FRANCE

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France spends approximately US$4.6 billion (€3.5 billion) on its nuclear forces each year. Like several of the other nuclear weapon states, France is in the middle of a broad modernization of its nuclear forces involving submarines, aircraft, missiles, warheads, and production facilities that will continue for another decade.

Having recently completed a reduction of its air-delivered nuclear forces, the indication from public statements and conversations with officials is that France will reject calls for additional nuclear reductions in the near term. Such a rejection is, especially when considered in context with its substantial nuclear modernization, in conflict with France's obligations under the nuclear Non-Proliferation Treaty to pursue additional reductions of nuclear weapons.

STATUS OF FRENCH NUCLEAR FORCES

As of early 2012, France possessed a stockpile of an estimated 300 nuclear warheads. Approximately 290 of these warheads are deployed or operationally available for deployment on short notice. A small number of additional warheads are in maintenance or awaiting dismantlement.

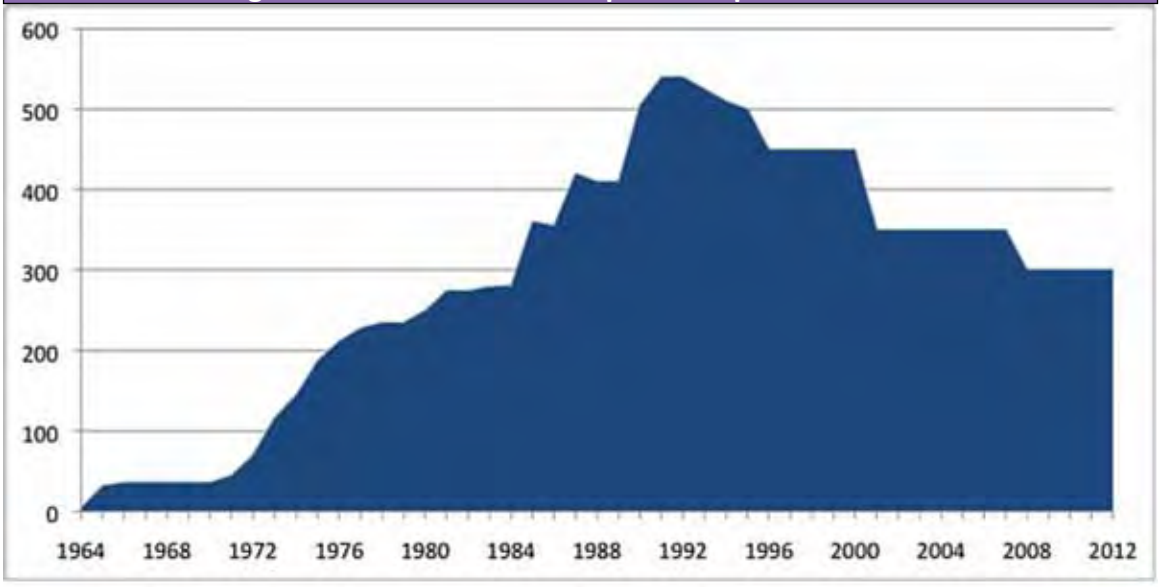
The current forces level is the result of recent adjustments made to the posture following President Nicolas Sarkozy's announcement on 21 March 2008, that the "arsenal" would be reduced to "fewer than 300 warheads" by cutting one of three nuclear bomber squadrons.[1]

Sarkozy also declared that France "has no other weapons besides those in the operational stockpile."[2] The statement was probably intended to signal that France, unlike the United States, does not have a designated reserve of non-deployed warheads that could be uploaded onto delivery systems to increase the size of force if necessary.

It seems likely, however, that in addition to the operational stockpile of warheads deployed on ballistic missiles and in storage facilities with operational forces, a small number of additional warheads are present in the maintenance cycle of the industrial complex either as new warheads, warheads undergoing repairs, or retired warheads awaiting dismantlement.

For example, at the time of Sarkozy statement in 2008, the new Air-Sol Moyenne Portee Amélioré

Figure 1: French nuclear weapon stockpile 1964–2012



The roughly 300 nuclear warheads in the current French nuclear weapons stockpile correspond to about half of the peak stockpile size at the end of the Cold War, and about equal to the stockpile size in 1984.

(ASMPA) cruise missile with the new Tête Nucleaire Aéroportée (TNA) warhead was not yet in the "operational stockpile" even though the warheads had been produced. Since then, the ASMPA has replaced the Air-Sol Moyenne Portee (ASMP), whose TN81 warheads have been retired and are awaiting dismantlement. Likewise, from 2015, the new TNO warhead will begin replacing the TN75 on the M51 submarine-launched ballistic missiles (SLBMs). Production of the Tête Nucléaire Océanique (TNO) warheads is probably complete but they are not yet in the "operational stockpile."

The current operational stockpile of nearly 300 warheads, Sarkozy declared, "is half of the maximum number of warheads we had during the Cold War."[3] The peak occurred in 1991–1992 at end of the Cold War, and the size of today's stockpile is about the same as in 1984 (see Figure 1), although the composition is significantly different.

Delivery systems

France's nuclear posture is based on two types of delivery vehicles: aircraft and ballistic missiles (see Table 1). France also used to deploy nuclear medium-range ballistic missiles in silos at Plateau d'Albion, but all were deactivated in 1996.

Land-based aircraft

The land-based aircraft are organized under the Strategic Air Forces (Forces Aériennes Stratégiques, or FAS), which operates two nuclear-capable fighter-bombers: the Mirage 2000N K3 and the Rafale F3. The force is in the middle of a transition from the old Mirage to the new Rafale, which by the end of this decade will completely replace the Mirage in the nuclear strike mission. Approximately 40 aircraft (20 of each type) are thought to be assigned a total of 40 ASMPA cruise missiles.

The Mirage 2000N K3, which first entered operations in 1988, carries two pilots and has an unrefueled combat range of approximately 1480 km. The standard nuclear strike configuration is with the ASMPA on the centerline pylon and two 1700-liter fuel tanks under the wings. The remaining Mirage 2000Ns at Istres will be replaced by the Rafale in 2018.

The two-seater Rafale F3 nuclear version, which first entered service in 2009 at Saint Dizier airbase, has an unrefueled combat range 1850 km. As with the Mirage 2000N, the standard nuclear strike configuration for the Rafale F3 is with the ASMPA on the centerline pylon and two fuel tanks under the wings. Initially projected at 294 aircraft (232 for the Air Force and 60 for the Navy), the Rafale programme has been scaled back to 132 aircraft for the Air Force (and 48 Ms for the Navy).

France operates a fleet of 14 Boeing-produced C-135FR tankers to refuel its nuclear strike aircraft. The tankers are organized under the 0/93 Bretagne squadron at Istres airbase. The C-135FR is schedule to be replaced with a new tanker from 2017, possibly in collaboration with the United Kingdom.

Table 1: French nuclear forces, 2012

Delivery vehicle	No. operational	Year deployed[a]	Range (kilometers)[b]	Warheads x yield (kilotons)	Warheads
Land-based aircraft					
Mirage 2000N/ASMPA	20	1988/2009	2,750	1 TNA x variable to 300	20
Rafale F3/ASMPA	20	2008/2010	2,000	1 TNA x variable to 300	20
Carrier-based aircraft					
Rafale MF3/ASMPA	10	2010/2011	2,000	1 TNA x variable to 300	10
SLBMs[c]					
M45	32	1997	5,000+	4-6 TN75 x 100[d]	160
M51.1	16	2010	6,000+	4-6 TN75 x 100[e]	80
M51.2	n.a.	2015	6,000+	4-6 TNO x 100	n.a.
Total	**98**				**290**[f]

[a] *For aircraft, the first number is for the aircraft, the second is for when the ASMPA became operational with that aircraft.*

[b] *For aircraft the range of the aircraft is listed. The maximum range of the ASMPA is 500 kilometers.*

[c] *Three sets of missiles are deployed on three of four SSBNs in the operational cycle.*

[d] *Compared with its predecessor, the M4, the M45 carries "higher-performance TN75 nuclear warheads (stealthier RV and penetration aids)."*[4]

[e] *The M51, which first became operational on the Terrible in late-2010, has "significantly greater range and payload capacity, as well as greater accuracy"*[5] *than the M45 and can potentially carry more than six warheads. Under normal circumstances, however, the M51 probably carries the same number of warheads as the M45 to maximize range. Payloads of individual missiles may vary significantly depending on mission.*

[f] *In addition to the operational stockpile, a small number of additional warheads are thought to be undergoing maintenance or awaiting dismantlement. The TN81 warhead was retired with the ASMP missile in 2010. Moreover, new TNO warheads for the M51.2 are either in production or stored for deployment from 2015.*

The ASMPA is a nuclear enhanced medium-range air-to-ground missile with a ramjet engine and a maximum range of 500 km. The missile carries the new TNA warhead with an estimated maximum yield of 300 kilotons, although lowers yield options are thought to be available. MBDA Missile Systems states that the TNA is a "medium energy thermonuclear charge, a concept validated during the last nuclear testing campaign [in 1995-1996]. Simulators have proven its effective operation."[6] Although validated by live nuclear tests, the French Ministry of Defence states that the TNA is the only nuclear warhead that has been designed and certified by simulation rather than nuclear tests.[7]

Following initial design development in 1997, the ASMPA production contract was awarded in 2000 to Aerospatiale Matra Missiles at a value of more than five billion French Francs (~US$1 billion).[8] Aerospatiale Matra Missiles later merged with other companies to form the MDBA, the current producer of ASMPA. The ASMPA programme cost $146 million (€110 million) in 2011, with another $68 million (€51 million) budgeted for 2012 as the programme is nearing completion.[9]

The ASMPA first became operational on 1 October 2009, on the Mirage 2000Ns of the 3/4 "Limousin" Fighter Squadron at Istres airbase in southern France. The ASMPA was declared operational on the Rafale F3s of the 1/91 "Gascogne" Fighter Squadron during a ceremony at Saint-Dizer airbase (Air Base 113) on 1 July 2010. Production and delivery of the ASMPA and its TNA warhead was completed in 2011.

Following the announcement by President Sarkozy in 2008 that the air-based nuclear posture would be reduced by one-third, the Strategic Air Force has been significantly reorganized in recent years. Of the three nuclear fighter-bomber squadrons that existed in 2008, two have been disbanded, one transferred, and an earlier disbanded squadron has be re-established at a new location. Of the two squadrons previously based at Luxeuil airbase, one (1/4 Dauphine) was disbanded in 2010 and the other (2/4 La Fayette) was moved to Istres airbase where it replaced the 3/4 Limousin squadron in 2011. Two squadrons now remain: the 2/4 "La Fayette" squadron at Istres airbase near Marseille and the 1/91 "Gascogne" squadron at Saint Dizier airbase east of Paris (see Table 2).

Apart from the decision to reduce the nuclear posture, the reorganization also reflects modernization of the remaining aircraft and weapons. In the nuclear mission, the Rafale is gradually replacing the Mirage 2000N, and the ASMP cruise missile that first entered service in 1988 has been replaced by the ASMPA.

Along with reorganization and modernization of the aircraft and their weapons, the nuclear custodial units have also been reorganized. The nuclear weapons custodial unit at Istres has been converted to ASMPA, and the nuclear weapons unit at Luxeuil has been disbanded. The nuclear weapons custodial unit at Saint Dizier that previously provided ASMP support to one of the two nuclear squadrons that used to be at Luxeuil, has now been converted to ASMPA to support the new 1/91 Gascogne squadron at Saint Dizier.

The airbase at Avord (BA 702) continues to provide nuclear support to the fighter squadrons. The base has a nuclear weapons storage area managed by a nuclear weapons custodial unit and recently converted to the new ASMPA missile.

Sea-based aircraft

The aircraft carrier Charles de Gaulle (R91) is equipped to carry ASMPA cruise missiles for delivery by Rafale MF3 fighter-bombers organized under the 12F squadron.

Table 2: French strategic air force nuclear reorganization

Base	2008	2012
Avord (BA 702)	14.004 DAMS	91.532 DAMS
Istres (BA 125)	3/4 Limousin Sq Mirage 2000N K3/ASMP 11.004 DAMS	2/4 La Fayette Sq Mirage 2000N K3/ASMPA 11.004 DAMS
Luxeuil (BA 116)	1/4 Dauphine Sq Mirage 2000N K3/ASMP 2/4 La Fayette Sq Mirage 2000N K3/ASMP 13.004 DAMS	No nuclear units but serves as dispersal base
Saint Dizier (BA 113)	18.004 DAMS*	1/91 Gascogne Sq Rafale F3/ASMPA 18.004 DAMS

*Key: ASMP = Air-Sol Moyenne Portee; ASMPA = Air-Sol Moyenne Portee Amélioré; BA = Base Aériennes; DAMS = Dépôt Atelier de Munitions Spéciales (special weapons depot); Sq = Squadron. * Provided ASMP support to the 1/4 Dauphine squadron at Luxeuil.*

This mission was previously performed by the Super Étandard, but the Rafale MF3 has taken over this mission and the Super Étandard is scheduled to be retired in 2015–2017. When not deployed on the carrier, the air wing is based at Landivisau in northern France.

When deployed, the Charles de Gaulle does not carry nuclear weapons under normal circumstances. Its complement of ASMPA missiles is probably stored at one of the airbases, probably Istres. Management of the ASMPA cruise missile for the Rafale MF3 on the Charles de Gaulle carrier is supported by centre d'expérimentations pratiques et de réception de l'aéronautique navale (center for practical experiments and integration of naval aviation, CEPA/10S) at Istres airbase (AB 125).

Sea-launched ballistic missile submarines

France operates four Triomphant-class nuclear-powered ballistic missile submarines (SSBNs) equipped with nuclear-armed long-range ballistic missiles (SLBMs). The fleet, which is known as the FOST (La Force Océanique Stratégique), is based at the Ile Longue peninsula near Brest.

Of the four SSBNs, at least two are always fully operational, one of them at sea on "deterrent patrol". A deterrent patrol reportedly lasts about 10 weeks.[10]

Ballistic missiles for non-operational submarines are stored at the Ile Longue base in unique silos, and the warheads are at the weapons storage facility near Saint-Jean, approximately 4 kms south of the Ill Longue.

The French SSBN force is in the middle of an upgrade from the M45 to the M51 missile. Currently, three of the four SSBNs are equipped to carry the M45, while the fourth submarine (*Terrible*) became operational with the M51 in late 2010.

The M45 entered service in 1997, has a range of more than 5000 km and can carry up to six TN75 thermonuclear warheads. The TN75 was proof tested during France's final nuclear test series at Mururoa in 1995–1996.

The current version of the M51 is known as M51.1. The production contract was awarded to EADS Astrium SPACE Transportation in 2004 at a price of $3 billion (€3 billion).[11] Production of the M51.1 cost $821 million (€620 million) in 2011 and another $857 million (€647 million) is budgeted for 2012.[12]

The M51.1 carries the same warhead (TN75) as the M45, but the M51.1 reportedly has "significantly greater range and payload capacity, as well as greater accuracy."[13] Increasing warhead load makes little sense today so the M51 probably carries the same number of warheads as its predecessor to maximize countermeasures and range.[14]

Conversion of the remaining three SSBNs to the M51 will happen during their normal maintenance and refueling cycles. The contract for the second (*Vigilant*) was awarded in 2010, and third conversions (*Triumphant*) will be signed in 2012. The final conversion (*Téméraire*) contract is planned in 2015 for completion in 2018.[15] A total of $248 million (€187 million) was spent on M51 conversion in 2011, and another $278 million (€210 million) is budgeted for 2012.[16]

From 2015, apparently beginning with the Vigilant, the M51.1 will be replaced with a modified version, the M51.2, which will carry a new warhead known as the TNO (Tête Nucléaire Océanique).[17] The development contract was awarded to EADS Astrium Space Transportation in the third quarter of 2010.

Operation of the SSBN force reportedly costs more than $2 billion (€1.5 billion) per year,[18] and a French audit report in 2010 found that the unit cost of the SSBNs had increased by more than 50 percent.[19]

Table 3: French SSBN missile and warhead modernization

SSBN Name	2008	2015	2018
Le Triomphant	M45/TN75	M51.1/TN75	M51.2/TNO
Le Téméraire	M45/TN75	M51.1/TN75	M51.2/TNO
Le Vigilant	M45/TN75	M51.2/TNO	M51.2/TNO
Le Terrible	M45/TN75	M51.1/TN75*	M51.2/TNO

Although not nuclear-armed themselves, Rubin-class nuclear-powered attack submarines play an important part in the nuclear mission by providing protection to SSBNs deploying on patrol.[20] The Rubin-class will be replaced by the Barracuda-class starting in 2016.

Fissile materials

France is no longer thought to be producing fissile materials for nuclear weapons. Large quantities produced during the Cold War are more than sufficient for the current warhead level. Plutonium production at the Marcoule facility ceased in 1992 with an estimated six tons remaining. HEU production ended in 1996 with an estimated 26 tons remaining, and the HEU production plant at Pierrelatte has been dismantled.[21]

THE NUCLEAR WEAPONS COMPLEX

France's nuclear weapons complex is managed by the DAM (Direction des Applications Militaires), a department within the Nuclear Energy Commission (Le Commissariat à L'énergie Atomique et aux Énergies Renouvelables, CEA). DAM is responsible for research,

Table 4: French Nuclear Weapons Complex		
Name of Facility	**Location (coordinates)**	**Role**
Centre d'Etudes de Valduc (CEA Valduc)	Burgundy (47°34'37.02"N, 4°52'6.79"E)	Warhead production and dismantlement. Hydrodynamic test center added from 2014.
DAM-Ile-de-France (CEA Bruyères-le-Châtel)	Ile-de-France (48°35'40.53"N, 2°12'0.30"E)	Warhead design research and computer simulation.
Centre d'Etudes de Ripault (CEA Ripault)	Centre (47°17'26.05"N, 0°40'13.66"E)	Research and production of non-nuclear components, including high explosives.
Centre d'Études Scientifiques et Techniques d'Aquitaine (CESTA)	Aquitaine (44°38'46.70"N, 0°47'42.20"W)	Design of equipment for nuclear weapons, reentry vehicles, and coordinates the development of nuclear warheads. The site is the location of the Mejoule facility designed to study the fusion process of secondaries.
Centre d'Etudes de Vaujour-Moronvilliers (CEA Moronvilliers)	Champagne-Ardenne (49°14'5.32"N, 4°19'16.88"E)	Airix x-ray machine used to study hydrodynamic behavior of pre-fission implosion of primary. Airix being moved to Valduc.
Centre d'études de Gramat (CEA Gramat)	Midi-Pyrénées (44°44'23.44"N, 1°44'3.05"E)	National center for studying vulnerability of nuclear weapons systems to nuclear effects.

design, manufacture, operational maintenance, and dismantlement of nuclear warheads. Of CEA's 15,000 employee, more than 4,700 are working for the DAM. In 2010, the DAM received €1.7 billion of the €4.2 billion allocated to CEA.

Following the decision to end nuclear testing in 1996, France has reorganized its nuclear weapons centers. Today, DAM operates six sites (see Table 4).

Warhead design and simulation of nuclear warheads take place at the DAM-Ile-de-France (Bruyères-le-Châtel) Centre approximately 30 kilometers south of Paris. The centre houses Tera 100, a super computer that went into operation in July 2010. The previous generation super computer, Tera 10, is also located at the centre, which employs about half of the people affiliated with the military section (DAM) of the CEA.

The Valduc Center (Centre d'Etudes de Valduc, or CEA Valduc) is responsible for nuclear warhead production, maintenance, and dismantlement. It is located approximately 30 kilometers northwest of Dijon and is undergoing expansion to accommodate new facilities resulting from the 2010 French-British defence treaty. The AIRIX x-ray radiography facility is being moved to Valduc from the Moronvilliers center to become operational in 2014. A second radiography facility will be added by 2019, and a third by 2022 to form the Epure facility.

The CESTA (Centre d'Études Scientifiques et Techniques d'Aquitaine) near Le Barp is responsible for the design of equipment for nuclear weapons, reentry, and coordinates the development of nuclear warheads. The site is also the location of the new Megajoule laser, France's equivalent of the US National Ignition Facility. Construction of Megajoule, which will study the thermonuclear process in warhead secondaries, began in 2005 and will be completed in 2014. A smaller Laser Integration Line (LIL) laser has been operating at CESTA since 2002 to validate the Megajoule design. The Megajoule reportedly costs €3 billion.[22] CESTA was established in 1965 and employs 970 people.

The Vaujour-Moronvilliers Centre 60 kilometers east of Reims includes the Airix x-ray pulse machine established in 2000 to study the pre-fission hydrodynamic behavior of imploding high explosives in a nuclear warhead primary. The results are used to validate warhead simulation computer codes. Airix will be dismantled and re-established at Valduc in 2014.

The Gramat Centre (Centre d'études de Gramat) is responsible for hardening nuclear weapons against radiation. The centre was transferred to the CEA in 2010.

Combined, warhead simulation costs accounted for approximately $831 million (€627 million) in 2011 with another $857 million (€647 million) budgeted for 2012.[23]

NAVAL NUCLEAR PROPULSION

In addition to nuclear weapons production, France spends considerable resources on building nuclear propulsion for naval vessels that carry the nuclear weapons. France currently has 11 nuclear-powered naval vessels in operation: four Triumphant-class ballistic missile submarines, six Rubis-class attack submarines, and one Charles de Gaulle-class aircraft carrier. Although nuclear-powered attack submarines are not nuclear-armed, they play an important role in the nuclear posture by protecting SSBNs on patrol. Construction of a replacement for the Rubin-class is underway, known as the Barracuda-class, at a price of more than €8.6 billion with the first unit expected in 2017.[24]

Construction of nuclear-powered vessels happens at the naval shipyard in Cherbourg on the English Channel. Development and testing of the nuclear reactors takes place at CEA Cadarache center north of Toulon. Production of the reactors happens near Nantes at the naval propulsion factory of DCNS (Direction des Constructions Navales), the manager of the naval shipyard at Cherbourg. Refueling of the nuclear-powered vessels takes place at the naval shipyard in Toulon. The fuel-life of French naval reactor cores is probably 6-8 years.

POLITICAL ECONOMY, INTERNATIONAL LAW, AND PUBLIC DISCOURSE

Assessing the total cost of French nuclear forces is difficult. There is no detailed official public budget and reports vary depending on sources and cost categories counted. But two sources in 2011 reach comparable estimates. A study by Global Zero set the number at approximately $6 billion (€4.1 billion) in 2011, of which some $4.7 billion (€3.2 billion) were so-called core costs from researching, developing, procuring, testing, operating, maintaining, and upgrading the nuclear arsenal (weapons and their delivery vehicles) and its key nuclear command-control-communications and early warning infrastructure.[25] In comparison, a report from the French Parliament's defence committee sets the appropriated "deterrence" cost at $4.6 billion (€3.5 billion).[26]

The government announced in November 2011 that the deficit would have to be cut by 20 percent in 2012 with half of the savings coming from spending cuts.[27] Yet the defence committee report indicated that the nuclear weapons budget will only see a 1.3 percent decrease in appropriations, from $4.6 billion (€3.5 billion) in 2011 to $4.5 billion (€3.4 billion) in 2012.[28]

Although there is some debate in France over the composition and cost of the nuclear forces, it is not a very prominent debate. Moreover, the French government has strongly opposed ideas for additional reductions in its nuclear forces—neither unilaterally nor as part of a potential NATO decision to reduce its nuclear forces in Europe. The condition in the NATO Lisbon Summit declaration that the Defence and Deterrence Posture Review would only examine the contribution of nuclear forces assigned to NATO apparently was included in the text at the insistence of the French government.[29] Although the French government will insist that its recent reduction of the land-based air-delivered nuclear force is consistent with France's obligations under article VI of the nuclear Non-Proliferation Treaty to pursue nuclear reductions, its rejection of additional reductions and its ongoing modernization if its nuclear forces might be seen as being out of sync with those obligations.

THE FRENCH GOVERNMENT HAS STRONGLY OPPOSED IDEAS FOR ADDITIONAL REDUCTIONS IN ITS NUCLEAR FORCES—NEITHER UNILATERALLY NOR AS PART OF A POTENTIAL NATO DECISION TO REDUCE ITS NUCLEAR FORCES IN EUROPE.

Given this situation, and that the budgetary pressure on the defence budget is likely to continue in the foreseeable future, one option for additional reductions in France's nuclear forces might be to consider retiring the ASMPA nuclear cruise missile. The United Kingdom has already made such a transition by retiring its air-delivered nuclear weapons, and for France to terminate its land-based nuclear capability would not only save money but also free the bomber squadrons from the additional burden of maintaining nuclear proficiency and instead focus on their conventional mission.

Pressure is building for Russia and the United States to reduce their non-strategic nuclear forces in Europe, and although the French government calls its air-delivered weapons *strategic*, the short range ASMPA is of course just as tactical as a Russian AS-4 cruise missile on a Tu-22M3 Backfire bomber or an American B61 bomb on an F-16 fighter-bomber. A French decision to retire the ASMPA would place France on the forefront of the nuclear agenda in Europe and increase the pressure on Russia and the United States to reduce their short-range nuclear weapon systems.

NOTES

1. Speech by Nicolas Sarkozy, President of the French Republic, Presentation of Le Terrible in Cherbourg, 21 March 2008, p. 8. A copy of the French version is available here: http://www.elysee.fr/president/root/bank/pdf/president-1944.pdf. For an overview of French nuclear forces in 2008, see: Robert S. Norris and Hans M. Kristensen, "French nuclear forces, 2008," Nuclear Notebook, *Bulletin of the Atomic Scientists*, September 2008, http://bos.sagepub.com/content/64/4/52.full.pdf+html.
2. Speech by Nicolas Sarkozy, President of the French Republic, Pre-

sentation of Le Terrible in Cherbourg, *op. cit.*

3. Ibid.
4. "French MSBS Programmes (Submarine-Launched Ballistic Missiles)," EADS, June 13, 2005, http://www.eads.com/eads/int/en/news/press.en_20050613_MSBS.html.
5. Ibid.
6. ASMPA: Air-To-Ground Missile, Medium Range, Enhanced, MBDA Missile Systems, n.d., http://www.mbda-systems.com/mediagallery/files/asmpa_ds.pdf. The yield of the TNA warhead is not known but the yields of the devices detonated in the South Pacific during the 1995–1996 probably provide a clue; the yields ranged from less than 20 to 120 kilotons. The last test conducted on 27 January 1996, had a yield of 120 kilotons. "Fifteenth Anniversary of France's Last Nuclear Test," CTBTO Preparatory Commission, 27 January 2011, http://www.ctbto.org/press-centre/highlights/2011/fifteenth-anniversaryof-frances-last-nuclear-test/.
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11. "Contract for the production of the M51 Weapon System," EADS, 23 December 2004, http://www.eads.com/eads/int/en/news/press.en_20041223_m51.html.
12. National Assembly, *op. cit.*
13. "French MSBS Porgrammes (Submarine-Launched Ballistic Missiles)," EADS, 13 June 2005, http://www.eads.com/eads/int/en/news/press.en_20050613_MSBS.html.
14. Some unofficial sources estimate the range a much higher: 8,000-10,000 kilometers. See: Nicolas Pillet, "Le Terrible a tiré avec succès un M-51!," Aeroplans, 28 January 2010, http://www.aeroplans.fr/Europespace/terrible-tir-m51.html; the article appears to draw upon this wiki-type web site: "Missile M51," http://fr.goldenmap.com/Missile_M51.
15. "Adaptation au M51 des SNLE," French Ministry of Defense, 3 December 2010, http://www.defense.gouv.fr/dga/equipement/dissuasion/adaptation-au-m51-des-snle/.
16. National Assembly, *op. cit.*
17. "M51 - Missile mer-sol balistique stratégique," French Ministry of Defense, 14 June 2011, http://www.defense.gouv.fr/dga/equipement/dissuasion/m51-missile-mer-sol-balistique-strategique/.
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20. The F67-class frigate was also used to protect SSBNs. The last of the class, *Touraille*, was retired in June 2011. Some of the new FREMM-class frigates might inherit the SSBN protection mission.
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22. National Assembly, *op. cit.*
23. For estimates of French fissile material production and status, see: *Global Fissile Material Report 2011: Nuclear Weapons and Fissile Material Stockpiles and Production*, International Panel on Fissile Materials, 2011; *Global Fissile Material Report 2011: Balancing the Books: Production and Stocks*, International Panel on Fissile Materials, 2010; both reports are available at http://www.fissilematerials.org.
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27. Tara Patel, "France to Cut Budget Deficit 20% With 'Rigorous' 2012 Budget, Fillon Says," *Bloomberg*, 5 November 2011, http://www.bloomberg.com/news/2011-11-05/france-to-lower-deficit-with-rigorous-2012-budget-fillon-says.html.
28. National Assembly, *op. cit.*
29. The condition "This only applies to nuclear weapons assigned to NATO" appears at the end of paragraph 30 in the document. See: Lisbon Summit Declaration, Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Lisbon, NATO Press Release (2010) 155, November 20, 2010, http://www.nato.int/cps/en/natolive/official_texts_68828.htm. For background on France's nuclear policy, see: Bruno Tertrais, "The Last to Disarm? The Future of France's Nuclear Weapons,"" *Nonproliferation Review* Vol. 14.2, 2007, pp. 251–73, James Martin Center for Nonproliferation Studies, 2007, http://cns.miis.edu/npr/pdfs/142tertrais.pdf.

ASSURING DESTRUCTION FOREVER

NUCLEAR WEAPON MODERNIZATION AROUND THE WORLD

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