IV. French nuclear forces

HANS M. KRISTENSEN AND MATT KORDA*

As of January 2024 France's nuclear weapon stockpile consisted of about 290 warheads, the same number as in January 2023. The warheads are allocated for delivery by 48 submarine-launched ballistic missiles (SLBMs) and approximately 50 air-launched cruise missiles (ALCMs) produced for land- and carrier-based aircraft (see table 7.5, end of section). However, the 10 warheads assigned to France's carrier-based aircraft are thought to be kept in central storage and are not normally deployed.

The estimate of France's nuclear weapon stockpile is based on publicly available information.[1] France is relatively transparent about many of its nuclear weapon activities and has in the past publicly disclosed the size of its stockpile and details of its nuclear-related operations.[2]

This section begins by outlining the role played by nuclear weapons in France's military doctrine. It then assesses France's nuclear modernization programmes and describes its air-delivered and sea-based weapons.

The role of nuclear weapons in French military doctrine

France has stated that its nuclear weapons remain de-targeted during peacetime and are not postured against any particular country, but rather are intended to be used against 'any State' in support of an 'all-azimuths' concept of nuclear deterrence.[3] France considers all of its nuclear weapons to be strategic and reserved for the defence of France's 'vital interests'.[4] Its vital interests include 'the integrity of [its] . . . territory and the protection of [its] . . . population' but 'cannot be restricted to the national scope, because France does not conceive its defence strategy in isolation, even in the nuclear field'.[5] This was highlighted in 2020 when President Emmanuel Macron invited France's European Union partners to a 'strategic dialogue . . . on the role played by France's nuclear deterrence in our collective security'.[6] However, the suggestion of a European dimension of nuclear deterrence is controversial because it remains unclear how such a mission would interact

[1] Kristensen, H. M. and Korda, M., 'Estimating world nuclear forces: An overview and assessment of sources', SIPRI Commentary, 14 June 2021.

[2] See e.g. Macron, E., French President, Speech on defence and deterrence strategy, École de Guerre, Paris, 7 Feb. 2020 (in French, with English translation).

[3] Macron (note 2); French Government, *Defense and National Security Strategic Review 2017* (French Government: Paris, 2017); and Tertrais, B., *French Nuclear Deterrence Policy, Forces and Future: A Handbook*, Recherches & Documents no. 04/2020 (Fondation pour la Recherche Stratégique: Paris, Feb. 2020), pp. 15–16.

[4] Tertrais (note 3) pp. 25–29, 62–63.

[5] French Government (note 3), p. 52.

[6] Macron (note 2), p. 10.

* The authors wish to thank Eliana Johns and Mackenzie Knight for contributing invaluable research to this publication.

with the North Atlantic Treaty Organization's existing nuclear sharing practices. An advisor to Macron clarified in 2022 that the proposal for European strategic dialogue remained on the table but was about connecting 'nuclear deterrence and European interests' and not about 'sharing the deterrent'.[7]

Other than a statement in October 2022 that France's 'vital interests . . . would not be at stake if there was a nuclear ballistic attack in Ukraine or in the region', France is deliberately ambiguous about the circumstances under which it would use its nuclear weapons.[8] In January 2023 France's Chief of Staff of the Armed Forces, General Thierry Burkhard, stated that France's doctrine 'is neither that of no first use nor that of sole purpose'—the concept that the sole purpose of nuclear weapons is to deter only nuclear weapon use by other countries—and that French deterrence 'does not revolve around the notion of threshold, because this would allow our adversaries to consciously manoeuvre around it and circumvent our deterrence "from the bottom up"'.[9]

France reserves the right to issue 'a sole, one-time-only nuclear warning', suggesting that it could use a nuclear weapon against a symbolic target as a signal to a potential adversary.[10] Although France's doctrine includes this 'nuclear warning' as a potential precursor to the general use of nuclear weapons, its long-standing policy is that it 'will never engage into a nuclear battle or any forms of graduated response'.[11] Rather, French doctrine appears to emphasize the deterrence value of delivering massive retaliation in the form of a single strike.[12]

Aircraft and air-delivered weapons

The airborne component of the French nuclear forces consists of land- and carrier-based aircraft. The French Air and Space Force has 40 deployed nuclear-capable Rafale B aircraft based at Saint-Dizier Airbase in north-east France. The French Naval Nuclear Air Force (*Force aéronavale nucléaire*, FANu) consists of a squadron of 10 Rafale M aircraft for deployment on the aircraft carrier *Charles de Gaulle*. The FANu and its nuclear-armed missiles are not permanently onboard the carrier but can be rapidly deployed by the

[7] Schuller, K., 'Nukleare Abschreckung: Frankreich erneuert das Angebot, mit der EU über Atomwaffen zu reden' [France renews offer to talk to EU about nuclear weapons], *Frankfurter Allgemeine*, 14 Jan. 2022.

[8] 'Avec Emmanuel Macron' [With Emmanuel Macron], L'événement, France 2, 12 Oct. 2022 (author translation). On France's policy of ambiguity see e.g. 10th NPT Review Conference, National report of France, NPT/CONF.2020/42/Rev.1, 1 Aug. 2022, p. 3.

[9] Burkhard, T., Statement before the Committee on National Defence and the Armed Forces, French National Assembly, 11 Jan. 2023 (in French).

[10] 10th NPT Review Conference, NPT/CONF.2020/42/Rev.1 (note 8), p. 4.

[11] Macron (note 2), p. 10.

[12] Tertrais, B., '"*Destruction assurée*": The origins and development of French nuclear strategy, 1945–1981', ed. H. D. Sokolski, *Getting Mad: Nuclear Mutual Assured Destruction, Its Origins and Practice* (US Army War College, Strategic Studies Institute: Carlisle, PA, 2004), p. 66.

French president in support of nuclear operations.[13] In 2023 France began to upgrade its Rafale aircraft to the new F4 standard; the full upgrade is scheduled to be complete by 2025.[14]

The Rafale aircraft are equipped with medium-range air-to-surface cruise missiles (*air–sol moyenne portée–améliorée*, ASMPA), which are currently being refurbished.[15] In March 2022 France conducted a second successful flight test of the new version, the *air–sol moyenne portée–amélioré rénové* (ASMPA-R). It subsequently approved the start of serial production of the missiles and midlife refurbishment of the upgraded missile inventory, which will keep the ASMPA in service until 2035.[16] The ASMPA-R missiles were scheduled to enter into service in October 2023 but this may have been delayed until 2024.[17] The missiles are equipped with the same warhead as the ASMPA, the *tête nucléaire aéroportée* (TNA, air-launched nuclear warhead), which the missile's producer (MBDA) says has a 'medium energy' yield.[18]

A fourth-generation air-to-surface nuclear missile (*air–sol nucléaire de 4e génération*, ASN4G) is being developed with enhanced stealth and manoeuvrability to counter potential technological improvements in air defences.[19] The ASN4G is scheduled to reach initial operational capability in 2035 to replace the ASMPA-R and will be initially carried by the next-generation Rafale F5 before being integrated onto a future replacement aircraft for the Rafale.[20]

[13] Pintat, X. et al., 'Rapport d'information fait au nom de la commission des affaires étrangères, de la défense et des forces armées par le groupe de travail "La modernisation de la dissuasion nucléaire"' [Information report made on behalf of the Committee on Foreign Affairs, Defence and the Armed Forces by the working group 'Modernization of nuclear deterrence'], Report no. 560, French Senate, 23 May 2017.

[14] Mille, S. and Bellanger, J., Statements before the Committee on National Defence and the Armed Forces, French National Assembly, 25 Jan. 2023 (in French); Hoyle, C., '"Now fight connected": Why F4-standard Rafale is a game-changer for France', FlightGlobal, 19 June 2023; and Machi, V., 'France receives first new Rafale fighter jet after four-year pause', *Defense News*, 11 Jan. 2023.

[15] For further detail see Kristensen, H. M. and Korda, M., 'French nuclear forces', *SIPRI Yearbook 2021*, p. 366.

[16] Mills, C., *Nuclear Weapons at a Glance: France*, Research Briefing no. 9074 (House of Commons Library: London, 28 July 2022), p. 10; and Scott, R., 'Successful flight test of upgraded ASMPA missile paves way for refurbishment', Janes, 30 Mar. 2022.

[17] Mille and Bellanger (note 14); and Air and Space Force (@Armee_de_lair), X, 26 Jan. 2024, <https://twitter.com/Armee_de_lair/status/1750839921529507871>.

[18] MBDA, 'ASMPA: Air-to-ground missile, medium range, enhanced', Jan. 2015.

[19] French Ministry of the Armed Forces, 'La dissuasion nucléaire' [Nuclear deterrence], *Actu Défense*, 14 June 2018, p. 1; and Tran, P., 'France studies nuclear missile replacement', *Defense News*, 29 Nov. 2014.

[20] Mille and Bellanger (note 14); and Medeiros, J., '"Faire FAS" : 55 ans de dissuasion nucléaire aéroportée' ['Go FAS': 55 years of airborne nuclear deterrence], *Air Actualités*, Oct. 2019, p. 36.

Sea-based missiles

The main component of France's nuclear forces is the Strategic Oceanic Force (*Force océanique stratégique*, FOST). It consists of four Le Triomphant-class nuclear-powered ballistic missile submarines (SSBNs, or *sous-marins nucléaires lanceurs d'engins*, SNLEs) based on the Île Longue peninsula near Brest, north-west France. Each can carry 16 SLBMs. France has 48 SLBMs in service—enough to equip the three operational SSBNs. The fourth SSBN is out of service for overhaul and maintenance work and is therefore not armed.

The French Navy maintains a continuous at-sea deterrence posture with one SSBN on patrol at all times. In March 2022 there were reports that the French Navy tested deploying more than one SSBN for the first time since the 1980s, possibly in response to Russia's invasion of Ukraine.[21]

France's SLBM, the M51, is undergoing a series of upgrades. The missile is equipped with multiple independently targetable re-entry vehicles (MIRVs) and the first version, the M51.1, can carry up to six 100-kiloton TN 75 warheads. The second version, the M51.2, is armed with a new warhead, the *tête nucléaire océanique* (TNO, sea-based nuclear warhead), which is assumed to have a yield of 100 kt.[22] In April 2023 one of France's submarines—*Le Terrible*—tested an M51 SLBM following a lengthy period in overhaul, probably indicating the completion of its upgrade to the M51.2 standard.[23] Based on recent statements from French officials, SIPRI estimates that only one of France's four SSBNs, *Le Vigilant*, has yet to be upgraded to carry the M51.2 SLBM and its accompanying TNO warhead.[24] To allow for targeting flexibility, some of the SLBMs carried by France's SSBNs carry fewer warheads than others.[25] France has also commenced design work on another upgrade, the M51.3, which is intended to have improved accuracy. France

[21] Jézéquel, S., 'Pourquoi la France a-t-elle fait appareiller trois sous-marins nucléaires au départ de l'Ile-Longue?' [Why did France sail three nuclear submarines from Île-Longue?], *Le Télégramme*, 21 Mar. 2022.

[22] Groizeleau, V., 'Dissuasion : 25 milliards en cinq ans pour le renouvellement des deux composantes' [Deterrence: 25 billion in five years for the renewal of the two components], Mer et Marine, 2 Oct. 2019; and Groizeleau, V., 'Dissuasion : F. Hollande détaille sa vision et l'arsenal français' [Deterrence: F. Hollande outlines his vision and the French arsenal], Mer et Marine, 20 Feb. 2015.

[23] Belhamiti, M., 'Avis fait au nom de la commission de la défense nationale et des forces armées sur le projet de loi de finances pour 2024, Tome VII, Défense: Équipement des forces—Dissuasion' [Notice on behalf of the Committee on National Defence and the Armed Forces on the Draft Finance Bill for 2024, vol. VII, Defence: Equipment of the forces—Deterrence', no. 1680, French National Assembly, 26 Oct. 2023.

[24] Salvetti, V., Director of Military Applications at the French Alternative Energies and Atomic Energy Commission (CEA), and Jacq, F., General Administrator of the CEA, Statements before the Committee on National Defence and the Armed Forces, French National Assembly, 18 Jan. 2023 (in French).

[25] Tertrais (note 3), p. 57.

conducted its first test launch of the M51.3 in November 2023; the missile is due to be operational in 2025.[26]

A production programme for a third-generation SSBN, designated the SNLE 3G, was officially launched in early 2021.[27] The SNLE 3G will eventually be equipped with a further modification of the M51 SLBM, the M51.4.[28] The construction of the first of four submarines in the class was scheduled to start in 2023, but work had not begun by the end of the year.[29] The first submarine is expected to be completed by 2035 and the other three submarines will be delivered on a schedule of one boat every five years.[30]

[26] Sébastien Lecornu (@SebLecornu), X, 18 Nov. 2023, <https://twitter.com/seblecornu/status/1725964236780621950>. See also French Ministry of the Armed Forces, 'Missiles balistiques stratégiques (MSBS)' [Strategic ballistic missiles], 28 Jan. 2020; and Parly, F., French Minister of the Armed Forces, Speech (in French), ArianeGroup, Les Mureaux, 14 Dec. 2017.

[27] French Ministry of the Armed Forces, 'Florence Parly, ministre des armées, annonce le lancement en réalisation des sous-marins nucléaires lanceurs d'engins de 3e génération (SNLE 3G)' [Florence Parly, minister of the armed forces, announces the launch of the 3rd-generation nuclear-powered ballistic missile submarines (SNLE 3G)], 19 Feb. 2021; and Mackenzie, C., 'France to begin building new ballistic missile subs', *Defense News*, 22 Feb. 2021.

[28] Tertrais (note 3), pp. 56, 60, 65.

[29] 'La première tôle des futurs sous-marins nucléaires lanceurs d'engins sera découpée fin 2023', La Presse de la Manche, 18 Feb. 2023.

[30] French Ministry of the Armed Forces (note 27); Groizeleau, 'Dissuasion : 25 milliards en cinq ans' (note 22); and Mackenzie (note 27).

Table 7.5. French nuclear forces, January 2024

All figures are approximate and some are based on assessments by the authors.

Type/designation	No. of launchers	Year first deployed	Range (km)[a]	Warheads x yield	No. of warheads
Land-based aircraft					
Rafale BF3/4[b]	40	2010–11	2 000	1 x [<300 kt] TNA[c]	40
Carrier-based aircraft					
Rafale MF3/4[b]	10	2010–11	2 000	1 x [<300 kt] TNA[c]	10[d]
Sea-based missiles (SLBMs)	*4/64*[e]				*240*
M51.1	16	2010	>6 000	4–6 x 100 kt TN 75	80
M51.2[f]	32	2016	>9 000[g]	4–6 x 100 kt TNO	160
M51.3[h]	–	[2025]	>[9 000]	[up to 6] x 100 kt TNO	–
Total stockpile					**290**[i]

– = nil or a negligible value; [ ] = uncertain SIPRI estimate; kt = kiloton; SLBM = submarine-launched ballistic missile; TNA = *tête nucléaire aéroportée* (air-launched nuclear warhead); TNO = *tête nucléaire océanique* (sea-based nuclear warhead).

[a] For aircraft, the listed range is for illustrative purposes only; actual mission range will vary according to flight profile, weapon payload and in-flight refuelling.

[b] The Rafale B and M aircraft both carry the ASMPA (*air–sol moyenne portée–améliorée*) air-launched cruise missile (ALCM). Most sources report that the ASMPA has a range of 500–600 kilometres, although some suggest that it might be over 600 km. In 2023 France began to upgrade its Rafale BF3 and MF3 aircraft to the new F4 standard; the full upgrade is scheduled to be complete by 2025.

[c] There is uncertainty as to the yield of the new TNA warhead. Some non-official sources continue to attribute a yield of 300 kt to the TNA, the same yield as the previous TN81 warhead carried by the original ASMP missile. However, MBDA, the manufacturer of the ASMPA missile that carries the TNA, has stated that the warhead has a 'medium energy' yield, which is thought to imply less than 300 kt. The TNA also appears to be based on the same design as the TNO, which is believed to have a yield of 100 kt. In the absence of official or consistent authoritative sources, these numbers should be treated as uncertain estimates.

[d] The 10 warheads assigned to France's carrier-based aircraft are thought to be kept in central storage and are not normally deployed.

[e] The first figure is the total number of nuclear-powered ballistic missile submarines (SSBNs) in the French fleet; the second is the maximum number of missiles that they can carry. However, the total number of missiles carried is lower. Of the 4 SSBNs, 1 is in overhaul at any given time. France has 48 SLBMs in service—enough to equip the 3 operational SSBNs.

[f] SIPRI estimates that 1 SSBN—*Le Vigilant*—has yet to be upgraded to carry the M51.2 SLBM and its accompanying TNO warhead.

[g] The M51.2 has a 'much greater range' than the 6000-km range of the M51.1 according to the French Ministry of the Armed Forces.

[h] The M51.3 is under development and has not yet been deployed.

[i] In Feb. 2020 President Emmanuel Macron reaffirmed that the arsenal 'is currently under 300 nuclear weapons'. A few of the warheads are thought to be undergoing maintenance and inspection at any given time.

Sources: Speeches (in French) of French presidents and defence ministers: Macron, E., Speech on defence and deterrence strategy, École de Guerre, Paris, 7 Feb. 2020; Parly, F., French Minister of the Armed Forces, Speech, ArianeGroup, Les Mureaux, 14 Dec. 2017; Hollande, F., Speech on nuclear deterrence, Istres Airbase, 19 Feb. 2015; Sarkozy, N., Speech on the new defence policy, Porte de Versailles, 17 June 2008; Sarkozy, N., Speech on the white paper on national defence

and security, nuclear deterrence and the non-proliferation of nuclear weapons, Cherbourg, 21 Mar. 2008; and Chirac, J., Speech on France's defence policy, Île Longue, Brest, 19 Jan. 2006. Other sources: French Ministry of Defence/Ministry of the Armed Forces, various publications; French National Assembly, various defence bills; *Air Actualités*, various issues; *Aviation Week & Space Technology*, various issues; *Bulletin of the Atomic Scientists*, 'Nuclear Notebook', various issues; Tertrais, B., *French Nuclear Deterrence Policy, Forces and Future: A Handbook*, Recherches & Documents no. 04/2020 (Fondation pour la Recherche Stratégique: Paris, Feb. 2020); and authors' estimates.