weapons are now produced at a factory set up in Pusan by Colt Military Industries
Pakistan	–	–	Rifle	Licenser not known; ordnance factory built by Chinese in 1970 and 8 other factories produce several small arms
Philippines	–	–	Rifle	Licensers: FR Germany, USA
Saudi Arabia	–	–	Rifle	Licenser: FR Germany; Saudi Arabia produces some small arms under licence
Singapore	–	–	Rifle, mortar	Licensers: Finland, USA
South Africa	–	–	Rifle, machine-gun	Licenser: Belgium; S. Africa produces most of its small arms requirements locally under licence
Turkey	–	–	Pistol, rifle	Licenser: FR Germany
Vietnam	Light machine-gun	Designed locally, it uses a Soviet cartridge	Sub-machine-gun, rifle, grenade	Licensers: China, USSR

Appendix 7E

Register of arms trade with third world countries, 1976

For sources and methods, see chapter 7. For conventions, see page 216.

In the register, the third world countries in the Recipient column are listed in alphabetical order. The major weapons in the Item column are entered in

Table 7E.1. Values of imports of major weapons by third world countries: by region, 1956–76[a]

Region		1956	1957	1958	1959	1960	1961	1962	1963	1964
Far East (excl Vietnam)	A	297	276	662	518	762	200	356	310	392
	B[b]	350	408	503	484	500	429	404	320	379
South Asia	A	230	332	638	194	268	289	188	221	80
	B	296	307	332	344	315	232	209	198	219
Middle East	A	458	392	326	311	161	196	574	394	387
	B	305	347	330	277	314	327	342	398	447
North Africa	A	8	7	5	8	12	16	39	34	39
	B	–	–	8	10	16	22	28	42	63
Sub-Saharan Africa	A	1	1	4	60	35	56	47	47	68
	B	9	17	20	31	40	49	51	62	70
South Africa	A	71	29	24	22	5	4	16	154	51
	B	33	33	30	17	14	40	46	82	100
Central America	A	20	8	14	18	59	212	298	97	34
	B	16	17	24	62	120	137	140	132	94
South America	A	154	146	175	59	182	204	109	72	51
	B	184	158	143	153	146	125	124	109	96
Total (excl Vietnam)	A	**1 239**	**1 191**	**1 848**	**1 190**	**1 484**	**1 177**	**1 627**	**1 329**	**1 102**
	B	**1 197**	**1 292**	**1 390**	**1 378**	**1 465**	**1 361**	**1 344**	**1 344**	**1 467**
Vietnam	A	14	7	63	12	31	75	75	56	92
	B	22	22	25	38	51	50	66	75	107
Total[c]	A	**1 253**	**1 198**	**1 911**	**1 202**	**1 515**	**1 252**	**1 702**	**1 385**	**1 194**
	B	**1 219**	**1 313**	**1 416**	**1 416**	**1 516**	**1 411**	**1 410**	**1 418**	**1 574**

[a] The values include licensed production of major weapons in third world countries. For the values for the period 1950–55, see *SIPRI Yearbook 1976*, pp. 250–51.
[b] Five-year moving averages are calculated from the year arms imports began, as a more stable measure of the trend in arms imports than the often erratic year-to-year figures.
[c] Items may not add up to totals due to rounding. Figures are rounded to nearest 10.
Source: SIPRI worksheets. Information on individual countries and arms transactions is available on request.

the following order: aircraft, missiles, armoured fighting vehicles and ships.

Tables 7E.1 and 7E.2 give the values of imports and exports of these weapons for the period 1956–76.

SIPRI estimates as expressed in US $ mn, at constant (1975) prices
A=yearly figures, B=five-year moving averages

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
340	497	199	265	586	271	418	175	302	248	639	1 038
348	339	377	363	347	343	350	282	356	480	–	–
213	391	271	297	313	299	498	409	289	373	178	414
235	250	297	314	335	363	361	373	349	332	–	–
441	439	1 063	1 258	1 212	1 462	1 765	1 087	2 228	2 955	3 526	3 614
545	717	882	1 087	1 352	1 357	1 551	1 899	2 312	2 682	–	–
81	122	135	84	88	120	123	167	145	228	761	929
82	92	102	110	110	116	129	157	285	446	–	–
94	93	81	55	72	124	133	89	186	391	231	432
77	78	79	85	93	95	121	185	206	266	–	–
186	92	78	44	46	77	69	37	37	275	179	118
112	90	89	67	63	55	53	99	119	129	–	–
18	21	17	8	10	5	47	35	56	118	137	58
37	20	15	12	17	21	31	52	79	81	–	–
110	139	128	208	158	148	222	310	480	531	630	710
100	127	149	156	173	209	264	338	435	532	–	–
1 483	**1 794**	**1 972**	**2 219**	**2 485**	**2 506**	**3 275**	**2 309**	**3 723**	**5 119**	**6 281**	**7 312**
1 536	**1 714**	**1 991**	**2 195**	**2 491**	**2 559**	**2 860**	**3 386**	**4 114**	**4 949**	–	–
75	237	494	473	298	433	435	1 199	82	186	20	–
191	274	315	387	427	568	489	467	384	–	–	–
1 558	**2 031**	**2 466**	**2 692**	**2 783**	**2 939**	**3 710**	**3 508**	**3 805**	**5 305**	**6 301**	**7 312**
1 727	**1 988**	**2 306**	**2 582**	**2 918**	**3 126**	**3 349**	**3 853**	**4 526**	**5 246**	–	–

Table 7E.2. Values of exports of major weapons to regions listed in table 7E.1: by supplier, 1956–76[a]

Country	1956	1957	1958	1959	1960	1961	1962	1963	1964
USA	432	452	498	326	713	392	367	514	371
USSR	194	335	256	145	216	511	1 028	430	375
UK	259	235	468	239	256	242	124	177	179
France	161	92	171	64	48	50	120	194	137
Canada	51	5	6	81	14	21	3	13	12
China	–	7	302	174	163	–	–	–	51
Czechoslovakia	76	8	30	76	59	6	6	16	9
FR Germany	12	6	9	34	30	6	3	13	26
Italy	40	38	37	*	9	–	*	20	20
Japan	12	14	30	16	–	14	24	1	1
Netherlands	1	3	1	5	1	3	3	*	12
Sweden	8	–	48	*	1	*	–	–	–
Other indus. West	*	–	–	–	1	3	1	3	*
Other indus. East	3	*	38	31	*	–	10	*	–
Third world	4	6	14	3	4	3	10	4	3
Total[b] (incl Vietnam)	**1 253**	**1 198**	**1 911**	**1 202**	**1 515**	**1 252**	**1 702**	**1 385**	**1 194**

[a] The values include licences sold to third world countries for production of major weapons. For the values for the period 1950–55, see *SIPRI Yearbook 1976*, pp. 252–53.
[b] Items may not add up to totals due to rounding.
* <$1 mn.

Source: SIPRI worksheets. Information on individual countries and arms transactions is available on request.

SIPRI estimates as expressed in US $ mn, at constant (1975) prices

1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
540	514	480	753	1 248	1 258	1 198	1 253	1 157	1 569	2 313	3 893
534	795	1 325	1 166	1 138	1 093	1 419	949	2 016	2 014	2 160	1 554
265	194	203	294	348	186	392	370	316	629	658	587
97	140	68	288	171	204	276	352	537	467	624	553
18	12	12	5	9	37	55	39	4	*	7	34
9	47	17	5	9	22	106	157	27	105	63	57
4	8	12	39	22	31	14	13	1	14	6	6
13	84	4	10	17	1	25	48	3	132	154	131
6	1	21	67	54	43	42	51	5	139	85	159
6	12	30	50	3	*	*	–	–	3	–	3
22	1	–	5	25	9	34	26	39	33	42	29
–	1	–	–	*	–	–	5	1	6	21	21
30	23	59	8	10	4	48	13	21	12	13	52
*	–	1	–	1	–	5	–	17	–	3	30
4	25	16	9	21	8	14	18	21	276	184	202
1 558	**2 031**	**2 466**	**2 692**	**2 783**	**2 939**	**3 710**	**3 508**	**3 805**	**5 305**	**6 301**	**7 312**

Register of arms trade with third world countries, 1976

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
Abu Dhabi[a]	France	18	Dassault Mirage 5	Fighter aircraft	Incl 3 recce and 1 trainer vers; brings total to 32	1976	. .
		. .	Thomson-CSF/Matra Crotale	SAM	Similar to "Shahine" ordered by Saudi Arabia; to supplement BAC Rapier	1976	(1977–)
	Italy/USA	(6)	Agusta Bell 205A	Light transport helicopter		. .	1975–76
	UK	. .	BAC Rapier	SAM	$80.5 mn incl 12 launchers and Blindfire radar trackers	Dec 1974	(1976)
		6	Vosper Thornycroft-type	Large patrol boat	Displ: 110 t; sixth ordered May 1974	1973–74	1975–76
		2	Sheverton-type, 27-ft	Coastal patrol boat	Displ: 33 t; under construction	1975	(1977)
Algeria	USA	3	Beech King Air 200	Transport aircraft		1976	(1976)
Angola[b]	Romania/UK	16	Britten-Norman BN-2 Islander	Transport aircraft	For ambulance duties; AF order; licensed production in Romania; British Foreign Office accepted provisional order	1976	. .
	Switzerland	>2	Pilatus PC-6 Turbo Porter	Transport aircraft	At least 2 purchased	1976	(1976)
Argentina	France	. .	Aérospatiale MM.38 Exocet	ShShM	Arming 4 Type 42 destroyers and 3 Type 21 frigates; see licensed production register	1974	1975–
	Israel	. .	IAI Gabriel	ShShM	Arming 2 Type 148 patrol boats under construction; see licensed production register	1975	. .
	Italy	3	Aeritalia G-222	Turboprop transp aircr	For military airline	Dec 1974	1977
		8	Aermacchi M.B.326GB	Strike/trainer COIN aircraft	Navy order	1974	1975–76
	Netherlands/ FR Germany	5	Fokker-VFW F28 Fellowship	Transport aircraft	For military airline	1974	1975–76
	UK/France	2	Westland/Aérospatiale WG-13 Lynx	ASW helicopter	U.c.: $1.2 mn; arming Type 42 destroyer; contract finalized 1976	1972	(1977)
		. .	BAC Sea Wolf	ShShM	Arming 8 Type 21 destroyers; see licensed production register	1975	. .

		..	Hawker Siddeley Dynamics HSD Sea Dart	ShAM	Arming 2 Type 42 destroyers; see licensed production register	1975	1975–76
	USA	2	Bell 212	Helicopter	For transport	1976	1976
		5	Cessna Model 207 Turbo Skywagon	Utility light plane	$0.5 mn; incl spares	1976	Apr 1976
		5	Cessna T-41D	Trainer aircraft			
		25	McDonnell Douglas A-4C Skyhawk	Fighter-bomber aircraft	Refurbished; in addition to 50 previously acquired	1975	1976–77
		3	..	Destroyer	U.c.: $125 000–$380 000; ex-USN; Senate approved sale Aug 1976	1976	(1977)
Bangladesh	USA	6	Bell 212	Helicopter		1976	1977
Barbados	USA	1	LST-type	Tank landing ship	Displ: 1 653 t; completed (1942); ex-USN	1975	Jan 1976
Bolivia	Argentina	18	FMA IA 58 Pucará	Twin turboprop light strike/COIN aircr		1975	1976–77
	Brazil	..	EMB-110 Bandeirante	Transport aircraft	Small number received	1975	1976
		40	Neiva T-25 Universal	Trainer/COIN aircraft	Firm order expected as production line reopens in 1977; replaces earlier order for 12	(1977)	(1978–)
	Israel	6	IAI 201 Arava	STOL transport aircraft	$5.5 mn incl spares, technical support and crew training	May 1975	1976
	USA	1	Lockheed C-130 Hercules	Transport aircraft	For military airline	Oct 1976	Oct 1977
Brazil	Australia	..	GAF Ikara	ShShM	$25 mn; arming 4 of 6 "Niteroi"-class frigates; see licensed production register	Feb 1972	Jul 1976–78
	France	>20	Aérospatiale MM.38 Exocet	ShShM	U.c.: $100 000 incl 4 launchers; arming 2 of 6 "Niteroi"-class frigates; see licensed production register	Nov 1972	Jul 1976–78
		..	Aérospatiale AS.11/12	ASM	Arming total of 162 AT-26 Xavante; see licensed production register	1972	1974–77
	France/FR Germany	6	Euromissile Roland II	SAM	$16 mn; fitted on Marder tracked vehicle; army order	1975	1976
	UK	..	BAC Sea Skua	AShM	Arming 9 Lynx helicopters	1975	1977
		..	Short Seacat	Naval SAM	Incl 12 launchers; arming 6 "Niteroi"-class frigates; see licensed production register	1972	Jul 1976–78

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
		2	"Oberon"-class	Submarine	Displ: 1 610 t; launched Sep 1975; in addition to 1 previously acquired; delivery delayed	1969–72	1977
	UK/France	9	Westland/Aérospatiale WG-13 Lynx	ASW helicopter	$24 mn; arms: BAC Sea Skua ShShM; to operate from "Niteroi"-class frigates	1975	1977
	USA	42	Northrop F-5E/B	Fighter-bomber aircraft	$115 mn incl spares and support equipment; incl 6 trainer vers; arms: Sidewinder AAM, Maverick ASM	1973	1975–76
		2	Boeing B.737-200L	Heavy transport aircraft	$6.7 mn	1975	1976
		..	Hughes AGM-65A Maverick	ASM	Arming latest of 36 F-5Es	1973	1975–76
		..	Raytheon AIM-9J-1 Sidewinder	AAM	Arming 36 F-5Es	1973	1975–76
Brunei	UK	2	"Sheverton Load Master"	Patrol boat	Displ: 45 t	1975	Dec 1975–76
Burma	Italy	10	SIAI-Marchetti SF-260	Trainer aircraft	U.c.: $140 000; may be converted to SF-260W COIN vers at u.c. of $30 000	1975	1976
Cameroon	China	2	"Shanghai 2"-class	Fast gunboat		(1975)	1977
	France	1	SFCN P-48 type	Large patrol boat	Displ: 250 t; new construction	Sep 1974	1976
	USA	2	Lockheed C-130H Hercules	Transport aircraft		Sep 1976	1977
Chad	France/UK	4	Aérospatiale/Westland SA-330 Puma	Helicopter		1976	1976
	Switzerland	2	Pilatus PC-6 Turbo Porter	Light STOL transp aircr		1976	1976
Chile	Brazil	3	EMB-110 Bandeirante	Light transport aircraft	$3.9 mn; incl spares; navy order	Feb 1976	Jul 1976
		6	EMB-110 Bandeirante	Light transport aircraft	Follow-on order being negotiated	(1977)	(1977)
		20	Neiva T-25 Universal Mk 2	Trainer/COIN aircraft	Follow-on order being negotiated; in addition to 10 surplus previously acquired; production line to reopen in 1977	(1977)	(1977)
		3	Douglas C-95	Transport aircraft	Ex-BAF surplus	1976	1977

	France	300	Aérospatiale AS.11/12	ASM		1976	(1977)
	FR Germany/ Switzerland	6	MBB Bo 105	Helicopter	Refitted in Switzerland with radio and electronics; police order	(1975)	1976
	Israel	. .	IAI Shafrir	AAM		1976	(1977)
	UK	2	"Oberon"-class	Submarine	$45 mn; displ: 1 610 t; delivery of second delayed until commercial debts regulated	1969	Jul–Aug 1976
	USA	34	Cessna A-37B Dragonfly	Strike/COIN aircraft	U.c.: $300 000; FMS sale approved by State Department 1974	Oct 1973	1975–76
		18	Northrop F-5E/F	Fighter-bomber aircraft	$65 mn incl spares, support equipment and training; arms: Sidewinder AAM, Maverick ASM; delivery to have been completed before embargo of 1 October 1976	Oct 1974	1976
		6	Sikorsky S-55T	Helicopter	U.c.: $175 000; converted to turbine power	1975	1976
		4	Swearingen Merlin 3	Light turboprop transp aircraft	Order not confirmed	(1976)	(1977)
		. .	Hughes AGM-65A Maverick	ASM	Arming 15 F-5Es	1975	1976
		. .	Raytheon AIM-9J-1 Sidewinder	AAM	Arming 15 F-5Es	1975	1976
Congo	France	1	Aérospatiale Frégate	Light transport aircraft	For AF; new production	1976	. .
Cuba	USSR	2	Ilyushin Il-62	Heavy transport aircr	To replace Il-18	(1975)	Jan 1976
Dominican Republic	USA	1	"Peconic"-class AOG 68	Gasoline tanker	Displ: 2 060 t; completed 1945; ex-USN	(1975)	1976
		3	AN 79, 86, 87	Net laying ship	Ex-USN	(1975)	1976
Dubai[a]	Italy	1	Aeritalia G-222	STOL transport aircr	Option on second	1976	Dec 1976
		4	Aermacchi M.B.326K/L	COIN/trainer aircraft	Brings total to 8; incl 1 M.B.326L advanced trainer vers	1975	1976
Ecuador	Canada	2	DHC-5D Buffalo	STOL transport aircraft	$12.5 mn incl 5 DHC-6s delivered 1975	Dec 1974	Apr 1976
	France	4	Aérospatiale SA-315 Lama	High-altitude hel	$1.25 mn	1974	1976

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
		. .	Aérospatiale MM.38 Exocet	ShShM	U.c.: $368 000 incl 12 launchers; arming 3 "Manta"-class patrol boats, Lürssen-type	1974	1976
		. .	Matra R.550 Magic	AAM	Arming 12 Jaguar aircraft	1974	(1977–)
		40	AMX-13	Light tank	>$27 mn; 5-year credit	1974	1975–76
	FR Germany	3	Lürssen-type	Fast missile boat	Displ: 250 t; arms: Exocet ShShM	1972	1976
		2	Type 209	Submarine	Displ: 980 t; Howaldtswerke construction	1974	1977
	Israel	10	IAI 201 Arava	STOL transport aircr	6 for AF, 2 for navy, 2 for army	1974–75	1975–76
		24	IAI Kfir	Fighter-bomber aircraft	$150 mn; US decision to block sale Feb 1977	1976	. .
	Italy	12	SIAI-Marchetti SF-260	Trainer aircraft	Order imminent; to replace T-34 and T-6	(1977)	(1977–)
	Spain	1	. .	School ship	Navy order; completed 1976	(1974)	Dec 1976
	UK/France	12	BAC/Dassault-Breguet Jaguar International	Strike/trainer aircraft	$68 mn incl 2 trainer vers; arms: Magic AAM	Apr 1974	Jan 1977–
	USA	14	Beech T-34C	Turboprop basic trainer aircraft	>$5 mn	1975	(1978–)
		12	Cessna A-37B Dragonfly	Strike/COIN aircraft	$20 mn; FMS sale	1975	1976
		4	Lockheed L-188 Electra	Turboprop transp aircr	Ex-surplus airline stocks	(1975)	1976
Egypt	France	>20	Aérospatiale Transall	Transport aircraft	U.c.: $7.2 mn; production line to be reopened	1976	. .
		38	Dassault Mirage III	Fighter-bomber aircraft	U.c.: $3 mn; contracted and paid for by Saudi Arabia; (on lease)	1973	1974–76
		50	Dassault Mirage F1-C/E	Fighter aircraft	U.c.: $6.3 mn in 1979 for F-1E with M53 turbofan; arms: Magic AAM; licensed production of up to 200 being negotiated	Jan 1975	1979–
	France/FR Germany	40	Dassault-Breguet/Dornier Alpha Jet	Light strike/trainer aircraft	U.c.: $3 mn; option on 80 more; West German government approval not obtained; licensed production being discussed	(1977)	. .
	France/UK	42	Aérospatiale/Westland SA-342 Gazelle	Light observation hel	Arms: HOT ATM; army order; delivery rate: 2/month	1975	1976–77
		. .	Aérospatiale AS.12	ASM	Arming 24 Commandos	1973	1974–76
		. .	Aérospatiale AS.12	ASM	Arming 4 Commandos; repeat order	Dec 1975	1978

		~100	Matra R.550 Magic	AAM	Arming F-1; licensed production being discussed	1975	1979–
		. .	Thomson-CSF/Matra "Arab Crotale"	SAM	Large number; to replace SAM-6; mounted on light vehicle; licensed production being discussed, but uncertain due to high-level technology; selected in preference to BAC Rapier	Aug 1976	1977–
	France/FR Germany	. .	Euromissile HOT	ATM	Arming 42 Gazelles	1975	1976–77
	Italy/France	>30	Oto Melara/Matra OTOMAT	ShShM	Advanced negotiations; to replace Styx on "Osa"- and "Komar"-class missile boats	(1977)	. .
	Switzerland/ Italy	20	FFA/SIAI-Marchetti AS-202/ 18A Bravo	Trainer aircraft	Advanced negotiations; licensed production of up to 200 being discussed	(1977)	. .
	UK	. .	BAC Swingfire	ATM	$42 mn initial contract; mounted on Land Rover; British offer of Striker AC with Swingfire; licensed production being discussed	1975	1976–
		3	British Hovercraft Corp SRN-6	Hovercraft	$2.8 mn; training in UK; second-hand; plans to build up hovercraft fleet	1975	1976
	UK/France	30–60	BAC/Dassault-Breguet Jaguar International	Strike/trainer aircraft	U.c.: $5.5 mn; negotiating initial batch; licensed production of up to 200 being discussed	(1977)	. .
	UK/USA	6	Westland/Sikorsky SH-3D Sea King Mk 2	ASW helicopter	Contracted and paid for by Saudi Arabia	1975	Jun 1976
		24	Westland/Sikorsky Commando Mk 1/2	Assault helicopter	Arms: 2×AS-12; contracted and paid for by Saudi Arabia	1974	1974–76
		4	Westland/Sikorsky Commando Mk 2	Assault helicopter	See above; repeat order	1975	1978
	USA	6	Lockheed C-130H Hercules	Transport aircraft	$65 mn; may order 14 more to replace An-12; paid for by Saudi Arabia; 1956 embargo lifted	1976	Dec 1976–
El Salvador	Israel	22	IAI 201 Arava	STOL transport aircr	U.c.: $650 000	1973	1974–77
Ethiopia	France	. .	Aérospatiale SS.12M	ShShM	Arming 1 "Wildervank"-class coastal minesweeper	(1975)	(1976)

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
	USA	12	Cessna A-37B Dragonfly	Light strike/COIN aircraft	Delivery suspended during 1974–76; President Carter announced in Mar 1977 that military aid to Ethiopia would be cut	1973	. .
		15	Cessna 310	Light transport aircraft	See above	1973	. .
		16	Northrop F-5E/F	Fighter aircraft	Arms: Sidewinder AAM, Maverick ASM; see above	1973	Apr 1976–
		. .	Hughes BGM-71 TOW	ATM		1976	. .
		. .	Hughes AGM-65A Maverick	ASM	Arming 14 F-5Es	. .	Apr 1976–
		. .	Raytheon AIM-9J-1 Sidewinder	AAM	Arming 14 F-5Es	1973	Apr 1976–
		24	M-60 A1	Tank	See above	1973	. .
		. .	Ford M-113 A1	APC	See above; production for new order started Apr 1976	1973	(1977–)
Fiji	USA	3	"Bluebird"-class	Coastal minesweeper	Displ: 270 t full load; completed 1955; 2 delivered 1975, third 1976; for Fiji Naval Force created 12 Jul 1975	1975	Oct 1975–76
Gabon	France	5	Dassault Mirage M-5	Strike interceptor/recce aircraft	Incl 2 recce vers; not Mirage III as previously reported	1975	(1977)
		1	. .	Patrol boat	40 m; under construction at Chantiers de l'Esterel	1976	. .
	Italy	2	. .	Patrol boat	27 m; under construction at Intermarine of Sarzana; arms: 2×40/70-mm Bofors	(1975)	. .
	Netherlands/ FR Germany	2	Fokker-VFW F28 Mk 1000C Fellowship	Freighter transport aircraft	For military/civilian use	1975	(1976)
	USA	1	Lockheed L 100-20 Hercules	Transport aircraft		1975	Dec 1976
Ghana	Italy	9	Aermacchi M.B.326K	Strike/COIN aircraft	U.c.: $1.5 mn	1976	(1977)
	UK	7	Scottish Aviation SA-3-120 Bulldog	Trainer aircraft	Delivery not completed 1975 as previously reported	Dec 1974	1975–Feb 1976
Guatemala	Israel	7	IAI 201 Arava	STOL transport aircraft		1976	1976

Guinea	China	2	"Shanghai-III"-class	Fast gunboat		(1976)	(1977)
Guyana	(UK/USA)	3	33-m type	Large patrol boat	Unconfirmed	1975	Nov 1976
	USA	2	LST-type	Tank landing ship	Displ: 1 653 t; completed (1942)	1975	(1976)
Honduras	Israel	3	IAI 201 Arava	STOL transport aircr		1976	1976
		12	Dassault Super Mystère IV	Fighter aircraft	Refurbished, ex-IAF; US engine caused criticism for third-country sale	1976	1977
	USA	1	LST-type	Tank landing ship	Displ: 1 653 t; completed (1942); for newly created navy	(1975)	(1976)
		6	Cessna A-37B Dragonfly	Light strike/ COIN aircraft		(1975)	1975– Feb 1976
India	Poland	50	WSK-Mielec TS-11 Iskra	Jet trainer aircraft	Purchased instead of L-39	May 1975	1976–
	UK/Belgium	5	Britten-Norman Defender	Light transport aircraft	For patrol	1976	May 1976
		(6	Westland Wasp	ASW helicopter	Arming 6 "Leander"-class frigates; fourth ship delivered 1976; see licensed production register	1972	. .)
		. .	Short Seacat	ShShM	See above	1972	1976
	USSR	7	Il-38 "May"	Maritime recce/ASW aircraft	Navy order; instead of too costly HS Nimrod	1975	1977–
		. .	SA-6 "Gainful"	SAM }	To be supplied prior to future licensed production	(1975)	. .
		. .	SA-7 "Grail"	Infantry SAM }			
		. .	SS-N-9	ShShM	Arming 8 new "Nanuchka"-class missile boats	1975	(1976–)
		. .	SS-N-2 "Styx"	ShShM	Arming (7) new "Osa"-class missile boats	1975	(1976–)
		8	"Nanuchka"-class	Missile corvette	Displ: 800 t; (new construction); arms: SS-N-9 ShShM	1975	(1976–)
		(7)	"Osa"-class	Missile patrol boat	Displ: 165 t; completed (1965); arms: SS-N-2 "Styx" ShShM	1975	(1976–)
		4	"Polnocny"-class	Tank landing ship	Displ: 780 t; in addition to 2 previously acquired	(1974)	1975–76
Indonesia	Australia	6	GAF N-22 Nomad	STOL turboprop transp aircraft	Military aid; navy order	1973	1975–76
		6	"Attack"-class	Patrol boat	Displ: 146 t; in addition to 2 previously acquired	Sep 1976	. .

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
	France	. .	Aérospatiale MM.38 Exocet	ShShM	Arming 3 new corvettes under construction in Netherlands; navy order	Nov 1976	1979–80
	FR Germany	2	(Type 209)	Submarine	$221 mn	Feb 1977	. .
	FR Germany/ Netherlands	8	Fokker-VFW F27 Friendship Mk 400M	Transport aircraft		May 1975	1976–77
	South Korea/ USA	4	. .	Missile boat	Displ: 280 t; arms: ShShM; licensed production in S. Korea by Tacoma Marine Industries; may order total of 18	1976	. .
	Netherlands	3	. .	Corvette	New construction; arms: Exocet ShShM	1975	1979–80
	Spain	6	CASA C.212 Aviocar	STOL transport aircraft	Initial purchase prior to licensed production of >30; see licensed production register	1975	1976
	USA	2	Beech King Air 100	Transport aircraft	$5 mn; Ex-Im Bank credit of $2.4 mn at 8% annual interest	1975	(1976–77)
		21	Beech Musketeer	Light trainer aircraft			
		3	Bell 47G	Helicopter	Ex-Im Bank credit; navy order	1975	(1976)
		2	Bell 206B	Helicopter	Ex-Im Bank credit	1975	(1976)
		16	Rockwell OV-10F Bronco	STOL transp/COIN aircraft	$6.2 mn for first 12; FMS sale; pilot training in USA; simultaneous order for 16 LTV Corsairs cancelled	1974	Aug 1976–77
Iran	France	4	Dassault Falcon 20	Transport aircraft	U.c.: $2.9 mn; not delivered in 1975, as previously reported	Aug 1975	1976
		. .	Aérospatiale AS.11/12	ASM	Arming 6 AB-212 helicopters	1973–74	1976–77
		142	Aérospatiale MM.38 Exocet	ShShM	$4.3 mn; arming 12 "Kaman"-class missile boats under construction	Feb 1974	Apr 1979
		12	"Kaman"-class	Missile boat	$57.6 mn; displ: 234 t; arms 4×Exocet and Harpoon ShShM; Oto Melara and Bofors guns; similar to Combattante II	Feb 1974	Apr 1979
	Italy/USA	6	Agusta-Bell 212	Helicopter	Arms: AS.11/12	Jan 1974	1976–77
		22	Agusta/Boeing Vertol CH-47C Chinook	Helicopter	$100 mn; in addition to 20 previously acquired; production delayed	1974	1976–
		2	Agusta/Sikorsky S-61A-4	Transport helicopter	For VIP use	1976	1977

Netherlands/ FR Germany	2	Fokker-VFW F27 Friendship	Transport aircraft	Army order; brings total to 25	1976	1977
UK	1 500	Chieftain Mk 5 "Shir Iran"	Tank	$2.3 bn arms-for-oil agreement signed Nov 1976, incl BAC Rapier (see licensed production register), and Scorpion ACs	1975–76	(1977–)
	110	Alvis Scorpion	Light tank	$63.9 mn; see above; in addition to 250 previously acquired	1976	(1977)
	250	Alvis Scorpion	Light tank		1975	1976
	. .	Fox	Scout car		1976	. .
	175	Vickers	Armoured recovery vehicle	$137 mn; negotiating payment; Iran wants arms-for-oil deal	1976	. .
	4	Vosper Thornycroft	Aircraft carrier	U.c.: $61 mn; displ: 8 000 t; carries 8×ASW helicopter and 8× HS Sea Harrier; negotiating payment; Iran wants arms for oil	(1977)	. .
	1	. .	Fleet tanker	Displ: 20 000 t; under construction by Swan Hunter	Oct 1974	1977
USA	202	Bell AH-1J	Assault helicopter	$367 mn; u.c.: $1.2 mn; army order; arms: 8×TOW ATM; 107 delivered by Oct 1976	Dec 1972	1974–77
	287	Bell 214A "Isfahan"	Utility helicopter	$63 mn; initial R&D funding by Iran; delivery rate 10/month; licensed production planned	Dec 1972	1975–77
	2	Bell 214B Big Lifter	Transport helicopter		1975	(1976)
	39	Bell 214C	Advanced utility hel	$40.2 mn incl support equipment; for SAR	Feb 1976	Jan 1977–Feb 1978
	7	Boeing 707-39JC	Tanker/transport aircraft	In addition to 6 previously acquired	1975	1976
	12	Boeing 747–131	Heavy transport aircraft	~$200 mn; purchased second-hand on commercial market; for conversion to military freighter/tanker	Aug 1975	1976–77
	160	General Dynamics F-16	Light-weight fighter aircraft	$3.4 bn incl spares, training, ground support equipment; incl 10 trainer vers; arms: Sidewinder AAM, Sparrow AAM, Phoenix AAM; delivery plan still being discussed; arms-for-oil deal being negotiated	1976	(1980–84)
	80	Grumman F-14A Tomcat	Fighter/interceptor aircraft	$2.3 bn; Iranian contribution to R&D funding; arms: Phoenix AAM; cost increase due to price of Phoenix	Jul 1974	1976–May 1978

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
		3	Lockheed P-3C Orion	Maritime recce/ASW aircraft	In addition to 6 previously acquired; to be equipped for ASW	1976	(1977)
		36	McDonnell Douglas F-4E Phantom	Fighter aircraft	$150 mn; in addition to 160 previously acquired; arms: Maverick ASM; Sidewinder and Sparrow AAM	1974	1976–77
		12	McDonnell Douglas RF-4E Phantom	Fighter/recce aircraft	In addition to 4 previously acquired	1974	(1976)
		141	Northrop F-5E Tiger II	Fighter aircraft	$377 mn; u.c.: $1.2 mn; arms: Sidewinder AAM	1973	1974–76
		28	Northrop F-5F Tiger II	Fighter/combat trainer aircraft	$102 mn; arms: Sidewinder AAM	1975	1976
		6	Sikorsky RH-53D	Helicopter	$25 mn; navy order, for mine countermeasures; 6 more planned	(1975)	1976–77
		. .	Hughes AGM-65A Maverick	ASM	Arming 36 F-4Es	1974	1976–77
		280	Hughes AIM-54A Phoenix	AAM	$241 mn incl Sparrow and Sidewinder; u.c.: $250 000; arming 80 F-14s	Jul 1974	1976–May 1978
		424	Hughes AIM-54A Phoenix	AAM	Arming 160 F-16s	1976	(1980–84)
		6 200	Hughes BGM-71A TOW	ATM	Arming 202 AH-1Js	Dec 1972	1974–77
		634	McDonnell Douglas FGM-77A Dragon	ATM	Infantry-portable	Dec 1975	(1977)
		222	McDonnell Douglas AGM-84A Harpoon	ShShM	Arming 12 Combattante II missile boats and 4 "Spruance"-class destroyers	1974	. .
		. .	Raytheon AIM-9J-1 Sidewinder	AAM	$79 mn for total of 3 462 missiles ordered 1971–74; arming F-5E	1974	1974–76
		754	Raytheon AIM-9J-1 Sidewinder	AAM	$241 mn incl Sparrow and Phoenix; arming F-14	1976	1976–May 1978
		516	Raytheon AIM-7 Sparrow	AAM	Arming 36 F-4Es	1974	1976–77
		. .	Raytheon AIM-7 Sparrow	AAM	Arming F-16s	1976	(1980–84)
		(. .	Rockwell International AGM-53A Condor	ASM	Arming F-14, P-3	1974	1976–May 1978)
		. .	Ford M-113 Al	APC	Production for new order began Apr 1976	1976	. .
		4	DD-963 "Spruance"-class	Destroyer	U.c.: $338 mn; incl in arms-for-oil negotiations; order reduced from 6 due to cost escalation; displ: 7 800 t; arms: Harpoon ShShM	1974	1980–

		3	"Tang"-class	Submarine	Displ: 2 100 t; completed 1952; ex-USN; completed early 1950s; modernized 1960; delivery uncertain	1975	. .
	USSR	. .	SAM-7	SAM			
		. .	SAM-9	SAM	$414 mn; agreement signed during War Minister Toufanian's visit to Moscow Nov 1976	Nov 1976	(1977–)
		. .	VCI BMP-1	APC			
		. .	ASU-85	SP A/T gun			
		. .	ZSU-23-4	SP A/A gun			
Iraq	Czechoslovakia	(60)	Aero L-39	Trainer aircraft	Production delayed; to replace L-29; may have also ordered L-39Z combat trainer	1973	(1977–)
	France	20	Aérospatiale Alouette III	Helicopter	Brings total to 60; arms: AS-11/12 ASM	(1974)	1976–77
		(40)	Aérospatiale SA-321 Super Frelon	Medium-lift helicopter	See above; 2 delivered 1976	1976	1976–77
	France/UK	(60)	Aérospatiale/Westland SA-342 Gazelle	Helicopter	Incl in order for 100 new helicopters	1976	. .
		2	Dassault Falcon 20	Transport aircraft	For VIP use	1975	(1976)
		80	Dassault Mirage F1	Fighter aircraft	U.c.: $9 mn; advanced negotiations; arms-for-oil deal	(1977)	. .
		~50	Dassault-Breguet/BAC Jaguar International	Fighter aircraft	See above	(1977)	. .
		2	. .	Patrol boat	See above	(1977)	. .
		. .	Aérospatiale AS.11/12	ASM	$14.7 mn; arming Alouette III	1974	1976–77
	USA	8	Lockheed C-130 Hercules	Transport aircraft	US government authorized sale	1976	(1977)
	USSR	(10)	"Scud"	Tactical battlefield SSM			
		. .	. .	Improved ATM			
		. .	T-64	Tank	$4 bn; with non-nuclear warhead; repeat order; recent supply	(1975)	(1976)
		. .	. .	152-mm SP rapid-fire artillery			
		. .	Mil Mi-8	Helicopter			
		. .	(Mil Mi-24)	Assault helicopter			
Israel	UK	3	IKL/Vickers Type 206	Patrol submarine	West German design; displ: 420 t; first hull laid down 1975	Apr 1972	(1977–)
	USA	. .	Bell AH-1J Cobra	Assault helicopter	$64 mn; incl in $241 mn sale approved before FY 1977; incl missiles and Walleye bombs; arms: Hughes TOW ATM	1974	(1977)
		8	Boeing Vertol CH-47C Chinook	Helicopter	Ordered before Oct 1973 war; delivery delayed	1973	1976–77

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
		(200–400	General Dynamics F-16	Light-weight fighter aircraft	U.c.: $6.7 mn; licensed production desired; US Administration may refuse to sell due to concern for Israeli re-export to third countries	1977	1980–)
		4	Grumman E-2C Hawkeye	AEW aircraft	$187 mn incl installation and test of data link system	Jan 1976	Nov 1977–Mar 1978
		8	Lockheed C-130H Hercules	Transport aircraft	Brings total to 24 troop transport/cargo vers	(1975)	1976
		2	Lockheed KC-130H Hercules	Tanker/transport aircraft		(1975)	Oct 1976–77
		12	McDonnell Douglas F-15 Eagle	Fighter aircraft	U.c.: $15 mn; order cut from 25 due to cost escalation; arms: Sidewinder and Sparrow AAM	1975	1976–77
		36	McDonnell Douglas A-4N Skyhawk	Fighter aircraft	Total of 287 ordered; arms: 2×Bullpup ASM	Sep 1974	1974–77
		~30	McDonnell Douglas A-4N Skyhawk	Fighter aircraft	To be delivered during 1977 as replacement	1976	1977
		30	McDonnell Douglas F-4E Phantom	Fighter aircraft	Total of 250 received since 1969; arms: Maverick ASM, Sidewinder AAM	Sep 1974	1976
		~30	McDonnell Douglas F-4E Phantom	Fighter aircraft	To be delivered during 1977 as replacements	1976	1977
		. .	Sikorsky CH-53	ELINT helicopter		1976	(1977)
		12	Sikorsky S-61R	Helicopter		(1975)	1976–77
		. .	Hughes AGM-65A/B Maverick	ASM	Incl in $241 mm sale approved before FY 1977; arming F-4E and Kfir; delivery delayed	1974	1976–
		(1 000)	Hughes BGM-71 TOW	ATM	Arming M-113 APC; delivery delayed	1974	1975–76
		330	LTV MGM-52C Lance	Tactical battlefield support SSM	Delivery delayed; with non-nuclear warhead	Nov 1974	Feb 1976–77
		. .	Martin AGM-12B Bullpup	ASM	Arming A-4 Skyhawk	Sep 1974	1974–77
		. .	McDonnell Douglas FGM-77A Dragon	ATM	Large number being delivered	1975	1976–77
		100	McDonnell Douglas AGM-84A Harpoon	ShShM	$13.5 mn	1975	1978–79
		. .	Raytheon AIM-9J-1 Sidewinder	AAM	Arming F-4E	Sep 1974	1974–77

		..	Raytheon AIM-9J-1 Sidewinder	AAM	$31.8 mn, incl in $241 mn sale approved before FY 1977	1976	(1977–)
		..	Rockwell AGM-53A Condor	ASM	Incl in $241 mn sales approved before FY 1977 after Sinai peace agreement	Oct 1976	(1977)
		..	..	Tele-guided ATM	See above; plus concussion bombs and ECM equipment; first customer outside USA	1976	(1977–)
		400	M-60 A1	Tank	Brings total to 600; delivery delayed	1975	1975–76
		125	M-60 A1	Tank	Incl in $241 mn sales approved before FY 1977 after Sinai peace agreement	Oct 1976	1977
		..	M-113 A1	APC	Production for new order started Apr 1976; arms: 10×Hughes TOW ATM	1976	(1977)
		..	..	155-mm howitzer		1976	(1977)
		..	"Firefish III"	Fast patrol boat	Displ: 6 t; under construction; remote-controlled	1971	..
		1	"Casa Grande"-class	Floating dock boat	Displ: 4 790 t; completed 1944; ex-USN; for use as dock for "Saar"-class gunboats	1975	(1976)
Ivory Coast	France	..	Aérospatiale SS.12M	ShShM	Arming P-48 patrol boat	(1977)	..
		1	P-48 type	Patrol boat	Arms: SS.12M ShShM	(1977)	..
		1	"Francis Garnier" type	Transport ship		(1977)	..
	Netherlands/ FR Germany	2	Fokker-VFW F28 Fellowship	Transport aircraft		1975	(1977)
Jamaica	USA	3	"Sewart"	Patrol boat	Displ: 104 t; (new construction)	1972	1974–76
Jordan	Spain	4	CASA C.212A/C Aviocar	STOL turboprop transp aircraft	U.c.: $1 mn; incl 1 CASA 212C for VIP use; to replace C-47	1975	1975–76
	UK	5	Scottish Aviation Bulldog	Trainer aircraft	Brings total to 13; for Air Academy	1975	Mar 1976
	USA	2	Lockheed C-130 Hercules	Transport aircraft		1976	(1977)
		22	Northrop F-5E Tiger II	Fighter aircraft	Brings total to 602; incl F-5As from Iran; MAP; arms: Sidewinder AAM	1974	May 1975–76
		4	Sikorsky S-76	Helicopter	For troop transport	1976	1978
		300	General Dynamics FIM-43A Redeye	SAM	$5 mn; incl in $800 mn air-defence order financed by Saudi Arabia	1974	1976

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
		100	General Dynamics M-61 A-1 Vulcan	A/A gun	$87 mn; for 8 batt; see above	1974	(1977–)
		532	Raytheon MIM-23B Improved Hawk	SAM	$540 mn; for 14 batt; see above; delivery delayed due to US demand for fixed sites only and for deletion of command and control system	1974	(1977–)
		. .	McDonnell Douglas FGM-77A Dragon	ATM		(1975)	1976
		200	M-48/M-60	Tank	Refurbished }	1976	(1977–)
		700	(M-113 A-1)	APC	}	1976	(1977–)
Kenya	Canada	4	DHC-5D Buffalo	STOL transport aircraft	Unconfirmed	1976	. .
	UK	9	Scottish Aviation Bulldog Model 127	Trainer aircraft	In addition to 5 previously acquired	1976	(1977)
		. .	Fox	Scout car		Nov 1975	. .
	USA	12	Northrop F-5E/F Tiger II	Fighter aircraft	$75 mn incl spares, training and technical assistance; sale approved by US Congress	1976	1977–
Korea, North	(USSR	~20	MiG-23	Fighter/interceptor aircr	Arms: Atoll AAM	. .	1976)
	(. .		"Atoll"	AAM	Arming MiG-23	. .	1976)
Korea, South	USA	34	Hughes 500 M/D	Armed helicopter	$50 mn for total of 100; 66 to be licence-produced; 4 delivered 1976 without arms; arms: 4×Hughes TOW ATM	Jun 1976	1976–78
		36	McDonnell Douglas F-4E/D Phantom	Fighter aircraft	In addition to 36 previously acquired; arms: Sidewinder and Sparrow AAM	1975	1976–77
		72	Northrop F-5E Tiger II	Fighter aircraft	Arms: Maverick ASM, Sidewinder AAM	Nov 1972	1974–76
		60	Northrop F-5E Tiger II	Fighter aircraft	$205 mn incl ground support equipment; arms: Maverick ASM, Sidewinder AAM	1975	1976–77
		24	Rockwell International OV-10G Bronco	Observation aircraft	$58.2 mn; part of total $116.1 mn sale before FY 1977	1976	(1977–)

		. .	General Dynamics RIM-66A Standard	ShShM	Arming 7 new Tacoma patrol boats; see licensed production register	1974	1975–77
		200	Hughes AGM-65A Maverick	ASM	$10.2 mn; arming 60 F-5Es; awaiting Congressional approval	1976	(1977–)
		. .	Hughes BGM-71 TOW	ATM	Arming some of 100 Hughes 500 helicopters	Jun 1976	1977–
		120	McDonnell Douglas RGM-84A Harpoon	ShShM	$81mn; arming 7 new missile boats	1975	1978–79
		733	Raytheon AIM-9J-1 Sidewinder	AAM	$20.8 mn; arming F-5 and F-4; sale approved by US Congress 1976; part of total $116.1 mn sale before FY 1977	1976	1977–
		. .	Raytheon AIM-7E Sparrow	AAM	Arming 36 F-4s	1975	1976–77
		421	M-48	Tank	$96 mn; part of total $116.1 mn sale before FY 1977	1976	(1977–)
		3	"Asheville"-class	Fast missile boat	Displ: 250 t full load; (new construction); arms: Standard ShShM; 4 more being built in S. Korea for delivery 1976–77; see licensed production register	. .	1975–76
		1	"Casa Grande"-class	Dock landing ship	Displ: 4 790 t; completed 1946; arms: A/A guns	(1975)	1976
		2	"Gearing"-class	Destroyer	Displ: 2 425 t; completed 1945; in addition to 2 previously acquired	1975	1976–77
Kuwait	France	20	Dassault Mirage F1-C/B	Air combat fighter aircr	$315 mn incl 2 F-1B trainer vers; arms: Matra Magic AAM; first 3 F1-Cs delivered 1976	Apr 1973	1976–
		480	Matra Super 530/550 Magic	AAM	$10.5 mn; arming 20 F-1C/Bs	Apr 1973	1976–
	France/FR Germany	. .	Euromissile HOT	ATM	Arming 20 Gazelle and 10 Puma helicopters	1974	1975–76
	France/UK	10	Aérospatiale/Westland SA-330 Puma	Helicopter	$37.5 mn incl 20 Gazelles; arms: Euromissile HOT ATM	1974	1975–76
		20	Aérospatiale/Westland SA-342 Gazelle	Helicopter	See above	1974	1975–76
	UK	165	Chieftain	Tank	$250 mn incl spares, ammunition instructors and training	Feb 1976	1977
	USA	2	McDonnell Douglas DC-9	Turbofan transport aircr	$42 mn incl spares and support equipment	1975	(1976)

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
		36+6	McDonnell Douglas A-4M/ TA-4 Skyhawk	Fighter aircraft	$450 mn incl Hawk SAM, spares, support equipment and training; arms: Sidewinder AAM	Nov 1974	Dec 1976–77
		1 800	Hughes BGM-71 TOW	ATM	Arming Land Rovers	1973	1975–76
		240	Raytheon MIM-23B Improved Hawk	SAM	$450 mn incl A-4 Skyhawks, to be deployed at 2 air bases constructed by Yugoslavia	1974	(1977)
		300	Raytheon AIM-9H Sidewinder	AAM	$32.3 mn; arming 36 A-4 Skyhawks	1975	Dec 1976–77
		. .	(M-113 A1)	APC	$18 mn; incl in US sales list presented 30 Jun 1976 for Congressional approval	1976	. .
Laos	USSR	6	Antonov An-24	Transport aircraft	Incl spares and support equipment	(1976)	1976–Jul 1977
		. .	Mil Mi-8	Helicopter	Incl spares	(1976)	1976–Jul 1977
Lebanon	FR Germany	1	. .	Patrol boat	Displ: 135 t; under construction by Hamelin	Jan 1974	(1977)
Liberia	USA	2	Cessna Model 172	Light plane	Incl among 10 light aircraft in newly created air arm	(1975)	1976
		1	Cessna Model 185	Light plane	See above	(1975)	1976
		1	Cessna Model 207	Light plane	See above	(1975)	1976
		2	McDonnell Douglas C-47	Transport aircraft	See above; refurbished	(1975)	1976
Libya	France	38	Dassault Mirage F1-A/B/C	Air combat fighter aircr	Arms: Matra Magic AAM	1975	(1977)
		. .	Aérospatiale MM.38 Exocet	ShShM	Arming 10 PR 72S missile boats under construction	1975	. .
		. .	Matra R.550 Magic	AAM	Arming 38 F-1s	1975	(1977)
		. .	Thomson-CSF/Matra Crotale	SAM	Displayed during military parade; different vers from that sold to Saudi Arabia and Egypt	(1975)	1976
		10	PR 72S	Fast missile boat	$186 mn; displ: 250 t; advanced type; arms: 4×Exocet; contract finalized 1976 after 2 years of negotiations	1976	. .

		2	. .	Tank landing ship	New construction by La Seyne	1975	1977
	France/Italy	110	Matra/Oto Melara OTOMAT	ShShM	Arming 4 missile corvettes under construction in Italy; may order 120 Mk 2s	1974	1977–78
	France/ Spain	4	"Agosta"-class	Submarine	Licence-produced in Spain; incl in new naval expansion programme	1976	. .
	Italy	4	. .	Missile corvette	Displ: 550 t; arms: 4×OTOMAT; under construction by CNR	1975	1977–78
	Italy/USA	24	SIAI-Marchetti/Boeing Vertol CH-47C Chinook	Medium-lift helicopter	First 2 delivered Jun 1976 despite US arms embargo; training in Italy	(1975)	1976–77
		1	Agusta/Sikorsky S-61A	Transport helicopter	For VIP use	(1976)	(1977)
	USA	8	Lockheed C-130H Hercules	Transport aircraft	$70 mn; embargoed since 1974	1973	1976–77
	USSR	12	Tupolev Tu-22 "Blinder"	Bomber aircraft	Arms: "Kitchen" ASM	1975	1976–77
		12	Mil Mi-8	Helicopter		1975	1975–76
		. .	"Kitchen"	ASM	Arming 12 Tu-22s	1975	1976–77
		25	"Scud"	Tactical battlefield support SSM	With non-nuclear warhead; displayed in military parade	. .	(1976)
		. .	SS-N-2 "Styx"	ShShM	Arming 24 "Osa"-class missile boats	(1975)	1976–77
		(~2 000)	T-62/64	Tank	Reportedly delivered, according to US intelligence	(1975)	(1976)
		6	"Foxtrot"-class	Submarine	Displ: 2 000 t; completed (1963); ex-USSR; diesel-powered	(1975)	1976–77
		24	"Osa"-class	Fast missile boat	Displ: 165 t; completed (1960–65)	(1975)	1976–77
	Yugoslavia	. .	Soko Galeb G-2A-E	Trainer aircraft	Production line reopened in 1975 to fulfil Libyan order; not delivered 1975 as previously reported	1975	(1977)
Malagasy	France/USA	4	Reims Cessna Model 172	Light plane		(1975)	Jan 1976
Malaysia	France/UK	>3	Aérospatiale SA-341K Gazelle	Helicopter	Unspecified number ordered; at least 3 completed to date	1976	1976–77
		. .	Aérospatiale MM.38 Exocet	ShShM	Arming 4 "Perdana"-class missile boats	1976	. .
		4	"Perdana"-class	Missile boat	Arms: 2×Exocet ShShM, Bofors guns; in addition to 4 previously acquired; similar to "Combattante II"-class	1976	. .

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
	Fr Germany	3	Lürssen type	Patrol boat	Displ: 62.5 t; in addition to 3 previously acquired; see licensed production register for new Lürssen boats	(1975)	. .
	(Israel	. .	IAI Gabriel	ShShM	Reportedly ordered	1976	. .)
	Sweden	4	Modified "Spica"-class	Fast patrol boat	$68 mn; payment terms: 30% on signing contract, 15% on completion of first keel, 10% on completion of second keel; 200 navy personnel training in Sweden from Apr 1976	Aug 1976	1977–79
	USA	6	Lockheed C-130H Hercules	Transport aircraft	$115 mn; first 3 delivered Jul 1976	Oct 1974	1976
		14	Northrop F-5E/B Tiger II	Fighter aircraft	U.c.: $5 mn incl spares and technical support; arms: Sidewinder AAM, Maverick ASM; 57 pilots and technicians trained in USA	Jul 1972	1975–76
		6	Sikorsky S-61A	Helicopter	Brings total to 14	1975	1976
		20	. .	Helicopter	Purchased; unspecified type	1976	. .
		. .	Hughes AGM-65A Maverick	ASM	Arming 14 F-5Es	Jul 1972	1976
		. .	Raytheon AIM-9J-1 Sidewinder	AAM	Arming 14 F-5Es	Jul 1972	1976
		2	LST type	Tank landing ship	Displ: 1 653 t; completed (1942); ex-USN; for cargo support	(1975)	1976
Mauritania	(France)	1	Douglas C-54	Transport aircraft	Refurbished; recent delivery to Mauritanian Islamic AF	(1975)	1976
	France/USA	2	Reims Cessna FTR 337 Milirole	Light trainer aircraft	See above; brings total to 4	(1975)	1976
	UK/Belgium	4	Fairey-Britten Defender	STOL transport aircraft	See above; for border patrol and liaison	(1975)	1976
Mexico	UK	21	"Azteka"-class	Large patrol boat	$29 mn; displ; 130 t; last 4 delivered 1976; new order for 10 placed in 1976 (see licensed production register)	1973	1974–76

Morocco	France	25	Dassault Mirage F1	Air combat fighter aircr	Option on 25 more; firm order expected; arms: Matra Magic AAM	Dec 1975	1978–79
		(. .	Aérospatiale MM.38 Exocet	ShShM	To arm 4 PR 72 missile corvettes	1975	. .)
		. .	Matra R.550 Magic	AAM	Arming 25 F1s	Dec 1975	1978–79
		2+2	PR 72 type	Missile corvette	Displ: 375 t; new construction; (arms: Exocet ShShM)	Jun 1973/ 1976	1976–
		6	P-92 type	Fast patrol boat	Displ: 90 t; new construction	Feb 1974	1975–76
		14	P-92 type	Fast patrol boat	Displ: 90 t; new construction; incl in naval expansion programme	1976	. .
		3	"Batral"-class	Transport ship	Displ: 750 t; 1 helicopter platform; under construction	1974–75	. .
	France/UK	40	Aérospatiale/Westland SA-330 Puma	Medium-lift helicopter		1975	1975–76
	Italy/USA	8	Agusta-Bell 206	Helicopter		(1975)	(1976)
		5	Agusta-Bell 212	Helicopter		(1975)	(1976)
		28	SIAI-Marchetti SF-260	Armed trainer/COIN aircr		1976	. .
	Switzerland	14	FFA AS-202/180 Bravo	Primary trainer aircraft	U.c.: $80 000	1976	. .
	USA	12	Beech T-34C Turbo Mentor	Turboprop trainer aircr	$5.5 mn; first buyer of new vers	1975	1977
		9	Lockheed C-130H Hercules	Transport aircraft	$6 mn; in addition to 6 previously acquired	May 1976	1977
		24	Northrop F-5E/F Tiger II	Fighter aircraft	$120 mn; US government agreed to sale	1976	(1978–79)
		20	Rockwell International T-2 Buckeye	Trainer aircraft	$89 mn; incl in US sales list presented 30 Jun 1976 for Congressional approval	Sep 1976	. .
		. .	Ford MIM-72A Chaparral	SAM	System u.c.: $1 mn with Sidewinder missile; FMS sale	1976	. .
		. .	Hughes BGM-71 TOW	ATM		1975	. .
		334	Ford M-113-A1	APC	$142.5 mn incl 80 A/A cannons, 753 trucks	1975	(1977–)
		100	M-48	Tank		1975	(1977–)
		. .	M-113 A1	APC	Production for new order started Apr 1976	1976	. .
Mozambique	USSR	. .	T-34/54	Tank	Large number delivered by ship to Beira according to US intelligence	. .	1976
		. .	. .	AC	Incl RL; see above	. .	Nov 1976

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
Nicaragua	Israel	14	IAI-201 Arava	STOL transport aircraft	Delivery delayed; 2 in service end-1976	1973	1974–(77)
Nigeria	Brazil	40	Aerotec T-23 Uirapuru	Primary trainer aircraft	Advanced negotiations; firm order expected	(1977)	. .
	France/UK	2	Aérospatiale/Westland SA-330 Puma	Medium-lift helicopter		. .	1976
	FR Germany	2	Abeking and Rasmussen type	Large patrol boat	Displ: 90 t; arms; 1×40-mm Bofors gun; in addition to 2 previously acquired	1975	. .
	Netherlands/ FR Germany	3	Fokker-VFW F27 Friendship Mk 500	Transport aircraft	In addition to 6 previously acquired	1975	1976
	UK	. .	Short Seacat	ShAM	Arming 2 Mk 9 corvettes under construction	1975	. .
		. .	Fox	Scout car		1975	(1977)
		. .	Alvis Scorpion	Light tank		1975	(1977)
		1	"Bulldog"-class	Survey ship	$7 mn; displ: 800 t; new construction	1973	1976
		2	Brooke Marine 33-m type	Fast patrol boat	$3.7 mn; displ: 115 t; in addition to 2 previously acquired	Oct 1974	(1977)
		2	. .	Patrol boat	Displ: 90 t	1976	. .
		2	Vosper Thornycroft Mk 9	Corvette	$36.8 mn; displ: 740 t; arms: 1× Seacat ShAM, Bofors RL, Oto Melara guns, Oerlikon cannon	1975	. .
	USA	6	Lockheed C-130H Hercules	Transport aircraft	$47 mn incl spares, technical assistance, support and training	Oct 1974	1975–76
		1–2	LST-type	Tank landing ship	Displ: 1 653 t; completed (1942); ex-USN	1976	(1977)
	USSR	12	MiG-21MF "Fishbed J"	Fighter aircraft	Arms: "Atoll" AAM	. .	1975–76
		. .	"Atoll"	AAM	Arming 12 MiG-21s	. .	1975–76
Oman	France	. .	Matra R.550 Magic	AAM	Arming 12 Jaguars	1975	1977–
	Italy/USA	>1	Agusta-Bell 212	Helicopter		1976	. .
	Netherlands	2	"Wildervank"-class	Minesweeper	Displ: 373 t; completed 1954; being refitted to patrol boats	Mar 1974	(1977)
	Switzerland	2	FFA AS-202/180 Bravo	Primary trainer aircraft		(1976)	1976
		2	Pilatus PC-6 Turbo Porter	Light turboprop utility aircraft		(1976)	1976

	UK	4	BAC 167 Strikemaster Mk 89	Fighter aircraft		1974	(1976)
		28	BAC Rapier	SAM	$150 mn incl 15 launchers	Sep 1974	1977–
		4	Brooke Marine 35-m type	Fast patrol boat	$14.3 mn; displ: 135 t; new construction; in addition to 3 previously acquired	Apr 1974	1976–77
		2	Cheverton 27-ft type	Coastal patrol boat	Displ: 3.5 t; new construction	Apr 1975	. .
	UK/France	12	BAC/Dassault-Breguet Jaguar International	Strike/fighter aircraft	$83 mn; arms: Matra Magic AAM; for integrated defence network with BAC Rapier SAMs	Sep 1974	Mar 1977–Feb 1978
	USA	5	Bell 214A Big Lifter	Heavy-lift helicopter		1974	1976
Pakistan	China	. .	. .	Submarine	Small number delivered; not known if gift or sale	. .	1976
		. .	. .	Destroyer	See above	. .	1976
	France	4	Aérospatiale Super Frelon	Helicopter		1975	. .
		3	Dassault-Breguet Atlantic	ASW fighter aircraft	$71 mn incl spares; credit: $38.2 mn; ex-French; refurbished; navy order	1973	1975–76
		10	Dassault Mirage III-R	Recce/fighter aircraft		Jul 1975	1977
		10	Dassault Mirage 5	Fighter aircraft	Ordered in addition to SA-330 Puma	Jan 1977	. .
		9 batt	Thomson-CSF/Matra Crotale	SAM		1975	. .
		. .	Aérospatiale AM.39 Exocet	ASM	Arming 4 of 6 Sea King ASW helicopters	1974	. .
		1	"Daphne"-class	Submarine	Displ: 700 t; new construction; in addition to 3 previously acquired	1973	1976
	France/Italy	. .	Matra/Oto Melara OTOMAT	ShShM		1976	. .
	France/UK	35	Aérospatiale/Westland SA-330 Puma	Helicopter	Ordered in addition to Mirage 5	Jan 1977	. .
	(Iran	50	Northrop F-5A	Fighter aircraft	Ex-Iranian; refurbished; may be on loan	1973	1976)
	Sweden	45	SAAB MFI-17 Supporter	Primary trainer aircraft	Can be armed with AS.11/12 ASM	1974	1974–76
	UK/France	100	BAC/Dassault-Breguet Jaguar International	Strike/fighter aircraft	Preferred to US LTV A-7 Corsair; BAC delegation in Pakistan Dec 76	(1977)	. .
	UK/USA	2	"Whitby"-class	Destroyer	Displ: 2 560 t; refit started 1975; not delivered 1975, as previously reported; funding problems	Oct 1974	(1977)

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
	USA	(100	LTV A-7 Corsair II	Bomber/attack aircraft	$700 mn; offer during Secretary of State Kissinger's visit Sep 1976 on condition that Pakistan abstains from nuclear reactor deal with France; Pakistani government declared 5 Jan 1977 that nuclear deal will go through	–	–)
		. .	Hughes BGM-71 TOW	ATM	$28 mn incl 200 launchers; deal may not go through; see above for French nuclear reactor connection	(1976)	(1977–79)
		. .	Raytheon AIM-9J-1 Sidewinder	AAM	$14.2 mn; incl in US sales list presented 30 Jun 1976 for Congressional approval; see above	(1976)	(1977–)
		. .	. .	Tank recovery vehicle	Incl in US sales list presented 30 Jun 1976 for Congressional approval; see above	(1976)	(1977)
Panama	UK/Belgium	1	Britten-Norman BN-2A Islander	Transport aircraft	In addition to 1 acquired 1975	1976	1976
Papua New Guinea	Australia	2	LCH-type	Heavy landing ship	Displ: 310 t; ex-Australian Navy	1975	1976
Paraguay	Brazil	20	Aerotec T-23 Uirapuru	Trainer aircraft		Mar 1972	1975–76
	Israel	6	IAI 201 Arava	STOL transport aircraft	>$7 mn incl spares and training	Dec 1976	1977
Peru	Cuba	12	MiG-21	Fighter aircraft	Ex-Cuban AF; initial training in Cuba; ordered pending delivery of Su-22	1976	1977
	France	16+4	Dassault Mirage 5	Ground attack fighter aircraft	Last 4 ordered for army Sep 1976; in addition to 14 previously acquired; arms: 1×AS.30 ASM	1975–76	1976–77

		. .	Aérospatiale AS.30	ASM	Arming Mirage 5	1975–76	1976–77
		. .	Aérospatiale MM.38 Exocet	ShShM	Arming 2 "Palacios"-class destroyers; 8 missiles/launcher	1976	. .
		3	. .	Missile boat	$65 mn; originally wanted "Reshef"-class (Israel); arms: Exocet ShShM	1977	. .
	FR Germany	2	Type 209	Submarine	Displ: 900 t; in addition to 2 delivered 1975	1976	(1977)
	Italy	. .	Selenia Albatros Aspide	ShAM	Arming 4 "Lupo"-class frigates; 1 octuple launcher on top of hel hangars	1975	1977–
		2	"Lupo"-class	Frigate	Displ: 2 208 t; helicopter-carrier; under construction in Italy; arms: 2×OTOMAT ShShM; 1×Albatros Aspide ShAM; 2 more to be built in Peru; see licensed production register	1974	1977–
	Italy/France	40	Oto Melara/Matra OTOMAT	ShShM	Arming 4 "Lupo"-class frigates	1974	1977–
	Italy/USA	12	Agusta Bell 212	ASW helicopter	Contract being finalized; for "Lupo"-class frigates	(Dec 1976)	(1977)
	Netherlands/ FR Germany	1	Fokker-VFW F28 Fellowship	Transport aircraft		Jun 1975	Apr 1976
		2	Fokker-VFW F27 PMA	Maritime patrol aircraft	First customer for new vers	1976	1977
	USA	3	Lockheed L-100-20 Hercules	Transport aircraft	$20 mn	Mar 1976	Jan 1977
		6	Pitts S-2A Special	Aerobatic biplane	AF order for training role	1976	. .
	USSR	23	Mil Mi-8	Helicopter	Credit terms: 3-year grace period, 7-year repayment at low interest rate, barter accepted	1976	. .
		36	Sukhoi Su-22	Fighter-bomber aircraft	$250 mn; u.c.: $7 mn; 10-year repayment at 2% interest; preferred to Northrop F-5E; pilot training in Peru by Soviet instructors	1976	(1977–)
		. .	. .	Helicopter	Contracted in late-1976, plus radar and communications equipment	1976	. .
		. .	SAM-3	SAM			
		. .	SAM-7	SAM			
Philippines	Australia	12	GAF Nomad 22 "Mission Master"	STOL utility/transp aircraft	$12 mn; req: navy 6, AF 6	1974	1975–76
		2	DeHavilland type	Fast patrol boat	Military aid; under construction	1974	(1977)
	USA	12	Boeing Vertol AC-47A	Gunship helicopter	For 2 COIN squads	1975	1975–76
		18	Bell UH-1H Iroquois	Helicopter		1975	1976–77
		11	Northrop F-5E Tiger II	Fighter aircraft	$61.4 mn; incl in US sales list presented 30 Jun 1976 for Congressional approval	1976	. .
		. .	Ford M-113 A1	APC	Production for new orders started Apr 1976	1976	. .

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
		1	DER-type	Frigate	Displ: 1 590 t; completed 1943; ex-USN to South Vietnam 1971; acquired by Philippines 1945	1975	Apr 1976
		6	Improved "Swift" type	Patrol boat	Displ: 33 t full load; under construction by Sewart; in addition to 18 "Swift" type previously acquired	1971	1975–77
		2	MSF-type	"Admirable"-class minesweeper	Displ: 650 t; completed 1943–44; ex-USN to South Vietnam 1962, 1964	1975	1976
		1	100-ft PGM-type	Patrol gunboat	Displ: 122 t full load; built for South Vietnam under MAP 1967	1975	1976
		1	173-ft PC-type	Patrol boat	Displ: 280 t, completed 1944; ex-USN to France 1951; to Khmer Republic 1956	1975	1976
		3	185-ft PCE-type	Patrol boat	Displ: 640 t; completed 1943–44; ex-USN to South Vietnam 1961, 1966, 1970	1975	1976
		6	311-ft	Coast Guard cutter	Displ: 1 766 t; completed 1943–44; ex-USN to South Vietnam	1975	Apr 1976
		3	LSIL-type	Infantry landing ship	Displ: 227 t; completed 1944; ex-USN to France 1951–53; to South Vietnam 1956	1975	1976
		3	LSM-type	Medium landing ship	Displ: 743 t; completed 1944; ex-USN to France and South Vietnam	1975	1976
		3	LSSL-type	Support landing ship	Displ: 227 t; completed 1944–45; ex-USN to France, Japan and South Vietnam 1965–66	1975	1976
		13	LST-type	Tank landing ship	Displ: 1 620 t; completed 1943–45; 3 ex-USN to South Vietnam; 10 ex-USN	1975	1976
		5	YO/YOG-type	Oiler	Displ: 520 t; completed 1943–44; 2 ex-USN to South Vietnam 1954, 1963; 3 ex-USN	1975	Jul 1975–76
		2	ARL/AGP-type	Repair ship	Displ: 4 100 t full load; completed 1945; ex-USN to South Vietnam 1970–71	1975	1976

	USA/Japan	2	"Bostwick"-class	Frigate	Displ: 1 220 t; completed 1943; ex-USN to Japan 1955; scrapped by Japan 1975	1975	1976
Qatar	Brazil/France	20	EE-9 Cascavel	Armed recce vehicle	Brazilian design; being fitted out in France with 90-mm cannon and IR-guidance	1974	. .
	UK	6	Vosper Thornycroft 103-ft type	Large patrol boat	Displ: 120 t; last 2 completed 1976	1972–73	1975–76
		5	Fairey Marine "Spear"-class	Coastal patrol boat	Displ: 4.3 t; in addition to 10 previously acquired	Dec 1975	(1977)
	UK/France	3	Westland/Aérospatiale WG-13 Lynx	ASW helicopter	Multi-role version	1976	(1977)
	UK/USA	4	Westland/Sikorsky Commando Mk 2	Assault helicopter	1 for VIP, 3 for troop transport	1974	1975–76
Rhodesia	South Africa	. .	BAC Canberra B(I)2	Bomber aircraft	Ex-SAAF; for recce	. .	1976
		18	Aérospatiale Alouette III	Helicopter	Ex-SAAF	. .	1976
		6	Dassault Mirage III-B	Fighter aircraft	Ex-SAAF	. .	1976
	(South Africa	. .	Centurion	Tank	Reportedly in use by Rhodesian Army; purchased by South Africa from Jordan 1975	. .	1975–76)
	South Africa/ Italy	. .	Atlas/Aermacchi Impala I	Trainer/COIN aircraft		. .	1976
Saudi Arabia	France	12	Aérospatiale Alouette III	Helicopter		1974	(1976)
		22	Aérospatiale Alouette III	Helicopter		Oct 1975	(1977–)
		48	Dassault Mirage F1	Air combat fighter aircr	Previously reported order for 38 Mirage IIIs confused with Saudi order for Egypt	Oct 1975	. .
		(2 000)	Aérospatiale Harpon	ATM	Incl in $860 mn arms-for-oil deal; arming 200 AMX-30 tanks	Dec 1974	1975–79
		(2 000)	Aérospatiale SS.11	ATM	$19 mn; arming 200 AMX-30 tanks	Dec 1974	1975–79
		. .	Thomson-CSF/Matra Crotale "Shahine"	SAM	Incl in $860 mn arms-for-oil deal; under development	Dec 1974	1980–
		200	AMX-30	Tank	Incl in $860 mn arms-for-oil deal; arms: SS.11 and Harpon ATM	Dec 1974	1975–79
		250	AMX-10 P	AC	See above	Dec 1974	1975–79
		. .	AMX-30 SA	SP A/A gun	See above	Dec 1974	. .

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
	France/FR Germany	. .	Euromissile Roland	ATM	$19 mn	1974	(1980–)
	FR Germany	600	Rheinstahl Marder	APC	$500 mn; negotiations broken off because of German arms embargo	–	–
	UK	10	BAC 167 Strikemaster Mk 81	Armed trainer/COIN aircraft	For Air Academy; in addition to 36 previously acquired	1976	. .
		. .	BAC Rapier	SAM		1975	. .
		. .	Fox	Scout car		(1974)	. .
		250	Alvis Scorpion	Light tank		1974	. .
	USA	400	Bell AH-1 Cobra	Assault helicopter	Previously unannounced order; revealed by USA on 23 Feb 1976 that 200 delivered	1975	1976–77
		10	Lockheed KC-130 Hercules	Transport aircraft	$90 mn; in addition to 26 previously acquired	1975	1977
		110	Northrop F-5E/B/F Tiger II	Fighter aircraft	$204.5 mn incl spares, support, training; arms: Sidewinder AAM, Maverick ASM	1975	1976–79
		4	Northrop F-5E	Fighter aircraft	$23.3 mn; part of total $1.2 bn military aid presented in US sales list 30 Jun 1976 for Congressional approval	1976	. .
		. .	General Electric Vulcan	A/A gun	$12.4 mn; see above	1976	. .
		650	Hughes AGM-65A Maverick	ASM	Arming 90 F-5E/Fs; order reduced from 1 500 before Congressional approval obtained	Jan 1975	1976–79
		1 000	Hughes BGM-71 TOW	ATM	Part of total $1.2 bn military aid; incl in US sales list presented 20 June 1976 for Congressional approval	1976	. .
		400	McDonnell Douglas FGM-77A Dragon	ATM	See above	1976	. .
		117	McDonnell Douglas AGM-84A Harpoon	ShShM	To arm 24 Tacoma patrol boats under construction	1975	1979
		. .	Raytheon MIM-23B Improved Hawk	SAM	$1.1 bn incl spares, training and maintenance; 18 batteries; additional contract signed 1976	1974; 1976	1976–79
		850	Raytheon AIM-9J-1 Sidewinder	AAM	$63 mn; to arm F-5Es; order reduced from 1 000 before Congressional approval obtained	1976	1977–

		250	M-60 A1	Tank	Part of total $1.2 bn military aid; final agreement 1976	1974; 1976	1977–
		250	M-113 A1	APC	See above	1974; 1976	1977–
		~350	. .	105-mm howitzer	See above	1974; 1976	1977–
		8	PGM-type	Missile boat	Announced 23 Feb 1976; (arms: Harpoon ShShM)	1974	. .
		24	Tacoma	Patrol boat	Arms: Harpoon ShShM; under construction	1974	1979–
		4	"322"-class	Coastal minesweeper	New construction by Peterson Builders	Sep 1975	1978
		6	. .	Large patrol boat	Incl in 10-year naval expansion programme	Jan 1972	. .
		2	. .	Coastal patrol boat	See above	Jan 1972	. .
		3	. .	Training ship	See above	Jan 1972	. .
		4	LCT-type	Landing ship	See above	Jan 1972	. .
Senegal	France	1	P-48 type	Large patrol boat	Displ: 250 t full load; in addition to 2 previously acquired	Aug 1975	Mar 1977
	Singapore	12	Vosper Thornycroft 45 ft-type	Patrol boat	Under construction by Vosper, Singapore	1973	. .
Singapore	USA	40	McDonnell Douglas A-4 Skyhawk	Fighter aircraft	Ex-USN; refurbished by Lockheed, Singapore; last 3 TA-4s ordered 1976	1972; 1976	1975–76
		7	McDonnell Douglas TA-4 Skyhawk	Fighter/trainer aircraft			
		21	Northrop E-5E/F Tiger II	Fighter aircraft	$118 mn; incl in US sales list presented 30 Jun 1976 for Congressional approval; purchased instead of 34 F-4 Phantoms; arms: Sidewinder AAM	1976	. .
		200	Raytheon AIM-9J-1 Sidewinder	AAM	Arming 21 F-5E/Fs; see above	1976	. .
		6	LST-type "501-1152"	Tank landing ship	Displ: 1 653 t; completed (1942); first ship transferred in 1975	(1975)	Dec 1975–76
South Africa	Belgium	7	Swearingen Merlin IVA	Light turboprop transp aircraft	Ex-BAF; US design; government order for air ambulance and VIP use	(1974)	May 1975–Aug 1976
	Canada	3	Canadair CL-215	Multi-purpose amphibious transport aircraft	U.c.: $3 mn; government order; production line reopened; delivery early 1977	1975	1977

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
	France	. .	Aérospatiale AS.11/12	ASM	Arming Impala II COIN aircraft; see licensed production register	. .	1975–
		. .	Aérospatiale MM.38 Exocet	ShShM	To arm 2 A-69 destroyers under construction	1976	1977–78
		. .	Aérospatiale AM.39 Exocet	ASM	To arm 15 Super Frelon hel	1974	1977–
		. .	Matra R. 550 Magic	AAM	Arming Mirage F1; see licensed production register	1972	1975–
		2	"Agosta"-class	Attack submarine	$68 mn; displ: 1 470 t; under construction by Dubignon	1975	Nov 1978 – Aug 1979
		2	Type A69 Aviso	Destroyer escort ship	U.c.: $21 mn; displ: 1 170 t; arms: 2×Exocet ShShM	Feb 1976	1977–78
	France/FR Germany	4	Airbus Industrie A300	Tanker/transport aircraft	To support Mirage F1 force; ordered by South African Airways but reports indicate military vers delivered	1975	1976–77
		. .	Euromissile Milan	ATM	Reportedly in use with SA Army on ACs, despite earlier information that FR Germany vetoed delivery	1973	(1975–76)
	Israel	. .	IAI Gabriel	ShShM	To arm 6 new "João Coutinho"-class corvettes and 6 missile boats under construction; see licensed production register	1974	1978–
		6	"Reshef"-class	Fast attack missile boat	Displ: 430 t full load; arms: 4× Gabriel ShShM; 3 under construction in Israel, 3 more to be licence-produced	1974	1977–78
	Italy	12	Oscar Partenavia P-64/66	Light plane	Replacement, in addition to previous licensed production by AFIC, Johannesburg	. .	1976
	USA	6	Lockheed C-130 Hercules	Transport aircraft	Ordered by SAFAIR Freighters airline	1976	. .
Sudan	Canada	1	DHC-6 Twin Otter	STOL transport aircraft		1976	. .
Surinam	Netherlands	3	. .	Patrol boat		1975	. .

Syria	France	15	Aérospatiale SA-321G Super Frelon	Helicopter	Arms: HOT ATM	1975	. .
	France/FR Germany	~2 000	Euromissile HOT/Milan	ATM	Arming ~40 new helicopters incl Super Frelon and Gazelle	1975	. .
	France/UK	. .	Aérospatiale/Westland SA-342 Gazelle	Light observation hel	Arms: HOT and Milan ATM	1976	. .
	Italy	24	Agusta A-109 Hirundo	Armed helicopter	Arms: HOT ATM; order imminent	(1977)	. .
	Italy/USA	18	Agusta Bell 212	ASW helicopter	Incl 6 for SAR; order imminent	(1977)	. .
		6	Agusta/Boeing Vertol CH-47C Chinook	Medium-lift helicopter		1976	. .
		6	Agusta/Sikorsky AS-61A-4	Helicopter	Order imminent	(1977)	. .
		~12	Agusta/Sikorsky SH-3D Sea King	Helicopter	Order imminent	(1977)	. .
		8	Lockheed C-130H Hercules	Transport aircraft	US State Department authorized sale	1976	. .
		2	Lockheed L-100 Hercules	Transport aircraft	U.c.: $10 mn; commercial sale, Congressional approval not required	1976	. .
	Spain	16	CASA 223 K1 Flamingo	Basic trainer aircraft	Follow-on order imminent; in addition to 32 previously acquired; sole production rights acquired by Spain from FR Germany	(1977)	. .
	USSR	. .	Kamov Ka-25 "Hormone"	ASW helicopter	In addition to 9 previously acquired	1976	. .
		. .	SAM-2/3/6	SAM	48 batteries reportedly delivered	. .	(1976)
		. .	"Frog-7"	SSM	Incl 24 launchers; reportedly delivered	. .	(1976)
		. .	SS-12 "Scaleboard"	Battlefield support SSM		1976	. .
		~500	T-55	Tank	To be supplied in 2 years	1976	(1977–79)
Taiwan	Israel	. .	IAI Gabriel	ShShM	Has been fitted into at least 8 "Allen Sumner"-class destroyers	(1974)	(1976)
	Italy	3	"SX-404"-class Midget	Submarine	Displ: 70 t submerged; in service	. .	(1976)
	USA	10	Grumman E-2C Hawkeye	AEW aircraft		1975	. .
		. .	Ford MIM-72A Chaparral	Vehicle-launched SAM	U.c.: $1 mn with 4×Sidewinder missiles; FMS sale	1976	(1977)
		. .	Hughes AGM-65A Maverick	ASM	Arming F-5E; see licensed production register	1973	1975–

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
		. .	McDonnell Douglas AGM-84A Harpoon	ShShM		1976	. .
		. .	Raytheon MIM-23B Improved Hawk	SAM	$34 mn; to upgrade existing Hawk air defence system	Jun 1976	. .
		2	"Agile"-class	Minesweeper	Displ: 665 t; completed 1953; ex-USN	1975	Mar 1976
		1	"Casa Grande"-class	Dock landing ship	Displ: 4 790 t; completed 1945	1975	1976
		1–2	Tacoma	Gunboat	New construction	1976	. .
Thailand	France	. .	Aérospatiale MM.38 Exocet	ShShM	To arm 3 Italian missile boats under construction	Jul 1976	(1979)
	Indonesia/ Spain	4	Lipnur/CASA C-212 Aviocar	Transport aircraft	Licence-produced in Indonesia	1976	. .
	(Israel	. .	IAI Gabriel	ShShM	Reportedly on order plus small arms and artillery	1976	. .)
	Italy	3	. .	Fast missile patrol boat	Displ: 255 t; arms: 4×Exocet ShShM, 40-mm Bofors cannon	Jul 1976	(1979)
	Singapore/ FR Germany	3	Lürssen 45-m type	Patrol boat	Displ: 224 t; unconfirmed reports of fourth boat ordered	Jun 1973	1976–77
	Switzerland	5	Pilatus PC-6 Turbo Porter	STOL utility aircraft		(1975)	1976–77
	UK	1	Britten-Norman BN-2A Islander	Transport aircraft		(1976)	1976
	USA	16	Northrop F-5E/F Tiger II	Fighter aircraft	$50 mn incl spares and ground support equipment; funding obtained 1976; (arms: AAM and ASM)	1976	1978
		1	"Bluebird"-class	Coastal minesweeper	Displ: 330 t; new construction; delivery planned for 1976 but delayed	. .	(1977)
	USA/ Switzerland	20	Fairchild/Pilatus AU-23A Peacemaker	Ground attack/COIN aircraft	$12 mn incl spares; FMS sale; new production	1974	1975–76
		14	Fairchild/Pilatus AU-23A Peacemaker	Ground attack/COIN aircraft	Ex-USAF	(1974)	1975–76
Togo	Brazil/Italy	3	EMBRAER/Aermacchi EMB-326 Xavante	Armed jet trainer aircraft	Incl pilot and ground crew training, technical support and spares; first sale outside Latin	Nov 1976	Dec 1976

					America of Brazilian licence-produced M.B.326		
	Canada	2	DHC-5D Super Buffalo	STOL transport aircraft	Originally built for Zaire	1976	1976
	France	5	Aérospatiale Fouga Magister	Jet trainer aircraft	Refurbished; incl training for newly created AF	1974	1976
		2	32-m type	Coastal patrol boat	Under construction	1975	(1977)
Tunisia	Austria	. .	Kuerassiers	Tank	Also negotiating for small arms and ammunition; licence-produced in Tunisia	1976	. .
	Italy	3	Aeritalia G-222	STOL transport aircraft	U.c.: $4.7 mn; contract not finalized	1975	1977–78
		4+6	Aermacchi M.B.326B/K	Armed trainer/COIN aircraft	To replace F-86F Sabres	1976	1977–78
	UK	2	Vosper Thornycroft 103-ft type	Fast patrol boat	Under construction	1974	. .
	USA	12	Northrop F-5E Tiger II	Fighter aircraft	$54 mn incl spares and technical assistance; sale announced by DoD 1975; arms: Maverick ASM, Sidewinder AAM	1975	. .
		~30	Ford MIM-72A Chaparral	Vehicle-launched SAM	$58 mn incl modified Sidewinder missile, spares, training; system u.c.: $1 mn; FMS sale	1976	. .
		. .	Hughes AGM-65A Maverick	ASM	Arming 12 F-5Es	1975	. .
		. .	Raytheon AIM-9J-1 Sidewinder	AAM	Arming 12 F-5Es	1975	. .
Uganda	Iraq	. .	MiG-17/19	Fighter aircraft	Ex-Iraq; surplus; to replace 7 MiG-21s and 5 MiG-17s destroyed during Israeli raid at Entebbe	(1976)	1976
	Libya	40	Dassault Mirage 5	Fighter aircraft	Ex-Libyan AF; 20 reportedly delivered by Jul 1976 to replace MiGs destroyed during Israeli raid at Entebbe; Libyan pilots; may be on loan	(1976)	1976–77
	USA	1	Bell 212	Helicopter	Sale approved by State Department 1975	1975	1976
		1	Grumman Gulfstream II	Transport aircraft	See above; for VIP use	1975	1976
	USSR	(12	MiG-21	Fighter aircraft	According to Uganda Radio, delivered to replace MiGs destroyed during Israeli raid at Entebbe	1976	1976)

Recipient	Supplier	No. of items	Item	Description	Comments	Date of order	Date of delivery
		15	T-55	Medium tank	Reported delivered; USSR offer of military aid mid-1976	1976	1976
United Arab Emirates	Italy	1	Aeritalia G-222	STOL transport aircraft		1975	. .
Uruguay	Brazil	5	EMBRAER EMB-110 Bandeirante	Transport aircraft	$5.5 mn incl 10 EMB-200 agricultural aircraft	1975	1975–76
	(FR Germany	2	Type 209	Submarine	Displ: 900 t; according to unconfirmed reports, under construction	1975	. .)
Venezuela	France	22	AMX-30	Tank	In addition to 120 previously acquired	(1975)	(1976)
		6	. .	Coastal patrol boat	Displ: 45 t; new construction; 4 delivered 1976	1975	1976–77
	FR Germany	2	Type 209	Submarine	Displ: 900 t; not delivered 1975 as previously reported	1971	Jul 1976–77
	Italy	21	. .	Coastal patrol boat	Displ: 65 t; under construction by INMA, La Spezia; some may be built in Venezuela; 10 delivered 1974–75	May 1973	1974–77
		. .	Selenia Aspide Albatros	ShAM	To arm 6 "Lupo"-class frigates under construction	1976	1978–81
	Italy/ France	. .	Oto Melara/Matra OTOMAT	ShShM	Incl 12 launchers; to arm 6 "Lupo"-class frigates; 48 more to be ordered 1977	1974	1978–81
		6	"Lupo"-class	Frigate	$507 mn; displ: 2 208 t; under construction; arms: 4× OTOMAT, 8× Aspide Albatros	Oct 1975	Oct 1978–81
	Italy/USA	2	Agusta Bell 212A	ASW helicopter	~$1.8 mn; for "Lupo"-class frigates; contract being finalized	(1977)	(1978)
	Spain	12	CASA C-212 Aviocar	STOL transport aircraft		1975	(1976)
	USA	7	Bell 206 JetRanger	Helicopter		1976	1976–77
		12	Rockwell International T-2D Buckeye	Trainer aircraft	$67 mn; FMS sale; in addition to 12 previously acquired from USN	1975	1976–77

Yemen	Saudi Arabia	. .	BAC Vigilant	ATM	Small number transferred; ex-Saudi Army stocks	. .	1976
Zaire	Canada	3	DHC-5D Buffalo	STOL transport aircraft	Order reduced from 6, of which 2 delivered to Togo instead	1974	1976
	France	14	Dassault Mirage 5	Fighter aircraft	$10.5 mn incl training in France; (arms: ASM)	Sep 1973	1975–76
		12	. .	Coastal patrol boat		1974	. .
	USA	15	Cessna Model 150 Aerobat	Trainer aircraft	Incl spares and maintenance; agreement during Secretary of State Kissinger's visit in spring 1976	1976	Jul–Nov 1976
		(12	Northrop F-5E Tiger II	Fighter aircraft	See above; no final contract	1977	. .)
		. .	Ford M-113 A-1	APC	See above	1976	. .
Zambia	Canada	7	DHC-5D Buffalo	STOL transport aircraft	U.c.: $4 mn	1974	1976
	Italy/USA	25	Agusta-Bell 205	Helicopter		Jan 1973	1973–76
	USSR	>6	Mil Mi-6	Helicopter	At least 6 in service	(1975)	1976
		8	T-54	Tank		(1975)	1976
		20	. .	Amphibious scout car		(1975)	1976

[a] Member of the United Arab Emirates, which created a joint Union Defence Force in May 1975.

[b] Soviet and Cuban arms deliveries to Angola during 1975 are to be listed in the forthcoming SIPRI publication *The Global Arms Trade*.

Part III. Developments in arms control and disarmament

Chapter 8. The implementation of arms control agreements

Strategic arms limitation / Limitation of nuclear explosions / Prevention of nuclear weapon proliferation / Prohibition of biological and chemical weapons / International agreements related to arms control and disarmament, as of 31 December 1976 / Bilateral agreements / Multilateral agreements / Treaty between the United States of America and the Union of Soviet Socialist Republics on underground nuclear explosions for peaceful purposes / Agreement between France and the Union of Soviet Socialist Republics on the prevention of accidental or unauthorized use of nuclear weapons / Announced and presumed nuclear explosions in 1975–76 / Nuclear explosions, 1945–76 (known and presumed) / Notifications of military manoeuvres in Europe, January 1976 – February 1977, in implementation of the Final Act of the Conference on Security and Cooperation in Europe / Working papers and other documents relating to a comprehensive nuclear test ban, presented in 1976 at the Conference of the Committee on Disarmament (CCD) / Working papers and other documents relating to the prohibition of chemical weapons, presented in 1976 at the Conference of the Committee on Disarmament (CCD)

Chapter 9. Chronology of major events concerning disarmament and related issues

8. The implementation of arms control agreements

Square-bracketed numbers, thus [1], *refer to the list of references on page 366.*

I. *Strategic arms limitation*

The 1972 treaty on anti-ballistic missile systems (ABM Treaty), which resulted from the first round of US-Soviet strategic arms limitation talks (SALT), limited the deployment of ABMs to two sites for each party, one to protect the national capital, and the other to protect an intercontinental ballistic missile (ICBM) site. No more than 100 ABM launchers and 100 interceptor missiles were allowed in each ABM deployment area, and both quantitative and qualitative restrictions were imposed on ABM radars. (For the text of the treaty, see *SIPRI Yearbook 1973,* pp. 20–24.)

At the time the treaty was concluded, the USA was completing an ABM complex for the defence of ICBM silo launchers at Grand Forks, North Dakota, while the USSR had 64 ABM launchers deployed around Moscow. Thus, each side was entitled to build one additional ABM site—the USA to protect Washington, and the USSR to protect an ICBM site—but it soon became apparent that neither side intended to do so. Renunciation of a second defence system was formalized in a protocol to the ABM Treaty, which was signed in 1974 and entered into force on 25 May 1976. The protocol provides a procedure for each country to follow if it wants to change its ABM site. A switch to an alternative area may be made only once and upon appropriate notification. (For the text of the protocol, see *SIPRI Yearbook 1975,* pp. 458–59.) It is doubtful, however, whether even this right will be exercised. The trend seems to be to deactivate rather than to maintain in operation the present defence systems which are inadequate to prevent penetration of offensive missiles equipped with multiple, independently targetable, as well as manoeuvrable (that is, capable of taking evasive action), re-entry vehicles. The anti-ballistic missile system at Grand Forks, the first and only US facility of this type (constructed at a cost of nearly $6 bn) had been operational for just one month before it was closed down; only a long-range radar, the Perimeter Acquisition Radar (PAR), has been preserved as an element in the national warning system. Neither have there been indications that the USSR is planning to expand its present capital defence to the permitted level of 100 missile launchers, or replace it by a defence of an ICBM site.

On the other hand, the parties seem to be using their right, under Article VII of the treaty, to modernize ABM systems or their components;

activities aimed at improving the acquisition, tracking, discrimination and interception of missiles have continued. Moreover, and this is perhaps more significant, research is being conducted on anti-ballistic weapons differing from those defined in Article II of the ABM Treaty. There have been reports about experiments with high-energy lasers and charged-particle beam devices—to be used from spaceborne platforms in order to intercept ICBMs in the boost phase after launch [1–2]. As a matter of fact, the USA and the USSR had envisaged the possibility of creating ABM systems based on other physical principles than the present ABMs, and including components capable of substituting for ABM interceptor missiles, ABM launchers or ABM radars, when, in 1972, they agreed that "specific limitations on such systems and their components would be subject to discussion and agreement" in accordance with relevant treaty provisions (Agreed Interpretation [E] initialled by the heads of the SALT delegations). Apparently, hopes for achieving some technological breakthrough in anti-missile defences have not been abandoned. The parties have the right to withdraw even from the obligations already contracted by invoking their "supreme interests".

The proponents of the ABM Treaty saw its main value in the adoption by the two great powers of a non-damage-limiting posture which, by emphasizing mutual vulnerability, minimizes the incentives to a first nuclear strike. If this understanding of the significance of the treaty is correct, that is, if deterrence really is the only intended mission for the US and Soviet strategic forces, there should be no need for ABMs whatsoever.

According to Article XIV of the ABM Treaty, a review conference is to be convened in October 1977, five years after the entry into force of the treaty. This conference may provide an opportunity for a complete renunciation of anti-ballistic missile defences. Such an undertaking could be reinforced by a prohibition on the testing of any ABM systems, whatever their type or components, which, as experience has shown, can be checked by national means of verification.

The ABM Treaty was conceived as an inseparable part of a package deal which included an Interim Agreement limiting strategic offensive arms. On 9 May 1972, the head of the US SALT delegation warned that if an agreement providing for more complete strategic offensive arms limitations were not achieved within five years, US supreme interests could be jeopardized, and that, should that occur, "it would constitute a basis for withdrawal from the ABM Treaty" (Unilateral Statement A, made during the negotiations). Indeed, limitations on ABM deployment were considered a concession on the part of the USA (which cancelled its 12-site anti-ballistic missile programme) or, more precisely, a *quid pro quo* for the limitation of Soviet land-based launchers for "heavy" missiles viewed as a potential first-strike weapon. There was, therefore, in 1972, some political logic in establishing a close link between the agreements on defensive and offensive missiles, and in demanding that they should enter into force simultaneously, and also lapse simultaneously if the situation deteriorated. But during the past five years, technological advances in the field of offensive missiles, especially with regard to their penetration capabilities, have by far outstripped the development of defences. Limitation of the latter can no more be deemed as an adequate compensation for the limitation of the former. Since the two issues have been decoupled, it may now be difficult for a party to argue that lack of progress in offensive arms limitation makes its continued adherence to the ABM Treaty impossible. A danger to the ABM Treaty could come rather from major civil defence programmes. Such programmes might be construed by the opposing side as aimed at diminishing losses from a second, retaliatory nuclear strike and, therefore, contradicting the very concept of the treaty. Fears of seeing the strategic relationship upset could then build up pressures to abrogate the treaty. It has also been suggested that a very drastic reduction of ICBMs would encourage serious development of anti-missile defences [3], but this is not likely to happen in the foreseeable future.

While the ABM Treaty is formally of "unlimited duration", the 1972 US-Soviet Interim Agreement "on certain measures with respect to the limitation of strategic offensive arms" remains in force only for a period of five years, which expires on 3 October 1977, unless replaced earlier by another agreement. Consequently, the Interim Agreement, which had introduced a freeze on the aggregate number of fixed land-based ICBM launchers and ballistic missile launchers on modern submarines (for the text of the agreement, see *SIPRI Yearbook 1973*, pp. 25–28), was to be followed by negotiations to bring about further measures limiting strategic offensive arms. These negotiations began in November 1972, but it was not before November 1974 that the two powers, at a summit meeting held in Vladivostok, USSR, had adopted concrete guidelines for a new accord. It was to cover the period from October 1977 to 31 December 1985, and to provide: (*a*) a ceiling of 2 400, for each side, on the total number of intercontinental ballistic missiles, submarine-launched missiles and heavy bombers; and (*b*) a subceiling of 1 320 (of each side's total of 2 400) missiles that can be equipped with multiple, independently targetable re-entry vehicles (MIRVs). Drafts submitted by both sides early in 1975, in Geneva, started a process of converting the Vladivostok understanding into a formal deal, but two major issues emerged: *first*, whether the new Soviet supersonic medium-range bomber, the so-called Backfire bomber, which, in US opinion, has intercontinental capabilities, should be counted in the total of 2 400 delivery vehicles; and, *second*, how US cruise missiles—subsonic, low-flying, remote-controlled, unmanned vehicles of great accuracy—should be either counted or limited. Each side wanted its own weapon excluded from, and the other country's weapon included under, the overall ceiling of launchers agreed upon in Vladivostok. One compromise solution which was considered during the talks consisted in exempting the Soviet bomber from

SALT limitations on condition that it would be deployed only as a medium-range aircraft; and in including the US long-range cruise missile (in excess of 600 km) within the Vladivostok ceiling. However, each aircraft carrying cruise missiles, whatever their range, would correspond to a missile equipped with MIRVs and counted against the 1 320 sublimit applying to such weapons. It was also suggested that the total ceiling should be lowered by 10 per cent, to 2 160 strategic launchers. This would require the USSR to phase out some weapon systems already operational, while the USA was still below the above-mentioned level.

Recently, another "grey area" weapon system added to the difficulties of defining the scope of the negotiated strategic arms limitation. It was revealed that the USSR was introducing a mobile, solid-fuel, two-stage, intermediate-range missile, listed by the USA as SS-20. Presumably, this missile, equipped with three MIRVs, can be quickly transformed into an intercontinental missile by the addition of a third stage, or by using a lighter single warhead. From a formal point of view, land-based missiles with a range shorter than the shortest distance between the northeastern border of the continental USA and the northwestern border of the continental USSR, are not considered to be strategic and, therefore, are not covered by SALT (Agreed Interpretation [H] initialled by the heads of the delegations during the negotiations on the Interim Agreement). However, numerical limits on strategic launchers could be deprived of meaning if an arms race in double-purpose missiles were allowed to continue without restrictions. This reasoning applies also to cruise missiles which, because of their high accuracies and varying ranges, can blur the distinction between strategic and tactical weapons. It is noteworthy that the possibility of deploying nuclear-tipped cruise missiles in Europe has already been considered in NATO. Should this happen, the very basis upon which SALT rests could be eroded.

Still other advances in weapons technology have taken place. The USA has been developing an ICBM, called Missile X, which is planned to be twice as heavy as the Minuteman missile now deployed, have several times the payload, carry several times more independently targetable warheads and have at least twice the accuracy. The new missiles are to be installed in silos or deployed in a mobile fashion (apparently in underground tunnels or trenches) to make them less vulnerable. The latter version would greatly complicate verification of the ceiling on strategic weapons. In addition, the USA is developing a new nuclear multiple warhead missile for the Trident submarine which is designed for a range of about 4 500 miles, and a later model of which could reach 6 500 miles.

Soviet advances have been equally impressive. During the past few years, the USSR has developed four new ICBMs with increased throw-weight and significantly improved warhead accuracy. Its 4 200 mile-range submarine-launched ballistic missile, called SS-N-8, has become operational. Another larger and more advanced model, SSNX-18, with a longer range, has been tested; this was the first successful test of a Soviet submarine-launched ballistic missile armed with multiple warheads.

None of these developments can be considered as a breach of the 1972 Interim Agreement, which was basically an agreement about numbers. As a matter of fact, by the end of 1976, neither power had taken full advantage of the replacement possibilities offered by the agreement. The USA had the same number of ICBM launchers (1 054) and submarine-missile launchers (656) as four years before, while the USSR had increased the number of its submarine-missile launchers by 140 (from 740 to 880) against 210 allowed, and decreased the number of its ICBM launchers (by taking them out of commission) by 168 (from 1 618 to 1 450)—more than the number required to keep the aggregate figures unchanged [4]. The Interim Agreement was never meant to halt or slow down qualitative improvement of arms. On the contrary, it explicitly allowed modernization and replacement and, at the time of signing, the USA and the USSR made it clear that they would be going ahead with armaments programmes which were beyond the accepted constraints. However, recent innovations in arms technology are of a special nature. They enhance counterforce capabilities and accentuate each side's aspirations for nuclear superiority. Thus, even before a treaty incorporating new quantitative limitations, as proposed in Vladivostok, had been worked out, its potential, parity-oriented arms-regulation value was seriously undermined. Once again, weapon development has made faster progress than diplomatic talks.[1]

Since 1974, several allegations have been made of non-compliance by the parties with the ABM Treaty and the Interim Agreement.

In particular, the USSR was accused of constructing new ICBM silos, testing an air defence radar in an "ABM mode", increasing the number of "heavy" missiles above the permitted level, concealing relevant activities from US "national technical means" of verification, deploying a modern phased-array radar for testing ABM systems in an area outside the "current" test range, and failing to dismantle older ICBM launchers being replaced with launchers on ballistic missile submarines.

Allegations concerning construction of new ICBM silos, as well as those regarding concealment, have been rejected by the USSR and the USA has not pursued them. Allegations related to testing in an "ABM mode", increasing the number of "heavy" missiles, or deploying an ABM radar outside the "current" test range, were based on unilateral US definitions of the relevant terms, and on unilateral US understanding of the provisions of the agreement.

Only in one case has the USSR admitted to not having fulfilled its

[1] In 1975, the US Congress passed a law ordering the government to include in every request for funds for new major weapon systems an "arms control impact" statement, so as to point out the problems that the new weapons might present to arms control negotiations. So far, this law has had no effect on weapon development.

commitments. According to Agreed Interpretation [K], attached to the Interim Agreement, the dismantling or destruction of ICBM launchers of older types deployed prior to 1964 and ballistic missile launchers on older submarines, being replaced by new submarine-launched ballistic missile (SLBM) launchers on modern submarines, should be initiated at the time of the beginning of sea trials of a replacement submarine, and completed in the shortest possible agreed period of time. The procedures related to these operations were subsequently worked out in the Standing Consultative Commission, a joint US-Soviet body monitoring the implementation of the parties' obligations. A protocol signed in 1974 stipulated that the USSR must dismantle the older SS-7 and SS-8 missile launchers being replaced by modern SLBM launchers, within four months of the new submarines' first sailing out into the open sea.

Since the first Soviet replacement submarines were sent to sea in September 1975, a corresponding number (about 20) of SS-7 and SS-8 missiles should have been dismantled by January 1976. This, however, did not happen, even though the missiles had been removed from the launchers. By March 1976, the USSR had launched additional submarines, building up a requirement for 51 ICBM launchers to be dismantled, but only 10 launchers had, in fact, been completely dismantled. The matter was raised at the Standing Consultative Commission, and on 29 March 1976, the Soviet side, referring to some technical difficulties, admitted that it had not met the stipulated time-limits for dismantling the ICBM launchers. It undertook to complete the operation by 1 June 1976, and the case has apparently been closed.

The Soviet Union has similarly put forward some accusations. It challenged, in particular, a US phased-array radar system outside the approved ABM test ranges and the placement of covers over new missile silos, but the USA has denied the charges.

On the whole, considering the complexity and the ambiguous language of the ABM Treaty and the Interim Agreement, the record of the implementation of the formal clauses of the first SALT accords does not seem to be unsatisfactory. With one exception, the allegations arose from misunderstandings, or excessive reliance on statements which were made during the negotiations by one side, but were not accepted by the other side. Complaints about non-compliance with the spirit, as opposed to the letter, of the accords, were based on different perceptions of the goals pursued by each side in the arms limitation exercise. At the same time, the debate about violations has disclosed the degree of accuracy of national means of verification relying mainly on reconnaissance satellites. It is understandable, therefore, that Soviet testing of an interceptor satellite, capable of destroying or disabling another satellite in orbit, has given rise to concern, especially in the USA [5–6]. As a countermeasure, the United States has begun developing satellites equipped with electronic alarm systems, and capable of taking evasive action [7]. A new dimension, threatening strategic stability, seems to have been added to the arms race. Consequently, a new topic is needed for the arms control agenda: the safeguarding of satellites, be they for reconnaissance, early warning, or any other purposes.

II. *Limitation of nuclear explosions*

The US-Soviet Threshold Test Ban Treaty (TTBT), signed on 3 July 1974, prohibited the carrying out of underground nuclear weapon tests with a yield exceeding 150 kt (for the text of the treaty, see *SIPRI Yearbook 1975*, pp. 453–56). But on 31 March 1976, the agreed cut-off date for explosions above the established threshold, the treaty was not yet in force. The parties then stated that they would observe the limitation during the whole pre-ratification period [8–9]. Apparently, by that time, all high-yield tests needed for current nuclear weapon programmes had already been conducted: during the 21 months which followed the signature of the treaty, the USA exploded 12 devices having a yield above 200 kt, while the USSR conducted five explosions in a similar range.

Only "national technical means", consisting mainly of seismic monitoring, are to be used to provide assurance of compliance with the TTBT. But yield assessments by teleseismic means contain large elements of uncertainty. Explosions of the same size at different places can produce quite different recordings, depending on the geological conditions of the testing sites and the location of seismological stations. To facilitate verification, the parties have agreed to provide each other with information which includes: the geographic coordinates of the boundaries of each test site and of the boundaries of the geophysically distinct testing areas therein; the geology of the testing areas; the geographic coordinates of tests, after they have been conducted; yield, date, time, depth and coordinates for two tests for calibration purposes from each geophysically distinct testing area where underground tests have been and are to be conducted. But the relevant data are to be exchanged only at the time of the exchange of instruments of ratification. In the meantime, each side must base the assessments of yields on the measurements derived from its own seismic instruments. Under these conditions, four Soviet explosions, which had been carried out in the second half of 1976—on 4 July, 29 July, 28 August and 29 September—gave rise to questions whether the agreed threshold had been exceeded. The USSR denied that it had broken its commitment, and the USA did not provide a proof to the contrary. It was then revealed that the two powers had reached an understanding, in an addendum to the TTBT, that "one or two slight, unintended breaches per year would not be considered a violation of the treaty" and that "such breaches would be the subject of consultations" [10]. It is certainly difficult to predict precisely the explosive force of underground explosions, but an escape clause may encourage the parties to design yields very close to the permitted level.

The most important reason why the TTBT had not become effective within the prescribed time-limit was that its provisions did not extend to underground nuclear explosions for peaceful purposes. Since such explosions cannot be distinguished from a distance from tests serving military purposes, the threshold limitation could be easily bypassed. It was, therefore, decided, in accordance with Article III of the TTBT, to work out an additional agreement which would close this loophole, the understanding being that the two treaties must enter into force simultaneously.

It took about 18 months of negotiations before a peaceful nuclear explosions treaty (PNET) was concluded. Signed on 28 May 1976, together with a protocol and an agreed statement (for the texts, see appendix 8B), the treaty regulates explosions which are carried out by the USA and the USSR outside their nuclear weapon test sites and are, therefore, considered to be for peaceful ends. (Under the TTBT, the parties have pledged themselves to conduct weapon tests solely within specified testing areas.) The treaty also applies to US and Soviet peaceful nuclear explosions that may be conducted on the territories of third states in conformity with Article V of the Non-Proliferation Treaty.[2]

To ensure that explosions declared peaceful should not provide weapon-related benefits that are not obtainable from limited weapon testing, the yield threshold of 150 kt, which had been agreed for weapon tests under the TTBT, was now established also for peaceful explosions. The restriction applies to individual explosions, but the possibility of carrying out such explosions with a yield greater than 150 kt has been left open for further consideration "at an appropriate time to be agreed". A group explosion, as opposed to an individual one, may, according to the PTBT, exceed the 150-kt limit and reach an aggregate yield as high as 1 500 kt, or one and one-half megatons, if it is carried out in such a way that individual explosions in the group can be identified and their yields determined to be no more than 150 kt. At the same time, the PNET provides that any explosion must be consistent with the 1963 Partial Test Ban Treaty (PTBT), the 1968 Non-Proliferation Treaty, and "other international agreements" entered into by the parties. Moreover, an agreed statement specifies that development testing of nuclear explosives is not considered a "peaceful application" (such testing must be carried out within the boundaries of nuclear weapon test sites and will be treated as the testing of a nuclear weapon) and that an explosion would not constitute a "peaceful application", if test facilities, instrumentation or procedures related only to the testing of

[2] Under Article V of the NPT, potential benefits from any peaceful applications of nuclear explosions must be made available to non-nuclear weapon states party to the treaty on a non-discriminatory basis and at a low cost.

nuclear weapons or their effects were associated with an explosion carried out under the terms of the PNET.

Since the data to be provided under the TTBT are not meant for monitoring the size of explosions conducted in areas where peaceful application would take place, namely, outside the designated weapon-test sites, the parties to the PNET have undertaken to supply each other with information which includes: the purpose, location, date and aggregate yield of the explosion; the number of explosives, the yield of each explosive, its location relative to other explosives in the group, its depth of emplacement, as well as the time intervals between individual explosions in the group; a description of specific technological features of the project of which the explosion is a part; and a description of the geological and geophysical characteristics of the site of each explosion which could influence the determination of yield. The higher the yields, the more extensive data would be required. If a group explosion has an aggregate yield above 150 kt, observers of the verifying party will be given access to the site of the explosion. Their main function will be to measure the yield of each individual explosion with the use of special equipment. For a group explosion with a planned aggregate yield exceeding 500 kt, the observers will, in addition, have the right to install and operate a local seismological network. On-site observation is envisaged also for some explosions with a planned aggregate yield of between 100 and 150 kt, but it is not mandatory as with explosions exceeding 150 kt. A protocol to the PNET contains detailed provisions regulating the number of observers, the geographical extent of their access, their equipment, records and immunities.

The acceptance of on-site observation is a breakthrough in the great powers' approach, notably that of the Soviet Union, to the problem of verification. It may be significant that, in a memorandum submitted to the UN General Assembly only a few months after the signing of the PNET, the Soviet government expressed its willingness to seek an agreement prohibiting all nuclear weapon tests, where on-site clarification of "relevant circumstances" could be envisaged "on a voluntary basis" [11]. Indeed, the revised Soviet draft treaty on the "complete and general prohibition of nuclear weapon tests", of 22 November 1976, contained, in Article II, paragraph 3, the following provision [12]:

In case a State Party to this Treaty has doubts regarding the nature of a seismic event that occurred in the territory of another State Party to this Treaty, it has the right to raise the question of carrying out an on-site inspection in order to ascertain the true nature of that event. The State Party to the Treaty that raised this question must cite appropriate grounds in support of the necessity of carrying out the inspection. The State Party to the Treaty which is the object of doubts regarding its compliance with the Treaty, recognizing the importance of this question, may take a favourable position regarding the carrying out of an inspection in its territory, provided it finds the grounds convincing, or it may take another decision. Such an inspection shall be carried out according to rules established by the inviting State Party.

As a companion document, the PNET cannot be terminated while the TTBT is in force. On the other hand, the termination of the TTBT will entitle the parties to withdraw from the PNET at any time. But by 31 December 1976, neither treaty had become effective.

The arms control value of the TTBT/PNET is very limited: the 150-kt threshold is so high that the parties will not experience burdensome restraints in continuing their nuclear weapon programmes. It is likely that the two agreements will start a process of gradually lowering the ceiling for the US and Soviet explosions, because it is generally admitted that detection and identification of nuclear explosions of much lower size is possible: British experts have concluded [13] that present networks of seismological stations can detect and identify explosions down to a yield of between 3 and 50 kt, provided that no steps are taken to reduce the detectability,[3] while Swedish experts consider it possible to establish a monitoring system by which most earthquakes and explosions corresponding to a yield of about one kiloton in hard rock could be detected, located and identified with a high degree of accuracy [15]. However, the agreements have not contributed to the speeding up of a multilateral prohibition of all nuclear weapon tests. The methods of control, which have been devised mainly to check the yield of US and Soviet explosions (the British commitment to respect the terms of the TTBT [16] can be easily checked, so long as British explosions are conducted at the US weapon test site in Nevada), are not applicable to a treaty under which all nations must assure themselves that no weapon test takes place, whatever its size. Neither has the problem of accommodating peaceful nuclear explosions under a comprehensive weapon test ban been solved. The risk that peaceful explosions may be used for clandestine military purposes can be reduced by expert observation of their preparation, conduct and effects, but even the most intrusive inspection would not deny all weapon-related benefits to a state carrying out such explosions.

During 1976, the non-nuclear weapon states continued exerting pressure on the powers concerned to bring about a permanent or, at least, a limited-in-time cessation of nuclear weapon tests. As in previous years, much attention was devoted to verification (see appendix 8G). In particular, possible undertakings facilitating global monitoring of a comprehensive ban were discussed. According to a Swedish proposal, these measures could include the establishment of a network of 46 highly sensitive seismological stations (most of which already exist), distributed over 26 countries: Afghanistan, Australia, Bolivia, Brazil, Canada, China, Colombia, Ethiopia, France, Federal Republic of Germany, German Democratic Republic, In-

[3] Evasion techniques could include "decoupling", or detonating a nuclear explosive in a large cavity or low-coupling medium (dry alluvium) so as to reduce the seismic signals; "hiding in an earthquake", or detonating in the vicinity of a large earthquake so that the seismic signals from the explosion would be masked by those of the earthquake; and simulating an earthquake by sequential firing of a number of explosives. But such schemes are of doubtful practicality and, in any event, very risky for the offender [14].

dia, Iran, Israel, Japan, New Zealand, Norway, South Korea, Spain, Swaziland, Sweden, Thailand, Turkey, the UK, the USA and the USSR. It was suggested that data from the stations should be sent regularly to an international data centre, the main task of which would be to define and locate reported events and to distribute the results arrived at to the parties. Procedures would also be established for the clarification of the nature of events insufficiently described by the data routinely available [17]. As a result of this initiative, an *ad hoc* group of experts was set up to consider international cooperative measures to detect and identify seismic events. The group should specify the characteristics of an international monitoring system including *inter alia:*

(1) A global network of seismological stations, selected from existing and planned installations;
(2) Data required from the stations to facilitate the analysis for detecting, locating and identifying seismic events;
(3) Transmission facilities for the timely exchange of data between seismological stations and data centres;
(4) Facilities, procedures and related financial implications with respect to contributing and receiving centres for detecting, locating and identifying seismic events throughout the world and facilitating the collation and dissemination of relevant documentation;
(5) The costs which would be incurred if an international monitoring system were established.

The group will also endeavour to estimate the detection and identification capability of such an international cooperative system. The estimates will be made on the basis of available data or, where desirable and feasible, also on the basis of data obtained from experimental exercises involving the whole or part of the specified global network. The group will not assess the adequacy of such a system for verifying a comprehensive test ban. Rather it will make available the factual results of its analysis to governments to assist them in making such an assessment and in directing future research [18]. However, a few countries, notably Mexico [19] and Nigeria [20], consider further discussion of verification problems as superfluous, and apprehend that reasons of a technical nature might be used to delay the decision, or to cover up the lack of political will, to halt testing.

At the beginning of 1977, a possibility of suspending nuclear testing was raised by the newly elected US President [21], but the prospect for reaching a treaty prohibiting all nuclear weapon tests, by all states, and for all times, remains remote. Even if a verification system could be set up to provide assurance that no party was conducting clandestine military tests (a system which for the USA and the UK still seems inconceivable without compulsory and intrusive controls), and if peaceful nuclear explosions were totally abandoned (which is unlikely in view of the importance attached to such explosions by the USSR), and even if all nuclear weapon powers joined the test-ban negotiations (which is problematic in view of the negative attitude of China and France towards these negotiations), military incentives to test may still prevail over political considerations.

Nuclear tests are conducted to maintain confidence in weapons already stockpiled, or to check the effects of explosions, but most tests (two-thirds in the USA for the period 1963–71) have been for development purposes. During the past 30 years, as many as 50 types of nuclear weapons were introduced into the US stockpile, 24 types were retired, and 24 candidate types were cancelled before development was complete. In 1976, the US stockpile consisted of 26 basic types of nuclear weapons incorporated into 33 weapon systems [22]. The USSR has also acquired a diversified arsenal of weapons. Nevertheless, according to a former director of a US laboratory engaged in nuclear weapons research, who is also an authoritative spokesman for the US military establishment, the search for invulnerability, reliability and safety requires changing nuclear weapon systems, together with their nuclear component, and "many of the changes cannot be made reliably without a nuclear test" [23]. Since, under the conditions of an uninhibited qualitative arms race, the need for constant modernization of nuclear weaponry, irrespective of political consequences, is considered an axiom, the need to check the predicted performance of changed nuclear devices by experimental testing has similarly become axiomatic.

The US military establishment is not alone among the nuclear weapon powers to hold the above views, as evidenced by the following testing record. By 31 December 1976, the USA had conducted a total of 614 nuclear explosions,[4] the USSR 354,[4] the UK 27, France 64, and China 21. India exploded only one nuclear device, in 1974, but its Prime Minister said that India would not give up its testing programme in spite of pressures being exerted on it by some countries to discontinue the experiments [24]. It is, furthermore, significant that in the 13 years that have elapsed since the conclusion of the Partial Test Ban Treaty, a treaty which was generally expected to be a first step towards a total prohibition of nuclear testing, more nuclear explosions have been carried out than during the whole preceding post-war period (see appendix 8E). The USA and the USSR are the most important testers, and the intensity of their testing activities has not diminished in spite of the undertaking under the 1974 TTBT to restrict weapon tests to a "minimum". (In the case of the USA, the number of tests in 1976 has even exceeded its annual average of the preceding five years.)

While all the 15 US, 16 Soviet, 1 British and 4 French nuclear explosions in 1976 were conducted underground, three out of the four Chinese tests were in the atmosphere. The first atmospheric explosion, which took place on 23 January 1976, was in the low-yield range (<20 kt) and only small amounts of radioactivity were globally distributed. In particular, low con-

[4] Only a very small number of these explosions are presumed to have been intended for peaceful purposes.

centrations of fresh fission products were discovered in Sweden on 7 February 1976, and a few weeks later. The debris was also detected in a few other countries [25]. The second atmospheric explosion, on 26 September, was in the yield range of 20–200 kt and produced unusually large amounts of globally distributed debris. Due to heavy rainfall over the Eastern states of the United States at the time the fallout cloud was passing, radioactivity was forced down to ground level. According to the US Energy Research and Development Administration (ERDA), the fallout presented no risk to public health, but the levels of radioactivity were the highest since the peak of nuclear weapon testing by the USA and the USSR in the 1950s and early 1960s [26]. As a precaution, the residents of Pennsylvania were advised not to eat unwashed vegetables or fruit [27]. Abnormal radioactivity, believed to have resulted from this test, was also detected in Japan, but the level was not judged dangerous to humans [28]. The third atmospheric explosion, on 17 November, was in the megaton range. Radioactive products from this test were deposited at very high altitudes and were hardly detectable in ground level air at the end of 1976; most of the fallout was expected to occur in the spring of 1977.

The number of nuclear tests conducted by China in 1976 (larger than in any other year since 1964, when its testing activities began) as well as the high yield of recent explosions, are clear signs of an acceleration of the Chinese nuclear weapon programme. It is noteworthy that the Chinese space programme is being sped up in parallel: out of a total of seven satellites launched since 1970, three were launched in 1975 and two last year. This development is a function of the US and Soviet advances in nuclear armaments, and, therefore, hardly surprising. But it is remarkable that the reaction to Chinese atmospheric tests has been relatively mild as compared with the international campaign of protests against the French atmospheric tests conducted in the Pacific up to 1974. It is true that, unlike France, China has not been testing overseas. However, the effects of atmospheric testing are often worldwide and cannot be contained within national boundaries.

Consistent pressure of world opinion could, perhaps, force China to stop testing in the atmosphere, as was the case with France, another non-signer of the Partial Test Ban Treaty, irrespective of whether or not it decides formally to join the treaty. This would not be too onerous a sacrifice for China, considering that it has already mastered the technology of underground testing, and has actually conducted three such tests.

III. *Prevention of nuclear weapon proliferation*

In assessing the implementation of the Non-Proliferation Treaty (NPT), the NPT Review Conference, held in May 1975, attached considerable importance to the continued application of International Atomic Energy

Agency (IAEA) safeguards on fissionable material in all peaceful nuclear activities of non-nuclear weapon states party to the treaty, with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices. At the same time, the Conference recommended that safeguards agreements with non-nuclear weapon states not party to the treaty be of adequate duration, preclude diversion to any nuclear explosive devices and contain appropriate provisions for the continuance of the application of safeguards upon re-export, and urged that the application of safeguards be extended to all peaceful nuclear activities in these states. In addition, the Conference took note of the suggestion to arrange for common safeguards requirements in respect of nuclear material processed, used or produced by the use of scientific and technological information transferred in tangible form to non-nuclear weapon states not party to the treaty. The need to ensure a uniform, minimum level of effective physical protection for nuclear material in use, storage and transit was also stressed. (For the text of the final declaration of the Conference, see *SIPRI Yearbook 1976*, pp. 403–13.)

Steps towards fulfilling the above postulates were taken in 1975/1976 by nuclear supplier states meeting in London. The so-called London Club drew up a catalogue of equipment and material which, when provided to any non-nuclear weapon state, would "trigger" IAEA safeguards. Transfer of items identified on the trigger list would be authorized only upon formal government assurances from recipients explicitly excluding uses which would result in any nuclear explosive device, and the materials and facilities in question would have to be placed under physical protection to prevent unauthorized use and handling. In conformity with the guidelines proposed in August 1973 by the IAEA Director General [29], and accepted in February 1974 by the IAEA Board of Governors [30], the duration of the safeguards agreements should be related to the period of actual use of the relevant items in the recipient states.[5] These requirements will also apply to facilities for reprocessing, enrichment, or heavy-water production, utilizing technology directly transferred by the supplier or derived from transferred facilities, or major components thereof. At the same time, the suppliers have pledged themselves to exercise restraint in the transfer of sensitive facilities, technology and weapons-usable materials. Retransfer of trigger list items will be subject to controls and, in certain cases, the consent of the original supplier will be required.

The suppliers will consult with each other and with other governments on specific sensitive cases to ensure that any transfer does not contribute to risks of conflict or instability. In the event of a diversion of materials or a violation or abrogation of supplier-recipient understandings consistent with the above guidelines, suppliers will consult promptly on appropriate re-

[5] Conditions for the termination of safeguards are set out in paragraphs 26 and 27 of the 1965 IAEA safeguards system, as provisionally extended in 1966 and 1968 [31].

sponses and possible common action. (The London Club's guidelines for nuclear transfers are further discussed in appendix 1A.)

The adopted rules have tightened the terms of nuclear supplies and, in particular, have reduced the advantages that non-parties may derive from remaining outside the NPT. But they are still insufficient to guarantee that no further nuclear weapon proliferation will occur as a result of transfers. They suffer from two major omissions: (*a*) they fail to require full-scope safeguards, that is, safeguards on *all* peaceful nuclear activities in recipient states, as a condition for nuclear supplies;[6] and (*b*) they do not definitively preclude exports of highly sensitive facilities.

Some suppliers, including the United Kingdom [33], have made formal statements of determination to follow the guidelines to the letter, while others demand more rigorous measures to control the nuclear activities of non-nuclear weapon states. Thus, the USSR has expressed the view that IAEA controls should cover not only nuclear material, equipment and technology transferred, but also all nuclear activities of non-nuclear weapon states, including states that have not adhered to the NPT [34]. The Soviet Union also insists that no assistance in the peaceful uses of atomic energy should be rendered to states which gave no assurance that they would not manufacture nuclear weapons or other nuclear explosive devices [35]. Nevertheless, it has agreed to sell heavy water to India, which does not meet the above requirement [36]. Canada went much further by taking unilaterally the following measures. In May 1976, it made permanent its suspension of nuclear cooperation with India, announced after the Indian nuclear explosion in 1974, because India had refused to accept an undertaking that Canadian supplies, whether past or future, should not be used for the manufacture of any nuclear explosive device [37]. On 22 December 1976, the Canadian government stated that its nuclear shipments to non-nuclear weapon states under future contracts would be restricted to those which ratified the NPT or otherwise accepted international safeguards on their entire nuclear programme [38]. This decision will affect, in addition to India, such client countries as Pakistan, Spain and Argentina.

The USA called upon all nations to exercise maximum restraint in the transfer of reprocessing and enrichment technology and facilities by avoiding such exports or commitments for a period of at least three years. In announcing, on 28 October 1976, its new nuclear policy, the US government said that, in judging whether to enter into new or expanded nuclear cooperation, it would apply the following criteria: (*a*) adherence to the NPT will be a strong positive factor favouring cooperation with a non-nuclear weapon state; (*b*) non-nuclear weapon states which have not adhered to the

[6] On 21 September 1976, in a statement to the 20th session of the General Conference of the IAEA, the Director General of the Agency suggested that the manufacturing states should stipulate "as an irrevocable condition for the delivery of nuclear material or equipment, that the receiving state accepts IAEA safeguards on its entire nuclear programme" [32].

NPT will receive positive recognition if they are prepared to submit to full fuel cycle safeguards, pending adherence; (*c*) recipient nations that are prepared to forgo or postpone for a substantial period the establishment of national reprocessing or enrichment activities or, in certain cases, are prepared to shape and schedule their reprocessing and enriching facilities to foster non-proliferation needs, will be favoured; and (*d*) positive recognition will also be given to nations prepared to participate in an international storage régime, under which spent reactor fuel and any separated plutonium would be placed pending use. (The USA is prepared to consider providing a site for international storage of spent fuel and radioactive wastes under IAEA auspices.)

In US opinion, any material violation of a nuclear safeguards agreement—especially the diversion of nuclear material for use in making explosives—must be universally judged to be an extremely serious affront to the world community, calling for the immediate imposition of drastic sanctions [39].

Even France, which has not signed the NPT, and which for years had been opposed to changing the *status quo* in the field of nuclear supplies, finally decided to adopt a policy of restraint. On 11 October 1976, the French council for foreign nuclear policy recognized the need to avoid commercial competition among nuclear suppliers that might encourage the spread of nuclear weapons [40]. And subsequently, in a communiqué of 16 December 1976, the French government announced that, in order "not to add to the terrible danger of nuclear weapons proliferation", it would not authorize, "until further notice", the signing of bilateral contracts dealing with the sale to "third countries" of industrial equipment for reprocessing irradiated fuel [41]. At the same time, France reiterated its assurance to provide nuclear fuel cycle services to the purchasers of French nuclear power plants.

While there were reports that also the Federal Republic of Germany was considering an embargo on exports of sensitive nuclear technologies to other countries [42], there were no indications in 1976 that the German-Brazilian agreement for the sale of a complete nuclear fuel cycle, including uranium enrichment and plutonium reprocessing plants, would be cancelled or modified. Equally uncertain was the fate of the deal for the supply of a French plutonium reprocessing plant to Pakistan.[7]

Brazil and Pakistan, not being party to the NPT, have not formally renounced the acquisition of nuclear weapons, and Brazil insists on the right to carry out nuclear explosions for peaceful purposes, "including explosions which involve devices similar to those used in nuclear weapons".[8] If,

[7] A similar deal between France and South Korea was "suspended" after strong representations made by the USA.
[8] A statement to this effect was made by Brazil on 9 May 1967, on the occasion of the signing of the Treaty prohibiting nuclear weapons in Latin America.

therefore, the French-Pakistani and the German-Brazilian transactions were carried through and, as a result, the recipient countries started manufacturing and accumulating highly enriched uranium and/or weapon-grade plutonium, the purpose of the new nuclear export policies would be defeated.

Separating and recycling plutonium as reactor fuel has not yet been shown to be economically justified. It is noteworthy that even the USA, with its 62 nuclear power plants, has decided to defer the commercialization of reprocessing activities, and has thereby made uncertain the future of the "fast breeder" reactor which uses plutonium as a fuel, and which is being developed as a replacement for existing reactors. Spent nuclear fuel will be stored unprocessed, and the USA will explore the feasibility of recovering the energy value from it without separating plutonium.[9] At present, the only significant industrial use for plutonium is for the manufacture of nuclear explosive devices by the nuclear weapon powers. In a non-nuclear weapon state, direct access to weapon-grade material would greatly reduce the lead-time toward the building of a nuclear bomb (non-nuclear parts can be prepared in advance and testing is no longer considered absolutely necessary, as exemplified by the case of Israel which, reportedly [43], has produced several bombs without conducting experimental explosions) and no controls could provide sufficient warning to allow effective countermeasures. Therefore, exports of plutonium separation plants, even under IAEA safeguards, create a serious danger of nuclear weapon proliferation.

Two industrialized states have recently ratified the NPT—Japan and Switzerland. But in 1976, new NPT safeguards agreements entered into force only for Nicaragua and Uruguay; negotiations with 23 other states party to the NPT had not been concluded by 31 December 1976, while agreements with 15 states, though approved by the IAEA Board or even signed, were not yet effective at that date. The last category of states includes non-nuclear weapon members of the European Atomic Energy Community (Euratom)—Belgium, the Federal Republic of Germany, Italy, Luxembourg and the Netherlands[10]—as well as Japan.

Although the nuclear weapon powers are not obliged under the NPT to submit to international controls, as early as 1967 the USA and the UK offered to accept such controls at a time when international safeguards were put into effect in non-nuclear weapon states in implementation of the NPT. These offers materialized in 1976, when an agreement was signed between the United Kingdom, Euratom and the IAEA, providing for the submission of British non-military nuclear installations to safeguards under IAEA supervision, and when also the USA completed negotiations to place its

[9] At the time this decision was taken, a commercial reprocessing plant was nearing completion in Barnwell, South Carolina.
[10] Safeguards agreements with these countries entered into force only in February 1977.

civilian nuclear facilities under the IAEA safeguards. IAEA safeguards will be applied there with a view to verifying that nuclear material is not withdrawn from activities in designated facilities, which are of no direct national security significance, while such material is being safeguarded. Since the great powers remain unrestricted in their military nuclear programmes, their safeguards agreements have no arms control value; they should be seen rather as a demonstration to non-nuclear weapon states that they would not be placed at a commercial disadvantage by reason of the application of safeguards pursuant to the NPT.

If the new export policies of nuclear suppliers, which go beyond the guidelines of the London Club, are pursued with consistency, the non-nuclear weapon states will find it more difficult than they do now to acquire a nuclear weapon capability. However, it is impossible to halt nuclear weapon proliferation definitively by export restrictions alone. The main driving force behind proliferation is not with the suppliers but with the recipients, and several states can "go nuclear" by using their indigenous resources. A series of additional measures, both economic and political, including progress in disarmament and the resolution of the most acute regional conflicts, would be needed to diminish the incentives and pressures for proliferation.

IV. *Prohibition of biological and chemical weapons*

In addition to its intrinsic merit of being the first and, so far, the only international agreement outlawing an entire category of arms, the 1972 convention prohibiting the development, production and stockpiling of biological and toxin weapons, raised the following expectations: (*a*) that adherence to the 1925 Geneva Protocol, which banned the use in war of chemical and biological means of warfare, and which was recognized by the convention as having an "important significance" (paragraph 2 of the preamble), would become universal, or almost universal; (*b*) that states would withdraw the reservation limiting the Geneva Protocol's applicability to parties and to first use only, because a total ban on possession of biological weapons is incompatible with a right to use them against non-parties, or in retaliation; and (*c*) that an early agreement would be reached for the effective prohibition of the development, production and stockpiling of chemical weapons and for their destruction, as envisaged in Article IX of the Biological Convention.

Although all militarily significant states have joined the Geneva Protocol, the adherence to it is still far from universal: as of 31 December 1976, there were no more than 96 parties.

Only two countries have withdrawn their reservations to the protocol: Ireland and Barbados. A number of states, former non-self-governing territories, informed the government of France, which is the depositary government, that they consider themselves bound by the Geneva Protocol by virtue of its ratification by the power formerly responsible for their administration but, unlike Barbados, they have not referred to reservations. In the absence of a statement to the contrary, their succession must be regarded as applying also to reservations attached to the ratification of the protocol.

As regards the commitment to bring about chemical disarmament, a new draft convention [44], worked out by the UK, was added, in 1976, to the proposals discussed in previous years, namely: a draft convention submitted in 1972 by the socialist states [45]; a working paper prepared in 1973 by Argentina, Brazil, Burma, Egypt, Ethiopia, Mexico, Morocco, Nigeria, Sweden and Yugoslavia [46]; and a draft convention put forward by Japan in 1974 [47]. (For a review of these proposals, see *SIPRI Yearbooks 1973, 1974* and *1975*.)

According to the British draft convention, the parties would undertake not to develop, produce or otherwise acquire, or use lethal chemical agents and other toxic chemical agents (of a nature and intended primarily to cause long-term physiological harm to human beings), of types and in quantities that have no justification for protective or other peaceful purposes; as well as munitions, equipment or systems designed to deliver such agents for hostile purposes or in armed conflict. On-site inspections are envisaged to check the non-production commitments. The stockpiled agents would be destroyed or converted to peaceful uses, while munitions, equipment and systems would be destroyed or converted to conventional weapons, under international observation, according to a phased programme agreed by the consultative committee, a body overseeing the working of the convention.

However, the draft failed to specify the agents to be covered by the ban. Neither did it describe the verification procedures in any detail. The solution of these two most important issues has been left for further negotiations. Indeed, a number of working papers dealing with the scope of a chemical disarmament convention as well as the methods for controlling the prohibitions, were submitted during the past few years (those submitted in 1976 are listed in appendix 8H). But the most controversial proposal made by the UK seems to be the requirement that states signatories should provide information on their stocks of chemical-warfare agents, if any, and on production facilities, actual or potential, and that they should stop further production of these agents even before the convention enters into effect.

A future agreement on chemical weapons prohibition may be comprehensive in framework, but it will probably provide only for first-phase partial measures. This seems to have been confirmed by the bilateral US-Soviet consultations which were held from 16 to 27 August 1976, at Geneva, pursuant to the two powers' commitment to develop a joint initiative "with respect to the conclusion, as a first step, of an international convention dealing with the most dangerous, lethal means of chemical warfare" (Joint US-Soviet communiqué of 3 July 1974).

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Appendix 8A

International agreements related to arms control and disarmament, as of 31 December 1976

I. *Bilateral agreements*

US-Soviet memorandum of understanding regarding the establishment of a direct communications link ("Hot Line" Agreement)

Establishes a direct communications link between the governments of the USA and the USSR for use in time of emergency. An annex attached to the memorandum provides for two circuits, namely a duplex wire telegraph circuit and a duplex radio telegraph circuit, as well as two terminal points with telegraph-teleprinter equipment between which communications are to be exchanged.

For the full text of the memorandum, see Documents on Disarmament 1963, US Arms Control and Disarmament Agency, p. 236.

Signed at Geneva on 20 June 1963.

Entered into force on 20 June 1963.

UK-Soviet agreement on the establishment of a direct communications line

Establishes a direct teletype communications line between the Kremlin and 10 Downing Street for contacts at government level.

Signed at London on 25 August 1967.

Entered into force on 27 October 1967.

Agreement on measures to improve the USA-USSR direct communications link ("Hot Line" Modernization Agreement)

Establishes, for the purpose of increasing the reliability of the direct communications link set up pursuant to the memorandum of understanding of 20 June 1963, two additional circuits between the USA and the USSR, each using a satellite communications system (the US circuit being arranged through Intelsat and the Soviet circuit through the Molniya II system), and a system of terminals (more than one) in the territory of each party. Matters relating to the implementation of these improvements are set forth in an annex to the agreement.

For the full text of the agreement, see SIPRI Yearbook 1973, pp. 31–35.

Signed at Washington on 30 September 1971.

Entered into force on 30 September 1971.

Agreement on measures to reduce the risk of outbreak of nuclear war between the USA and the USSR (Nuclear Accidents Agreement)

Provides for immediate notification in the event of an accidental, unauthorized incident involving a possible detonation of a nuclear weapon (the party whose nuclear weapon is involved should take necessary measures to render harmless or destroy such weapon), immediate notification in the event of detection by missile warning systems of unidentified objects, or in the event of signs of interference with these systems or with related communications facilities, as well as advance notification of planned missile launches extending beyond the national territory in the direction of the other party.

For the full text of the agreement, see SIPRI Yearbook 1973, pp. 29–30.
Signed at Washington on 30 September 1971.
Entered into force on 30 September 1971.

US-Soviet agreement on the prevention of incidents on and over the high seas

Provides for measures to assure the safety of navigation of the ships of the armed forces of the USA and the USSR on the high seas and flight of their military aircraft over the high seas, including rules of conduct for ships engaged in surveillance of other ships as well as ships engaged in launching or landing aircraft. The parties also undertake to give notification of actions on the high seas which represent a danger to navigation or to aircraft in flight, and exchange information concerning instances of collisions, instances which result in damage, or other incidents at sea between their ships and aircraft.

For the full text of the agreement, see SIPRI Yearbook 1973, pp. 36–39.
Signed at Moscow on 25 May 1972.
Entered into force on 25 May 1972.

US-Soviet treaty on the limitation of anti-ballistic missile systems (SALT ABM Treaty)

Prohibits the deployment of ABM systems for the defence of the whole territory of the USA and the USSR or of an individual region, except as expressly permitted. Permitted ABM deployments are limited to two areas in each country—one for the defence of the national capital, and the other for the defence of some intercontinental ballistic missiles (ICBMs). No more than 100 ABM launchers and 100 ABM interceptor missiles may be deployed in each ABM deployment area. ABM radars should not exceed specified numbers and are subject to qualitative restrictions. National technical means of verification will be used to provide assurance of compliance with the provisions of the treaty.

The treaty is accompanied by agreed interpretations and unilateral statements made during the negotiations.

For the full text of the treaty, see SIPRI Yearbook 1973, pp. 20–24.

Signed at Moscow on 26 May 1972.

Entered into force on 3 October 1972.

US-Soviet interim agreement on certain measures with respect to the limitation of strategic offensive arms (SALT Interim Agreement)

Provides for a freeze for up to five years of the aggregate number of fixed land-based intercontinental ballistic missile launchers and ballistic missile launchers on modern submarines. The parties are free to choose the mix, except that conversion of land-based launchers for light ICBMs, or for ICBMs of older types, into land-based launchers for modern "heavy" ICBMs is prohibited.

A protocol which is an integral part of the interim agreement specifies that the USA may have not more than 710 ballistic missile launchers on submarines and 44 modern ballistic submarines, while the USSR may have not more than 950 ballistic missile launchers on submarines and 62 modern ballistic missile submarines. Up to those levels, additional ballistic missile launchers—in the USA over 656 ballistic missile launchers on nuclear-powered submarines and in the USSR over 740 ballistic missile launchers on nuclear-powered submarines, operational and under construction—may become operational as replacements for equal numbers of ballistic missile launchers of types deployed prior to 1964, or of ballistic missile launchers on older submarines.

The interim agreement is accompanied by agreed interpretations and unilateral statements made during the negotiations.

For the full text of the interim agreement, see SIPRI Yearbook 1973, pp. 25–28.

Signed at Moscow on 26 May 1972.

Entered into force on 3 October 1972.

Protocol to the US-Soviet agreement on the prevention of incidents on and over the high seas

Provides that ships and aircraft of the parties shall not make simulated attacks by aiming guns, missile launchers, torpedo tubes and other weapons at non-military ships of the other party, nor launch nor drop any objects near non-military ships of the other party in such a manner as to be hazardous to these ships or to constitute a hazard to navigation.

For the full text of the protocol, see US Department of State, Treaties and Other International Act Series 7624, 1973.
Signed at Washington on 22 May 1973.
Entered into force on 22 May 1973.

US-Soviet agreement on the prevention of nuclear war

Provides that the parties will act in such a manner as to exclude the outbreak of nuclear war between them and between either of the parties and other countries. Each party will refrain from the threat or use of force against the other party, against the allies of the other party and against other countries in circumstances which may endanger international peace and security. If at any time relations between the parties or between either party and other countries appear to involve the risk of a nuclear conflict, or if relations between countries not parties to this agreement appear to involve the risk of nuclear war between the USSR and the USA or between either party and other countries, the Soviet Union and the United States, acting in accordance with the provisions of this agreement, shall immediately enter into urgent consultations with each other and make every effort to avert this risk.
For the full text of the agreement, see SIPRI Yearbook 1974, pp. 409–10.
Signed at Washington on 22 June 1973.
Entered into force on 22 June 1973.

Protocol to the US-Soviet treaty on the limitation of anti-ballistic missile systems

Provides that each party shall be limited to a single area for deployment of anti-ballistic missile systems or their components instead of two such areas as allowed by the ABM Treaty. Each party will have the right to dismantle or destroy its ABM system and the components thereof in the area where they were deployed at the time of signing the protocol and to deploy an ABM system or its components in the alternative area permitted by the ABM Treaty, provided that, prior to initiation of construction, notification is given during the year beginning 3 October 1977, and ending 2 October 1978, or during any year which commences at five-year intervals thereafter, those being the years for periodic review of the ABM Treaty. This right may be exercised only once. The deployment of an ABM system within the area selected shall remain limited by the levels and other requirements established by the ABM Treaty.
For the full text of the protocol, see SIPRI Yearbook 1975, pp. 458–59.
Signed at Moscow on 3 July 1974.
Entered into force on 25 May 1976.

US-Soviet treaty on the limitation of underground nuclear weapon tests (Threshold Test Ban Treaty—TTBT)

Prohibits the carrying out of any underground nuclear weapon test having a yield exceeding 150 kt, beginning 31 March 1976. Each party undertakes to limit the number of its underground nuclear weapon tests to a minimum. The provisions of the treaty do not extend to underground nuclear explosions for peaceful purposes which are to be governed by a separate agreement. National technical means of verification will be used to provide assurance of compliance and a protocol to the treaty specifies the data that have to be exchanged between the parties to ensure such verification.

For the full text of the treaty, see SIPRI Yearbook 1975, pp. 453–56.

Signed at Moscow on 3 July 1974.

Not in force by 31 December 1976.

US-Soviet treaty on underground nuclear explosions for peaceful purposes (Peaceful Nuclear Explosions Treaty—PNET)

Prohibits the carrying out of any individual underground nuclear explosion for peaceful purposes, having a yield exceeding 150 kt, or any group explosion (consisting of two or more individual explosions) with an aggregate yield exceeding 1 500 kt. The treaty governs all nuclear explosions carried out outside the weapon test sites after 31 March 1976. The question of carrying out individual explosions with a yield exceeding 150 kt will be considered at an appropriate time to be agreed. In addition to the use of national technical means of verification, the treaty provides for an exchange of information and, in certain specified cases, access to sites of explosions. A protocol to the treaty sets forth operational arrangements for ensuring that no weapon-related benefits precluded by the TTBT are derived from peaceful nuclear explosions. The PNET may not be terminated while the TTBT remains in force.

For the full text of the treaty, see SIPRI Yearbook 1977, pp. 381–97.

Signed at Moscow and Washington on 28 May 1976.

Not in force by 31 December 1976.

French-Soviet agreement on the prevention of the accidental or unauthorized use of nuclear weapons

Provides that the parties will maintain and, possibly, improve their organizational and technical arrangements to prevent the accidental or unauthorized use of nuclear weapons under their control. They will notify each other immediately of any accidental occurrence or any other unexplained incident that could lead to the explosion of one of their nuclear weapons and could be construed as likely to have harmful effects on the other party. In the event of an unexplained nuclear incident, each party will act in such a manner as to avoid the possibility of its actions being misinterpreted by the other party. For transmission of urgent information, primary use will be made of the direct communications link between the Elysée Palace and the Kremlin. (The link has been established following an accord between France and the USSR, of 9 November 1966.) The agreement was concluded through an exchange of letters between the foreign ministers of France and the USSR, of 16 July 1976.

For the full text of the letters, see SIPRI Yearbook 1977, pp. 398–99.

Entered into force on 16 July 1976.

II. *Multilateral agreements*

Protocol for the prohibition of the use in war of asphyxiating, poisonous or other gases, and of bacteriological methods of warfare (Geneva Protocol)

Declares that the parties accept the prohibition of the use in war of asphyxiating, poisonous or other gases, and of all analogous liquids, materials or devices, and agree to extend this prohibition to the use of bacteriological methods of warfare.

For the full text of the protocol, see SIPRI Yearbook 1969/70, p. 438.

Signed at Geneva on 17 June 1925.

The protocol enters into force for each signatory power as from the date of deposit of its ratification; accessions take effect on the date of the notification by the government of the French Republic.

The depositary government: France.

New parties in 1976:	Barbados	16 July 1976[1]
	Qatar	18 October 1976

Number of parties as of 31 December 1976: 96*

Antarctic Treaty

Declares the Antarctic an area to be used exclusively for peaceful purposes. Prohibits any measure of a military nature in the Antarctic, such as the establishment of military bases and fortifications, the carrying out of military manoeuvres, or the testing of any type of weapons, as well as any nuclear explosions.

For the full text of the treaty, see SIPRI Yearbook 1973, pp. 487–93.

Signed at Washington on 1 December 1959.

Entered into force on 23 June 1961.

The depositary government: USA.

No new parties in 1976.

Number of parties as of 31 December 1976: 19**

[1] In a note of 22 June 1976, addressed to the French government, the government of Barbados declared that it considered the protocol to be in force in respect of Barbados in virtue of its extension to Barbados by the United Kingdom. It further declared that the reservation made on 9 April 1930 on behalf of the British Empire was withdrawn.

* For the list of states which have signed, ratified, acceded or succeeded to the Geneva Protocol, as of 31 December 1975, see *SIPRI Yearbook 1976*, pp. 469–75.

** For the list of states which have signed, ratified, acceded or succeeded to multilateral agreements related to disarmament, as of 31 December 1975, see *SIPRI Yearbook 1976*, pp. 427–68.

Treaty banning nuclear weapon tests in the atmosphere, in outer space and under water (Partial Test Ban Treaty—PTBT)

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.

For the full text of the treaty, see SIPRI Yearbook 1974, pp. 502–504.

Signed at Moscow on 5 August 1963.
Entered into force on 10 October 1963.
The depositary governments: UK, USA, USSR.

New parties in 1976:	Bahamas	13 August 1976[2]
	Guinea-Bissau	20 August 1976

Number of parties as of 31 December 1976: 108*

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.

For the full text of the treaty, see Documents on Disarmament 1967, US Arms Control and Disarmament Agency, pp. 38–43.

Signed at London, Moscow and Washington on 27 January 1967.
Entered into force on 10 October 1967.
The depositary governments: UK, USA, USSR.

New parties in 1976:	Bahamas	11 August 1976[3]
	Guinea-Bissau	20 August 1976
	Singapore	10 September 1976

Number of parties as of 31 December 1976: 74*

[2] Notification of succession.
[3] Notification of succession.
* For the list of states which have signed, ratified, acceded or succeeded to multilateral agreements related to disarmament, as of 31 December 1975, see *SIPRI Yearbook 1976*, pp. 427–68.

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.

For the full text of the treaty and the protocols, see SIPRI Yearbook 1969/70, pp. 237–53.

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, that is, that all states in the region which were in existence when the treaty was opened for signature, deposit the instruments of ratification, that 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.

The 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.

New signatory in 1976: Surinam 13 February 1976

No new ratifications in 1976.

Number of parties to the treaty as of 31 December 1976: 20*

Number of parties to Protocol I as of 31 December 1976:2*

Number of parties to Protocol II as of 31 December 1976: 4*

* For the list of states which have signed, ratified, acceded or succeeded to multilateral agreements related to disarmament, as of 31 December 1975, see *SIPRI Yearbook 1976,* pp. 427–68.

Treaty on the non-proliferation of nuclear weapons (Non-Proliferation Treaty—NPT)

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 with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices.

The parties undertake to facilitate the exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy and to ensure that potential benefits from peaceful applications of nuclear explosions will be made available to non-nuclear weapon parties to the treaty. They also undertake to pursue negotiations on effective measures relating to cessation of the nuclear arms race and to nuclear disarmament, and on a treaty on general and complete disarmament.

For the full text of the treaty, see SIPRI Yearbook 1968/69, pp. 349–54.

Signed at London, Moscow and Washington on 1 July 1968.
Entered into force on 5 March 1970.
The depositary governments: UK, USA, USSR.

New parties in 1976:	Singapore	10 March 1976
	Japan	8 June 1976[4]
	Surinam	30 June 1976[5]
	Bahamas	11 August 1976[5]
	Guinea-Bissau	20 August 1976

Number of parties to the treaty as of 31 December 1976: 101*

In 1976, NPT safeguards agreements with the IAEA entered into force for:

Uruguay	17 September 1976[6]
Nicaragua	29 December 1976[6]

Number of NPT safeguards agreements in force, as of 31 December 1976: 45*

[4] On depositing the instruments of ratification, Japan expressed the hope that France and China would accede to the Treaty; it urged a reduction of nuclear armaments and a comprehensive ban on nuclear testing; appealed to all states to refrain from the threat or use of force involving either nuclear or non-nuclear weapons; expressed the view that peaceful nuclear activities in non-nuclear weapon states party to the Treaty should not be hampered and that Japan should not be discriminated against in favour of other parties in any aspect of such activities. It also urged all nuclear weapon states to accept IAEA safeguards on their peaceful nuclear activities.

[5] Notification of succession.

[6] The agreement covers the NPT and the Treaty of Tlatelolco.

* For the list of states which have signed, ratified, acceded or succeeded to multilateral agreements related to disarmament, as of 31 December 1975, see *SIPRI Yearbook 1976*, pp. 427–68.

Postscript: Panama and Switzerland deposited the instruments of ratification on 13 January and 9 March 1977, respectively, bringing the total number of parties to the NPT to 103. Switzerland stated, *inter alia,* that it would accept only such interpretations and definitions of the terms "equipment or material especially designed or prepared for the processing, use or production of special fissionable material", as mentioned in the Treaty, that it would expressly approve.

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 12-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.

For the full text of the treaty, see SIPRI Yearbook 1972, pp. 537–41.

Signed at London, Moscow and Washington on 11 February 1971.
Entered into force on 18 May 1972.
The depositary governments: UK, USA, USSR.

New parties in 1976:	Netherlands	14 January 1976[7]
	Switzerland	4 May 1976
	Guinea-Bissau	20 August 1976
	Singapore	10 September 1976

Number of parties to the treaty as of 31 December 1976: 62*

Convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (BW Convention)

Prohibits the development, production, stockpiling, acquisition by other means or retention of 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, as well as weapons, equipment or means of delivery designed to

[7] The ratification covers the Netherlands Antilles.
* For the list of states which have signed, ratified, acceded or succeeded to multilateral agreements related to disarmament, as of 31 December 1975, see *SIPRI Yearbook 1976,* pp. 427–68.

use such agents or toxins for hostile purposes or in armed conflict. The destruction of the agents, toxins, weapons, equipment and means of delivery in the possession of the parties, or their diversion to peaceful purposes, should be effected not later than nine months after the entry into force of the convention.

For the full text of the convention, see SIPRI Yearbook 1972, pp. 517–22.

Signed at London, Moscow and Washington on 10 April 1972.

Entered into force on 26 March 1975.

The depositary governments: UK, USA, USSR.

New parties in 1976:	Kenya	7 January 1976
	Sweden	5 February 1976
	Luxembourg	23 March 1976
	Cuba	21 April 1976
	Switzerland	4 May 1976[8]
	Paraguay	9 June 1976
	Sierra Leone	29 June 1976
	Guinea-Bissau	20 August 1976
	Tonga	28 September 1976

Number of parties to the convention as of 31 December 1976: 73*

[8] The ratification by Switzerland contains the following reservations:

1. Owing to the fact that the convention also applies to weapons, equipment or means of delivery designed to use biological agents or toxins, the delimitation of its scope of application can cause difficulties since there are scarcely any weapons, equipment or means of delivery peculiar to such use; therefore, Switzerland reserves the right to decide for itself what auxiliary means fall within that definition.

2. By reason of the obligations resulting from its status as a perpetually neutral state, Switzerland is bound to make the general reservation that its collaboration within the framework of this convention cannot go beyond the terms prescribed by that status. This reservation refers especially to Article VII of the convention as well as to any similar clause that could replace or supplement that provision of the convention (or any other arrangement).

In a note of 18 August 1976, addressed to the Swiss Ambassador, the US Secretary of State stated the following view of the US government with regard to the first reservation: The prohibition would apply only to (a) weapons, equipment and means of delivery the design of which indicated that they could have no other use than that specified, and (b) weapons, equipment and means of delivery the design of which indicated that they were specifically intended to be capable of the use specified. The government of the United States shares the view of the government of Switzerland that there are few weapons, equipment, or means of delivery peculiar to the uses referred to. It does not, however, believe that it would be appropriate, on this ground alone, for states to reserve unilaterally the right to decide which weapons, equipment, or means of delivery fell within the definition. Therefore, while acknowledging the entry into force of the convention between itself and the government of Switzerland, the United States government enters its objection to this reservation.

* For the list of states which have signed, ratified, acceded or succeeded to multilateral agreements related to disarmament, as of 31 December 1975, see *SIPRI Yearbook 1976*, pp. 427–68.

Convention on the prohibition of military or any other hostile use of environmental modification techniques (ENMOD Convention)

Prohibits military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to states party to the convention. The term "environmental modification techniques" refers to any technique for changing—through the deliberate manipulation of natural processes—the dynamics, composition or structure of the Earth, including its biota lithosphere, hydrosphere, and atmosphere, or of outer space. The parties undertake to consult one another and to cooperate in solving problems which may arise in the application of the provisions of the convention. Consultation and cooperation may also be undertaken through international procedures including the services of appropriate international organizations as well as of a consultative committee of experts to be convened upon the receipt of a request from any party.

The depositary: UN Secretary-General

On 10 December 1976, the UN General Assembly decided that the convention should be opened for signature and ratification.

Appendix 8B

Treaty between the United States of America and the Union of Soviet Socialist Republics on underground nuclear explosions for peaceful purposes

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Proceeding from a desire to implement Article III of the Treaty between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Underground Nuclear Weapon Tests, which calls for the earliest possible conclusion of an agreement on underground nuclear explosions for peaceful purposes,

Reaffirming their adherence to the objectives and principles of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, the Treaty on the Non-Proliferation of Nuclear Weapons, and the Treaty on the Limitation of Underground Nuclear Weapon Tests, and their determination to observe strictly the provisions of these international agreements,

Desiring to assure that underground nuclear explosions for peaceful purposes shall not be used for purposes related to nuclear weapons,

Desiring that utilization of nuclear energy be directed only toward peaceful purposes,

Desiring to develop appropriately co-operation in the field of underground nuclear explosions for peaceful purposes,

Have agreed as follows:

ARTICLE I

1. The Parties enter into this Treaty to satisfy the obligations in Article III of the Treaty on the Limitation of Underground Nuclear Weapon Tests, and assume additional obligations in accordance with the provisions of this Treaty.

2. This Treaty shall govern all underground nuclear explosions for peaceful purposes conducted by the Parties after 31 March 1976.

ARTICLE II

For the purposes of this Treaty:

(a) "explosion" means any individual or group underground nuclear explosion for peaceful purposes;

(b) "explosive" means any device, mechanism or system for producing an individual explosion;

(c) "group explosion" means two or more individual explosions for which the time interval between successive individual explosions does not exceed five seconds and for which the emplacement points of all explosives can be interconnected by straight line segments, each of which joins two emplacement points and each of which does not exceed 40 kilometres.

ARTICLE III

1. Each Party, subject to the obligations assumed under this Treaty and other international agreements, reserves the right to:

(a) carry out explosions at any place under its jurisdiction or control outside the geographical boundaries of test sites specified under the provisions of the Treaty on the Limitation of Underground Nuclear Weapon Tests; and

(b) carry out, participate or assist in carrying out explosions in the territory of another State at the request of such other State.

2. Each Party undertakes to prohibit, to prevent and not to carry out at any place under its jurisdiction or control, and further undertakes not to carry out, participate or assist in carrying out anywhere:

(a) any individual explosion having a yield exceeding 150 kilotons;

(b) any group explosion:

(1) having an aggregate yield exceeding 150 kilotons except in ways that will permit identification of each individual explosion and determination of the yield of each individual explosion in the group in accordance with the provisions of Article IV of and the Protocol to this Treaty;

(2) having an aggregate yield exceeding one and one-half megatons;

(c) any explosion which does not carry out a peaceful application;

(d) any explosion except in compliance with the provisions of the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, the Treaty on Non-Proliferation of Nuclear Weapons, and other international agreements entered into by that Party.

3. The question of carrying out any individual explosion having a yield exceeding the yield specified in paragraph 2 (a) of this article will be considered by Parties at an appropriate time to be agreed.

ARTICLE IV

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each Party shall:

(a) use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law; and

(b) provide to the other Party information and access to sites of explosions and furnish assistance in accordance with the provisions set forth in the Protocol to this Treaty.

2. Each Party undertakes not to interfere with the national technical means

of verification of the other Party operating in accordance with paragraph 1 (a) of this article, or with the implementation of the provisions of paragraph 1 (b) of this article.

ARTICLE V

1. To promote the objectives and implementation of the provisions of this Treaty, the Parties shall establish promptly a Joint Consultative Commission within the framework of which they will:

(a) consult with each other, make inquiries and furnish information in response to such inquiries, to assure confidence in compliance with the obligations assumed;

(b) consider questions concerning compliance with the obligations assumed and related situations which may be considered ambiguous;

(c) consider questions involving unintended interference with the means for assuring compliance with the provisions of this Treaty;

(d) consider changes in technology or other new circumstances which have a bearing on the provisions of this Treaty; and

(e) consider possible amendments to provisions governing underground nuclear explosions for peaceful purposes.

2. The Parties through consultation shall establish, and may amend as appropriate, Regulations for the Joint Consultative Commission governing procedures, composition and other relevant matters.

ARTICLE VI

1. The Parties will develop co-operation on the basis of mutual benefit, equality, and reciprocity in various areas related to carrying out underground nuclear explosions for peaceful purposes.

2. The Joint Consultative Commission will facilitate this co-operation by considering specific areas and forms of co-operation which shall be determined by agreement between the Parties in accordance with their constitutional procedures.

3. The Parties will appropriately inform the International Atomic Energy Agency of results of their co-operation in the field of underground nuclear explosions for peaceful purposes.

ARTICLE VII

1. Each Party shall continue to promote the development of the international agreement or agreements and procedures provided for in Article V of the Treaty on the Non-Proliferation of Nuclear Weapons, and shall provide appropriate assistance to the International Atomic Energy Agency in this regard.

2. Each Party undertakes not to carry out, participate or assist in the

carrying out of any explosion in the territory of another State unless that State agrees to the implementation in its territory of the international observation and procedures contemplated by Article V of the Treaty on the Non-Proliferation of Nuclear Weapons and the provisions of Article IV of and the Protocol to this Treaty, including the provision by that State of the assistance necessary for such implementation and of the privileges and immunities specified in the Protocol.

ARTICLE VIII

1. This Treaty shall remain in force for a period of five years, and it shall be extended for successive five-year periods unless either Party notifies the other of its termination no later than six months prior to its expiration. Before the expiration of this period the Parties may, as necessary, hold consultations to consider the situation relevant to the substance of this Treaty. However, under no circumstances shall either Party be entitled to terminate this Treaty while the Treaty on the Limitation of Underground Nuclear Weapon Tests remains in force.

2. Termination of the Treaty on the Limitation of Underground Nuclear Weapon Tests shall entitle either Party to withdraw from this Treaty at any time.

3. Each Party may propose amendments to this Treaty. Amendments shall enter into force on the day of the exchange of instruments of ratification of such amendments.

ARTICLE IX

1. This Treaty including the Protocol which forms an integral part hereof, shall be subject to ratification in accordance with the constitutional procedures of each Party. This Treaty shall enter into force on the day of the exchange of instruments of ratification which exchange shall take place simultaneously with the exchange of instruments of ratification of the Treaty on the Limitation of Underground Nuclear Weapon Tests.

2. This Treaty shall be registered pursuant to Article 102 of the Charter of the United Nations.

Done at Washington and Moscow, on 28 May 1976, in duplicate, in the English and Russian languages, both texts being equally authentic.

For the United States of America:
The President of the United States of America

For the Union of Soviet Socialist Republics:
General Secretary of the Central Committee of the CPSU

Protocol to the treaty between the United States of America and the Union of Soviet Socialist Republics on underground nuclear explosions for peaceful purposes

The United States of America and the Union of Soviet Socialist Republics, hereinafter referred to as the Parties,

Having agreed to the provisions in the Treaty on Underground Nuclear Explosions for Peaceful Purposes, hereinafter referred to as the Treaty,

Have agreed as follows:

ARTICLE I

1. No individual explosion shall take place at a distance, in metres, from the ground surface which is less than 30 times the 3.4 root of its planned yield in kilotons.

2. Any group explosion with a planned aggregate yield exceeding 500 kilotons shall not include more than five individual explosions, each of which has a planned yield not exceeding 50 kilotons.

ARTICLE II

1. For each explosion, the Party carrying out the explosion shall provide the other Party:

(a) not later than 90 days before the beginning of emplacement of the explosives when the planned aggregate yield of the explosion does not exceed 100 kilotons, or not later than 180 days before the beginning of emplacement of the explosives when the planned aggregate yield of the explosion exceeds 100 kilotons, with the following information to the extent and degree of precision available when it is conveyed:

(1) the purpose of the planned explosion;

(2) the location of the explosion expressed in geographical co-ordinates with a precision of four or less kilometres, planned date and aggregate yield of the explosion;

(3) the type or types of rock in which the explosion will be carried out, including the degree of liquid saturation of the rock at the point of emplacement of each explosive; and

(4) a description of specific technological features of the project, of which the explosion is a part, that could influence the determination of its yield and confirmation of purpose; and

(b) not later than 60 days before the beginning of emplacement of the explosives the information specified in subparagraph 1 (a) of this article to the full extent and with the precision indicated in that subparagraph.

2. For each explosion with a planned aggregate yield exceeding 50 kilotons, the Party carrying out the explosion shall provide the other Party, not later than 60 days before the beginning of emplacement of the explosives, with the following information:

(a) the number of explosives, the planned yield of each explosive, the location of each explosive to be used in a group explosion relative to all other explosives in the group with a precision of 100 or less metres, the depth of emplacement of each explosive with a precision of one metre and the time intervals between individual explosions in any group explosion with a precision of one-tenth second; and

(b) a description of specific features of geological structure or other local conditions that could influence the determination of the yield.

3. For each explosion with a planned aggregate yield exceeding 75 kilotons, the Party carrying out the explosion shall provide the other Party, not later than 60 days before the beginning of emplacement of the explosives, with a description of the geological and geophysical characteristics of the site of each explosion which could influence determination of the yield, which shall include: the depth of the water table; a stratigraphic column above each emplacement point; the position of each emplacement point relative to nearby geological and other features which influenced the design of the project of which the explosion is a part; and the physical parameters of the rock, including density, seismic velocity, porosity, degree of liquid saturation, and rock strength, within the sphere centred on each emplacement point and having a radius, in metres, equal to 30 times the cube root of the planned yield in kilotons of the explosive emplaced at that point.

4. For each explosion with a planned aggregate yield exceeding 100 kilotons, the Party carrying out the explosion shall provide the other Party, not later than 60 days before the beginning of emplacement of the explosives, with:

(a) information on locations and purposes of facilities and installations which are associated with the conduct of the explosion;

(b) information regarding the planned date of the beginning of emplacement of each explosive; and

(c) a topographic plan in local co-ordinates of the areas specified in paragraph 7 of Article IV, at a scale of 1 : 24 000 or 1 : 25 000 with a contour interval of 10 metres or less.

5. For application of an explosion to alleviate the consequences of an emergency situation involving an unforeseen combination of circumstances which calls for immediate action for which it would not be practicable to observe the timing requirements of paragraphs 1, 2 and 3 of this article, the following conditions shall be met:

(a) the Party deciding to carry out an explosion for such purposes shall inform the other Party of that decision immediately after it has been made and describe such circumstances;

(b) the planned aggregate yield of an explosion for such purpose shall not exceed 100 kilotons; and

(c) the Party carrying out an explosion for such purpose shall provide to the other Party the information specified in paragraph 1 of this article, and the information specified in paragraphs 2 and 3 of this article if applicable, after the decision to conduct the explosion is taken, but not later than 30 days before the beginning of emplacement of the explosives.

6. For each explosion, the Party carrying out the explosion shall inform the other Party, not later than two days before the explosion, of the planned time of detonation of each explosive with a precision of one second.

7. Prior to the explosion, the Party carrying out the explosion shall provide the other Party with timely notification of changes in the information provided in accordance with this article.

8. The explosion shall not be carried out earlier than 90 days after notification of any change in the information provided in accordance with this article which requires more extensive verification procedures than those required on the basis of the original information, unless an earlier time for carrying out the explosion is agreed between the Parties.

9. Not later than 90 days after such explosion the Party carrying out the explosion shall provide the other Party with the following information:

(a) the actual time of the explosion with a precision of one-tenth second and its aggregate yield;

(b) when the planned aggregate yield of a group explosion exceeds 50 kilotons, the actual time of the first individual explosion with a precision of one-tenth second, the time interval between individual explosions with a precision of one millisecond and the yield of each individual explosion; and

(c) confirmation of other information provided in accordance with paragraphs 1, 2, 3 and 4 of this article and explanation of any changes or corrections based on the results of the explosion.

10. At any time, but not later than one year after the explosion, the other Party may request the Party carrying out the explosion to clarify any item of the information provided in accordance with this article. Such clarification shall be provided as soon as practicable, but not later than 30 days after the request is made.

ARTICLE III

1. For the purposes of this Protocol:

(a) "designated personnel" means those nationals of the other Party identified to the Party carrying out an explosion as the persons who will exercise the rights and functions provided for in the Treaty and this Protocol; and

(b) "emplacement hole" means the entire interior of any drill-hole, shaft, adit or tunnel in which an explosive and associated cables and other equipment are to be installed.

2. For any explosion with a planned aggregate yield exceeding 100 kilotons but not exceeding 150 kilotons if the Parties, in consultation based on information provided in accordance with Article II and other information that may be introduced by either Party, deem it appropriate for the confirmation of the yield of the explosion, and for any explosion with a planned aggregate yield exceeding 150 kilotons, the Party carrying out the explosion shall allow designated personnel within the areas and at the locations described in Article V to exercise the following rights and functions:

(a) confirmation that the local circumstances, including facilities and installations associated with the project, are consistent with the stated peaceful purposes;

(b) confirmation of the validity of the geological and geophysical information provided in accordance with Article II through the following procedures:

(1) examination by designated personnel of research and measurement data of the Party carrying out the explosion and of rock core or rock fragments removed from each emplacement hole, and of any logs and drill core from existing exploratory holes which shall be provided to designated personnel upon their arrival at the site of the explosion;

(2) examination by designated personnel of rock core or rock fragments as they become available in accordance with the procedures specified in subparagraph 2(b)(3) of this article; and

(3) observation by designated personnel of implementation by the Party carrying out the explosion of one of the following four procedures, unless this right is waived by the other Party;

(i) construction of that portion of each emplacement hole starting from a point nearest the entrance of the emplacement hole which is at a distance, in metres, from the nearest emplacement point equal to 30 times the cube root of the planned yield in kilotons of the explosive to be emplaced at that point and continuing to the completion of the emplacement hole; or

(ii) construction of that portion of each emplacement hole starting from a point nearest the entrance of the emplacement hole which is at a distance, in metres, from the nearest emplacement point equal to six times the cube root of the planned yield in kilotons of the explosive to be emplaced at that point and continuing to the completion of the emplacement hole as well as the removal of rock core or rock fragments from the wall of an existing exploratory hole, which is substantially parallel with and at no point more than 100 metres from the emplacement hole, at locations specified by designated personnel which lie within a distance, in metres, from the same horizon as each emplacement point of 30 times the cube root of the planned yield in kilotons of the explosive to be emplaced at that point; or

(iii) removal of rock core or rock fragments from the wall of each emplacement hole at locations specified by designated personnel which lie within a distance, in metres, from each emplacement point of 30 times the cube root of the planned yield in kilotons of the explosive to be emplaced at each such point; or

(iv) construction of one or more new exploratory holes so that for each emplacement hole there will be a new exploratory hole to the same depth as that of the emplacement of the explosive, substantially parallel with and at no point more than 100 metres from each emplacement hole, from which rock cores would be removed at locations specified by designated personnel which lie within a distance, in metres, from the same horizon as each emplacement point of 30 times the cube root of the planned yield in kilotons of the explosive to be emplaced at each such point;

(c) observation of the emplacement of each explosive, confirmation of the depth of its emplacement and observation of the stemming of each emplacement hole;

(d) unobstructed visual observation of the area of the entrance to each emplacement hole at any time from the time of emplacement of each explosive until all personnel have been withdrawn from the site for the detonation of the explosion; and

(e) observation of each explosion.

3. Designated personnel, using equipment provided in accordance with paragraph 1 of Article IV, shall have the right, for any explosion with a planned aggregate yield exceeding 150 kilotons, to determine the yield of each individual explosion in a group explosion in accordance with the provisions of Article VI.

4. Designated personnel, when using their equipment in accordance with paragraph 1 of Article IV, shall have the right, for any explosion with a planned aggregate yield exceeding 500 kilotons, to emplace, install and operate under the observation and with the assistance of personnel of the Party carrying out the explosion, if such assistance is requested by designated personnel, a local seismic network in accordance with the provisions of paragraph 7 of Article IV. Radio links may be used for the transmission of data and control signals between the seismic stations and the control centre. Frequencies, maximum power output of radio transmitters, directivity of antennas and times of operation of the local seismic network radio transmitters before the explosion shall be agreed between the Parties in accordance with Article X and time of operation after the explosion shall conform to the time specified in paragraph 7 of Article IV.

5. Designated personnel shall have the right to:

(a) acquire photographs under the following conditions:

(1) the Party carrying out the explosion shall identify to the other Party those personnel of the Party carrying out the explosion who shall take photographs as requested by designated personnel:

(2) photographs shall be taken by personnel of the Party carrying out the explosion in the presence of designated personnel and at the time requested by

designated personnel for taking such photographs. Designated personnel shall determine whether these photographs are in conformity with their requests and, if not, additional photographs shall be taken immediately;

(3) photographs shall be taken with cameras provided by the other Party having built-in, rapid developing capability and a copy of each photograph shall be provided at the completion of the development process to both Parties;

(4) cameras provided by designated personnel shall be kept in agreed secure storage when not in use; and

(5) the request for photographs can be made, at any time, of the following:

(i) exterior views of facilities and installations associated with the conduct of the explosion as described in subparagraph 4 (a) of Article II;

(ii) geological samples used for confirmation of geological and geophysical information, as provided for in subparagraph 2 (b) of this article and the equipment utilized in the acquisition of such samples;

(iii) emplacement and installation of equipment and associated cables used by designated personnel for yield determination;

(iv) emplacement and installation of the local seismic network used by designated personnel;

(v) emplacement of the explosives and the stemming of the emplacement hole; and

(vi) containers, facilities and installation for storage and operation of equipment used by designated personnel;

(b) photographs of visual displays and records produced by the equipment used by designated personnel and photographs within the control centres taken by cameras which are component parts of such equipment; and

(c) receive at the request of designated personnel and with the agreement of the Party carrying out the explosion supplementary photographs taken by the Party carrying out the explosion.

ARTICLE IV

1. Designated personnel in exercising their rights and functions may choose to use the following equipment of either Party, of which choice the Party carrying out the explosion shall be informed not later than 150 days before the beginning of emplacement of the explosives:

(a) electrical equipment for yield determination and equipment for a local seismic network as described in paragraphs 3, 4 and 7 of this article; and

(b) geologist's field tools and kits and equipment for recording of field notes.

2. Designated personnel shall have the right in exercising their rights and functions to utilize the following additional equipment which shall be provided by the Party carrying out the explosion, under procedures to be established in accordance with Article X to ensure that the equipment meets the specifications of the other Party: portable short-range communication equipment, field glasses, optical equipment for surveying and other items which may be specified by the other Party. A description of such equipment and operating instructions shall be provided to the other Party not later than 90 days before the beginning of emplacement of the explosives in connexion with which such equipment is to be used.

3. A complete set of electrical equipment for yield determination shall consist of:

(a) sensing elements and associated cables for transmission of electrical power, control signals and data;

(b) equipment of the control centre, electrical power supplies and cables for transmission of electrical power, control signals and data; and

(c) measuring and calibration instruments, maintenance equipment and spare parts necessary for ensuring the functioning of sensing elements, cables and equipment of the control centre.

4. A complete set of equipment for the local seismic network shall consist of:

(a) seismic stations each of which contains a seismic instrument, electrical power supply and associated cables and radio equipment for receiving and transmission of control signals and data or equipment for recording control signals and data;

(b) equipment of the control centre and electrical power supplies; and

(c) measuring and calibration instruments, maintenance equipment and spare parts necessary for ensuring the functioning of the complete network.

5. In case designated personnel, in accordance with paragraph 1 of this article, choose to use equipment of the Party carrying out the explosion for yield determination or for a local seismic network, a description of such equipment and installation and operating instructions shall be provided to the other Party not later than 90 days before the beginning of emplacement of the explosives in connexion with which such equipment is to be used. Personnel of the Party carrying out the explosion shall emplace, install and operate the equipment in the presence of designated personnel. After the explosion, designated personnel shall receive duplicate copies of the recorded data. Equipment for yield determination shall be emplaced in accordance with Article VI. Equipment for a local seismic network shall be emplaced in accordance with paragraph 7 of this article.

6. In case designated personnel, in accordance with paragraph 1 of this article, choose to use their own equipment for yield determination and their own equipment for a local seismic network, the following procedures shall apply:

(a) the Party carrying out the explosion shall be provided by the other Party with the equipment and information specified in subparagraphs (a) (1) and (2) of this paragraph not later than 150 days prior to the beginning of emplacement of the explosives in connexion with which such equipment is to be used in order to permit the Party carrying out the explosion to familiarize itself with such equipment, if such equipment and information has not been previously provided, which equipment shall be returned to the other Party not later than 90 days before the beginning of emplacement of the explosives. The equipment and information to be provided are:

(1) one complete set of electrical equipment for yield determination as described in paragraph 3 of this article, electrical and mechanical design information, specifications and installation and operating instructions concerning this equipment; and

(2) one complete set of equipment for the local seismic network described in paragraph 4 of this article, including one seismic station, electrical and mechanical design information, specifications and installation and operating instructions concerning this equipment;

(b) not later than 35 days prior to the beginning of emplacement of the explosives in connexion with which the following equipment is to be used, two complete sets of electrical equipment for yield determination as described in paragraph 3 of this article and specific installation instructions for the emplacement of the sensing elements based on information provided in accordance with subparagraph 2 (a) of Article VI and two complete sets of equipment for the local seismic network as described in paragraph 4 of this article, which sets of equipment shall have the same components and technical characteristics as the corresponding equipment specified in subparagraph 6 (a) of this article, shall be delivered in sealed containers to the port of entry;

(c) the Party carrying out the explosion shall choose one of each of the two sets of equipment described above which shall be used by designated personnel in connexion with the explosion;

(d) the set or sets of equipment not chosen for use in connexion with the explosion shall be at the disposal of the Party carrying out the explosion for a period that may be as long as 30 days after the explosion at which time such equipment shall be returned to the other Party;

(e) the set or sets of equipment chosen for use shall be transported by the Party carrying out the explosion in the sealed containers in which this equipment arrived, after seals of the Party carrying out the explosion have been affixed to them, to the site of the explosion, so that this equipment is delivered to designated personnel for emplacement, installation and operation not later than 20 days before the beginning of emplacement of the explosives. This equipment shall remain in the custody of designated personnel in accordance with paragraph 7 of Article V or in agreed secure storage. Personnel of the Party carrying out the explosion shall have the right to observe the use of this equipment by designated personnel during the time the equipment is at the site of the explosion. Before the beginning of emplacement of the explosives, designated personnel shall demonstrate to personnel of the Party carrying out the explosion that this equipment is in working order;

(f) each set of equipment shall include two sets of components for recording data and associated calibration equipment. Both of these sets of components in the equipment chosen for use shall simultaneously record data. After the explosion, and after duplicate copies of all data have been obtained by designated personnel and the Party carrying out the explosion, one of each of the two sets of components for recording data and associated calibration equipment shall be selected, by an agreed process of chance, to be retained by designated personnel. Designated personnel shall pack and seal such components for recording data and associated calibration equipment which shall accompany them from the site of the explosion to the port of exit; and

(g) all remaining equipment may be retained by the Party carrying out the explosion for a period that may be as long as 30 days, after which time this equipment shall be returned to the other Party.

7. For any explosion with a planned aggregate yield exceeding 500 kilotons, a local seismic network, the number of stations of which shall be determined by designated personnel but shall not exceed the number of explosives in the group plus five, shall be emplaced, installed and operated at agreed sites of emplacement within an area circumscribed by circles of 15 kilometres in radius centered on points on the surface of the earth above the points of emplacement of the explosives during a period beginning not later than 20 days before the beginning of emplacement of the explosives and continuing after the explosion not later than three days unless otherwise agreed between the Parties.

8. The Party carrying out the explosion shall have the right to examine in the presence of designated personnel all equipment, instruments and tools of designated personnel specified in subparagraph 1 (b) of this article.

9. The Joint Consultative Commission will consider proposals that either Party may put forward for the joint development of standardized equipment for verification purposes.

ARTICLE V

1. Except as limited by the provisions of paragraph 5 of this article, designated personnel in the exercise of their rights and functions shall have access along agreed routes:

(a) for an explosion with a planned aggregate yield exceeding 100 kilotons in accordance with paragraph 2 of Article III:

(1) to the locations of facilities and installations associated with the conduct of the explosion provided in accordance with subparagraph 4 (a) of Article II; and

(2) to the locations of activities described in paragraph 2 of Article III; and

(b) for any explosion with a planned aggregate yield exceeding 150 kilotons, in addition to the access described in subparagraph 1 (a) of this article:

(1) to other locations within the area circumscribed by circles of 10 kilometres in radius centered on points on the surface of the earth above the points of emplacement of the explosives in order to confirm that the local circumstances are consistent with the stated peaceful purposes;

(2) to the locations of the components of the electrical equipment for yield determination to be used for recording data when, by agreement between the Parties, such equipment is located outside the area described in subparagraph 1 (b) (1) of this article; and

(3) to the sites of emplacement of the equipment of the local seismic network provided for in paragraph 7 of Article IV.

2. The Party carrying out the explosion shall notify the other Party of the procedure it has chosen from among those specified in subparagraph 2 (b) (3) of Article III not later than 30 days before beginning the implementation of such procedure. Designated personnel shall have the right to be present at the site of the explosion to exercise their rights and functions in the areas and at the locations described in paragraph 1 of this article for a period of time beginning two days before the beginning of the implementation of the procedure and continuing for a period of three days after the completion of this procedure.

3. Except as specified in paragraph 4 of this article, designated personnel shall have the right to be present in the areas and at the locations described in paragraph 1 of this article:

(a) for an explosion with a planned aggregate yield exceeding 100 kilotons but not exceeding 150 kilotons, in accordance with paragraph 2 of Article III, at any time beginning five days before the beginning of emplacement of the explosives and continuing after the explosion and after safe access to evacuated areas has been established according to standards determined by the Party carrying out the explosion for a period of two days; and

(b) for any explosion with a planned aggregate yield exceeding 150 kilotons, at any time beginning 20 days before the beginning of emplacement of the explosives and continuing after the explosion and after safe access to evacuated areas has been established according to standards determined by the Party carrying out the explosion for a period of:

(1) five days in the case of an explosion with a planned aggregate yield exceeding 150 kilotons but not exceeding 500 kilotons; or

(2) eight days in the case of an explosion with a planned aggregate yield exceeding 500 kilotons.

4. Designated personnel shall not have the right to be present in those areas from which all personnel have been evacuated in connexion with carrying out an explosion, but shall have the right to re-enter those areas at the same time as personnel of the Party carrying out the explosion.

5. Designated personnel shall not have or seek access by physical, visual, or technical means to the interior of the canister containing an explosive, to documentary or other information descriptive of the design of an explosive nor to

equipment for control and firing of explosives. The Party carrying out the explosion shall not locate documentary or other information descriptive of the design of an explosive in such ways as to impede the designated personnel in the exercise of their rights and functions.

6. The number of designated personnel present at the site of an explosion shall not exceed:

(a) for the exercise of their rights and functions in connexion with the confirmation of the geological and geophysical information in accordance with the provisions of sub-paragraph 2 (b) and applicable provisions of paragraph 5 of Article III—the number of emplacement holes plus three;

(b) for the exercise of their rights and functions in connexion with confirming that the local circumstances are consistent with the information provided and with the stated peaceful purposes in accordance with the provisions in sub-paragraphs 2 (a), 2 (c), 2 (d) and 2 (e) and applicable provisions of paragraph 5 of Article III—the number of explosives plus two;

(c) for the exercise of their rights and functions in connexion with confirming that the local circumstances are consistent with the information provided and with the stated peaceful purposes in accordance with the provisions in sub-paragraphs 2 (a), 2 (c), 2 (d) and 2 (e) and applicable provisions of paragraph 5 of Article III and in connexion with the use of electrical equipment for determination of the yield in accordance with paragraph 3 of Article III—the number of explosives plus seven; and

(d) for the exercise of their rights and functions in connexion with confirming that the local circumstances are consistent with the information provided and with the stated peaceful purposes in accordance with the provisions in sub-paragraphs 2 (a), 2 (c), 2 (d) and 2 (e) and applicable provisions of paragraph 5 of Article III and in connexion with the use of electrical equipment for determination of the yield in accordance with paragraph 3 of Article III and with the use of the local seismic network in accordance with paragraph 4 of Article III—the number of explosives plus 10.

7. The Party carrying out the explosion shall have the right to assign its personnel to accompany designated personnel while the latter exercise their rights and functions.

8. The Party carrying out an explosion shall assure for designated personnel telecommunications with their authorities, transportation and other services appropriate to their presence and to the exercise of their rights and functions at the site of the explosion.

9. The expenses incurred for the transportation of designated personnel and their equipment to and from the site of the explosion, telecommunications provided for in paragraph 8 of this article, their living and working quarters, subsistence and all other personal expenses shall be the responsibility of the Party other than the Party carrying out the explosion.

10. Designated personnel shall consult with the Party carrying out the explosion in order to co-ordinate the planned programme and schedule of activities of designated personnel with the programme of the Party carrying out the explosion for the conduct of the project so as to ensure that designated personnel are able to conduct their activities in an orderly and timely way that is compatible with the implementation of the project. Procedures for such consultations shall be established in accordance with Article X.

ARTICLE VI

For any explosion with a planned aggregate yield exceeding 150 kilotons, determination of the yield of each explosive used shall be carried out in accordance with the following provisions:

1. Determination of the yield of each individual explosion in the group shall be based on measurements of the velocity of propagation, as a function of time, of the hydrodynamic shock wave generated by the explosion, taken by means of electrical equipment described in paragraph 3 of Article IV.

2. The Party carrying out the explosion shall provide the other Party with the following information:

(a) not later than 60 days before the beginning of emplacement of the explosives, the length of each canister in which the explosive will be contained in the corresponding emplacement hold, the dimensions of the tube or other device used to emplace the canister and the cross-sectional dimensions of the emplacement hole to a distance, in metres, from the emplacement point of 10 times the cube root of its yield in kilotons;

(b) not later than 60 days before the beginning of emplacement of the explosives, a description of materials, including their densities, to be used to stem each emplacement hole; and

(c) not later than 30 days before the beginning of emplacement of the explosives, for each emplacement hole of a group explosion, the local co-ordinates of the point of emplacement of the explosive, the entrance of the emplacement hole, the point of the emplacement hole most distant from the entrance, the location of the emplacement hole at each 200 metres distance from the entrance and the configuration of any known voids larger than one cubic metre located within the distance, in metres, of 10 times the cube root of the planned yield in kilotons measured from the bottom of the canister containing the explosive. The error in these co-ordinates shall not exceed 1 per cent of the distance between the emplacement hole and the nearest other emplacement hole or 1 per cent of the distance between the point of measurement and the entrance of the emplacement hole, whichever is smaller, but in no case shall the error be required to be less than one metre.

3. The Party carrying out the explosion shall emplace for each explosive that portion of the electrical equipment for yield determination described in sub-paragraph 3 (a) of Article IV, supplied in accordance with paragraph 1 of Article IV, in the same emplacement hole as the explosive in accordance with the installation instructions supplied under the provisions of paragraph 5 or 6 of Article IV. Such emplacement shall be carried out under the observation of designated personnel. Other equipment specified in sub-paragraph 3 (b) of Article IV shall be emplaced and installed:

(a) by designated personnel under the observation and with the assistance of personnel of the Party carrying out the explosion, if such assistance is requested by designated personnel; or

(b) in accordance with paragraph 5 of Article IV.

4. That portion of the electrical equipment for yield determination described in sub-paragraph 3 (a) of Article IV that is to be emplaced in each emplacement hole shall be located so that the end of the electrical equipment which is farthest from the entrance to the emplacement hole is at a distance, in metres, from the bottom of the canister containing the explosive equal to 3.5 times the cube root of the planned yield in kilotons of the explosive when the planned yield is less than 20 kilotons and three times the cube root of the planned yield in kilotons of the explosive when the

planned yield is 20 kilotons or more. Canisters longer than 10 metres containing the explosive shall only be utilized if there is prior agreement between the Parties establishing provisions for their use. The Party carrying out the explosion shall provide the other Party with data on the distribution of density inside any other canister in the emplacement hole with a transverse cross-sectional area exceeding 10 square centimetres located within a distance, in metres, of 10 times the cube root of the planned yield in kilotons of the explosion from the bottom of the canister containing the explosive. The Party carrying out the explosion shall provide the other Party with access to confirm such data on density distribution within any such canister.

5. The Party carrying out an explosion shall fill each emplacement hole, including all pipes and tubes contained therein which have at any transverse section an aggregate cross-sectional area exceeding 10 square centimetres in the region containing the electrical equipment for yield determination and to a distance, in metres, of six times the cube root of the planned yield in kilotons of the explosive from the explosive emplacement point, with material having a density not less than seven-tenths of the average density of the surrounding rock, and from that point to a distance of not less than 60 metres from the explosive emplacement point with material having a density greater than one gram per cubic centimetre.

6. Designated personnel shall have the right to:

(a) confirm information provided in accordance with sub-paragraph 2(a) of this article;

(b) confirm information provided in accordance with sub-paragraph 2(b) of this article and be provided, upon request, with a sample of each batch of stemming material as that material is put into the emplacement hole; and

(c) confirm the information provided in accordance with sub-paragraph 2(c) of this article by having access to the data acquired and by observing, upon their request, the making of measurements.

7. For those explosives which are emplaced in separate emplacement holes, the emplacement shall be such that the distance D, in metres, between any explosive and any portion of the electrical equipment for determination of the yield of any other explosive in the group shall be not less than 10 times the cube root of the planned yield in kilotons of the larger explosive of such a pair of explosives. Individual explosions shall be separated by time intervals, in milliseconds, not greater than one-sixth the amount by which the distance D, in metres, exceeds 10 times the cube root of the planned yield in kilotons of the larger explosive of such a pair of explosives.

8. For those explosives in a group which are emplaced in a common emplacement hole, the distance, in metres, between each explosive and any other explosive in that emplacement hole shall be not less than 10 times the cube root of the planned yield in kilotons of the larger explosive of such a pair of explosives, and the explosives shall be detonated in sequential order, beginning with the explosive farthest from the entrance to the emplacement hole, with the individual detonations separated by time intervals, in milliseconds, of not less than one times the cube root of the planned yield in kilotons of the largest explosive in this emplacement hole.

ARTICLE VII

1. Designated personnel with their personal baggage and their equipment as provided in Article IV shall be permitted to enter the territory of the Party carrying out the explosion at an entry port to be agreed upon by the Parties, to remain in the

territory of the Party carrying out the explosion for the purpose of fulfilling their rights and functions provided for in the Treaty and this Protocol, and to depart from an exit port to be agreed upon by the Parties.

2. At all times while designated personnel are in the territory of the Party carrying out the explosion, their persons, property, personal baggage, archives and documents as well as their temporary official and living quarters shall be accorded the same privileges and immunities as provided in Articles 22, 23, 24, 29, 30, 31, 34 and 36 of the Vienna Convention on Diplomatic Relations of 1961 to the persons, property, personal baggage, archives and documents of diplomatic agents as well as to the premises of diplomatic missions and private residences of diplomatic agents.

3. Without prejudice to their privileges and immunities it shall be the duty of designated personnel to respect the laws and regulations of the State in whose territory the explosion is to be carried out insofar as they do not impede in any way whatsoever the proper exercising of their rights and functions provided for by the Treaty and this Protocol.

ARTICLE VIII

The Party carrying out an explosion shall have sole and exclusive control over and full responsibility for the conduct of the explosion.

ARTICLE IX

1. Nothing in the Treaty and this Protocol shall affect proprietary rights in information made available under the Treaty and this Protocol and in information which may be disclosed in preparation for and carrying out of explosions; however, claims to such proprietary rights shall not impede implementation of the provisions of the Treaty and this Protocol.

2. Public release of the information provided in accordance with Article II or publication of material using such information, as well as public release of the results of observation and measurements obtained by designated personnel, may take place only by agreement with the Party carrying out an explosion; however, the other Party shall have the right to issue statements after the explosion that do not divulge information in which the Party carrying out the explosion has rights which are referred to in paragraph 1 of this article.

ARTICLE X

The Joint Consultative Commission shall establish procedures through which the Parties will, as appropriate, consult with each other for the purpose of ensuring efficient implementation of this Protocol.

Done at Washington and Moscow, on 28 May 1976.

For the United States of America:

The President of the United States of America

For the Union of Soviet Socialist Republics:

General Secretary of the Central Committee of the CPSU

Agreed statement

The Parties to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on Underground Nuclear Explosions for Peaceful Purposes, hereinafter referred to as the Treaty, agree that under sub-paragraph 2 (c) of Article III of the Treaty:

(a) Development testing of nuclear explosives does not constitute a "peaceful application" and any such development tests shall be carried out only within the boundaries of nuclear weapon test sites specified in accordance with the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Underground Nuclear Weapon Tests;

(b) Associating test facilities, instrumentation or procedures related only to testing of nuclear weapons or their effects with any explosion carried out in accordance with the Treaty does not constitute a "peaceful application".

Appendix 8C

Agreement between France and the Union of Soviet Socialist Republics on the prevention of accidental or unauthorized use of nuclear weapons

LETTER DATED 16 JULY 1976 FROM THE MINISTER FOR FOREIGN AFFAIRS OF THE UNION OF SOVIET SOCIALIST REPUBLICS, MR ANDREI GROMYKO, ADDRESSED TO THE MINISTER FOR FOREIGN AFFAIRS OF FRANCE, MR JEAN SAUVAGNARGUES

As a result of our conversation of 28 April 1976, we considered it desirable to reaffirm the importance attached in the USSR and in France to the prevention of the accidental or unauthorized use of nuclear weapons. Such an initiative is in keeping with the special responsibilities incumbent on the Soviet Union and France as nuclear Powers.

Having regard to the views exchanged concerning measures to avoid any risk of such accidental or unauthorized use, it was agreed that the following provisions should be adopted:

1. Each Party undertakes to maintain and, possibly, improve, as it deems necessary, its existing organizational and technical arrangements to prevent the accidental or unauthorized use of nuclear weapons under its control.

2. The two Parties undertake to notify each other immediately of any accidental occurrence or any other unexplained incident that could lead to the explosion of one of their nuclear weapons and could be construed as likely to have harmful effects on the other Party.

3. In the event of an unexplained nuclear incident, each Party undertakes to act in such a manner as to avoid, as far as possible, the possibility of its actions being misinterpreted by the other Party. In any such situation, each Party may inform the other Party or request such information as it considers necessary.

4. For transmission of urgent information in situations requiring prompt clarification, the Parties shall make primary use of the Direct Communications Link between the Kremlin and the Elysée Palace.

5. The two Parties shall consider together the possibility of further improving, by mutual agreement, their means of direct communication.

If the above points meet with your approval, I have the honour to propose that this letter and your reply should constitute an agreement between the Soviet Union and France.

This agreement shall enter into force on today's date.

(*Signed*) Andrei GROMYKO
Minister for Foreign Affairs of the USSR

LETTER DATED 16 JULY 1976 FROM THE MINISTER FOR FOREIGN AFFAIRS OF FRANCE, MR JEAN SAUVAGNARGUES, ADDRESSED TO THE MINISTER FOR FOREIGN AFFAIRS OF THE UNION OF SOVIET SOCIALIST REPUBLICS, MR ANDREI GROMYKO

As a result of our conversation of 28 April 1976, we considered it desirable to reaffirm the importance attached in France and the USSR to the prevention of the accidental or unauthorized use of nuclear weapons. Such an initiative is in keeping with the special responsibilities incumbent upon France and the Soviet Union as nuclear Powers.

Having regard to the views exchanged concerning measures to prevent any risk of such accidental or unauthorized use, it was agreed that the following provisions should be adopted:

1. Each Party shall undertake to maintain and, possibly, improve, as it deems necessary, its existing organizational and technical arrangements to prevent the accidental or unauthorized use of nuclear weapons under its control.

2. The two Parties undertake to notify each other immediately of any accidental occurrence or any other unexplained incident that could lead to the explosion of one of their nuclear weapons and could be construed as likely to have harmful effects on the other Party.

3. In the event of an unexplained nuclear incident, each Party undertakes to act in such a manner as to avoid, as far as possible, the possibility of its actions being misinterpreted by the other Party. In any such situation, each Party may inform the other Party or request such information as it considers necessary.

4. For transmission of urgent information in situations requiring prompt clarification, the Parties shall make primary use of the Direct Communications Link existing between the Elysée Palace and the Kremlin.

5. The two Parties shall consider together the possibility of further improving, by mutual agreement, their means of direct communication.

If the foregoing points meet with your approval, I have the honour to propose that this letter and your reply should constitute an agreement between France and the Soviet Union.

This agreement shall enter into force on today's date.

(*Signed*) Jean SAUVAGNARGUES
Minister for Foreign Affairs of France.

Appendix 8D

Announced and presumed nuclear explosions in 1975–76

Note:

1. The following sources have been used in compiling the list:
(*a*) US Geological Survey,
(*b*) US Energy Research and Development Administration (ERDA),
(*c*) Research Institute of the Swedish National Defence,
(*d*) Press reports.

2. The event marked with an asterisk * may be part of a programme for peaceful uses of nuclear explosions in view of its location outside the usual weapon testing sites.

3. m_b (body wave magnitudes), M_s (surface wave magnitudes) indicate the size of the event; the data have been provided by the Hagfors Observatory of the Research Institute of the Swedish National Defence.

4. The yields of US and British explosions are based on ERDA announcements, the yields of Soviet explosions on estimates of the Hagfors Observatory, and the yields of Chinese explosions on ERDA announcements and press reports.

5. In the case of very weak events, it is impossible to distinguish, through seismological methods alone, between chemical and nuclear explosions.

I. Revised list of nuclear explosions in 1975[a]

Date *GMT*	Latitude *deg*	Longitude *deg*	Region	m_b	M_s	Yield *kt*
USA						
28 Feb	37.106 N	116.056 W	S Nevada	6.0	4.3	20–200
7 Mar	37.134 N	116.084 W	S Nevada	5.6		20–200
5 Apr	37.188 N	116.214 W	S Nevada	5.0		<20
24 Apr	37.116 N	116.087 W	S Nevada			20–200
30 Apr	37.109 N	116.029 W	S Nevada	5.4		20–200
14 May	37.221 N	116.474 W	S Nevada	6.3	4.7	200–1 000
3 Jun	37.340 N	116.523 W	S Nevada	6.1	4.5	20–200
3 Jun	37.095 N	116.036 W	S Nevada	5.9	4.2	20–200
19 Jun	37.350 N	116.320 W	S Nevada	6.3	5.0	200–1 000
26 Jun	37.279 N	116.369 W	S Nevada	6.5	5.2	200–1 000
6 Sep	37.024 N	116.028 W	S Nevada			<20
24 Oct	37.222 N	116.179 W	S Nevada	5.1		<20
28 Oct	37.290 N	116.411 W	S Nevada	6.4	5.3	200–1 000
20 Nov	37.225 N	116.368 W	S Nevada	6.4	4.6	200–1 000
26 Nov	37.117 N	116.019 W	S Nevada			<20
20 Dec	37.128 N	116.062 W	S Nevada	5.9		20–200
USSR						
20 Feb	49.820 N	78.078 E	E Kazakh	6.1		
11 Mar	49.787 N	78.251 E	E Kazakh	5.9		
25 Apr	47.5 N	47.5 E	W Russia*	4.9		
27 Apr	49.990 N	78.984 E	E Kazakh	6.7	3.9	
8 Jun	49.764 N	78.089 E	E Kazakh	6.0	3.6	
30 Jun	50.000 N	78.999 E	E Kazakh	5.9		
7 Aug	49.813 N	78.240 E	E Kazakh	5.4		20–200
23 Aug	73.369 N	54.641 E	Novaya Zemlya		5.4	Multimegaton
29 Sep	69.592 N	90.396 E	Central Siberia*	4.4		
5 Oct			E Kazakh	4.6		
18 Oct	70.843 N	53.690 E	Novaya Zemlya		5.2	
21 Oct	73.351 N	55.078 E	Novaya Zemlya		5.3	Multimegaton
29 Oct	49.984 N	78.975 E	E Kazakh	6.7	3.6	20–200
13 Dec	49.798 N	78.196 E	E Kazakh	5.2		
25 Dec	50.043 N	78.899 E	E Kazakh	6.9		20–200
France						
5 Jun			Fangataufa			
26 Nov			Fangataufa			
China						
27 Oct	41 N	88 E	Lop Nor	5.0		<20

[a] A preliminary list of nuclear explosions in 1975 was published in the *SIPRI Yearbook 1976*, pp. 414–15.

II. Preliminary list of nuclear explosions in 1976

Date *GMT*	Latitude *deg*	Longitude *deg*	Region	m_b	M_s	Yield *kt*
USA						
3 Jan	37.297 N	116.333 W	S Nevada	6.4	5.5	200–1 000
4 Feb	37.069 N	116.030 W	S Nevada	6.0		20–200
4 Feb	37.107 N	116.037 W	S Nevada	5.9		20–200
12 Feb	37.271 N	116.488 W	S Nevada	6.4	5.4	200–1 000
14 Feb	37.243 N	116.420 W	S Nevada	6.2	4.9	200–500
9 Mar	37.310 N	116.364 W	S Nevada	6.0	5.0	200–500
14 Mar	37.306 N	116.471 W	S Nevada	6.5	5.3	500–1 000
17 Mar	37.258 N	116.312 W	S Nevada	6.3	4.6	200–500
17 Mar	37.107 N	116.052 W	S Nevada	6.1	4.5	200–500
12 May	37.209 N	116.212 W	S Nevada	5.1		<20
27 Jul	37 N	116 W	S Nevada	5.7		20–150
23 Nov	37 N	116 W	S Nevada			<20
8 Dec	37 N	116 W	S Nevada			<20
21 Dec	37 N	116 W	S Nevada			<20
28 Dec	37 N	116 W	S Nevada	5.8		20–150
USSR						
15 Jan	49.870 N	78.246 E	E Kazakh	5.5		<20
21 Apr	49.818 N	78.198 E	E Kazakh	5.4		<20
21 Apr	49.932 N	78.824 E	E Kazakh	6.4		20–150
19 May	49.856 N	78.007 E	E Kazakh	5.2		<20
9 Jun	50.023 N	79.080 E	E Kazakh	5.9		20–150
4 Jul	49.915 N	78.952 E	E Kazakh	7.0	4.2	20–150
23 Jul	49.791 N	78.051 E	E Kazakh	5.4		<20
29 Jul	47.782 N	48.120 E	W Kazakh*	6.4	4.2	20–150
4 Aug	50 N	78 E	E Kazakh	4.1		<20
28 Aug	50 N	79 E	E Kazakh	6.8	3.5	20–150
29 Sep	73 N	55 E	Novaya Zemlya	6.5	3.8	20–150
20 Oct	73 N	55 E	Novaya Zemlya	5.7	3.4	20–150
30 Oct	50 N	78 E	E Kazakh	4.5		<20
23 Nov	50 N	79 E	E Kazakh	6.7		20–150
7 Dec	50 N	78 E	E Kazakh	7.1		20–150
30 Dec	50 N	78 E	E Kazakh	5.5		<20
United Kingdom						
26 Aug	37.125 N	116.082 W	S Nevada	5.5		20–150
France						
2 Apr			Mururoa			
11 Jul	22.673 S	138.607 W	Mururoa			
23 Jul			Mururoa			
8 Dec			Mururoa			
China						
23 Jan	41 N	89 E	Lop Nor			<20 (in atmosphere)
26 Sep	41 N	89 E	Lop Nor			20–200 (in atmosphere)
17 Oct	41 N	89 E	Lop Nor	5.1		
17 Nov	41 N	89 E	Lop Nor	4.7	5.1	3 000–4 000 (in atmosphere)

Appendix 8E

Nuclear explosions, 1945–76 (known and presumed)

I. 16 July 1945 – 5 August 1963 (the signing of the Partial Test Ban Treaty)

USA	USSR	UK	France	Total
293	164	23	8	**488**

II. 5 August 1963 – 31 December 1976

a atmospheric
u underground

	USA		USSR		UK		France		China		India		
Year	a	u	a	u	a	u	a	u	a	u	a	u	Total
5 Aug 1963 – 31 Dec 1963	0	14	0	0	0	0	0	1					**15**
1964	0	28	0	6	0	1	0	3	1	0			**39**
1965	0	29	0	9	0	1	0	4	1	0			**44**
1966	0	40	0	15	0	0	5	1	3	0			**64**
1967	0	29	0	15	0	0	3	0	2	0			**49**
1968	0	39[a]	0	13	0	0	5	0	1	0			**58**
1969	0	28	0	15	0	0	0	0	1	1			**45**
1970	0	33	0	12	0	0	8	0	1	0			**54**
1971	0	15	0	19	0	0	5	0	1	0			**40**
1972	0	15	0	22	0	0	3	0	2	0			**42**
1973	0	11	0	14	0	0	5	0	1	0			**31**
1974	0	9	0	19	0	1	7	0	1	0	0	1	**38**
1975	0	16	0	15	0	0	0	2	0	1	0	0	**34**
1976	0	15	0	16	0	1	0	4	3	1	0	0	**40**[b]
Total	**0**	**321**	**0**	**190**	**0**	**4**	**41**	**15**	**18**	**3**	**0**	**1**	**593**

III. 16 July 1945 – 31 December 1976

USA	USSR	UK	France	China	India	Total
614	**354**	**27**	**64**	**21**	**1**	**1 081**

[a] Five devices used simultaneously in the same test (Buggy) are counted here as one.
[b] The data for 1976 are preliminary.

Appendix 8F

Notifications of military manoeuvres in Europe, January 1976–February 1977, in implementation of the Final Act of the Conference on Security and Cooperation in Europe

(For the list of notifications in 1975, see *SIPRI Yearbook 1976*, pp. 476–77.)

State giving notification	Date of notification	Duration of manoeuvre	Designation of manoeuvre	Number of troops involved	Area of manoeuvre
USSR	4 Jan 1976	25 Jan–6 Feb 1976	Kavkaz[a]	~25 000	Region of Kutaisi, Yerevan and Tbilisi
Norway	3 Feb 1976	10–15 Mar 1976	Atlas Express[b]	~17 000	North Norway
Hungary	5 Apr 1976	6–9 Apr 1976	. .	~12 000	. .
USSR	24 May 1976	14–18 Jun 1976	Sever[c]	~25 000	Leningrad military district–Petrozavodsk, Sestroretsk, Vyborg
Federal Republic of Germany	16 Aug 1976	6–10 Sep 1976	Grosser Bär[d]	~50 000	Papenburg–Oldenburg–Bremen–Uelzen–Gifhorn–Hildesheim–Paderborn–Coesfeld–Rheine–Lingen–Meppen
United States	16 Aug 1976	6–10 Sep 1976	Grosser Bär[d]	~50 000	Federal Republic of Germany
Federal Republic of Germany	16 Aug 1976	7–11 Sep 1976	Gordian Shield[e]	~30 000	Hessen
United States	16 Aug 1976	7–11 Sep 1976	Gordian Shield[e]	~30 000	Federal Republic of Germany
Yugoslavia	17 Aug 1976	20–23 Sep 1976	Golija-76[f]	24 000	Southwest Socialist Republic of Serbia
Poland	19 Aug 1976	9–16 Sep 1976	Tarcza-76[g]	~35 000	Bydgoszcz–Szczecin–Wrocław
Federal Republic of Germany	23 Aug 1976	13–17 Sep 1976	Lares Team[h]	~44 000	Bavaria and Baden-Württemberg
United States	23 Aug 1976	13–17 Sep 1976	Lares Team[h]	~44 000	Federal Republic of Germany
Canada	23 Aug 1976	13–17 Sep 1976	Lares Team[h]	~44 000	Federal Republic of Germany
Norway	31 Aug 1976	20–24 Sep 1976	Team Work[i]	13 500	North Tröndelag, Central Norway
Denmark	17 Sep 1976	11–18 Oct 1976	Bonded Item[j, k]	~ 8 000	West Jutland
Federal Republic of Germany	20 Sep 1976	17–21 Oct 1976	Bonded Item[j, l]	~ 9 000	Schleswig-Holstein: Flensburg–Förde and the Baltic coast to Eckernförde-Schleswig
United States	20 Sep 1976	11–21 Oct 1976	Bonded Item[j, m]	~11 000	Denmark and Federal Republic of Germany

United Kingdom	12 Oct 1976	2–11 Nov 1976	Spearpoint[n]	~18 000	Northwest Germany: Detmold, Hameln and Hildesheim
Hungary	18 Oct 1976	18–23 Oct 1976	. .[o]	15 000	Hungary
Sweden	3 Feb 1977	5–9 Mar 1977	. .[p]	~10 000	Lower Norrland in the vicinity of Östersund

[a] Purpose of the manoeuvre: cooperation of different types of forces under winter conditions. Command level: army corps.

Participating units: ground forces, including airborne detachments, as well as air force units.

Foreign observers were invited to attend.

[b] This was a multinational combined manoeuvre with the participation of Allied Command Europe Mobile Forces land and air components, AMF (L and A).

Purpose of the manoeuvre: to exercise the deployment of AMF to North Norway and alongside Norwegian forces under winter conditions. Command level: Commander Allied Forces North Norway.

Participating units: Brigade North, Regimental Combat Team No. 15, AMF (L) and, in addition, one commando group UK Royal Marines and one company Royal NL Marine Commando; AMF (A) and, in addition, air force units from Norway, the USA, the UK, Canada, the Netherlands, the Federal Republic of Germany and Italy, and minor Norwegian naval forces.

Foreign forces were to start deployment into the manoeuvre area on 2 March and return to their duty stations on 23 March 1976.

[c] Purpose of the manoeuvre: cooperation of different types of forces.

Participating units: army and air force.

Foreign observers were invited to attend.

[d] This manoeuvre took place in the context of "Autumn Forge", a series of national and multinational field training and command post manoeuvres conducted by members of NATO.

Purpose of the manoeuvre: to exercise ground forces supported by air forces. Command level: First Corps.

Participating units: 41st Netherlands Brigade, 103rd Netherlands Reconnaissance Battalion, one FRG corps, one US brigade, 7th UK Brigade.

Absence from garrisons: 1–14 September 1976.

Foreign observers were invited to attend.

[e] This manoeuvre took place in the context of "Autumn Forge", a series of national and multinational field training and command post manoeuvres conducted by members of NATO, and included US troops transported to Europe in the "Reforger" movement.

Purpose of the manoeuvre: to exercise sea and air strategic deployment and test unique capabilities of air assault division in the European environment.

Participating units: elements of 5th US Corps, 101st US Airborne Division, 13th FRG Mechanized Infantry Brigade and Belgian forces.

[f] Participating units: one infantry division with air support and smaller units of the territorial defence.

Absence from garrisons: one to three days before the beginning of the manoeuvre—one day after the end of the manoeuvre.

Foreign observers were invited to attend.

[g] In addition to Polish troops, units from the USSR, the German Democratic Republic and Czechoslovakia took part. Command level: Polish Minister of National Defence.

Foreign observers were invited to attend.

[h] This manoeuvre took place in the context of "Autumn Forge", a series of national and multinational field training and command post manoeuvres conducted by members of NATO, and included US troops transported to Europe in the "Reforger" movement.

Purpose of the manoeuvre: to exercise sea and air strategic deployment and test unique capabilities of air assault division in the European environment.

Participating units: elements of the 7th Corps and 101st US Airborne Division; FRG armoured brigade; elements of 4th Canadian Mechanized Brigade Group and elements of the Canadian Air Group in Europe.

Foreign observers were invited to attend.

[i] This exercise was part of the larger NATO "Team Work" manoeuvre which took place from 10 to 24 September 1976.

Purpose of the manoeuvre: routine training of procedures related to NATO supporting forces. Command level: regional commander of South Norway.

Participating units: Regimental Combat Team No. 13 (reinforced), one

US Marine amphibious brigade, one UK parachute brigade, one UK commando brigade, including one company of Netherlands Marines, supported by US, UK and FRG naval and air forces.

Foreign observers were invited to attend.

[j] This manoeuvre took place in the context of "Autumn Forge", a series of national and multinational field training and command post manoeuvres conducted by members of NATO. It was held in two phases: one in Denmark and one in the Federal Republic of Germany.

[k] Purpose of the manoeuvre: reinforcement operations at brigade level. Command level: Allied Command Baltic Approaches.

Participating units: ground, air, naval and amphibious forces. Major units —3rd Jutland Brigade and 4th US Marine Amphibious Brigade.

[l] Purpose of the manoeuvre: exercise with opposing forces, with support of air forces; reinforcement training; operations at brigade level. Command level: 6th FRG Armoured Infantry Division.

Participating units: headquarters and elements of 6th FRG Armoured Infantry Division, elements of 18th FRG Armoured Infantry Brigade, elements of territorial command Schleswig-Holstein, one US amphibious brigade.

Absence from garrisons: 16–25 October 1976.

[m] Purpose of the manoeuvre: field training with opposing forces, including reinforcement training.

Major participating units: headquarters and elements of 6th FRG Armoured Infantry Division, 18th FRG Armoured Infantry Brigade, one US amphibious brigade, Danish 3rd Jutland Brigade.

[n] This manoeuvre took place in the context of "Autumn Forge", a series of national and multinational field training and command post manoeuvres conducted by members of NATO.

Purpose of the manoeuvre: annual corps field training exercise.

Major participating units: 2nd UK Armoured Division, 4th UK Division, 4th US Mechanized Brigade and two Danish battalions.

Foreign observers were invited to attend.

[o] This manoeuvre took place within the framework of the annual training plans.

Participating units: formations of the Hungarian People's Army with units of the Soviet troops stationed in Hungary.

[p] This manoeuvre was part of the basic military training and the periodical refresher courses for conscript personnel.

Purpose of the manoeuvre: coordinated training of brigade and battalion functions under winter conditions. Command level: Lower Norrland Military Command.

Participating units: Army and Air Force.

Foreign observers were invited to attend.

Appendix 8G

Working papers and other documents relating to a comprehensive nuclear test ban, presented in 1976 at the Conference of the Committee on Disarmament (CCD)

1.	26 March 1976	Sweden: The Test Ban Issue (CCD/481)
2.	26 March 1976	Sweden: Working Paper on co-operative international measures to monitor a CTB (CCD/482)
3.	9 April 1976	Norway: Working Paper on some new results in seismic discrimination (CCD/484)
4.	12 April 1976	United Kingdom: Working Paper on the United Kingdom's contribution to research on seismological problems relating to underground nuclear tests (CCD/486 and Corr. 1)
5.	12 April 1976	United Kingdom: Working Paper on the processing and communication of seismic data to provide for national means of verifying a test ban (CCD/487 and Corr. 1)
6.	12 April 1976	United Kingdom: Working Paper on the recording and processing of P waves to provide seismograms suitable for discriminating between earthquakes and underground explosions (CCD/488)
7.	13 April 1976	Japan: Working Paper on the estimation of focal depth by pP and sP phases (CCD/489)
8.	20 April 1976	Canada: The verification of a comprehensive test ban by seismological means (CCD/490)
9.	20 April 1976	United States: Current status of research in seismic verification (CCD/491)
10.	21 April 1976	United Kingdom: Text of a statement on a comprehensive test ban made by Mr Fakley at an informal meeting of the CCD on 20 April 1976 (CCD/492)
11.	26 April 1976	Japan: Working Paper containing statement by Dr Shigeji Suyehiro at the informal meetings with participation of experts on a Comprehensive Test Ban on 20 April 1976 (CCD/493)
12.	24 June 1976	Sweden: Terms of reference for a group of scientific governmental experts to consider international co-operative measures to detect and identify seismic events (CCD/495)

13.	28 July 1976	Finland: Working Paper on Finnish capabilities of seismological detection of underground nuclear explosions (CCD/509)
14.	6 August 1976	First Progress Report by the *Ad Hoc* group of scientific experts to consider international co-operative measures to detect and to identify seismic events (CCD/513)

Appendix 8H

Working papers and other documents relating to the prohibition of chemical weapons, presented in 1976 at the Conference of the Committee on Disarmament (CCD)

1.	8 April 1976	Japan: Working Paper on the question of chemical-warfare agents to be prohibited by the convention on the prohibition of chemical weapons (CCD/483)
2.	9 April 1976	Sweden: Working Paper on some aspects of on-site verification of the destruction of stockpiles of chemical weapons (CCD/485)
3.	29 June 1976	United States: Verification of destruction of declared stocks of chemical-warfare agents (CCD/497)
4.	29 June 1976	United States: The use of seals and monitoring devices in CW verification; Fibre optic seals; Cameras; Tamper indicating containers; Future developments (CCD/498)
5.	29 June 1976	United States: Review of proposals for defining chemical-warfare agents in a CW agreement (CCD/499)
6.	2 July 1976	Finland: Working Paper on the methodology for chemical identification of CW agents and related compounds. Progress of a Finnish research project (CCD/501)
7.	2 July 1976	United Kingdom: Working Paper on the feasibility of extraterritorial surveillance of chemical weapon tests by air monitoring at the border (CCD/502 and Corr. 1)
8.	5 July 1976	Yugoslavia: Medical protection against nerve gases poisoning (Present situation and future possibilities) (CCD/503)
9.	5 July 1976	Yugoslavia: A method of categorization of chemical compounds regarding binary technology (CCD/504)
10.	5 July 1976	Yugoslavia: Working Paper on the definition of chemical-warfare agents (CCD/505)
11.	6 July 1976	German Democratic Republic: The catalytic detoxification of organophosphorus CW agents (CCD/506)

12.	8 July 1976	Czechoslovakia: Some medical aspects of the CW problem and its perspectives (CCD/508)
13.	17 August 1976	Japan: Working Paper: Draft of one form of LD 50 spectrum (CCD/515)

9. Chronology of major events concerning disarmament and related issues

January–December 1976

28 January–26 February The second session of the Conference of government experts on the use of certain conventional weapons takes place at Lugano, Switzerland, under the auspices of the International Committee of the Red Cross. The conference adopts a report containing proposals for the prohibition or restriction of the use of certain weapons.

19 February During the NATO-WTO negotiations on the mutual reduction of forces, which are being held in Vienna, the Warsaw Treaty countries propose that, in the first phase, Soviet and US troops in Central Europe be reduced by an equal percentage (2–3 per cent) of the total number of forces of both pacts in this area. Each side would also reduce 300 tanks, 54 aircraft, an equal number of tactical missile launchers, together with a certain number of nuclear warheads for these means of delivery, as well as 36 anti-aircraft missile launchers. All other states would reduce the number of their armed forces in Central Europe in the next phase, so that eventually all participants would have the strengths of their forces cut by an equal percentage.

24 February The report of the Central Committee of the Soviet Communist Party to the 25th Congress of the Party stresses the need for the completion of a new agreement between the USSR and the USA on the limitation and reduction of strategic weapons, as well as the conclusion of agreements on a comprehensive nuclear test ban, the prohibition and destruction of chemical weapons, the prohibition of the development of new types and systems of weapons of mass destruction and the prohibition of environmental modification for hostile purposes. It also calls for new efforts to intensify the negotiations on the reduction of armed forces and armaments in Central Europe, systematic reduction of military expenditure, and the convening of a world disarmament conference at the earliest possible date.

15 March–7 May The fourth session of the Third United Nations Conference on the Law of the Sea takes place in New York.

21 April–11 June The third session of the Diplomatic Conference on the reaffirmation and development of international humanitarian law applicable in armed conflicts takes place in Geneva.

12–15 May The Seventh Islamic Conference of Foreign Ministers takes place in Istanbul. The conference reiterates its call on the nuclear weapon states not to use or threaten to use nuclear weapons under any circumstances against non-nuclear states not covered by nuclear guarantees. It also calls for the early implementation of proposals for the establishment of nuclear weapon-free zones in Africa, the Middle East and South Asia, and for the creation of a zone of peace in the Indian Ocean.

13 May The candidate for the US Democratic presidential nomination, J. Carter, proposes a five-year US-Soviet agreement prohibiting all nuclear explosions, including those for peaceful development. He calls the US-Soviet treaty limiting the yield of underground nuclear explosions a wholly inadequate step.

20–21 May The North Atlantic Council meets in ministerial session in Oslo. The ministers express concern at the sustained growth in the Warsaw Treaty countries' military power. In examining the progress made in implementing the Final Act of the Conference on Security and Cooperation in Europe, the ministers note that a number of military manoeuvres in Europe have been notified and observers have been invited to some of them.

25 May The protocol to the US-Soviet Treaty on the limitation of anti-ballistic missile systems, signed on 3 July 1974, enters into force.

28 May The US-Soviet Treaty on underground nuclear explosions for peaceful purposes is signed in Moscow and Washington.

8 June Japan deposits the instrument of ratification of the Non-Proliferation Treaty in Moscow, London and Washington.

10 June At the Vienna negotiations on the mutual reduction of forces, the Warsaw Treaty countries, for the first time, reveal statistics on their military manpower in Central Europe.

10–11 June The NATO Defence Planning Committee meets in ministerial session in Brussels. The ministers take note of the substantial advances in size and effectiveness achieved during recent years in every sector of Soviet military capabilities, and consider the setting up of a NATO airborne early warning system.

14–15 June The NATO Nuclear Planning Group holds its meeting in Brussels. The participating defence ministers agree on the need to improve the effectiveness of NATO's theatre nuclear forces, including their survivability.

29–30 June A conference of 29 communist and workers' parties of Europe takes place in Berlin. In the final document of the conference the participants propose: an end to the arms race, particularly in nuclear armaments;

a reduction of military budgets, particularly of states possessing nuclear weapons and of others with a large military potential; an undertaking by all states to renounce the use of or the threat to use nuclear weapons; a ban on all nuclear weapon tests; the establishment of zones free of nuclear weapons; a prohibition of the production of nuclear weapons and the destruction of such weapons; the transformation of the Mediterranean into a "sea of peace", including withdrawal of nuclear-armed vessels, dismantling of all foreign military bases and withdrawal of all foreign fleets and troops; simultaneous dissolution of NATO and the Warsaw Treaty Organization, and, as a first step, disbandment of their military organizations.

16 July France and the USSR conclude an agreement (through an exchange of letters between the foreign ministers) on the prevention of an accidental or unauthorized use of nuclear weapons.

22 July The Conference of the Committee on Disarmament (CCD) decides to establish an *ad hoc* group of scientific experts to consider international cooperative measures to detect and identify seismic events.

4 August A communiqué issued in Canberra at the conclusion of the twenty-fifth ANZUS (Australia–New Zealand–United States Security Pact) Council meeting, reaffirms the dangers posed by the proliferation of nuclear explosives and weapons capabilities and the need to move against these dangers. It also endorses measures to strengthen the nuclear non-proliferation régime, including strengthened safeguards and controls on the export of nuclear equipment, materials and technology.

12 August The United Kingdom submits to the Conference of the Commitee on Disarmament a draft convention on the prohibition of the development, production and stockpiling of chemical weapons and on their destruction.

16–19 August The fifth conference of heads of state or government of non-aligned countries takes place in Colombo. The conference declares that the arms race is inconsistent with efforts aimed at achieving the new international economic order. It calls for the cessation of all nuclear weapon tests pending the conclusion of a test ban treaty, an unequivocal renunciation of the use or threat of use of nuclear weapons as well as chemical, bacteriological and other weapons of mass destruction, and the elimination of arsenals of all such weapons; the prohibition of conventional weapons of an indiscriminate or cruel nature, particularly the prohibition of the use of napalm and other incendiary weapons. The conference also recommends the holding of a special session of the UN General Assembly on disarmament, not later than 1978.

3 September In an annual report to the UN General Assembly, the CCD submits a draft convention on the prohibition of military or any other hostile use of environmental modification techniques.

6 September An agreement is signed in Vienna between the United Kingdom, the International Atomic Energy Agency (IAEA) and the European Atomic Energy Community (Euratom), providing for the submission of British non-military nuclear installations to international safeguards under IAEA supervision.

28 September The USSR submits to the UN General Assembly a memorandum which contains proposals for the cessation of the nuclear arms race, prohibition of nuclear weapon tests, strengthening of the nuclear non-proliferation régime, prohibition and destruction of chemical weapons, prohibition of new types of weapons of mass destruction, reduction of armed forces and conventional armaments, creation of zones of peace in the Indian Ocean and in other regions, as well as reduction of military budgets.

8 October In a treaty of friendship and cooperation signed in Moscow between Angola and the USSR, the parties undertake to develop cooperation in the military sphere. Each side declares that it will not participate in alliances directed against the other side.

11 October A communiqué issued by the French Council for foreign nuclear policy emphasizes the need to avoid commercial competition among nuclear suppliers that might encourage the spread of nuclear weapons.

14 October The US presidential candidate, J. Carter, says that the USA must move to secure agreement with the Soviet Union on a freeze on the number of atomic missiles and warheads, total throw-weight and qualitative weapon improvements, and then move towards step-by-step mutual reductions in the atomic arsenals, maintaining at all times rough equivalence in destructive power.

28 October The USA makes an announcement on its nuclear policy. It calls upon all nations to avoid exports of reprocessing and enrichment technology and facilities for a period of at least three years. It states that in its nuclear cooperation with non-nuclear weapon states, it will favour those which have adhered to the NPT, or are prepared to submit to full fuel cycle safeguards pending adherence; and that it will also favour those nations that are prepared to forgo or postpone the establishment of national reprocessing or enrichment activities and are willing to participate in an international storage régime under which spent reactor fuel and any separated plutonium would be placed pending use.

8 November The UN General Assembly invites states to examine a draft treaty on the non-use of force in international relations submitted by the USSR, as well as other proposals related to the conclusion of such a treaty.

18 November Speaking in the UN General Assembly, the US representative proposes the conclusion of an international agreement to ban the use of radioactive materials as radiological weapons.

18 November The NATO Nuclear Planning Group concludes its conference in London. The participating ministers stress the importance of maintaining the essential linkage between strategic nuclear, theatre nuclear and conventional forces, and especially the importance of strong conventional forces.

22 November The USSR submits to the UN General Assembly a new draft treaty on the complete and general prohibition of nuclear weapon tests.

25–26 November The Political Consultative Committee of the Warsaw Treaty holds its session in Bucharest. The meeting approves a draft treaty to be submitted to the participants in the Conference on Security and Cooperation in Europe, under which the parties would pledge themselves not to be the first to use nuclear weapons against each other. The Warsaw Treaty members urge all countries not to undertake any action that could lead to the expansion of existing military alliances or to the establishment of new ones.

7–8 December The NATO Defence Planning Committee meets in ministerial session in Brussels. The ministers note that the Soviet Union is currently estimated to be spending about 13 per cent of its GNP at factor cost for military purposes, and that this is a much higher level than obtains in NATO generally.

10 December The North Atlantic Council, meeting in ministerial session in Brussels, rejects the Warsaw Treaty proposals made on 26 November 1976 (see above). The participating ministers state that the countries of NATO, in the event of an attack on them, cannot renounce the use, as may be required for defence, of any of the means available to them, and that NATO will remain a free association open to all European states devoted to the defence of the freedom, common heritage and civilization of their peoples.

10 December The UN General Assembly condemns all nuclear weapon tests, in whatever environment they may be conducted; urges the CCD to adopt a comprehensive programme dealing with all aspects of the problem of the cessation of the arms race and general and complete disarmament; appeals to all states not to deliver to South Africa or place at its disposal any equipment or fissionable material or technology that will enable South Africa to acquire a nuclear weapon capability; refers the text of a convention on the prohibition of military or any other hostile use of environmental modification techniques, to all states for their consideration, signature and ratification, and requests the UN Secretary-General to open the convention for signature and ratification at the earliest possible date.

14 December The UN General Assembly invites the parties to the Conference on Security and Cooperation in Europe to implement fully all the provisions of the Final Act of the Conference, including those which relate to the Mediterranean, and to consider favourably the conversion of the Mediterranean into a zone of peace and cooperation.

16 December The French government announces that it will not authorize, until further notice, the signing of bilateral contracts dealing with the sale to third countries of industrial equipment for reprocessing irradiated fuel.

16 December At a press conference held in Vienna, the official spokesman for the Western side at the negotiations on the mutual reduction of forces in Central Europe, states that the Warsaw Treaty proposals of 19 February 1976 (see above) are unacceptable, because if implemented, they would contractualize in treaty form the Eastern superiority in soldiers and tanks and other major armaments. He also points out that, in imposing national ceilings on the post-reduction levels of the forces of every direct participant, the Eastern approach interferes with NATO's integrated defence system.

21 December The UN General Assembly decides to convene a special session of the General Assembly devoted to disarmament, to be held in May/June 1978.

22 December The Canadian government states that its nuclear shipments to non-nuclear weapon states under future contracts will be restricted to those which have ratified the NPT or have otherwise accepted international safeguards on their entire nuclear programmes.

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