NPS-AM-22-197

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Navy Auxiliary System Acquisition Analysis

June 2022

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Thesis Advisors: Dr. Robert F. Mortlock, Professor
Raymond D. Jones, Professor

Department of Defense Management

Naval Postgraduate School

Prepared for the Naval Postgraduate School, Monterey, CA 93943.

ACQUISITION RESEARCH PROGRAM
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The research presented in this report was supported by the Acquisition Research Program of the Department of Defense Management at the Naval Postgraduate School.

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ABSTRACT

The Defense Industrial Base (DIB) is an ever-changing landscape that requires acquisition professionals to maintain vigilance over its climate. Ever since the mid-1990s, the DIB has shrunk substantially due to a variety of reasons. In this study, we focus on two Navy Auxiliary Systems: air conditioning and refrigeration (AC&R) and compressed air systems. Data gained through analysis of contracting history and from subject matter experts (SME) and in-service engineering agents (ISEA) are used to perform a sector by sector, tier by tier (S2T2) fragility and criticality (FaC) assessment of AC&R and compressed air systems. The assessment revealed that both AC&R and compressed air systems carry moderate risk. With both systems, it is important to avoid vendor lock with an aim to increase competition to optimize cost, schedule, and performance on future capabilities.

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Raymond Belko is a civil service employee at the Naval Surface Warfare Center – Philadelphia Division. He previously graduated from Villanova University in 2010 with a Bachelor's degree in Mechanical Engineering. He has served the past 12 years as an in-service engineer for Navy cryogenic oxygen and nitrogen systems. After graduating NPS he will serve as the program management lead of the Navy Common Core Controller (NC3) program. In his free time, Raymond enjoys spending time with his wife Amanda and two young boys.

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ACKNOWLEDGMENTS

Thank you to my wife, Amanda, for putting up with me during these past two years while I pursued my graduate degree. Between working full time, raising our two monsters, and taking graduate classes yourself, you have been so supportive, I do not think I would have made it through this program without you.

Dr. Mortlock, thank you for your support and guidance. I will never not be amazed by how quickly you have turned around student work with thoughtful and constructive feedback. I have become a better student, acquisition professional, and government employee thanks to your leadership.

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LIST OF ACRONYMS AND ABBREVIATIONS

AC&R	Air Conditioning and Refrigeration
CASREP	Casualty Report
DIB	Defense Industrial Base
FaC	Fragility and Criticality
FAR	Federal Acquisition Regulation
FFP	Firm Fixed Price
GEECO	Gas Equipment Engineering Corporation
J&A	Justification and Approval
JCNS	Johnson Controls Naval Systems
NRE	Non-recurring Engineering
NSWCPD	Naval Surface Warfare Center – Philadelphia Division
O2N2	Oxygen and Nitrogen
OEM	Original Equipment Manufacturer
RMC	Regional Maintenance Center
S2T2	Sector-by-sector, Tier-by-tier
SAP	Simplified Acquisition Procedure
SCD	Ship Change Document
SEP	Systems Engineering Process

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I. INTRODUCTION

United States Navy auxiliary ship systems can easily find themselves in a bilateral monopoly situation. A bilateral monopoly in defense systems is when the government has only one vendor supporting a system and that vendor has no other business or revenue streams other than supporting that system for the government. Due to the long life span of Navy ships and ship classes, the company that wins the initial competition at the beginning of a new ship class gains a leg up on any competition for the lifetime of that ship. Auxiliary systems and their original equipment manufacturers (OEMs) are selected early in the shipbuilding planning process. Selected OEMs then have their equipment installed on Navy vessels for what can be decades, providing a steady stream of parts and service requests. These requests lead to the government issuing service contracts that are awarded based on a single bid or a sole-source basis. Every 3 to 5 years, a follow-on contract is awarded with rates that are deemed fair and reasonable based on the previous contract. The first way to determine if a price is fair and reasonable is to "whenever possible, base price reasonableness on competitive quotes or offers" (FAR 13.106-3.a.1, 2022). Another way is to compare the "proposed price with prices found reasonable on previous purchases" (FAR 13.106-3.a.2.ii, 2022). As follow-on contracts go through several iterations and become further in time from the initial competition, the challenge for the government is to be certain it is getting fair value.

Competition among the defense industrial base (DIB) is essential to the continued successful support of America's national security. Healthy competition provides benefits to the cost, schedule, and performance of Department of Defense (DOD) programs. At the beginning of a program, competition promotes innovation and ensures the best solution for the best value. Throughout the system life cycle, competition ensures that companies perform well and prevents cost inflation.

Since the 1990s, the DIB has reduced from 51 aerospace and defense prime contractors to five (Office of the Under Secretary of Defense for Acquisition and Sustainment, 2022). This is especially prevalent with Navy auxiliary systems, which inherently have a high criticality factor – meaning the systems are essential to the overall

effectiveness of the ship. Many contracts for support of Navy auxiliary systems have been awarded on a sole-source basis to OEMs. Some have been issuing follow-on contracts for several years, essentially eliminating any competition.

Navy auxiliary systems are integral to a ship accomplishing its mission; system degradation or interruption beyond the ship's force capability quickly leads to a casualty report (CASREP). A CASREP is a fleet message a ship issues requesting immediate assistance to remedy any issue. Having existing service contracts in place allows for the government to quickly respond to CASREPs by allowing the platform office or system engineering agents to award task orders (TO) on the existing contract to provide on-ship assistance relatively quickly. Because CASREPs are often emergency, short lead-time requests, the service contract must have fair and reasonable rates to ensure that the DOD is still getting good value with taxpayer dollars.

The nature of the sole-source or single-bid contract leads to an assumption of high fragility in the marketplace – meaning the DOD has not alternative and relies exclusively on a single contractor. Without competition, the DOD is reliant on one entity to support national defense efforts. Companies, especially small businesses, are susceptible to volatility and changes in management or ownership, and are at risk of leaving the DIB. The government must take proactive steps to reduce risk when the market for critical systems has a high fragility rating.

The central question posed by this thesis is how the government can be certain it is getting fair and reasonable pricing on OEM follow-on service contracts after several iterations. The DIB for several auxiliary systems have been whittled down to just a few vendors and in many cases only one. The government needs to take measures to ensure costs remain fair and reasonable. The best way to do this is to increase competition either by reducing the barrier for entry to other companies or through other methods such as utilizing the DOD's internal personnel to accomplish work that may otherwise be contracted to OEMs.

The primary goal of this study is to analyze Navy auxiliary system service contracts awarded on a sole-source basis. This is done by looking into previous iterations of the current follow-on contracts and to understand the history of the competition in the

sector. By understanding the history and projecting where the future of the market is going, recommendations can be made to revive competition. This study presents a sector-by-sector, tier-by-tier (S2T2) analysis using fragility and criticality assessment of a few select Navy auxiliary systems. The systems chosen are compressed air systems and air conditioning and refrigeration (AC/R).

The Naval Surface Warfare Center–Philadelphia Division (NSWC-PD) currently manages active service contracts awarded to Curtis Wright for compressed air systems and Johnson Controls (JCNS) for AC/R. The current versions of the contract are products of several iterations of service contracts awarded to these two companies on a sole-source basis.

NSWCPD is a division of Naval Sea Systems Command (NAVSEA) and is a hub for Navy Auxiliary Systems Life Cycle Engineering. NSWCPD fits mainly within the in-service and sustainment realm of acquisitions. NSWCPD in-service engineering agents (ISEAs) are responsible for cradle-to-grave life-cycle management of their respective systems. ISEAs will often review and provide input on new ship specifications for system development but are not a major part of the initial acquisition of systems during ship construction. ISEA acquisitions typically involve sustainment, upgrades, obsolescence, and troubleshooting and repair. Common contracting vehicles are multiple award contracts (MACs) for engineering and technical services as well as OEM Services contracts and single-award firm-fixed-price simple acquisition procedures (SAP).

A. RESEARCH QUESTIONS AND OBJECTIVES

1. Primary Research Question

- What can the Navy do to protect its interests in Navy auxiliary systems when there is a lack of competition among the Defense Industrial Base?

2. Secondary Research Questions

- What is a “fair and reasonable” price?
- Is there a common theme between sole-source justification documents?
- How can competition be increased in high fragility environments?
- What can the government do to protect its interests in high fragility environments?

B. SCOPE, LIMITATIONS, AND ASSUMPTIONS

The scope of this analysis was limited to existing service contracts managed by the NSWCPD Division 41. The history of these subjects is limited by record-keeping and publicly available data. For instance, the contract package documents are unavailable. However, the sole-source justifications are publicly available via sam.gov in addition to the contracts themselves, which include the statements of work. Additionally, detailed pricing data for each contract is publicly unavailable.

This chapter has served as an introduction to the research questions and why they are important. The issue revolves around competition within the Navy auxiliary systems DIB. Chapter II details the mission of NSWCPD Division 41. It also describes some of the contracting history, current state, and future outlook for compressed air and AC/R systems. Case study scenarios are introduced to further detail the importance of risk mitigation in critical and fragile markets.

Chapter III contains a literature review describing sector by sector, tier by tier analysis (S2T2), fragility and criticality (FaC) analyses, and obsolescence issues. This chapter examines how the FAR is applied to justify sole-source documentation.

Chapter IV contains the S2T2 and FaC analyses and risk assessment applied to compressed air systems and AC/R systems. This analysis answers the primary and secondary research questions posed in Chapter I.

Chapter V is an overall summary of the research and conclusions. It outlines general recommendations, as well as for the specific systems covered under this analysis. Finally, Chapter V proposes recommendations for future further research.

II. BACKGROUND

When competition has been diluted down to one company to support critical national defense assets, the nation is put in a precarious situation. Subject matter experts, specifically in-service engineering agents (ISEAs) had difficulty answering the following question: What would you do to support the fleet if your prime vendor suddenly went out of business or decided to no longer do business with the government? This may seem like a leading question, but it has happened before and most likely will happen again. The following two case studies illustrate some of the consequences that can occur when the DIB is whittled down to one vendor and the Navy enters into a bilateral monopoly. The other side of the issue with a bilateral monopoly is what happens when a company no longer supports a Navy system. This is most common with obsolescence where a replacement is identified and implemented through a ship change document (SCD) and the systems engineering process (SEP). But there are other instances where a company deems a line of products no longer economically viable and no longer supports the DOD.

In February 2022, the Office of the Under Secretary of Defense for Acquisition and Sustainment published a report titled *The State of Competition within the Defense Industrial Base*. The report documents a reduction in the DIB ever since the 1990s, explains the importance of competition, and outlines five ways the DOD can attempt to revive competition. The first is to reinforce oversight of mergers that threaten DOD interests by supporting the Federal Trade Commission (FTC) and Department of Justice (DOJ) antitrust investigations relating to the DIB. Next is to address intellectual property (IP) limitations by addressing IP early in the acquisition life cycle. This can help reduce the vendor lock that is common among Navy auxiliary systems. The next two recommendations are to increase new entrants and increase opportunities for small businesses by reducing the barriers to entry into the DIB. Last, the report highlights five specific sectors that require chain resiliency plans; none of the sectors are pertinent to Navy auxiliary systems on ships.

Naval Sea Systems Command, more commonly known as NAVSEA is responsible for cradle to grave life cycle management of all Navy ships, submarines and

combat systems. Within NAVSEA are ten warfare centers that are responsible for providing technical expertise and innovative engineering solutions to the fleet. The Naval Surface Warfare Center – Philadelphia Division's (NSWCPD) mission is "to provide research, development, test and evaluation, acquisition support, engineering, systems integration, in-service engineering, and fleet support with cybersecurity, comprehensive logistics and life-cycle savings through commonality for surface and undersea material" (Naval Surface Warfare Center Philadelphia Division, 2021)

NSWCPD Division 41 employs the Navy's subject matter experts (SMEs) on several Navy auxiliary ship systems. Its mission statement is as follows: "To serve as the Navy's experts for in-service engineering support, life cycle management, and testing and evaluation for main propulsion steam systems, secondary steam systems, and auxiliary machinery while striving for on-time delivery of ships and submarines, fostering a culture of affordability, and enhancing the cybersecurity of our systems" (Naval Surface Warfare Center Philadelphia Division, n.d.a). Division 41 is then broken down into different Codes, or groups of engineers or technicians that all support similar auxiliary systems.

The next two case studies are shown as worst case scenario type examples that illustrate the importance of a healthy defense industrial base. The O2N2 case study is an example of a company leaving the DIB, leaving the Navy without a key OEM. The next case study shows what can happen when a company takes advantage of their position as a sole source provider for a key technology.

A. CASE STUDY: O2N2

U.S. Navy Nimitz class aircraft carriers come equipped with two cryogenic liquid production plants capable of producing both liquid oxygen (LOX) and liquid nitrogen from compressed air, called O2N2 Plants. The LOX was particularly important to the ship's mission as it supplies all the oxygen for pilots breathing on aircraft with multiple seats. In the late 1980s, three vendors made up the DIB for O2N2 Systems: Gas Equipment Engineering Company (GEECO), Cosmodyne, and Air Products. Over the next 20 years, GEECO grasped the majority of the market share with Cosmodyne making up the rest. Air Products' last plant was retired with CVN-65 USS *Enterprise* and the company no longer participates in the Navy cryogenics marketplace. In the early 2010s,

the Navy operated 24 O2N2 plants, 18 on the nine ships in the Nimitz class aircraft carriers, two on each of the hospital ships USNS *Mercy* and USNS *Comfort*, and 21 of the 24 plants were all produced and supported by one OEM, GEECO. The submarine tenders USS *Emery S. Land* and USS *Frank Cable* are also equipped with O2N2 plants, but the plants had not been operated for some time by the early 2010s. After decades of stable ownership and government support, GEECO went through ownership and management strife when the founder and president passed away and left the company split between his three children. A few years later the company defaulted on a contract to provide next-generation technology liquid oxygen plants for the new Ford-class aircraft carrier and filed for bankruptcy. Sibling rivalry potentially crippled a major U.S. defense asset (M. Bosch, personal communication, April 23, 2022).

B. CASE STUDY: COMPANY X

In another case study, Company X is an OEM for Navy submarine life support systems. Company X has been awarded four consecutive service contracts with each contract having 3 years of performance. The contract is strictly for shipboard troubleshooting and repair, but ISEAs would like to add non-recurring engineering (NRE) into the statement of work (SOW) to proactively address issues such as obsolescence and implementing design improvements but are unable to do so due to the companies high rates. Company X is restricted by eCRAFT, which governs the rates that the field service technicians can charge; however, overhead rates are determined by the company. This company is in a bilateral monopoly with the government and has no competition to drive down the asking price. The overhead rates Company X charges are among the highest ever and are paid, due to the absolute need for this company's services. Due to the high costs, NRE efforts are unable to be accomplished under this contract. Modernization efforts are accomplished through awarding a firm fixed price (FFP) contract through the Simplified Acquisition Process (SAP). This process allows the company to bid on a SAP contract line item number (CLIN) without the need to disclose individual labor hours or rates, it simply bids one price to complete a task. The drawback with using the SAP vehicles is that each task must be kept under the $250k ceiling. With each successive contract, Company X pricing will continue to increase, and the

government will have to keep paying until the company can be replaced, goes out of business, or the need no longer exists.

C. RESEARCH FOCUS: AC&R AND COMPRESSED AIR

Both of these examples are what can happen when competition amongst the DIB is not made a priority when awarding contracts. For the research in this study, compressed air systems and air conditioning and refrigeration (AC&R) systems were chosen. Compressed air and AC&R systems are auxiliary systems, just like O2N2 and Life Support systems, and the life cycle mangers are all a part of NSWCPD Division 41. The ISEAs that support AC&R and compressed air systems come from NSWCPD Codes 411 and 418 respectively. These ISEAs are responsible for the entire life-cycle engineering management requiring management of active fleet assets along with obsolescence and modernization. It is their responsibility to ensure that the fleet is supported when issues arise and to plan for future sustainability.

Air conditioning systems are primarily supported by Johnson Controls Naval Systems (JCNS). NSWCPD has been awarding service contracts to JCNS on a sole-source basis since the 1990s to maintain and modernize Navy ships' air conditioning systems. The expansion of electronic systems has increased the need for air conditioning on more compartments of Navy ships than ever before. During new ship class construction, air conditioning systems are competitively bid, and there are companies with the capability and capacity in the commercial marketplace that could enter the DIB. But with decades of experience designing Navy systems and a steady flow of sole-source service contracts, the barrier to entry for a competing company is high. At this point, the DIB is essentially one company for all Navy air conditioning systems.

The Navy and JCNS both acknowledge this bilateral monopoly. The Navy has taken steps to secure its future by placing orders with JCNS for up to 30 years out. JCNS has demonstrated its commitment to supporting the Navy by investing $15 million in its production machining centers and equipment to support capacity expansion (C. Hollish, email to author, February 23, 2022).

Future AC&R efforts include a Modular Refrigeration System (MRS). The MRS program is pursuing military specification (MIL-SPEC) certification to encourage competition that will allow any qualified vendor to build to the drawings and specifications. The MRS is designed to maintain temperatures of ship storerooms, refrigerated storerooms need to be kept at 33–41 F while freeze storerooms are kept below 0 F. Previous efforts have led to high lead times, which in turn have resulted in unacceptable downtimes for fleet units. The MIL-SPEC cooler should improve competition for parts support for in-service units. The MRS program is now in its third generation and has three separate OEMs supporting the program: Johnson Controls Navy Systems, DRS Marlo coil Engineering, Cospolich (C. Hollish, personal communication, February 23, 2022) The MRS is currently installed on CVN 78 *USS GERALD FORD* and DDG1000 class Destroyers with future plans to back fit onto Nimitz class carriers and other amphibious and surface vessels.

Additionally, the industrial base for compressed air systems will be studied. Compressed air systems provide low and high-pressure air to a variety of essential ship systems. High-pressure air is used to support various weapons systems such as torpedoes and vertical launch systems and to provide start-up air to gas turbine generators and gas turbine propulsion engines. Low-pressure air is supplied to the O2N2 plants, elevator accumulators, and shops all over the hull to support pneumatic tools.

Compressed air systems are supported from a DIB competition by three major vendors: Curtiss-Wright, Rix Industries, and Sauer Compressors. NSWCPD holds a contract with Curtiss-Wright to support fleet repairs. The contract is a FFP Indefinite Delivery Indefinite Quantity (IDIQ) contract awarded on a sole-source basis. The cost for repairs of overhauls on each type of the Navy's Curtiss-Wright compressors is set, and the ISEAs can place orders on the contract as needed to support the fleet. No such contract vehicle exists for Rix or Sauer, so ISEAs resort to developing simplified acquisition process (SAP) packages on a task-by-task basis.

This chapter detailed two case studies that can be viewed as worst case scenarios, one where a company exited the DIB and another where the prices grew out of control thanks to a bilateral monopoly. These cases serve as examples of the importance of

competition in the DIB, highlighted in the USD(A&S) issued report, mentioned previously in this chapter. This chapter also introduces the two systems as case studies that are analyzed using the sector-by-sector, tier-by-tier (S2T2), fragility and criticality (FaC) analysis techniques in Chapter IV. The next chapter, Chapter III contains a literature review that further explains what a sector-by-sector, tier-by-tier analysis is and does as well as how to perform a fragility and criticality analysis.

III. LITERATURE REVIEW

The government standard to assess the health of the DIB is to analyze risk with a sector by sector, tier by tier (S2T2) analysis. The objectives of the S2T2 analysis are to establish early warning indicators and to identify risk in the DIB. In particular, a S2T2 analysis identifies single points of failure, overreliance on foreign sourcing, and areas of limited competition. Furthermore, the S2T2 analysis defines strategies for mitigating the identified risks and outlines long-term support strategies (R. Mortlock, PowerPoint slides, April 13, 2021).

The S2T2 analysis was developed by the DOD in 2002 to perform in depth assessments of the defense industrial base. The S2T2 analysis breaks a large system such as a plane or ship down into individual sub-systems, which allows the assessor to identify key weaknesses in the supply chain and applies targeted improvements at those weaknesses. The difficulty with S2T2 assessments is that most companies in the DIB treat their list of individual suppliers as proprietary information. In order to successfully accomplish a S2T2 assessment, the assessor must contact and survey SMEs, ISEAs, and system engineering managers (SEM) with extensive knowledge of the systems being assessed.

A key aspect of the S2T2 analysis is the Fragility and Criticality Assessment (FaC).

> The FaC is specifically designed to systematically evaluate the need for program adjustments or investments to sustain specific niches in the defense industrial base. This common framework, developed by the AT&L with the support of the Military Departments, will allow DOD leadership to compare industrial capabilities across all the sectors and tiers of the industrial base and combine scores for industrial capabilities that contribute to multiple programs. (USDAT&L, 2013)

The FaC output is a matrix that rates the risk to the DIB, see Figure 1. The matrix is a graph that rates fragility versus criticality on an XY axis. Fragility takes into account the financial outlook, the existing firms in the market, DOD sales, and the existing marketplace. Criticality analyzes the facility or equipment requirements, uniqueness to the DOD, requirements for skilled labor, reconstitution time, requirements for DOD

design, and the availability of alternatives. Both fragility and criticality assessments for individual companies are plotted on a graph similar to the risk assessment matrix.

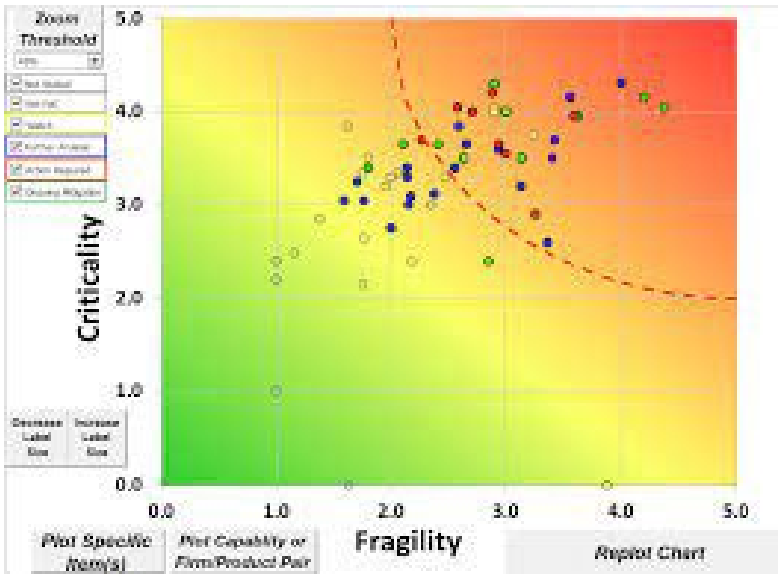

Figure 1. Sample FaC Matrix. Source Sleeper et al. (2014)

Six questions are asked, and the answers are assessed on a scale to generate the overall criticality rating that answers the following questions:

1. To what degree is the market for this capability commercial?
2. To what degree are specialized skills needed and available to integrate, manufacture, or maintain the capability?
3. To what degree is defense-specific knowledge required to reproduce this capability, an alternative, or the next-generation design?
4. Are specialized equipment or facilities needed to integrate, manufacture, or maintain this capability?
5. What is the impact on the DOD in time to restore this capability is lost?
6. To what degree are cost, time, and performance-effective alternatives available to meet DOD needs? (Sleeper et al., 2014)

Four questions are asked for the fragility rating, and the answers are also assessed:

7. What is the risk of this facility going out of business or exiting the market for this capability?
8. How much total sales for this facility are from DOD contracts?
9. How many firms currently participate in this firm's market for this capability?
10. What is the dependence on foreign sources for this capability? (Sleeper et al., 2014)

Competition is diluted through the repeated award of sole-source contracts known as vendor-lock. The authority for sole-source contracts is provided by 10 U.S.C.2304(c)(1) and is explained in FAR Part 6.3. FAR 6.3, which outlines the requirements for awarding a government contract with other than full and open competition. FAR 6.302-1 is used by Navy auxiliary systems and includes the requirements for awarding when there exists "only one responsible source and no other supplies or services will satisfy agency requirements" (FAR 6.302-1, 2022). Particularly relevant are FAR 6.302-1a2ii and 6.302-1a2iii, which allow for a sole source award to a contractor if "substantial duplication of cost to the government is not expected to be recouped through competition" (FAR 6.302-1a2ii, 2022). Essentially stating that competition could not reasonably be expected to provide savings to the taxpayer. The other reason for a sole source award would be if competition could result in "unacceptable delays in fulfilling the agency's requirements" (FAR 6.302-1a2iiB, 2022).

The NSWCPD Contracts department has developed and maintains a Justification and Approval (J&A) template document that is prepared while developing a contract package to award a sole-source contract. An example published J&A is provided in the appendix with proprietary information redacted. The J&A references 10 U.S.C. 2304(c)(1) and FAR 6.3202-1 as statutory authority. However, it relies on the ISEA to provide sufficient documentation as to why competition should be avoided. New requirements dictate that the SME generate an educated guess for the time as the cost required for a novel firm to become proficient enough to adequately satisfy the requirements of the contract. Training for this task does not exist; it is a best guess and as such, is subjective. Ultimately it is up to the contracting officer to accept or reject the J&A prepared by the SME, and it is the contracting officer's determination if the requirements for FAR 6.302-1 have been satisfied for a sole-source award.

In the case of AC&R support, sole-source contracts have been awarded as far back as 1997 and renewed every 5 years. These contracts were awarded to York International Company, which is now Johnson Controls Naval Systems. The publicly available sole-source justification is heavily redacted. The J&A does reference York IP and states that the government has been unable to procure top-level Technical Data Packages (TDP) required to competitively bid these contracts. The refusal to sell the

TDPs has enabled then York and now JCNS to have a vendor-lock on Navy A/C plants for the past 2 decades and into the foreseeable future.

This chapter provided a summary of the S2T2, FaC analysis techniques, its purpose and how it is performed. The chapter also covered the requirements for awarding a sole source contract per the FAR and how the FAR can be applied to continually award sole source contracts. The next chapter contains the S2T2, FaC analysis of the AC&R and compressed air systems.

IV. RESEARCH METHODOLOGY AND ANALYSIS

This chapter will cover the methodology used to conduct the S2T2 analysis and FaC Assessment. Then it will outline the results of the FaC assessment for AC&R and compressed air systems and provide answers to each of the key FaC questions listed in Chapter III. Finally, it will apply the results to major points from the February 2022 report from OUSD(A&S) titled *The State of Competition within the Defense Industrial Base*.

What makes the S2T2 assessment so difficult is that there is no single source for all the answers or data. Data must be collected by consulting senior subject matter experts (SME) that can speak to the state of the DIB within their area of expertise. For this study, several both AC&R and compressed air systems ISEAs were contacted as well as the LHA 9 Systems Engineering Manager, the retired team lead for Navy Oxygen and Nitrogen (O2N2) Systems as well as the Lead Acquisition Manager for NSWCPD Department 40, which is responsible for Life Cycle Engineering of all Navy Auxiliary and Hull, Mechanical and Electrical (HM&E) systems. Personal correspondence was conducted via email, over the phone, through video teleconference, and in-person. Additional historical context was gathered by searching through SAM.gov for contracts awarded in support of either AC&R or Compressed Air systems.

For each system, the main companies that make up the current DIB were analyzed. The commercial markets for each system was also studied and analyzed for overall market health. The FaC analysis was applied to the private market with the goal of analyzing the barriers to a public market company from joining the DIB for that system.

To perform the FaC analysis, the ten FaC analysis questions, six for criticality and four for fragility, were posed to each company. The responses were then rated on a 1–5 scale and then the even weighted average of fragility and criticality are plotted on the FaC matrix. Higher scores correlate to higher market risk.

A. COMPRESSED AIR SYSTEM FAC ANALYSIS

1. Compressed Air System Criticality Rating

The criticality ratings for Curtiss-Wright, Rix Industries and Sauer Compressors came out to be identical (shown in Table 1). This is due to the fact that compressors are fairly simple machines and that the models produced by the three different companies all have similar components and functionality. The main difference between the DIB companies and the general public compressed air market is the DOD specific requirements imposed on compressors that need to be installed on a war vessel. The Navy's shock, vibration, electromagnetic interference and cybersecurity requirements raise the price of DOD models to where they are not purchased by the public sector. Risk of one of the three DIB companies leaving the defense marketplace is mitigated by redundancy on ships and the inherent modularity of compressors. In a worst case scenario, a single or series of commercial compressors that meets the ships pressure and flow rate needs can be mounted on a skid and temporarily installed where necessary.

Table 1. Compressed Air System Criticality Ratings

	Defense Unique	Skilled Labor	Defense Design	Facility & Equipment	Reconstitution Time	Availability of Alternatives	Average
Curtiss Wright	2	3	3	3	3	2	2.67
Rix	2	3	3	3	3	2	2.67
Sauer	2	3	3	3	3	2	2.67
Market	1	2	3	2	2	1	1.83

2. Compressed Air System Fragility Ratings

The fragility ratings in Table 2 is where there is some separation between the three DIB companies as well as the general marketplace. Curtiss Wright is a multifaceted organization that purchased the Dresser Rand DOD division in 2018. Rix Industries carries slightly more fragility risk mostly due to the high percentage of DOD business compared to their public product lines. Rix has recently ventured into gas separation and cryogenic technology which improves their financial outlook score. Rix developed a new gaseous nitrogen production system for *CVN-77 USS GEORGE HW BUSH* during new construction and even took over the *CVN-78 USS GERALD R FORD* liquid oxygen system development and delivery contract when GEECO went out of business. Sauer has

a higher score than both Curtiss Wright and Rix because their DOD product line is diminished compared to the other two companies and they have no new compressors being installed during new ship construction. The non-DOD market companies have low fragility due to the high global demand for new compressors and compressor sustainment.

Table 2. Compressed Air Fragility Ratings

Compressed Air Fragility Ratings					
	Financial Outlook	DOD Sales	Firms in Sector	Foreign Dependency	Average
Curtiss Wright	3	3	3	2	2.75
Rix	2	5	3	2	3.00
Sauer	4	5	3	2	3.50
Market	1	5	1	3	2.50

3. Compressed Air System FaC Matrix

The compressed air system FaC matrix (displayed in Figure 2) confirms suspicions about the market place. There is a large, strong non-DOD market with stable demand. The DOD market is also stable as the Navy has a constant need for new compressors and compressed air parts and maintenance. The main barrier between the DOD and non-DOD market is the hardened requirements for Navy vessels, the compressors that meet these standards are priced out of competition for non-DOD contracts.

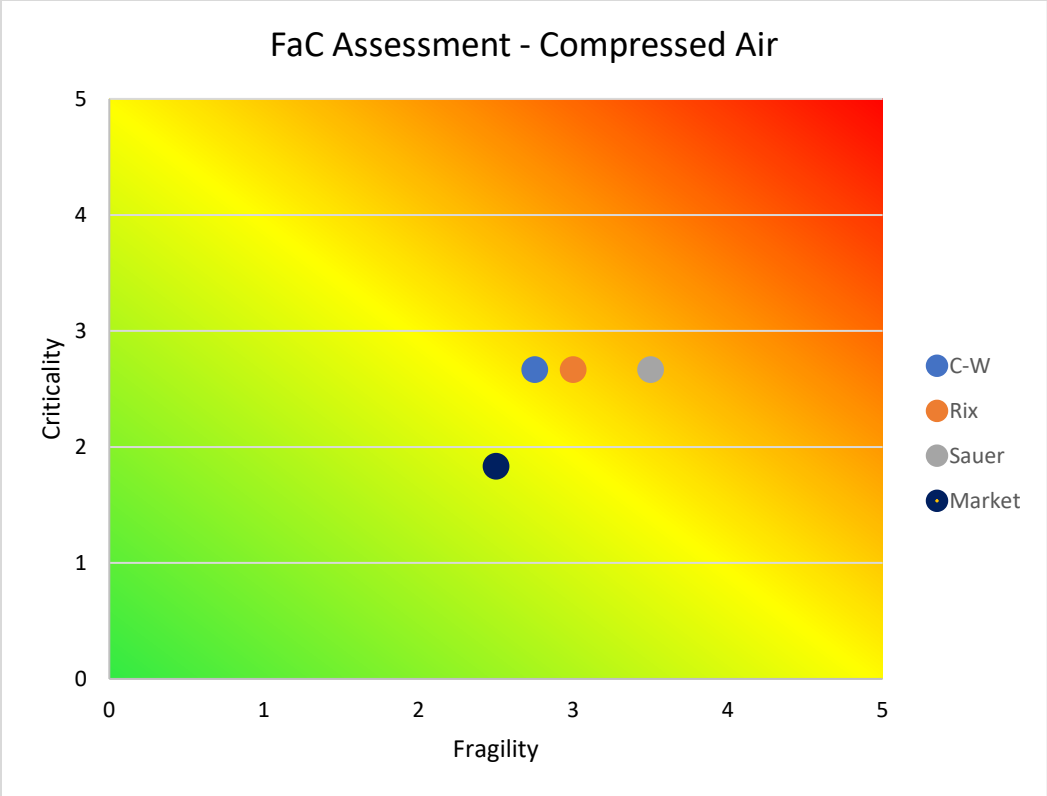

Figure 2. Compressed Air FaC Matrix

B. AC&R SYSTEM FAC ANALYSIS

1. AC&R System Criticality Ratings

The criticality ratings, presented in Table 3, between JCNS and the general market were very similar. For the market sector summary, the assumption was made that a commercial off-the-self product line exists that meets the Navy's requirements with only minor changes required to successfully pass shock, vibration, electromagnetic interference and cybersecurity testing and scans.

Table 3. AC&R Criticality Ratings

	Defense Unique	Skilled Labor	Defense Design	Facility & Equipment	Reconstitution Time	Availability of Alternatives	Average
JCNS	3	3	2	4	4	4	3.33
Market	1	3	2	4	4	2	2.67

2. AC&R System Fragility Ratings

Fragility ratings (shown in Table 4) are high due to the small amount of firms that have capability and capacity in both the global and DOD market. Further, while the DOD

marketplace does provide a steady, easy to predict demand for chillers, the amount of business the DOD does is dwarfed by non-DOD business demands. The global market supports end users in medical, pharmaceutical, food and beverage, and hospitality markets. The global supply chain is dominated by foreign owned companies, with Carrier being the only major U.S. based chiller supplier. Even the U.S. based JCNS is a subdivision of Johnson Controls – Hitachi Air Conditioning, headquartered in Japan. The barrier to entry for a new company is high, as none of the major commercial markets will purchase the high priced military models. This makes increasing competition exceptionally hard, there is not enough demand to support more than one company and new companies are reluctant to dedicate the non-recurring engineering labor to modify their commercial lines to meet DOD standards for such a low return on investment compared to non-DOD market.

Table 4. AC&R Fragility Ratings

	Financial Outlook	DOD Sales	Firms in Sector	Foreign Dependency	Average
JCNS	1	4	5	3	3.25
Market	1	5	2	3	2.75

3. AC&R System FaC Matrix

The DIB for AC&R carries fairly high risk as JCNS is the only vendor for a critical Navy system. The FaC matrix is displayed on Figure 3. The MRS program has encouraged competition and brought in two additional firms, but the MRS is only for ship storerooms. The larger chillers that are responsible for ships chilled water and cool air are all currently supplied by JCNS. In fact, the government seems to have given up on fostering competition in this sector as JCNS has been reserved for new ship construction for several years into the future. JCNS will need to be closely monitored by acquisition professionals to ensure that the Navy does not suffer a lapse in support or supply.

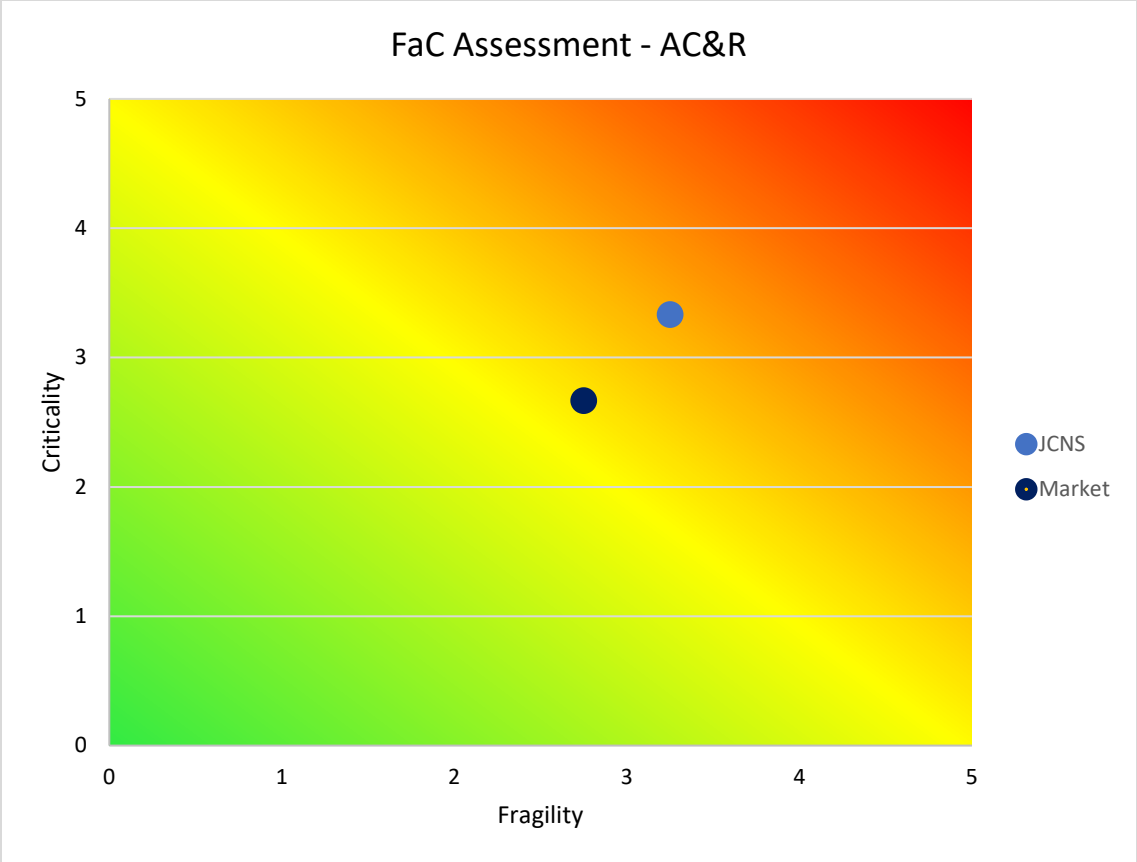

Figure 3. AC&R FaC Matrix

Chapter V will contain the conclusions and recommendations that can be drawn from the analysis done in Chapter IV. These conclusions will provide answers to the primary and secondary research questions posed in Chapter I. Chapter V will also contain some areas for future research that can be done to further identify risk areas amongst Navy Auxiliary systems.

V. CONCLUSIONS AND RECOMMENDATIONS

The primary research questions for this S2T2, FaC analysis was: What can the Navy do to protect its interests in Navy auxiliary systems when there is a lack of competition among the Defense Industrial Base? That question can be answered by considering some of the strategies outlined in the February 2022 report from the Office of the Under Secretary of Defense for Acquisition and Sustainment and applying them to Navy Auxiliary systems. First is for DOD SMEs and acquisition professionals to remain vigilant to mergers. For example, Curtiss-Wright absorbed the government sector of Dresser Rand in 2018 and JCNS assimilated the York Refrigeration government sector in 2005. Second is to address IP shortfalls that lead to vendor lock. As outlined in this report, York and now JCNS has been awarded sole source contracts for over two decades due to the government's lack of AC&R technical data packages. Future AC&R efforts are pursuing a MIL-SPEC designation to allow for increased competition. With compressed air systems, NSWCPD developed the NC3 program to replace obsolete compressor controllers with a Navy developed and owned controller that utilizes common components across several different models of compressors. Further competition can be increased by separating contracts into maintenance, modernization and material contracts. For example, the modernization efforts that drive the sole source requirement for AC&R contracts does not necessarily apply to maintenance and troubleshooting efforts. These can be handled by qualified third party vendors, by regional maintenance centers or by ships force.

The secondary research questions have been considered throughout the literary review and analysis process.

- What is a "fair and reasonable" price?

Competition determines if a price is fair and reasonable. Without competition, making this determination becomes much more difficult. Therefore, it is imperative that the DOD maintain competition as much as possible. In a bilateral monopoly environment, it is extremely difficult for the government to get good value on taxpayer dollars. That is why sole-source awards should be used only when necessary and acquisition professionals should make every effort to allow for competition to avoid vendor lock.

- Is there a common theme between sole-source justification documents?

FAR pat 6.3 outlines the requirements for awarding a government contract without full and open competition. Ultimately, it is up to the contracting officer to determine if they have sufficiently met the requirements of FAR 6.3.

- How can competition be increased in high fragility environments?
- What can the government do to protect its interests in high fragility environments?

The DOD will always have systems that operate with high fragility risk, that's the nature of the national defense business. The NC3 and MRS programs, for example, each seek to mitigate this risk in their own way. The NC3 reduced risk to obsolescence by establishing a DOD run program that uses common controller components across several different models of compressors. The MRS program pushed to reduce barriers to competition by pursuing a specification certification to allow any qualified vendor to build the MRS to spec.

Research for this project revealed a culprit of DIB reduction in Navy auxiliary systems. Equipment that is designed for Navy ships is not suitable for commercial sale due to the high price incurred to meet Navy hardening standards. This makes the barrier to entry for new companies high, as the return on their investment for developing a new system to beat out an incumbent ranges from low to zero. Funding for Title III projects under the Defense Production Act can be used for Navy auxiliary systems to incentivize companies to compete. This funding should be targeted on systems where the government is in a bilateral monopoly to bring back competition and ultimately reduce cost and improve performance.

This research only covered two specific areas of Navy auxiliary systems but there are several other systems that could benefit from a S2T2, FaC analysis. Cryogenic Oxygen and Nitrogen systems, Life Support, Seawater, Degaussing, and Fuel systems, to name a few, are valid candidates for further study. The common thread between many auxiliary systems is that they have been in place for decades. This leads to mature systems that are susceptible to obsolescence issues and a small DIB supporting them due to entry barriers for new vendors.

APPENDIX. EXAMPLE PUBLISHED J&A

DEPARTMENT OF THE NAVY
NAVAL SURFACE WARFARE CENTER PHILADELPHIA DIVISION
5001 SOUTH BROAD STREET
PHILADELPHIA PA 19112-1403

IN REPLY REFER TO:
J&A Number: 0232-15-045-00
Code: 0232
P.R. Number: 16-JTZ-001

JUSTIFICATION AND APPROVAL
FOR USE OF OTHER THAN FULL AND OPEN COMPETITION

JUSTIFICATION

1. Contracting Activity

The Naval Sea Systems Command, Naval Surface Warfare Center, Philadelphia Division (NSWCPD), Code 0232, Philadelphia, PA.

2. Description of Action Being Approved

This is a sole source action to be awarded without full and open competition as a Firm-Fixed-Price/Cost-Plus-Fixed-Fee (CPFF), Indefinite-Delivery Indefinite-Quantity (IDIQ) contract to York International Corporation, 631 South Richland Avenue, York, PA 17403 to assist in naval research, development, testing and evaluation program for shipboard Air Conditioning and Refrigeration (AC&R) programs. This contract is a replacement follow-on contract for continuing AC&R modernization work under Contract No. N65540-14-D-0006.

3. Description of Supplies/Services

The proposed contract will provide for development and fabrication of compressors, control systems, refrigeration systems and air conditioning systems and technology integration kits based upon current Navy designs; develop documentation for all system modifications including revising or developing new technical manuals, installation instructions, installation drawings and final configuration drawings; testing and qualification of modified air conditioning and refrigeration systems; installation start-up services; carryout engineering analyses and in-service field support. The total estimated dollar value of the proposed procurement is $44,580,000.

Table I below illustrates the acquisition and appropriation schedule of the equipment/services being procured. The estimate is approximately 50% material and 50% services.

The Government's minimum needs have been verified by the certifying technical and requirements personnel.

MOPAS Acquisition Strategy Plan No. 0232-15-045-01 covers this acquisition.

1

Adapted from Naval Surface Warfare Center Philadelphia Division (n.d.b).

Table 1 – Acquisition/Appropriation Schedule

	Estimated Dollar Value			
	Base Year	Year 2	Year 3	Total
[redacted]				

The Period of Performance for this effort will be three (3) years form the date of award.

4. Statutory Authority Permitting Other Than Full and Open Competition

10 U.S.C. 2304 (c) (1), "Only One Responsible Source and No Other Supplies or Services Will Satisfy Agency Requirements," as implemented by Part 6.302-1 of the Federal Acquisition Regulation (FAR).

5. Rationale Justifying Use of Cited Statutory Authority

Since 1980 the York International Corporation has been the only source for large Air Conditioning (A/C) Plants, and is the original designer, developer and sole manufacturer all [redacted] A/C Plants with a capacity of [redacted] Class ships [redacted] compressors found in air conditioning and refrigeration systems onboard [redacted] ships [redacted] and [redacted] refrigeration systems onboard [redacted] class ships. The air conditioning and refrigeration systems were originally procured on the basis of a performance specification that only established basic operational features and parameters. They were not acquired on the basis of a detailed design specification that set forth required materials, dimensions, tolerances, etc.

York was tasked under NSWC Annapolis Contract No. N65133-97-D-0033 to develop the CFC-114 to HFC-236fa Conversion Kits. In order to limit the time and cost of this development effort and to achieve standardization with other Air Conditioning Plants, it was agreed that York would use or adapt parts developed for their commercial Air Conditioning Plants. The resulting Conversion Kits, for example, include a [redacted] that is the same as used in York's commercial products. The [redacted] and design as the Air Conditioning Plants on the [redacted] Class Ships, which were developed by York at the same time. If not for these trade-offs, the development effort would have taken significantly more time to accomplish, and the cost would have been substantially higher. Since the design of the Conversion Kits, CFC-114, HFC-236fa and HFC-134a [redacted] A/C plants, and CFC-12 and HFC-134a refrigeration systems are based on York's commercial Air Conditioning Plants, the Government only received limited data rights to the Conversion Kits, and the drawings contain a restrictive legend stating the data is proprietary to York.

The Navy does not possess the ability to conduct complex repairs and system improvements without these detailed proprietary drawings and information. Based on the above, the

Conversion Kits, Enhanced A/C Plants, and Technology Integration Kits covered by the proposed acquisition are considered unique supplies available only from the York International / Johnson Controls Incorporated. Similar development efforts were previously procured under CDNSWC contract numbers N61533-97-D-0033 and N65440-04-D-0029. These contracts were negotiated with York International on the same basis as discussed above.

The Government has awarded sole source contracts to York International for the production of Air Conditioning and Refrigeration (AC&R) plants based on York's ability to meet Government requirements. The AC&R plants and engineering support was awarded to York based on the fact that York owns the top level Technical Data Packages (TDPs) for the plants and has been unwilling to sell the Government sufficient access to the TDPs to allow a competitive acquisition of the required services as indicated. The cost and time to competitively acquire, test and qualify alternative A/C plants were considered excessive when compared with the Government's requirements and remain so today. Other contractors have been contacted and express no interest in supplying A/C plants that meet the Navy's shock and vibration Grade "A" shock requirements. For example, [redacted] significant cost to the Government. Additionally, most York A/C plants use [redacted] The A/C plant design has to meet acoustic design criteria for [redacted] applications and requires testing in York's sound evaluation and performance testing facility. The Government does not have the facilities to match York's anechoic test chamber, nor does the Government have the ability to [redacted] Without the A/C plant TDPs and a proper testing facility, the A/C plant requirements would necessitate extensive redevelopment. Based on previous experience, the time to achieve these requirements for alternative AC&R equipment is shown below in Table 2.

Table 2 – Estimated Alternate A/C Plant Schedule

Task	Duration
[redacted]	

Additionally to the estimated time require listed in Table 2, significate time and effort will be required to manufacture and support all the different [redacted] A/C Plants with a capacity of [redacted] class ships [redacted] This also does not include new technology York has been exclusively working on [redacted]

In addition to unacceptable acquisition program delays, the cost to the Government to develop, integrate, and sustain alternate AC&R plants would be substantial due to duplication costs. Table 3 summarizes the estimated significant duplicated costs to the Government.

Table 3 – Estimated Duplicate Development, Integration and Sustainment Costs

Task	Estimated Cost
[redacted]	

To develop alternate AC&R equipment for the various systems and ships to meet Navy requirements, another manufacturer would necessitate substantial time and funding to duplicate the AC&R plant manufacturing and experience York has obtained over the past thirty (30) years. For the abovementioned reasons, at this time York is the only vender capable of providing fully qualified A/C plants in accordance with the Government's required acquisition schedule. Based on the expenses listed in Table 3, changing to alternate AC&R equipment would result in an estimated [redacted] in duplication costs to the Government. Award to any source other than York International would result in unacceptable delays in fulfilling Navy's requirements and substantial duplication of cost that is not expected to be recovered through competition.

6. Description of Efforts Made to Solicit Offers from as Many Offerors as Practicable

The proposed acquisition Request for Proposal No. N65540-15-R-5159 was synopsized in the Federal Business Opportunities (FedBizOpps) website on 10 June 2015 in accordance with FAR Subpart 5.2. No responses to the synopsis have been received to date, and no other sources have expressed an interest in the proposed acquisition. No additional Market Research was conducted.

A Request for Information (RFI) was completed on November 19, 2015 and closed on November 27, 2015. No responses were received from the sources sought notice. An additional sources sought notice was posted on 9 February 2017 due to the amount of time that had passed since the original notice. No responses were received from the sources sought notice.

7. Determination of Fair and Reasonable Costs

The Contracting Officer will make a determination that the price negotiated under the proposed contract is fair and reasonable pursuant to FAR Part 15. Assistance from Defense Contract Audit Agency (DCAA) and Defense Contract Management Agency (DCMA) will be utilized as appropriate to analyze, evaluate and assist in negotiation based upon detailed cost and pricing data which will be certified by the Contractor at conclusion of negotiations. Services similar to those in this solicitation have been purchased from York in the past two York Engineering Services Contracts. Cost/pricing information was received on those past procurements that should prove sufficient to lend further support the fair and reasonable cost determination of this procurement.

8. Actions to Remove Barriers to Competition

For the reasons set forth in Paragraph 5, NSWCPD has no plans at this time to compete future contracts for the types of services covered by this document. If another potential source emerges, the Contracting Activity will assess whether competition for future requirements is feasible.

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