Acquisition of Gear Systems from a Selected Department of the Navy Contractor

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N2009-0023
6 April 2009
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MEMORANDUM FOR DEPARTMENT OF NAVY OFFICE OF GENERAL COUNSEL, ASSISTANT GENERAL COUNSEL (ACQUISITION INTEGRITY)

Subj: ACQUISITION OF GEAR SYSTEMS FROM A SELECTED DEPARTMENT OF THE NAVY CONTRACTOR (AUDIT REPORT N2009-0023)

Ref: (a) SECNAV Instruction 7510.7F, “Department of the Navy Internal Audit”
(b) NAVAUDSVC memo N2008-NAA000-0078.000, dated 9 January 2008

Encl: (1) LECP 40 Design Improvements
(2) ECP 41 Design Improvements
(3) Activities Visited and/or Contacted
(4) Acronyms
(5) AMAD/PTS Diagrams

1. **Introduction.** In accordance with reference (a), and as announced in reference (b), we have completed the subject audit. Results of the audit are provided in paragraph 6. The Department of the Navy (DON) Office of the General Counsel, Acquisition Integrity Office (AIO) requested that the Naval Audit Service conduct an audit on a selected DON contractor’s quality assurance program.

2. **Reason for Audit.** The audit objective was to verify that aircraft gear components, which DON acquires from a selected DON contractor, are in accordance with quality assurance/quality control requirements and applicable Federal Acquisition Regulation (FAR) provisions. DON AIO asked that we perform this audit to verify that the contractor was meeting its obligation to provide Airframe Mounted Accessory Drive (AMAD) gear systems with a Mean Time Between Failure (MTBF) rate in accordance with the contract.

3. **Background.**

   a. AMAD is the gear system for the F/A-18 aircraft. Each F/A-18 has two AMAD gearboxes, one for each engine. Each AMAD is connected to its respective engine by the
Power Transmission Shaft (PTS). The AMAD is responsible for transmitting power from the aircraft engines to drive electrical accessories that supply aircraft hydraulic power, electrical power, and meet aircraft fuel flow requirements (see Enclosure 5 for diagrams).

b. In June 2000, the Naval Inventory Control Point-Philadelphia, PA (NAVICP) entered into an agreement with the contractor to implement a Logistics Engineering Change Proposal (LECP 40) for the AMAD. An LECP is a reliability- or maintainability-related Engineering Change Proposal (ECP) for a NAVICP-managed secondary item, which is sponsored and funded by NAVICP to reduce support costs. Further, in December 2007, NAVICP signed a contract with the contractor for an ECP (ECP 41). Military Handbook Configuration Management Guidance (MIL-HDBK-61A (SE), dated 7 February 2001, defines an ECP as the management tool used to propose a configuration change to a configuration item and its Government-baselined performance requirements.

c. The National Aerospace and Defense Contractors Accreditation Program (NADCAP) provides Society of Automotive Engineers, Inc. Aerospace Standard Quality Certifications of processes through periodic audits. The three production processes that are NADCAP-certified with the contractor are heat treating, chemical processing, and nondestructive testing. NADCAP conducts annual audits of the contractor’s heat treating and chemical processing. Audits of nondestructive testing occur every 2 years.

d. Defense Contract Management Agency (DCMA) representatives issue Corrective Action Requests (CARs) to defense contractors to: (1) identify instances of noncompliance with established methods of production; (2) correct instances of noncompliance; and (3) control quality system issues or violations of contract/purchase order requirements. There are four levels of CARs. Level I CARs are issued verbally or in writing for contractual noncompliance that can be corrected with short-term actions. Level II CARs are used for systematic noncompliance and require formal responses. Level III CARs are serious noncompliance issues addressed to the contractor’s senior management. Level IV CARs are the most serious and involve other contractual remedies.

   a. FAR 46.105 prescribes contractor’s responsibilities to ensure that supplies and services acquired under a Government contract conform to the contract’s quality and quantity requirements. FAR 46.202-4 prescribes the circumstances where the contracting officer may indicate a higher level quality standard that will satisfy the government’s requirement, such as International Organization for Standardization (ISO) 9001. We examined the applicable contracts and noted whether DON included applicable provisions into the F/A-18 AMAD repair and overhaul contracts.

   b. The selected contractor is ISO certified. The ISO 9001 standards sections 1-8.5 require the adoption of a quality management system and sets guidelines for establishing a system. We specifically tested for compliance with ISO 9001 8.5.2.Corrective Actions.

   c. Society of Automotive Engineers, Inc. standardizes the quality system requirements of the aerospace industry.

5. Scope and Methodology.

   a. To accomplish the audit objective, we focused our audit on three major areas:

      (1) Acquisition and modification/upgrade of the AMAD for the F/18 A-D aircraft to include the applicable FAR provision(s);

      (2) DCMA and DON contractor oversight; and

      (3) The contractor’s Quality Assurance Program.

   b. To verify compliance with FAR provisions for the acquisition and modification/upgrade of the AMAD, we reviewed the LECP 40 and ECP 41 agreements, as well as the related contract requirements, such as MTBF rates. We reviewed contract number N00383-97-G-003D-003 for LECP 40, and contract number N00383-03-G-003H for ECP 41. In addition, we reviewed the Failure Review Board process for validating the causes of AMAD failures. The Failure Review Board is chaired by an official within the Naval Air Systems Command (NAVAIR) Reliability and Maintainability Department. We relied on computer-based data to examine actual MTBF for the F/A-18 A-D LECP 40 AMAD. To assess the accuracy and validity of the computer-processed data, we reconciled individual records to the summary AMAD reliability report obtained from NAVAIR.

   c. To verify compliance with quality assurance/quality control requirements of Navy aircraft gear component production, we reviewed DCMA’s contractor oversight and the selected contractor’s quality assurance policies and procedures. These include CARs that DCMA submitted to the contractor. For DON oversight, we reviewed the DON process
for tracking and assessing actual MTBF rates. In addition, we obtained and analyzed AMAD-related data, such as maintenance, repair, production, and delivery schedules.

d. Subsequent to obtaining authorization from the Department of Defense Inspector General to visit DCMA and the contractor facility, we met with DCMA and contractor personnel to assess the contractor’s quality assurance program. Specifically, we met with the Director of Quality, the manager of Quality Systems, the coordinator for corrective actions, the internal auditor, the Material Review Board Chairman, quality/inspection engineers, and the Director of Human Resources. We reviewed the contractor’s quality assurance policies and procedures and internal/external audit results. In addition, we reviewed contractor responses to 64 CARs issued by DCMA to the contractor from July 2004 through December 2007. This audit was performed between 12 February 2008 and 6 April 2009. During the audit, we met with NAVICP and NAVAIR on 17 December 2008 to discuss our audit results and obtain management’s responses to our discussion draft. On 27 January 2009, we met with DON Assistant General Counsel (Acquisition Integrity) (AIO) and staff to discuss preliminary results of our audit.

e. We visited and/or contacted the locations noted in Enclosure 3.

f. The most common acronyms used in this report are listed in Enclosure 4.

g. We conducted this performance audit in accordance with Generally Accepted Government Auditing Standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our results and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for results and conclusions based on our audit objectives. During the past 5 years, there were no prior audits concerning acquisition of gear systems from the selected DON contractor; therefore no follow up was required.

6. Audit Results.

a. Acquisition and Modification/Upgrade of AMAD. We found that DON acquired gear systems for the F/A-18 A-D aircraft in accordance with FAR and quality assurance requirements. Additionally, although the AMAD gear system was not meeting required reliability and maintainability rates, the failures primarily occurred because the dynamic loads experienced during actual fleet operations were greater than the AMAD and interconnecting (PTS were designed to withstand. Neither the interconnecting external PTS (made by a different contractor) nor the internal AMAD PTS to which it attaches were initially designed to withstand the actual pressure of the dynamic loads to which

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1 Dynamic loads mainly consist of the combination of radial loads and vibratory forces. A radial load is defined as a “force that is applied perpendicular to the axis of a bearing's shaft ... also called rotary loads.”
they were subjected. Two ECPs (LECP 40 and ECP 41) incorporated major engineering design changes to address this problem by strengthening the AMAD components to improve MTBF rates.

(1) Analysis of LECP 40

(a) AMAD Upgrades/Improvements. NAVAIR, NAVICP, DCMA, and the contractor held technical interchange meetings and critical design reviews (from 1999 to 2005) to determine the causes for the increase in maintenance actions and the decrease in MTBF rates for the AMAD. These meetings determined that the primary reason for AMAD failures was excessive dynamic loads between the AMAD and the PTS. This environment caused oil leaks from, and oil contamination in, the AMAD. According to procurement specifications, the PTS was not to exceed designed loads of 235 pounds-force. However, testing conducted by NAVAIR showed actual loads induced on the AMAD varied between 375 and 500 pounds-force. As a result of the increased loads, the AMAD PTS ball bearings, adjacent to the magnetic seal, experienced sporadic failures which destroyed the magnetic seals and allowed large amounts of debris into the AMAD oil system (see Enclosure 1 for details).

(b) AMAD Contractual Reliability and Maintainability Requirements. NAVAIR uses MTBF to measure AMAD reliability and maintainability. MTBF is a basic measure of reliability. We obtained documentation that indicated the LECP 40 AMAD MTBF requirements fluctuated between 3,000 and 5,000 hours from May 1996 to October 1999. For example, an AMAD procurement specification, dated 22 May 1996, stated that the MTBF requirement was 4,000 hours. However, we were unable to find any evidence that the 4,000-hour requirement was ever included in an actual contract. In contrast, the procurement specification, dated 15 June 1998, was included in contract number N00383-97-G-003D-0003, and stated that the MTBF requirement was 5,000 hours. Finally, an AMAD/PTS test plan, dated October 1999, stated that the MTBF requirement was 3,000 hours. However, we were unable to find any evidence that the 3,000-hour requirement was ever included in an actual contract.

(c) AMAD Reliability and Maintainability Rates. We reviewed available documentation to determine if the AMAD was achieving required MTBF rates of 5,000 MTBF hours. We obtained correspondence and meeting minutes from AMAD technical reviews that discussed actual MTBF rates prior to LECP 40 approval. For example, we obtained a copy of a letter from the contractor (at the time) to NAVAIR, dated May 1996, which stated that the actual cumulative MTBF\(^3\) for the period December 1992 through

\(^2\) Enclosure 5, Figures 1d and 1e, include diagrams of the external PTS shaft. Enclosure 5, Figures 1a and 1b, include diagrams of the internal AMAD PTS shaft to which the external PTS shaft connects. The external (interconnecting) PTS shaft is made by a different contractor than the AMAD PTS shaft.

\(^3\) Actual Cumulative MTBF was computed by an independent firm based on information from the National Aviation Logistics Data Analysis database.
May 1994 was 3,344 hours. Also, we obtained internal NAVAIR correspondence, which stated that the actual cumulative MTBF for the period January 1998 through May 1999 was 3,121 hours. However, we were unable to obtain underlying documentation to support the MTBF figures for data prior to January 2003.\(^4\)

i. In addition, we obtained correspondence that documented the actual MTBF rates prior to LECP 40 approval. However, we were unable to determine the timeframes associated with the MTBF rates and the source of the data discussed in the correspondence. For example, a critical design review, dated May 1999, documented an actual MTBF of 988 hours, and a briefing slide from a technical interchange meeting, dated July 1999, documented an actual MTBF of 1,600 hours. In January 2003, the NAVAIR Reliability and Maintainability Department began collecting and analyzing flight and failure data to track MTBF for the LECP 40 AMAD. According to the Department’s data, the actual cumulative MTBF for the period January 2003 through December 2007 was 2,007 hours (see Table 1 below).

Table 1: AMAD Mean Time Between Failure Rates

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<th>Calendar Years</th>
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<tr>
<td>2003</td>
<td>3,177</td>
</tr>
<tr>
<td>2003-2004</td>
<td>2,504</td>
</tr>
<tr>
<td>2003-2005</td>
<td>2,509</td>
</tr>
<tr>
<td>2003-2006</td>
<td>2,400</td>
</tr>
<tr>
<td>2003-2007</td>
<td>2,007</td>
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ii. Since the Department began collecting and analyzing flight and failure data in January 2003, the number one cause of AMAD failures reported by the fleet was AMAD seal leaks. From January 2003 to December 2007, the fleet reported a total of 358 AMAD failures. However, the Failure Review Board determined that 229 of the 358 failures reported by the fleet were operationally related.\(^5\) Of the 229 failures, 216 (94 percent) were caused by AMAD oil seal leaks.\(^6\) Contract N00383-97-G-003D-0003 for LECP 40 states that the contractor is not responsible for adverse impacts of the support equipment that is manufactured by other contractors. The AMAD MTBF rate as of December 2007 was 2,007 hours, which is below the 5,000-hour requirement in the procurement specification dated 15 June 1998 and incorporated into contract N00383-97-G-003D-0003. However, based on information in the contract, we could not

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\(^4\)We were able, however, to obtain documentation for actual MTBF figures for the LECP 40 AMAD beginning the period of January 2003 through December 2007.

\(^5\) The other 129 (358-229) either failed for reasons unrelated to operating the AMAD (114 items), such as breakage while handling, or final determination has not been made (15 items).

\(^6\) Breakdown of the 229 failures related to the AMAD operation and covered under warranty are as follows: 216 PTS Leaks, 12 Pressure Relief Valve failures, and 1 Chip Detector failure.
find that the AMAD contractor was responsible for failures caused by dynamic operating conditions beyond the contract specifications, and/or impacts of the external associated support equipment operating in conjunction with the AMAD. Therefore, the contractor may not be accountable for the failures, even though the AMAD did not meet the MTBF requirement.

(2) Analysis of ECP 41 -- AMAD Upgrades/Improvements. The ECP 41 upgrade included a redesigned wave spring that reduced the loads from the PTS. This upgrade was necessary because the previous wave spring allowed the magnetic seal to disengage and subsequently caused oil leakage from the PTS seal (see Enclosure 2 for details). ECP 41 included an MTBF requirement of 3,487 hours. However, since ECP 41 was not approved until December 2007, sufficient MTBF data were not available to provide a meaningful analysis of AMAD performance after the upgrade. Also, contract number N00383-03-G-003H for the ECP 41 upgrade (and contract number N00383-97-G-003D-0003 for LECP 40) states that the contractor was not responsible for adverse conditions imposed on the AMAD by the support equipment, including the PTS.

b. DCMA Contractor Oversight. DCMA was responsible for performing quality system reviews to ensure the contractor was compliant with quality assurance requirements. DCMA exercised sufficient oversight over the contractor’s quality assurance system in support of the AMAD component. The DCMA Salt Lake City office provided on-site surveillance of the contractor. Specifically, DCMA had quality assurance representatives located at the contractor’s plant to help ensure that AMADs met contractual requirements. For example, DCMA performed random inspections and floor checks during the repair of AMADs at the contractor’s site. In addition, DCMA issued CARs to document contractual noncompliance with products, manufacturing processes, or quality assurance systems. Also, DCMA participated in Failure Review Board decisions on dispositions of AMADs. Further, DCMA attended technical interchange meetings and critical design reviews held by the contractor from February 1999 to February 2001 to discuss engineering changes for the AMAD.

c. DON Contractor Oversight. DON was responsible for ensuring the AMAD upgrades were implemented in accordance with the LECP 40 and ECP 41 contracts. NAVAIR and NAVICP provided the necessary assistance and oversight of the AMAD program to ensure that the contractor’s performance and quality assurance system was sufficient. For example, NAVAIR validated the causes of AMAD failures, and NAVICP prepared a cost-benefit analysis that established justification for LECP 40. In addition, NAVICP helped to enforce quality assurance requirements, and evaluated and monitored contractor performance in addressing design issues associated with LECP 40 and ECP 41.
d. **Contractor Quality Assurance Program.** Generally, the contractor’s quality assurance program was sufficient and in compliance with the quality assurance requirements of the contracts, FAR 46, and ISO 9001. In July 2007, DCMA issued a Level III CAR identifying non-conformities with the contractor’s Quality Assurance Systems. This Level III CAR was based on data DCMA had reviewed from January through July 2007 that indicated potential contractual noncompliance, to include inadequate root cause analysis, ineffective policies and procedures, inadequate management reviews, and defective internal audit performance.\(^7\) Subsequent to the Level III CAR, based on information from DCMA, the contractor has implemented, documented, maintained, or made efforts to improve the effectiveness of its quality management system. For example, the contractor established a quality manual that included the scope of the quality management system, quality objectives, procedures, internal audits, and corrective actions. In addition, the contractor developed measurements, analyses, and improvement processes to demonstrate conformity of the product and quality management system. However, in our opinion, the contractor still has opportunities to improve its responsiveness to DCMA CARs.

(1) **Review of Corrective Action Requests.**

(a) We found opportunities for improvement with the contractor’s quality assurance system in the areas of responses to CARs and root cause analyses of CARs.

(b) We reviewed each of the 64 CARs DCMA issued to the contractor from July 2004 through December 2007. The 64 CARs included 14 Level I CARs, 49 Level II CARs, and one Level III CAR. DCMA issued the Level III CAR because prior Level I and Level II requests for corrective action had been ineffective in obtaining contractor resolution.

(c) The contractor had established a set of cause codes to help identify systemic or repetitive issues. However, as identified by DCMA, we noted instances where the contractor did not always use cause codes during root cause analysis to help identify repeat issues. Specifically, 13 of the 64 CARs we reviewed either had no cause code or had no place on the CAR form to document the cause code.\(^8\)

(d) In addition, 13 CARs had AMAD quality-assurance-related issues. Three of the 13 were Level I CARs. Ten of the 13 AMAD quality-assurance-related issues were Level II CARs. A Level I CAR does not require the contractor to perform a root cause analysis, whereas a Level II CAR does. We found that none of the 13 AMAD-

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\(^7\) DCMA Level III CAR issued in July 2007 consisted of a total of 16 CARs which addressed the following issues: inadequate root cause analyses, ineffective policies and procedures, inadequate management reviews, inadequate performance of internal audits, resource management issues, and quality escapes.

\(^8\) Cause code issues were included in the DCMA’s documentation supporting the issuance of the Level III CAR; however, we do not consider these to be material enough to impact our audit conclusions.
related CARs adversely affected AMAD performance. For example, one of the Level II CARs identified an instance in which the contractor did not notify DCMA of late deliveries for AMAD parts.

(2) National Aerospace and Defense Contractors Accreditation Program Audit Results. The DCMA Level III CAR noted that the contractor received poor performance ratings from NADCAP audits. We reviewed NADCAP audit results for a 4-year period (2004-2007) and found that the contractor did not pass two of three assessed areas within the 4-year period tested. Specifically, the contractor did not pass heat treating testing in December 2006, and chemical processing testing in March 2007. Subsequently, the contractor did pass heat treating testing in September 2007, and chemical processing testing in August 2007. Therefore, the contractor regained its NADCAP certification.9

(3) Parent Company Audit Results. Internal auditors of the parent company of the contractor performed an audit of the contractor’s quality management system in June 2007. The auditors found that the audit schedule was not completed or updated to address scheduling changes, the audits did not occur in a timely fashion as stated in the audit schedule, and the internal audit team of the contractor was not designated or trained. Because of the parent company’s audit and recommendations, the contractor: (1) hired, as an employee, an internal auditor from NADCAP; (2) completed the audits as required; and (3) obtained certification for all NADCAP areas. Therefore, we consider these actions sufficient in addressing the weaknesses regarding the contractor’s internal audit process.

7. Conclusion.

a. DON acquired gear systems for the F/A-18 A-D aircraft in accordance with FAR and quality assurance standards. In addition, we found that NAVAIR, NAVICP, and DCMA provided sufficient oversight over the contractor’s performance and Quality Assurance system in support of AMAD. Based on our review of the upgrade of AMAD, we also found the contractor sufficiently implemented, documented, and maintained its quality management system in accordance with the contracts and FAR 46. Although we found opportunities for improvements with the contractor’s quality assurance system, we did not find these to have an adverse impact on AMAD performance. The improvement opportunities identified were in the areas of responses to CARs and the associated root cause analyses as identified in the DCMA Level III CAR. Additionally, while the AMAD gear system was not meeting required reliability and maintainability rates, the failures primarily occurred because dynamic loads experienced by the interconnecting external PTS and the internal AMAD PTS during operations were greater than

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9 The contractor failed heat treat testing in two attempts before regaining its heat treat certification in September 2007.
anticipated by the original contract design requirements for both the AMAD and the connecting external PTS.

b. The Federal Managers’ Financial Integrity Act of 1982, as codified in Title 31, United States Code, requires each Federal agency head to annually certify the effectiveness of the agency’s internal and accounting system controls. In our opinion, the conditions noted in this report do not warrant reporting in the Auditor General’s annual Federal Managers’ Financial Integrity Act memorandum identifying management control weaknesses to the Secretary of the Navy.

8. Recommendations. This report contains no recommendations because the audit did not find any material deficiencies in the contractor’s quality assurance process that directly or adversely affected the performance of the AMAD gear system. In addition, the contractor has taken sufficient action to address weaknesses in the contractor’s quality assurance system and internal audit process that were not attributable to the AMAD itself.

9. Any requests for this report under the Freedom of Information Act must be approved by the Auditor General of the Navy as required by reference (b). This audit report is also subject to followup in accordance with reference (b).

10. We appreciate the cooperation and courtesies extended to our auditors.

Assistant Auditor General
Research, Development, Acquisition, and Logistics Audits

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The design improvements for the Logistics Engineering Change Proposal 82402-97-E-0040 (LECP 40), approved on 19 June 2000, addressed oil contamination within the Airframe Mounted Accessory Drive (AMAD), which resulted in damage and failure to the AMAD. The seven major design improvements noted in LECP 40 include the following:

1. Oil Screen Upgrade: The upgraded oil screens protected the internal oil pumps against damage from oil contamination. The problems with the prior oil screens included oil contamination from the Air Turbine Starter and Generator, which attach to the AMAD, and share oil and components within the AMAD. As a result, the current design had unfiltered oil being supplied to the pump inlets and testing showed that contaminated oil can jam or lock up the pump rotor since the rotor has small internal clearances. The solution to the design improvement was to add two oil screens on the C/D AMAD that were identical in micron rating to those already incorporated into the E/F AMAD design.

2. Coarse Pump Gears Upgrade: The upgrade incorporated a stronger gear mesh, reducing the susceptibility to damage caused by contamination in the oil system. The problems with the prior gear mesh included damage to the pump drive gears, and polishing wear and surface fatigue that, in some cases, caused the gear teeth to bend. Additionally, the high levels of vibration in the aircraft contributed to the gear teeth stresses. Wear from the teeth can contribute to oil contamination in the AMAD. The solutions to the design improvements were to incorporate a stronger pump drive and change the material and hardness of the gear teeth. The changes to the pump drive and gear teeth were identical to the F/A-18 AMAD E/F designs.

3. Power Transmission Shaft (PTS) Bearing Upgrade and PTS Fit Enhancement: The upgrade incorporated a larger PTS bearing with a greater load carrying capability. The upgrade also provided a tighter fit for the PTS mating components. The problem with the prior configuration included sporadic failures of the PTS aft ball bearing that destroyed the adjacent magnetic seal. As a result, a large amount of debris entered the lubrication system and unfiltered oil eventually contaminated the lube pumps. The solutions to the design improvements were to replace the PTS bearing with a larger type of ball bearing that could handle greater loads and upgrade the PTS bearing with improved fit.
4. Enhanced Bearing Materials and Fits: The change incorporated tighter fits and enhanced materials into four ball bearings within the AMAD. The change eliminated the creation of oil debris from inner bearing rotation.

5. Decoupler Handle Material Change: The changes eliminated wear from incompatible material used for the decoupler ball that was used in the actuator assembly. The actuator assembly is used to lock and unlock the input drive to the AMAD gearbox. The decoupler ball was softer than the mating components and would wear to a point that it loosened. The solution presented was to change the material in a component of the decoupler handle assembly to the same material used in the mating components.

6. Magnetic Seal Upgrade: The upgrade changed the magnetic seals in three locations of the AMAD to reduce the amount of oil leakage. The previous design experienced periodic leakage. The new design incorporated new material and processes designed to stabilize the thermal growth properties and dynamic operation that resulted in a seal that reduced leakage incidents of the AMAD.

7. Generator Bearing Preload: The upgrade resulted in the generator gear shaft bearings being preloaded with axial force that stabilized the rotating ball elements and cage interaction. The generator bearings experienced occasional failure of the cage rivets and were changed to stainless steel rivets. The proposed solution was to modify the bearing retainer assembly to accept a new wave spring.
Enclosure 2:
ECP 41 Design Improvements

The design improvements for the Engineering Change Proposal 82402-07-E-0041 (ECP 41), approved on 12 December 2007, addressed warranty issues with the Airframe Mounted Accessory Drive (AMAD) associated with LECP 40, and provided improvements to the overall reliability of the F/A 18 C/D fleet of aircraft. From November 2002 to May 2005, 190 AMADs were returned to the contractor for warranty claims. Of the 190 AMADs, 53 were returned due to Power Transmission Shaft (PTS) seal leakage, and 10 were returned for faulty pressure relief valve operation. The two major design improvements noted in ECP 41 include the following:

1. PTS Seal Upgrade: The upgrade included a newly-designed wave spring that will exert a greater force of 130 to 180 pounds on the bearings to keep the PTS Shaft from movement that can cause oil leakage. The problem with the prior configuration was that the wave spring provided a lesser force of 18 to 32 pounds on the bearings, enabling too much movement in the PTS shaft that allowed the magnetic seal to disengage under shock and vibration operating conditions, causing oil leakage from the PTS seal. This resulted in AMADs being returned to Naval Aviation Depots earlier than was normal for repair and maintenance actions due to the AMAD seal leaks.

2. Pressure Relief Valve Upgrade: The upgraded pressure relief valve improved slide and seat performance to prevent the AMAD from experiencing pressure fluctuations. The problem with the prior valve was that it was sticking and binding due to differences in material between the seat and slide, and from burrs on the slide. The seat material was changed to match the slide material, and burrs were removed from the slide to make it smoother. This should improve the performance of the pressure relief valve to prevent AMADs being returned to Naval Aviation Depots for pressure fluctuations.
Enclosure 3:

Activities Visited and/or Contacted

- Office of the Department of Defense Inspector General, Arlington, VA
- Defense Contract Management Agency, Salt Lake City, UT
- Naval Air Systems Command, Patuxent River, MD
- Naval Supply Systems Command, Naval Inventory Control Point-Philadelphia, PA
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>AMAD</td>
<td>Airframe Mounted Accessory Drive</td>
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<td>CAR</td>
<td>Corrective Action Request</td>
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<td>Defense Contract Management Agency</td>
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<td>Department of the Navy</td>
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Enclosure 5:

AMAD/PTS Diagrams

Fig 1a: Airframe Mounted Accessory Drive (AMAD) Pictorial Diagram: Gearbox Assembly

[Diagram of Gearbox Assembly with labeled parts: HYDRAULIC PUMP GEAR, HYDRAULIC PUMP IDLER GEAR, OIL JET RING, FUEL PUMP GEAR, FUEL PUMP IDLER GEAR, OIL JET RING, P.T.S. GEARSHAFT, GENERATOR GEARSHAFT, P.T.S. ASSEMBLY, DECOUPLER ASSEMBLY]
Fig 1b: AMAD Gearbox Assembly (Top/Front View)
Fig 1c: AMAD Gearbox Assembly (Rear/Bottom View)
Fig 1d: PTO PTS Shaft Diagram
Fig 1e: PTO PTS Shaft Diagram (View thru Door)