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ACQUISITION RESEARCH CASE SERIES

**Naval Aviation Maintenance:
A Case Study for Process Improvement**

15 December 2006

by

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About the Authors

Lieutenant Commander Eric Jafar, Supply Corps, United States Navy, is currently assigned to the Navy Expeditionary Combat Command (NECC) Staff at the Naval Amphibious Base, Little Creek, Virginia.

Lieutenant Commander Jafar came to the Navy Expeditionary Combat Command (NECC) Staff from an assignment as a student in the Graduate School of Business and Public Policy at the Naval Postgraduate School, Monterey, California. Prior to that assignment he served as the Principal Assistant for Logistics and Principal Assistant for Services aboard *USS Theodore Roosevelt* (CVN 71), Norfolk, Virginia.

Lieutenant Commander Jafar has earned qualifications as a Surface Warfare Supply Officer, and Aviation Supply Officer. His tours afloat as an officer began with a tour as First Lieutenant, *USS Vincennes* (CG 49), Supply Officer in *USS George Philip* (FFG-12), and Principal Assistant for Logistics and Principal Assistant for Services, *USS Theodore Roosevelt* (CVN-71).

Lieutenant Commander Jafar's assignments ashore include Department of Defense Navy Acquisition Contracting Officer Intern at the Defense Supply Center, Richmond, Virginia, and Logistics Management Student at the Naval Postgraduate School, Monterey, California.

Lieutenant Commander Jafar grew up in New York and earned his bachelor's degree at San Diego State University, San Diego, California, and was commissioned in January 1996 through the Enlisted Commissioning Program as an Ensign. He received a master's degree in Business Administration with a subspecialty in Supply Chain Management from the Naval Postgraduate School, Monterey, California.

His personal awards include the Joint Commendation Medal, the Navy and Marine Corps Commendation Medal (third award), and the Navy and Marine Corps Achievement Medal (third award).

LCDR(sel) Terence Noel C. Mejos, Aerospace Maintenance Duty Officer, United States Navy, was born on October 30, 1970 in Olongapo City, Philippines. He graduated from the Philippine Air Transport and Training School of Aeronautics with a Bachelor of Science degree in Aeronautical Engineering in 1990. He also graduated from Southern Illinois University at Carbondale with a Bachelor of Science degree in Aviation Management in 1994. He is a licensed Aeronautical Engineer in the Philippines.

He enlisted in the Navy in 1991 as an Aircraft Structural Mechanic. He completed the military indoctrination course at the Naval Recruit Training Center in San Diego, CA, and received the Most Outstanding Recruit Award. He attended the



Aircraft Structural Mechanic “A” School at the NATTC Millington, TN, and finished top of his class. His tours of duty and accomplishments as an enlisted include:

- VF-124/101 NAS Miramar, San Diego, CA (1992-95). Collateral Duty Inspector and Low Power Turn Qualified for F-14A/D “Tomcat” model aircraft.
- VP-1 NAS Whidbey Island, Oak Harbor, WA (1995-98). Quality Assurance Representative and Aviation Gas-Free Engineer/Qualifier for P-3 “Orion” model aircraft.

He completed the Officer Candidate School in Pensacola, FL in June, 1998. His first AMDO assignment was in HSL-41 at NAS North Island, San Diego, CA. He served there as Aircraft Assistant Division Officer, Material Control Officer and Material/Maintenance Control Officer. In 2002, he reported aboard the USS Carl Vinson in Aircraft Intermediate Maintenance Department, and served there as Quality Assurance Officer, IM-2 (General Aircraft Maintenance), and IM-3 (Aircraft Avionics and Armament) Division Officer. He also performed collateral duties, such as, Departmental 3M Officer and Damage Control Repair Locker Officer. While on Vinson, he completed the 2003 Western Pacific deployment in support of Operation Southern Watch, and majority of the 2005 “global” deployment in support of the Global War on Terrorism. In 2005, he reported aboard the Naval Postgraduate School as a Defense-Focused Master of Business Administration Program student, specializing in Material Logistics Support.

His personal awards include the Navy and Marine Corps Commendation Medal (one award), and the Navy and Marine Corps Achievement Medal (three awards).

LCDR(sel) Terry Mejos is married to Cheryl Avenido of Cagayan de Oro, Philippines. They have three children: Terence (10), Camille (3) and Cailene (6 months).

Lieutenant Chieh Yang, Aviation Limited Duty Officer, United States Navy, is an immigrant from Taiwan. He enlisted in the Navy in 1986 as Aviation Structural Mechanic (Structural). In December 1996 He graduated from the University of Illinois at Carbondale with a Bachelor of Science in Aviation Management. He was commissioned on October 1, 2002 as an Ensign via the Navy’s Limited Duty Officer Program.

On December 13, 1986, LT Yang reported for duty to Fleet Logistics Support Squadron 30 (VRC-30) in San Diego, California. He deployed on all west coast based aircraft carriers in support of squadron carrier qualification. In May 1990 he deployed onboard USS Constellation in support of Rim of the Pacific Exercise (RIMPAC). In September 1990 he checked onboard Helicopter Combat Support Squadron 11 (HC-11) for duty. In December 1990, he made his first 6 month



deployment aboard USS Kansas City (AOR-3) in support of Operation Desert Shield/Storm. In September 1993, he was deployed aboard USS New Orleans (LPH-11) in support of Exercise Valiant Usher and Operation Restore Hope at Mogadishu, Somalia. In July 2001 he checked onboard Service School Command at Naval Training Center, Point Loma, California. After completing his Bachelor degree he received orders to Early Airborne Warning Squadron 115 (VAW-115) in Naval Air Facility Atsugi, Japan. Upon checking into VAW-115 in January 1997, within a week he was deployed onboard USS Independence in support of Exercise Southern Swing and in February 1998 made another deployment in support of Operation Southern Watch (OSW) in the Persian Gulf. After the deployment he was selected for Officer Candidate School in Pensacola, Florida. Due to personal reasons, he declined the opportunity and was sent back to HC-11. In November 1998 he returned to serve a second tour at HC-11. In February 1999 he was deployed onboard USS Sacramento in Support of OSW and Maritime Interception Operation (MIO). After the deployment he was hand-selected to be the Day shift Maintenance Control Leading Petty Officer for one year. After Maintenance Control, he was selected to serve as Detachment TWO's chief and flight deck coordinator aboard the USS Nimitz in support of her voyage around the Cape of Good Hope to her new Homeport in Naval Operating Base Coronado in San Diego, California. In January 2002 he checked onboard Aircraft Intermediate Maintenance Department at NASNI. In February 2002 he was selected as an Aviation Limited Duty Officer and was commissioned on October 1, 2002. He was assigned to Helicopter Combat Support Squadron 6 (HC-6) as his first commissioned tour. In December 2002 he reported for duty and served as a Detachment Maintenance Officer and deployed onboard the USS BATAAN in support of Operation Iraq Freedom (OIF) and Enduring Freedom (OEF). In June 2005 he reported aboard Naval Postgraduate School serving as a student to obtain the Master of Business Administration Degree that specializes in logistics.

His personal accomplishment includes: Chosen twice as VRC-30's junior sailor the month. He was selected as AOR-3's Junior Sailor of the Month, for March and AOR-3's Junior Sailor of the Cruise (1991). At HC-11 he was meritoriously advanced to Second Class Petty Officer under the Command Advancement Program (CAP). He earned the Enlisted Aviation Warfare Specialist qualification. The selection to EEAP (1994), OCS (1998), LDO program (2002), selected as HC-11 and Helicopter Combat Support Wing Pacific's Sailor of the Year for 2000. He has received one Navy Commendation Medal and five Navy Achievement Medals.

He has three children living in Monterey, California, they are: Jay Michael 17, Christopher Blake 13, and Amanna 5.



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Disclaimer: The views represented in this report are those of the author and do not reflect the official policy position of the Navy, the Department of Defense, or the Federal Government.



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List of Acronyms

AGI	Avraham Y. Goldratt Institute, LLP (consultants)
AIMD	Aircraft Intermediate Maintenance Department
AMSU	Aircraft Maintenance Screening Unit
ASD	Aviation Support Division
ATAF	All Tools Accounted For
AWP	Awaiting Parts
BCM	Beyond Capability of Maintenance
CAG	Carrier Airwing
CCS	Component Control Section
CDI	Collateral Duty Inspector
COMNAVAIRFOR/CNAF	Commander, Naval Air Forces
CNO	Chief of Naval Operations
COMVAQWINGPAC	Commander, Electronic Attack Wing, Pacific
D-level	Depot-level (maintenance)
DoD	Department of Defense
DoN	Department of the Navy
DRC	Dynamics Research Corporation (consultants)
FCA	Field Cognizant Activities
FIFO	First-In-First-Out
FOD	Foreign Object Damage (engine damage from foreign materials)
I-level	Intermediate-level (maintenance)
IMA	Intermediate Maintenance Activities
IW	In Work
JIT	Just-in-Time
MATCON	Material Control
MEI	Major Engine Inspection
NALCOMIS	Naval Aviation Logistics Command Maintenance Information System
NAMP	Naval Aviation Maintenance Program



NASWI	Naval Air Station, Whidbey Island
NATO	North Atlantic Treaty Organization
NAVAIR	Naval Air Systems Command
NADEP	Naval Aviation Depot
NMC	Non-Mission-Capable
NRFI	Not Ready for Issue
OIC	Officer-in-Charge
O-level	Organizational-level (maintenance)
OMA	Organizational Maintenance Activities
PC	Production Control
QAR	Quality Assurance Representative
QECK	Quick Engine Change Kit
RFI	Ready-for-Issue
RFT	Ready-for-Test
SAR	Search and Rescue
SE	Support Equipment
SPT	Shortest Processing Time
SRS	Supply Response Section
TAD	Temporary Additional Duty
TOC	Theory of Constraints
VSM	Value Stream Mapping



Report Structure Summary

This case is divided into two parts:

Part A describes the J52-P408 engine repair process prior to the implementation of AIRspeed at the AIMD Naval Air Station, Whidbey Island (NASWI) J52 engine repair shop.

Part B discusses the post-implementation of AIRSpeed and the use of Value Stream Mapping (VSM) to eliminate non-value-added processes; the use of which resulted in increased productivity.



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Part A: Student Case Study

In April 2004, the Aircraft Intermediate Maintenance Department (AIMD), Naval Air Station Whidbey Island (NASWI), implemented “AIRSpeed” in order to improve the turnaround time, i.e., the repair cycle-time, of the J52-P408 engine. The J52 engine provides propulsion for all US Navy and Marine Corps’ EA-6B “Prowler” aircraft. AIRSpeed was implemented to help reduce the cost of managing and distributing Ready-for-Issue (RFI) engines, while increasing aircraft engine availability to the Department of the Navy (DoN). The AIMD NASWI was the fifth Naval aircraft maintenance facility to implement the AIRSpeed concept.

The AIRSpeed program is a combination of philosophy and strategy adapted from proven corporate practices that integrates four management methodologies tailored to meet the US Navy’s cost-wise readiness initiative. These four methodologies are: Theory of Constraints (TOC), Just-In-Time (JIT), Lean, and Six-Sigma. TOC is a management tool used to focus on bottlenecks, continuous improvement, and removing constraints; JIT is intended to make available the right part, in the right place, at the right time for the customers; the Lean concept is to reduce or eliminate unnecessary procedures and inventories; Six-Sigma is designed to raise the quality level, reduce the variability of the process, and increase the reliability of reworked items. The incorporation of these four concepts under one process generated the desired outcome for the Navy’s cost-wise readiness initiative and was named AIRSpeed.



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I. Introduction

Based on a combined 56 years of experience in Naval supply and aviation maintenance, the authors opine that redundant or non-value-added procedures and management practices have been culturally ingrained among maintainers and managers in the Naval aviation community, and have unnoticeably contributed to fluctuations in the levels of production and readiness. An example of a management norm that requires careful analysis is the practice of excessive stocking of spare parts to reduce equipment downtime and achieve a small percentage increase in readiness. Because of the perceived value created from having available parts on-site, hoarding excessive spare parts becomes the alternative solution for readiness rate issues that results in accountability problems and a shortage of spare parts at other maintenance sites. Facilities experiencing a shortage of parts end up resorting to cannibalization,¹ which creates an adverse impact on the equipment repair cycle-time (e.g., turnaround time).

In January 2001, the Comptroller General of the United States reported that lack of control and accountability over inventory and equipment are two major management challenges or inefficiencies faced by the Department of Defense (DoD).² The Navy reportedly spent over \$8 billion in operations and maintenance appropriations to acquire more spare parts in fiscal years 2001 and 2002.³ Consequently, the Navy accumulated over 475,000 cannibalizations between fiscal years 1996 and 2000, which translates into millions of maintenance hours.⁴

¹ Cannibalization is the process of transferring serviceable parts from one weapon system (i.e., aircraft, engine, etc.) to another weapon system for installation.

² General Accounting Office, *Major Management Challenges and Program Risks: Department of Defense*, January 2001, GAO-01-244, 32 and 66.

³ General Accounting Office, *Defense Inventory: Navy Logistics Strategy and Initiatives Need to Address Spare Parts Shortages*, Report to the Chairman, Subcommittee on Defense, of the House Committee on Appropriations, June 2003, GAO-03-708, 1.

⁴ General Accounting Office, *Military Aircraft: Cannibalization Adversely Affects Personnel and Maintenance*, Testimony before the Subcommittee on National Security, Veterans Affairs, and International Relations, of the House Committee on Government Reform, May 2001, GAO-01-693T, 1-3.



Additionally, management inefficiencies in its aircraft repair facilities cost the DoN billions of dollars. Meanwhile, the cost of operating and maintaining aircraft continues to increase, while the DoD's budget steadily declines—which affects the future capability of the Navy to buy more ships and aircraft. In response to this behavior, the Chief of Naval Operations (CNO) directed the Navy to operate more efficiently.⁵ Thus, Naval Air Systems Command (NAVAIR) turned toward successful organizations in the private sector in search of production philosophies and techniques that could be applicable to Naval aircraft maintenance facilities, i.e., the Naval Aviation Depot (NADEP) and the AIMD. As a result, NAVAIR mandated the implementation of a cost-wise readiness initiative (AIRSpeed) leveraging the TOC, JIT, Lean, and Six-Sigma methodologies that sparked a Fleet-wide transformation.⁶ NAVAIR's goal is to reduce production turnaround time by eliminating unnecessary procedures. In July 2003, AIRSpeed concepts were first implemented at NADEP facilities and produced substantial cost savings for the Navy, which suggested that these practices could also increase performance and readiness levels. After the initial foundation was established at NADEP facilities, the implementation process commenced at intermediate maintenance activities (IMA).

In early April 2004, AIRSpeed concepts were first introduced at NASWI's J52-P408 Engine Repair Shop under the direction of consultants Avraham Y. Goldratt Institute, LLP (AGI) and Dynamics Research Corporation (DRC).⁷ The Navy contracted with both firms to develop, implement, and sustain AIRSpeed concepts at aircraft repair facilities. AGI is headquartered in New Haven, Connecticut, and has over 19 years of experience in TOC development, implementation, and education.

⁵ Department of the Navy, Office of Information, *CNO Guidance for 2003*. Accessed 13 August 2006; available from <http://www.chinfo.navy.mil/navpalib/cno/clark-guidance2003.html>.

⁶ Mark Nieto, "Enterprise AIRSpeed," *The Navy Supply Corps Newsletter* 68, iss. 5 (September/October 2005): 10.

⁷ PRNewswire, "U.S. Navy Awards a Major Contract to a Connecticut Small Business," January 2006. Accessed 19 July 2006; available from <http://www.prnewswire.com/cgi-bin/stories.pl?ACCT=104&STORY=/www/story01-13-2006/0004248807&EDATE>.



DRC is headquartered in Andover, Massachusetts, and is experienced in providing workshops for the Lean and Six-Sigma methodologies.

Initial assessments by the AIMD Whidbey Island AIRSpeed Teams⁸ of the production area and repair procedures in the J52 shop revealed several “muda.” Under the lean concept, muda is the Japanese word for waste or non-value-added processes.⁹ This concept was adopted from the Toyota Production System developed by Taiichi Ohno.¹⁰ By eliminating muda and streamlining the repair process, the AIMD projected that the J52 engine repair cycle-time would decrease from 468 hours to 233 hours.¹¹

⁸ The AIRSpeed Team consists of one officer (O-3), one chief petty officer (E-7), and four senior petty officers (E-5 – E-6).

⁹ William M. Feld, *Lean Manufacturing: Tools, Techniques, and How to Use Them* (Boca Raton, FL: St. Lucie Press, 2001), 10.

¹⁰ David McBride, “The 7 Manufacturing Wastes,” August 2003. Accessed 10 July 2006; available from <http://www.emsstrategies.com/dm090203article2.html>.

¹¹ Betsy Haley, “EA-6B Thrives with NAVRIIP/Enterprise AIRSpeed,” November 2004. Accessed 13 May 2006; available from <http://www.cnaf.navy.mil/airspeed/main.asp?ItemID=413>.



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II. Background

The Commander of Naval Air Forces (CNAF) established the Naval Aviation Maintenance Program (NAMP),¹² which outlines the mission of the three levels of maintenance: (1) Depot-level (D-level) maintenance; (2) Intermediate-level (I-level) maintenance; and (3) Organizational-level (O-level) maintenance. We will focus on I-level maintenance.

I-level maintenance's mission is to enhance and sustain the combat-readiness and mission capability of support at the nearest location with the lowest practical resource expenditure. It consists of on- and off-equipment material support and may be grouped as follows:

- Maintenance on aeronautical components and related Support Equipment (SE).
- Utilization of Field Cognizant Activities (FCAs), which perform I-level calibration of designated equipment.
- Processing of aircraft components from stricken aircraft (non-mission-capable (NMC) aircraft).
- Incorporation of technical directives.
- Manufacture of selected aeronautical components, liquids, and gases.
- Performance of on-aircraft maintenance when required.
- Age exploration of aircraft and equipment under Reliability Centered Maintenance.

A. Aircraft Intermediate-Level (I-Level) Maintenance

The AIMD Whidbey Island provides I-level maintenance support to 15 EA-6B "Prowler" squadrons, 6 P-3 "Orion" squadrons, 12 aircraft carriers, 1 C-9 squadron,

¹² Department of the Navy, *Naval Aviation Maintenance Program*, 1 February 2005, OPNAVINST 4790.2J, 7-1 – 7-3.



the station Search-and-Rescue (SAR) component, and various Northwest Regional activities.

In addition, the sea component¹³ provides afloat I-level support such as repairing avionics, airframes, power plants, and life-support systems for embarking EA-6B squadrons onboard 12 aircraft carriers.

The Expeditionary Logistics Unit component of the AIMD provides I-level maintenance and logistics support to forward-deployed, expeditionary EA-6B Prowlers at overseas expeditionary sites, and assists other North Atlantic Treaty Organization (NATO) aviation units with maintenance and logistics support, utilizing the unique capabilities of the Expeditionary Logistics Units.

As of May 2006, the AIMD Whidbey Island had a staff of 481 permanently-assigned enlisted Sailors, 13 Marines, 29 civilian personnel, and 213 Sea Operational Detachment personnel supporting all carrier requirements, plus 190 Van Operational Detachment personnel and 81 P-3 Operational Detachment personnel supporting the operational requirements of three P-3 squadrons. Additionally, a limited number of Temporary Additional Duty (TAD) personnel are provided from nondeployed EA-6B squadrons for ALQ-99 Pod Pool maintenance support.¹⁴

The AIMD schedules over 147,000 maintenance actions each year in support of NAS Whidbey Island-based aircraft, deployed aircraft carriers, and various other Naval activities in the Pacific Northwest Region. Roughly 105,000 aircraft parts are inducted, of which 82.5% are repaired and returned to service, while the rest are

¹³ Sea component is a portion of AIMD's personnel that provides afloat I-level maintenance support to a Carrier Air Wing (CAG) onboard an aircraft carrier. Any time CAG is scheduled to operate on an aircraft carrier, the sea component aspect of the AIMD will accompany the CAG throughout its training and deployment cycles.

¹⁴ Naval Air Station Whidbey Island Website, Benchmark Publications, Inc., 2004. Accessed May 2006; available from <http://www.militarynewcomers.com/WHID/Resources/Tenantcommands.html>.



referred for depot-level repair or scrapped. There are 73 work centers that log over 940,000 man-hours of aviation maintenance annually.

The AIMD also staffs and manages the Support Equipment Rework Facility at Naval Air Station Everett in support of Pacific Northwest aircraft carriers. In addition to permanently assigned technicians, Navy and Marine Corps Reservists receive mobilization training and contribute to the production effort during drill weekends.

B. Aviation Support Division (ASD)

The ASD is the single point of contact for maintenance activities requiring direct supply support. It is responsible for providing logistics support for assigned Organizational and Intermediate Maintenance Activities (OMA and IMA). It is where Material Control (MATCON) places requirements for material and equipment needed to support maintenance of weapons systems. MATCON places these requirements by submitting requisitions to the ASD.

NASWI ASD provides logistic support to the EA-6B and P-3 tenant commands and consists of two major sections: the Component Control Section (CCS) and the Supply Response Section (SRS); see Figure 1. CCS manages over 2,800 line-item inventory (valued at over \$360 million) and processes an average of 2,500 repairable demands monthly. CCS includes Awaiting Parts and Supply Screening units. SRS is the pulse point of the ASD, encompassing the Program Management Unit, Preexpended Bin Unit, and the Material Delivery Unit. SRS is responsible for the receipt and delivery of over 4,500 aviation-support and related requirements monthly.



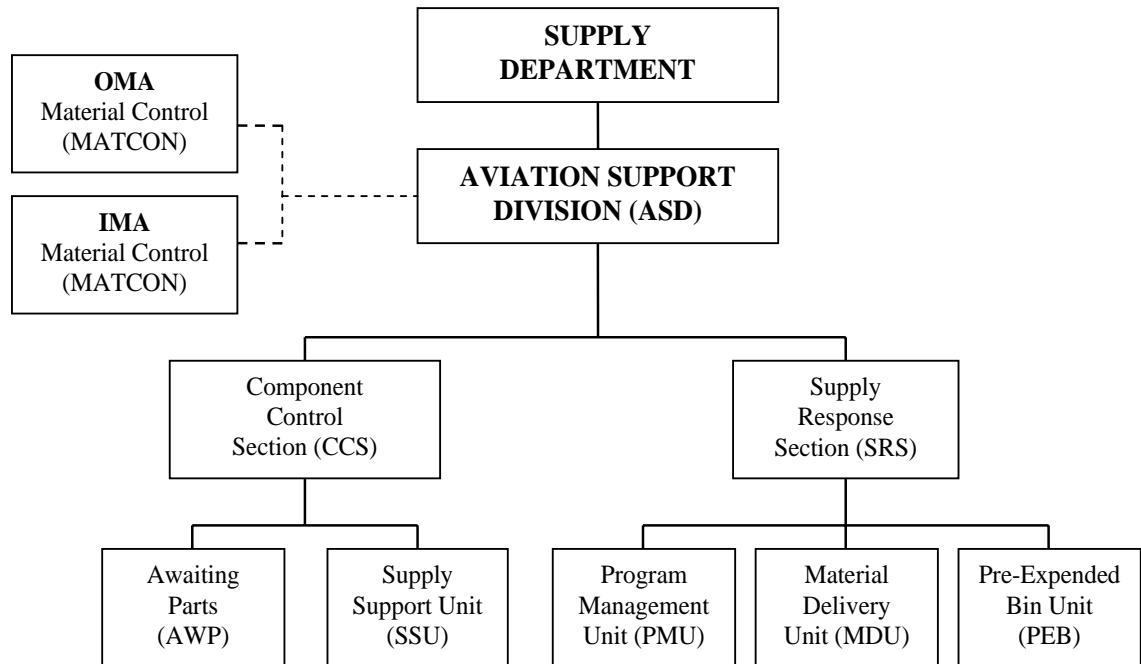


Figure 1. Simplified ASD Organizational Chart¹⁵

C. Aviation Squadrons

Squadrons are tenant commands assigned to Naval air installations and are referred to in the Naval aviation arena as the supported activities—otherwise known as customers. Squadrons are synonymous with OMAs. NASWI supports 15 EA-6B “Prowler” squadrons (13 of which deploy to aircraft carriers), 4 expeditionary squadrons not assigned to carrier air wings, and 1 Whidbey-based training squadron. With the exception of the training squadron, each deployable or expeditionary squadron consists of an average of four aircraft. Each aircraft consists of two J52-P408 Pratt and Whitney engines. These EA-6B squadrons are under the leadership of the Commander, Electronic Attack Wing, Pacific (COMVAQWINGPAC), who oversees their training operations. Commander, Naval Air Forces (COMNAVAIRFOR or CNAF) manages the total inventory of 366 J52

¹⁵ Department of the Navy, *Naval Aviation Maintenance Program*, 1 February 2005, OPNAVINST 4790.2J, Vol. 1, Chapter 18, 18-41.



engines for the Navy and Marine Corps and directs the repositioning and transfer of these engines to different locations or aircraft depending on the priority of need.¹⁶

Similar to the AIMD, squadrons are manned with the same mix of aviation technical talents necessary for the upkeep of assigned aircraft. Squadron maintenance personnel are limited to performing only O-level maintenance procedures, which are “on-aircraft” repair such as engine or parts removal and reinstallation, minor aircraft inspection, minor crack repair, etc. Maintenance Control is responsible for the planning and tasking of maintenance operations as well as assigning aircraft to meet the daily flight schedule. Working hours in the squadron vary depending on aircraft availability for the next day’s flight schedule or on deployment requirements. Otherwise, EA-6B squadrons operate in two 10-hour shifts on weekdays with a quarter of maintenance personnel working on weekends.

¹⁶ John E. Pike, “J52 Engines,” March 2006. Accessed 13 July 2006; available from <http://www.globalsecurity.org/military/systems/aircraft/systems/j52.htm>.



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III. Engine Repair Process

A. Engine Removal

Unlike removal/repair of other systems in the aircraft, engine removal from an aircraft requires a considerable amount of man-hour coordination among different divisions and, more importantly, renders the aircraft NMC for an extended period of time. An empty engine bay in an aircraft is considered as having one “bare firewall” (e.g., the EA-6B has two engine bays to accommodate two J52 engines). Different circumstances constitute engine removal for I-level repair and are categorized as either a scheduled or unscheduled maintenance operation.

Scheduled engine removal is performed on engines that are within minus 10% of an operating cycle or “high-time” (unless granted a waiver by CNAF). The high-time interval for J52 engines is 1,100 flight hours. Unscheduled engine removal is triggered by unplanned events such as damage from Foreign Object Damage (FOD), unacceptable flight performance parameters, failing oil samples, or characteristics of an internal leak.

The engine-removal process begins from the time the discrepancy is reported to or identified by the squadron Maintenance Control. Maintenance Control then directs the Line Division to tow the aircraft from the flight line to the hangar bay. When the aircraft reaches the hangar bay, the Aircraft Division prepares the aircraft by removing panels and positioning a mobile engine rack below the discrepant engine. Mobile or wheeled-engine racks are used for mounting the bad engine and transporting it on station via tow tractors. Removed engines are further stripped of parts that are required to stay with the aircraft. These parts include clamps, oil/fuel lines, constant-speed drive generators, hydraulic pumps, air-inlet and nose-cone assemblies, exhaust pipes, and engine performance wiring harnesses and connectors. While the shop is protecting the engine and lines from environmental exposure, the squadron Administrative Division performs part and serial number



verification of the engine and its associated components to ensure that the part and serial numbers match the logbook records. When satisfied, the squadron Quality Assurance Division performs the final inspection for NAMP compliance. Lastly, the squadron's MATCON Division (Supply): verifies the serial number and part number of the engine match the Naval Aviation Logistics Command Maintenance Information System (NALCOMIS) Supply, collects the required logbook records from the Administrative Division, and transfers the engine to the AIMD Aircraft Maintenance Screening Unit (AMSU) for induction to the AIMD, thus ending the process at the squadron level.

The entire engine-removal process, from the time the discrepancy is discovered to the time the engine is received by AMSU, takes, on average, 13 hours.

B. J52 Shop

1. Screening Process

The screening process begins by assessing whether the engine is within the AIMD's repair capability or Beyond Capability of Maintenance (BCM). A CDI from the J52 Repair Shop performs this function. After the CDI screens the engine, the shop waits for AMSU to induct it for repair or, if BCM, to transfer it to a Depot facility. The screening process normally takes an average of 1.75 hours.

Once AMSU inducts the engine for repair, the floor supervisor assigns a repair crew who will be responsible for the repair of the engine from the tear-down to the build-up process, a practice known as engine-ownership concept. A repair crew normally consists of one CDI (crew leader) and four workers. The same crew may have other NRFI engines at different stages of repair waiting to be processed. The crew leader prioritizes which engines should be worked on that day based on the availability of resources. These resources can be personnel, replacement parts from Supply or parts that can be cannibalized. If the inducted NRFI engine cannot be processed, it will be preserved and "cubby holed" (parked) to be repaired at a later



time. Cubby-holed engines are also used for parts cannibalization to repair other engines. Although the engine-ownership concept promotes competition, crew sense of pride, and accountability for producing more and good quality engines, it can also easily turn production into a serious state of disarray. Because different repair crews are overseeing multiple engines at various stages of repair, engines and major components are scattered everywhere on the production room floor.

Engines inducted for repair are further categorized as either requiring a Major Engine Inspection (MEI) or repair (Quick Fix). MEI engines are disassembled into individual components (nonmodular engine) for a more detailed inspection, while Quick-fix engines are only disassembled as necessary to access areas for inspection and component replacement. Theoretically, the repair processing time of MEI engines is constant, but the variable lead time of replacement parts misleads crew leaders with their prioritization techniques and results to crews migrating from one engine to another. Recognizing the constant processing time of MEI engines is important in determining what prioritization rule should be enforced.

2. Tear-Down Process

Once it is determined that the engine is ready to be repaired, the tear-down process begins. First, the crew leader logs into the NALCOMIS computer to put the engine job order In Work (IW), then other assigned mechanics can log in to record their start times. A member will then check out a tool box at the Tool Room, where there is normally a line of other mechanics formed at the counter. After getting issued a tool box, the mechanic inventories its contents at the site to ensure an All-tools-accounted-for (ATAF) condition as part of the acceptance process. The average time mechanics spend on this process is 0.5 hours; and this procedure occurs a minimum of 12 times per day—at the beginning and end of each shift, and at the beginning and end of each job order.

From the Tool Room, the mechanic then returns to the shop, reopens the job order in the NALCOMIS computer, enters the tool box number and his initials to



record the ATAF condition, rolls the tool box to the engine location, and reinventories its contents before any engine work can begin. Mechanics remove only the parts that would lead them to the suspect damaged component or bad engine module and separate these parts between a Quick Engine Change Kit (QECK) and a non-quick engine change kit. A QECK is a composite of various categories of hardware, hoses, tubing, clamps, connectors, and small repairable items that are normally replaced during the repair process. QECK parts are placed in small cardboard boxes and stashed in locked 5 x 2 x 4-foot cages (see Figure 2). Non-QECK parts are tagged with the engine serial number and placed in shelves inside the orphanage area (see Figure 3).



Figure 2. QECK Storage¹⁷



Figure 3. Parts Orphanage Area¹⁸

While the tear-down is in progress, the crew leader would order a replacement for the suspect damaged component or engine module from the NALCOMIS computer. Production Control (PC) assigns a document number under the job order and forwards it to the Aircraft Support Division (ASD), which then checks if the item on order is available “on station” for immediate issue. If the item is not available on station, the ASD forwards the requisition “off station” to be filled by

¹⁷ NASWI AIMD AIRSpeed Office, “400 Before and After,” PowerPoint Presentation, 2006, slide 3.

¹⁸ Ibid., slide 5.



the supply system, and PC assigns the job order an “awaiting parts” (AWP) status until the part is received. Partially disassembled engines in AWP status are preserved and parked at the NRFI section of the shop and become sources for cannibalization.

Although the tear-down process normally lasts an average of 3.5 days, a partially torn-down MEI engine stays in AWP status between 6 (without cannibalization) to 10 (with cannibalization) weeks.

After the tear-down process, the same crew spends another 30 hours cleaning and inspecting parts removed from the engine. Serviceable parts are stowed in the orphanage area, while replacements for unserviceable parts are ordered in the supply system. Replacement parts normally arrive within three weeks of placing the order.

3. Build-Up Process

The engine build-up process begins as soon as the replacement item is received from the ASD. In a process similar to screening, the ASD asks for a CDI to screen and receive the part. Once PC directs the shop to resume work, the shop assigns a build-up crew to de-preserve¹⁹ the NRFI engine and rolls it to the build station. The crew leader places the job order from AWP in IW status in the NALCOMIS computer and directs someone to perform the tool check-out process. The rest of the crew begins gathering the non-QECK components from the orphanage area.

At the orphanage area, crew members search for items that are tagged with the same engine serial number. Previous cannibalization actions for other engines have often led to misplaced items or items that have not been properly retagged. Because of this, depending on the mechanic’s familiarity with the part, the search

¹⁹ To de-preserve is to take preserved equipment out of prolonged inactivity, storage, or shipment condition for the purpose of verifying or cannibalizing an RFI part.



takes up to two hours. This includes backtracking documentation in the pass-down book and NALCOMIS, or examining diagrams in the maintenance manuals. Without using roll-away carts to transfer non-QECK parts and heavy engine components, the crew will have to take several trips from the orphanage area. This operation takes up to one hour, depending on the location and accessibility of the engine on the floor.

During the build-up process, Quality-assurance Representatives (QARs) are called upon to occasionally perform in-process inspections. The entire build-up process for a MEI engine normally takes up to three weeks, and sometimes up to several months, due to work stoppages caused by late identification of a failed part with long lead-time requirements.

The floor supervisor inspects the completely assembled engine. Then, the Quality-assurance Representative approves the engine as ready-for-test (RFT). This process takes approximately 2.5 hours to complete. After the inspection, the engine goes to the local engine test facility to verify if it meets flight condition parameters. The test takes 8 hours to complete.

After passing the test, the engine is moved back to the shop for a post-test inspection and the installation of the QUECK. This process takes around 6 hours to complete. Consequently, PC directs the Administrative Division to put together the engine records (logbook) for part number verification. Administrative personnel wait until the engine returns to the shop to perform the physical part verification. Improper document swaps from previous cannibalization actions causes the Administrative Division to spend an average of 7 hours to organize an engine record.

After the installation of a QUECK, a QAR conducts one final inspection for a half-hour and reports the completion to PC. Once PC is satisfied with the accuracy of the engine logbook and repair procedures, he signs off on the completed work order in the NALCOMIS, which completes the engine repair cycle. The RFI engine then becomes available to fill any bare firewalls or replenish the engine spares in the Fleet.



Case Study Questions

1. The AIMD pre-AIRSpeed implementation working hours were M-F 0700 to 1500 (7 A.M. to 3 P.M.) working only one shift. The shift loses one hour for administrative functions (e.g., parts searching and ordering, tool checkout, and cannibalization) and another hour for lunch and breaks. Based on Figure 4, determine the total repair cycle-time of a J52 engine inducted for a major engine inspection (MEI) at NASWI AIMD. Assuming that there are only six working hours devoted for production per day:
 - (a) Calculate the AIMD J52 repair cycle-time without cannibalization.
 - (b) Calculate the AIMD J52 repair cycle-time with cannibalization.
2. Employing the Lean concept of reducing the repair cycle, identify any non-value-added procedures. What changes would you make?
3. Given the cultural climate in the shop, what steps should you take in order to catalyze the adoption of the changes you proposed in Question 2? Would you practice an authoritarian or a participative leadership role, or both?
4. From the OIC's projection, did your proposed process improvements reduce repair cycle-time significantly enough to meet their expectations?



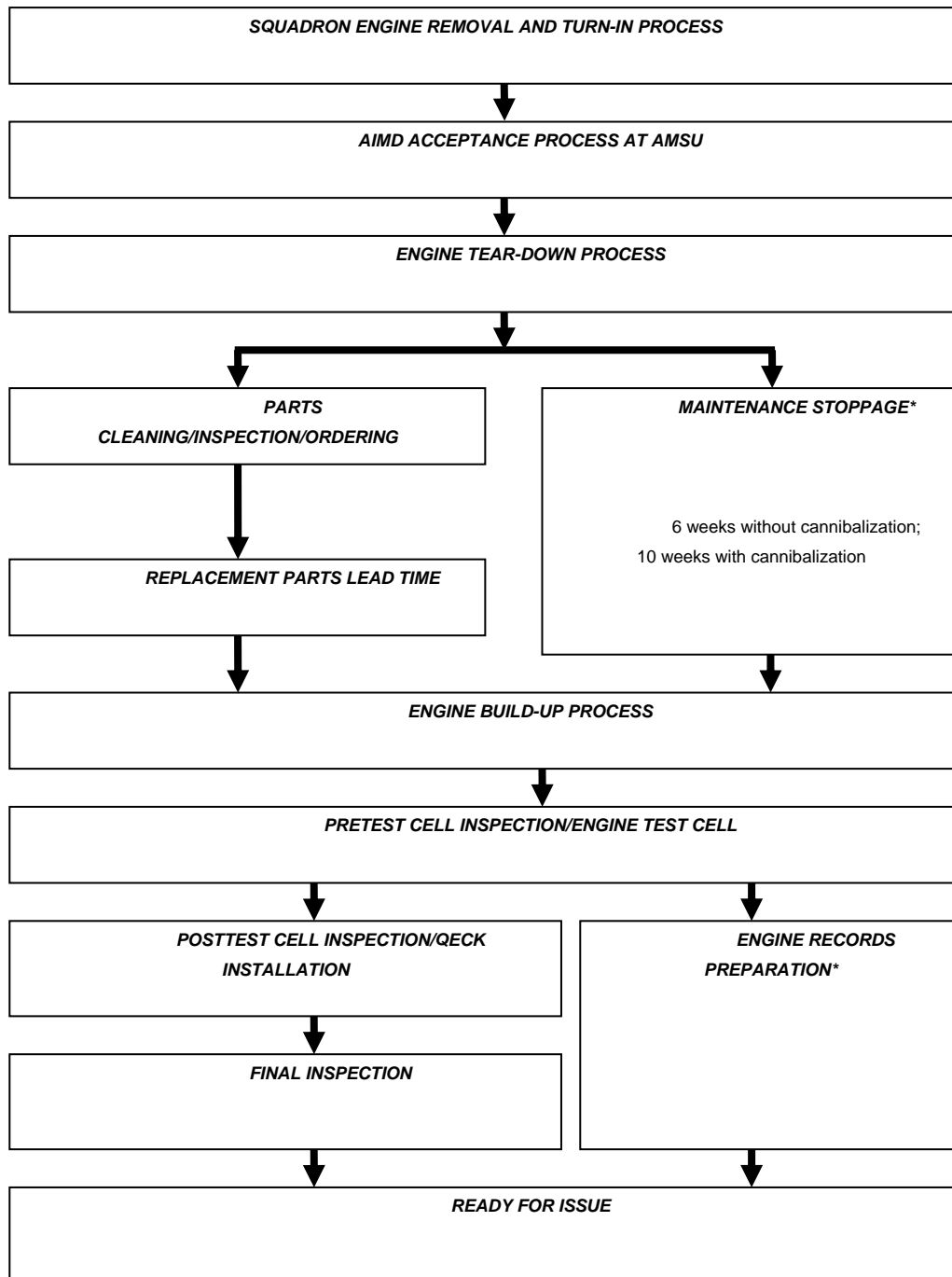


Figure 4. NASWI J52-P408 Engine Repair Flow



Part B: Faculty Teaching Notes

Part B is designed to be used as teaching notes by the professor when presenting this case study. Please contact Karey Shaffer at klshaffe@nps.edu to request a copy of the complete text associated with this case study.



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