

IV. French nuclear forces

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As of January 2022, France's nuclear weapon stockpile consisted of about 290 warheads, the same number as in January 2021. 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 10.5). 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

The role of nuclear weapons in French military doctrine

France considers all of its nuclear weapons to be strategic and reserved for the defence of France's 'vital interests'.³ While this concept has appeared in various governmental white papers and presidential speeches for several decades, what constitutes France's 'vital interests' remains unclear, and President Emmanuel Macron has implied that these 'vital interests' could increasingly take on a European dimension.⁴ No changes to French military doctrine were announced in 2021.

Nuclear weapon modernization

President Macron has reaffirmed the French government's commitment to the long-term modernization of France's air- and sea-based nuclear deterrent forces.⁵ Current plans include the modernization of France's nuclear-powered ballistic missile submarines (SSBNs, or *sous-marins nucléaires lanceurs d'engins*, SNLEs), SLBMs, aircraft and ALCMs (see below). The 2018 Law on Military Planning (Loi de Programmation Militaire, LPM) for

¹ For additional information see Kristensen, H. M. and Korda, M., 'Estimating world nuclear forces: An overview and assessment of sources', SIPRI Topical Background, 14 June 2021.

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

³ 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. 25–29, 62–63.

⁴ Macron (note 2). See also Kristensen, H. M. and Korda, M., 'French nuclear forces', *SIPRI Yearbook 2021*.

⁵ Macron, E., French President, Speech on the challenges and priorities of defence policy (in French), Toulon, 19 Jan. 2018.

Table 10.5. French nuclear forces, January 2022

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
<i>Land-based aircraft</i>					
Rafale BF3 ^b	40	2010–11	2 000	1 x <300 kt TNA ^c	40
<i>Carrier-based aircraft</i>					
Rafale MF3 ^b	10	2010–11	2 000	1 x <300 kt TNA ^c	10 ^d
<i>Sea-based missiles (SLBMs)</i>					
M51.2 ^f	48 ^g	2017	>9 000 ^h	4–6 x 100 kt TNO	240
M51.3 ⁱ	–	[2025]	>[9 000]	[up to 6] x [100 kt] TNO	–
Total stockpile					290^j

[] = uncertain SIPRI estimate; – = nil or a negligible value; 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 BF3 and MF3 aircraft both carry the ASMP-A (*air-sol moyenne portée-améliorée*) air-launched cruise missile (ALCM). Most sources report that the ASMP-A has a range of 500–600 kilometres, although some suggest that it might be over 600 km.

^c The TN81 warhead for the original ASMP had an estimated yield of 300 kt, but the new TNA warhead has a so-called medium energy yield.

^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 (see note g). Of the four SSBNs, one is in overhaul at any given time.

^f The last M51.1 missiles were offloaded from *Le Terrible* in late 2020 in preparation for a one-year refuelling overhaul and upgrade to the more advanced M51.2 missile.

^g France has 48 SLBMs in service—enough to equip the three operational SSBNs.

^h The M51.2 has a 'much greater range' than the M51.1 according to the French Ministry of the Armed Forces.

ⁱ The M51.3 is under development and has not yet been deployed.

^j 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., Speech, ArianeGroup, Les Mureaux, 14 Dec. 2017; Hollande, F., Speech on nuclear deterrence, Istres Air Base, 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; 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.

2019–25 allocated €37 billion (\$43.7 billion) for maintenance and modernization of France's nuclear forces and infrastructure.⁶ This is a significant nominal increase on the €23 billion (\$30.5 billion) allocated to nuclear forces and associated infrastructure by the LPM for 2014–19.⁷

The 2022 budget of the Ministry of the Armed Forces (France's defence ministry) allocated €5.3 billion (\$6.3 billion) to nuclear weapon-related activity, which is €0.3 billion more than in the 2021 budget.⁸ France intends to spend a total of €25 billion (\$29.5 billion) on nuclear modernization between 2019 and 2023.⁹

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 BF3 aircraft based at Saint-Dizier Air Base in north-east France. The French Naval Nuclear Air Force (Force aéronavale nucléaire, FANu) consists of a squadron of 10 Rafale MF3 aircraft for deployment on the aircraft carrier *Charles de Gaulle*. The FANu and its nuclear-armed missiles are not permanently deployed but can be rapidly deployed by the French president in support of nuclear operations.¹⁰

The Rafale aircraft are equipped with medium-range air-to-surface cruise missiles (*air-sol moyenne portée-améliorée*, ASMPA), which are currently being refurbished, with delivery expected in 2022 or 2023.¹¹ The ASMPA missiles are equipped with a new warhead, the *tête nucléaire aéroportée*

⁶ Agence-France Presse, 'Macron promulgue la loi de programmation militaire 2019–2025' [Macron signs the Law on Military Planning for 2019–2025], *Le Figaro*, 13 July 2018; Loi relative à la programmation militaire pour les années 2019 à 2025 [Law on Military Planning for the Years 2019 to 2025], French Law no. 2018-607 of 13 July 2018, *Journal Officiel de la République Française*, 14 July 2018; and Agence-France Presse, 'France to spend 37 bn euros on upgrading nuclear arsenal', *France 24*, 8 Feb. 2018. The total defence budget approved for the seven-year period was €295 billion (\$348 billion). On France's military expenditure see chapter 8, sections I and II, in this volume.

⁷ Loi relative à la programmation militaire pour les années 2014 à 2019 [Law on Military Planning for the Years 2014 to 2019], French Law no. 2013-1168 of 18 Dec. 2013, *Journal Officiel de la République Française*, 19 Dec. 2013.

⁸ French Ministry of the Armed Forces (MAF), *Projet de loi de finances: Année 2022* [Finance bill: Year 2022] (MAF: Paris, Sep. 2021), p. 43; and Rose, M., 'Amid arms race, Macron offers Europe French nuclear wargames insight', *Reuters*, 7 Feb. 2020.

⁹ 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.

¹⁰ 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, Defense and the Armed Forces by the working group 'Modernization of nuclear deterrence'], Report of the French Senate no. 560, 23 May 2017.

¹¹ For further detail see Kristensen and Korda (note 4), p. 366.

(TNA), which the missile's producer (MBDA) says has a 'medium energy' yield.¹²

The Ministry of the Armed Forces has begun developing a successor: a fourth-generation air-to-surface nuclear missile (*air-sol nucléaire de 4e génération*, ASN4G) with enhanced stealth and manoeuvrability to counter potential technological improvements in air defences.¹³ The ASN4G is scheduled to reach initial operational capability in 2035.¹⁴ France's Rafale aircraft are also being modernized, and flight trials for the latest F4 configuration with new radars and targeting capabilities began in May 2021.¹⁵

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 SSBNs based on the Île Longue peninsula near Brest, north-west France. Each is capable of carrying 16 SLBMs. However, at any given time one SSBN is out of service for overhaul and maintenance work, and is not armed. France has 48 SLBMs in service—enough to equip the three operational SSBNs.

The French Navy (Marine nationale) maintains a continuous at-sea deterrence posture with one SSBN on patrol at all times. It has conducted more than 500 such patrols since 1972.¹⁶

France's SLBM, the M51, is being upgraded. The first version, the M51.1, was capable of carrying up to six TN-75 warheads in multiple independently targetable re-entry vehicles (MIRVs), each with an explosive yield of 100 kilotons. Over the past several years, the M51.1 has been gradually replaced by the M51.2, an upgraded version with greater range and improved accuracy. With the deployment of the M51.2 on *Le Téméraire* in mid 2020, the only SSBN left to receive this upgrade, *Le Terrible*, began its major refit in late 2020.¹⁷ Thus, the M51.1 had been officially removed from service by early 2021.

¹² MBDA, 'ASMPA: Air-to-ground missile, medium range, enhanced', Fact sheet, [n.d.].

¹³ 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.

¹⁴ Medeiros, J., "'Faire FAS": 55 ans de dissuasion nucléaire aéroportée' ['Go FAS': 55 years of airborne nuclear deterrence], *Air Actualités*, Oct. 2019, p. 36.

¹⁵ Jennings, G., 'France begins Rafale F4 flight trials', *Janes*, 21 May 2021.

¹⁶ French Ministry of the Armed Forces, '500e patrouille d'un sous-marin nucléaire lanceur d'engins' [500th patrol of a nuclear-powered ballistic missile submarine], 12 Oct. 2018.

¹⁷ French Ministry of the Armed Forces and Naval Group, 'Le SNLE *Le Terrible* transféré de l'île Longue à la base navale de Brest pour son grand carénage' [The SSBN *Le Terrible* transferred from Île Longue to the Brest naval base for its major refit], Press release, 8 Jan. 2021.

The M51.2 is designed to carry a new, stealthier nuclear warhead, the *tête nucléaire océanique* (TNO), which has a reported yield of up to 100 kt.¹⁸ To allow for targeting flexibility, some of the missiles have fewer warheads than others.¹⁹ France has also commenced design work on another upgrade, the M51.3, which will have improved accuracy. The first M51.3 missiles are scheduled to replace their M51.2 predecessors and become operational in 2025.²⁰

In April 2021 France conducted a successful test launch of the M51 from the missile testing site near Biscarosse in south-west France; however, the impact area referenced in the notice to mariners was significantly offset from a regular ballistic trajectory.²¹ This could potentially indicate that the launch included a test of a manoeuvrable re-entry vehicle or a post-boost capability. This was the 10th test of the M51.

In the LPM for 2019–25, the French government announced that it would produce a third-generation SSBN, designated the SNLE 3G.²² The programme was officially launched in early 2021.²³ The SNLE 3G will eventually be equipped with a further modification of the M51 SLBM, the M51.4.²⁴ The construction of the first of four submarines in the class is scheduled to begin in 2023 and is expected to be completed by 2035. The other three submarines will be delivered on a schedule of one boat every five years.²⁵ In 2021 France dismantled its second of five retired SSBNs and plans to complete the deconstruction programme by 2026.²⁶

¹⁸ Groizeleau (note 9); 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.

¹⁹ Tertrais (note 3), p. 57.

²⁰ 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.

²¹ French Ministry of the Armed Forces, 'Succès d'un tir d'essai de missile M51 sans charge militaire', 28 Apr. 2021; and Dr Marco Langbroek (@Marco_Langbroek), 'Navigational Warnings suggest that France will be test-firing an #ICBM from DGA Essais de Missiles near Biscarosse towards Bermuda between Apr 28–May 21. Target area does not fit a simple ballistic trajectory', Twitter, 25 Apr. 2021.

²² French Ministry of the Armed Forces, 'Projet de loi de programmation militaire, 2019–2025' [Military Planning Bill, 2019–2025], Press kit, Feb. 2018, p. 38.

²³ 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.

²⁴ Tertrais (note 3), pp. 56, 60, 65.

²⁵ French Ministry of the Armed Forces (note 23); Groizeleau (note 9); and Mackenzie (note 23).

²⁶ Naval Group, 'Naval Group starts the deconstruction of a third French nuclear-powered ballistic missile submarine in Cherbourg', News release, 15 Sep. 2021.