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Solid Rocket Motors for Missile Defense

Challenges and Opportunities for Expanding the Industrial Base

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A Report of the CSIS Missile Defense Project

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Introduction

Even before the 2026 U.S.-Israeli operation in Iran, expenditures of both offensive and defensive munitions had begun to generate concerns about the depth and resilience of U.S. inventories and production rates.[1] The increasing use of missiles as "weapons of choice" led the Department of Defense (DOD) in early 2025 to make munitions production a department priority. These efforts included the creation of a Munitions Acceleration Council (MAC), a pilot program to accelerate contracting for munitions, provide "direct-to-supplier investment" in solid rocket motors (SRMs) and other sub-tier suppliers, and execute multiple framework agreements to substantially increase production.[2] The importance of this challenge is reflected in the 2026 National Defense Strategy, which noted that "Our fighting force depends on the [defense industrial base] to produce, deliver, and sustain critical munitions."[3]

The need to accelerate production of munitions is a product of today's threat environment, which is increasingly characterized by an array of salient missile threats, causing the global demand for air and missile defenses (AMD) to soar. This phenomenon has manifested in conflicts in Ukraine, Israel, and the Red Sea.[4] Modern conflicts have seen an increased role for all types of missile-based strike, which has created a persistent need for AMD interceptors in response. The challenges in responding to this demand led one former official to characterize the Ukraine war as a "wake-up call" about munitions production and supply chains.[5]

The need for such a wake-up call has since intensified. In the first 100 hours of Operation Epic Fury, Iran fired over 500 ballistic missiles and 2,000 drones, requiring the United States and its allies to expend large numbers of interceptors in response.[6] Less than a week into the operation, officials characterized the U.S. inventory of precision-guided munitions as "sufficient . . . for the task at hand." The question, however, is whether there is sufficiency for future conflicts.[7] U.S. readiness for future conflicts will depend significantly on the ability to produce large numbers of precision-guided munitions, especially long-range standoff strike missiles and air and missile defense interceptors.[8]

The missile market has several characteristics that create both challenges and opportunities for growth, many of which are common with other industries and some which are unique. Missiles are composed of numerous components and subcomponents, which themselves often have a high degree of complexity. The use of hazardous chemicals in missile components involves significant government regulation of the manufacturing process. The complexity of missiles also increases the challenge of managing the supply chains for multiple high-technology components. Rather than managing subcomponents directly, DOD has leveraged the expertise of industry to oversee these complex arrangements. This network of specialized subcontractors for missile-related technology introduces risk, leaving the industrial base vulnerable to interruptions if critical nodes in the supply chain fail. Persistent issues with supply chain components contained within common subsystems such as SRMs, which have a role in every U.S. missile program, can thus disrupt the industrial base and constrain DOD's surge capability in response to crises. Inherent capacity for increased production—even excess capacity—at many stages of production does not equate with resilience.

This arrangement poses a set of challenges and opportunities as the United States faces renewed pressure on its missile inventories. Because much of the capacity for production of new missiles lies outside of the organic industrial base, DOD can incentivize industry to build production capacity in a way that can meet both parties' needs. This will involve a balancing act among the efficient spending of defense dollars, the demand for greater surge capacity, and industry's business needs.

There remain three key challenges to increasing capacity. First, the single-customer market has faced highly cyclical demand, a problem that has made it difficult for industry to have the confidence to make long-term investments in infrastructure for expanded capacity. Recent funding increases have come from less predictable supplemental appropriations rather than more regular budget processes. Second, the government approach to industry prioritizes cost and efficiency over capacity building, which can pose a challenge when the government looks to accelerate production or create a broader and more diverse supply chain. The government has furthermore tolerated relatively little innovation in design and manufacturing processes, a particular challenge for new entrants. Third, the existing contracting structure, wherein the government purchases the final assembled missile and relies on industry to manage sub-tier suppliers, has resulted in supply chain opacity and risk.

The industrial base for SRMs and their subcomponents serves as a useful case study for managing and scaling AMD interceptor supply chains. For SRMs, DOD has faced challenges acquiring the number of systems that it requires, including industry consolidation, which was itself driven by inconsistent and depressed demand signals. Inconsistent and cyclical demand from the government customer has perhaps been the biggest limitation on translating latent or idle capacity into throughput.

Although the current AMD interceptor industrial base is insufficiently suited to supply DOD in a protracted conflict with a high expenditure rate, considerable opportunities exist for improvement. Recent conflicts have created momentum for substantial supplemental funding for these munitions. Demand for AMD interceptors seems strong from both the U.S. government and allies and partners, which incentivizes prime contractors to make investments in their sub-tier supply chains and offers opportunities for new entrants. The current momentum for modernizing and improving acquisition processes as well as expanding and employing capacity for critical munitions creates an opportunity to consider reform, both in acquisition and contracting.

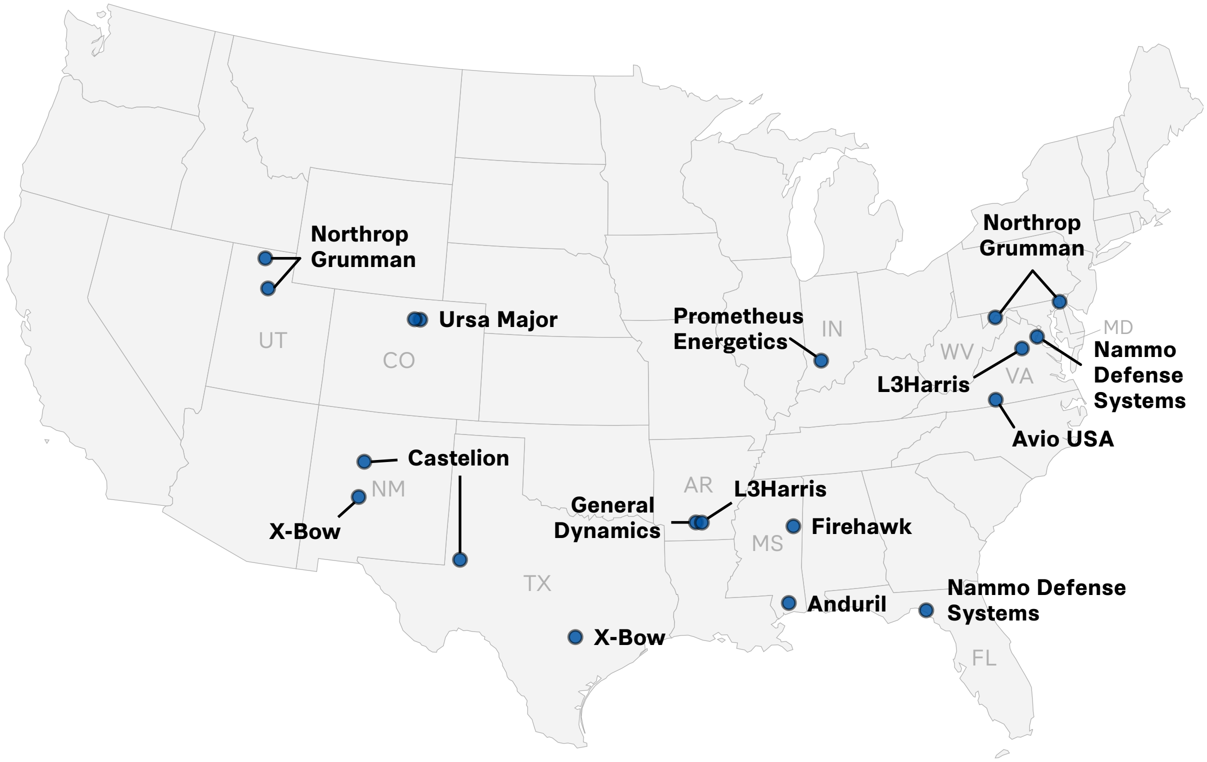
Characteristics of the Missile Industrial Base

Growing attention to the munitions industrial base suggests the need for an assessment of its characteristics and condition. The complex nature of modern missiles, their lack of commercial analogs, and the way that the U.S. government buys its missiles all have a considerable impact on the overall industrial base. Understanding these characteristics allows for a better explanation of the challenges the industry faces and helps illustrate realistic opportunities and pathways for expansion.

One characteristic of the missile industrial base is a supply chain that must contend with numerous types of hazardous materials. Even hit-to-kill missile defense interceptors, which do not feature traditional explosives in a warhead, still rely on focused combustion from their rocket motors to create propulsion. Building large numbers of these missiles thus requires industrial facilities that are capable of safely handling large amounts of combustible and explosive materials. When this goes wrong, the consequences can be severe, even at a relatively small facility.[9]

As a result, key industrial facilities in the AMD interceptor supply chain face extensive safety regulations and low fault tolerances. Any facility handling Class 1 energetics category materials requires large blast-hardened structures, remote operations, and extensive safety zoning.[10] That makes building new infrastructure not only capital-intensive but also subject to multiyear environmental and permitting timelines under DOD and local regulations. Building new facilities or expanding existing ones is thus subject to cross-cutting reviews by multiple levels of government and across multiple agencies. These concerns often push SRM production facilities far away from major population centers (Figure 1).

Figure 1: Selected SRM Manufacturing Facilities



Source: CSIS Missile Defense Project.[11]

In addition to requiring the use of many explosive materials, modern missiles have much more extensive supply chains than munitions produced for prior conflicts. Rather than being propelled by guns, modern missiles require their own propulsion units in the form of complex rocket motors. Covering the ranges demanded of modern missile capabilities requires large and complex missile propulsion systems, often staging together multiple rocket motors into a single missile structure. The need for precision guidance only compounds the technical complexity, adding electronics and communications devices to provide the missile with in-flight data feeds from multiple sources. These components also need to be hardened against electronic warfare and jamming effects, which have presented problems for some lower-cost munitions on modern battlefields.[12]

How Solid Rocket Motors Are Made

Solid rocket motors (SRMs) consist of five main components: cases, thermal insulation layers, nozzles, igniters, and propellant.[13] The SRM manufacturing process is comprised of eight steps, each involving complex and specialized materials and sub-processes: propellant mixing, curing, casting, assembly, X-ray inspection, testing, coating, and painting.

Solid propellant is a mix of fuel and oxidizer compressed and packed into a solid cylinder.[14] In missile production, solid propellant is commonly produced via the batch-mixing process.[15] During the mixing stage, the propellant ingredients are ground to reduce particle size and then mixed in large bowls to form a thick, semi-fluid mixture.[16]

The viscous liquid is then poured into the rocket motor case. During this casting process, a mandrel, sometimes a large cylindrical rod, is sometimes placed down the center of the rocket case to help the propellant form and create a hollow chamber in the center of the motor.[17] When pouring the propellant from the mixing bowl into the casing, a specialized device is used to remove the air from the mixture to ensure the propellant can cure and bond properly.[18] The propellant is inserted into the case using a funnel with a valve to control the flow rate.[19] The size and type of equipment used during the casting process depend on the size of the rocket motor case.

The motor is then cured, during which the propellant hardens into a stable, rubber-like grain.[20] The curing process allows the propellant to bond to the liner and case while retaining the internal shape formed by the mandrel.[21] A controlled baking stage may follow to complete hardening, stabilize the grain, or prepare the motor for inspection. The curing stage may, depending on the size of the cast, take 3-14 days to fully cure, although there are ways to speed up the process.[22] Once curing is complete, the mandrel is removed, leaving the internal hollow port that controls how the motor burns.[23]

The motor then moves to assembly. Technicians install or attach components such as the nozzle, igniter, closures, seals, joints, skirts, and external fittings.[24] The nozzle directs exhaust gases and helps generate thrust, while the igniter initiates combustion when the motor is fired.[25] Assembly also includes checks of seals, interfaces, and mechanical connections to ensure the loaded motor can withstand storage, transport, and launch.[26]

After assembly, the motor undergoes extensive nondestructive inspection, particularly X-ray inspection.[27] X-rays are used to identify internal flaws that cannot be seen from the outside, including cracks, voids, porosity, debonds, foreign material, or separation between the propellant and case liner.[28] Additional inspections may include dimensional checks, visual inspections, bondline evaluations, and material verification.[29] Internal defects can alter the burn pattern or create structural weaknesses.[30]

Before acceptance, SRMs also undergo a tailored set of inspections and tests. These may include leak checks, pressure-related inspections, electrical checks, igniter continuity checks, environmental exposure tests, vibration and shock tests, thermal cycling, and material lot testing.[31] The test matrix is not identical for every motor; it is determined by program requirements, motor size and application, expected storage requirements, and whether the motor is new or already qualified.[32] Developmental motors may be static fired to mature the design and identify problems, while qualification motors are flight-representative test articles used to prove that the final design, manufacturing process, and assembly procedures meet required specifications.[33] SRMs are generally single-use systems—with the exception of some rocket boosters which can be recovered—meaning actual flight motors destined for missiles are usually not static fired. Instead, qualification motors or lot-acceptance motors are fired to verify thrust, burn time, pressure behavior, and structural performance.[34] Production motors are then accepted only after they meet required inspection, documentation, and performance standards.[35]

In the final stages, the motor receives protective coatings and paint. Internal coatings, liners, and inhibitors help manage heat transfer and control which propellant surfaces burn.[36] Exterior coating and paint protect the motor from corrosion, moisture, handling damage, and environmental exposure during storage and deployment.[37] Once painting and markings are complete, the motor is packaged, documented, stored, and prepared for integration into a missile, launch vehicle, or booster system.

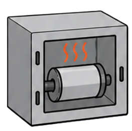
Figure 2: Solid Rocket Motor Production Process

1 

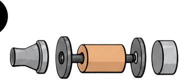
Propellant mixing: Fuel oxidizers, binders, metal powders, stabilizers, curing agents, and burn-rate modifiers are mixed in large mixing bowls to form a thick slurry.

2 

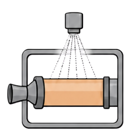
Casting: The slurry is poured into the rocket motor case. A cylindrical rod is placed in the center to create a hollow chamber. The rod is meant to create a hollow port that controls how the motor burns.

3 

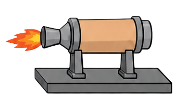
Curing: The motor is then placed in, depending on the size, an electrically or steam-heated oven to cure. The process turns the slurry into a stable, rubber-like grain that can be shaped into the final motor shape.

4 

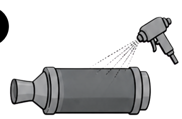
Assembly: After the motor has cured, technicians install major components such as the nozzle, igniter, closures, seals, joints, skirts, and external fittings.

5 

X-ray inspection: X-rays are used to identify internal flaws, including cracks, voids, porosity, debonds, foreign material, or separation between the propellant and case.

6 

Testing: The motor then undergoes a series of tests to include leak checks, pressure-related inspections, electrical checks, igniter continuity checks, environmental exposure tests, vibration and shock tests, and thermal cycling. Each batch also undegoes lot testing, in which one motor from the batch is test-fired for reliability.

7 

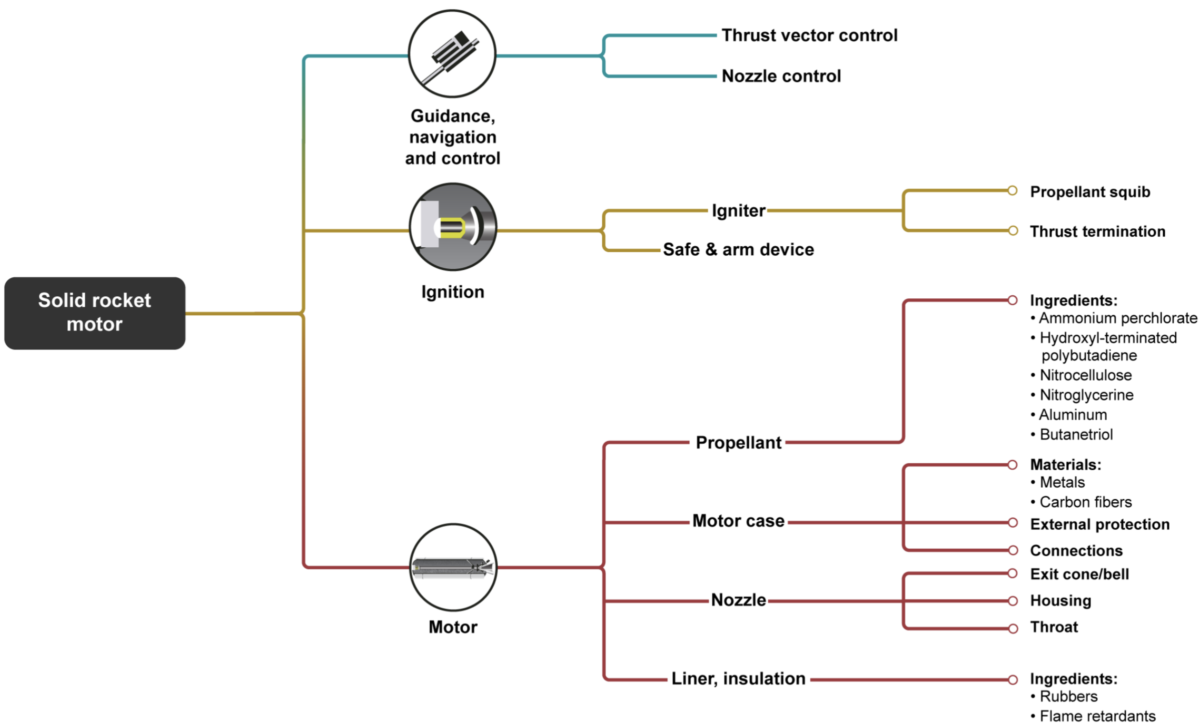
Coating and painting: The motor then receives protective coating and paint to protect the motor from corrosion, moisture, handling damage, and environmental exposure. Lastly, the motor is marked with proper identification.

Source: CSIS Missile Defense Project.

Much of this complexity is the cost of building relevant capabilities for modern battlefields. This is particularly true for AMD interceptors, which must keep up with the technical characteristics of the missiles they intercept while simultaneously being precise enough to hit a moving missile-sized target. The demanding technical characteristics of these systems lend themselves to very strict requirements for every subcomponent, since even a small variance in the behavior of a component can have a significant impact on mission effectiveness.

While missile supply chains are far less complex than those for ships or aircraft, even critical subcomponents can have sprawling supply bases. For example, a 2017 Government Accountability Office (GAO) study of the SRM supply base estimated that more than 1,000 suppliers are involved in various stages of the process, a figure that represents significant consolidation over the last 20 years (Figure 3).[38] These suppliers vary considerably in both size and sector, including chemical production companies, producers of processed materials, and traditional defense companies.

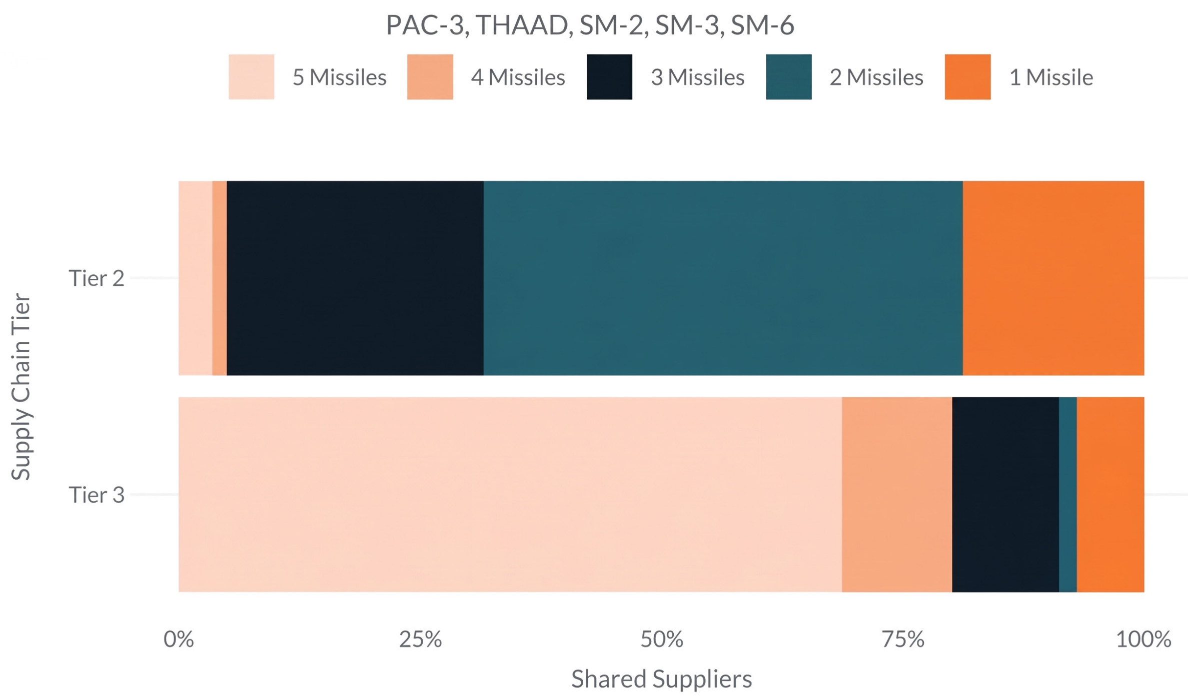
Figure 3: Solid Rocket Motor Supply Chain



Source: Government Accountability Office.[39]

Missile supply chains also have considerable overlap between suppliers, especially into lower tiers of the supply chain. Rather than spreading out like a pyramid from the defense primes that are contracted to produce the final interceptor missiles, these supply chains are more like a diamond, where many of the middle-tier suppliers of important components go to many of the same suppliers for their materials. A Govini analysis of the supply chain for five interceptor missile programs shows this arrangement clearly (Figure 4). At Tier 2, supplier overlap between the missiles is relatively manageable, with a majority of suppliers only working on one or two missile programs. At Tier 3 however, the supply chain diversity reduces considerably, with over 80 percent of Tier 3 suppliers contributing to at least four of these critical missile programs.

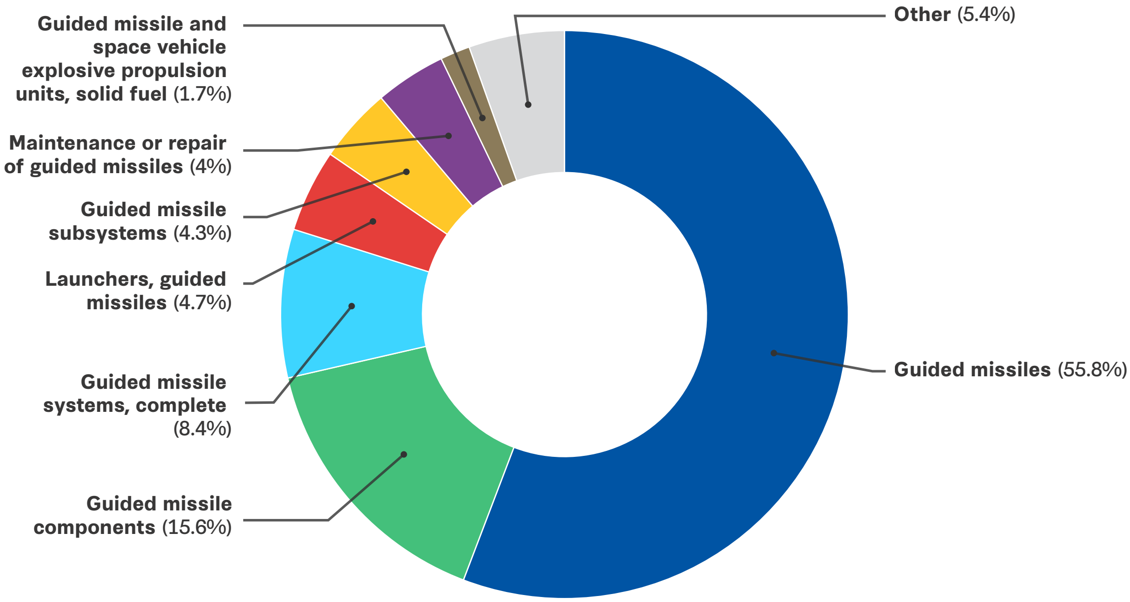
Figure 4: Overlapping Suppliers in Air and Missile Defense Critical Munitions Supply Chains



Source: Govini.

A third feature of the missile market, like many others, is that while DOD does have some interaction with subsystem suppliers, it generally purchases completed missile systems. Among missile-related product and service codes, nearly 65 percent of the contracted obligations between 2000 and 2025 have gone to completed missile systems (Figure 5).[40] Roughly 20 percent of the product and service missile contract obligations have gone to components and subsystems, with most of the rest going toward maintenance and services contracts.

Figure 5: Missile Product and Service Categories with Percentage of Obligations, FY 2000–FY 2025

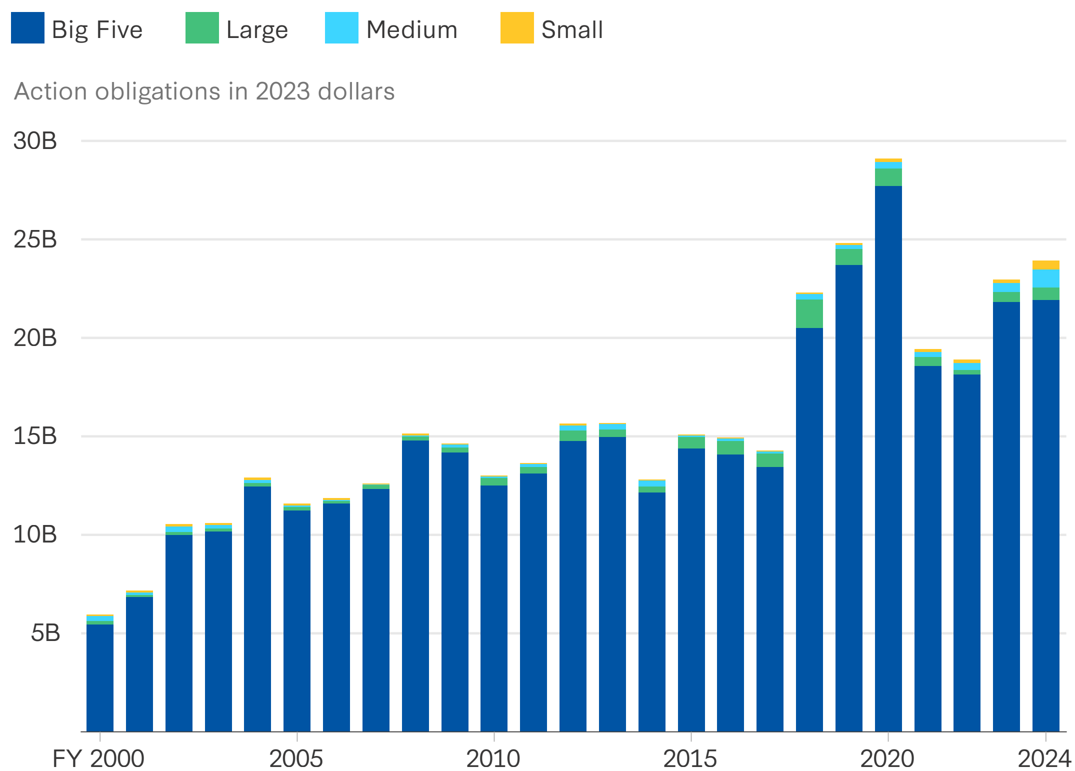


Note: The combined figure for "Guided Missiles" and "Guided Missile Systems, Complete" is not consolidated because of changing labels of product and service codes over the course of the data time period.

Source: Federal Procurement Data System (FPDS); and CSIS analysis.

As a result, DOD delegates much of the responsibility for supply chain management to the prime contractors that integrate the completed missile system. As Figure 6 shows, most DOD contract obligations go to the Big Five defense contractors (Lockheed Martin, RTX, Northrop Grumman, Boeing, and General Dynamics), who then subcontract for the various components they need for the completed system. While DOD does collect some data on these subcontractors, its data is much less comprehensive, making it difficult to even describe the full extent of the supply chain through publicly released data.

Figure 6: Federal Procurement Data System Missile Contracts by Vendor Size, FY 2000–FY 2024



Note: Vendors are categorized into "Small," "Medium," and "Large" based on data reported to the FPDS database and additional revenue-based criteria. The "Big Five" category includes Lockheed Martin, Boeing, RTX, Northrop Grumman, and General Dynamics, which have been given a separate category due to their system integrator function and consistent market share.[41]

Source: FPDS; and CSIS Missile Defense Project.

This characteristic of the missile market might be shifting somewhat, however, with DOD increasingly investing money into subcomponent suppliers to alleviate bottlenecks to munitions production. The $1 billion direct-to-supplier investment into L3Harris' SRM production facilities suggests a new initiative to provide funding directly to suppliers of key subsystems from larger industrial base funds.[42] This harkens back to previous investments from the Cold War, in which DOD was much more involved in direct production of munitions subcomponents in addition to completed missiles.[43]

Another significant trend is the considerable growth in dollars obligated for missile-related products and services (Figure 6). After many years of flat demand, an upward trend began in 2018, growing to nearly $30 billion in 2020 (in 2023 dollars). After two years of relative contraction, the market bounced back in 2023 and 2024 to nearly $25 billion (in 2023 dollars). While the 2025 contract data is not yet complete, it will likely reflect continued growth of this market segment. This data also does not include research and development contracts, which are not classified as clearly by the type of capability.

This growing DOD contracting activity is critical because the final key characteristic of the missile market is that it is almost entirely defined by government demand. While some subcomponents and materials have applications in commercial sectors, many missile parts are unique to the sector. Whereas ships, airplanes, and even small arms ammunition all have closer commercial market analogs, demand for many missile components is driven exclusively by DOD and other foreign militaries. As a result, when government demand drops, the market for many of these components evaporates.

The closest commercial market analog to missile capabilities is space launch, which also uses large rockets to propel heavy objects. Two critical factors, however, undermine this sector's ability to serve as a backstop for demand for guided missiles. The first issue is NASA's 2011 decision to retire its Space Shuttle program, which eliminated a major source of demand for SRMs and their components. A 2017 GAO estimate found that this decision cut yearly demand for SRM propellant from about 20 million pounds to 5 million pounds.[44] The facilities that had been used for the shuttle motors, as well as others, still retain latent capacity that is not being tapped by customer demand.

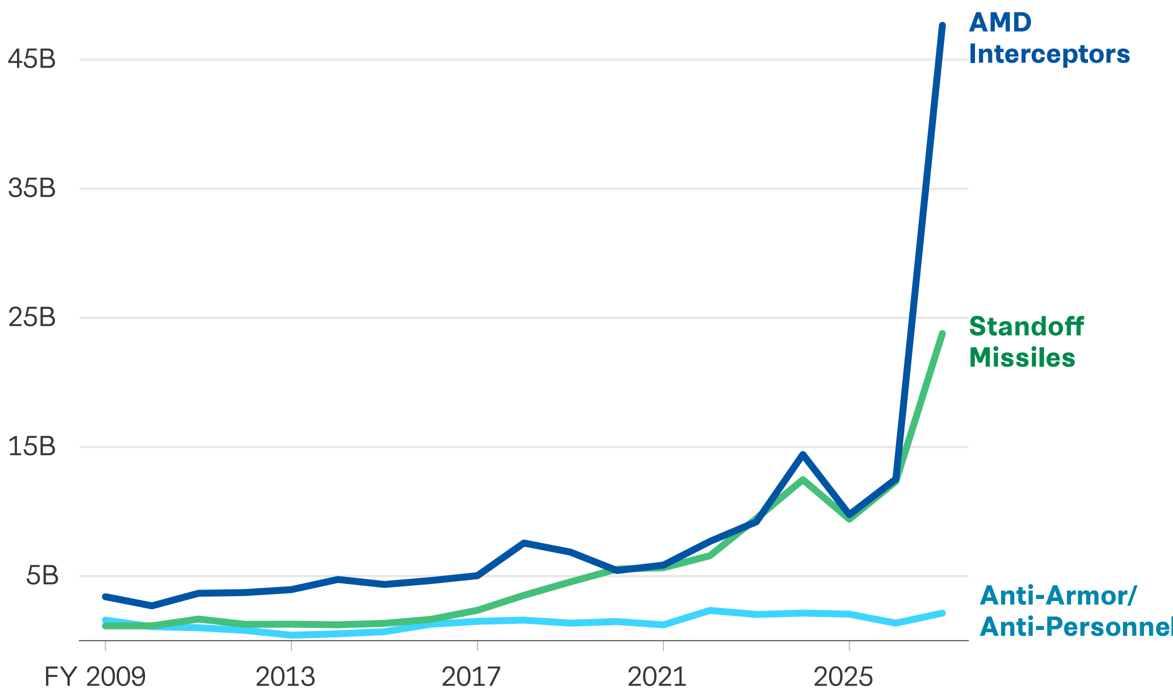
The second issue is that, in contrast to the missile market, most (but not all) space launch vehicles use liquid propellants rather than solid due to the different demands of the sector.[45] Liquid-fuel missiles are difficult to transport with their propellant and oxidizer load in the missile due to the volatility, so they are often fueled shortly before launch.[46] This differentiation creates additional logistical and operational barriers to military use. Military applications usually prefer solid-fuel missiles because they can be launched without waiting to fuel at the launch site and because they are more stable during storage. Many of these constraints do not exist in space launch, where launches are planned far in advance. Liquid propellants also make it easier to throttle the fuel that runs through a rocket engine, as well as increase efficiency, which is critical to the reusable launch vehicles that have revolutionized space launch economics.[47]

One positive trend for the missile industrial base is that government demand has grown substantially in recent years. Multiple global conflicts have featured heavy missile usage, most notably the Russian invasion of Ukraine and Israel's 12-day war with Iran. These conflicts have driven governments around the world to invest heavily in their missile arsenals, both to replace weapons used by or transferred to combatants and in response to operational lessons.

Figure 7 shows the defense budget trends for anti-armor/anti-personnel missiles, conventional standoff missiles (defined as those with a maximum range of 70 km or more), and AMD interceptors—three categories of munitions that use SRMs. The appropriated dollars for these missiles, which serve as a measure of government demand for conventional missile capabilities, previously peaked at a combined $29 billion (2027 dollars) in 2024. This includes relatively consistent demand growth, particularly for AMD interceptors and standoff missiles. The compound annual growth rate was 7 percent for the AMD interceptor portfolio and 14 percent for standoff missiles between 2009 and 2026. The 2027 budget request includes over $73 billion of funding for these missile programs between its requests for both mandatory and discretionary appropriations, which would constitute a substantial demand spike if approved by Congress.

Figure 7: Missile Modernization by Type, 2009–2027

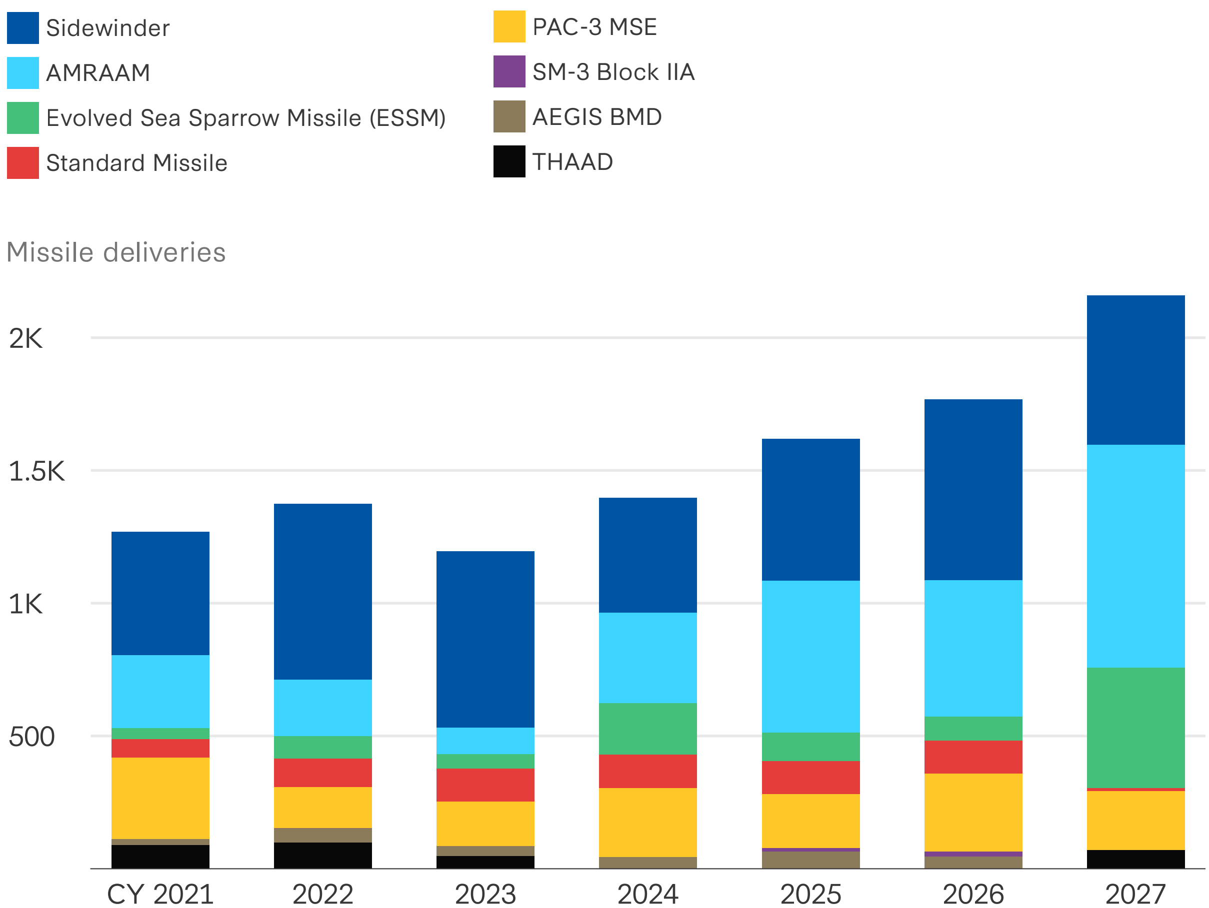
Total obligational authority in 2027 dollars



Source: DOD Comptroller; and CSIS Missile Defense Project.

This surge in demand has translated into considerable growth in the projected capacity of the industrial base. Figure 8 shows the DOD data on projected delivery timelines for important AMD interceptors and illustrates how this investment has translated into growth. DOD expects delivery of over 2,100 interceptors in calendar year 2027, a 70 percent increase compared to the nearly 1,300 interceptors delivered in 2021. Considerable increases in Advanced Medium-Range Air-to-Air Missile (AMRAAM) and Evolved SeaSparrow Missile (ESSM) deliveries are driving much of this projected surge.

Figure 8: Selected AMD Procurement Deliveries by Interceptor, FY 2018–FY 2025



Source: DOD Comptroller data, updated through the PB 2026 budget request; and CSIS Missile Defense Project.

These figures may understate the throughput the AMD interceptor industrial base can currently handle. Data on the number of Patriot Advanced Capability-3 Missile Segment Enhancement (PAC-3 MSE) interceptors procured using Ukraine supplemental funds in 2023 was classified, meaning their delivery schedules are also not included here.[48] Using the unit cost data for unclassified missiles from that year along with the total appropriated funding suggests that there are roughly 375 additional PAC-3 MSE interceptors scheduled for delivery, although the timeline is harder to predict. What is clear, however, is that increasing demand and funding for AMD interceptors is now translating into increased industrial output. Sustaining that demand will be necessary to sustain investment and continued output.

Conclusion

Despite these recent increases, this output falls far short of announced DOD targets for future AMD interceptor production. As part of its announced framework agreements for a munitions ramp, DOD has established annual production targets of at least 1,900 AMRAAM, more than 500

Standard Missile 6 (SM-6), 2,000 PAC-3 MSE, and 400 Terminal High-Altitude Aerial Defense (THAAD) missiles per year while also increasing the production capacity for SM-3 Block IB and IIA interceptors.[49] Achieving these goals will require dealing with myriad challenges to increasing interceptor production. These numerical goals were set, moreover, prior to the commencement of Operation Epic Fury, which could necessitate greater urgency and the demand for still higher production rates to replenish interceptors expended in early 2026.

Challenges to Building the Munitions Ramp

As DOD looks to build a sustainable munition ramp for AMD interceptors, the Pentagon faces three primary challenges: (1) the cyclical nature of demand in the missile market, (2) the existing approach to industry that prioritizes cost and efficiency over capacity, and (3) DOD's lack of visibility into sub-tier supply chains. Understanding these challenges and implementing appropriate policies to mitigate the barriers they present will be essential to DOD success in developing a productive relationship with prime contractors and building a robust and responsive AMD interceptor industrial base.

Cyclical Funding for Munitions

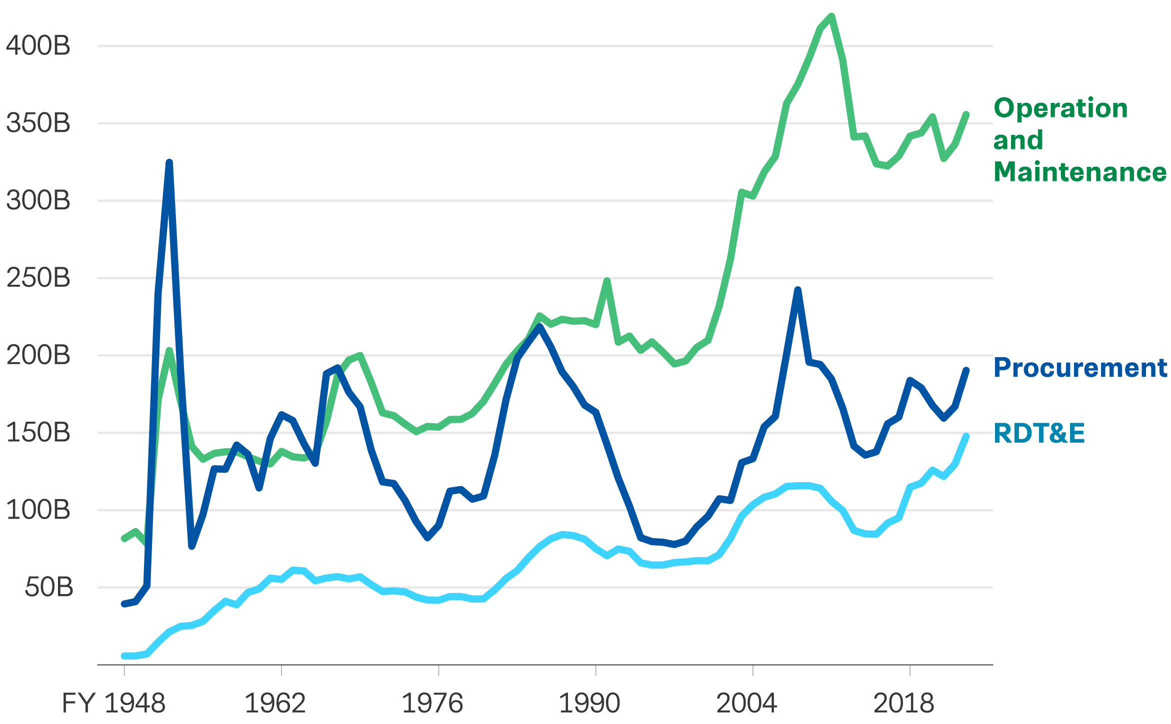
As previously mentioned, the missile market in general has consistently been characterized by cyclical demand, which creates a challenge for the AMD industrial base. As one study summarized, "It is difficult to match supply and demand when demand can change much faster than supply."[50] Munitions spending has fluctuated considerably over the last 20 years, in both positive and negative directions. Munitions demand is cyclical for two primary reasons: defense budget dynamics and the nature of munitions procurement.

The first driver of the pattern is the cyclical nature of the overall defense budget in response to shifting political and operational priorities. This trend is not unique to the current period. In fact, munitions production has often faced considerable fluctuations in funding tied to overall defense spending levels. A 1977 Army study on munitions mobilization observed that "Cuts in budgets, cuts in resources, and priorities of other social and economic programs leave very little resources for mobilization planning."[51]

DOD procurement funding has seen big swings since the end of World War II, driven by either direct conflicts or major defense buildups during the early 1980s (Figure 9). Notably, the more recent conflicts in Iraq and Afghanistan saw much larger growth in operations and maintenance funding than procurement increases. This suggests that while the United States has been involved in conflicts for most of the last 25 years, this cycle of increased defense spending did not translate into significant funding across the munitions industrial base, particularly for AMD interceptors.

Figure 9: DOD Total Obligation Authority, FY 1948–FY 2023

Total obligational authority in 2025 dollars

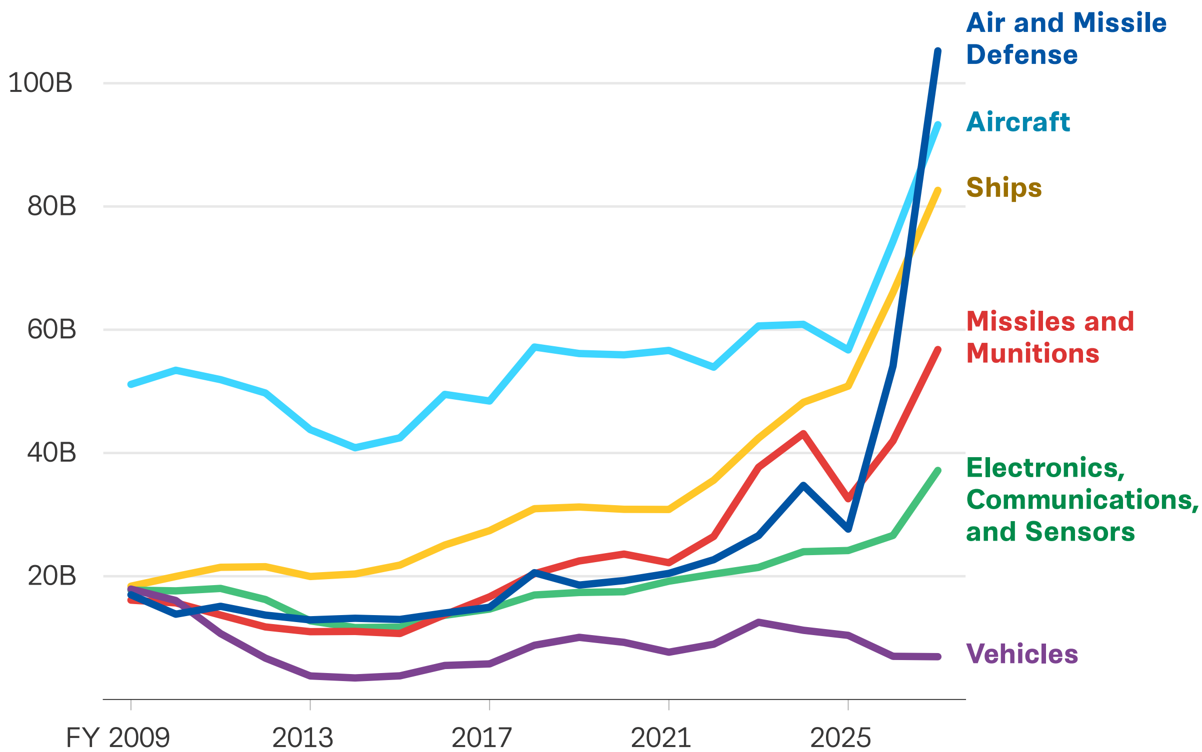


Source: DOD Comptroller; and CSIS Missile Defense Project.

Most recently, the Budget Control Act created downward pressure on demand for missiles, munitions, and AMD interceptors. Procurement and research, development, testing, and evaluation (RDT&E) funding since 2009 shows how this has affected the air and missile defense and missile and munition portfolios. This data shows a recent trough in spending on both capability sets between about 2011 and 2016 (Figure 10). This corresponds with overall declining modernization spending, mostly caused by defense budget caps that led to considerable cuts to modernization of aircraft and vehicles as well.[52] The DOD Acquisition Transformation Strategy notes this fluctuation has been particularly severe for munitions, "where programs have historically been decremented to cover shortfalls on other programs resulting in wide ranging procurement quantities year over year."[53]

Figure 10: Department of Defense Modernization by Platform

Total obligational authority in 2027 dollars



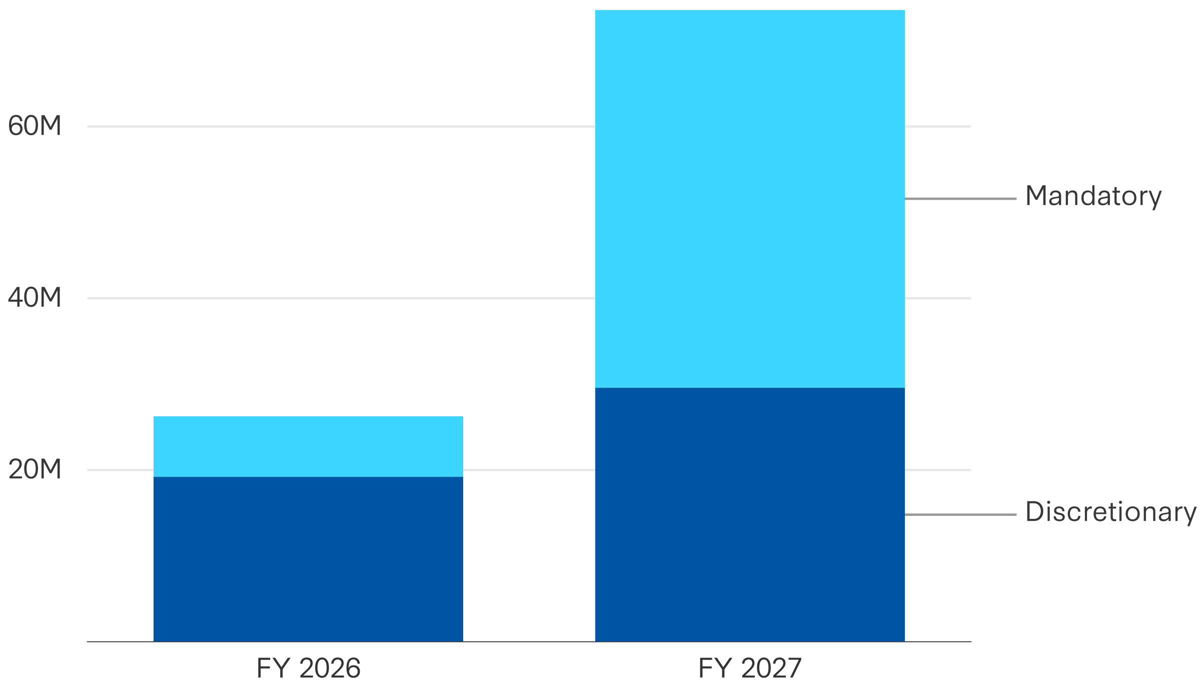
Source: DOD Comptroller; and CSIS Missile Defense Project.

A recent Army Science Board highlighted this trend, stating that "[r]esponding to fiscal cuts in 2010, the Army accepted risk with munitions production."[54] While its conclusions were limited to Army programs, the challenges it identified for munitions programs apply across the board. The board later observed that, "When projections and programmed funds for munitions form a wavelength . . . there are no steady and predictable levels of production, costs increase, and timelines grow."[55] Lean budget environments are especially bad for munitions budgets because cutting a few munitions offers a means to find distributed savings compared to cutting an entire ship or airframe. That ability to shave munitions budgets by rounds has made them a regular billpayer.

Even the recent surge in munitions funding offers challenges to building the industrial base. A large part of the recent upswing in funding for guided missiles stems from supplemental funding for military assistance to Ukraine and Israel and the recent reconciliation bill (Figure 11). While this approach may be a reasonable response to overall congressional dysfunction, their nature as non-standard appropriations raises questions about the durability of the investments. Because the funding is short term and requires abnormal legislative maneuvering, it may not incentivize industry investments in durable production capacity. Industry might be less inclined to invest in production facilities or hire and train the additional workforce to staff them if they perceive it will be idle when supplemental funds run out.

Figure 11: Missile Spending by Funding Type

Total obligational authority in 2027 dollars



Source: DOD Comptroller; and CSIS Missile Defense Project.

This also highlights that the task of sending a consistent demand signal falls not only to DOD, but also to Congress in its appropriations role. Years of continuing resolutions and occasional shutdowns, mostly unrelated to defense spending issues, have affected the defense industrial base. The impact falls especially on smaller firms at the lower tiers of the supply chain. While large firms have the capital and cash flow to withstand contract delays, uncertainty from appropriations delays can be existential for smaller firms that operate on tighter margins.[56]

This inconsistent demand also creates challenges because of the past lack of new-start interceptor programs. Some new programs of the last 20 years have primarily consisted of improvements to existing interceptors, such as the first increment of the Indirect Fire Protection Capability (IFPC), which uses the AIM-9X Sidewinder and the Hellfire Longbow missiles.[57] DOD is taking some steps to alleviate this challenge by holding a competition to develop a new interceptor for IFPC Increment 2 designed to counter supersonic cruise missiles.[58] The absence of new-start programs has reduced opportunities to integrate and test new technologies and suppliers. When new programs begin, they serve as an opportunity for DOD to test out new suppliers, qualify new components, and update manufacturing technology. A lack of these opportunities has likely contributed to some industry consolidation.

Government-Industry Relationship and Incentives

In addition to the inconsistent demand signal, there are other challenges in the relationship between government and industry that hinder production of AMD interceptors. Both sides of this relationship have strong incentives to minimize cost and maximize efficiency, which often comes at the expense of building and maintaining capacity that could prove valuable in a wartime environment. The nature of the missile industrial base also requires engagement with multiple levels of government, requiring industry to navigate relationships with multiple federal and local agencies that do not always coordinate effectively.

The Pentagon is incentivized to pursue industrial efficiency and decreased costs because of its accountability to the American taxpayer. The need to be able to explain how DOD spends the public's money also creates some of the impetus behind the maze of regulations governing defense acquisition. Navigating this complex set of regulations and statutes creates challenges to speedy contracting actions, creating challenges for all defense contractors, especially for smaller and newer suppliers, which may not have the experience or large teams to manage the process.[59]

Industry has incentives to behave in a similar way. The prime contractors are public companies that are legally obligated to be responsive to stockholder interests. Facing an imperative to turn a profit and minimize costs, industry similarly focuses on maximizing efficiency and avoids building in spare capacity in its facilities and supply chains without an adequate business case that supports investments, as the cost would cause upward pressure on price per missile at reduced quantities. As a GAO study noted in 2017, "excess capacity keeps SRM manufacturers from being cost competitive, which can jeopardize the viability of the manufacturers as well as their sub-tier suppliers."[60]

This structure has historically created problems when industry faces exogenous shocks that introduce uncertainty, as seen during the Covid-19 pandemic when changes in delivery times had wide-ranging ripple effects across the industrial base.[61]

These competing incentives can undermine government attempts to accelerate production through concessions to industry. For example, the government has increased its use of undefinitized contract actions to try to alleviate some of the delays in the contracting process by allowing work to start before final details are agreed. Nevertheless, the Army has found that the fear of later audits that would disallow certain costs from compensation has undermined its use.[62]

Another challenge in the government-industry relationship is the nature of the supplier qualification process on missile programs. DOD requirements for safety, reliability, and performance often lead to a very high bar to qualify alternative suppliers for components, making it challenging for industry to truly diversify the supply chain. Qualifying new components, processes, or materials requires additional testing and potentially the requalification of the entire missile, an expensive and time-consuming process.[63] This gives producers of subcomponents that are already qualified a significant incumbency advantage, as the government does not need to continually pay to qualify those parts.

Table 1: Population at Select Current and Planned SRM Manufacturer Locations

Company	Site	Population within a 50-mile radius*
Anduril	McHenry, MS	784,216
Avio USA	Hurt, VA	1,283,113
Castelion	Midland, TX	406,686
Castelion	Rio Rancho, NM	964,558
Firehawk	Crawford, MS	286,261
General Dynamics	Camden, AR	186,213
L3Harris	Camden, AR	192,133
L3Harris	Orange County, VA	2,097,590
Nammo Defense Systems	Perry, FL	275,877
Nammo Defense Systems (Naval Surface Warfare Center)	Indian Head, MD	6,937,190
Northrop Grumman (Allegany Ballistics Lab)	Rocket Center, WV	649,265
Northrop Grumman	Promontory, UT	675,269
Northrop Grumman	Bacchus, UT	2,604,337
Northrop Grumman	Elkton, MD	6,986,466
Prometheus Energetics	Crane, IN	632,444
Ursa Major	Galeton, CO	1,430,153
Ursa Major	Berthoud, CO	3,497,188
X-Bow Systems	Socorro, NM	59,557
X-Bow Systems	Luling, TX	2,526,595

Note: Total population estimates were calculated using the Missouri Census Data Center (MCDC) Circular Area Profiling System (CAPS), which measured the population within a 50-mile radius of the facilities based on 2020 U.S. Census block-level data.
Source: CSIS Missile Defense Project; Missouri Census Data Center; and U.S. Census.[64]

Weapons requirements are not the only barrier industry faces from government in building industrial capacity to produce AMD interceptors. Industry efforts to build additional capacity also face considerable federal environmental regulation as well as state and local siting and construction policy that can take time, cost, and effort to navigate.[65] This regulatory caution is exacerbated by the safety hazards associated with many components of AMD interceptors, particularly in propellants for SRMs and explosives for warheads.

These hurdles create additional challenges to maintaining industrial capacity, especially when demand is inconsistent. Since many of these facilities must be built away from population centers, finding the workforce to staff them is difficult, especially on short notice (Table 1).[66] Companies can invest in local job training and other efforts to create the skills necessary in the local population, but these efforts take a considerable amount of time to bear fruit.

Training these new employees often takes a long time, considering many of the hazards and special equipment involved. An Army munitions study estimated the average line worker at a munitions facility takes two years to be fully effective. For energetics, that timeline extends to seven years.[67]

Supply Chain Management

The structure of the AMD industrial base that delegates supplier management to industry inherently limits DOD's visibility and ability to mitigate bottlenecks in the sub-tier supply chain. In its industrial base analyses of the munitions sector, DOD has consistently identified lack of supply chain visibility as a problem, making it difficult to address shortcomings before problems arise.[68]

There are two main reasons for this opacity. First, the number of complex, unique subcomponents in guided missiles poses an inherent challenge for managing the supply chain. As missiles become more complex, it becomes increasingly difficult to track and manage inputs for a growing number of specialized parts that are themselves comprised of a number of distinct components with their own supply chains. Second, the relationship between DOD and industry, as currently envisioned, assigns responsibility for sub-tier management to industry. Part of the value industry provides in this arrangement is expertise in the supply chains underlying their final product, a problem sometimes exacerbated due to intellectual property limitations. With sustained demand from the customer, the incentives for management can be better sustained.

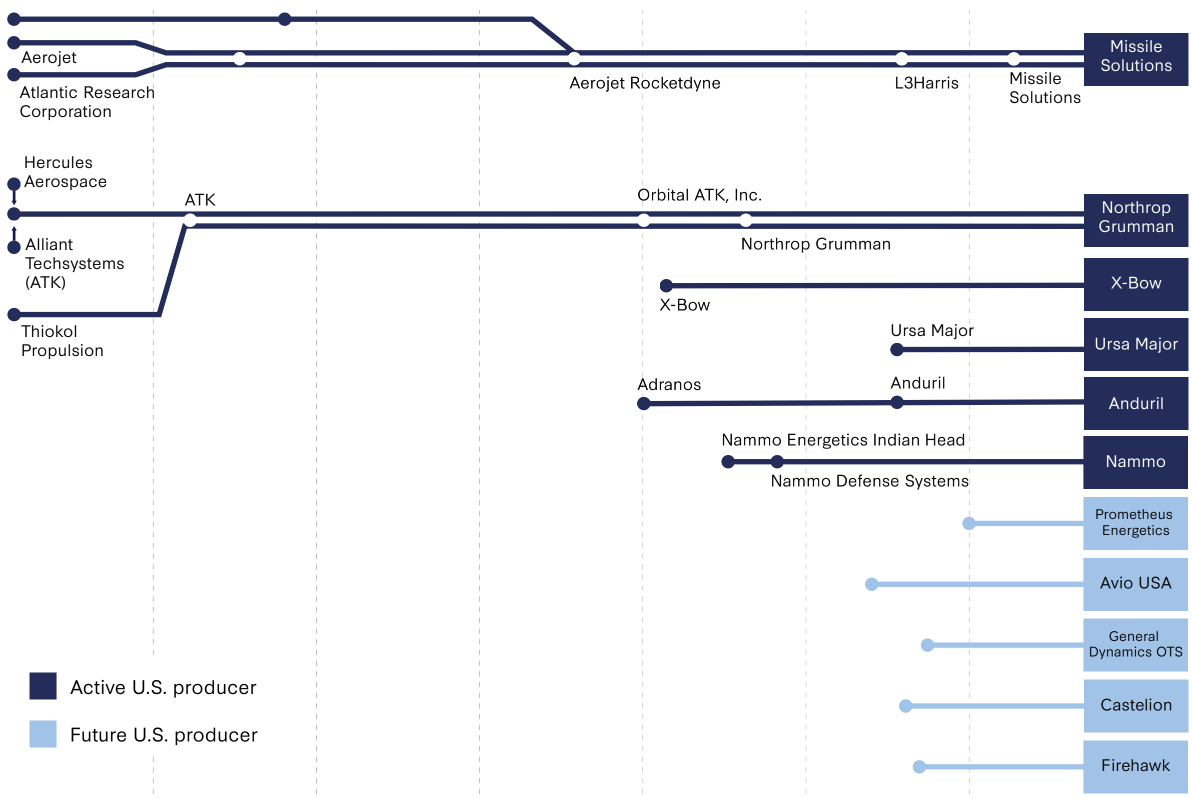
SRMs serve as a useful case study for the supply chain challenges facing the AMD industrial base. SRMs are a major subassembly common to nearly all interceptors and illustrate the challenges DOD and industry face managing sub-tier supply chains.

The SRM supplier base has consolidated since 2000 and has been characterized as having a hollowed-out or less experienced workforce and single points of failure at the sub-tier level.[69] While there have been several new entrants since 2015, the scalability of their systems and processes remains uncertain, but progress toward protoyping and production activities is being made in many quarters.

The industry's consolidation emerged from a decade of declining demand beginning in the early 2000s in two areas. First, there were few new programs for tactical missiles over the decade, which resulted in a lack of design improvements in the SRMs themselves.[70] Compounding the problem, the industry suffered as a result of the "post-drawdown decline in procurement," which came alongside NASA's suspension of the Space Shuttle program in 2011, significantly reducing the commercial space launch demand for SRMs and their components.[71] Until 2011, the Space Shuttle program protected SRM suppliers from fluctuation in DOD procurement, but when the program ended and new space launch providers favored liquid-fueled engines, the civil sector demand signal plummeted. The result of a lack of a commercial analog is striking: Between 2000 and 2015, the industry shrunk from six domestic suppliers to just two: Aerojet Rocketdyne and Orbital ATK.[72] The most basic cause of this consolidation to a more shallow and more fragile industrial base stemmed from reduced and cyclical government customer demand.

Reversing that consolidation will take time. Since 2015, increased DOD demand for missiles has prompted the entrance of several new manufacturers. New entrants include Nammo Defense Systems (an American subsidiary of the Norwegian company Nammo Raufoss), X-Bow, Ursa Major Technologies, Firehawk, Castelion, Anduril, and others (Figure 13). Other firms which have either not yet begun or which may soon begin production include Prometheus Energetics, Avio USA, and General Dynamics Ordnance and Tactical Systems.

Figure 12: U.S. and Foreign SRM manufacturers, 1995–2026



Source: CSIS Missile Defense Project; and GAO.[73]

In many respects, new entrants still lag far behind the two major suppliers, L3Harris (following its acquisition of Aerojet) and Northrop Grumman (following its acquisition of Orbital ATK). These new entrants could eventually contribute to the diversification of DOD's SRM supply chain, but they have not yet demonstrated they can transition from prototyping or limited production of small numbers of rocket motors to larger lots. Creating and demonstrating scalability will be a critical next step for these producers in their efforts to integrate themselves into existing supply chains.

Challenges that newer entrants face are wider ranging than just facilities or scale. The hollowing out of the SRM industrial base in the 2000s and early 2010s resulted in a small, aging workforce and a lack of an institutionalized knowledge base for future generations of workers as it relates to novel design and development of motors.[74]

With the goal of increasing missile production and inventory, DOD will have to balance investment between the two leading manufacturers and new entrants. Near-term focus on volume may counsel acceleration among current leaders (as with the munitions acceleration efforts). Longer-term diversification of both primes and potentially the supply chain will benefit from investment in new entrants.

Like the SRMs themselves, the subcomponents that make up the motors have similarly faced supply chain challenges. Historically, the industrial base has faced challenges with supply of rayon, a precursor to a component found in nozzles, and with the cost of ammonium perchlorate (AP), the primary oxidizer in composite propellants.[75]

AP is a non-substitutable propellant ingredient for nearly all U.S. and allied SRM systems and serves as a case for understanding challenges with single points of failure.[76] In the past, only one qualified domestic manufacturer, American Pacific Corporation (AMPAC), produced AP for defense applications.[77] This reliance has since been mitigated, and AP is not the primary impediment to SRM production. While reliance on AMPAC alone for production of AP is not currently a bottleneck in the production of SRMs—the company's production capacity outpaces demand by a significant margin—there are several challenges posed by relying on a single supplier.[78]

A disruption to production of this oxidizer could create a bottleneck with industry-wide effects. A stop or reduction in production caused by, for example, a safety incident or internal financial challenge, could not be mitigated by turning to alternative qualified sources, such as Northrop Grumman. In 2025, Nammo raised concerns about the loss of a single-source provider for one of its other propellant components. One company representative noted that the loss of a sole source of one ingredient could have wide-reaching effects in their production, explaining that if a source is lost, "I then have to requalify the propellant. . . . I then have to requalify, potentially, the rocket motor, and I have to potentially requalify the missile."[79]

Relying on AMPAC as a single source also creates risk for industry's ability to surge motor production because of the company's price-setting power. In 2016, rising prices following a transition in AMPAC's ownership drove Northrop Grumman to begin the process of establishing an internal production line.[80] Although AMPAC remains the leading supplier of AP for weapons programs, Northrop Grumman has become an alternative source for space launch applications following approval in 2021.[81]

An additional challenge in the sub-tier supply chain is reliance on commercial demand to maintain production capacity during downcycles in demand. This challenge has been demonstrated with rayon, a component of SRM nozzles that helps protect the aluminum structure from the heat of the expanding gases; it is also a fiber used in clothing, sewing thread, and tire cord.[82] Rayon demand for defense applications is relatively low and cyclical.[83] Alone, it is not sufficient to make production profitable, meaning that manufacturers have had to rely on commercial sales to keep lines open.

The defense market faced challenges as rayon was displaced by polyester in many of its commercial applications.[84] Without an alternative source of demand, rayon suppliers began to exit the industry in the 1990s. The reduction in available suppliers for a component that could not be easily replaced in motors prompted NASA to commission a stockpile of 2.5 million pounds of rayon fiber to support SRM production through 2005 while it looked for alternatives.[85] Today, rayon continues to be part of DOD efforts to build supply chain resilience for SRMs, including new funding to support additional suppliers.[86]

Conclusion

The AMD industrial base faces several challenges driven by the nature of the missile market, incentives to prioritize efficiency over capacity, and the current relationship between government and industry. Swings in procurement funding in the broader defense budget have created financial disincentives to expand capacity. Supplemental and reconciliation funding has signaled increased demand in recent years, but these one-off funding surges are not a substitute for consistent demand and may not translate to additional, durable capacity.

The challenges to capacity building are compounded by incentives for both industry and the government to prioritize cost and efficiency. The government is accountable to taxpayers, and industry to shareholders, making it hard to invest in capacity above what is needed to meet near-term demand. The same problem arises with respect to supply chain resilience: The process of qualifying new sources and manufacturers is time consuming and expensive, creating an incumbency advantage and making it challenging to add new sources for subcomponents and materials given the incentives to produce interceptors cost efficiently.

Despite these challenges, there is momentum in Congress, DOD, and the broader executive branch to address this issue set. Turning today's demand for interceptors and momentum for acquisition reform into meaningful improvements in capacity and procurement will depend on the government's ability to identify the most suitable pathways for investment.

Opportunities for Expansion

Although the AMD interceptor industrial base faces many challenges, there are also many opportunities to improve its capacity and resiliency. The second Trump administration has prioritized modernizing and improving the defense acquisition process, which manifested in an April 2025 executive order calling for a "comprehensive overhaul of the system" and a November 2025 Acquisition Transformation Strategy report from DOD.[87] The momentum has extended to Congress and industry alike. The increased attention on acquisition reform for AMD creates an opportunity to explore the requirements themselves and the subsequent pathways and vehicles that might be best suited to the missile market, including multiyear procurement and block buy contracting, direct-to-supplier investment vehicles, and other transaction agreements. It is also important to understand the limitations to each of these pathways, however, to ensure that each is applied in the most appropriate context.

Acquisition and Requirements Reform

In particular, the attention to reforms to the Joint Requirements Oversight Council (JROC) and greater scrutiny of DOD requirements present an opportunity to reexamine opportunities to strengthen the industrial base. Requirements can be grouped into two buckets: those dealing with the specifications of individual weapons systems and those established to set target inventory numbers. These requirements influence the behavior of the AMD industrial base by establishing the benchmarks munitions need to meet, both in terms of performance characteristics and the quantities in which they must be made available. Each of these levers offers different opportunities for the AMD industrial base but also carries its own challenges and limitations.

Documents detailing weapons systems requirements lay out the specifications for AMD interceptors that industry must meet, allowing DOD to impose penalties or refuse delivery when they are not met.[88] These specifications and fault tolerances often create challenges for industry in managing the supply chain because there are commonly few suppliers that can meet these standards. Once a supplier is approved, industry is functionally locked in to using them because of the difficulty of qualifying new suppliers. This can contribute to increasing costs and lack of diversity at lower levels of the supply chain. These challenges, however, create an opportunity. A reexamination of munitions requirements that cause particular pain and hinder new suppliers could yield significant benefits in supply diversification, cost, and introduction of innovation.

The Acquisition Transformation Strategy, which is reorganizing service requirements management from Program Executive Offices (PEO) to Portfolio Acquisition Executives (PAE), offers another opportunity to shift the way the DOD handles its requirements. The old PEO structure encouraged requirements specific to each program, incentivizing the design of very specific components for each system. The PAE structure, with its ability to manage requirements at the portfolio level, may allow its executives to create greater commonality across the requirements inside of their portfolio. This structure could reduce the number of specialized parts for each weapons system and potentially broaden the number of suppliers that can participate.[89] One way to accomplish this could be to introduce greater modularity into AMD interceptor design, potentially making it easier to shift production between subcomponents and even interceptor types.[90] Nevertheless, this may also introduce risk by incorporating new modular components into mature weapons systems and supply chains, which is also likely to increase cost in the short term.

One example of the sort of requirement that could be revisited is the shelf life of munitions. Specifications that require long shelf lives can increase the cost of individual munitions by forcing industry to use components that do not degrade over time—often for decades. This includes extra costs to address corrosion prevention, the aging of energetics components, and the design of power sources, such as liquid reserve batteries.[91] This requirement makes sense for more expensive munitions one expects to husband over long time periods. Nevertheless, if DOD is looking to increase the number of cheaper AMD interceptors that it can expend sooner, loosened shelf-life requirements might offer one way to reduce the cost of these munitions and include new suppliers.

Changing shelf-life requirements entails some risk, however. If a large group of these munitions reach the end of their service lives during a more challenging budget cycle, the effect on the inventory could be detrimental. To offset this, munitions with shorter shelf lives would likely require more consistent funding, rather than the current peaks-and-valleys approach. Revising the requirements on existing systems could also result in drawn-out negotiations between government and industry and long testing and qualification timelines, potentially undermining the goals of speeding production and reducing cost.

Another requirements lever DOD can use to influence the industrial base is its inventory requirements and service acquisition objectives. The Total Munitions Requirements (TMR) process defines the inventory of munitions required by the various combatant commands to execute their operational plans.[92] These lists then go into the budgeting process to provide input into the number of munitions each service needs to buy to conduct current operations as well as fill stockpiles for future readiness.

Recent conflicts provide a clear indication of the need for larger inventories of AMD interceptors. Updates to the TMR should factor expenditure rates from recent conflicts into their calculations, which should then drive greater investment in service budgets to meet these requirements. Although this should provide a clear demand signal, there are circumstances in which the services fail to meet the inventory targets set out in the TMR.[93] Congress has shown a particular interest in maintaining oversight of these targets, adding air and missile defense interceptors to the reporting requirements on the TMR in the most recent National Defense Authorization Act (NDAA).[94] The services themselves can also enhance this demand signal by updating their acquisition objectives for individual missile systems. For example, the Army recently quadrupled its total acquisition objective for the PAC-3 MSE missile, giving industry an indicator of long-term demand for that interceptor.[95]

Likewise, when setting munitions requirements, DOD decisionmakers should also consider lead times for munitions production. Munitions with longer lead times must be produced in advance of a conflict, as surging production will take longer. At the same time, those with shorter production processes are candidates to be effectively surged during wartime. For example, unmanned aircraft systems (UAS) interceptors may be a capability that can be surged quickly during a conflict and thus can be produced at lower volumes during peacetime to prioritize other capabilities. Conversely, THAAD and SM-3 interceptors have much longer production lead times. For this reason, industry would not be able to produce them at a replacement rate during conflict, making it necessary to stock close to the full objective inventory required before the outset of a conflict.

Acquisition Pathways

The momentum behind acquisition reform also creates an opportunity to consider the use of multiple acquisition pathways in new ways to accelerate munitions production and build capacity. Some of the options for these pathways include multiyear procurement, direct-to-supplier investment vehicles, termination and liability penalties for the government, and other transactions authorities.[96]

MULTIYEAR PROCUREMENT AND BLOCK BUY CONTRACTING

One popular solution to munitions acquisition is an expanded use of multiyear procurement (MYP). Expanded use of MYP could have positive effects for volume buys of capabilities over longer time horizons. Analysts have made the case for using MYP for missiles and munitions procurement to drive down costs and send a signal to industry about the stability of demand.[97]

The list of munitions eligible for MYP opportunities expanded in the FY 2024 NDAA to include the Guided Multiple Launch Rocket System (GMLRS), PAC-3 MSE, and AMRAAM, among others (Table 2).[98] The list was updated in both the FY 2026 NDAA and appropriations bill to reflect shifts in the munitions prioritized for acquisition under this structure in recent years (Table 3). These multiyear contracts could help drive down overall costs and incentivize industry to invest in facilitization for increased production capacity and modernization of existing production capability to increase throughput and decrease cost.

Table 2: Munitions Eligible for MYP Opportunities by Eligibility Source in FY 2026 NDAA

NDAA	Appropriations
▪ SM-3 Block IB ▪ SM-6 ▪ Tomahawk ▪ AMRAAM ▪ JASSM ▪ LRASM ▪ THAAD ▪ PAC-3 MSE ▪ FAMM ▪ ERAM ▪ ETV ▪ Low Cost Hypersonic Strike	▪ SM-3 Block IB ▪ SM-6 ▪ Tomahawk ▪ AMRAAM ▪ JASSM ▪ LRASM ▪ THAAD ▪ PAC-3 MSE

Source: U.S. Congress.[99]

Table 3: Munitions Eligible for MYP Opportunities by Eligibility Source, FY 2023 NDAA

NDAA	Appropriations
▪ XM1128, XM1113, M107, and M795 (155mm rounds) ▪ JAGM ▪ HIMARS ▪ ATACMS ▪ Harpoon ▪ Naval Strike Missile ▪ GMLRS ▪ PAC-3 MSE ▪ Stinger ▪ Javelin ▪ AMRAAM ▪ MACS ▪ 155m Excalibur M982A1 ▪ LRASM ▪ JASSM ▪ SM-6 ▪ AIM-9X	▪ Naval Strike Missile ▪ Guided Multiple Launch Rocket System ▪ PATRIOT Advanced Capability-3 Missile Segment Enhancement ▪ Long Range Anti-Ship Missile ▪ Joint Air-to-Surface Standoff Missile ▪ Advanced Medium-Range Air-to-Air Missile

Note: The list of munitions authorized for multiyear procurement in FY 2023 NDAA was not approved by appropriators until FY 2024. See https://www.congress.gov/118/plaws/publ47/PLAW-118publ47.pdf.

Source: James M. Inhofe National Defense Authorization Act for Fiscal Year 2023.[100]

The MYP structure poses several potential challenges. While several interceptors are suitable candidates for procurement by multiyear contracts, the statutory requirements governing its use limit how widely it can be applied. To be eligible for MYP, a program must have a stable design, requirements, demand, and funding.[101] It also must show that the program will yield “significant savings” because of a transition from annual contracting to MYP.[102] The stability provided by the MYP structure could also limit private investment in the industrial base for the selected munitions. It could communicate that the government may not use additional capacity above and beyond what is requested in the MYP contract, generating few incentives to invest in surge capacity.

Another potential challenge of MYP comes from fiscal uncertainty affecting how well the government can commit to executing the multiyear options. While MYP contracts give authority for the buys across multiple years, funds still must be appropriated annually for DOD to execute the contract. As demonstrated in the FY 2026 budget process, DOD can face opposition to MYP requests when submitted without sufficient lead time.[103] Additionally, Congress has neglected to fund procurement for munitions with MYP contracts, essentially breaking those agreements.

Block buy contracting could be a useful alternative for programs that may not meet the statutory criteria for MYP. Like MYP, this pathway can be used to contract the procurement of a capability beyond one year, but because there is no governing statute, there are not the same requirements for design stability that can limit options for supply chains.[104] While the lack of strict requirements may be beneficial in some cases, block buy contracts may prove less desirable for industry than MYP when both options exist, due to the lack of defined cancellation penalties. Each block buy contract must be independently negotiated and approved, which may make benefits less predictable and introduce significant risk for suppliers if the contract does not include sufficiently robust termination and liability (cancellation) penalties.[105]

DIRECT-TO-SUPPLIER INVESTMENT VEHICLES

The use of the Defense Production Act (DPA) and industrial base funds also presents an opportunity for DOD to make targeted investments to resolve supply chain bottlenecks. The DPA gives the president broad authority to influence the production of goods and materials needed for national defense by prioritizing government contracts and offering production incentives to industry.[106] DOD has recently used DPA authorities to make investments in SRMs, rare earth minerals, select chemical components, and microelectronics.[107] In addition to DPA funding, DOD has also seen significant growth in its Industrial Base Analysis and Studies (IBAS) funding line, creating another source for direct-to-supplier investment. Another significant investment in the AMD interceptor supply chain is a $1 billion convertible preferred equity investment with L3Harris.[108]

This sort of direct-to-supplier investment can provide critical funding to resolve supply chain issues that are common across multiple munitions. DPA and IBAS funding can provide critical capital for facilities expansion and modernization, especially for lower-tier suppliers that have tighter margins and a harder time accessing private funding. Most of these agreements will likely be far smaller than the $1 billion equity stake. DOD used $12.6 million in DPA funds to address some of its challenges with rayon production for rocket nozzle insulation.[109] This type of targeted government intervention can help relieve supply chain bottlenecks by either expanding production capacity and efficiency for existing suppliers or providing support for establishing or qualifying new market entrants to create a more diverse supplier base.

This sort of direct-to-supplier intervention, however, cannot substitute for more proactive supply chain management by both the government and prime contractors in the AMD industrial base. DPA and IBAS funding is reactive by nature: The funding goes to addressing already evident problems in the supply chain. While cash infusions provided under DPA authorities can help resolve short-term shortages and bottlenecks, they cannot be relied on to head off the unforeseen bottlenecks of the future. Even less can these interventions substitute for clear and sustained demand signals from the government customer. While munitions supply chains are a current priority for these funding streams, the goal should be a munitions industrial base that is robust and resilient without a need for direct-to-supplier investment.

OTHER TRANSACTION AGREEMENTS

Other transactions (OTs) offer another acquisition pathway to streamline prototyping and initial production, but they carry some risk for capabilities that will be procured over longer time horizons. These pathways might be leveraged for one-off opportunities to incorporate new suppliers by streamlining administrative and regulatory requirements under the Federal Acquisition Regulations (FAR). This may result in reducing barriers to entry for new companies, which could be a boon for innovation in the industrial base.[110] Other Transaction Agreements (OTAs) have been used by the Army for missile and munition subcomponents, as well as the systems themselves, including for the Integrated Fires Protection Capability (IFPC) Increment 2 Second Interceptor and its associated motor, including at least one new SRM entrant.[111]

Nevertheless, DOD risks shrinking the traditional RDT&E phase by using OTAs, possibly making it more challenging for new entrants to build expertise in DOD processes early in their development cycles. This could result in reducing the number of opportunities for suppliers to improve their ability to manufacture products and components at scale. System development and demonstration—where industry is supposed to determine the producibility of a prototype and invest in industrial tooling—is typically one of the more expensive portions of the traditional RDT&E path. It may be acceptable to bypass this step for capabilities that the U.S. government only intends to purchase a small number of, but for those munitions DOD will need to acquire in large volumes over long periods, the full RDT&E cycle in traditional pathways may prove necessary to maximize producibility and scalability.

Allies and Partners

Allies and partners also function as a source of opportunity to support the AMD industrial base. In particular, allies and partners can provide additional demand to AMD suppliers, potentially provide surge capacity during a crisis, and offer potential sources of innovation to U.S. industry.

ARMS SALES TO ALLIES AND PARTNERS

The addition of allied orders of American-made weapons systems could provide increased overall demand for U.S. industry. These arms sales, managed through the Foreign Military Sales (FMS) and Direct Commercial Sales (DCS) programs, offer one path to smooth out demand during periods of tighter U.S. funding. Global defense spending has grown each of the last 11 years, suggesting potentially fruitful markets to be tapped into for the AMD industrial base.

The THAAD sale to Saudi Arabia offers one example of how this could work, along with some of the potential challenges this strategy faces. Initially approved in 2017, the $15 billion THAAD sale provided significant additional demand to the program, compensating for weaker demand from the United States.[112] However, considerable U.S. use of THAAD interceptors in the last two years will likely interfere with the delivery timelines for filling Saudi Arabia's order as American demand has spiked.[113]

When allied demand rises at the same time as U.S. demand, production capacity can become a significant limiting factor, causing tense trade-offs between FMS and domestic production. For example, Gulf allies are already searching for alternatives to U.S. air and missile defense systems due to supply constraints.[114] This pattern has also played out in Europe. Since the invasion of Ukraine in 2022, defense spending across NATO has increased meaningfully. NATO Europe and Canada defense expenditures have increased every year since 2015, hitting a high of 18.6 percent growth in 2024.[115] The alliance reported a total defense expenditure level for NATO Europe and Canada of $559 billion in 2025. American companies may not be able to capitalize on this increased spending, however, as NATO allies increasingly look to European manufacturers to reduce dependence on U.S. exports.[116]

This suggests that global demand cycles for interceptors may be somewhat correlated, as countries often increase their orders in response to conflicts and crises. This creates a timing problem for the industrial base, as arms sales are likely to surge when there is greatest competition from U.S. demand and then fall at the same time U.S. demand sinks.

One way to mitigate some of these concerns is through allied and partner coproduction that could also serve as surge capacity during demand peaks. For example, Australia's newly created Guided Weapons and Explosive Ordnance Enterprise (GWEO) is already working with the U.S. government to identify the kinds of weapons systems and components that can be manufactured in Australia "informed by US supply chain constraints."[117] To date, GWEO has made meaningful investments in the Australian industrial base for, among other things, coproduction of GMLRS as well as SRMs and their subcomponents.[118] The integration of these supply chains into the U.S. market, even on a limited basis, could establish the practices necessary to allow for rapidly surged production in wartime. Constraints such as the International Traffic in Arms Regulations (ITAR) and the Missile

Technology Control Regime (MTCR) have inhibited the ability to export capabilities to even the closest U.S. allies.[119]

Incorporating overseas companies into supply chains can also potentially boost innovation within the supply chain by increasing the number of potential suppliers for each subcomponent. Nammo Raufoss is an example of one such company—the Finnish and Norwegian defense and aerospace company has manufacturing facilities in the United States that today produce rocket motors as well as a number of other components and missiles.[120] Nammo has integrated itself into U.S. supply chains and is currently under contract by Raytheon for work on the MK72 SRM that is a part of Standard Missiles.[121] The new production lines resulting from the contract will be based in Perry, Florida, one of Nammo's six production facilities currently in operation in the United States.[122] By bringing the methods and expertise they have developed in their European operations to the United States, Nammo could integrate new methods, sources, and sub-tier suppliers to the market that were previously untapped. However, foreign companies such as Nammo may also become a source of competition that displaces domestic companies in the U.S. market during periods of lower demand.

Conclusion

The momentum for reform under the current administration creates multiple opportunities for DOD to expand production capacity of AMD interceptors and their subcomponents. Translating this momentum and funding into durable and sustained industrial capacity will depend on choosing the correct acquisition pathways for each munition type and mitigating the risks those pathways create.

Going Forward

Operation Epic Fury has reemphasized the importance of revitalizing the industrial base for air and missile defense interceptors, but the imperative to action was clear even before the conflict. The expanded role of missiles in modern conflicts has created significant opportunities for investment into the munitions industrial base, but efforts to expand its capacity have faced multiple challenges.

The characteristics of the missile market, some unique but many endemic to the defense industrial base at large, are important to understanding both of these challenges and opportunities. The complexity of modern missiles and the uniqueness of many of their components mean that each missile is the product of a sprawling supply chain that relies on niche suppliers qualified for defense work. Because of the potentially hazardous nature of many of these components, these suppliers are often subject to multiple cross-cutting sets of regulations, not only to meet strict DOD performance standards but also environmental and safety rules. The government does not manage these supply chains itself, instead relying on prime contractors in industry to serve as lead integrators to provide completed missiles. This can reduce government visibility, however, when issues further down the supply chain become challenges to meeting production targets. Common subsystems like solid rocket motors, which are required to power each missile, can become bottlenecks in surging production and building capacity if their own complex supply chains run into problems.

Highly cyclical funding for air and missile defense interceptor programs poses the most significant challenge to the munitions industrial base. The lack of stable demand in this market causes cascading financial problems down the supply chain, which has an especially large effect on smaller firms that make critical materials and subcomponents. Without stable funding and predictable munitions budgets, it will be challenging to convince industry to make investments in durable goods like factory infrastructure, tools, and the workforce. While the DOD has signaled much stronger demand in recent years, much of it has come from supplemental funding or relies on the reconciliation funding mechanism, raising concerns about the durability of those funding sources.

DOD's approach to industry also limits the options regarding how to achieve its goals of accelerating production and increasing surge capacity. The government's focus on cost, as well as its acquisition regulations and requirements, can inhibit the introduction of innovative new materials, components, and manufacturing processes, limiting the flexibility of both existing suppliers and also inhibiting new entrants. Momentum for acquisition and requirements reform could open up new opportunities to introduce innovation into the munitions industrial base and unlock additional suppliers and capacity.

Much attention has been given to solving some of these problems, suggesting many opportunities to scale production and increase surge capacity. New acquisition approaches like multiyear procurements offer a path to greater demand stability, while requirements reform could open up new opportunities for innovation. Global demand for air and missile defense interceptors is surging, creating an opportunity to sell these systems around the world.

Efforts to translate this momentum and increased funding into real industrial capacity will take time. Factories for missiles and their relevant subcomponents cannot be built overnight. Not every new acquisition pathway will be right for every missile program. However, a modern and responsive air and missile defense industrial base is a critical component of national defense in the new era of missile warfare. The Department of Defense must seize this moment to rebuild a foundational industrial capability to meet modern threats.

About the Authors

Wes Rumbaugh is a fellow in the Missile Defense Project at the Center for Strategic and International Studies (CSIS) in Washington, D.C. His work focuses on missile defense, conventional long-range strike, and defense budgets and organizations. He has published on the composition of the Missile Defense Agency budget, homeland ballistic missile defense, new operational concepts for missile defense systems, the role of elevated sensors in missile strike and defense, and trends in hypersonic strike. Previously, he was director of advocacy and a Van Cleave fellow at the Missile Defense Advocacy Alliance. He holds a BS in political science from Missouri State University.

Tom Karako is the director of the Missile Defense Project and a senior fellow with the Defense and Security Department at CSIS, where he arrived in 2014. His research focuses on national security, missile defense, nuclear deterrence, and public law. In 2010-2011, he was an American Political Science Association congressional fellow, working with the professional staff of the House Armed Services Committee and the Subcommittee on Strategic Forces on U.S. strategic forces policy, nonproliferation, and NATO. Dr. Karako received his PhD from Claremont Graduate University and his BA from the University of Dallas.

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