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CH-53E MAIN ROTOR HEAD LOGISTICS SUSTAINMENT STRATEGY

June 2018

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CH-53E MAIN ROTOR HEAD LOGISTICS SUSTAINMENT STRATEGY

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Submitted in partial fulfillment of the
requirements for the degree of

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CH-53E MAIN ROTOR HEAD LOGISTICS SUSTAINMENT STRATEGY

ABSTRACT

The H-53E heavy lift helicopter will play a vital role for both Navy and Marine Corps missions through the year 2029. The aging platform is currently plagued with material availability issues that result in degraded aircraft readiness. Of these material availability issues, one of the most critical is sourcing the components for the main rotor head during depot-level overhaul. This study focuses on analysis of existing maintenance and logistics support and sustainment strategies currently in use. It identifies improvements to the H-53E main rotor head logistics support structure in order to better support the Navy and Marine Corps heavy lift mission. The results of this research provide recommendations on short-, mid-, and long-term logistics sustainment strategies aimed at improving material availability and increasing aircraft readiness.

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TABLE OF CONTENTS

I.	INTRODUCTION.....	1
A.	PURPOSE AND SCOPE.....	1
B.	METHODOLOGY	2
C.	RESEARCH QUESTIONS	3
1.	Primary Research Question.....	3
2.	Secondary Research Questions.....	3
D.	ORGANIZATION OF THE RESEARCH REPORT	3
II.	BACKGROUND	5
A.	H-53E	5
1.	CH-53E.....	5
2.	MH-53E.....	6
B.	NAVAL AVIATION MAINTENANCE PROGRAM.....	7
1.	Three Levels of Maintenance.....	8
C.	LOGISTICS SUPPORT STRUCTURE	9
1.	NAVSUP WEAPONS SYSTEMS SUPPORT.....	10
2.	DEFENSE LOGISTICS AGENCY.....	10
3.	REWORK FACILITIES.....	11
4.	TYPE COMMANDER.....	11
D.	MAIN ROTOR HEAD	12
III.	LITERATURE REVIEW	15
A.	DEPARTMENT OF DEFENSE LOGISTICS STRATEGIC PLAN.....	15
B.	BETTER BUYING POWER	17
C.	PERFORMANCE-BASED LOGISTICS	19
IV.	RESULTS AND ANALYSIS	23
A.	SERVICE LIFE EXTENSIONS.....	23
B.	PRODUCTION VERSUS DEMAND	25
C.	MATERIAL BACKORDER.....	26
V.	CONCLUSION, RECOMMENDATIONS, AND SUMMARY	27
A.	SHORT-TERM SUSTAINMENT STRATEGY	27
1.	Communications Strategy	27
2.	Review Forecasted Materials	28
3.	DLA Emergency Buy.....	28

B. MID-TERM SUSTAINMENT STRATEGY28

C. LONG-TERM SUSTAINMENT STRATEGY29

1. Procurement Strategy.....29

2. Contracting Strategy29

3. Metrics30

D. SUMMARY30

APPENDIX A. UPDATED MATERIAL FORECAST31

APPENDIX B. DLA RICHMOND TOP 15 MATERIAL DEGRADERS47

LIST OF REFERENCES49

INITIAL DISTRIBUTION LIST53

LIST OF FIGURES

Figure 1.	CH-53E Dimensions Diagram. Source: NAVAIR. (2017).....	6
Figure 2.	MH-53E Dimensions Diagram. Source: DoN (2014.).....	7
Figure 3.	Main Rotor Head and Components. Source: DoN (2017b).....	13
Figure 4.	H-53E Main Rotor Heads under Service Life Extensions 2012-2014.....	24
Figure 5.	November 2014 H-53E Main Rotor Head Service Life Extensions.....	24

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LIST OF TABLES

Table 1. Scheduled FY15 MRH Production by Overhaul Facility25

Table 2. Production Capacity Given no Material Constraints by Overhaul
Facility25

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LIST OF ACRONYMS AND ABBREVIATIONS

AIMD	Aviation Intermediate Maintenance Department
ALM	Aircraft Life Management
AT&L	Office of the Under Secretary of Defense for Acquisition, Technology and Logistics
AVLOG	Aviation Logistics
BBP	Better Buying Power
BOM	Bill of Materials
CNO	Chief of Naval Operations
COMNAVAIRFOR	Commander Naval Air Forces
COMNAVAIRFORINST	Commander Naval Air Forces Instruction
DECKPLATE	Decision Knowledge Programming for Logistics Analysis and Technical Evaluation
DLA	Defense Logistics Agency
DOD	Department of Defense
DoDI	Department of Defense Instruction
ECP	Engineering Change Proposal
FCOE	Fleet Common Operating Environment Facility
FRC-E	Fleet Readiness Center East
ILSMS	Integrated Logistics Support Management System
IWST	Integrated Weapon Support Team
LSP	Department of Defense Logistics Strategic Plan
MALS	Marine Aviation Logistics Squadron
MCAS	Marine Corps Air Station
MRH	Main Rotor Head

NAMP	Naval Aviation Maintenance Program
NAVAIR	United States Navy Naval Air Systems Command
NAVSUP	Naval Supply Systems Command
NIIN	National Item Identification Number
OEM	Original Equipment Manufacturer
O&S	Operations and Support
PBL	Performance Based Logistics
PMIC	Periodic Maintenance Information Cards
QDR	Department of Defense Quadrennial Defense Review
RFI	Ready for Issue
SMP	Department of Defense Strategic Management Plan
SRC	Subsystems Removal Card
SS	Sleeve and Spindle
SAC	Sikorsky Aircraft Corporation
TMS	Type Model Series
TYCOM	Aircraft Type Commander
USMC	United States Marine Corps
USN	United States Navy
WSS	Weapon System Support

I. INTRODUCTION

The H-53E is an Acquisition Category I program managed by PMA-261 located at Naval Air Systems Command (NAVAIR), Patuxent River, MD. The program is currently in the operations and support (O&S) phase of the Defense Acquisition Management System with the expectation that the United States Navy (USN) and the United States Marine Corps (USMC) will both operate the H-53E through the year of 2029 (Department of the Navy [DoN], 2016). Due to its growing age and increased operational tempo over the past fourteen years, the H-53E has developed significant fatigue life, maintenance supportability, and performance degradation concerns.

The Main Rotor Head (MRH) has consistently been one of the H-53E's top readiness degraders in recent years. The H-53E Fleet has found itself in a poor state of material readiness and is often forced to perform cannibalization maintenance actions on Main Rotor Heads and associated dynamic components in order to keep sufficient aircraft readiness levels on the flight line.

The issue at hand is that Fleet demand for Main Rotor Heads consistently outstrips the production output of repair facilities. This is exacerbating itself in increased service life extensions and decreased flight line readiness. Production of Main Rotor Heads at rework and manufacture facilities is impacted by the lack of material availability. Ready for Issue (RFI) Main Rotor Heads are managed by the Aircraft Type Commander (TYCOM) in order to extend useful service time on the aircraft by the use of engineering approved service life extensions. This is not an efficient means of conducting business therefore the H-53E Program Office, PMA-261, would like a sustainment strategy set in place that will alleviate the issue of Main Rotor Head material availability.

A. PURPOSE AND SCOPE

It is understood that material readiness contributes directly to flight line aircraft readiness. Over the past fourteen years, the H-53E's Main Rotor Head has grown to be one of the top readiness inhibitors for both the USN and the USMC's fleet of H-53E helicopters. The purpose of this research is to identify improvements to the Main Rotor Head logistics

support structure in order to better support the Navy and Marine Corps Heavy Lift Mission. This study focused on the analysis of existing maintenance and logistics support and sustainment strategies for the H-53E type model series (TMS) from a program level. This research does not cover possible Organizational and Intermediate Level maintenance actions or practices that could potentially drive up demand for RFI Main Rotor Heads. It appears the material readiness issues currently being experienced are stemming from higher-level logistics planning and not due to flight line activities. This is due to the fact components are being flown past their original scheduled removal due to depot level backorders, not maintenance malpractice or poor component life management. While it is important to have an overall understanding of the integrated supply, maintenance, and logistics chain currently used to support the H-53, this analysis will focus on depot level overhaul and the organizations responsible for material support at that level of maintenance.

B. METHODOLOGY

To begin the project, the author first focused on familiarizing himself with H-53E publications, policies, and the maintenance and logistics support structure. He then gathered and reviewed relevant literary material to include research articles, government publications, internet based research, and memorandums on current Department of Defense (DOD) acquisition and logistics policy and guidance. Once an adequate base of knowledge was established the author began to gather and analyze appropriate and relevant supply and production data in order to gain a background understanding of how material is currently being procured for Main Rotor Head overhaul. After analyzing this data, a decision was made into the root cause of the H-53E's material readiness problem and how to systematically improve material readiness. The results of this research will provide leadership with recommendations on short-, mid-, and long-term logistics sustainment strategies aimed at improving H-53E Main Rotor Head material availability which will in turn increase aircraft readiness.

C. RESEARCH QUESTIONS

In order to guide both qualitative and quantitative research, the author developed a list of research primary and secondary questions that he determined to be of significant value to understanding the problem at hand. These questions were created with the intent of keeping data analysis on topic and ensuring all relevant data was taken into consideration when evaluating the problem

1. Primary Research Question

The primary research question, a comprehensive question that will guide the author's actions throughout the research and analysis process, is this: How do we ensure the warfighter has sufficient levels of material availability throughout the remainder of the H-53E's acquisition life cycle?

2. Secondary Research Questions

The secondary research questions serve as a guide to ensure data research stays within the scope of this project and collects meaningful data.

- How large is the current material backorder compared to the entire inventory of Main Rotor Heads?
- Does the current material forecast for depot overhaul support reducing backlog of Main Rotor Heads?
- What specific Main Rotor Head components comprise the top 15 material degraders?

D. ORGANIZATION OF THE RESEARCH REPORT

In the first section of this research report, Chapter II will introduce the reader to background information about Naval Aviation Logistics (AVLOG). It will provide brief definitions about the organizations that play a role in AVLOG sustainment as well as governing documents. Chapter III will examine current DOD publications and guidance in regards to cost effective logistics support strategies that will guide the future sustainment strategy of the Main Rotor Head. In Chapter IV, data pulled from PMA-261's Fleet

Common Operating Environment Facility (FCOE), the Decision Knowledge Programming for Logistics Analysis and Technical Evaluation (DECKPLATE) program, Integrated Logistics Support Management System (ILSMS), and Fleet Readiness Center East's (FRC-E) Bill of Materials (BOM) data are analyzed. This data will provide a better understanding to the scope and depth of material deficiencies. The last section, Chapter V, will present recommendations for short-, mid-, and long-term logistics sustainment strategies that should be employed in order to improve the material readiness of the H-53E Main Rotor Head.

II. BACKGROUND

In order to gain understanding of the issue PMA-261 is experiencing with material readiness, it is first essential to have a solid foundation of the key elements involved in Naval Aviation Maintenance and Logistics. This background chapter describes the H-53E airframe, its service specific variants, the Naval Aviation Maintenance Program (NAMP), the Main Rotor Head, and identifies the agencies responsible for providing material support for the H-53E.

A. H-53E

The H-53E is the largest helicopter in the United States military and serves a critical role within the Navy and Marine Corps warfighting concept by fulfilling the requirement for heavy lift capability. The airframe was designed in the 1960s and introduced in the early 1980s as an Engineering Change Proposal (ECP) to the H-53D. Sikorsky Aircraft Division of United Technologies, Stratford, Connecticut, manufactured the helicopter. There are two variants of this airframe currently in naval service that are each suited to perform specific mission sets. Both variants are equipped with a seven-blade main rotor and four-bladed tail rotor powered by three General Electric T-64 engines. The rear of the helicopter has a drop down cargo ramp providing it the ability to load combat vehicles, troops, and gear both on land and at sea. For the purpose of this research, the airframe will be referred to as the H-53E since the Main Rotor Head and its associated dynamic components are interchangeable between aircraft.

1. CH-53E

The CH-53E Super Stallion is used exclusively by the USMC. According to the CH-53E Training and Readiness manual, the primary mission of the CH-53E is “providing assault support transport of heavy equipment, combat troops, and supplies, day or night under all weather conditions during expeditionary, joint, or combined operations” (DoN, 2017a). The CH-53E can transport supplies internally or up to 32,000 pounds externally with a cargo hook. The maximum gross operating weight is 69,750 pounds. The H-53E is equipped with an extendable refueling probe and can be refueled in flight giving the

helicopter extended range of operation. A combat crew for the CH-53E is composed of two pilots, a crew chief, and door and tail gunners. The helicopter can carry up to 55 passengers (Pike, 1999). The USMC currently has 149 CH-53E in its inventory.

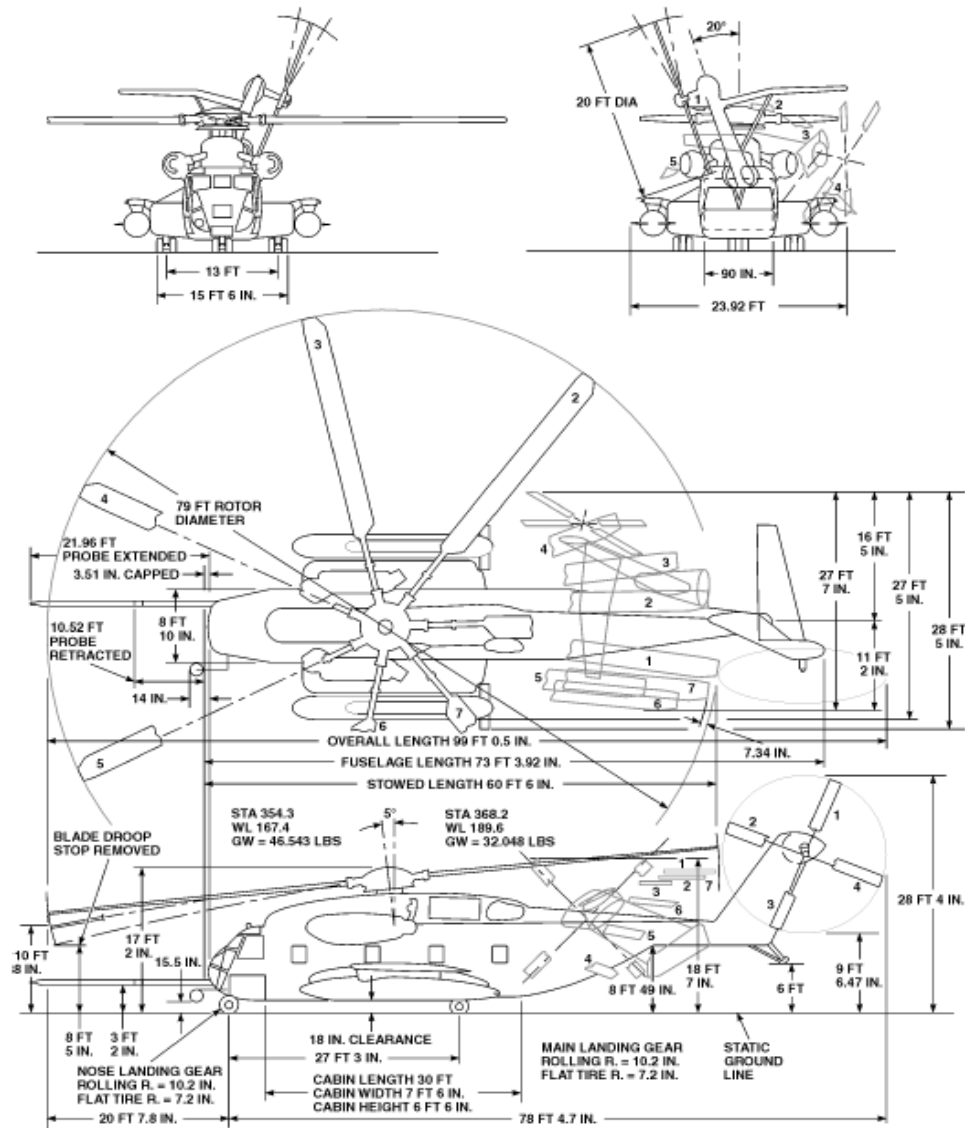


Figure 1. CH-53E Dimensions Diagram. Source: NAVAIR. (2017).

2. MH-53E

The USN exclusively uses the MH-53E Sea Dragon. “Its primary mission is Airborne Mine Countermeasures (AMCM), with a secondary mission of shipboard

delivery. Additional mission capabilities include air-to-air refueling, search and rescue, and external cargo transport operations, in both land and seaborne environments” (Pike, J., 1999). The MH-53E differentiates itself from the CH-53E by having an increased fuel capacity and internally mounted tow winch, which allows it to pull multiple minesweeping countermeasures systems. The USN currently has 28 MH-53E in their inventory.

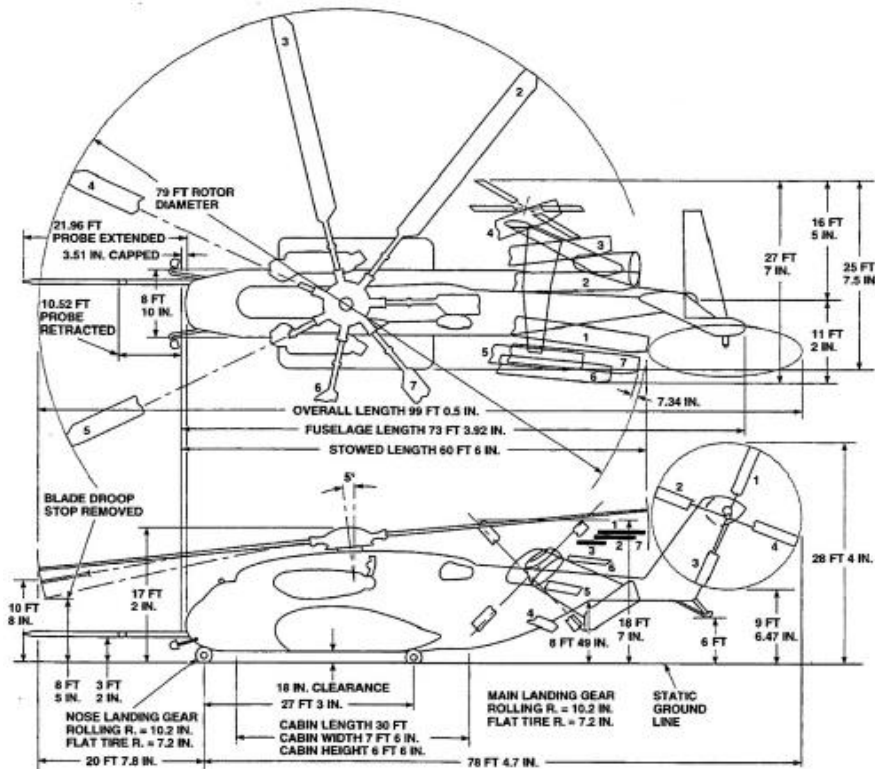


Figure 2. MH-53E Dimensions Diagram. Source: DoN (2014.)

B. NAVAL AVIATION MAINTENANCE PROGRAM

The Naval Aviation Maintenance Program is sponsored by the Chief of Naval Operations (CNO) and implemented by the Commander Naval Air Forces (COMNAVAIRFOR). The Commander Naval Air Forces Instruction (COMNAVAIRFORINST) 4790.2C sets the guidelines for the three level maintenance system the Navy and Marine Corps utilize as well as provide standardized performance metrics for aircraft and material readiness. It provides the management tools required for efficient and economical use of personnel and material resources in performing

maintenance. The NAMP also provides the basis for establishing standard organizations, procedures, and responsibilities for the accomplishment of all maintenance on naval aircraft, associated material, and equipment (DoN, 2017c).

1. Three Levels of Maintenance

The NAMP is focused on a three-tier maintenance concept with each level of maintenance providing different levels of repair. The division of maintenance into three levels allows management to do the following, as described in the NAMP:

- Classify maintenance functions by levels.
- Assign responsibility for maintenance functions to a specific level.
- Assign maintenance tasks consistent with the complexity, depth, scope, and range of work performed.
- Accomplish any particular maintenance task or support service at a level that ensures optimum economic use of resources.
- Collect, analyze, and use data to assist all levels of NAMP management.
(DoN, 2003)

a. Organizational-Level Maintenance

Organization-level maintenance, often referred to as “O-Level” maintenance, is the lowest level of maintenance. This level of maintenance is the day-to-day wrench turning composed scheduled and unscheduled maintenance, as well as servicing and inspecting the aircraft.

Unlike the subsequent two levels of maintenance, the maintainers at an O-Level activity must actively fix aircraft in order to meet the units’ daily flight schedule. Unscheduled maintenance is performed when aircraft break due to unforeseen material reliability issues. Scheduled maintenance is performed for preventative measures. The focus of maintenance at the organizational level is maintaining full mission capable aircraft and equipment in order to complete the unit’s mission.

b. Intermediate-Level Maintenance

Intermediate-level maintenance, often referred to as “I-Level” maintenance, is performed at the Marine Aviation Logistics Squadrons (MALS) in the USMC and Aircraft Intermediate Maintenance Department (AIMD) in the USN. The intermediate-level of maintenance is not focused on completing a flight schedule like the organization-level but rather ensuring the organizational- level has enough RFI components to meet their mission requirements. In both the Navy and the Marine Corps, the intermediate level of maintenance performs more in depth repair of aircraft structures, systems, and support equipment than the O-Level is capable. I-Level repair facilities have more in depth tooling and specialized equipment, which allow for higher-level repairs to be performed.

c. Depot-Level Maintenance

Depot-Level maintenance, often referred to as “D-Level” maintenance, is the highest level of Naval Aviation Maintenance that performs the most in depth overhaul of both aircraft and aircraft materials. This maintenance is performed at Naval Aviation Industrial Facilities that rely on highly skilled non-military workers to complete maintenance actions that are not possible anywhere else. According to DoDD 4151.18, Depot level maintenance is “materiel maintenance requiring major overhaul or a complete rebuilding of parts, assemblies, subassemblies, and end items, including the manufacture of parts, modifications, testing, and reclamation as required. Depot maintenance serves to support lower categories of maintenance by providing technical assistance and performing that maintenance beyond their responsibility. Depot maintenance provides stocks of serviceable equipment because it has available more extensive facilities for repair than are available in lower maintenance activities” (Department of Defense [DoD], 2004).

C. LOGISTICS SUPPORT STRUCTURE

There are multiple organizations involved with providing material support for repair and overhaul of the Main Rotor Head during depot-level overhaul. This section will describe the organizations and how they play a key role in supporting Naval Aviation. This is not considered an overall guide to the supportability of aviation materials and equipment but rather a synopsis of the key entities involved in this particular project. The emphasis

will be specifically as to how they interact with one another and what they are currently doing to meet requirements of the warfighter.

1. NAVSUP WEAPONS SYSTEMS SUPPORT

The mission of Naval Supply Systems Command (NAVSUP) Weapons Systems Support (WSS) is to “provide Navy and Marine Corps forces with supply support for the weapons systems that keep our naval forces mission ready” (A History, 2018). NAVSUP WSS owns all major repairable components, to include the MRH, used on Navy and Marine Corps aircraft. It is their responsibility to ensure repairable components in their custody are in a material condition that promotes a healthy supply posture.

NAVSUP WSS structures their organization into separate Integrated Weapon Support Teams (IWST) which are each responsible for the management of a weapons system. These IWST are composed of a diverse group of individuals that specialize in the various aspects of supporting a weapons system through the different stages of the logistics life cycle providing contract and supply support. The IWST responsible for management of the H-53E uses demand signals from Naval Supply databases to create material forecasts, which support Fleet requirements. These forecasts are used as a basis of ordering repair materials to support the H-53E, to include MRH overhaul at Fleet Response Center East (FRC-E).

2. DEFENSE LOGISTICS AGENCY

DLA receives stores, maintains, and distributes materials to all branches of the armed services with their primary aviation distribution point being located in Richmond, Virginia. NAVSUP WSS relies on DLA Richmond to fulfill their material requirements through securing contracts with private industry. When DLA receives a requirement from NAVSUP WSS, they identify a vendor to fulfill the requirement, manage the contract, receive the product, and distribute it to the required location. Like NAVSUP WSS, DLA breaks their support structure into teams that support specific weapon systems. These teams are responsible for ensuring the material requirements NAVSUP WSS funds make it to the end user in a timely and efficient manner.

3. REWORK FACILITIES

Fleet Readiness Center East, a Naval Aviation Industrial Facility, is located aboard Marine Corps Air Station (MCAS) Cherry Point, North Carolina and serves a critical role in the sustainment of the H-53E. Commanded by a Marine Corps Colonel, it is the largest aviation repair depot on the East coast. FRC-E is the primary overhaul point for all H-53E components in the country. According to the FRC-E Bill of Materials, the current cost to overhaul a MRH at FRC-E is \$1,354,163. At full production capacity with no material shortages, FRC-E is able to produce 24 MRH per year.

Sikorsky Aircraft Corporation, the Original Equipment Manufacturer (OEM) for the H-53E, is the second source of MRH overhaul. NAVSUP WSS contracts SAC to supplement FRC-E's Main Rotor Head production. SAC charges a premium to produce these MRH; however, they are able to do so due to their easy access to materials through their sub-contractors and in house supply resources. The current cost to overhaul a MRH at SAC is \$2,995,000 per unit. At full production capacity, SAC can produce 36 MRH per year.

4. TYPE COMMANDER

“The aircraft Type Commander (TYCOM) is responsible for the maintenance and material condition of the aircraft and equipment assigned to their custody” (Marine Corps Combat Development Command [MCCDC], 2016. According to Marine Corps Warfighting Publication 3-21.2, TYCOM coordinates logistics support for support equipment and aircraft within their respective control to include Aircraft Life Management (ALM) plans and depot rework schedules (MCCDC, 2016). The TYCOM stays up to date on pressing logistics matters related to material readiness in order to ensure their aircraft are supported to a level that meets mission requirements.

The H-53E's material readiness issue has grown to the point that it now requires TYCOM attention. Currently, the H-53E TYCOM is being forced to individually track and manage the on-wing service life extensions of MRH's in order to satisfy mission requirements. MRH are not removed from an aircraft in the Navy or Marine Corps without prior approval. By requesting engineering approvals to leave MRH on aircraft for longer periods of time the TYCOM has been able to keep the Fleet from having to take aircraft

out of service due to lack of MRH. Four separate life extensions can be granted at this time, which extends the on wing life span of the MRH from 1400 to 1960 hours (DoN, 2013).

D. MAIN ROTOR HEAD

The H-53E's Main Rotor Head, which is the focus of this research, is composed of over four hundred different piece parts, which work in harmony to manipulate the helicopters flight control surfaces in order to produce lift and perpetuate stable flight. In addition to enabling controlled flight, the main rotor head provides the H-53E the capability of folding its blades down the length of the fuselage. This characteristic allows the helicopter to be stored on amphibious platforms.

Due to its criticality, the MRH is a life-limited component that requires it to be removed from the aircraft at the Organizational Level after 1400 hours of service to undergo Depot Level Overhaul. Due to the age of the H-53E airframe, no new Main Rotor Heads are being produced and entering service. Rather, all current in service rotor heads and spares receive rework multiple times. All major overhauls on H-53E Main Rotor Heads are performed at Fleet Readiness Center East (FRC-E) or Sikorsky Aircraft Corporation (SAC). During overhaul, life limited components are screened, inspected, and replaced as needed. All consumable items on the Main Rotor Head also are replaced during overhaul. At the completion of Depot overhaul, a MRH is considered to have zero hours and be a new product.

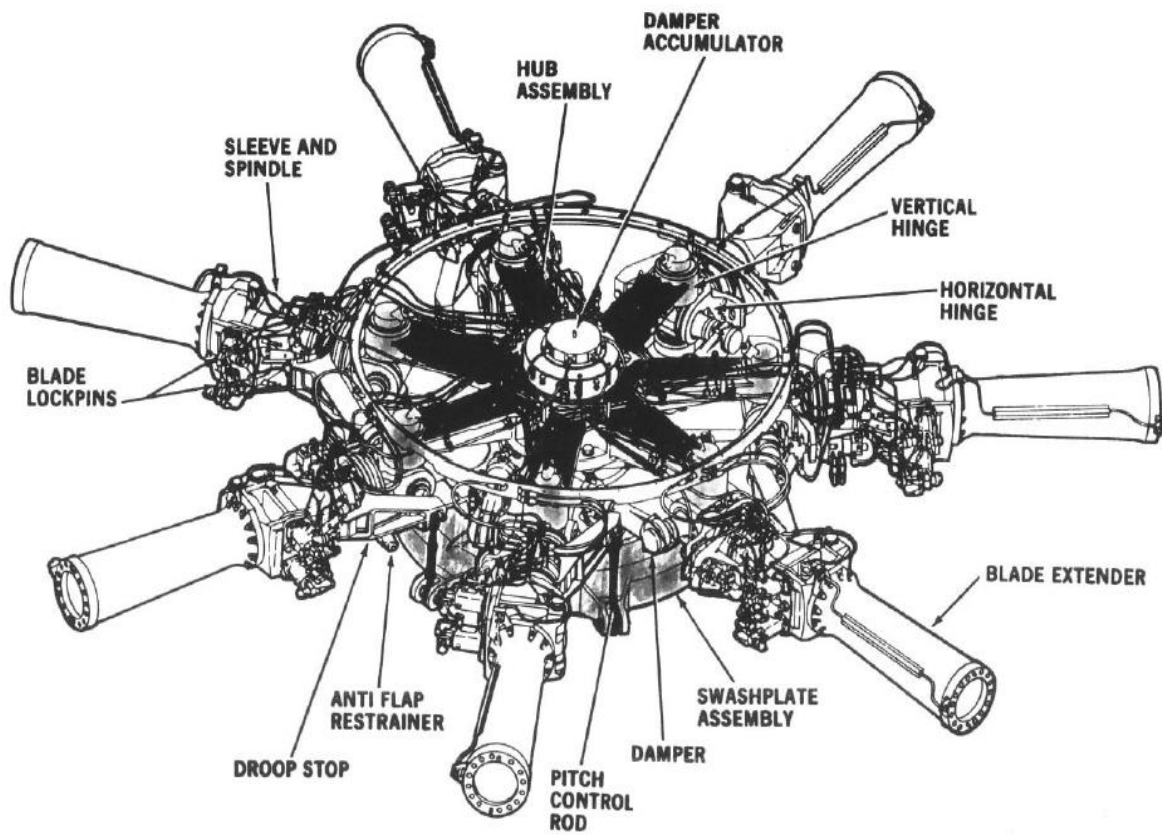


Figure 3. Main Rotor Head and Components. Source: DoN (2017b).

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III. LITERATURE REVIEW

This chapter contains a literary review of the current DoD Logistics Strategic Plan (LSP) as well as policies and guidance concerning Performance Based Logistics (PBL) and achieving affordable readiness. The material below provides insight into the expectations of higher-level leadership, current DOD policy, and planning documents. This will serve as a foundation and guide to developing a three phased logistics plan for Main Rotor Head sustainment.

A. DEPARTMENT OF DEFENSE LOGISTICS STRATEGIC PLAN

According to the DoD (2009), “the mission of logistics within the DOD is to provide globally responsive, operationally precise, and cost effective joint logistics support for the projection and sustainment of America’s warfighters” (p.4). In 2006, the DOD initiated efforts to re-evaluate how logistics was being performed and reshape the way we support our warfighting priorities. This becomes especially relevant when working with complex systems that are constantly evolving such as the aircraft and equipment managed by NAVAIR. The push for addressing shortfalls in defense acquisition programs and capabilities led to the publishing of the Fiscal Year 2009 Department of Defense Strategic Management Plan (SMP). Within the plan, two business priorities were identified.

- Business Priority: Support Contingency Business Operations
 - Defense business operations must provide adaptable, responsive, effective support to the warfighter. Accordingly, the goals and measures listed here apply lessons learned on the battlefield and adapt industry best practices to enhance the support to the deployed warfighter and to provide necessary flexibility to address new, future challenges. (DoD, 2009, p.4)
- Business Priority: Reform the DOD Acquisition and Support Process
 - Streamlined, focused acquisition and support processes result in more rapid delivery of capability and can generate savings for re-investment into the Defense enterprise. Accordingly, the goals and measures associated with the acquisition process focus on eliminating waste in the procurement process and improving underlying business processes and efficiencies for logistics, real

property management, and industrial base management. (DoD, 2009, p.4)

These two business priorities laid the framework for which the LSP is based; supporting contingency operations and reforming acquisition support processes.

The LSP was first published in 2010 in order to further establish logistics goals that were outlined in the 2010 Quadrennial Defense Review (QDR) and SMP. The LSP was created as a living document to which annual updates will ensure the DOD's logistics strategy stays abreast current events and changes in global posture. The LSP provides a method of sharing guidance, best business practices, strategy, and promoting emerging ideas that will prove to create efficiencies within DOD logistics. Each year the LSP is updated with goals that are aligned to the SMP as well as success indicators. These goals and indicators can be used by logisticians to ensure they are keeping their efforts in line with key DOD initiatives. Current goals found in the LSP are summarized below.

- Provide logistics support in accordance with warfighters requirements.
 - Achieving success means the combatant commander's freedom of movement and action is enabled by logistics support rather than constrained. The warfighter has what they need when they need it. Commanders must be provided the visibility of their logistics resources in order to incorporate the tools and resources they need into strategic planning and execution.
- Institutionalize operational contract support.
 - Operational Contract Support (OCS) success means solutions to commander's problems are resolved by contract personnel who deploy with military forces and accepted as the standard. These solutions will be responsive and in accordance with DOD policy.
- Ensure supportability, maintainability, and costs are considered throughout the acquisition life cycle.
 - Ensuring a weapons system or programs success is dependent on enforcing life cycle management principles throughout the acquisition life cycle. Management principles should be used as key decision factors to life cycle sustainment decisions.
- Improve supply chain processes by adopting challenging but achievable standards for each element of the supply chain.

- Simply put, the logistics support structure will achieve success when warfighter assets make it from source of supply to end user in an efficient and effective manner. (DoD, 2010)

There is value in adopting some of the strategies detailed in the LSP and applying them to the case of the H-53E Main Rotor Head. Taking a careful look at supply chain processes and material delivery schedules should provide an avenue for increasing material availability. With the requirement to operate the H-53E until the year 2032, ensuring an affordable and effective supply chain management plan is in place will prove key to successfully completing life cycle sustainment. This includes exploring the use of contract personnel and support to alleviate some of the pressure placed on Depot Level repair facilities. In summary, the LSP is a guidebook that all persons involved with logistics actions within the DOD should familiarize themselves with and review on a regular basis. The goals and guidance established in the LSP, if followed, will enable our commanders and warfighters to maintain the strategic and tactical edge in global conflict.

B. BETTER BUYING POWER

Launching in 2010 along with the LSP, the Better Buying Power (BBP) initiative was created by the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics to promote the use of best practices in DOD acquisitions. “The purpose of BBP is to restore affordability in defense procurement and improve defense industry productivity” (Kendall, F., 2015). Since the introduction of BBP 1.0 in 2010, the initiative has continued to evolve; just as the defense acquisition environment has, progressing into the current BBP 3.0 that was introduced in April 2015. According to BBP 3.0 (2015), it is organized into seven focus areas, which include the following:

- Achieving Affordable Programs
 - This is a pillar of the BBP initiative that strives to promote affordability of weapons systems throughout the acquisition life cycle. By incorporating policies into the Department of Defense Instruction (DoDI) 5000.2 on affordability caps, leadership has been able to ensure programs have long-term affordability in both production and sustainment before they are ever initiated. Due diligence at the appropriate stages of the acquisition life cycle produce long-term benefits over the duration of a program.

- Achieving Dominant Capabilities While Controlling Life Cycle Costs
 - BBP 3.0 shows a strong shift to the concern that our nations technological superiority is at risk more now than ever before. This tenant places emphasis that managers should key in on “should cost” strategies as well as being mindful of threats and risks to their programs. Incorporating and planning for cyber security throughout the product life cycle decreases overall program risk.
- Incentivizing Productivity and Innovation in Industry and Government
 - Encouraging the use of Performance Based Logistics (PBL) contracts and incentivizing industry to align their performance with the goals of the customer will in turn provide all parties with an increased return on investment. With functional incentive-based contracts in place, the contractor is able to create more profit, the government gets timely delivery of a quality product, and the warfighter receives the capability they need to accomplish the mission.
- Eliminating Unproductive Processes and Bureaucracy
 - BBP seeks to eliminate unnecessary processes, requirements, and policy that create inefficiencies in the acquisition life cycle. By actively seeking out these inefficiencies and providing corrective actions acquisition professionals are able to save time and reduce waste which leads to lower costs.
- Promoting Effective Competition
 - The DOD strives to promote competition as it controls cost and fuels innovation. This includes incorporating small business and products from the global stage to fill key requirements.
- Improving Tradecraft in Acquisition of Services
 - The DOD is using services contracting to supplement the military and government workforce now more than ever before. Over 50% of the DOD acquisition budget is allocated towards service contracts which requires those involved to continue proactive management in order to ensure we are getting the most for our money. Strengthening our processes with detailed requirements and holding managers accountable for their mission will be key in increasing future return on investment.
- Improving the Professionalism of the Total Acquisition Workforce

- Strengthening the work force through more robust training requirements for both military and civilian employees will reap results in the future. Leadership wants to ensure that the acquisition work force is skilled, competent, and capable of understand and adapting to the ever changing requirements of DOD acquisitions. (Kendall, F., 2015)

The use of BBP to guide acquisition and life cycle sustainment processes is standard practice at NAVAIR. There is no one solution set that will fit all defense acquisition processes so each situation must be evaluated and assessed in its own right. PMA-261 has institutionalized the use of BBP to help guide logistics management decisions that makes it imperative the tenants of BBP are considered in the sustainment strategy for the MRH. There should be value in exploring current inefficiencies in the contracting process as well of the use of PBLs. In the case of our current material backlog, incentivizing industry to deliver materials in a more expeditious manner would help increase depot level production. The importance of incorporating BBP fundamentals into everyday decisions will prove to enhance material readiness in other program areas, specifically in the use of PBL to reach material readiness requirements.

C. PERFORMANCE-BASED LOGISTICS

The Main Rotor Head and its associated components are currently being sustained using the DOD's traditional approach to weapons system support. This approach has proven difficult to manage and has placed a burden on aircraft readiness. Successful material delivery currently relies on three key stakeholders, NAVSUP WSS, DLA, and FRC-E, to align their priorities to ensure the warfighters needs are met. This process requires a significant amount of management oversight and coordination between stakeholders. FRC-E must properly forecast material for NAVSUP WSS to fund the requirements through DLA. DLA must then put these requirements on contract and track the status to ensure industry is conforming to contract requirements. After successful material delivery, FRC-E must then manage production to a level that meets the customers demand while continuing to forecast for upcoming material requirements. This may not sound like a difficult process but it is important to remember that each one of these organizations is responsible for tens of thousands of line items and oversight can quickly

be lost. Each organization also grades their success based on a different set of performance metrics that do not directly align with satisfying the requirements of the warfighter. In order to provide a level of material readiness that meets the warfighters requirements over the remainder of the H-53E's acquisition life cycle new avenues of support must be explored.

The Defense Acquisition Guidebook (2013) defines Performance Based Logistics, or Performance Based Life Cycle Support, as “the purchase of support as an integrated, affordable, performance package designed to optimize system readiness and meet performance goals for a weapon system through long-term support arrangements with clear lines of authority and responsibility. Application of Performance Based Logistics may be at the system, subsystem, or major assembly level depending on program unique circumstances and appropriate business case analysis” (DoD, 2013).

The objective of PBL from the DOD standpoint is to buy an overall outcome, which satisfies the warfighters requirements. “The inherent incentive for the supplier is that if they can make equipment more reliable so that it spends less time at the shop for repairs, their costs will go down and their profit margin will increase. The military has already seen a rise in readiness rates for equipment under these types of contracts,” (Grahm L., 2013) said Navy Capt. John Spicer, who oversees DLA's PBL Program Office.

According to the Secretary of the Navy Instruction (SECNAVINST) 5000.2E (2008), Performance Based Logistics is the preferred support strategy for providing effective long-term logistics support of DOD weapon systems (DoN, 2008). One of the most successful DOD PBL contracts was implemented in 2002 to provide supply support for Auxiliary Power Units (APU) in various fixed wing naval aircraft. “Over the course of a decade Honeywell International produced solid levels of material availability hovering near 97 percent and on time delivery at 99 percent to support aircraft readiness” (Kovack, 2012). Applying the lessons learned from the Honeywell APU contract to a Sikorsky MRH contract could help to reduce material backlog.

Another successful PBL contract within Naval Aviation is the Tip to Tail program being utilized by the H-60. “PMA-299 put a contract in place with Maritime Helicopter Support Company, composed of the H-60 OEM, SAC, and Lockheed Martin, to sustain

over 1200 parts used by the H-60. This contract is fixed price plus incentive fee. The fixed price is per flight hour of the aircraft, not per part. The incentive fee is based on delivering requisitions on time. This fixed price per flight hour structure creates the incentive for the support provider to lower its costs through improving the effectiveness of the support system, and lowering demand for parts” (Hatnick, 2012). This contract has proven to be so successful that it has been renewed and over doubled in size since its inception.

Since 2005, NAVSUP WSS has held a PBL contract, N00383-16-D-003F, with Sikorsky which supports the material availability of various H-53E aircraft components, excluding the MRH. Within this contract, key H-53E stakeholders defined critical National Item Identification Numbers (NIIN) that Sikorsky is now responsible for managing. NAVSUP WSS along with PMA-261 and FRC-E have a bi-weekly conference call to monitor the contract with Sikorsky representatives. Under the terms of the contract, Sikorsky is able to source parts from DLA as well as utilize their own supply chain to meet material demand. Under the provisions of 10 USC 2466, Depot Work Split, Sikorsky is required to sub-contract FRC-E for half of their total production. This spreads the workload and ensures the depot maintains their ability to be a second source of supply for the associated line items (Limitations on the Performance, 2006). Over the past decade, NIINs on this contract have shown an increase in material availability, reliability, and reduced obsolescence issues for the H-53E platform.

PBL contract in place with Sikorsky is under review and due to be renewed through a Phase II contract in FY17. There is currently Justification and Approval for sole source competition in place with Sikorsky due to their being uniquely qualified to produce products for the H-53E as the OEM. Based on previous success the H-53E has had with the SAC PBL contract, the addition of the MRH to a future phase of the existing PBL contract may serve as a long-term solution to the current material availability shortage.

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IV. RESULTS AND ANALYSIS

Chapter IV will discuss the data analysis conducted during this project. Since the Naval Supply System is in a constant state of flux, only conducting data analysis at one specific point of time would not provide benefit to creating a sustainment strategy. Using multiple supply and logistics analysis tools, the author was able to study historical as well as current supply data. In doing so, he was able to validate his assumptions as well as discover new items of interest. Throughout the analysis process, secondary research questions were reviewed to keep actions on track

A. SERVICE LIFE EXTENSIONS

The author wanted to begin analysis by grasping what effect the material availability of the MRH was having on aircraft readiness. PMA-261 began a MRH service life-extension program due to the fact the supply system was full of backorders for MRHs. Service life extensions are granted in 140-hour increments starting at 1400 hours with a maximum head time of 1960 hours. These extensions are being granted via engineering authority and are only in place because the supply system does not have Ready for Issue Main Rotor Heads to replace the ones currently in use. They are granted on a case-by-case basis and are not the preferred method of aircraft sustainment. Service Life Extensions are simply a short-term fix to a systemic issue. Without these extensions, the current supply posture would result in the grounding of aircraft due to lack of serviceable Main Rotor Heads.

Using the H-53E Fatigue Life Tracking System, the author was able to get visual representation of exactly how fast service life extensions have grown over the past three years. In November of 2012, before MRH material availability became a severe issue for the H-53E community, only five aircraft were under MRH service life extensions. This number grew exponentially from November 2012 with service life extensions affecting 35 aircraft in October 2014. (Figure 4)

What is even more alarming is that this number does not take into account the aircraft that are coming due for extensions in the near future. By calculating the aircraft

utilization rate for the H-53E community, it is possible to project how many aircraft are within 10%, or 140 hours, of their first service life extension. The aircraft utilization rate is taken by averaging monthly flight hours over a 24-month period. For the H-53E community this is currently 19.4 hours per month. At the time this data was analyzed, 13 additional aircraft were within the 140-hour window of their first service life. (Figure 5)

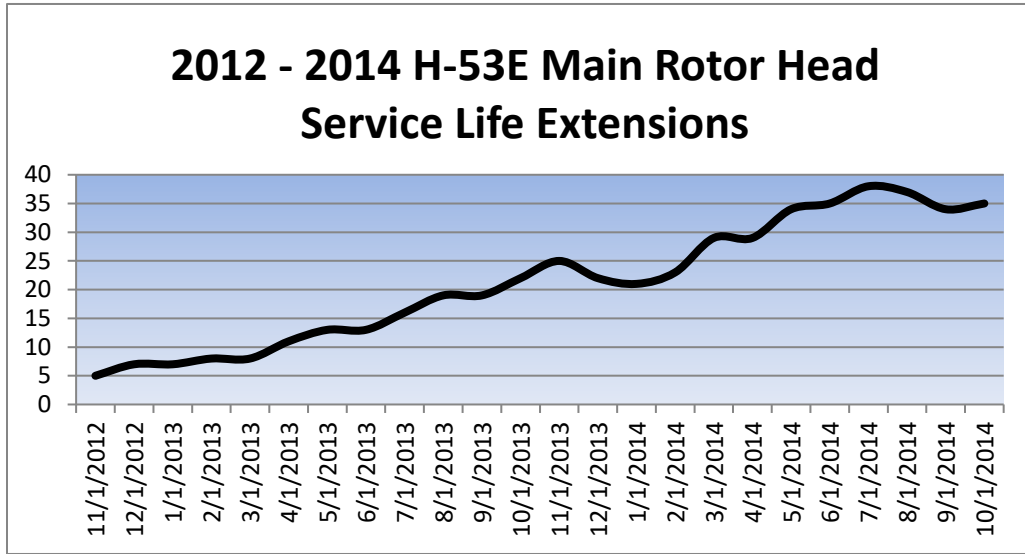


Figure 4. H-53E Main Rotor Heads under Service Life Extensions 2012-2014

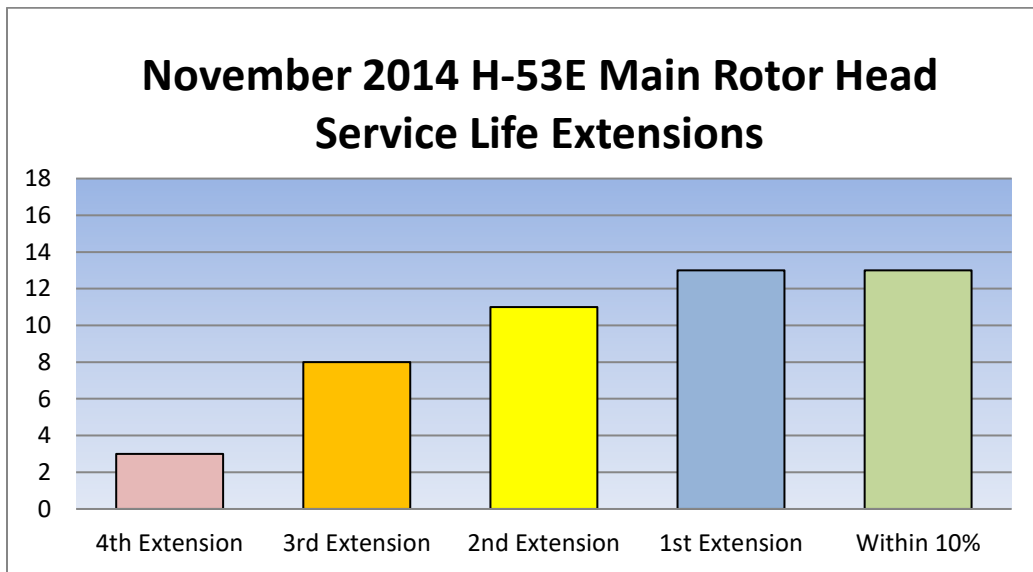


Figure 5. November 2014 H-53E Main Rotor Head Service Life Extensions

Of the 177 H-53Es in the Navy and Marine Corps inventory, 48 of these aircraft are currently affected by service life extensions. These extensions are presently masking the readiness problem and will only serve as a short-term fix. Operational tempo among Navy and Marine Corps Squadrons has not subsided as the Fleet continues to sustain operational training at home and support contingency operations abroad. By using the current utilization rate to forecast when aircraft will run out of extension time, future forced removals can be forecasted.

B. PRODUCTION VERSUS DEMAND

The only way to combat service life extensions is by increasing material availability to support increased depot level production. Neither FRC-E nor SAC are currently operating at full capacity due to lack of materials. The FY15 FRC-E and SAC MRH production schedule is as depicted in Table 1. Table 2 depicts each rework facilities maximum production capacity if they were not constrained by material shortages or other unforeseen events.

Table 1. Scheduled FY15 MRH Production by Overhaul Facility

ASSY	NIIN	Location	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
MRH	012643928	FRC-E	5	4	4	4	17
		SAC	5	4	4	4	17

Table 2. Production Capacity Given no Material Constraints by Overhaul Facility

ASSY	NIIN	Location	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
MRH	012643928	FRC-E	6	6	6	6	24
		SAC	9	9	9	9	36

After understanding FY15 scheduled production, the author then calculated the actual Delta between fleet demand and scheduled production. This was accomplished by

utilizing the Fatigue Life Tracking System as well as ILSMS to forecast how many service life extensions would be required in 2015. The resulting fleet demand for FY15 was 60 MRH, a number that would increase MRH backorders for FY16 by 26. What was alarming about this Delta was that FRC-E bases their material requirements forecast off the fiscal year MRH production schedule. FRC-E was not scheduling enough yearly production to begin placing a pull signal on the supply system for adequate material delivery. This means that the amount of material that DLA was contracting to purchase for FRC-E was grossly inadequate.

C. MATERIAL BACKORDER

After understanding the range and depth of service life extensions as well as actual demand for MRHs, the author wanted to gather data on current material backorders. To do this he used the CH/MH-53E Periodic Maintenance Information Cards (PMIC) deck to break down the Main Rotor Head by Scheduled Removal Components (SRC) which are those components having hourly life limits. He also got a list of all consumable components on the MRH from FRC-E's Bill of Materials. Using the spreadsheet in Appendix A, the author was able to begin gathering real time supply data from NAVSUP WSS in order to aid in forecasting material requirements. The author's goal in this research was to gather enough data that he could validate FRC-E's material forecast against the actual material demand. What he found was that 72 line items, highlighted yellow in Appendix A, required for the overhaul of MRH's were not supported by the current material forecast. After making modifications to this forecast to support a 50% increase in the current production schedule He provided it to FRC-E's Planning and Estimator for review.

Working off this updated forecast, FRC-E worked with NAVSUP WSS and DLA to allocate addition funds to in order to support the increased material requirements. The H-53E Weapons System Program Manager at DLA Richmond also compiled a list of the top 15 material degraders. These materials are listed in Appendix B.

V. CONCLUSION, RECOMMENDATIONS, AND SUMMARY

Sustainment of an aging weapons system such as the H-53E is a very challenging process, however not without its necessity. For PMA-261 to ensure material requirements are met along with the needs of the warfighter it is imperative that leadership continually evaluates the effectiveness of their life cycle sustain plan. Based on the research and analysis conducted during the course of this project it is the author's recommendation that PMA-261 actively pursues placing the Main Rotor Head on a Performance Based Logistics contract with Sikorsky Aircraft Corporation. This section will detail short- and mid-term strategies that will increase material availability until a final long-term solution can be put in place.

A. SHORT-TERM SUSTAINMENT STRATEGY

The practice of granting service life extensions has been masking the true scope of the material readiness problem from leadership as well as supply planners. Taking immediate actions to correct material deficiencies will show dividends in the out years as the H-53E continues to age. The short-term sustainment strategy for the MRH focuses on actions that can be performed within the next year, which will start to effectively reduce the number of MRHs currently under engineering extensions. These strategies should prove to develop a solid base on which a proactive, rather than reactive, long-term logistics sustainment strategy can be built.

1. Communications Strategy

Shortly after this research began, a communications drumbeat was established between PMA-261, NAVSUP WSS, DLA, FRC-E and the TYCOM. This drumbeat consists of monthly teleconferences to review and update contract statuses as well as track material readiness. The H-53E Deputy Program Manager for Logistics at PMA-261 serves as the chair to lead these meetings. In addition to these monthly calls, it was important to stress the importance of fixing this material readiness issue to senior leadership. DLA Richmond is currently hosting quarterly MRH Summits in order to facilitate management oversight and review of the issue at the O5/O6 level. It is recommended that these meetings

continue to be held with top-level management to ensure proper oversight until the MRH is determined to be at a healthy level of material readiness.

2. Review Forecasted Materials

During the course of this research effort, FRC-E's material forecast was updated to ensure adequate lead time is in place to acquire materials in support of MRH production at both FRC-E and SAC. It is recommended that this forecast as well as the Bill of Materials continue to be screened for accuracy on a bi-monthly basis to ensure accuracy. The results of these updates to this forecast, as well as problem NIINs, should be shared in the monthly teleconference and MRH Summits.

3. DLA Emergency Buy

It is recommended that NAVSUP WSS place FRC-E's top 15 material degraders on emergency buy in order to spur an immediate production increase. These materials as well as their current supply status are listed in Appendix B.

B. MID-TERM SUSTAINMENT STRATEGY

Facilitating a contract that places the MRH on PBL will not happen until FY17 even if SAC and NAVSUP WSS quickly work through the required process and agree to mutually beneficial terms. It is my recommendation that in the interim, PMA-261 leadership ensure the following:

- NAVSUP WSS lays out funding for the level of material required to begin operating both FRC-E and SAC at capacity.
- Continue use of the Fatigue Life Tracking System to aid in creating accurate forecasts of requirements versus production scheduling.
- Conduct addition research into improving efficiencies through the use of lean and six sigma during depot level overhaul in order to reduce MRH turn-around time.

- Continue the use of strategies already in place that have a positive effect on increasing material readiness. These include a drumbeat call to ensure communication between stakeholders and accurate material forecasting.

C. LONG-TERM SUSTAINMENT STRATEGY

PBL contracts have a proven record of accomplishment within the DOD of addressing weapons systems supply deficiencies on a subsystems level. NAVAIR has seen success across many platforms after initiating performance based contracts to include the H-53E. With current MRH overhaul practices not satisfying the needs of the war fighter, it is imperative that other options be pursued. The authors' research indicates that adding the MRH to the already existing PBL contract with SAC will serve to reduce MRH material backlog by incentivizing the prime contractor to focus efforts on the MRH. This will in turn increase aircraft readiness.

1. Procurement Strategy

NAVSUP WSS along with PMA-261 should seek to award a MRH sustainment contract to the OEM, SAC, during negotiations of phase II, N00383-16-D-001, of the current PBL contract. Sole source justification is approved on the current PBL due to the fact SAC is imminently qualified, has subcontracts in place for piece parts, and maintains data rights. As with the existing PBL contract, SAC will continue to partner with FRC-E and renew a Commercial Services Agreement covering the depot work split requirement set forth in 10 U.S.C. §2466. FRC-E will continue to serve as a subcontractor for SAC.

2. Contracting Strategy

In order for a PBL to be successful, it must be beneficial to the government while giving industry benefit for reaching contract goals and requirements. The author's research on similar PBL contracts already in place within the DOD and NAVAIR leads him to believe that a cost plus incentive fee contract would be the best avenue of approach. The H-53E program should work with SAC to set realistic contract requirements that increase MRH material availability, decrease weapon system downtime, and increase logistics response time. Within the current contract, SAC is responsible for the following MRH

sustainment activities: “requisition processing, requirements forecasting, inventory management, depot repair in partnership with FRC-E, overhaul, modification, packaging, handling, storage, transportation, procurement of piece parts, material management, configuration and obsolescence management, and reliability or improvement.” (J&A No. 14244, 2015) As in the Tip to Tail contract with the H-60, the fixed price should be based on H-53E flight hours and the incentive fee based on delivery requisition time. SAC’s goal and will be on time MRH delivery to operational level squadrons. They will be evaluated on the total time it takes from the moment an operational level squadron enters a requisition into the supply system until requisition fulfillment. This will in turn increase aircraft availability.

3. Metrics

Using the single performance metric of Supply Response Time has proven successful in the H-60 Tip to Tail contract and the author believes it would serve the H-53E MRH PBL as well. Supply Response Time is the time it takes from the moment a requisition is entered into the system by an organizational level squadron until the asset is delivered. NAVSUP WSS and SAC will have to settle on an acceptable response time for a 100% fulfillment requirement. This metric will need to address current backorders as well as an acceptable response time once the MRH is a healthy asset. If SAC is able to meet a negotiated Supply Response Time for the contract period then they will receive their incentive.

D. SUMMARY

This Joint Applied Project examined the current state of material readiness for the United States Navy and Marine Corps H-53E Heavy Lift Helicopter with a focus on the Main Rotor Head. The project analyzed current methods of logistics sustainment in use by the DoD as well as researched best practices and policy. As a result of this project, the Navy and Marine Corps will have a better understanding of the impact the Main Rotor Head is having on flight line readiness as well as a framework for building a long term sustainment strategy which can be applied to address material deficiency.

APPENDIX A. UPDATED MATERIAL FORECAST

FRC-E Main Rotor Hub Assembly Updated Forecast						
	NIN: 01-11300-050					
NIIN	Sum of Quantity Per Assy.	Sum of FY-14 Forecast (36 Inducts)	Monthly Forecast	Monthly Consumption Quantity	Delta	Stock On Hand
000040392	2	0	0	4.33	-4.33	668
000075407	2	0	0	76.86	-76.86	797
000119924	1	1.08	0.09	0.71	-0.62	12
000214057	1	4.68	0.39	0.95	-0.56	0
000273590	4	0	0	106.35	-106.35	3864
000444153	1	0	0	16.54	-16.54	1093
000578300	1	2.52	0.21	0.27	-0.06	11
001133757	1	0	0	63.02	-63.02	6395
001176947	3	0	0	74.77	-74.77	2715
001413009	2	0	0	169.83	-169.83	6313
001487616	2	72	6	9.35	-3.35	0
001499130	9	0	0	49.51	-49.51	6323
001815173	1	0	0	3.71	-3.71	141
001821853	2	2.16	0.18	146.86	-146.68	21928
001864945	1	0.36	0.03	98.15	-98.12	141
001981050	1	0	0	57.01	-57.01	778
002262490	1	0	0	1.71	-1.71	29
002419759	1	0	0	18.89	-18.89	79
002458826	1	0	0	252.53	-252.53	7515
002464353	2	0	0	16.96	-16.96	557
002717746	2	0	0	36.48	-36.48	102
002770119	2	2.16	0.18	40.67	-40.49	30293
002775084	2	0	0	153.50	-153.50	1753
002859842	1	0	0	46.61	-46.61	1617
003223816	1	0	0	0.00	0.00	4
003602002	1	9.36	0.78	1.00	-0.22	0
004219083	18	0	0	121.76	-121.76	1072
004278059	8	279.36	23.28	1.25	22.03	0
004552307	7	234.36	19.53	5.46	14.07	94
004713323	9	300.24	25.02	6.29	18.73	156

004774623	16	57.6	4.8	12.00	-7.20	256
004838452	18	600.48	50.04	15.28	34.76	0
005969678	3	0	0	5.87	-5.87	1078
005992934	1	0	0	865.43	-865.43	29825
006045131	1	5.76	0.48	1.93	-1.45	43
006305958	1	0	0	83.77	-83.77	4390
006843576	1	0	0	31.29	-31.29	483
007197480	1	0	0		0.00	
007200048	1	0	0	17.24	-17.24	195
007201586	1	0	0	20.55	-20.55	313
007215697	1	0	0	21.13	-21.13	485
007224969	1	0	0	21.94	-21.94	928
007525544	2	0	0	0.97	-0.97	263
007578943	1	0	0	0.67	-0.67	23
007578947	1	0	0	0.87	-0.87	28
007578949	1	0	0	0.80	-0.80	161
007592343	1	11.88	0.99	1.75	-0.76	13
007717406	2	0	0	3678.02	-3678.02	11614
007828886	1	0	0		0.00	
007898779	4	0	0	60.46	-60.46	2772
					-	
008052966	4	0	0	18696.42	18696.42	206437
008084467	1	0	0	7.37	-7.37	742
008224086	1	8.64	0.72	0.48	0.24	129
008289671	1	36	3	7.55	-4.55	0
008357712	1	0	0	286.36	-286.36	7266
008391901	28	403.2	33.6	811.46	-777.86	16232
008520800	12	0	0	40.10	-40.10	952
008580728	2	0	0	1.36	-1.36	21
008837706	1	0	0	78.59	-78.59	2760
009036714	2	5.04	0.42	0.72	-0.30	51
009157445	2	41.04	3.42	4.23	-0.81	0
009157450	2	72	6	7.94	-1.94	0
009215602	1	30.24	2.52	14.01	-11.49	165
009231063	1	2.52	0.21	0.92	-0.71	0
009231064	1	0	0	1.04	-1.04	23
009231080	1	2.52	0.21	0.50	-0.29	8
009237236	1	36	3	5.17	-2.17	226
009257506	2	19.44	1.62	3.24	-1.62	5
009259688	14	504	42	16.95	25.05	189

009271925	1	0.36	0.03	0.29	-0.26	0
009289135	1	0	0	0.13	-0.13	0
009303610	1	0	0	0.59	-0.59	20
009362174	1	0	0	93.98	-93.98	13
009389516	2	72	6	9.71	-3.71	0
009389542	14	0	0	0.83	-0.83	86
009390616	1	23.04	1.92	4.59	-2.67	0
009398584	1	36	3	0.13	2.88	45
009399232	1	0	0	159.64	-159.64	47433
009428113	6	70.56	5.88	11.91	-6.03	527
009432011	2	0	0	11.70	-11.70	475
009435177	1	11.88	0.99	1.67	-0.68	172
009435422	17	226.44	18.87	94.78	-75.91	0
009435425	16	420.48	35.04	45.77	-10.73	904
009442625	2	0	0	0.65	-0.65	47
009445490	1	16.92	1.41	3.10	-1.69	0
009445491	7	252	21	5.50	15.50	145
009461260	1	14.4	1.2	3.63	-2.43	238
009462819	1	36	3	10.29	-7.29	64
009462867	18	0	0	40.69	-40.69	585
009473390	1	36	3	9.07	-6.07	85
009473392	1	36	3	5.83	-2.83	0
009474206	12	135.36	11.28	19.43	-8.15	425
009476905	1	31.32	2.61	2.68	-0.07	0
009480364	4	0	0	53.92	-53.92	996
009493661	14	236.88	19.74	29.52	-9.78	221
009496110	2	16.56	1.38	0.96	0.42	0
009499052	1	36	3	6.48	-3.48	0
009556703	5	50.4	4.2	18.42	-14.22	119
009666579	2	5.04	0.42	0.55	-0.13	531
009667151	1	0.72	0.06	0.38	-0.32	10
009667158	1	0.72	0.06	0.79	-0.73	89
009748219	5	0	0	5.12	-5.12	22
009972573	14	504	42	101.76	-59.76	2572
009984532	1	2.52	0.21	0.63	-0.42	31
009984533	9	0	0	11.19	-11.19	0
010261877	1	0	0	557.89	-557.89	1174
010431419	2	0	0	670.46	-670.46	11644
010460628	18	0	0	698.20	-698.20	9895
010481448	2	0	0	1.38	-1.38	269

010746036	2	0	0	63.14	-63.14	2476
010761239	1	0	0	1.13	-1.13	40
010785719	1	0.36	0.03	6.33	-6.30	35
010885363	4	0	0	1174.25	-1174.25	25701
011001179	1	0	0	21.58	-21.58	100
011074956	1	0	0	195.96	-195.96	3858
011074961	16	0	0	612.28	-612.28	13092
011079311	4	38.88	3.24	0.50	2.74	50
011080827	1	2.52	0.21	1.35	-1.14	36
011140244	1	0	0	17.93	-17.93	897
011228003	1	0	0	17.71	-17.71	16
011232177	11	11.88	0.99	0.83	0.16	23
011233934	4	2.88	0.24	0.75	-0.51	4
011234663	14	403.2	33.6	3.17	30.43	0
011237097	28	0	0	5.07	-5.07	0
011237118	14	504	42	16.37	25.63	153
011238616	2	16.56	1.38	1.02	0.36	77
011239949	14	403.2	33.6	0.08	33.52	421
011240555	2	0	0	0.00	0.00	6
011240636	10	187.2	15.6	20.50	-4.90	856
011241425	14	403.2	33.6	7.10	26.50	374
011243397	2	0	0	0.00	0.00	12
011243398	4	1.44	0.12	0.60	-0.48	42
011243719	6	86.4	7.2	1.54	5.66	49
011243720	2	2.16	0.18	3.71	-3.53	139
011244475	2	0	0	0.03	-0.03	19
011244573	7	201.6	16.8	5.88	10.93	0
011245793	90	0	0	5.83	-5.83	390
011247712	8	0	0	15.95	-15.95	323
011250647	1	17.28	1.44	8.75	-7.31	0
011251231	4	33.12	2.76	2.67	0.09	228
011253162	2	0	0	0.02	-0.02	13
011254363	12	8.64	0.72	11.28	-10.56	116
011254641	1	27	2.25	7.71	-5.46	144
011255330	1	26.64	2.22	8.89	-6.67	0
011256251	7	201.6	16.8	4.55	12.25	0
011256252	7	201.6	16.8	8.37	8.43	20
011256310	18	6.48	0.54	3.28	-2.74	294
011256534	16	0	0	0.00	0.00	0
011256563	2	0	0	2.21	-2.21	239

011256906	9	0	0	16.31	-16.31	59
011256937	1	0	0	0.00	0.00	0
011256938	1	2.52	0.21	0.00	0.21	3
011256940	1	0	0	0.00	0.00	3
011256942	2	54	4.5	20.67	-16.17	0
011256943	7	219.24	18.27	7.15	11.12	0
011256944	7	252	21	3.79	17.21	244
011256945	14	246.96	20.58	9.09	11.49	0
011256946	1	0	0	0.00	0.00	7
011256947	14	403.2	33.6	11.43	22.17	0
011256948	1	4.68	0.39	0.10	0.29	14
011256949	14	403.2	33.6	10.65	22.95	89
011256950	14	403.2	33.6	0.00	33.60	0
011257129	1	0	0	4.58	-4.58	0
011257130	2	0	0	0.25	-0.25	0
011257347	1	0	0	0.13	-0.13	4
011259119	6	79.92	6.66	19.29	-12.63	37
011259133	1	0	0	0.00	0.00	0
011259136	1	36	3	0.92	2.08	0
011259139	11	11.88	0.99	1.50	-0.51	134
011259140	1	2.52	0.21	0.30	-0.09	10
011259143	1	36	3	6.40	-3.40	0
011259231	18	0	0	0.00	0.00	350
011265937	8	129.6	10.8	17.66	-6.86	0
011265940	18	32.4	2.7	1.92	0.78	50
011265998	1	7.2	0.6	9.08	-8.48	0
011266001	14	5.04	0.42	0.79	-0.37	48
011266040	7	252	21	33.15	-12.15	854
011266041	2	12.24	1.02	0.98	0.04	0
011266042	1	16.92	1.41	0.43	0.98	4
011266043	1	36	3	2.23	0.77	9
011266044	1	0	0	0.63	-0.63	0
011266045	14	267.12	22.26	78.16	-55.90	439
011266046	3	23.76	1.98	0.00	1.98	30
011266047	6	36.72	3.06	4.96	-1.90	111
011266048	7	45.36	3.78	8.37	-4.59	100
011266049	2	0	0	0.00	0.00	0
011266051	5	5.4	0.45	6.13	-5.68	121
011266053	6	79.92	6.66	14.44	-7.78	0
011266056	7	52.92	4.41	6.40	-1.99	60

011266057	2	1.44	0.12	13.33	-13.21	0
011266058	8	54.72	4.56	5.23	-0.67	53
011266060	24	250.56	20.88	19.91	0.97	0
011266061	1	0	0	0.00	0.00	7
011266062	36	90.72	7.56	18.64	-11.08	0
011266063	6	79.92	6.66	27.86	-21.20	0
011266064	8	17.28	1.44	0.42	1.02	9
011266066	6	79.92	6.66	17.29	-10.63	0
011266067	7	7.56	0.63	2.18	-1.55	0
011266070	1	0	0	0.00	0.00	20
011266071	5	5.4	0.45	1.38	-0.93	0
011266072	3	0	0	0.00	0.00	12
011266074	2	0	0	0.05	-0.05	12
011266075	11	7.92	0.66	0.00	0.66	2
011266078	1	0	0	0.07	-0.07	3
011266079	1	0	0	0.00	0.00	3
011266080	1	0	0	0.21	-0.21	3
011266084	2	0	0	0.00	0.00	2
011266085	2	0	0	0.04	-0.04	1
011266086	1	0	0	0.00	0.00	2
011266088	1	0	0	0.04	-0.04	26
011266090	1	0	0	0.06	-0.06	0
011266091	1	0	0	0.00	0.00	3
011266092	1	0	0	0.00	0.00	4
011266094	2	0	0	0.60	-0.60	18
011266095	10	7.2	0.6	1.71	-1.11	77
011266098	1	0	0	0.00	0.00	4
011266099	1	0	0	0.00	0.00	3
011266100	1	0	0	0.00	0.00	3
011266101	1	0	0	0.00	0.00	6
011266103	1	0	0	0.09	-0.09	8
011266114	1	0.72	0.06	0.50	-0.44	0
011266115	1	9.36	0.78	3.96	-3.18	155
011266116	1	0.36	0.03	2.83	-2.80	93
011266117	1	10.44	0.87	3.75	-2.88	0
011266119	1	8.64	0.72	2.85	-2.13	0
011266120	1	5.76	0.48	2.38	-1.90	0
011266121	6	2.16	0.18	3.20	-3.02	1
011266122	2	2.16	0.18	0.54	-0.36	0
011266234	2	14.4	1.2	1.10	0.10	35

011266235	1	16.92	1.41	0.44	0.97	11
011266246	3	14.04	1.17	1.98	-0.81	46
011269151	13	4.68	0.39	0.47	-0.08	21
011271808	2	0	0	5.29	-5.29	591
011273007	1	0	0	1.75	-1.75	180
011278165	1	1.08	0.09	0.42	-0.33	9
011291694	1	2.52	0.21	0.17	0.04	10
011293446	2	0	0	6.72	-6.72	0
011296794	6	0	0	1.02	-1.02	63
011298102	4	46.08	3.84	7.35	-3.51	0
011298192	1	0	0	0.68	-0.68	171
011298491	1	11.88	0.99	0.43	0.56	30
011303359	1	0.36	0.03	47.03	-47.00	2985
011310509	1	36	3	4.67	-1.67	0
011311862	1	0.36	0.03	11.08	-11.05	403
011312978	1	0	0	0.02	-0.02	12
011325854	2	0	0	3.92	-3.92	0
011351251	1	0	0	0.00	0.00	0
011351441	2	0.72	0.06	4.44	-4.38	10
011351442	2	15.84	1.32	16.28	-14.96	0
011351466	7	252	21	5.26	15.74	0
011351702	1	0	0	5.83	-5.83	0
011358775	4	144	12	138.22	-126.22	682
011361339	13	468	39	40.13	-1.13	222
011396842	4	0	0	0.29	-0.29	0
011397217	1	0	0	0.00	0.00	39
011402348	1	0	0	4.98	-4.98	119
011403689	5	0	0	7.47	-7.47	171
011403867	1	4.68	0.39	0.17	0.22	0
011404060	1	4.68	0.39	0.34	0.05	5
011404061	1	30.96	2.58	9.33	-6.75	11
011404190	1	0	0	0.00	0.00	7
011422082	2	72	6	39.14	-33.14	170
011431750	2	26.64	2.22	4.04	-1.82	95
011431770	8	279.36	23.28	5.82	17.46	20
011435328	7	252	21	9.27	11.73	0
011436559	16	0	0	20.12	-20.12	323
011437229	4	2.88	0.24	0.71	-0.47	7
011439702	7	98.28	8.19	5.02	3.17	0
011439767	10	115.2	9.6	24.14	-14.54	0

011439769	1	0	0	0.00	0.00	3
011439771	1	0	0	0.00	0.00	6
011439773	1	19.08	1.59	4.71	-3.12	0
011454184	10	3.6	0.3	0.70	-0.40	13
011455160	64	0	0	85.72	-85.72	1023
011455739	6	0	0	5.50	-5.50	250
011468158	7	252	21	76.99	-55.99	857
011468160	4	87.12	7.26	10.25	-2.99	92
011468166	7	110.88	9.24	22.27	-13.03	0
011468167	20	367.2	30.6	32.70	-2.10	302
011468173	7	73.08	6.09	19.42	-13.33	267
011468404	1	11.88	0.99	0.64	0.35	22
011472623	1	21.6	1.8	1.53	0.27	0
011474662	1	2.52	0.21	0.10	0.11	0
011474682	8	167.4	13.95	14.02	-0.07	33
011476261	1	4.32	0.36	0.61	-0.25	0
011486311	2	53.28	4.44	6.00	-1.56	188
011487310	7	252	21	36.19	-15.19	87
011510639	5	94.68	7.89	6.71	1.19	0
011520610	8	0	0	41.42	-41.42	144
011529938	7	252	21	1.83	19.17	0
011530732	2	9.36	0.78	1.17	-0.39	0
011542628	2	5.04	0.42	6.25	-5.83	323
011542958	1	11.88	0.99	0.30	0.69	14
011545812	8	8.64	0.72	1.21	-0.49	50
011594743	3	74.52	6.21	12.06	-5.85	0
011624706	9	0	0	78.71	-78.71	5155
011657468	1	0	0	0.00	0.00	2
011702437	3	0	0	1.17	-1.17	57
011702438	12	0	0	2.54	-2.54	53
011702439	8	0	0	0.38	-0.38	51
011710630	17	0	0	3.38	-3.38	63
011746725	5	64.8	5.4	7.62	-2.22	3
011746733	1	0	0	0.17	-0.17	40
011785066	1	0	0	3.88	-3.88	107
011840429	3	108	9	27.17	-18.17	62
011840430	3	108	9	21.76	-12.76	64
011840431	3	108	9	14.58	-5.58	0
011844246	2	72	6	17.99	-11.99	92
011844247	6	216	18	47.81	-29.81	126

011852584	9	0	0	35.73	-35.73	1185
011852587	9	0	0	99.09	-99.09	2080
011855281	14	0	0	11.21	-11.21	191
011855360	3	108	9	9.04	-0.04	0
011933425	2	25.2	2.1	4.29	-2.19	24
011944115	1	22.32	1.86	4.25	-2.39	0
011974403	1	5.04	0.42	0.25	0.17	5
012061871	2	0	0	1.61	-1.61	7
012061872	1	2.52	0.21	0.40	-0.19	38
012093092	1	11.88	0.99	0.50	0.49	31
012093093	1	0	0	1.40	-1.40	0
012093094	2	21.6	1.8	1.05	0.75	35
012093097	2	7.2	0.6	0.80	-0.20	42
012093099	2	5.04	0.42	1.00	-0.58	44
012093102	18	272.16	22.68	24.66	-1.98	0
012097916	140	4082.4	340.2	198.23	141.97	1306
012099229	12	4.32	0.36	1.21	-0.85	0
012155702	6	0	0	16.34	-16.34	0
012198705	2	0	0	0.00	0.00	12
012225125	1	0	0	0.25	-0.25	5
012225249	1	0	0	0.00	0.00	0
012265146	7	252	21	2.21	18.79	267
012292237	2	0	0	171.77	-171.77	5774
012309094	2	11.52	0.96	2.57	-1.61	0
012312906	8	0	0	0.00	0.00	88
012343356	14	158.4	13.2	32.72	-19.52	413
012401817	1	0	0	240.55	-240.55	671
012424370	0	0	0	6.74	-6.74	0
012458083	2	0	0	0.00	0.00	0
012458084	1	0	0	0.00	0.00	0
012458085	1	0	0	0.00	0.00	0
012458086	3	0	0	0.00	0.00	0
012493833	7	252	21	12.99	8.01	0
012502676	2	0	0	0.00	0.00	0
012688004	1	0	0	3.88	-3.88	29
012688055	1	14.4	1.2	0.00	1.20	0
012718754	1	18.72	1.56	1.75	-0.19	0
012870861	1	21.6	1.8	4.00	-2.20	297
013029412	11	3.96	0.33	0.75	-0.42	0
013139140	1	0	0	1.55	-1.55	75

013166093	1	0	0	1.75	-1.75	21
013280330	16	0	0	7.47	-7.47	274
013398120	1	7.92	0.66	2.10	-1.44	0
013404994	1	0	0	0.03	-0.03	1
013465349	2	19.44	1.62	3.50	-1.88	28
013475681	1	36	3	13.29	-10.29	117
013483051	1	36	3	8.96	-5.96	87
013529570	1	0	0	242.81	-242.81	2903
013529575	12	0	0	104.25	-104.25	7641
013546218	5	0	0	0.60	-0.60	55
013566970	2	59.76	4.98	151.78	-146.80	0
013581831	0	0	0	0.00	0.00	213
013626893	16	184.32	15.36	34.54	-19.18	0
013626894	17	194.4	16.2	47.43	-31.23	0
013635005	1	12.96	1.08	10.04	-8.96	0
013659604	6	8.64	0.72	1.40	-0.68	0
013672858	1	13.32	1.11	10.39	-9.28	0
013790932	3	0	0	11.31	-11.31	0
013802222	1	0	0	0.13	-0.13	13
013899213	10	20.16	1.68	0.08	1.60	9
014062338	7	0	0	0.67	-0.67	2
014075099	1	7.56	0.63	0.31	0.32	0
014077975	4	5.76	0.48	28.87	-28.39	152
014513636	2	0	0	0.50	-0.50	49
014513741	7	252	21	45.22	-24.22	0
014591072	1	8.64	0.72	0.00	0.72	0
014591075	2	12.96	1.08	3.60	-2.52	254
014591079	1	24.12	2.01	18.17	-16.16	44
014594409	2	15.12	1.26	0.68	0.58	10
014594410	1	7.56	0.63	0.32	0.31	7
014594414	2	15.12	1.26	0.63	0.63	0
014594445	1	7.56	0.63	0.33	0.30	1
014594449	2	15.84	1.32	0.70	0.62	0
014601048	2	0.72	0.06	0.40	-0.34	145
014612987	1	14.4	1.2	2.98	-1.78	0
014636636	1	0	0	0.29	-0.29	0
014670890	2	15.12	1.26	0.57	0.69	0
014696565	4	36	3	2.70	0.30	102
014699364	3	45.36	3.78	2.40	1.38	31
014706416	1	14.4	1.2	2.25	-1.05	0

014814264	1	0.36	0.03	1.29	-1.26	27
014814481	2	0.72	0.06	0.00	0.06	0
015051074	7	182.88	15.24	19.56	-4.32	793
015087497	2	19.44	1.62	1.92	-0.30	34
015243190	6	0	0	0.91	-0.91	50
015429977	2	0.72	0.06	6.37	-6.31	59
015587979	3	10.8	0.9	4.90	-4.00	63
LLNC00249	2	0	0			
LLNC02006	1	0	0			
LLNC03319	1	0	0			
LLNC04019	1	0	0			
LLNC04493	2	5.04	0.42			
LLNC06306	1	29.88	2.49			
LLNC10190	2	2.16	0.18			
LLNC10191	6	0	0			
LLNC10192	2	2.16	0.18			
LLNC10498	2	0	0			
LLNC10527	8	63.36	5.28			
LLNC10624	1	1.44	0.12			
LLNC10914	2	0	0			
LLNC11080	6	0	0			
LLNC11081	6	0	0			
LLNC11103	12	0	0			
LLNC11104	12	0	0			
LLNC11105	32	0	0			
LLNC11106	32	0	0			
LLNC11107	32	11.52	0.96			
LLNC11108	12	0	0			
LLNC11109	32	23.04	1.92			
LLNC11110	38	0	0			
LLNC11111	12	0	0			
LLNC11112	12	0	0			
LLNC11113	32	11.52	0.96			
LLNC11114	12	0	0			
LLNC11115	16	17.28	1.44			
LLNC11118	32	0	0			
LLNC11119	32	11.52	0.96			
LLNC11120	32	0	0			
LLNC11121	28	0	0			
LLNC11124	12	0	0			

LLNC11158	32	11.52	0.96			
LLNC12019	5	10.8	0.9			
LLNC12221	16	0	0			
LLNC12222	12	0	0			
LLNC12224	10	82.8	6.9			
LLNC12228	2	2.16	0.18			
LLNC12231	0	0	0			
LLNC12242	4	0	0			
LLNC12244	4	0	0			
LLNC12245	4	0	0			
LLNC12248	4	0	0			
LLNC12249	4	0	0			
LLNC12393	1	3.24	0.27			
LLNC12508	12	0	0			
LLNC12663	2	0	0			
LLNC12673	4	0	0			
LLNC12675	4	0	0			
LLNC12676	4	0	0			
LLNC12687	2	0	0			
LLNC12688	2	0	0			
LLNC12694	4	0	0			
LLNC12698	4	0	0			
LLNC12821	1	2.52	0.21			
LLNC12958	1	0	0			
LLNC12993	7	141.12	11.76			
LLNC12995	14	0	0			
LLNC13197	4	0	0			
LLNC13198	4	0	0			
LLNC13491	1	29.88	2.49			
LLNC13894	4	0	0			
LLNC13942	2	0	0			
LLNC13943	2	0	0			
LLNC13946	4	0	0			
LLNC13947	4	0	0			
LLNC14053	2	7.2	0.6			
LLNC14083	6	4.32	0.36			
LLNC14211	2	0	0			
LLNC14285	0	0	0			
LLNC14506	2	0	0			
LLNC14520	4	0	0			

LLNC14522	12	0	0			
LLNC14523	2	0	0			
LLNC14530	2	0	0			
LLNC14532	4	0	0			
LLNC14541	4	0	0			
LLNC14542	2	0	0			
LLNC14543	2	0	0			
LLNC14544	2	0	0			
LLNC14545	2	0	0			
LLNC14598	1	0	0			
LLNC14706	32	0	0			
LLNC14813	1	1.44	0.12			
LLNC15152	4	0	0			
LLNC15172	6	36.72	3.06			
LLNC15362	3	8.64	0.72			
LLNC15364	3	6.48	0.54			
LLNC15369	3	4.32	0.36			
LLNC15386	3	11.88	0.99			
LLNC15395	1	1.44	0.12			
LLNC15438	4	10.08	0.84			
LLNC15442	2	0	0			
LLNC15443	4	0	0			
LLNC15461	4	0	0			
LLNC15463	2	0	0			
LLNC15465	4	0	0			
LLNC15466	2	0	0			
LLNC15528	1	36	3			
LLNC15596	6	32.4	2.7			
LLNC15690	1	0	0			
LLNC15691	1	0	0			
LLNC15710	1	36	3			
LLNC15728	1	2.52	0.21			
LLNC15831	4	0	0			
LLNC15916	3	14.04	1.17			
LLNC16085	1	2.52	0.21			
LLNC16119	3	5.4	0.45			
LLNC16120	1	0	0			
LLNC16121	1	0	0			
LLNC16122	1	0	0			
LLNC16202	3	20.52	1.71			

LLNC16203	3	4.32	0.36			
LLNC16232	4	28.8	2.4			
LLNC16235	1	0	0			
LLNC16253	16	0	0			
LLNC16254	2	0	0			
LLNC16255	2	0	0			
LLNC16256	20	0	0			
LLNC16396	3	5.4	0.45			
LLNC16397	12	12.96	1.08			
LLNC16398	3	4.32	0.36			
LLNC16399	2	2.16	0.18			
LLNC16401	4	8.64	0.72			
LLNC16478	2	58.32	4.86			
LLNC16745	1	0	0			
LLNC16814	1	2.52	0.21			
LLNC16887	6	0	0			
LLNC16888	1	0	0			
LLNC16889	1	1.44	0.12			
LLNC16890	1	2.52	0.21			
LLNC16891	1	0	0			
LLNC16892	1	2.52	0.21			
LLNC16893	1	0.72	0.06			
LLNC16894	1	2.52	0.21			
LLNC16895	1	0	0			
LLNC16896	6	2.16	0.18			
LLNC16897	2	0.72	0.06			
LLNC16898	25	9	0.75			
LLNC16899	6	69.12	5.76			
LLNC16900	7	0	0			
LLNC16901	1	1.44	0.12			
LLNC16902	1	3.24	0.27			
LLNC16903	1	0	0			
LLNC16904	1	0.72	0.06			
LLNC16905	1	0.72	0.06			
LLNC16906	6	216	18			
LLNC16907	20	7.2	0.6			
LLNC16908	7	7.56	0.63			
LLNC16909	2	0	0			
LLNC16910	1	36	3			
LLNC16951	15	21.6	1.8			

LLNC17211	2	59.04	4.92			
LLNC17909	1	0	0			
LLNC17913	1	0	0			
LLNC18872	1	14.4	1.2			
LLNC18901	14	372.96	31.08			
LLNC18902	14	156.24	13.02			
LLNC18942	4	0	0			
LLNC18978	32	0	0			
LLNC21295	1	0.72	0.06			
LLNCA1043	20	144	12			
LLNCA4994	1	0.36	0.03			
LLNCA7520	2	0	0			
LLNCA7544	6	2.16	0.18			
LLNCA7570	1	0	0			
LLNCB0968	0	0	0			
LLNCB0975	7	0	0			
LLNCB0977	1	0	0			
LLNCB1038	6	8.64	0.72			
LLNCB1316	4	53.28	4.44			
LLNCB3729	14	0	0			
LLNCC2984	2	0	0			
LLNCC3693	1	36	3			
LLNCP6959	1	2.52	0.21			
Grand Total	3152	24752.88				

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APPENDIX B. DLA RICHMOND TOP 15 MATERIAL DEGRADERS

NIIN	NOMEN	MRH Production Requirements <i>(Unfilled Holes)</i>	QPA (Quantity Per Assembly)
011439702	Sleeve Nut / 65122-11369-101 (COMMENTS)	210	7
011468166	Spindle Nut	149	7
011266043	SPLIT CONE, ROTARY HUB / 65121-11319-101	17	1
011487310	ARM, CAM-DROOP / 65105-11002-103	98	7
011266118	HOUSING,CYLINDER	150	12
004838452	RETAINER,SEAL	174	14
011351442	PISTON ASSEMBLY / 65664-11175-04 (COMMENTS)	291	12
013626893	SPACER SPIN PN 65102-11082-109	277	28
011746725	HEAD ASSEMBLY,SLEEV	142	6
011265937	BEARING, BALL, ANNULAR 65951-11527-101	72	7
011241281	RETAINER,PACKING S13050-214-5	197	24
013626894	SPACER MRH SPINDLES 1-7 65102-11082-108	188	28
011404061	PISTON,PITCH LOCK	39	6
011256945	LOCK,SEAL,HUB ASSEM 65123-11246-101	57	7
009473392	CONE AND ROLLERS,TAPERED SB3260A1	86	14

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