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Military Stockpiles: A Life-Insurance Policy in a High-Intensity Conflict?

Léo PÉRIA-PEIGNÉ

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Focus stratégique

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Executive Summary

For the first time after thirty years of budgetary restriction, European armies must face a high-intensity conflict involving heavy human and material losses. Having run down their military stockpiles to the bare minimum, supporting Ukraine has taken a heavy toll on their operational inventory; as modern operational inventories are limited, much decommissioned and older equipment has also been donated. Russia too has mobilized its extensive military stockpiles, inherited from the USSR, to maintain its combat capability after the initial failure of its "special military operation". Russian efforts to retrofit older systems have also intensified as production of modern equipment has stalled. As a result, we are seeing modern and ancient weapons pitted against each other in Ukraine.

This situation raises questions about France's military storage strategy and prompts comparisons with those of other nations. US forces have kept a significant proportion of their Cold War arsenal in working condition, using it as a valuable commercial, diplomatic, and military asset. This arsenal also allows the United States to dominate the second-hand weapons market as it can supply cheap and almost immediately available systems. In Russia, despite an apparent modernization process, military power still relies on Soviet-era stocks of vehicles and weapons. For the Russian navy, modernization of old hulls is a way to compensate for the slow production of modern ships. Chinese armed forces are being modernized and rationalized: substantial quantities of older equipment could therefore become available before 2030, a potential asset for Chinese diplomacy. In Europe, military stockpiling strategies diverge along a rough east–west line. Western powers such as the United Kingdom and France chose quality over quantity, while Eastern ones, closer to the Russian threat, try to maintain large volumes while also modernizing their equipment. While the war in Ukraine may prompt Western nations to begin a reinforcement program, Eastern European countries such as Poland had already begun their own before 2014 and the Crimea crisis.

After the 2015 terrorist attacks in Paris, France began to restore its military means and budgets, but the overall size of its armed forces is still inadequate to face a high-intensity conflict. The professionalization of the armed forces, the 2008 financial crisis, and budget cuts progressively led to the practice of stockpiling being replaced with a generalized "just-in-time" approach, to reduce infrastructure needs and costs more broadly. French armed forces had to make tough choices with their limited budgets, keeping what was immediately useful to their current missions and abandoning what was not. Operations in Africa and the Middle East and anti-terrorist

operations in French cities absorbed considerable budgets, while specialized military units and infrastructure necessary to maintain stocks required for high-intensity conflicts were disbanded.

Several initiatives and processes are at work to restore minimum storage capabilities, but a relevant stockpiling strategy, in line with France's resources and strategic context, is still far off. The French army is building several military reserve units that could drive greater retention of older equipment and vehicles, although compatibility issues with more recent models may arise. As storing combat aircraft would be far too costly, the French Air and Space Force is trying to optimize the availability of its fleet, especially through a new approach to private industry partners in maintenance and training. The French navy has initiated a reform and rationalization process of its spare-parts-storage policy to optimize the availability of its ships as well as their capabilities. A coherent equipment reserve and stockpiling program is an essential component of a military driven by a clear strategic framework. However, in the French case, this strategy is currently being pulled in two directions: between the probable end of expeditionary operations in Africa and the Middle East, and the likelihood of a high-intensity conflict. The whole French stockpiling approach cannot be based entirely on the experience in Ukraine, and it is therefore necessary to evaluate multiple probable scenarios to develop relevant recommendations. A conflict in Eastern Europe fought by a coalition differs from one led by Europe without US support, or from a major crisis in the French territories of the Pacific or Indian Ocean.

Moreover, recommendations must reflect military realities, as French resources are limited and would not allow for the creation of a reserve stock strategy similar to that of the United States. To support an allied nation under attack, the French army would need a much expanded ammunition stockpile. Similarly, the French air force lacks advanced munitions, while the French navy needs to rebuild a support fleet sufficient to enable combat operations far away from the French mainland and infrastructure.

Résumé

La guerre en Ukraine rappelle la place de l'attrition d'un conflit en haute intensité à des armées européennes taillées au plus juste après trois décennies de réduction budgétaire. L'ensemble des forces européennes ont dû réduire leurs stocks au strict minimum. En conséquence, le soutien à l'Ukraine s'est traduit par d'importants prélèvements sur leurs capacités opérationnelles. Une quantité non négligeable de systèmes retirés du service a également été donnée, par manque d'épaisseur des parcs opérationnels. La Russie a, quant à elle, mobilisé les vastes stocks hérités de l'Union des républiques socialistes soviétiques (URSS) pour soutenir son effort de guerre après l'échec initial de son « opération militaire spéciale ». Le processus de rénovation des systèmes les plus anciens est également accru, alors que la production russe de matériel moderne reste insuffisante. Le conflit en cours voit donc s'affronter des parcs mixtes composés de systèmes très modernes et d'autres beaucoup plus anciens – voire obsolètes – issus de stocks de long terme.

Cette situation incite à s'interroger sur les stratégies de stockage des armées françaises et à les comparer à celles qui existent ailleurs. Les branches des forces américaines ont ainsi conservé une part importante de l'arsenal hérité de la guerre froide dans des conditions permettant leur utilisation, et l'utilisent comme un atout majeur de leur diplomatie. Les États-Unis sont aussi en mesure de dominer le marché de l'armement de seconde main en proposant d'importantes quantités de matériel à des prix faibles et dans des délais bien plus courts que des systèmes plus modernes. Malgré un processus de modernisation, les forces russes, notamment terrestres, reposent encore sur les importants stocks soviétiques. La conservation et la rénovation de nombreuses coques achevées dans les années 1990, mais non remises en service, permettent en outre à la Marine russe de compenser la lenteur des chantiers navals de Russie. Alors que les armées chinoises connaissent un processus de modernisation des équipements et de réduction globale des formats, une quantité très importante de matériel militaire pourrait devenir disponible et être utilisé comme un argument diplomatique décisif par la République populaire de Chine. Du côté européen, les pays de l'Ouest et de l'Est du continent diffèrent : des puissances traditionnelles comme le Royaume-Uni et la France sont passées d'une logique de quantité à une logique de qualité, tandis que les pays de l'Est, se sentant plus directement menacés par la puissance russe, ont cherché à maintenir une certaine masse tout en modernisant leurs matériels. Si la remontée en puissance militaire des Européens de l'Ouest pourrait se renforcer face au conflit en cours, elle est amorcée au moins depuis 2014 pour des pays comme la Pologne, qui s'engage résolument dans une logique de masse.

Motivé par les crises sécuritaires et sanitaires, le rattrapage amorcé depuis 2015 permet aux forces françaises de restaurer certaines capacités mais leur format reste encore trop limité pour envisager sereinement un conflit de haute intensité. La professionnalisation des forces armées, l'application de la Révision générale des politiques publiques (RGPP) et les conséquences de la crise de 2008 ont contribué à l'éviction d'une logique de stock au profit d'un fonctionnement en flux tendu généralisé, destiné à limiter les coûts. Les forces françaises ont dû privilégier la préservation des moyens nécessaires à la réalisation des contrats opérationnels contre le maintien de ceux adaptés à une conflictualité considérée comme improbable. Opérations extérieures (OPEX) et opération *Sentinelle* ont ainsi fléché les budgets et investissements tandis qu'unités et infrastructures liées aux stocks indispensables à un conflit en haute intensité ont été sacrifiées.

Plusieurs initiatives existent pour rétablir la situation, mais une logique de stockage en accord avec les moyens et le contexte stratégique français reste encore lointaine. Le développement des unités de réserve opérationnelle de l'armée de Terre permet à cette dernière de conserver des armées et équipements, et de recréer un minimum de stocks, bien que cette conservation pose également des difficultés de compatibilité avec des systèmes plus modernes. Si la constitution d'un stock d'avions de combat représenterait un coût trop important, l'armée de l'Air et de l'Espace cherche à optimiser la disponibilité de son parc existant en faisant évoluer sa relation avec les acteurs privés. La Marine a également entamé un processus de réforme et de rationalisation de sa politique de stockage de pièces détachées et d'équipements de mission depuis déjà plusieurs années, afin d'optimiser la disponibilité de ses navires et de leurs capacités.

Une politique de stock cohérente suppose un format d'armée adapté à un cadre stratégique clair. Or ce dernier fait aujourd'hui défaut à des armées françaises tiraillées entre fin des OPEX et possible conflit de haute intensité. Alors qu'il est impensable d'adapter la stratégie française des stocks aux seuls retours du conflit ukrainien, il est nécessaire d'étudier les principaux scénarios de conflits potentiels pour en tirer des recommandations pertinentes : l'équipement nécessaire à un conflit en Europe de l'Est mené en coalition diffère de celui indispensable à un affrontement mené sans le soutien américain, voire à une crise majeure en outre-mer.

Les recommandations doivent également s'adapter aux différents milieux pour prendre en compte les besoins spécifiques de chacun, d'autant que les moyens français ne permettent pas une stratégie tous azimuts à l'image des forces américaines. L'armée de Terre a un besoin criant de renforcement de ses stocks de munitions, tant pour son propre usage que pour soutenir des alliés en difficulté. L'armée de l'Air et de l'Espace manque de munitions avancées, tandis que la Marine doit pouvoir s'appuyer sur une flotte de soutien étoffée pour permettre des déploiements prolongés loin de la métropole.

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Introduction

The night of February 23, 2022, marked the return of high-intensity conflict to Europe. This conflict is characterized by very high volumes of fire, leading to heavy consumption of munitions and heavy loss of life and material. As the devastating "special military operation" has turned into a prolonged war, the belligerents have been forced to mobilize their resources to maintain their combat capability. Ukraine has had to throw open its arsenals to equip its mobilized forces, while Russia has been compensating for its losses of material by drawing on stockpiles inherited from the USSR. Foreign military stockpiles have also been involved: the United States and European nations have provided Kyiv with the means to defend itself, with deliveries of material and munitions growing over time to a value of €25 billion in the first nine months of the war, while Belarus, North Korea, and Iran have been called upon by Moscow to provide substantial quantities of munitions and unmanned aerial vehicles (UAVs).

Ukraine, which had large quantities of material inherited from the Soviet era, has been able to count on significant support from Eastern European nations that are former Warsaw Pact members and therefore have stockpiles of similar equipment. Poland alone has supplied more than two hundred tanks, for example. Germany, which retained some of the weapon systems recovered after unification, has also provided several hundred Soviet-made very short-range anti-aircraft systems since March 2022.[1] With the exception of Hungary and Serbia, most of the former "people's democracies" have contributed by sending vehicles, weapons, and spare parts to allow Kyiv to refurbish immobilized fleets. However, the scale of Ukraine's needs and the volume of weekly losses have far outstripped what could be supplied by recycling Soviet material. Sending North Atlantic Treaty Organization (NATO)-standard material, as requested by the Ukrainian military very early on, rapidly became the West's main contribution. This effort, led principally by the United States, enabled weapon systems covering a wide span of the conventional spectrum to be provided to Ukraine. The result of this dual supply line has been the astonishing coexistence of Soviet and NATO equipment, with American 155mm howitzers with digital fire control and modern ammunition in the field alongside old Soviet 122mm howitzers donated by Finland.

The Russian forces, for their part, have suffered losses that, since April 2022, have forced them to draw on storage sites ever more distant from

1. "Deutschland sendet weitere »Strela« - Raketenwerfer in die Ukraine", *Der Spiegel*, March 23, 2022, available at: www.spiegel.de.

the front line to resupply their ranks with vehicles and artillery systems. Over time, the proportion of up-to-date material in the lists of Russian losses—the majority in the early months of the war—has declined to the point where some of the items lost are considered to have been retired from active service. The proportion of T-72 tanks modernized in 2016 or even 2010 has declined over the months, with a corresponding increase in 1989 or even the far more basic T-72A models. While these older models may have been in use since February 2022, the fact that the modern models are becoming rarer in the lists of losses makes it clear that they are gradually disappearing from inventories. This trend peaked in September 2022, when losses of T-62 tanks, developed in the 1950s, were recorded.

Resorting to material put into storage also betrays Russian manufacturers' inability to produce enough flow to compensate for losses, while the Ukrainians are able to count on supplies held by their foreign partners. More recently, Russia has resorted to Iranian UAVs, after the use of its own weapon systems became less common over the summer of 2022.

This high-intensity conflict is thus seeing a clash in all environments between very modern material (UAVs, armored vehicles, fighter aircraft) and much older items. On the ground, modern anti-tank missiles are destroying vehicles more than sixty years old. In the air, new strike-fighters and combat helicopters are exposed to MANPADs (portable surface-to-air missiles) used in the Soviet-Afghan war, while at sea, Ukrainian missiles that entered service in 2021 sank a ship laid down in 1976. In infantry combat, we have seen weapons developed at the end of the nineteenth century alongside others fresh out of the factory.

This incongruity highlights how crucial military stockpiles are to the ability to withstand a prolonged high-intensity conflict. Indeed, the increased lethality and high rates of attrition caused by high-intensity conflict leave the belligerents engaged in a "war of material" with only two possible ways of generating stronger flows: increasing the pace of production or exploiting their stockpiles. However, the first of these is not really an option, because the short timescale of a conflict does not match the long timescale required for building manufacturing capacity, and while it is always possible to optimize a manufacturing apparatus, moving through several orders of magnitude involves an in-depth transformation requiring time and long-term funding. From this perspective, making use of old stockpiles may be perceived as "making do in the absence of anything better, but better than nothing". Admittedly, such an approach can only be taken if an appropriate maintenance policy has been implemented.

What is more, an appropriate stockpiling policy may turn out to be a significant strategic advantage beyond high-intensity conflict and be capable of being deployed in many variations on the triptych of "competition,

dispute, and confrontation".[2] While the war in Ukraine demonstrates how indispensable stockpiles are when conflicts occur, the ways in which parties who are only indirectly involved can use stockpiles shows their wider potential. Having been brought into a dispute, the West has been able to support its Ukrainian partner under attack without exposing itself to direct military reprisals. Stockpiles therefore represent a vital diplomatic and military asset. In the present case, the United States is putting a sizable dent in Russian long-term military potential at a cost of a few tens of billions of dollars, when the conflict in Afghanistan cost more than $1,000 billion between 2001 and 2021. Being able to give massive support to an ally under attack because of stockpiles is also a stabilizing factor in a competitive context: the example of Ukraine will encourage potential aggressor states to take into account the possibility of their adversary receiving massive support in material. In contrast, states whose armed forces are perceived as being a "glass cannon", in other words a single-use weapon with poor durability, will be perceived to be more vulnerable in competition than others that can sustain their effort over time.

In this context, France's military support for Ukraine begs questions when compared to the support provided by similar nations. While French involvement has been signaled at the diplomatic level, French deliveries of military supplies have been much more limited. At the end of September 2022, France was in eleventh place in financial terms, with military deliveries reaching €233 million, and in twenty-second place with regard to the proportion of its GDP given (less than 0.009 percent). These values should be distinguished from humanitarian and purely financial aid, where the United Kingdom is in fifth and seventh place respectively. In comparison, Poland stands in third place in terms of military assistance, with more than €1.8 billion (0.3 percent of its GDP), behind the United Kingdom which has given more than €4 billion worth of assistance (0.15 percent of its GDP). The Baltic states, obviously more directly concerned, are punching above their weight, with Estonia tenth in terms of absolute contribution but top of the ranking as a proportion of GDP (0.8 percent).[3]

Similarly, the French decision to send equipment in active service like CAESAR truck-mounted howitzers or Crotale anti-aircraft defense systems rather than older material begs questions about French stockpiling practices. Despite their difficulties with maintenance in operational condition (MOC), the German armed forces have been able to send Kyiv weapon items that were retired from service several years ago, like the Gepard armored self-propelled anti-aircraft guns (SPAAG), which had been decommissioned since

2. E. Vincent, "'Gagner la guerre avant la guerre', nouvelle stratégie de l'armée française", *Le Monde*, October 5, 2021. *Translator's note*: Our translation. Unless otherwise stated, all translations of cited foreign language material in this article are our own.
3. *Ukraine Support Tracker*, Kiel Institute for the World Economy, available at www.ifw-kiel.de.

at least 2016, as well as East German material that had been in storage for decades.

The relatively modest level of French support can also be explained by lower levels of strategic investment compared with other actors such as Poland, directly affected by the Russian threat, or the United Kingdom, which has been training the Ukrainian armed forces since 2014. France, less directly involved, may be more reluctant to deprive its own armed forces of material and expose itself as other partners are doing. Faced with this new geostrategic situation and with feedback from the war in Ukraine, how should we envision France's stockpiling strategy?

The concept of "stockpile" comes with definitions that vary over time and between actors. It is therefore necessary to define a set of terms and explain how they will be used throughout this article. "Stockpile" refers to numerous applications that have no direct link to military matters: all policies for storing long-lasting commodities that are necessary to preserve the interests of the nation. During the Covid-19 pandemic, the issue of "strategic stockpiles" of medical materials (masks, gowns, and so on) and then of vaccines was the subject of intense debate. More recently, issues around strategic stockpiles of grains, rare metals, semiconductors, and hydrocarbons have all been significant in current events. These stockpiles ensure that essential activities can be maintained in the event of scarcity but are also sometimes used for price regulation. The wider meaning of different strategic stockpiling policies is not examined here, even though the questions around them ought to be included in a more exhaustive study, as the return of these questions is in itself an indicator of how the geopolitical and geoeconomic environment has deteriorated.

A "strategic" stockpile refers to materials, whether raw or refined, that are essential for maintaining a manufacturing chain (materials and metals) or for the overall functioning of the armed forces (gasoline). An "operational" stockpile refers to material intended for everyday use, while a "long-term" or "contingency" stockpile refers to material kept for emergencies.

The methods by which stockpiles are built up and the ways they are used also vary widely according to the situation. Stockpiles may be created "upstream", as soon as the material is acquired, or "downstream", when it is taken out of active service. Material put into storage may typically be used for replacing items that have been destroyed or are unavailable because of maintenance requirements. It may also be cannibalized, that is, used as a store of spare parts to keep other items in service—an essential for items that are no longer being produced. There are also many other possible ways of using stockpiles, such as for the export or transfer of second-hand material, for training purposes, and so on.

The techniques used for preserving material also vary. Items may be stored passively, without any special measures. Others may benefit more from attention, being kept indoors, and regularly checked or operated. The

most favored items are mothballed and cared for with a set of measures aimed at maximizing the length of time they can be kept in satisfactory condition. The different modes of preservation depend on the objective for the stockpile: a piece of equipment intended to be cannibalized will require less attention than one intended to be capable of being reactivated and used in operational service. Stored items may be "refurbished" to return to their original state or "retrofitted", their obsolete components upgraded, potentially improving their performance.

The term "reserve", close to the concept of "stockpile", will be used in relation to devices linked to the operational reserve, to avoid confusion. The term "fleet" will be used to refer to stockpiles of vehicles, whether operational or long term.

This study focuses on the issue of stockpiles of weapons systems and vehicles. The very complex and highly confidential issue of munitions will be addressed from time to time, but addressing it in greater depth would require more time and access.[4] Wider strategic aspects linked to health, energy,[5] and industrial[6] issues or to human resource or staffing considerations[7] will be referred to only in passing. This research has also come up against the confidentiality of some of the data, which has limited the author's ability to provide quantified and dated examples.

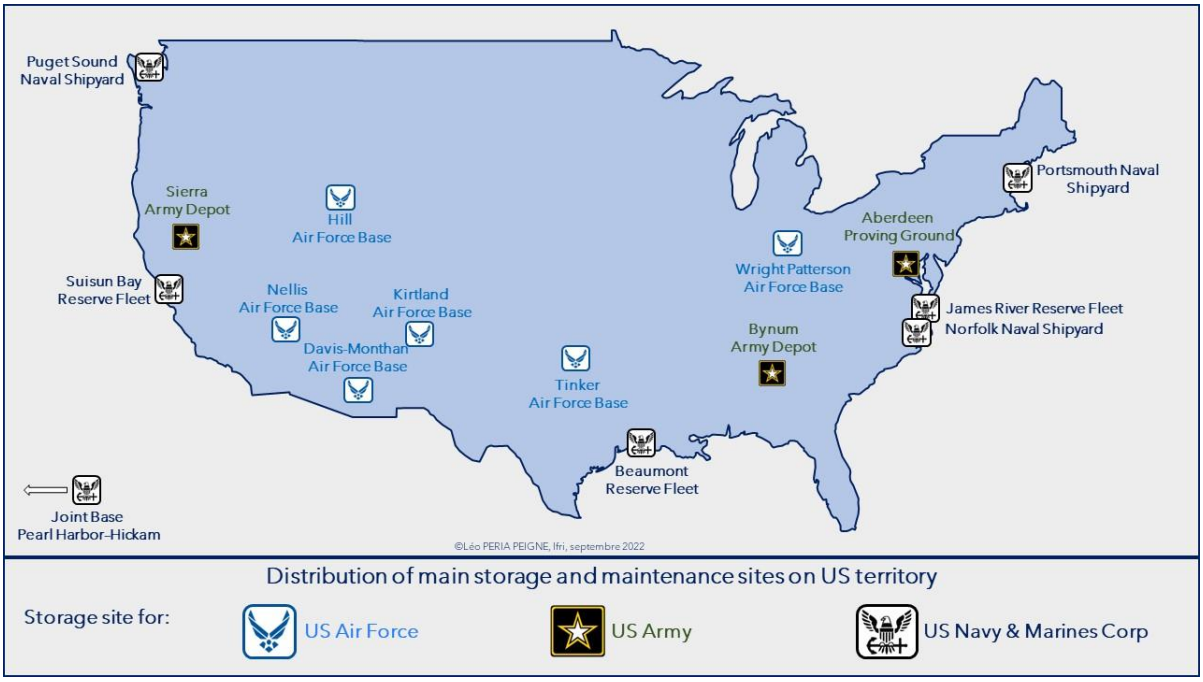
The first section of this article will examine the stockpiling strategies of the major world powers and European states comparable to France and their development over the last ten to twenty years. The second section will analyze the situation of the French military, to identify the special features of each armed force and changes linked to the health crisis and the war in Ukraine. Finally, these different elements will facilitate forward-looking discussion and recommendations for a stockpiling strategy appropriate to France's resources and strategic context.

4. R. Briant, "La filière munitions française face à la haute intensité : des équilibres à redéfinir ?", *Briefings de l'Ifri*, Ifri, January 2022.
5. P. Kaeser, "La sécurité énergétique des armées françaises. Le soutien pétrolier à l'heure de la transition", *Focus stratégique*, No. 66, Ifri, March 2016.
6. V. Donnen, "Vers une ère métallisée : renforcer la résilience des industries par un mécanisme de stockage stratégique de métaux rares", *Notes de l'Ifri*, Ifri, May 2022.
7. M. Bessot, "L'ancrage de la Garde nationale sur le territoire : quel bilan ?", *Briefings de l'Ifri*, Ifri, August 2021.

Military Stockpiles: Matching Practices to Objectives

When considering France's situation, it is important to make comparisons with the capability-related stockpiling strategies of the major world powers, as these can have a powerful impact on their approaches to making war or peace. In most cases, the issue of stockpiles has been characterized by the management of a legacy of huge Cold War arsenals, generally by shrinking them rapidly or not carrying out maintenance. However, the return of strategic competition is now having an impact.

Map no. 1: Main storage and maintenance sites on US territory



Sources: Naval Sea Systems Command, Air Force Material Command, US Army Tank-Automotive & Armaments Command.

The United States: A Wide-ranging Stockpiling Policy

The United States remains a vital actor with regard to its stockpiling strategy, as with other aspects of military power. What stands out is its ability to combine quantity and quality, achieved by means of a vision that is integrated and valued across the whole strategic spectrum. After having had to rebuild its power very rapidly in 1941 following the attack on Pearl Harbor, during the Cold War period the US maintained a strong capacity to upsize rapidly in the event of further global conflict. At the end of the Cold War and during the thirty years that followed it, American forces were able to take advantage of that arsenal while they shrank in size. Vehicles, airframes, and entire ships can be preserved for decades. While the strategy of preservation is on the decline, particularly in the domain of airborne defense, the stockpiles already built up constitute tools that can be used for the benefit of the armed forces and for defense cooperation. Through the Foreign Military Sales (FMS) program, the US Department of Defense (DoD) transfers or sells military equipment and training services to partner nations at a discount via the Defense Security Cooperation Agency.[8] In this way, material and services with a value of $50 billion are delivered to the US's partners, with congressional review.

The US Air Force: A Stockpile of Unparalleled Size

The post-war US Air Force (USAF) had several storage sites for allied and enemy airframes, which were gradually brought together at a single location at the Davis-Monthan Air Force Base in Arizona. This base is home to more than three thousand aircraft spread over one thousand hectares. Though most of the aircraft came from the USAF, they can come from any US government service, such as the US Coast Guard. Aircraft produced over the last sixty years are housed there, from F-4 Phantom II fighter-bombers, which entered service in 1960, to MQ-1 Predator UAVs, which entered service in 1995. More impressive aircraft such as B-52 strategic bombers are also stored there for spare parts or further use. It is also where American ballistic missiles are retired to and partially reconverted for civilian use, as the thrusters can be reused on NASA rockets. The ideal location—very low rainfall and dry air combined with flat, firm terrain[9]—limits the cost of preserving these items.

8. "Arms Sales: Congressional Review Process", Congressional Research Service, June 10, 2022, available at: www.sgp.fas.org.
9. Congressional Research Service, "Transfer of Defense Articles: Foreign Military Sales (FMS)", In Focus IF11437, February 21, 2020, available at: www.sgp.fas.org.

The airframes stored at Davis-Monthan are the responsibility of the 309th Aerospace Maintenance and Regeneration Group (AMARG).[10] They are divided into four main categories:

- 4000: airframes intended to be sold whole or for parts;
- 3000: airframes carefully preserved and mobilizable at very short notice;
- 2000: airframes intended for internal cannibalization and given minimal attention;
- 1000: airframes kept mothballed for long-term preservation as a contingency reserve.

A stockpiling system of this kind has several benefits for the US government and armed forces. In addition to providing a substantial reserve of spare parts for the country's own forces, it also enables the US to provide allies with parts for items that have been out of production for a long time. The Turkish, Greek, and South Korean air forces thus benefit from an indispensable source of parts for maintaining their aging F-4s that are still in service. The cost of maintenance is also partially offset by the value of the parts collected internally or sold, with approximately $500 million recovered by this means in 2012 alone.[11]

Stockpiling old planes also enables a significant amount of refurbishment and retrofitting to be carried out. More than three hundred F-16 Fighting Falcons of differing models are preserved with the option of bringing them up to Block 70/72 standard if necessary. Even though they were brought into service in 1978, these stored aircraft retain a potential that justifies their preservation.

For more than a decade, the USAF, then heavily engaged in counterinsurgency missions in Iraq and Afghanistan, explored—and debated extensively—the desirability of a light turboprop reconnaissance and fire support aircraft that would cost less per flight hour than a modern fighter. Research finally showed that developing such a system, complicated by current security and connectivity requirements, would have cost significantly more than "digging the old F-16s out of their boneyard and refurbishing them".[12] Acquisitions were ultimately limited to those made by the US Special Operations Command.[13]

Such a stockpile also allows American manufacturers, supported by the diplomatic apparatus, to offer second-hand aircraft at very attractive prices and for delivery at very short notice, when delivering a new and much more expensive aircraft might take several years. The war in Ukraine has also

10. "AMARG Summary by Type and Parking Area", *GMAP*, available at: www.gmap.nl.
11. J. A. Tirpak, "Living Boneyard", *Air & Space Forces Magazine*, February 1, 2013, available at: www.airandspaceforces.com.
12. S. Lefeez, "Toujours plus cher ? Complexité des armements et inflation des coûts militaires", *Focus stratégique*, No. 42, Ifri, February 2013.
13. B. Gabbert, "Military to Purchase Air Tractor 802s", *Fire Aviation*, August 7, 2022.

highlighted alternative uses for stored airframes. The concept of necro-aeronautics, which consists of converting an old airframe into a UAV to create a high-caliber loitering munition or a decoy, is gaining traction in the specialist literature.[14] Some AMARG airframes have already been converted to UAVs so they can be used for target practice in training.

The US Army: Giving Priority to Diplomatic Tools?

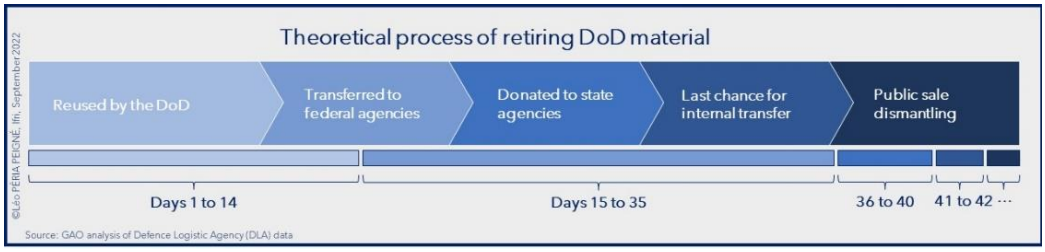
The US Army has several storage sites, the largest of which are the Sierra Army Depot (SIAD) in California and the Anniston Army Depot in Alabama. These sites are locations for stockpiling, maintaining, and repairing a wide range of materials. Hundreds of armored vehicles are stored there, from 1960 M113s to M1 Abrams tanks waiting to be refurbished to a new standard. Abrams tanks retired from the Marine Corps have been stored and refurbished at the SIAD before being sold on to the Polish army for the cost of the upgrade. The triptych of storage, maintenance, and refurbishment or modernization helps delay the need for new main battle tanks and infantry combat vehicles. Although production was interrupted between 1980 and 1990, the preservation of surplus chassis allows them to be upgraded progressively by rotation, with vehicles awaiting retrofitting being stored without reducing the size of operational fleets. The vast Future Combat Systems program, designed in part to replace the Abrams/Bradley generation, was postponed, and then canceled in 2009. This decision was largely down to flaws in the operational concept envisaged and budgetary constraints at a time when the US Army's budget was predominantly directed toward spending on personnel and counterinsurgency needs. The program that followed it, the Ground Combat Vehicle, was similarly canceled in 2014, because of a lack of credible technologies that met the US Army's specifications. The reason the US Army has allowed itself to delay launching its new generation of vehicles to such an extent is the flexibility it has because of the development potential of existing vehicles and the high availability of inventory of chassis and parts, which have been properly stored for decades. While primarily dedicated to storing US Army material, the SIAD also houses components from the F-22 Raptor production line.

The existence of stockpiles like the SIAD also gives the DoD significant capacity to transfer or sell at an attractive price. Half of the 350 M113s donated to Ukraine by Western countries since February 2022 came from American stockpiles. Other states with limited means, such as Lebanon and Croatia, regularly benefit from free transfers via the FMS program, an essential aspect of American defense diplomacy.

14. Z. Kallenborn, "Necro-Aeronautics: Raising Undead Aircraft for War", *War on the Rocks*, August 10, 2022.

Retired land material (and to a lesser extent, air and naval material too) therefore goes through a series of stages to find a use for it before being finally destroyed. After being offered to various DoD programs, including the FMS, it may be transferred to various federal and state agencies before being sold or destroyed. Available in very large quantities, some of the Humvees replaced by the Joint Light Tactical Vehicle have thus been transferred to the National Park Service and US Coast Guard, before being offered to state police forces and large municipalities and finally destroyed.

Diagram no. 1: Theoretical process of retiring DoD material



Source: "DoD Can Better Manage Demilitarization Coding and Disposition Decisions", GAO Report.

The US Navy: Stockpiling Hulls and Pptimizing Maintenance

The US Navy, less often quoted as an example, also has some stockpiling resources at its disposal. Its strategy is implemented by a number of bodies, depending on how readily available the stored material is.

The Naval Inactive Ship Maintenance Facilities (NISMF), managed by the US Navy, group together a number of military ships that are no longer in service but still have value. Located at the Bremerton, Philadelphia, and Pearl Harbor sites, these ships are categorized as capable of being transferred via the FMS (for example, Oliver Hazard Perry-class frigates), reactivated if necessary (helicopter-carrying Tarawas), or cannibalized to repair vessels still in service (Ticonderoga-class cruisers). The NISMF went from holding nearly two hundred ships in 1995 to fewer than fifty units by the early 2010s. The US Navy's last conventional aircraft carriers, which were stored at the NISMF for a long time, were dismantled in the late 2010s. Some of the US Navy's auxiliary and support vessels have been stored there for some time, awaiting a final decision on their fate. Several Littoral Combat Ships, the multiple defects of which have led to their early retirement, are also held in reserve, but their future is uncertain. These highly complex vessels are not entirely suitable for FMS, yet the US Navy is looking to dispose of them, even though some hulls are less than ten years old, whereas most of the vessels stored at the NISMF are more than thirty years old.

The National Defense Reserve Fleet, managed by the US Department of Transportation's Maritime Administration, preserves hulls that can be reactivated within 20 to 120 days. This naval reserve, sometimes described

as the "Mothball Fleet", is essentially composed of transport and logistics vessels that are kept afloat and can be called upon for transport and training missions. Created in 1946, the National Defense Reserve Fleet maintained more than 2,200 ships at its peak in 1950, and has been on a downward trend since then, with fewer than 100 hulls in 2021. This reserve fleet was called upon to provide transport during the Korean and Vietnam wars, and also during more recent conflicts, notably the one in Iraq.

The vessels in these various storage facilities are categorized according to their resale or reuse potential:[15]

Table no. 1: Categorization of US in-service and stored vessels

Category	Status	Care & Maintenance
A	In service	Maximum
B	Potentially mobilizable	Maximum
C	Potentially mobilizable, secondary	Maximum
D	Awaiting decision	Reduced
X	Awaiting dismantling, potential FMS	Minimum security
Z	Nuclear vessels awaiting dismantling	Enhanced minimum security

Source: US Department of the Navy, "General Policy for the Inactivation, Retirement, and Disposition of U.S. Naval Vessels", available at: www.secnav.navy.mil.

Iconic vessels such as the Iowa-class battleships have been in and out of active service several times, depending on estimated needs: laid down in 1940, they were withdrawn from service after the Korean War and then reactivated in 1984 for six years, participating in the bombing of Iraq in 1991. They were reactivated one last time in 1999 before being definitively withdrawn in 2006 and converted into museums. Right up to 2004, it was envisaged that these ships might potentially be reactivated, to maintain a naval fire support capability for the landing of American forces. The budget required, including restarting the production of a special powder, exceeded $400 million for two ships.[16]

As with other iconic items, Congress and the American armed forces were at odds over the future of these battleships. The US Navy obtained their definitive withdrawal from service to reallocate its human resources to more modern capabilities that were considered more appropriate. Congress, keen to preserve ships it perceived as having potential, obstructed this process for a long time, however. Similar conflict can be seen around the A-10 Fairchild ground support aircraft. The USAF wanted to replace these with an F-35/UAV pairing, but as early as 2017, Congress, supported by the US Army,

15. US Department of the Navy, "General Policy for the Inactivation, Retirement, and Disposition of U.S. Naval Vessels", September 4, 2020, available at: www.secnav.navy.mil.
16. US Government Accountability Office, "Issues Related to Navy Battleships", US GAO, December 13, 2005.

succeeded in ruling out any idea of withdrawing these aircraft from service in the medium term.[17] The USAF's parts and airframe storage strategy makes it possible to maintain A-10s in service, even though their production was halted in 1984.

The potential of the stored ships should not be overestimated, however. While they are undeniably useful as a source of parts, their contribution to a resurgence of the US Navy is limited. The ten or so frigates preserved in this way are primarily intended for resale and transfer, as reactivation at an appropriate standard would require too many resources to produce a positive effect. The five Ticonderoga cruisers, which are more than thirty years old, would need to be thoroughly modernized to be a real asset. After studying the issue in the late 2010s, the US Navy concluded that only some of the logistics ships and the small number of amphibious assault ships kept at Pearl Harbor were likely to provide a rapid back-up force in an emergency.[18]

As naval competition with China accelerates and US naval production lacks the appropriate infrastructure, the US Navy must find other solutions to reach its goal of a fleet of 321 ships.[19] Having fallen below the three-hundred-hull mark, in the face of a rapidly growing Chinese navy,[20] the US Navy is therefore seeking to improve the availability of its ships in service, modernize its two public shipyards (with a vast plan worth more than $20 billion over twenty years), and develop new in-theater maintenance and repair solutions. In its widest sense, the concept of "sea basing",[21] created more than twenty years ago, includes the possibility of carrying out some repairs closer to the conflict zone, without returning to US ports, by maintaining whole modules at sea and at operating bases. The design of future ships is also being studied to extend their service life beyond forty years, against only thirty years at present.[22]

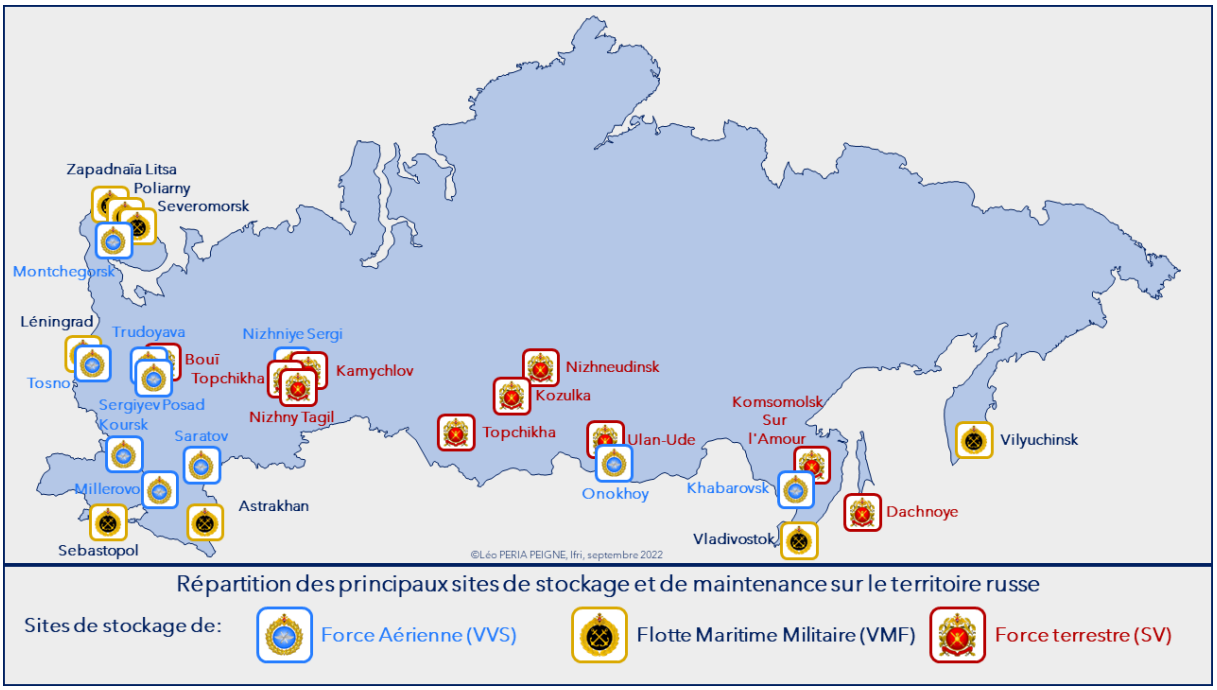
Russia: A cumbersome but Vital Soviet Legacy

The Russian stockpiling strategy, more focused on land equipment, is the result of a specific industrial design inherited from the USSR and focused on continental combat. The navy and air force suffered from the drastic cuts of

17. J. Bennett, "The A-10 Retirement Could Be Delayed Yet Again", *Popular Mechanics*, September 19, 2016.
18. K. Mizokami, "The U.S. Navy Won't Bring Back Mothballed Ships to Boost the Fleet", *Popular Mechanics*, February 21, 2019.
19. M. Eckstein, "Navy Releases Long-range Shipbuilding Plan that Drops Emphasis on 355 Ships, Lays Out Fleet Design Priorities", *Defense News*, June 18, 2021.
20. M. F. Cancian, "U.S. Military Forces in FY 2022: Navy", *CSIS Report*, Center for Strategic and International Studies, November 2, 2021.
21. US Department of Defense, "Seabasing, Joint Integrating Concept", August 1, 2005, available at: www.jcs.mil.
22. G. Harkins, "Navy Won't Resurrect Decommissioned Ships for 355-Fleet Buildup, Admiral Says", *Military.com*, February 20, 2019.

the 1990s, which limited their resources; the result is a very different relationship to capability conservation than that of the land forces, with a stronger inclination toward production flow and retrofitting. That said, the Serdyukov reform of 2008, which aimed to move from a mass model to a smaller size—first put to the test in 2014[23]—, contributed to a substantial reduction in the stockpiling policy across all the armed forces. The difficulties encountered in Ukraine nevertheless highlight the limitations of this reform.

Map no. 2: Main known storage and maintenance sites on Russian territory



Source: interviews with several specialists on the Russian forces.

The Russian Ground Forces (SV): The Weight of the Soviet Past

The Russian Federation inherited from the USSR the largest conventional arsenal in the world, as well as the conscript army for which these vehicles were intended in the event of partial or general mobilization. These huge storage bases, located east of the Urals to comply with the 1990 Treaty on Conventional Armed Forces in Europe, house tens of thousands of vehicles, ranging from the first version of the BMP-1, designed in 1961, to the T-90 produced since 1994, as well as more complex motorized artillery systems such as the 2S1 Gvozdika.

Some storage sites are open-air junkyards where vehicles in compact rows deteriorate, winter after winter. Others offer rudimentary care,

23. P. Baev, "Ukraine: A Test for Russian Military Reforms", *Focus stratégique*, No. 56, l'Ifri, May 2015.

generally a tarpaulin cover with dry air injection to optimize conservation. The best equipped have enclosed storage facilities, including controlled-atmosphere storage. A large proportion of the oldest systems is thus left in the open air without maintenance, acting as a reservoir of spare parts for a better-preserved minority. This is the case for the oldest troop transport vehicles and tanks, such as the BMP-1 and 2 or the T-55 and T-62. Modernized versions of newer tanks and armored vehicles seem to receive more attention, while complex systems, especially those involving truck-mounted artillery, are more often mothballed.

This distribution remains theoretical, however, and the reality often depends on the resources available. Personnel suffering from irregular wages commonly resell parts on the black market, further complicating any possibility of returning the systems to service. A number of Russian T-62s reactivated during exercises conducted in 2018 required more than a month to become operational again.[24] The Ukrainian forces, which have been drawing and refurbishing systems from their own inventories since 2014, attest to the difficulties of returning systems to service after they have been stored in a state of near abandonment. Losses in Ukraine and likely difficulties in maintaining recent equipment also appear to have pushed Russia to upsize its policy of renovating older tanks, planning a three-year retrofit of eight hundred T-62Ms, last modernized in the 1980s, to bring them up to the latest standard.[25]

This stockpiling policy is the result of a military-industrial strategy developed after the Great Patriotic War (1941–1945). The magnitude of the losses suffered pushed the Soviet Union toward a different line of thinking from the West's with regard to their relationship to the losses and to the maintenance and production of military vehicles. Indeed, at the end of the war, the Soviets started from the assumption that vehicles in high-intensity combat would have a short lifespan, which pushed them to develop a strategy based on cannibalization and systematic whole-weapon replacement rather than on advanced repair MOC, which involves recovery under fire, divisional workshops, and significant logistic support services. A damaged armored vehicle that could not be repaired in situ by cannibalization had to be replaced, implying a large fleet of available replacements rather than a complex MOC chain.[26]

This choice gears the whole Soviet production strategy toward coherent mass production spread out over time. Since they were to be produced in large numbers with a maximum of common components, Soviet vehicles favored incremental development marked by relatively short technological cycles. The Soviet approach favored frequent improvement of a previous

24. "Russia to Prepare Soviet Era T-62M Tanks to Replenish Reserves", *Defense Express*, May 23, 2022, available at: www.en.defence-ua.com.
25. J. Trevithick, "Russia to 'Modernize' 800 Vintage T-62 Tanks Due to Ukraine Losses", *The Warzone*, October 12, 2022.
26. J. H. Irvine, "Soviet Weapon-System Acquisition", Naval Weapons Center, September 1, 1991.

model by integrating points of innovation, and continuous production of prototypes that reduced the generation gap. The design departments, which regularly competed with each other and benefited from the patents made available by the Soviet State, also benefited from a constant flow of orders, which encouraged them to maintain the same teams over time and make incremental improvements to a given system. This approach explains the persistence over nearly half a century of a range of vehicles that are constantly improved and intended to be compatible with each other, when most Western armies changed them several times during the Cold War. It also explains the great similarity of Soviet tank models, from the T-55 to the T-90.

Westerners, in contrast, adopt a more "revolutionary" approach, with "generations" of systems designed to last a long time (in principle at least two decades, often three or four) and separated by major qualitative leaps (technological breakthroughs) that often prompt starting development from scratch.

With the Russian approach, long-term storage and MOC are also envisaged ab initio by encouraging the interchangeability of a high proportion of the parts and their resistance to climatic variations. Although the hardiness of Soviet systems is sometimes questionable, the alloy used for most of them is indeed more resistant to extreme cold, facilitating outdoor storage and limiting maintenance costs.[27] Finally, the volume of material produced and the high level of interchangeability of parts between models in the same range also favors making use of a common stock of spare parts, as well as making it easier to return stored systems to service rapidly. With several thousand vehicles in storage, the possibility of putting a fraction of them back into service by cannibalization provides a potentially out-of-date but significant volume, in line with a philosophy of "making do in the absence of anything better, but better than nothing".

Imperfect as it may be, this stockpiling strategy is now allowing Russia to keep up its war effort against Ukraine despite the losses it has suffered. The Russian military would probably not have been able to sustain its effort without the hundreds of increasingly ancient tanks and vehicles committed as early as April 2022. While the stockpile of Soviet-era 227mm rockets was also put to good use, the situation with artillery munitions is slightly different, as a standard shell can be used properly and safely between seven and fifteen years after its production in Russia. The second Chechen war had already highlighted problems with the availability of these munitions, and an effort to rebuild stockpiles was undertaken in the first decade of the twenty-first century. In addition to wanting to improve storage conditions for these munitions after multiple explosive accidents, the SV have also renovated a

27. *Ibid.*

large quantity of shells, at a rate of one renovated shell for every two new items produced.[28]

The Russian Military Maritime Fleet (VMF): Resurgence Through Renovation

Given the country's continental geography, the Soviet and then Russian navies were rarely given priority in budget allocation, and recent modernization efforts are slowly making up for years of underinvestment. As a result, it is difficult to identify a stockpiling practice similar to that of the US Navy, and stockpiling whole vessels remains an exception rather than the norm. However, some Soviet and then Russian practices are relevant as examples or counterexamples of an integrated stockpiling policy.

Admiral Gorshkov, the head of the Soviet fleet from 1956 to 1985, set out to make it a credible rival to the US Navy. By increasing the quantity and quality of hulls produced, he provoked an American overreaction in the 1980s, with the Reagan program for a fleet of six hundred ships. Faced with this new competition, the USSR kept in service ships that were increasingly old and hard to adapt to technological developments. The oldest ships were kept in active service rather than being scrapped, despite their increasingly questionable operational value. Moreover, because these ships were designed for mass production and a war of attrition, in line with the doctrine of the time, their working life—initially designed to be short—was artificially extended to inflate numbers. As a consequence, maintenance costs exploded in the 1980s, to the detriment of resources allocated to training.[29] This policy of keeping vessels in service shows the limits of an overly ambitious policy of stockpiling old systems of limited real value. An appropriate policy for the preservation of legacy systems must therefore be based on a detailed evaluation of their potential and a cost-benefit calculation that takes into account the operational needs of the armed forces as well as the engagement situations envisaged.

Today's Russian fleet has not completely broken with the Soviet heritage, although its practices are evolving. Ships of recent design are expected (Admiral Gorshkov-class frigates and Gremyashchiy-class corvettes, among others), but the slowness of naval production is partially compensated for by the modernization of old hulls. The nine Udaloy-class destroyers launched in the early 1990s have been undergoing a total refurbishment since 2015. Designed for escort and anti-submarine warfare combat, their armaments are being diversified and the vessels are also being re-engined and having modern electronics installed. The two Gepard-class patrol ships are another example: they were almost ready in 1994, but were

28. P. Luzin, "A Farewell to Arms. By Year End Russia Will Be Left Almost Without Shells, Artillery and Armored Vehicles", *The Insider*, August 31, 2022.
29. B. Bihan, "Gorshkov, le démiurge soviétique", *Guerres & Histoire*, No. 22, December 2014.

then mothballed for nearly a decade before being completed and fully re-equipped in the first decade of the twenty-first century and the 2010s. While not a perfect solution, the recovery and modernization of vessels nearly thirty years old enables the Kremlin to support the growth of its fleet by compensating for the hazards and slowness of its production of modern vessels.[30]

The loss of the *Moskva* at the beginning of the Ukrainian conflict in 2022 challenges this practice, however. The *Moskva* was laid down in 1976 but remained inactive due to lack of resources for most of the 1990s before being modernized several times between 2016 and 2020. The stated objective was then to keep it in service until 2040,[31] a lifespan of some sixty years. However, these modernizations did not prevent it being destroyed, despite the installation of multiple defense systems and powerful radars intended to protect it from missile attack.[32] The high level of corruption in Russia, particularly in military contracts, may also cast doubt on the diligence with which these costly modernizations were carried out.

The Russian air force (VKS): A Production Flow Supposed to Dwarf the Stock

For the Russian air force, the number of airframes available does not seem to have been an issue, thanks to stable, autonomous production lines. Its biggest problem has been recruiting and training enough pilots.

In the late 2000s, the threat of foreign industrial sanctions prompted the government to autonomize its aircraft production lines. As a result, limited production of new aircraft, combined with years of almost no losses, made it unnecessary to build up stockpiles. Moreover, Russian combat aircraft in operation rarely have dedicated hangars and thus are exposed to the effects of the local climate. Airframes at the end of their service life are, therefore, generally in too poor a condition to be stored and tend to be abandoned or cannibalized.[33] Hence Russian combat aviation has virtually no combat aircraft in storage.

This observation must be qualified for transport aircraft, the production of which was the prerogative of the Ukrainian Soviet Socialist Republic during the Soviet era. Some abandoned airframes were recovered for renovation. About 93 IL-76MDs in service with the VKS were renovated in the 2010s, as well as one An-22 and one An-12. Similarly, the P versions of the Mi-24 attack helicopter, appreciated for their 30mm cannon, were taken

30. Interview with an independent researcher, September 2022.
31. "Russian Black Sea Fleet Flagship to Remain in Service until 2040", Tass Agency, July 5, 2020.
32. "Russian Cruiser *Moskva* Sunk in the Black Sea—Assessing the Implications", *Navy Lookout*, April 15, 2022.
33. Interview with an independent researcher, September 2022.

out of storage and renovated, while the others were gradually replaced by a more modern version, the Mi-35.[34]

In contrast, stocks of ballistic and cruise missiles have been particularly well cared for. These, more than aviation, constitute the VKS's main effector and are placed at the forefront of the Russian doctrine of "active defense" against NATO, more specifically the Russian concept of the Strategic Operation for Repelling Aerospace Aggression (SORASA). The offensive firepower deployed in Ukraine shows that these stocks have been underestimated by many Western sources. For example, the Swedish Defence Research Agency (FOI) estimated the number of Russian land attack standoff missiles (mainly Kalibr and Iskander) at fewer than nine hundred in 2019 (and mostly nuclear, by the way),[35] whereas Russian forces have already fired a greater number of such missiles at Ukraine (more than 1,500). Admittedly, the fact that many other munitions have been deployed surface-to-surface (anti-ship missiles and S-300 surface-to-air missiles, of which there are reported to be more than seven thousand) shows that stocks of Iskanders are depleted, perhaps even near exhaustion.[36] Nevertheless, Moscow had stockpiled a firepower roughly equivalent to the inventory of American Tomahawks and joint air-to-surface standoff missiles (JASSM).

Today's VKS lacks pilots rather than airframes. While there is no shortage of volunteers, the selection process eliminates a very high proportion of them on the basis of physical and intellectual aptitudes. VKS pilots are therefore older than their NATO peers. This phenomenon is particularly marked when it comes to highly specialized aircraft: the average age of MiG-29K pilots, the naval version of the MiG-29, is over fifty, and those qualified to land at sea are even older on average.[37] The Russian pilots shot down in Ukraine are thus surprisingly old,[38] and the Russian decision to avoid overflights of Ukrainian territory is explained by a concern to preserve its qualified human resources, rather than to save its aircraft. The main threat to the VKS's ability to act is therefore more the number of pilots available than the number of airframes.

34. Interview with an independent researcher, September 2022.
35. F. Westerlund and S. Oxenstierna (eds.), "Russian Military Capability in a Ten-Year Perspective – 2019", FOI, December 2019.
36. M. Szopa, "When Will Russia Finally Run Out of Missiles?", *Defence24*, October 11, 2022, available at: https://defence24.pl [in Polish].
37. Interview with an independent researcher, September 2022.
38. L. Lagneau, "Le plus ancien des pilotes de chasse russes a été abattu en Ukraine, alors qu'il volait à bord d'un Su-25", *Zone militaire,* May 25, 2022.

China: Strong Potential in the Coming Years

Studying China's capability-related stockpiling strategy is a challenge because of the scarcity of reliable sources and the difficulty of accessing them. However, developments in the People's Liberation Army (PLA) allow us to envisage short- and medium-term changes in Chinese military diplomacy.

Reduction and modernization

China's military forces, which have long been excessively large, have begun a transition marked by a dual movement toward reduced numbers (except in the navy) and higher quality in terms of both personnel and equipment—a movement similar to the Russian military reforms begun early in the first decade of the twenty-first century, but involving much greater volumes and resources. The PLA has gone from six million personnel in 1975 to two million today.[39]

Significant quantities of material are planned to be gradually withdrawn from active service. While the Type 69 tank, the Chinese version of the Soviet T-62 introduced in 1974, is still in limited service, modernization is accelerating within the forces, and the ZTZ-99 developed early in the first decade of the twenty-first century is expected to gradually replace most of the older tanks.[40] This trend, observed across a significant proportion of the capability spectrum, needs to be monitored. In the absence of accurate data on China's stockpiling policy, it is possible that China will decide to store material withdrawn from service for later use, or that it could be used as a strategic tool in the American way, either to provide military depth or to be exported or transferred for diplomatic leverage. China would thus acquire a tool, the use of which by the United States it regularly criticizes.[41]

If this material is not stored for later use, China will have colossal quantities of equipment that it could trade with its allies, as Washington does through the FMS program. If it were able to offer a partner the possibility of completely re-equipping its forces or upgrading them at a lower cost, Chinese diplomacy would acquire a tool with considerable potential. China's large production capacity for military material at a controlled cost also suggests that Beijing could favor "diplomatic deployment" rather than stockpiling or destruction. A country that has recently suffered a military setback and significant losses of material might be interested in such an offer so it can

39. M. Julienne and C. Lagraulet, "Modernizing the People's Liberation Army: The Human Factor", *Asie.Visions*, No. 130, Ifri, October 2022, available at: www.ifri.org.
40. Y. Obraztsov, "Du Type 59 au ZTZ-99", *Défense Expert*, No. 11, December 2022.
41. L. Xuanzun, "US Uses Sales of Second-hand Arms as Bait to Expand Influence", *Global Times*, May 22, 2022.

rebuild its military potential, at least on the surface, and thus resume or continue the fight.

A Minimal Presence in Current Exports

This concern can be qualified by several observations. In the arms market, material from Soviet stockpiles remains a potential obstacle to the market being flooded with Chinese material, especially in the field of individual weapons. Furthermore, while quality problems with modern items have diminished over the years, Chinese military material, especially older material, has a reputation for dubious reliability and mediocre performance.[42] However attractive a Chinese offer of second-hand material might be in certain respects (namely quantity and cost), more demanding partners might find it unappealing, while the most recent Chinese material has its share of problems.

Until now, Chinese arms sales have relied on new and recent material, with second-hand sales primarily concerning ships and submarines. Another major problem seems to be the lack of post-contract industrial support, which leaves buyers in possession of items for which they cannot find the MOC components needed outside China. Bangladesh's 2013 acquisition of two second-hand Chinese Type 035G submarines[43] nevertheless remains an example that could be repeated. While some fifteen Type 035s are still in service with the PLA navy, six have already been retired and one lost by accident with its crew.

The two submarines sold to the navy in Dhaka had been modernized after being withdrawn from service. A third was sold to Myanmar, where it joined another second-hand Indian submarine. Sold for around $100 million each, these submarines remain a remarkable opportunity for nations with limited resources, reinforcing China's attractiveness.

Europe: Healing the Scar Left by the Iron Curtain

Western European states, equipped with military material that is high-performance but limited in quantity by budgetary constraints, are in a different situation from Eastern European states, which still have large quantities of Warsaw Pact legacy material with varying degrees of modernization and compliance with NATO standards. The process of modernization and progressive replacement of old Soviet material has been considerably accelerated by the Ukraine conflict, because these older items

42. H. Young, "The Defective Chinese Equipment & Weapons", *Reportika*, accessed on October 21, 2022, available at: www.ij-reportika.com.
43. A. Hussain, "Submarines Lead Bangladesh Navy Into New Waters", *Dhaka Tribune*, March 13, 2017.

are being sent into the field on a massive scale and also because Eastern European states want to acquire military material that is higher performance and less dependent on a flow of parts from Russia. This development is encouraging the trajectories of Western and Eastern forces to converge on a similar level of ambition, although the conflict has also highlighted the absence of stockpiles in certain states.

In Western Europe, New Material but in Small Quantities

Over the past thirty years, the armed forces of Western and Northern Europe have been the quickest to reduce their size, due to the absence of any prospect of major conflict in their immediate geographical environment after the fall of the USSR. This policy has resulted in a drastic reduction in sizes, accompanied by—depending on preferences—a modernization effort guided by the desire to maintain either interoperability with the United States within the framework of NATO, or a force projection capability for stabilization or crisis management missions (in the case of France and the United Kingdom in particular). As the capability requirements for such missions do not include any particular mass or superiority in equipment, stockpiles have gradually been reduced to a minimum.

This trend has been further accelerated by several fiscal and technological factors. The economic and budgetary crisis of 2008 forced states to reduce their spending in all areas. In the absence of a proven threat, the budget allocated to the armed forces was reduced in most European countries, leading to reductions in size and, for the least well-funded, even the abandonment of entire capabilities. Belgium and the Netherlands, for example, gave up their last tanks in 2014 and 2011 respectively. Others, such as Spain, chose to place some of their tanks in long-term storage, retaining the possibility of using them if necessary and maintaining a semblance of mass capability.[44] Furthermore, the growing sophistication of material, linked to the rise of electronics and digitization, is leading to an increase in acquisition and utilization costs, which contribute to reducing the size of fleets,[45] while military budgets remain constrained.[46]

The United Kingdom, similar to France in terms of the size of its military, has been affected by budget reduction and cuts to the resources allocated to the armed forces. The British contribution to the conflict in Ukraine nevertheless occurred earlier and on a larger scale than that of France.

44. É. de Durand, "Europe : d'une démilitarisation l'autre", *Politique étrangère*, vol. 79, No. 1, Ifri, 2014, pp. 103–116.
45. R. Briant, J.-B. Florant, and M. Pesqueur, "La masse dans les armées françaises : un défi pour la haute intensité", *Focus stratégique*, No. 105, Ifri, juin 2021.
46. S. Lefeez, "Toujours plus cher ?".

Table no. 2: Comparison of British and French military contributions as of October 15, 2022

	Total contribution (Rank order)	Humanitarian contribution (Rank order)	Financial contribution (Rank order)	Military contribution (Rank order)
United Kingdom	€6.650 billion (2nd)	€365 million (4th)	€2.545 billion (2nd)	€3.740 billion (2nd)
France	€1.145 billion (7th)	€130 million (6th)	€0.800 billion (7th)	€0.216 billion (13th)

Source: Kiel Institute, available at: www.ifw-kiel.de, accessed October 15, 2022.

There are several reasons for this difference. Even before 2014, British support amounted to more than €1 million per year, primarily in the area of Command, Control, and Communications (C3) capabilities.[47] Following the annexation of Crimea, the UK became involved in rebuilding the Ukrainian forces, alongside Canada and the United States. In early 2015, the British forces launched Operation Orbital, designed to provide more training to the Ukrainian forces in the medical, logistics, infantry combat, and intelligence domains. The stated aim was to "train Ukrainian trainers" to increase the autonomy of Ukraine's forces. Though it is difficult to estimate the effectiveness of this aid precisely, it has increased over time, while the British were the first to question the European taboo on delivering lethal weapons in 2015. Between 2015 and 2017, the United Kingdom provided assistance worth more than €2.5 billion, while in November 2021, the two countries signed an agreement providing for support of nearly €2 billion more. As early as March 2022, British diplomacy was also very active in mobilizing European and Commonwealth opinion in support of Ukraine.[48]

The first step in British assistance was to massively scale up the training of Ukrainian troops in early March 2022, when Operation Interflex replaced Operation Orbital, which had trained more than twenty thousand Ukrainian soldiers over eight years. The goal of Operation Interflex is to provide one month of intensive training in infantry combat, first aid, mine clearance, and cyber security to successive groups of ten thousand Ukrainian soldiers in the United Kingdom and elsewhere in Europe.

Significant quantities of material have been pledged and delivered, including material that is being or has already been retired, along with much more modern material. This support is split between items taken directly from the UK forces' stockpiles (such as the FV family of vehicles), second-

47. "Question for Ministry of Defence", September 11, 2014, available at: www.questions-statements.parliament.uk.
48. C. Mills, "Military Assistance to Ukraine 2014–2021", *House of Commons Library*, March 4, 2022.

hand items procured from private contractors or partner states (such as the M109s), and new items procured specially (such as UAVs and munitions).[49]

Table no. 3: Transfers of British military material to Ukraine

Name	Type	Quantity	First delivery
FV103/104/106/107	Tracked armored vehicle	+70 (?)	June 2022
Stormer high-velocity missile (HVM)	Tracked armored vehicle	6	April 2022
Wolfhound	Mine-resistant ambush protected (MRAP)	20–40(?)	May 2022
Mastiff	MRAP	20–40(?)	June 2022
Husky	Armored vehicle	20–40(?)	June 2022
L118/L119	105mm towed howitzer	+60 (?)	July 2022
M109	155mm self-propelled howitzer	20+ (?)	June 2022
M270B1	Self-propelled multiple rocket launcher	6	August 2022
Harpoon	Anti-ship missile	?	June 2022
Brimstone	Anti-tank missile	?	May 2022
Javelin/Next generation light anti-tank weapon (NLAW)	Anti-tank missile	+ 5,000 (?)	March 2022
Black Hornet	Micro UAV	850	August 2022
Individual protection	Helmets, plate-carriers	+ 300,000	March 2022

Source: G. Allison, "What Military Aid Has Britain Given to Ukraine?", UK Defence Journal, *October 4, 2022.*

This generosity, therefore, forms part of a strategic rationale developed since 2014. It is also based on a future reduction in the British army's resources and size from eighty-two thousand to seventy-three thousand by 2025.[50] This reduction makes available a certain amount of material of all types that will soon be considered surplus. While seventy-nine Challenger 2 tanks are expected to be mothballed because they cannot be modernized, it is likely that only their high complexity and advanced technology have kept the United Kingdom from donating them to Ukraine. Some of the mothballed tanks were nevertheless sent to Poland to backfill the capability gap caused

49. G. Allison, "What Military Aid Has Britain Given to Ukraine?", *UK Defence Journal*, October 2022.
50. T. Ripley, "UK Aims to Downsize British Army to 73,000 Soldiers", *Janes.com*, November 25, 2021.

by Warsaw dispatching more than two hundred tanks to Ukraine,[51] an alternative and appropriate way to use capability-related stockpiles.

The United Kingdom has suffered as much as France from the end of the Cold War and the reduction of its resources and contingency stocks, however. The Harrier jump jets long kept in flying condition at the Cottesmore airbase after their withdrawal from service were sold to the US Marine Corps in 2011. The last British aircraft carrier, the *Ark Royal*, was going to be kept as a helicopter carrier until 2016, to reduce the capability gap between its retirement and the arrival of Queen Elizabeth-class aircraft carriers in 2020. However, in 2010, the British government decided to dispose of the *Ark Royal* to save on maintenance costs, thus depriving itself of a force projection tool.

The Falklands War had nevertheless demonstrated the importance of these military assets, as well as of naval stockpiles, whether these belonged to the Royal Navy or the latter had arrangements in place allowing it to requisition the necessary resources in an emergency. One of the two assault ships used in the Falklands War had to be reactivated in a hurry after being taken out of service a year previously. Similarly, a large number of civilian merchant ships were requisitioned to ensure logistics on the far side of the globe. The Ships Taken Up From Trade (STUFT) mechanism allowed the use of some thirty ships, from oil tankers to offshore response vessels.[52] These requisitions were accompanied by a very rapid transformation effort, of the order of a few weeks in total, to adapt this new fleet to the needs of the moment: a cargo ship was modified in five days so that military helicopters could take off from and land on its flight deck.[53]

This process of requisition and adaptation provided the British forces with the logistic and maintenance support fleet the operation required. While this process was in part a form of emergency improvisation, it was nevertheless made possible by the advance organization of STUFT-related procedures. This type of mechanism is akin to a “hidden stockpile” or “indirect store” kept in the hands of non-military actors who can, if necessary, be compelled to make their assets available to the armed forces. While this mechanism has proven valuable, it relies on assets that are relatively beyond military and government control, and its availability at critical times may be too limited to provide truly effective support, as accelerating globalization has scattered merchant ships around the globe. The lessons of the Falklands War must also be adapted, as combat conditions have changed dramatically over forty years. Today it would be more difficult

51. J. Adamowski, “Poland Confirms T-72 Tank Delivery to Ukraine, with Challenger 2 Tanks to Fill Gap”, *Defense News*, April 26, 2022.
52. N. Messinger, “Ships Taken Up From Trade - ‘STUFT’: What They Did in the Falklands War”, Report for the Directorate of Naval Operations and Trade, January 1983.
53. H. Masse, “Les Malouines, 35 ans après : que reste-t-il des enseignements du conflit ?”, Tribune No. 888, *Revue défense nationale*, May 10, 2017.

to adapt requisitioned ships urgently, as the infrastructure required is becoming scarcer and the threats, more varied. In 1982, one of the requisitioned cargo ships was sunk by an Argentine anti-ship missile, but the lethality of today's sea combat could lead to even greater losses of poorly adapted ships.

In Eastern Europe, New Developments

For the countries of Eastern Europe, the fall of the Berlin Wall led to major reductions in size and an in-depth reorganization of their armed forces, accompanied by their integration into NATO. This transformation led to a large quantity of systems inherited from the Soviet period, mainly in the airborne and land sectors, being resold and placed into reserves. The aging of the Soviet systems—accelerated by occasional disagreements with Russia, the main supplier of parts—has nevertheless pushed Eastern European states into a progressive replacement of their systems with a mixture of material acquired abroad. Off-the-shelf purchases are coupled with a significant movement to modernize specific locally produced material and their own production apparatus inherited from the Soviet era. While land vehicles benefit from national expertise, more complex items such as fighter aircraft are often acquired from NATO partners.

Romania, for example, chose to modernize its TR-85 battle tanks and MLI-84 armored infantry vehicles, which were derived from Soviet models and produced locally. In contrast, the Romanian air force has acquired second-hand F-16 Fighting Falcons from the US and Portuguese air forces so it can retire its last MiG-21s, which have been in service since the 1960s. Croatia recently followed the same path, modernizing its Yugoslav-origin M-84 tanks derived from the Soviet T-72 as much as possible, while acquiring twelve second-hand Rafales from France in 2021.

Although less expensive than making off-the-shelf purchases, the modernization of Eastern European nations' land capabilities nevertheless led to a proportion of the fleets being stockpiled, since not all of them could be modernized. These stockpiles were then put to good use during the conflict in Ukraine, enabling Eastern European states to provide massive assistance that the Ukrainian forces could use immediately. This choice is all the more in keeping with the movement toward modernizing forces as Germany has committed to replacing the systems given to Ukraine with more modern alternatives, via the *Ringtausch* (Exchange) initiative mechanism. The Czech Republic will thus receive fifteen Leopard 2 tanks (of the earliest iteration) to replace the fifty or so T-72s it delivered to Ukraine in the spring of 2022.[54]

Poland's strategy for renewing its armed forces stands out because of its ambitions for its capabilities, which are on a totally different scale from those

54. "Czech Republic Becomes First Country to Send Tanks to Ukraine", *Kafkadesk*, April 6, 2022.

of its Eastern European neighbors, while Polish support for Ukraine ranks third in the world, with a value approaching €2 billion.[55]

Table no. 4: Transfers of Polish military material to Ukraine

Name	Type	Quantity	First delivery
T-72P/PT-91	Battle tanks	+ 250 (?)	April 2022
BWP-1	Armored infantry vehicle	40	April 2022
LPG WDSz	Artillery observation vehicle	> 20 (?)	June 2022
AMZ Dzik 2	Armored vehicle	> 40 (?)	May 2022
AHS Krab	155mm self-propelled howitzer	18	June 2022
2S1 Gvozdika	122mm self-propelled howitzer	+ 20 (?)	April 2022
BM-21 Grad	Multiple rocket launcher	+ 20 (?)	April 2022
R-73	Air-to-air missile	100	February 2022

Source: "Answering The Call: Heavy Weaponry Supplied to Ukraine", April 11, 2022, Oryxpioenkop.com.

Wealthier than most other Eastern European countries, Poland has embarked on a process of renewing its forces to a standard rarely seen since the end of the Cold War, replacing almost all of the material inherited from the Warsaw Pact with more modern material that meets NATO standards. While the process has yet to be confirmed over time and through possible changes of government, all three of Poland's armed forces could complete full transition to a NATO capability standard before the end of the decade. The F-16s will be joined by the thirty-two F-35s and forty-eight FA-50s recently ordered to replace the Soviet-era MiG-29s. While several hundred T-72s and their local version, the PT-91s, have been donated to Ukraine, the Polish land forces will receive assorted replacements in the form of three hundred American Abrams tanks, a thousand Korean K2s, and two hundred and fifty German Leopard 2s, while the old BMP-1s are being replaced by locally produced Patrias. The artillery will not lag behind, with more than a thousand self-propelled howitzers of various types having been ordered as the Soviet 2S1s and BM-21s have been put into storage or sent to Ukraine. The Polish navy also stands out for its ambition: although the level of investment has been lower, several ships have been acquired since 2015, while a modernized local construction capability has been developed.

Polish generosity can be explained by the prospect of a complete renewal of its material in the short and medium terms, but also by a different perception of the Russian threat. It is likely that the Polish government chose to equip its attacked neighbor on a massive scale because it believed that any

55. Data from the Kiel Institute *Ukraine Support Tracker*, available at: www.ifw-kiel.de.

reduction in Russian military potential in Ukraine would indirectly contribute to securing Poland's strategic situation. With this end in mind, it is rational for a nation to deprive itself of a large quantity of relatively outdated stockpiled equipment to inflict maximum losses on opposing forces, while the transition to more modern systems is accelerating.

Germany, in the Center and Caught in the Middle

Germany's situation is interesting in that it finds itself "in between", as it experiences the dynamics of both Western and Eastern Europe. Between 1990 and 1994, the absorption of the former German Democratic Republic's National People's Army by the Bundeswehr resulted in a near doubling of the number of personnel and provided the new country with a very large quantity of material. While the surplus human resources were cut back, the bulk of the Soviet equipment was put into storage, to be gradually given away, resold, or destroyed. The twenty-two remaining MiG-29s were sold to Poland in 2003 after having been brought up to NATO standards. More recently, hundreds of SA-7 Strela-2 anti-aircraft systems have been taken out of storage and sent to Ukraine, although their general condition has raised questions about their safety in use.[56]

The Bundeswehr is also suffering from budget cuts that drastically limit its operational capabilities, along with an acute problem of lacking appeal to potential recruits. Like many other European nations, Germany has finally resolved to increase its military spending, announcing an "epochal shift" (*Zeitenwende*) in the context of the conflict in Ukraine. The €100 billion fund announced for the recapitalization of the Bundeswehr is more than welcome, but finding the right balance between spending on refurbishment of existing equipment and spending on purchases of new equipment could prove tricky.[57] This observation is all the more valid as the German forces have stored some of their land material due to a lack of human and financial resources to maintain it. Other material, like the Gepard SPAAGs now donated to Ukraine, has been preserved for more than a decade, after the last unit to be equipped with them was disbanded at the end of the first decade of the twenty-first century.

Stockpiling military material thus remains a feature shared by the major world powers, and China's attitude to this activity, which remains unknown, could in the future be an effective lever for Beijing and its military diplomacy. European forces, less well equipped than other major world powers, have nevertheless been able to take advantage of their limited capabilities to influence the ongoing conflict. The gradual disappearance of old material

56. Bundeswehr press release [in German], Bundeswehr, January 17, 2022, available at: www.bundeswehr.de.

57. É.-A. Martin, "La modernisation de la Bundeswehr : un retour aux fondamentaux ?", *Notes du Cerfa*, No. 171, Ifri, October 2022.

inherited from the Soviet era makes it possible to contemplate a comprehensive replacement of the Eastern European armies' material. In the meantime, Western European countries, including France, are pondering changes to their military budgets.

France's situation

For almost a decade, from 2007 to 2016, the French Ministry of Defense attempted to reduce the number of defense personnel and government spending on defense. In this context, military stockpiling policy was largely rethought, to save maintenance and infrastructure costs expended on resources deemed to be inactive. The catch-up in budget and personnel that has been under way since 2016 has given the armed forces a first hint of leeway, while the Covid-19 pandemic has demonstrated how essential it is to have stockpiles, including non-military ones, to deal with crises. In line with this, the conflict in Ukraine has provided evidence of the importance of having significant capability-related stockpiles to protect the country in the event of high-intensity conflict or to support a partner involved in such a conflict.

French Regulations on Stockpiling

The stockpiling policy of the French military is legally defined by the Decree of February 21, 2012, on the logistic management of movable property assigned to the Ministry of Defense, Article 2 of which gives the following classification:[58]

- assets "in operation", deemed to be in use;
- "available" assets, not being used but capable of being put into operation;
- "unavailable" assets, not capable of being put into operation.

"Unavailable assets" include a set of subcategories: some are undergoing maintenance, in transit, or awaiting destruction, while others are simply awaiting a decision. Finally, unavailable assets labeled as "reserved" are "retained and maintained for mobilization to meet specific needs or respond to exceptional circumstances". This category theoretically includes items taken out of service but kept for use in the event of a crisis and preserved from cannibalization.

The interviews conducted for this report with the dedicated services of the three armed forces converge on the same observation: stockpiles, understood as unavailable reserved assets, generally disappeared between 2007 and 2016, as a result of budget changes and the reorganizations undertaken to deal with them. Forced to make a difficult choice, the armed forces logically favored preserving existing capabilities over prudent

58. This decree applies to all three armed forces, each of which uses its own terms internally, making it considerably more difficult to study the subject.

stockpiling policies, even if the latter were only moderately costly in terms of human and financial resources. As a result, stockpiles that could not be cannibalized or used in some way were mostly sold, dismantled, or destroyed. Some of the storage infrastructure freed up was also sold, to save money and provide the ministry with additional income for years to come.

By doing away with the strategy of maintaining stockpiles, the budgetary imperative led to the rise of a "just-in-time" operating approach that went far beyond the context of reserved assets and extended to munitions and operational fleets. The just-in-time approach, first developed in manufacturing, seeks to limit the waste and inactivity of value as much as possible by optimizing flow, which is active, to the detriment of inventory, which is inactive. Deliveries must coincide as closely as possible with the use of the items delivered, to do away with internal storage costs. Products are therefore manufactured just in time, in the right quantity, while seeking to keep the level of quality as consistent as possible. Adapted from Japanese Toyotism of the 1960s, this approach relies on perfectly oiled internal mechanisms and suitable transport infrastructure, because the slightest delay in one segment of the chain causes shifts and delays along the whole chain, since no inventory is available. As a result, this system is vulnerable to exogenous crises and unforeseen imponderables such as major armed conflicts.

The sizing of military forces is based on two different levels: the baseline operational situation of "crisis management", where requirements are limited, and that of a large-scale armed conflict, the major engagement hypothesis (*hypothèse d'engagement majeur*), where supply requirements are likely to increase suddenly. With the just-in-time approach, flows are sized to cover the requirements of the baseline operational situation, but in the event of a major engagement, would prove insufficient to regenerate forces experiencing a much higher attrition rate.

An analogy can be drawn with the French health system during the Covid-19 crisis: the system, which was sized according to the requirements of a normal situation, in terms of its capacity and its stockpiles (masks, supplies, etc.), went through a period of arduous and generally sub-optimal improvisation, even though the virus could have proved to be more contagious and pathogenic than it actually was. In the military context, such a degree of haphazard improvisation could also have terrible consequences. While nuclear deterrents make it possible to prevent some meltdown scenarios, taking a just-in-time approach deprives France of certain capacities to influence external conflicts: cut to the bone and stripped of capability-related stockpiles, the French forces cannot afford to lose the material they have in the field.

The French military contribution to the Ukrainian war effort has thus been limited to a small quantity of individual equipment and advanced munitions, to the detriment of its own equipment: of the seventy-six

CAESARs it started out with, the French army now has only fifty-eight available. This number must be further qualified in view of an estimated 70% availability rate (65% in 2019), which would leave it below the forty-eight units specified in the major engagement hypothesis operational contract.[59] Meanwhile, the donation of a number of retired French armored personnel carriers (*véhicules de l'avant blindés* or VABs) has also shown the value of keeping a stock of equipment not exclusively intended for cannibalization. When Kyiv requested anti-aircraft systems to defend itself against Russian missile salvos, the French forces' low inventory of this type of material made a contribution unlikely. The decision to send Ukraine a proportion of France's Crotale systems thus further diminishes an already very limited capability within the forces.[60]

Budget reduction has been the predominant factor, but it is not the only one affecting French stockpiling policy. The growing sophistication of military material has led to a rapid escalation of costs. The reduction in the size of orders and series has further increased the unit cost of modern material, particularly in the naval and air sectors.[61] This dynamic starts a vicious circle: the lack of budget reduces orders, forcing an increase in performance, which leads to an increase in cost, which in turn limits purchasing capacity.

Aversion to military casualties has also contributed to systems becoming more expensive, with increased security requirements tailored to the risks associated with low-intensity operations, such as improvised explosive devices. The expeditionary nature of French military operations in recent decades also implies higher operational costs than equivalent military activity in or near mainland France.

The French Armed Forces and the General Review of Public Policies (RGPP)

While all the French armed forces have been affected by the spread of the just-in-time approach, they have been affected in different ways. In general, the effects of the post-Cold-War "peace dividend", which limited military spending, were compounded by the application of France's 2007 General Review of Public Policies (*Révision générale des politiques publiques* or RGPP) and then the consequences of the 2008 economic crisis. Government departments were required to make additional efforts to reduce their

59. "Question n° 25691 du député Cornut-Gentille sur la disponibilité des équipements de l'armée de Terre sur l'année 2018-2019", *Assemblée nationale*, available at: www.assemblee-nationale.fr.
60. L. Lagneau, "L'armée de l'Air et de l'Espace pourrait céder à l'Ukraine des systèmes de défense aérienne Crotale NG", *Zone militaire*, October 13, 2022.
61. S. Lefeez, "Toujours plus cher ?", p. 15.

expenditure, or the growth of their expenditure, resulting in far-reaching reorganizations. The armed forces were thus requested to "restructure their support and administration, as well as reducing their size".[62] These two objectives were to be achieved by two methods: outsourcing certain functions via public-private partnerships, seen as less costly, and pooling services to achieve economies of scale. In the midst of this upheaval, cutting 54,000 out of the 320,000 civilian and military positions in the French Ministry of Defense was an objective from the outset, and was facilitated by the creation of the Defense Base Support Groups (GSBdD).[63] Unlike normal military budgets, the RGPP did not allow for any additional spending,[64] considerably limiting the armed forces' ability to adapt. In this context, creating contingency stocks proved largely impossible, while any asset categorized as "useless" was deemed to be under threat from a budget point of view.

The Army: The stockpile is Dead, Long Live the Reserve?

For the army, the application of the RGPP resulted in around twenty units being cut, predominantly in maintenance and logistics, and a number of bases being closed down. Important skills were lost, particularly those related to maintaining stored systems, making it all the more difficult to preserve the remaining stockpiles. The exact impact on material is difficult to calculate, as the data required is often confidential. Nevertheless, the systems stored by the material support bases, notably at Saint-Astier, were scrutinized. The items that had been withdrawn from service and could not be used for spare parts were recycled to save on maintenance and infrastructure costs. The AMX-10P, for example, replaced in 2008 by the armored infantry combat vehicle (*véhicule blindé de combat d'infanterie* or VBCI), seems to have disappeared entirely from inventories, including the hundred or so units modernized to cope with delays in bringing through its successor. In a period of more generous budgets, the preservation of modernized units, facilitated by the abundance of spare parts from withdrawn vehicles, would have made it possible to have a substantial fleet that could, for example, have been transferred to Ukraine, as was done with the VAB armored personnel carriers, which had just been withdrawn.

The extent of the cuts should not lead to an idealization of what has been "lost", however. Although long-term storage of material was much more widespread until the end of the Cold War, it was not without its problems. Sources about the time often mention an overabundance of parts of different types, leading to a lack of monitoring of their compatibility or even their

62. R. Doaré, "La mutualisation au cœur de la réforme des armées", *Inflexions*, vol. 21, No. 3, 2012, pp. 121–131.
63. G. Roger and A. Dulait, "Bases de défense, une réforme à conforter", Rapport d'information No. 660, Sénat, July 11, 2012.
64. S. Kott, "La RGPP et la LOLF: consonances et dissonances", *Revue française d'administration publique*, vol. 136, No. 4, 2010, pp. 881–893.

usefulness. There were also not entirely favorable impressions of the storage of systems that had been taken out of service: high maintenance costs, dubious usefulness, and refurbishment to operational condition taking place too infrequently to maintain a satisfactory level of performance or even of availability.

Despite the reduction in its budgets, the army has been aware of the indispensability of stockpiles for any urgent operation and managed to maintain a certain culture of stockpiling. It has mechanisms that have made it possible to keep stockpiles in an administrative category other than the "reserved assets" category now so despised in budgetary audits. Supply dumps "for autonomous initial projection" ("*d'autonomie initiale de projection*") or "Guépard" supply dumps, located on French forward operating bases in Africa, were designed to provide land force units deployed in an emergency with access to the material and vehicles required for their action. These facilities enabled Operation Serval to take place very rapidly, but they were not restocked after 2013 due to a lack of resources.[65] Unless they are replaced, carrying out a similar operation under the same conditions would be extremely difficult, if not impossible. The Guépard supply dumps are part of the French national emergency echelon mechanism that allows the military to maintain a hard core of material ready for combat and for the rapid projection of a joint immediate reaction force of 2,300 soldiers within a radius of 3,000 kilometers.[66]

Another mechanism, the adoption in 1997 of the concept of the Reinforcement of African Peacekeeping Capabilities (*renforcement des capacités africaines de maintien de la paix* or RECAMP), led to the creation of supply dumps at the disposal of the General Staff of the Armed Forces, to have a capability-related stockpile for supporting partner forces, such as multinational detachments belonging to African regional organizations.[67] Limited funds were made available for purchasing or buying back equipment to stock the dumps. This mechanism was supposed to be linked to the African Standby Force, a pre-positioned peacekeeping force under the direction of the African Union that was conceived in 2002 but has not yet materialized. Deemed to be a stockpile of "assets made available" rather than of "reserved assets", it was nevertheless used by the French armed forces to provide the vehicles needed for Operation Sentinelle. As these supply dumps have not been replenished since Operation Sentinelle, they are now used essentially as a mechanism for transferring items to partner nations and are therefore also operating on a just-in-time basis.

65. J.-C. Notin, *La Guerre de la France au Mali*, Paris, Tallandier, 2014.
66. "Projet de loi relatif à la programmation militaire pour les années 2019 à 2025 et portant diverses dispositions intéressant la défense", Sénat, May 15, 2018, available at: www.senat.fr.
67. "La France et la gestion des crises africaines : quels changements possibles ?", Rapport d'information No. 450, Commission des affaires étrangères, Sénat, July 3, 2006, available at www.senat.fr.

The suspension of the process of reducing manpower, following the 2015 terrorist attacks in France, and the subsequent budget increases allow us to look at the future from a different perspective, however. It should be noted that some of the systems left over from the unit cuts have been preserved, in particular the modernized Leclerc battle tanks. In contrast, most of the two hundred or so units put into storage when they were received early in the first decade of the twenty-first century have been cannibalized.[68] During the reconstitution of the Fifth Dragoon Regiment in the context of an opposing force (OPFOR) training exercise, recovering a few dozen tanks from those in storage proved to be a long and complex process, because of the extent to which the remaining specimens had been stripped.

VAB armored personnel carriers, which are being replaced by Griffons, are also the focus of particular attention, and it seems they are not destined for straightforward elimination, like other retired systems. The number of vehicles available following the withdrawal from service—in the order of 2,500 units—makes it possible to envisage reusing and preserving a significant number of them for various purposes. Some will be used to provide armored protection for certain operational functions, in particular logistics, recovery under fire, and the dog regiment. VAB armored personnel carriers used for artillery observation and Nuclear, Biological, Chemical Reconnaissance Vehicles will remain in service until their replacements are available, because of their specific capabilities. To support this preservation effort, some of them will be preserved as a maintenance reserve and vital spare parts. The Ministry of Defense will ultimately dispose of them by resale or transfer, mainly to African partners. As an indication of the political importance accorded to the conflict in Ukraine, the VAB armored personnel carriers sent to Kyiv in July 2022 were the subject of a procedure that took only a few weeks, whereas the usual transfer procedures can take several months.[69]

Ultimately, keeping these vehicles is in line with the ambition to increase the power of the operational reserve, aiming to create reservist units with dedicated fleets, like the Twenty-Fourth Infantry Regiment. While "ambition doesn't cost much",[70] this trend helps the land forces to justify budgets for keeping in reserve more weapon systems, vehicles, and individual weapons that are in the process of being replaced, like the Beretta 92 (PAMAS) and MAC 50 (PAMAC) semi-automatic pistols and FAMAS assault rifle. These developments suggest that the succession of crises since 2015 is leading to an internal reconsideration of just-in-time delivery in favor of an at least partial return to a strategy of targeted stockpiling.

68. J.-D. Merchet, "La France serait-elle capable de livrer des chars *Leclerc* à l'Ukraine ?", *L'Opinion*, September 28, 2022.
69. Interview with officers of the SIMMT (the command structure for the French Army's Integrated Structure for the Maintenance of Terrestrial Material in Operational Condition), September 2022.
70. Quotation from an interview with French army officers, September 2022.

The return of stocks for use by reserve forces also poses certain technical problems. PR 4G radios are gradually being transferred to the stock intended for use by reservists, but they are not entirely compatible with their successors, the Contact tactical radios, which means that a dedicated intergenerational interface must be preserved.[71] This resurgence of a strategy of maintaining stockpiles is also limited to relatively basic systems, for the moment. As the armed forces are already short of qualified personnel in technological areas, it seems undesirable to reduce this limited resource by allocating some of them to maintaining inactive systems, to the detriment of the operational fleet. Consequently, preserving advanced systems will require a closer relationship with industrial partners, unless a particular effort is made with training.

This problem is even more acute for the French Air and Space Force (AAE) and navy. Without denying the complexity of past systems, increasing sophistication has led to maintenance needs requiring increasingly specialized skills. Maintenance methods and solutions have evolved along with systems toward automated diagnostic procedures that make it easier to identify the origin of a problem, but solving those problems may require specific skills that are less available within the armed forces, which are less attractive than the private sector. In the case of the army, the re-creation in 2020 of a technical school for non-commissioned officers also marks a recognition of the challenges linked to the increasing sophistication of the systems used by the military.

The French Air and Space Force: Verticalization and the End of Contingency Stocks

For the French AAE, the application of the RGPP meant the closure of eight air bases. The closure of Base BA 279 at Châteaudun, effective in 2016, was symptomatic of the end of the AAE's centralized stockpiling policy. More than five hundred airframes in various states were stored there, in controlled-atmosphere hangars or along the edge of the runway. With the largest hangar in Europe, the base was able to look after dozens of mothballed Mirage F1s, Mirage IIIs, and Mirage 2000s, along with TB-30 Epsilons, Alpha Jets, and Fouga Magisters. The oldest and most damaged airframes, such as those from Jaguars, Mirage IVs, Nord 262Ds, C-160 Transalls, and Mystère 20s, were left outdoors, as they only had less fragile components left to offer.[72]

As no other base had similar infrastructure, the closure of Châteaudun was accompanied by the destruction of almost all the airframes stored there.

71. Interview with officers of the SIMMT, September 2022.
72. P. Stevens, "Châteaudun – The French Air Force's Warehouse", Target Aviation Photography, February 2012, available at: www.targeta.com.

Because dismantling aircraft is a complex and costly process, effort was focused instead on their transfer or sale to state and private partners such as Sofema (*Société française d'exportation de matérial militaire et aéronautique*), which was given responsibility for renovating them and then exporting them or extracting spare parts. A significant proportion was also made available to museums or associations and transformed into exhibition material. The preservation of airframes is now piecemeal and not part of a centralized strategy. A large number of spare parts rendered useless by the storage of old devices coming to a scheduled end was also destroyed or resold at the end of the first decade of the twenty-first century. The end of Châteaudun is thus symptomatic of the spread of a just-in-time approach, amid shrinking human resources and constant increases in the cost of fleet acquisition and maintenance.

In addition to the downstream stock at Châteaudun, the AAE at one time had an upstream stock of surplus Mirage 2000s,[73] acquired to build up a contingency reserve of airframes and preserved from cannibalization. These aircraft were also used to enable active and reserved airframes to be rotated, to prolong their useful life and be able to carry out the biggest maintenance tasks during these periods of inactivity. This mechanism reduced the average wear and tear on the airframes in the field, thus spreading the growth of maintenance costs and periods over time. However, financial difficulties led to these Mirage 2000s being cannibalized and the end of this contingency reserve in France.

The end of contingency reserve airframes and the limited number of combat aircraft now in service have pushed the AAE to optimize its MOC to make the most of the available aircraft by increasing their availability. In the absence of sufficient stocks of parts, an increasing number of combat aircraft in service are grounded: in 2021, fourteen Rafales were grounded because they were cannibalized to enable other aircraft to be flown.[74] As the application of the RGPP caused the AAE to lose a significant proportion of its own maintenance capacities, a growing proportion of aircraft MOC was delegated to private-sector players in the aerospace industry, led by Dassault Aviation. The result is the current process of verticalization of MOC through the RAVEL (for Rafales) or BOLERO (for M88 engines) contracts, with end-to-end responsibility delegated to a private partner and a requirement for results expressed in terms of the number of flight hours to be made available. While the financial profitability of the process is uncertain, the significant increase in average availability is an encouraging sign, although the necessary data became confidential in 2021.

However, the increasing delegation of MOC creates new problems by increasing the armed forces' dependence on external players, including in

73. No precise period was given, but probably during the 1980s.
74. L. Lagneau, "Selon Mme Parly, 14 *Rafale* de l'armée de l'Air sont actuellement cloués au sol pour avoir été 'cannibalisés'", *Zone militaire*, October 7, 2021.

theaters of operation. This development must be taken into account when creating a coherent stockpiling strategy, which may require the services of industrial technicians. The growing importance of private players in the activities of the military, and particularly the AAE, is not limited to MOC, as subcontracts are multiplying in the field of training via companies specializing in training and adversary support (red teaming).

The Navy: Limited Series and MOC Optimization

The mothballing of ships—carried out by the French navy only occasionally until the early 1980s—is irrelevant today. The lack of funding and suitable infrastructure makes preserving contingency hulls in dry docks or wet docks unrealistic. The last experiments carried out by the United Kingdom also yielded results that were only partly satisfactory, due to difficulties with maintenance and reactivation. The greater sophistication of modern ships increases the difficulty of long-term preservation and the need for skilled personnel, an already limited resource for active ships in the French navy. Decommissioned ships, such as tripartite mine hunters or P400 patrol boats, have often been used beyond their reasonable working life to compensate for their low numbers and hence are not in a condition that would allow them to be preserved. A hull stockpiling policy would therefore require very significant human and financial resources in return for uncertain utility, while more important projects such as replacing the naval air group will absorb a significant proportion of budgets for decades to come.

Faced with a reduction in its size but no reduction in its level of ambition, the navy is obliged to optimize the lifespan and availability of its ships. The issue of maintenance and stocks of spare parts is therefore a higher priority than that of hull stockpiling, which is reserved for more generously funded players. The navy needs large quantities of parts and contingency spare parts ("*rechanges de grande prévoyance*"[75]), and it is already commonplace for one or more vessels in a particular class to be cannibalized to ensure that the other(s) can remain operational. The situation with munitions is also tricky: in firing training, the oldest munitions are used, which leads to higher failure rates than those encountered with younger munitions.

Short series of vessels and long lifespans make it imperative to preserve supplies of possibly unique smaller and larger contingency spare parts for long periods. The time that elapses between the laying down of the first and last ships in a series also implies a progressive implementation of new technologies and sometimes leads to significant differences between two ships of the same class, which may end up sharing only a limited number of

75. "*Rechanges de grande prévoyance*" (contingency spare parts) is a term used by the French navy to denote large parts and subsystems.

common parts. Ironically, the reduction of the FREMM European multipurpose frigate series has made available a certain quantity of parts acquired by the manufacturer for the canceled units.

The concept of inventories was revived during the Covid-19 pandemic, when supply problems demonstrated how unsuitable just-in-time operations are in times of crisis. The navy had got a head start in this regard in 2018 by conducting research to identify five hundred critical parts, stocks of which needed to be increased as a priority. This process of increasing stocks in a targeted manner is coupled with a drive in the opposite direction to identify reusable parts in ships withdrawn from service, notably following the withdrawal of anti-submarine frigates. An intense open data inventory (ODIN) project has been launched, covering more than one million parts, from door hinges to turret housings. The great complexity of such an undertaking has also highlighted the need for a centralized parts management system to monitor inventory status and the properties and compatibility of parts as accurately as possible. The ODIN project should enable the navy to replace its current system, dating back to the 1990s, with a more modern, centralized, and standardized system by 2028.

The storage space saved by disposing of unnecessary parts also provides an opportunity to rationalize stocks further. On-board stocks must be condensed, favoring the most frequently used parts as identified by a statistical analysis. Rather than having equal numbers of different parts, there will be larger numbers of the most frequently used parts on board to facilitate maintenance operations at sea. The staging forward of spare parts on land will also be reviewed and adapted to needs, including by increasing the stocks kept overseas to limit dependence on stocks in mainland France. In addition, the long-haul transport of parts must be improved to ensure the most sensitive components, particularly electronic and chemical components, are better protected during the journey. If stored in inappropriate conditions, such components arrive at their destination unusable, corroded, or oxidized.

As the systems on board military vessels grow more complex, the role of industrial players is becomingly increasingly important for the French navy, just as it is for the AAE. The presence of civilian technicians is occasionally required onboard French ships, including at sea, to repair complex subsystems, as occurred during Operation Harmattan. With the next generation of ships expected to be even more complex, this requirement could become more frequent.[76] To meet the potential need for qualified

76. The US Navy is already experiencing the difficulties created by ships' increasing complexity: the Littoral Combat Ships built by Lockheed Martin have to spend one week a month at berth for routine maintenance operations, as the manufacturer is the sole owner of the diagnostic tools essential for routine maintenance. This dependence naturally complicates the operational deployment of the ships, and a complete civilian team was taken on board during a humanitarian operation lasting more than three weeks.

civilian personnel in a theater of operations, the French navy is trying to develop a reservist status for such personnel with the companies concerned.

The French forces are gradually emerging from a decade of budgetary constraint that has undermined the strategy of maintaining long-term stockpiles and cut quantities and budgets to the bone. In addition to undergoing a significant weakening of its forces, France has also deprived itself of tools available to actors who made the opposite choice. Successive crises have, nevertheless, underlined how vital it is to have a minimum level of strength in depth, the just-in-time system being, by definition, incapable of dealing with any variation in flow. In each armed force, the resurgence of the strategy of maintaining stockpiles is reflected in different ways, focused on preserving old systems or optimizing maintenance and reserves of parts.

Rethinking France's Stockpiling Strategy

The conflict in Ukraine, following on from the health crisis, has painfully highlighted the consequences of the just-in-time approach widely adopted to cope with financial difficulties. In the absence of preserved stockpiles, the French armed forces have been able to provide material support only at the cost of a lasting reduction in their own capabilities. The loss rates observed in the field and the high consumption of munitions have also highlighted the inadequacy of French operational fleets, which have been reduced to the bare minimum after two decades of severe budgetary restrictions. In a situation similar to the one in Ukraine, the French armed forces would have seen entire capabilities wiped out in a matter of weeks or months at most. The reduced size imposed on the French military, already strained by certain aspects of the baseline operational situation, seems increasingly outdated in view of the reality of a high-intensity conflict taking place on the far side of Europe.

France is not Ukraine, however, and its geographical location, maintenance of a deterrent force, and NATO membership protect it from a large-scale invasion of its national territory. Consequently, it would be nonsensical to adopt a stockpiling strategy and expend limited resources in ways that would exclude other possibilities, based solely on feedback from Ukraine. It is therefore appropriate to consider the frameworks for engagement, as they currently stand, as a basis for deciding on a stockpiling strategy consistent with the strategic context and French means.

Matching Stockpiles to Prospects

As the French armed forces convalesce after twenty years of budgetary austerity, the issue of stockpiles is a sort of blank sheet, strictly speaking. The vast majority of what was previously available has now disappeared, and uncertainties about the future leave the forecasting process a degree of flexibility in identifying what will be required for the type of engagement envisaged.

Major Conflict in the Euro-Atlantic Area

In the event of France becoming involved in a major conventional engagement in Eastern Europe within the framework of the North Atlantic Alliance, it is important to remember that whatever the outcome of the

conflict between Russia and Ukraine, Russian military potential is, as it stands, permanently diminished with respect to both material and human resources. It could take years for Russia to replace the material lost in the first eight months of the conflict, and Russian industry is struggling to produce modern systems in quantity because of Western sanctions. The loss of a significant proportion of its junior officers and non-commissioned officers, already in short supply before the war, will affect a crushed Russian army's ability to rebuild itself in the short term.

However, if the Russian army is downsized, this might lead to in-depth reform in the direction of professionalization and the modernization of its material and philosophies. A defeated Russia could create a much more efficient military tool that is free of the constraints of the past. It would therefore be a mistake to neglect the possibility of another major engagement in Europe's East between now and 2040, as a militarily refreshed and vengeful Russia could prove a formidable adversary.

From this perspective, a reformed stockpiling strategy will need to be inspired by the facts of the Ukrainian conflict, as a minimum, but must not be circumscribed by them. The primacy of artillery in the Ukrainian war must lead to a re-evaluation of French capabilities in this area, in terms of guns, munitions, and spare parts. With barely one hundred large-caliber artillery barrels and fewer than ten Multiple Launch Rocket Systems, France is extremely impoverished in this area; the Russians and Ukrainians are capable of exchanging more shells in a few days than France fired against the Islamic State over a period of several years. While the context and the role of artillery in the French, Ukrainian, and Russian armies are quite different, it would be a mistake to downplay the importance of these weapons in a high-intensity conflict. The required resurgence in artillery strength should be accompanied by a return to creating stockpiles of contingency parts, to guarantee the strength in depth over time of a capability that is proving to be indispensable. The spare parts necessary for high-intensity use of artillery must also be stockpiled. The PzH 2000s sent to Ukraine, designed for use limited to a hundred rounds per day, have had to be supplied with replacement barrels as a matter of urgency, and multiple images show Russian and Ukrainian guns that suffered irreparable damage due to excessive barrel wear.

The issue of stockpiling munitions is perhaps the most salient point from all the capability feedback coming out of Ukraine. A very substantial increase in stockpiling of 155mm shells and 120mm mortars rounds seems essential. This must be accompanied by changes to safety standards. Some missile components must be inspected regularly, in some cases as frequently as every three months, which places constraints not only on their storage, but also on their presence in the theater of operations. In the absence of suitable infrastructure, some operational systems must be repatriated to mainland France for inspection. Munitions storage sites are also strictly regulated, and

the multiple French, European, and international security requirements governing them make it even more difficult to extend them.

Ukrainian successes have also demonstrated the importance of mobile firepower in dealing with the danger of counterattack. CAESAR howitzers and MARS and HIMARS rocket launchers are thus appreciated for their ability to fire and move quickly. Consequently, a coherent stockpiling strategy must be implemented to maintain the large quantities of parts and spares essential to the MOC of such systems.

Finally, the Ukrainian conflict has shown the wide diversity of airborne threats and the need for nations to equip themselves with appropriate means of defense. It is a complex business protecting a nation from missiles, UAVs, and loitering munitions, and these days, total protection seems impossible. However, the operational deployment of Iranian UAVs has highlighted the importance of air defense based on both interception missiles and guns, while the versatility of the German Gepard SPAAG has proven invaluable. With a view to an engagement in the east, France must therefore endeavor to build up a large stockpile of varied air defense mechanisms, to retain some freedom of action.

While such a hypothesis suggests an essentially ground-based conflict, Russia's difficulties nonetheless underline the importance of having a substantial stockpile of long-range guided munitions, which are indispensable for providing effective ground support without exposing the already inadequate numbers of aircraft and pilots to a dangerous extent. The Libyan air campaign had already pointed to similar conclusions, while a lack of air support is one of the main factors explaining Russian failure in Ukraine. The Ukrainian advantage in terms of airborne battlespace awareness also shows the need for a substantial stock of UAVs of various types, and also for more sophisticated tools, especially in terms of radar and other detection devices.

Intervention in the Near East and Middle East

The volatility of the strategic situation in the MENA zone and on the southern shore of the Mediterranean compels us to consider the possibility of conflict there, in a region where the density of weaponry and the modernization of conventional and paramilitary capabilities are on a completely different scale from those in the Sahel. American leadership is no longer a given, however, for many reasons. If France, constrained by the size of its forces, were engaged in a conflict without American support and surrounded only by certain European and local allies, it could find itself in a tricky situation. The functional requirements previously outlined therefore also apply in this scenario.

In addition, French forces would be obliged to provide material support to less well-equipped allies and would therefore require a stockpile of

relatively basic equipment so that a partner force could be familiarized with it. A coherent strategy for emergencies should thus take into consideration both upstream and downstream supply issues and be capable of supporting the war efforts of both France's own forces and allies. Without precedents to rely on, forward thinking in this direction is limited, especially since the uncertain nature of the adversary prevents us from making specific recommendations as to the types of equipment to be preserved.

It would nevertheless be a helpful first step to stockpile a quantity of equipment used by both France and its allies of convenience—personal protective equipment (PPE), small and medium-caliber weapons and ammunition, light vehicles, logistic transport, rations, and fuel—while not losing sight of the fact that the ally in question might not comply with NATO standards. In this context, the material required largely overlaps with that kept by the French army for its operational reserve (VAB armored personnel carriers, FAMAS assault rifles/Beretta 92 semi-automatic pistols, PPE, etc.). If stocked in advance and available in quantity, this material would make it possible to secure the basis of military effort in the field, without requiring dedicated logistics structures.

A stockpile of this kind would also provide the armed forces with alternatives, allowing them to direct the most efficient material toward combat missions and replace it with older items for current conflict-prevention and protection missions on French territory or to the rear of the front. Here again, the Ukrainian conflict has shown the importance of having a logistics fleet large enough to supply a high-intensity combat front, hence the importance of having a specific or rapidly mobilizable fleet.

In the presence of better-equipped allies, France would still be in a superior position in some respects, with unique capabilities that it must be able to use in a sustained manner (naval air group, space intelligence, etc.). Such a situation implies sustaining a long-term effort, despite significant material losses if necessary, and requiring stocks of munitions and complex systems to be made available rapidly for replacement in real time.

Security crises in French overseas territories

The possibility of a future threat to one or more French overseas territories must also be taken into consideration. It poses an even greater size-related problem, given the current sizes of the French navy and AAE, which would be called upon to intervene most directly, possibly without allies or partners. A stockpiling strategy capable of dealing with such a situation requires not only an increase in the resources that can be mobilized by the forces, but also decentralization and changes in the way these stockpiles are distributed, as the navy is currently doing with its spare parts.

In a scenario of this type, the main vulnerability remains the distance of most of the naval and air forces from the theater involved and the time needed to get there, while the forces present remain limited. An appropriate stockpiling policy could therefore include future UAVs that can be kept inactive for a relatively long time and act, when required, as a significant force-multiplier in the event of an unexpected intervention by opposing forces. The underwater and surface UAV models currently under development have a high capability potential in the medium term for offensive and defensive mine warfare and interdiction missions. Armed and pre-positioned UAVs, less expensive than manned ships and requiring less infrastructure and maintenance, could increase French overseas territories' response potential.

If compelled to take a defensive stance, the French forces present would also require a significant reinforcement with pre-positioned stockpiles of all types of air defense weapons to enable them to hold their own until friendly forces arrived. Decentralized stockpiles of air defense equipment would also increase the capacity of French overseas territories to defend themselves for short periods.

For conflicts conducted on the other side of the globe from mainland France, in theaters far from the infrastructure required for maintaining and repairing capital ships, the navy will also need ships dedicated to these support missions—a capability it has had to abandon over the years. If no stockpile of specialized ships is envisaged, it is necessary to pursue the possibility of requisitioning adapted civilian ships, or ships that can be modified for the occasion, as the British naval forces did during the Falklands War.

The Ukrainian conflict teaches us at least three lessons on the prospect of high-intensity conflict that apply to all the assumptions discussed above and affect a future French stockpiling policy.

- High-intensity conflicts are not necessarily brief. They can last for several months (or even for more than a year) as long as the belligerents retain sufficient offensive and defensive resources, often at the cost of a gradual decline in quality and sophistication as the most advanced material is consumed.

- The engagements are inherently extremely destructive in terms of personnel and material, forcing the belligerents to deploy ever greater resources to avoid allowing the opponent to prevail.
- Consequently, high-intensity conflict can take the form of attrition warfare, in which the side that will achieve victory is the one that is more determined and better able to extract military potential from its economic, social, and diplomatic structure.

In view of this, preparing forces for a high-intensity conflict implies a return to prioritizing quantity in both human and material resources, to cope with the demands of a prolonged engagement. It also implies a clear identification of what is at stake in the conflict and of the effort that may be required. While it is difficult to change the sizes of professional armed forces, the prospect of casualties from high-intensity conflict requires large, trained human reserves and substantial stockpiles of munitions, systems, and mission equipment. These reserves of various kinds are necessary to ensure a high level of performance from the outset and to sustain it over time, despite inevitable losses. They are an effective means of conventional deterrence, but also an essential diplomatic tool to ensure that France can influence—even indirectly—a conflict affecting French interests through donations and training. In the absence of the funding necessary to increase the size of active armed forces, a return to an ambitious stockpiling policy seems to be one of the few levers of power that is both accessible and effective, perhaps even indispensable.

Upstream and downstream stockpiling strategies are complementary:

- Upstream stockpiling of quantities of recent material surplus to immediate requirements is essential for dealing with possible losses and maintaining a satisfactory level of efficiency in the three military environments.
- Downstream stockpiling of equipment withdrawn from service is essential for supporting allies in need without making oneself vulnerable, but also, within the framework of the operational reserve, for ensuring the continuity of conflict-prevention and protection missions by standing in for more modern equipment used for high-intensity operations requiring a higher level of performance.

As it stands, not only have the active armed forces been maintained for too long at a level that is barely sufficient to allow them to properly carry out their missions in the baseline operational situation, but France has also deprived itself of the levers and tools that are essential to ensuring it can play a relevant role in a crisis.

The right solution for each armed force

Producing specific stockpiling recommendations for each armed force is a demanding task, requiring one to juggle the conflicting demands of limited resources, rapid technological development, and a fluid geopolitical context. It is essential to support dynamics already in motion and to envisage possible breakthrough solutions, each of which will require additional in-depth research to assess its feasibility.

The army: MOC adapted to high-intensity conflict

Accompanying the ramping-up of the operational reserve with an ambitious stockpiling policy is a positive dynamic that breaks with a decade of domination by the just-in-time philosophy. This policy needs to go further and be allowed more time to produce effects before its benefits and areas of improvement can be evaluated. The experiences of the French army reserve regiments, which were mentioned during interviews conducted for this research, could provide a precedent for the current project. These reserve units were brought together once a year and armed with weapons retired from active service, in some cases decades previously. As they were disbanded before the end of the 1980s, it is difficult to assess their relevance now, but discussions with former officers provide some leads. Several of them mention very inferior-quality and poorly staffed units, given inadequate access to (out-of-date) equipment during their all-too-rare training exercises.

However, bad experiences in the past should not lead to the whole idea being rejected. On the contrary, if the aim is to multiply units like France's Twenty-Fourth Infantry Regiment, examining the reasons for this apparent failure might facilitate the current process and avoid some damaging mistakes. Reserve units were brought together too infrequently to maintain a satisfactory standard and were also apparently equipped with material that had been kept beyond the point at which it could usefully be maintained. Even when material is intended to be an operational reserve, long-term storage is not a total solution and remains subject to a set of operational requirements. The Ukrainian conflict has also highlighted the existence of new solutions, often from the civilian world and requiring the armed forces to make new kinds of investments. The example of the retention of 4G PR radios has led to internal reflections on their possible replacement by devices based on civilian smartphones, similar to the artillery or intelligence software used in Ukraine. These might also be a better match for the missions assigned to reserve units, such as securing sensitive sites and static guarding.

More broadly, the subject of the French land forces' capability-related stockpiles raises the question of their maintenance and operational replacement policy in the theater of operations, especially for future material

that is more complex. The balance between industrial support and operational maintenance capabilities tends to evolve over time, and is a decisive issue for vehicles under development such as the Main Ground Combat System. Vehicles used in combat—produced in large numbers, compared with the capability systems of other armed forces—must be capable of being repaired in theater or replaced within a reasonable timeframe to sustain military action. Earlier generations of armored vehicles (VABs, ERC 90, AMX 10RC) were relatively basic, allowing a significant proportion of repairs to be carried out in the field. More complex vehicles with more electronics might have to be sent back to mainland France, in the absence of appropriate infrastructure and skills on the spot. If repatriation of vehicles is to be a common practice, as part of a strategy of replacement, this will require a well-stocked fleet of replacement vehicles and therefore a substantial stockpile. Without this, the military effort will quickly be undermined by a lack of vehicles, which field workshops will not be able to restore to operating condition after damage, or even carry out routine maintenance on. The small number of engagements that Leclerc battle tanks have been involved in is at least partly due to this logic: because such systems need the right maintenance infrastructure, it is hard to deploy them abroad without providing particularly demanding logistic support—and that is before losses in combat are envisaged.

A strategy of systematic replacement remains sustainable for an operation like Barkhane, which simultaneously engages only a limited number of vehicles and therefore allows vehicles to be rotated between operational and maintenance/repair fleets. However, the deployment of an entire division would require maintenance fleets of several hundred vehicles plus the transport resources needed to maintain the flow. This estimate by the SIMMT (the command structure for the French army's Integrated Structure for the Maintenance of Terrestrial Material in Operational Condition) is based on figures and estimates drawn from French engagements in Africa, in other words, low-intensity conflicts causing only occasional losses of equipment. Implementing a strategy of systematic replacement in a high-intensity conflict with losses similar to those experienced in Ukraine would require a much larger fleet.

From the outset, Soviet military thinkers developed a strategy of replacing damaged vehicles rather than creating an efficient field maintenance and repair chain. They also developed a range of vehicles specifically adapted to this strategy and available in large quantities from an appropriately sized industrial apparatus.

The AAE: Toward new stockpiling mechanisms?

The AAE's lack of strength in depth makes it difficult to envisage upstream stockpiling of new aircraft, when there are insufficient resources to keep the

aircraft currently in service flying. However, in the context of rebuilding the strength of the armed forces, downstream stockpiling of aircraft destined to be withdrawn from service in the medium term, such as Mirage 2000Ds, should be seriously considered. This implies thinking about recreating a centralized storage infrastructure. A return to structures as imposing as those at Châteaudun need not be contemplated, but a centralized storage mechanism would make it possible to preserve aircraft with potential for use by French or partner forces.

A more specific recommendation concerns the development of a "differentiated" storage mechanism. The rise of companies specializing in adversary support services and red teaming primarily affects the military air sector. Babcock, Airborne Tactical Advantage Company (ATAC), and Draken buy up old airframes and use them for training exercises for the air forces of various nations. In 2017, for example, ATAC purchased sixty-three Mirage F1s from France to train USAF pilots.[77] The maintenance of these aircraft is based on cannibalizing some of them and purchasing second-hand parts and spares from military and private stocks.

As the armed forces move onto newer generations of aircraft and the resources of adversary support contractors increase, the latter could, in the long term, have access to increasingly modern aircraft and purchase their spare parts directly from the manufacturers. When the French Future Combat Air System or the American Next Generation Air Dominance become a reality, older versions of the Rafale or the F-35 could become available, even before these aircraft cease production. In this context, it is possible to imagine new types of civil-military partnership: airframes nearing the end of their life but retaining sufficient potential could be transferred to suppliers of adversary support services, subject to them being maintained and returned in the event of a major crisis. The private actor would gain important potential for its activity at a lower cost, while taking on financial responsibility for maintaining the donated systems. The average age of the AAE's aircraft would be reduced, saving it money on maintaining the oldest aircraft.

Such a process would require the AAE to give up part of the useful life of the aircraft it purchased, but would facilitate the establishment of a reserve of airframes maintained and kept in flight condition at a lower cost. Although it could not involve the latest generation systems or those meeting the most up-to-date standards, such an agreement could go beyond the fighter sector and be applied to other types of aircraft, notably military transport aircraft—the training of military transport pilots is increasingly being carried out by private players.

77. P. Samama, "Le *Mirage F1* prêt à décoller pour entraîner les pilotes américains de F-35", BFM Business, August 2, 2020.

The question of transport aircraft such as the A400M also leads to another forward-looking reflection. Two dynamics are emerging at the European level. The European Union wishes to become more involved in military and defense industry issues; at the same time, cooperative projects are becoming increasingly common. A conjunction of these two dynamics could favor the emergence of a long-term stockpiling system managed at the European level or at least at the intergovernmental level. The states that have acquired systems developed in this way could contribute to a centralized long-term storage facility. Pooling resources would allow for significant economies of scale, while fitting into the framework of European integration on defense.

"Spill-over" is a term used to describe the way the integration of one policy area by EU mechanisms is followed by related policy areas also being integrated. This process, considered to be part and parcel of the building of Europe, could be applied to other aspects of the military domain: after having supervised the development of military material, the EU would thus focus on the storage and maintenance of this material, which is politically less sensitive than its use.

The navy: Regaining flexibility in the face of greater ambitions

Downstream stockpiling of current naval platforms due to be withdrawn from service in the medium term does not appear to be a viable solution for the French navy. Furthermore, it has already embarked on a thorough reform of its policies on the stockpiling of parts and spares, to optimize the availability of in-service systems. This shift, initiated in 2018, needs time to be embedded before the benefits of this rationalization and optimization drive can be evaluated. In any event, while hull stockpiling is of limited relevance and unrealistic in view of French resources, the French navy's weapons and equipment stockpiling policy is an initial response to the challenges around the availability and operation of existing ships. It is also possible to envisage "hidden" stockpiling mechanisms, through an evolution in the relationship between military institutions and industrial players. Two avenues could be explored in this connection.

The production of a capital ship can take more than three years—twenty months for a lesser vessel. As a result, it is hard to imagine that a decision to increase production in naval shipyards, taken after a situation involving genuine danger has already arisen, could have any perceptible impact. The slow rate of production can hardly be compensated for by building up the stockpile, as the mothballing of modern hulls is facing the difficulties already discussed. Faced with this impasse, it is vital to consider alternatives that are compatible with the limited resources imposed by the budgetary context. Shipbuilders are facing an increasingly competitive market, with the emergence of new players with significant production capacities, such as

South Korea and Turkey, which are developing their production infrastructures. The issue of delivery times is becoming increasingly important in competing for contracts, while developing new production infrastructure remains a significant and risky investment.

The following is a potential partial solution that addresses the difficulties on both sides: when the navy orders a series of ships, the shipbuilder could produce a small number of additional ships at its own expense (of the order of one or two ships out of a series of six). In exchange for a financial arrangement under France's SOUTEX (support for defense exports) program, the surplus ships could then be made available to the navy, which would supply personnel and equipment. In this way the navy would have access to additional capabilities at a lower cost than outright purchase. These ships would be maintained and used by the navy in its usual missions, demonstrating their capabilities in use, which would make it easier for the manufacturer to promote them abroad as they would be "sea proven". If a buyer is found, the ship would be sold by the manufacturer, while in the event of a major crisis, emergency military credits should allow these surplus units to be permanently acquired, to secure them as part of French naval forces. This would provide the French navy with a significant contribution to its strength at a limited cost, without waiting for a hypothetical ramping-up. Even if the ship were sold, the navy would still have a trained crew and therefore be more resilient. The manufacturer, meanwhile, would be able to smooth out its production and maintain a constant flow of activity, while gaining a considerable competitive advantage on products with proven efficiency. Both parties would also benefit from the scale effects of larger production runs.

An experiment along these lines has already been attempted with the patrol boat *Adroit*, which entered service with the French navy in 2012 before finally being sold to Argentina in 2018. The interviews conducted on this subject highlighted certain difficulties, particularly around the handover of the vessel to its industrial owner. Nevertheless, repeating this process over time would allow France to capitalize on this experience to reduce the difficulties in the medium term.

However, the increase in the number of hulls made possible by such a mechanism would only underline the navy's major difficulties with both the quantity and quality of its human resources. At a time when the navy is already struggling to achieve satisfactory levels of personnel retention, arming new ships would require a significant effort to train new permanent crews. The lack of specialists, already a problem with the current number of ships, would also become more acute with larger numbers. When added to the high cost of capital ships, these staffing issues limit the relevance of such a co-construction strategy to medium-sized vessels such as patrol boats, which are both less costly and have a lower impact on strained human

resources. The strategy could also be applied to some specialized vessels, particularly support vessels.

It is also possible to envisage other forms of public-private partnership that could contribute to a gradual strengthening of the fleet. The development of some marine industries (offshore wind turbines, maintenance of submarine communication cables) increases the need for vessels with specific capabilities. A civil-military design of these vessels that balanced the requirements of both parties could facilitate the development of a "shared" fleet, used and maintained by civilian actors in peacetime, but which could be mobilized by French forces in case of urgent need.

This idea could not be applied to capital ships, but a certain number of support ships could find a civil-military use and thus allow the development of a possible procedure for requisitioning civilian hulls, as the United Kingdom's Royal Navy did during the Falklands conflict.[78] The vessels taken at the time were initially oil tankers for refueling at sea, cargo ships capable of autonomous unloading, and repair ships equipped with specific equipment for repair at sea. These vessels were urgently modified to meet military needs. Vessels designed from the outset for military missions but adapted for civilian use could more easily be recovered by the navy in emergencies, for large-scale force projection, or for support missions following natural disasters. An evolution of this kind is all the more necessary because a high-performance and sufficiently large support fleet is essential for mission duration at sea and to compensate for the navy's weakness in numbers, while ensuring optimal availability on missions. The multipurpose repair ships *Jules Verne* and *Loire*, which retired from service between 2005 and 2010, provided the French navy with a combat repair capability that has not been replaced to date. If France's ambitions in the Indo-Pacific are confirmed, then, in the absence of suitable infrastructure in overseas French territories in the zone, regaining these capabilities seems crucial to enabling the French navy to increase its resilience: if it is not possible to stockpile hulls, everything must be done to enable existing ones to carry out their missions as well as possible, including allowing them to be repaired in theater.

The Ukrainian conflict opens a window of opportunity for the return of a stockpiling strategy, which must, however, be adapted to the strategic context and to French resources. If the mass stockpiling that was possible thirty years ago can hardly be conceived of today, alternative solutions can nevertheless be envisaged to give the armed forces the strength in depth and the resilience in material upon which depends their ability to participate in a high-intensity conflict, of whatever kind it may be.

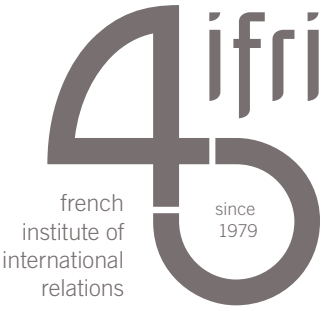
78. H. Masse, "Les Malouines", p.32.

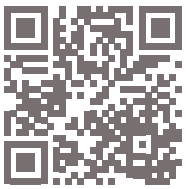
Conclusion

While the prospect of a high-intensity conflict restores the legitimacy of stockpiling, current reflection on the topic must be accompanied by questioning that goes beyond the conflict in Ukraine. Whether victorious or defeated, Russia has lost a conventional combat potential that it will take several years to recover, from the point of view of both personnel and equipment. Yet France's main major engagement hypothesis was a confrontation with Russia. Russia's eviction from the strategic landscape, even temporarily, may call into question any investment to forge a military tool capable of confronting it, while the budgetary context remains tight due to the consequences of the current conflict. However, a reduction in the Russian threat does not eliminate all prospects of high-intensity conflict, which is not the sole prerogative of the major world powers. The increase in Sino-American competition and the likely destabilization of Russia's "near-abroad" could lead to a proliferation of conflicts between local powers, increased by the return of the tactic of confrontation by proxy.

Because of the reluctance of the nuclear powers to engage in military confrontation, China's assertiveness in the face of the American bloc could thus multiply the number of high-intensity indirect confrontations, including to the detriment of French interests in Africa, the Middle East, and central Asia. In such a context, France must maintain its capacity to influence such confrontations beyond acting as a "balancing power". In a dispute or a proxy war, having stockpiles of resources and armed forces capable of influencing such conflicts would give some heft to a position hitherto based on words alone. The French effort to deliver arms to Ukraine, agreed to at the beginning of October 2022, gave substance to the French position, which until then had been suspected of camouflaging a certain half-heartedness.

Successive cost-cutting plans have limited France's capacity to take real action in a conflict, while a succession of external operations has worn out potential that could have been preserved. By returning to an appropriate stockpiling policy, France will regain a set of military and diplomatic tools that it now largely lacks, as revealed by events since February 2022.





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