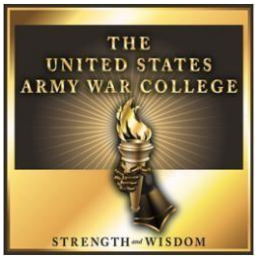
Strategy Research Project

Resourcing Organic Defense Industrial Base Production Facilities

by

Colonel Steven N. Carozza
United States Army

Under the Direction of:
Colonel Benjamin Nutt



United States Army War College
Class of 2017

DISTRIBUTION STATEMENT: A
Approved for Public Release
Distribution is Unlimited

The views expressed herein are those of the author(s) and do not necessarily reflect the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government. The U.S. Army War College is accredited by the Commission on Higher Education of the Middle States Association of Colleges and Schools, an institutional accrediting agency recognized by the U.S. Secretary of Education and the Council for Higher Education Accreditation.

REPORT DOCUMENTATION PAGE

Form Approved--OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
01-04-2017	STRATEGY RESEARCH PROJECT	

4. TITLE AND SUBTITLE
Resourcing Organic Defense Industrial Base Production Facilities

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Colonel Steven N. Carozza
United States Army

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Colonel Benjamin Nutt

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army War College, 122 Forbes Avenue, Carlisle, PA 17013

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT Distribution A: Approved for Public Release. Distribution is Unlimited.

To the best of my knowledge this SRP accurately depicts USG and/or DoD policy & contains no classified information or aggregation of information that poses an operations security risk. **Author:** ☒ **Mentor:** ☒

13. SUPPLEMENTARY NOTES
Word Count: 5314

14. ABSTRACT

President Eisenhower, in his final days in office and using the farewell address to the nation as a vehicle, communicated a stark warning to the nation. His counsel was that despite the desire to reduce defense spending during periods of relative peace, it was precisely during these periods that investment would be necessary to ensure that our long-term security could endure. In recent years the foresight of President Eisenhower has fallen victim to the challenges of balancing competing priorities and is undermined by a prevailing assumption that the resources necessary to wage war will be there when we need them. That assumption is visible today in our reliance upon aging infrastructure to both produce and deliver the munitions necessary for any future conflict and the expectation that these facilities, many of which have only received minimal capital reinvestment over the decades, can meet the surge capacity needed to support major contingency operations. Despite its criticality to our national interests, the organic industrial base ammunition production facilities are unlikely to meet those requirements without taking a hard look at the resourcing models that limit investment and prioritizing additional resources to address emerging vulnerabilities.

15. SUBJECT TERMS
Defense Critical Missions, Ammunition

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(w/ area code)*
UU	UU	UU	UU	26	

Resourcing Organic Defense Industrial Base Production Facilities

(5314 words)

Abstract

President Eisenhower, in his final days in office and using the farewell address to the nation as a vehicle, communicated a stark warning to the nation. His counsel was that despite the desire to reduce defense spending during periods of relative peace, it was precisely during these periods that investment would be necessary to ensure that our long-term security could endure. In recent years the foresight of President Eisenhower has fallen victim to the challenges of balancing competing priorities and is undermined by a prevailing assumption that the resources necessary to wage war will be there when we need them. That assumption is visible today in our reliance upon aging infrastructure to both produce and deliver the munitions necessary for any future conflict and the expectation that these facilities, many of which have only received minimal capital reinvestment over the decades, can meet the surge capacity needed to support major contingency operations. Despite its criticality to our national interests, the organic industrial base ammunition production facilities are unlikely to meet those requirements without taking a hard look at the resourcing models that limit investment and prioritizing additional resources to address emerging vulnerabilities.

Resourcing Organic Defense Industrial Base Production Facilities

> Our arms must be mighty, ready for instant action, so that no potential aggressor may be tempted to risk his own destruction.
>
> –President Dwight D. Eisenhower[1]

With this statement, President Eisenhower, in his final days in office and using the farewell address to the nation as a vehicle, communicated a stark warning to the nation. His counsel was that despite the desire to reduce defense spending during periods of relative peace, it was precisely during these periods that investment would be necessary to ensure that our long-term security could endure. He continued to reinforce the need to maintain a strategic armaments manufacturing capability that would transcend periods of relative peace, stating:

> Until the latest of our world conflicts, the United States had no armaments industry. American makers of plowshares could, with time and as required, make swords as well. But now we can no longer risk emergency improvisation of national defense; we have been compelled to create a permanent armaments industry of vast proportions.[2]

President Eisenhower's foresight has recently fallen victim to the challenges of balancing competing priorities and is undermined by a prevailing assumption that the resources necessary to wage war will be there when we need them. That assumption is visible today in our reliance upon aging infrastructure to both produce and deliver the munitions necessary for any future conflict and the expectation that these facilities, many of which have only received minimal capital reinvestment over the decades, can meet the surge capacity needed to support major contingency operations. Despite its criticality to our national interests, the Department of Defense's (DODs) organic industrial base ammunition production facilities are unlikely to meet those requirements

without taking a hard look at the resourcing models that limit investment and prioritizing additional resources to address emerging vulnerabilities.

Unfortunately, as both historic and contemporary accounts indicate, ammunition production is often unable to rapidly adapt to either increased need or changing tactics, techniques, and procedures for the use of specific types of munitions that significantly alter anticipated consumption rates. The struggle to meet increased and rapidly evolving requirements for preferred munitions is further exacerbated by the decreased capital investment in industrial infrastructure characteristic of interwar periods of decreased demand that often precede major trans-regional conflicts. Developing an effective plan requires we consider historic precedent to help anticipate future shortfalls, reinforced by an understanding of the strategic importance of ammunition production capacity, and identify the most critical vulnerabilities to the industrial base. We can then recommend a more comprehensive approach to address shortfalls and reinforce this crucial national resource.

Historic Challenges Providing Preferred Munitions

The suggested concern is not without precedent. There is a mistaken belief, rising to the level of romanticizing the surge ability of the World War II industrial base, that ammunition shortages have never impacted operational reach in modern conflict. In fact, there are numerous historic examples from World War II, Korea, and Vietnam, as well as more contemporary examples, that identify shortfalls and restrictions on, what were even then referred to as, preferred munitions. These restrictions resulted then, as they do today, from the ever-present struggle to balance the competing resourcing requirements of modernization, force structure, and readiness. The historic tendency to focus scarce resources on maintaining force structure and ensuring readiness accepts

risk in modernizing industrial capacity, limiting flexibility and responsiveness to deliver preferred munitions in support of surging requirements. Resourcing preferred munitions production capacity remains a strategic priority capability identified by the Secretary of Defense[3] yet the facilities required under the current production model continue struggling with aging infrastructure. This section will explore some of the history related to the development of ammunition production and distribution infrastructure, highlighting examples of preferred munitions shortfalls experienced by the United States (U.S.) Armed Forces over the years.

As Eisenhower referenced in his farewell speech, prior to World War II the U.S. did not maintain a dedicated and ready armaments industry. Arming the massive force that was being built up in the months preceding World War II presented the U.S. with a significant challenge. William H. Harrison foresaw the emerging challenge and in a November 1940 address to the National Defense Advisory Commission reminded them that:

> These items, not being among the commercial products of industry, require a relatively long time to produce in the quantities essential to a major defense effort. At present men can be trained more rapidly than munitions can be provided.[4]

Fortunately, his warnings were heeded and the War Department took the necessary steps to develop a government-owned munitions production capacity, allotting approximately $700 million towards that effort.[5]

Congressional appropriation was just the first of many challenges facing the War Department in establishing crucial production capacity. Similar to issues facing the U.S. military sustainment community in the contemporary environment, frustrations with accurately forecasting production requirements and scaling facilities appropriately were

prevalent throughout initial construction. Additionally, emphasis on Ordnance facility development was only of passing concern to many of the decision-makers involved in the process as they became pre-occupied by other pressing construction issues related to combat systems production and troop cantonment.[6] Despite these, and multiple other challenges, those resolute in their focus to complete ammunition production facility construction pressed forward; by mid-1941 several facilities were able to begin initial production[7] and by the end of 1941 all but two of the planned facilities initiated production.[8]

Emplacing this massive production capacity turned out to be just one of many tests facing the munitions industry. The emerging challenge facing industry in 1941, and one that we continue to grapple with today, is how to meet the ever evolving appetite for preferred munitions, adapt the existing infrastructure to meet increasing demands, and ensure the remainder of the supply chain is postured to provide the raw materials necessary.

This very real challenge emerged during the initial stages of World War II, despite the forward-thinking efforts of those in 1940-1941 to develop a robust domestic munitions industry. Prior to the onset of the war, we presumed that sufficient raw materials existed to support production requirements, therefore paid little concern to conservation of materials.[9] As the new production facilities came online and ammunition expenditures increased, raw material consumption rates exceeded initial expectations. The resultant shortfalls in copper, steel, and zinc supply forced a re-prioritization of material usage for all wartime materiel, ammunition included.[10] At the conclusion of the war, senior military leaders began to recognize the significance of the preparation time

afforded the U.S. Not only did they appreciate that significance, but foresaw that the nation may never again be afforded the time to prepare for future conflict. The Honorable Robert P. Patterson, Secretary of War, highlighted this in 1946, stating, “Twice in world wars, we gained the time to prepare from the fighting of our allies. Almost certainly we will never again get the same chance.”[11] Unfortunately his foresight would prove true on multiple occasions during conflicts in subsequent years.

Munitions production capacity limitations resulting from the national desire to reduce defense spending during inter-war periods directly impacted the initial stages of the Korean War. North Korean technological advances drove combat forces to adopt new tactics, techniques, and procedures to meet the emerging operational challenges. The new tactics, techniques and procedures significantly challenged pre-existing ammunition consumption assumptions and highlighted the limits of the military industrial complex’s ability to rapidly respond. In the initial stages of the Korean War, World War II era technology, such as the 2.36-inch rocket launcher, were ineffective against North Korean armored forces. In response, 105mm artillery was utilized in a direct fire role, dramatically increasing consumption rates and quickly depleting the limited available munitions stocks.[12] The supply chain was unable to respond to the dramatically increased high explosive anti-tank (HEAT) artillery round consumption, impacting the tactical employment of forces and limiting commanders’ operational reach. In one vignette it was noted that of 1,200 rounds of ammunition available, only six were HEAT with the remainder made up of normal high explosive (HE) rounds. The HEAT rounds were quickly consumed and the remaining HE rounds were wholly ineffective against advancing North Korean armor forces, even at ranges as short as 150-300 yards.[13]

Preferred artillery ammunition shortfalls continued to plague U.S. Army efforts throughout the first year of the war, where at some points commanders were preparing for attacks with as little as one day of fire available in reserve.[14] By mid-September 1950, the artillery ammunition shortage was so acute, each gun was only allocated 25 rounds of 105mm ammunition per day and General MacArthur personally engaged to accelerate resupply efforts.[15]

The Vietnam War again challenged ammunition supply (in what could now be categorized as a trend) when adapting tactics, techniques, and procedures caused shortfalls in a different set of preferred munitions. The specific munitions shortfalls experienced were with the 2.75 inch rocket, the 4.2 inch HE cartridge, and finally 105mm HE and illumination artillery rounds.[16] The 2.75 inch rocket and 105mm artillery ammunition shortfalls resulted from operational employment decisions based on commanders' assessment of the operational environment. These shortfalls highlighted the long-lead time requirement for production capacity to adapt to non-forecasted increased consumption rates.

The 2.75 inch rocket, originally envisioned as an air-to-air weapon, was increasingly being used to engage ground targets. With a larger than expected fleet of aircraft consuming the rounds at a higher rate than forecasted, production simply could not keep pace. Similarly, the Secretary of Defense deployed artillery units to Vietnam in larger than anticipated numbers and due to increased nighttime operations, those units employed illumination rounds more often than expected. These two factors compounded and the production base could not accelerate production fast enough to keep up with increased demand.[17]

The challenges associated with forecasting ammunition production and maintaining the surge capacity to meet emerging demands continues into the present-day operating environment. Commanders at all levels are challenged to develop new and innovative ways to counter increasingly adaptive adversaries. As the Korean War direct fire 105mm HEAT and the Vietnam War 2.75inch rocket vignettes illustrate, a type of ammunition developed to meet very specific requirements may be found useful for an alternate purpose thus dramatically increasing demand with little to no advance warning.

An even more recent example of this occurred during Operation Hamkari in the Arghandab District outside Khandahar, Afghanistan in 2010. In the face of increasing improvised explosive device (IED) use against dismounted troops during patrols, the commander on the ground identified the potential use of mine-clearing line charges (MCLC) in advance of patrols to clear any IEDs. Given the unorthodox use of MCLCs in this role, there were none forecasted for use and none present within the country[18]. It took great effort to get this preferred ammunition item into country to support the timely initiation of the operation and the production line is still impacted by that non-forecasted increase in expenditure.[19] This is just another example of the continuous trend of shortfalls in the U.S. Military's ammunition production and distribution capacity's ability to adapt to changing environments and employment of forces.

Historically, the military-owned, ammunition industrial capacity has performed well, during time of need, in meeting forecasted ammunition requirements for routine purposes. However, the examples above illustrate that the same industrial capacity struggles when attempting to surge production beyond forecasted rates to meet

increased demand in the face of shifting tactics, techniques, and procedures. As President Eisenhower stated during his 1955 State of the Union:

> We must stay alert to the fact that undue reliance on one weapon or preparation for only one kind of warfare simply invites an enemy to resort to another. We must, therefore, keep in our Armed Forces balance and flexibility adequate to our needs.[20]

Strategic National Interest

The historic challenges the military has experienced with maintaining the organic industrial base raises the question of whether or not it remains in our national security interest to sustain this capacity or if we would be better off eliminating the overhead costs associated with maintaining ownership over these production facilities. Would we be better served leveraging commercial partners, maximizing their innovation efforts and capitalizing on advanced manufacturing techniques? Existing statutory requirements in addition to national strategic guidance and policy all indicate that maintaining an organic capacity for munitions and military explosives production remains a tenet of ensuring our national security. Each of the three current, top-level military strategic documents reinforces the need to maintain an industrial capacity dedicated to supporting our national security.

The National Security Strategy clearly identifies several interests linked to our ability to supply the force with necessary munitions. The first among these is to ensure the security of the U.S., its citizens, and its allies and partners.[21] This is reinforced in the Quadrennial Defense Review that clearly articulates that U.S. Military advantages “are built on the continued strength of our defense industrial base, a national asset that the Department of Defense is committed to supporting.”[22] Finally, in the Defense Planning Guidance, which provides both planning and resourcing guidance for the force, the

Secretary of Defense identifies the ability to provide precision strike (specifically air to surface missiles, the current preferred munitions) as one of the key priority capability areas for resourcing.[23] Taking into account the level of strategic value the Commander-in-Chief and two successive Secretaries of Defense placed on maintaining our industrial capacity, it is difficult to argue the importance of retaining this capacity as an integral part of our national security. To further reinforce the point, Secretary Carter clearly identifies the DOD's need to invest in the industrial base capacity to ensure that those capabilities--"costly to maintain or reconstitute"--remain available as they are essential to national security.[24]

In addition to the importance national security documents levy upon the industrial base, there are several statutory requirements that currently preclude any divestiture of specific, identified capabilities. Title 10, the portion of U.S. law that provides the legal basis for the armed forces, directs the military to maintain, "An essential nucleus of Government-owned industrial plants," along with the specific tools and equipment necessary to sustain our requirements during a period of national emergency.[25] This same portion of federal law requires the military to rely on private industry when practical, however the U.S. Army has identified at least 23 munitions-specific production capabilities that are so unique to the military industrial base that no qualified or capable alternate manufacturing capability exists. These capabilities must be maintained at all cost to enable us to meet our statutory requirements. Of further significance, there are six additional capabilities identified that, while a commercial source exists, it is already identified that commercial capacity cannot meet military surge requirements.[26]

Having established that it is a strategic imperative that we maintain a ready and capable industrial capacity, to both meet our statutory requirements in accordance with title 10 U.S. Code and to support the Secretary of Defense's guidance to prioritize capabilities in support of preferred munitions, what is our approach to reinforce this capacity?

Fortifying the munitions production capacity to enable the organic industrial base to meet emerging requirements for preferred munitions is an identified Army sustainment priority. To reinforce the importance of this crucial capacity in the face of continuous fiscal challenges and reduction in available resources, the Army has implemented several programs supporting a framework described in a comprehensive organic industrial base strategic plan.

Ongoing Efforts to Reinforce Capacity

Concerns about the Army's ability to meet emerging requirements within the existing ammunition production capacity are commonly understood and several programs are in place today to address specific identified problem areas. Some of these programs were established to address the issues associated with the aging nature of the capital infrastructure, the real property that makes up the ammunition plant, and other programs address some of the issues that are created by the contracting process in place to secure operations within the facilities. In this section I will explore aspects of the U.S. Army Ammunition Industrial Base and Organic Industrial Base Strategic Plans as well as the Provision of Industrial Facilities (PIF) program that directly relate to the capital infrastructure investment necessary to ensure the ongoing operation of ammunition production facilities.

The Army Organic Industrial Base Strategic Plan recognizes “the critical role that the Army Organic Industrial Base plays in support of our National Security Strategy,” and outlines a program designed to address five key component areas related to the maintenance of this capability.[27] Those five areas are modernization, capacity, capital investment, aligning resources and promoting public private partnerships.[28] While this plan is not specific to the ammunition production capacity of the U.S. Army, the principles outlined in the plan are still applicable. For example, in the strategic plan’s discussion of capacity, it is recognized that the ability to surge capacity to meet emerging requirements during contingencies is a key consideration yet also a significant challenge in maintaining industrial facilities.

The U.S. Army Ammunition Industrial Base Strategic Plan, published in January 2016 by the Program Executive Office Ammunition, builds upon the Army Organic Industrial Base Strategic Plan and applies lessons learned in an attempt to ensure our production capacity maintains the flexibility necessary to meet emerging warfighter needs. This strategy recognizes the key challenges related to the ability to maintain flexibility while simultaneously ensuring the manufacturing is cost effective, right-sized, invulnerable, and modernized, and applies the same five component areas to describe the strategy, this time specifically related to ammunition production capacity.[29]

The PIF program is designed to provide a consistent and prioritized infusion of funds specifically dedicated to modernization efforts within the government owned, contractor operated (GOCO) ammunition production facilities. An element of the Production Base Support program, described in Army Regulation 700-90, *Army Industrial Base Process*, PIF provides funds dedicated to investing in government-

owned property under one of six uses: initial production facilities, expansion of capacity, rehabilitation or replacement of existing facilities, modernization of existing facilities, or construction of real property.[30] According to an office of the Army G-4 briefing in December 2016, the fiscal year *2018 Program Objective Memorandum* requested $206 Million in PIF funds for a variety of modernization projects at the GOCO production facilities. This same report identifies over $210 Million worth of project requirements in each subsequent fiscal year through fiscal year 2023 for a total investment request of nearly $1.06 Billion over the *Future Years Defense Program* 19-23.[31] On the surface, this appears to indicate a significant move forward in addressing the capital needs of the ammunition production facilities; it bears mentioning that those projects funded are still based on prioritization and available resources. Priority is given to those identified requirements deemed critical, which is defined as "necessary to avoid significant supply disruptions" or to "meet specific environmental compliance regulation or safety standards."[32] In practice those requirements deemed critical receive the funding necessary while other, non-critical, requirements remain unfunded. The weighted criteria used to assist in the prioritization effort include operational continuity (30%), safety (20%), environmental (15%), financial benefit (15%), and cost reduction (20%).[33]

Although the PIF effort is to be applauded, we must fight the urge to claim complete success as a result of this dedicated funding. One individual, who requested anonymity, stated that we still have a long way to go to undo the utter neglect of our ammunition plants that resulted during the lean budget years of the 1990's.[34] If we consider this statement, there are likely hundreds of smaller, lower priority projects that remain unrequested, recognized by the plant commanders and operators of the facilities

as desired to improve the overall operations and reliability of the plant, but unlikely to meet the criticality criteria as defined. This leads to a scenario where only the most crucial requirements are requested leaving numerous, likely beneficial, projects unrequested. Those projects, while not deemed critical at this particular moment, are destined to become a critical requirement in the future. Without a holistic view of the total capital investment requirement at the government-owned facilities the true readiness of these facilities to meet our statutory and national strategic requirements remains in question.

Lest we are led to believe that this problem is unique to the Army's contractor operated facilities, a similar challenge exists within the government operated depot system. The capital improvement program is Army Materiel Command's effort to ensure capital reinvestment within the industrial base. This program requires commanders to reinvest at least 6% of their annual business back into infrastructure improvement. In the case of Letterkenny Army Depot, this amounted to $25 million of capital reinvestment in Fiscal Year 16. On the surface this appears significant however, when considering that just one planned military construction project necessary to support future workload is estimated to cost over $250 million, the shortfall in meeting the overall requirements for industrial base improvements and maintenance becomes apparent.[35]

Vulnerabilities to Production and Distribution Capacity

While the ongoing efforts described are making great strides towards the goal of bolstering our industrial capacity, several layers of vulnerability still exist as a result of historic failures to resource both the ammunition production and distribution infrastructure. These layers are physical, environmental, and cyber. Physical

vulnerabilities are a result of continuously deteriorating aging infrastructure. Environmental vulnerabilities result from the impact of new environmental regulations on the DOD's ability to upgrade aging infrastructure or improve the efficiency of outdated production processes. Finally, cyber vulnerabilities exist resulting from the lack of resources dedicated to improving the security of industrial control systems (ICS) and other supervisory control and data acquisition (SCADA) systems. Considering the increasing cyber intrusion threat, the vulnerability of the organic industrial base munitions production capability created by ICS and SCADA systems generates a level of risk that needs to be considered during future resourcing decision making processes.

Improvements to production processes historically focus on increasing efficiency in operations as a way to reduce overall cost per unit. One way that has become more prevalent is the installation of a variety of ICS and SCADA systems. Facilitated by the explosive expansion of electronic, wireless, and other networked communications systems, ICS and SCADA systems became a quick and relatively easy way to reduce operating costs, enabling remote monitoring and manipulation of manufacturing processes and reducing reliance on manpower intensive manual processes and procedures. In addition to the obvious cost benefit in reducing manpower requirements and expenses, in an ammunition production environment, reducing the overall number of personnel required to produce a given type of explosive device is exceptionally valuable as it allows for the minimization the number of people exposed to explosive risk at any given time. Despite the numerous benefits gained by installing ICS and SCADA systems within ammunition and explosive production facilities, they present very real challenges in an era of ever increasing threats to cyber-dependent capabilities.

The challenges with ICS emplaced within the military munitions industrial base facilities is not unlike control systems challenges that the U.S. Army Corps of Engineers is grappling with at military facilities worldwide.[36] Most ICS are one-off systems operating off a variety of, and in some cases now obsolete, information technology platforms and developed to support a very specific industrial process that is unlikely to be replicated in any other facility. This is especially pronounced in the case of military munitions production facilities that produce very unique materials and equipment. Additionally, many of the ICS developed in the initial decades of networked operations support capabilities were constructed and emplaced during a time prior when functionality is what mattered most, cyber threats were of minimal concern, and the ability of upgrade platforms to meet future security requirements for the systems was not considered.[37] These systems, especially those installed during the nascent days of computerized controls, now present potentially significant vulnerabilities to the very capabilities they were designed to enable due to an inability to keep pace with emerging cyber threats.

The problems associated with cyber security at critical infrastructure nationwide, such as industrial production facilities similar to the military organic industrial base and major transportation/distribution hubs, are so pronounced the President of the U.S. issued E*xecutive Order* 13636 in February 2013 directing all federal government agencies to immediately take steps to address these concerns.[38] Among the steps directed in the order, the National Institute of Standards and Technology (NIST) was directed to lead development of a, “Framework to reduce cyber risks to critical infrastructure.”[39] This framework, originally published in February 2014, and currently

undergoing review, clearly identifies up front that the increasing prevalence of and reliance on ICS has likewise dramatically expanded the potential vulnerability of these same facilities.[40] If we acknowledge the basic formula that overall risk to mission capability is a function of the criticality of a facility to mission accomplishment combined with its vulnerability to a given threat vector (in this case the prevalent threat of cyber intrusion) it is reasonable to conclude that ICS vulnerabilities, if not addressed, present a potentially significant risk to long-term operations. In an effort to identify ways to more effectively address issues related to ICS vulnerabilities, the DOD Mission Assurance Senior Steering Group (MASSG), the proponent for DOD critical infrastructure activities, requested assistance from the Naval Sea Systems Command Warfare Center (NSWC) at Dahlgren to ascertain and report back on best practices in implementing the NIST framework from assessments conducted across the department.[41]

The NSWC Dahlgren has been involved in the implementation of the DOD's Mission Assurance efforts, specifically aligned with critical infrastructure protection, since its inception. These best practices were categorized into the following seven areas: password usage, security awareness and training ICS patch management, ICS maintenance activities, ICS modem connection, ICS network design, and securing ICS host systems.[42] This report, provided to the MASSG, clearly describes several key steps that should be taken to rectify some of the most commonly occurring vulnerabilities identified through assessments at critical infrastructure locations nationwide. Several, seemingly simple, options that can be taken with minimal cost impact, like changing default passwords on the systems or disabling auto-reboot processes[43], are presented in the NSWC Dahlgren report. However, not all identified issues are as simply resolved

and demand much more significant and cost/time-intensive actions such as the complete development of replacement systems based on stronger, more secure operating systems[44].

Recommendations and Conclusion

Munitions production is a vital national interest. In making this assertion, it is important to understand that if faced with potential conflict against an existential threat to the nation, and to which Secretary Patterson alluded in 1946, we will likely not be afforded the time to establish increased production capacity. Future conflict in the global operating environment with a peer adversary will very likely extend to our shores, attacking the capabilities that would allow us to project power globally; ammunition production capabilities are merely one of those capabilities. Federal statute, in place since 1948, recognizes the need to maintain these unique processes and capabilities. National strategic direction and guidance specifies that priority must be placed on resourcing the production capacity for crucial munitions. Unfortunately the resourcing levels necessary to maintain the aging infrastructure is hampered by existing policies and resourcing models. We need to recognize that ongoing efforts, while laudable, are insufficient to meet the urgent needs of the aging infrastructure and ensure our ability to maintain the flexibility necessary to meet rapidly changing requirements in the future operating environment. In response to these challenges, some options are presented for consideration.

Current acquisition rules and polices limit the GOCO contract award duration to short terms; typically less than a decade. Despite these limitations, within existing legal boundaries, Army acquisition officials are incorporating incentives to contractors to invest in capital improvements to the facilities that they are competing to operate.[45]

However, in the competitive contracting environment of today, contractors are reluctant to risk over-estimating a return on that investment. Adjusting acquisition rules and policies, specifically for industrial facility operations, to allow for longer term contracts will afford acquisition officials the flexibility needed to encourage much more significant capital investment by the facility operators in the initial stages of contract execution with the understanding that they would have a better chance of recouping those costs over the term of the contract.

A second option is presented based off a public-private partnership model that the commander of Letterkenny Army Depot is currently pursuing.[46] As a designated center of industrial and technical excellence facility, the commander of Letterkenny Army Depot is encouraged to leverage public-private partnerships in an effort to reduce or eliminate the costs of facility ownership, operation, and maintenance.[47] In the current environment, military construction funding is either extremely limited or not available due to acquisition limitations for government-owned contractor-operated facilities. To minimize the costs of new facility construction and long term maintenance, local commanders could work with local community leaders to encourage investment in new industrial facilities adjacent to existing military facilities, purpose-built to meet emerging requirements. The Army could then lease these facilities for the term necessary without incurring the initial construction costs. Legal, policy, and contractual concerns will need to be addressed, but this option could prove valuable in increasing partnership with local communities and provides for new infrastructure investment. It also provides for an opportunity for the government to more easily divest the additional infrastructure when it is no longer necessary to support operations. It is worth closely observing the ongoing

initiative at Letterkenny Army Depot to determine if this is a viable strategy executable across the military organic industrial base.

These are by no means the only options to consider however, other options, including a massive (likely measured in the billions of dollars), comprehensive capital reinvestment program infrastructure or completely eliminating government ownership of critical munitions production capabilities, while both feasible, are unlikely to be considered. Regardless of the selected course of action, any program implemented needs to be prioritized, based on resources available and the criticality of the location to currently identified preferred munitions. The Secretary of Defense approved Munitions Strategic Portfolio Review and the Army G-3/5/7 published Army Prioritized Protection List are two suggested starting points for prioritization of resourcing efforts.

Separate from the physical infrastructure issues, and likely the most pressing area of concern that must be dealt with is vulnerabilities resulting from increased ICS use. A comprehensive review of ICS throughout the organic industrial base, utilizing the U.S. Army Corps of Engineers Industrial Control Systems Inventory Methodology and in line with the NIST framework is crucial to ensuring the longer-term resilience of facility operations. Several visits that I personally conducted over recent years indicate that many locations, while recognizing the importance of ICS to the operations of their facilities, do not understand the number of disparate systems, their various operating software systems, the upgrade/maintenance process, and the underlying security system that would protect the systems. The prevailing response typically relates that the ICS is either not connected to the network or is on a “closed-loop network,” assuming that this provides a level of protection against a cyber-attack. This ignores the possibility

that adverse actors could infiltrate the system through the various contractors who provide system and/or security patches, which are often developed on a network-connected computer outside of the facility and brought in on thumb-drives or other vulnerable, un-scanned, removable media. Only when identification of the types and system capabilities is complete can a strategy to address the remaining NIST framework functions of identify, protect, detect, respond, and recover be completed.

The current Commander of the U.S. Army Materiel Command once stated that a logistician arguing from the perspective of the status quo is fighting a losing battle.[48] While previous and current efforts to reinforce the munitions production capacity are a significant positive trend, additional and more innovative solutions must be considered if we hope to reverse the toll wrought by years of insufficient action. Following dated policies and procedures without challenging the status quo leaves us at risk to repeat the shortfalls of the past decades; without some action we may not be postured to produce munitions in the type and quantity necessary to avert an existential crisis if called upon.

Endnotes

[1] Dwight D. Eisenhower, “Farewell Speech to the Nation,” public speech, The White House, Washington, DC, January 16, 1961, https://www.ourdocuments.gov/doc.php?doc=90&page=transcript (accessed December 21, 2016).

[2] Ibid.

[3] Ashton Carter, *Defense Planning Guidance, Fiscal Years 2017-2021* (Washington, DC: U.S. Department of Defense, March 23, 2015), 8.

[4] Lenore Fine and Jesse A. Remington, *United States Army in World War II, The Technical Services, The Corps of Engineers: Construction in the United States* (Washington, DC: Center of Military History, 1989), 309.

[5] Ibid.

[6] Ibid., 312-313

[7] Ibid., 335.

[8] Ibid., 340.

[9] Henry C. Thomson and Peter C. Roots, *United States in World War II: The Technical Services – The Ordnance Department: Planning Munitions for War* (Washington, DC: Center of Military History, 1955), 478.

[10] Ibid., 480-496.

[11] Robert P. Patterson, *Army Information Digest* 1, no. 5 (September 1946): Back Cover.

[12] James F. Schnabel, *United States Army in the Korean War, Policy and Direction: The First Year* (Washington, DC: Center for Military History, 1992), 84.

[13] Roy E. Appleman, *United States Army in the Korean War, South to the Naktong, North to the Yalu* (Washington, DC: Center of Military History, 1992), 70.

[14] Schnabel, *United States Army in the Korean War,* 257.

[15] Appleman, *South to the Naktong*, 431.

[16] LTG Joseph M. Heiser, *Vietnam Studies, Logistic Support* (Washington, DC: U.S. Department of the Army, 1974), 117-118.

[17] Ibid., 118.

[18] Personal experience of the author, while assigned as the 43rd Sustainment Brigade Support Operations Officer in Kandahar, Afghanistan from 2010-2011 I was personally involved in coordinating with the 2nd Brigade, 101st Airborne Division and U.S. Forces-Afghanistan (USFOR-A) to meet this emergent requirement in support of Operation Hamkari.

[19] Susan Carlson, US Army, Chief, Munitions Division, DA-G4, interview by author, December 19, 2016.

[20] Dwight D. Eisenhower, “State of the Union,” public speech, United States Capitol, Washington, DC, January 6, 1955.

[21] Barack H. Obama, *National Security Strategy* (Washington, DC: The White House, February 2015), 2.

[22] Charles T. Hagel, *Quadrennial Defense Review* (Washington, DC: U.S. Department of Defense, March 4, 2014), 9.

[23] Ashton Carter, *Defense Planning Guidance,* 8.

[24] Ibid., 21-22.

[25] USCODE Title 10-Defense Industrial Reserve (1948), V section 2535.

[26] Program Executive Office Ammunition, *Single Manager for Conventional Ammunition (SMCA) Industrial Base Strategic Plan (IBSP): 2025* (Picatinny Arsenal, NJ: Program Executive Office Ammunition, January 2016), 26.

[27] Joseph W. Westphal, *United States Army Organic Industrial Base Strategic Plan 2012-2022* (Redstone Arsenal, AL: U.S. Department of the Army, October 15, 2012), 1.

[28] Ibid., 2.

[29] Program Executive Office Ammunition, *Single Manager,* 8.

[30] U.S. Department of the Army, *Army Industrial Base Process*, Army Regulation 700-90 (Washington, DC: U.S. Department of the Army, December 14, 2004), 16.

[31] Gregory O'Connor, Ph.D., "Provision of Industrial Facilities (PIF) POM FY19-23 Requirements Brief to the Council of Colonels," briefing slides, Picatinny Arsenal, NJ, Office of the Project Director Joint Services, December 15, 2016.

[32] Ibid.

[33] Ibid.

[34] Interview with confidential source, December 21, 2016.

[35] COL Deacon Maddox, U.S. Army, Commander, Letterkenny Army Depot, interview by author, January 25, 2017.

[36] Zachary A. Collier et al., "Security Metrics in Industrial Control Systems" in *Cyber Security of Industrial Control Systems, Including SCADA Systems* (Springer, NY: U.S. Army Corps of Engineers, 2016), 1.

[37] Ibid.

[38] Barack H. Obama, *Executive Order 13636 – Improving Critical Infrastructure Cybersecurity* (Washington, DC: The White House, February 12, 2013).

[39] Ibid.

[40] National Institute of Standards and Technology, *Framework for Improving Critical Infrastructure Cybersecurity Draft Version 1.1* (Washington, DC: January 10, 2017), 3.

[41] Neil Holloran, *Mission Assurance Senior Steering Group Task 12: Identify Platform IT-Control Systems Best Practices* (Dahlgren, VA: NSWC Dahlgren, November 10, 2016).

[42] Ibid., 2.

[43] Ibid.

[44] Ibid., 10.

[45] Interview with multiple representatives from Program Executive Office – Ammuntion, December 21, 2016.

[46] Maddox, interview by author, January 25, 2017.

[47] Centers of Industrial and Technical Excellence: designation; public-private partnerships, 10 USC 2474 (November 18, 1997).

[48] Brigadier General Gustav Perna, U.S. Army, Commander, Joint Munitions Command, "Officer Professional Development Session," statement, 43rd Sustainment Brigade Headquarters, Fort Carson, CO, April 2011.