NPS-LM-11-016

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**Operational Analysis of Contractor-Supported Ground Support Equipment (GSE) at the Oklahoma City Air Logistics Center**

**7 June 2011**

**by**


**LCDR Brian Garbert, USN,**

**LCDR Geoff Holly, USN, and**

**LCDR Joseph Peth, USN**

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# ABSTRACT

This exploratory study provides a detailed analysis of ground support equipment (GSE) maintenance and operations at the Oklahoma City Air Logistics Center (OC-ALC) to support future contract negotiations. The United States has been engaged in combat operations for over ten years. A key component of these combat operations has been airpower. A high wartime operational tempo and the use of aging airframes, some of which were scheduled to be retired decades ago, have solidified the need for a refined depot-level maintenance system designed to quickly and effectively dismantle, rebuild, and reconstitute combat and support aircraft. A critical part of the foundation that this system is built upon is the management of critical GSE, which is essential to depot-level maintenance operations. The purpose of this study is to provide a top-level analysis of current GSE management processes in order to better understand the effectiveness of current contractor logistics support, estimate the operational availability of ten categories of GSE, and provide specific findings and recommendations for the leadership at the OC-ALC.

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AE | Aeromedical Evacuation |
| AF | Air Force |
| AFB | Air Force Base |
| AFI | Air Force Instruction |
| AFMC | Air Force Materiel Command |
| AFPD | Air Force Policy Directive |
| ALC | Air Logistics Center |
| Ao | Operational Availability |
| A/R | Aerial Refueling |
| BPP | Business Planning Process |
| CLS | Contractor Logistics Support |
| CBM+ | Condition-Based Maintenance Plus |
| DAF | Department of the Air Force |
| DLA | Defense Logistics Agency |
| DoD | Department of Defense |
| DoDD | Department of Defense Directive |
| DoDI | Department of Defense Instruction |
| eFMS | Electronic Facility Management System |
| FFP | Firm-Fixed Price |
| FY | Fiscal Year |
| GSE | Ground Support Equipment |
| ILCM | Integrated Life Cycle Management |
| IUID | Item Unique Identification Device |
| NPA | Non-Powered Assembly |
| JCS | Joint Chiefs of Staff |
| OC-ALC | Oklahoma City Air Logistics Center |
| OCAMA | Oklahoma City Air Material Area |
| OPTEMPO | Operational Tempo |
| PA | Powered Assembly |
| PBL | Performance-Based Logistics |
| PPP | Public-Private Partnership |
| RFI | Request for Information |
| RFID | Radio Frequency Identification |
| SECDEF | Secretary of Defense |
| SOA | Service-Oriented Architecture |
| SOR | Sources of Repair |
| SORAP | Source of Repair Assignment Process |
| U.S. | United States |
| TAT | Turnaround Time |
| TO | Technical Order |
| USAF | United States Air Force |
| U.S.C. | *United States Code* |

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# I. INTRODUCTION

The United States Air Force (USAF) has been engaged in continuous combat operations for more than a decade. Sustained combat operations have increased the operational tempo (OPTEMPO) of combat and support aircraft alike. Aircraft such as the B-52 and B-1B have been utilized not only in their original strategic bombing role but also in a close air support role, for which they were not originally designed. Air refueling and strategic lift capabilities are being pushed to the limit. The aerial refueling (A/R) capability provided by the tanker fleet allows U.S. fighters, bombers, transports, and reconnaissance aircraft to fly farther and longer and reach places and targets that would otherwise be unattainable. Tanker aircraft are the key enablers of our joint global force, and without them, much of our current and future military operations would come to a halt and our nuclear deterrence capability would be drastically reduced. The missions that tankers fly are wide-ranging: from Deployment Support A/R, Air Bridge A/R, Global Attack A/R, Theater Support A/R (both Combat Air Forces and Mobility Air Forces), Aeromedical Evacuation (AE), Nuclear Missions Support, and Homeland Defense Support to nuclear deterrence. The tanker fleet, on average, exceeds 50 years of age and requires a specific depot-level maintenance schedule designed to keep the fleet in the air. The security interests of the United States are potentially at risk if there is a delay associated with redeploying from depot repair operations. If missions are delayed, the U.S. and its ability to project combat power will be drastically affected. The increased OPTEMPO has decreased the life cycle of each airframe, while the demand for each airframe has increased to meet wartime and homeland security requirements (Government Accounting Office [GAO], 2004, pp. 1–7). The USAF has created a periodic depot-level maintenance program to offset the degradation of the entire fleet. High throughput and quick turnaround times (TATs) are an integral part of this maintenance process. Slower throughput during depot-level maintenance will have a detrimental effect on training and combat operations.

The USAF depot-level maintenance relies on several moving parts and processes. Ground support equipment (GSE) is a critical part of these processes because it provides the underlying infrastructure required to effectively perform depot-related maintenance on individual airframes. Without GSE, depot-level maintenance grinds to a halt. The USAF must find the right mix of GSE to provide the right equipment at the right time at the lowest cost and be able to accurately account for the GSE to prevent any loss in throughput.

# II. PROJECT OVERVIEW

The USAF currently operates three Air Logistics Centers (ALCs), located at Tinker Air Force Base (AFB), OK; Ogden AFB, UT; and Robins AFB, GA. Each ALC is designed to support the depot-level maintenance of different airframes while prolonging the aircraft's life span through replacement of critical spares, life cycle extension programs, and system upgrades. These maintenance operations have proven to be critical to the long-term sustainment of combat power in light of the fact that the U.S. has conducted continuous combat operations for over a decade now. Airframes such as the B-52 and the C-135 derivatives, which in some cases are over fifty years old and were scheduled to be decommissioned years ago, had their service lives extended beyond original life cycle estimates. Reasons for this extension include delayed development of newer aircraft to replace existing airframes, increasingly constrained funding sources, and increased OPTEMPO. The three ALCs are critical to the sustainment of the combat, combat support, and logistics support capabilities provided by the USAF and are in themselves a force multiplier. This top-level exploratory study is focused on the optimization of GSE, which is an integral part of the maintenance and overhaul process at the Oklahoma City ALC (OC-ALC). The study has been requested by the leadership at the OC-ALC and does not include the processes or data associated with the two remaining ALCs.

Typically, the GSE category includes items such as jack stands, air conditioners, and other equipment used to service or overhaul. The GSE located at the OC-ALC is currently managed through contractor logistics support (CLS), which is governed by several laws and regulations, including those listed in the appendix of this study. A contractor is responsible for the maintenance, overhaul, movement, and logistical support of GSE required to sustain the current number of aircraft being processed at the OC-ALC. Several studies have reviewed the operational and cost effectiveness of CLS and its support of major weapons systems. According to one study performed by the RAND Corporation, titled *Contractor Logistics Support*, 86% of the funding provided for CLS is spent on aircraft systems such as the B-1, B-52, and C-135 derivatives and the E-3 (Boito, Cook, & Graser, 2009, p. IX). These airframes are the primary customer base at the OC-ALC. However, there is a lack of in-depth analysis of support equipment for major weapons systems at the depot maintenance level that is managed through

CLS. The purpose of this study is to fill that gap by examining the current processes used to track and maintain GSE and to provide recommendations for process improvement that will optimize GSE at the OC-ALC. Specific research questions, methodology, and recommendations will be addressed in Chapters V through VII.

# III. OC-ALC HISTORY AND BACKGROUND

## A. HISTORY

In October 1940, a group of Oklahoma City executives formed the Industries Foundation in an attempt to attract a military facility to the Oklahoma City area when they learned that the Department of Defense (DoD) was looking for a centralized maintenance depot for its B-24, B-17, and B-29 bomber aircraft. It was through their efforts that the Tinker Army Airfield was created. On April 8, 1941, the U.S. War Department announced Oklahoma City as the future site of a new air material depot that would encompass more than 1,500 acres and employ an expected 3,500 people. A few months after that announcement, the Army Air Forces also chose to construct a large assembly plant to be operated by Douglas Aircraft next to the air material depot. Tinker Army Airfield became a permanent base after the end of World War II. The Tinker Air Material Depot acquired the Douglas Aircraft assembly plant soon after the war, and new workloads were shifted to take advantage of the new capacity. The Tinker Air Material Depot was renamed the Oklahoma City Air Material Area (OCAMA) on July 2, 1946. Tinker AFB, formerly known as Tinker Army Airfield, was now poised to become a leader in aviation maintenance (OC-ALC, n.d., pp. 7–13).

Since its inception, Tinker has performed maintenance on aircraft, parts, and engines including the B-29 Superfortress, the B-47 Stratojet, the C-97 Stratofreighter, the KC-135 Stratotanker, the B-52 Stratofortress, the F-4 Phantom II, and F-I05 Thunderchief fighter jets, as well as the A-7 Corsair II attack aircraft and the TF41 engine. On April 1, 1974, OCAMA became the Oklahoma City Air Logistics Center (OC-ALC). In 1975, the OC-ALC assumed the management responsibility for the E-3 Sentry aircraft, and in July 1976, the 552nd Airborne Warning and Control Wing activated its units at Tinker AFB. During the 1980s, the OC-ALC was assigned additional management responsibilities for the B-1 Lancer and the B-2 Spirit bombers and completed maintenance work on its first B-1 in 1988. It continued depot work on the FI0l, the FI07, the FI08, and the Fll0 engines in the mid-1980s while maintaining management responsibilities for a host of other engines. Tinker continued its efforts and supported the war efforts of Operations Desert Shield and Desert Storm in 1991. The Navy's

Strategic Communications Wing ONE completed its move to Tinker in 1992, which was the first time a Navy wing had relocated to an Air Force Base (OC-ALC, n.d., pp. 7–13).

Tinker AFB is currently the largest single-site employer in the state of Oklahoma and has the largest percentage of civilian personnel of any organization within the Air Force Materiel Command (AFMC). Tinker AFB's 5,001 acres include two active runways and 254 acres of ramp space. The OC-ALC facility has over 138 acres of indoor maintenance facilities and 93 acres of covered warehouse space. Building 3001, which is the headquarters of the OC-ALC, covers 62 acres and stretches for nearly a mile (OC-ALC, n.d., pp. 7–13).

## B. OC-ALC BACKGROUND

Currently, the OC-ALC supports an inventory of 2,261 aircraft—primarily the B-1, the B-2, the B-52, the E-3, the VC-25 (two modified Boeing 747-200s, best known as Air Force One), the E-4, and the KC-135. In addition to the aircraft depot-level airframe maintenance mission, the OC-ALC supports the depot-level maintenance of nearly 23,000 jet engines and missile systems (e.g., air-launched cruise missiles, conventional cruise missiles, harpoons).

The largest organization within the OC-ALC is the 76th Maintenance Wing. The 76th Maintenance Wing is composed of more than 8,500 military and civilian professionals who are primarily tasked with performing maintenance on, repairing, and overhauling the E-3, the C-135 derivatives, the B-52, the B-1, the C-130 Hercules, and the Navy's E-6 Mercury, as well as more than 22,000 engines and 32,000 components for the Air Force. The 76th Maintenance Wing is also tasked with developing software and operational flight programs for aircraft, cruise missiles, test stations, and support equipment. Five groups make up the 76th Maintenance Wing: Aircraft Maintenance Group, Propulsion Maintenance Group, Commodities Maintenance Group, Software Maintenance Group, and Maintenance Support Group.

The 76th Aircraft Maintenance Group is responsible for the management of organic depot-level maintenance, repair, modification, overhaul, functional check flights, and reclamation of all C-135 derivatives and B-1, B-52, C-130, E-3, and E-6 aircraft. The 76th Aircraft Maintenance Group supports the depot support operations for the fleet of Air Force, Air Force Reserve, Air National Guard, Navy, and Foreign Military Sales aircraft, as well as some expeditionary combat-logistics depot maintenance and distribution support. The 76th

Aircraft Maintenance Group is additionally responsible for the welfare and training of more than 2,800 military and civilian personnel, 10 facilities, and a $692 million annual operating budget.

The mission of the 76th Aircraft Maintenance Group is to "provide our customers responsive, cost-effective Maintenance, Repair and Overhaul capabilities while delivering safe, reliable, and defect-free aircraft to enable our warfighters' mission accomplishment" (OC-ALC, n.d., p. 17). The signature capabilities of the 76th Aircraft Maintenance Group are the following:

- overhaul, repair, and testing;
- manufacturing and machining; and
- engineering services.

As the only Air Force depot-level maintenance facility supporting Air Force and Navy aircraft engines, the Propulsion Maintenance Group is responsible for the maintenance of these aircraft engines. The group performs repairs on engines and major engine assemblies for the F-15 Eagle, the F-16 Falcon, the E-3 Sentry, the E-6, the E-8, the B-52, the B-1, the B-2 Spirit, the C-18, the C-135 derivatives, and the F-22 Raptor. This group is also the prime contractor for the repair of the F100 engine for the Propulsion Business Area contract.

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# IV. GSE OVERVIEW

GSE encompasses a wide variety of equipment used for aircraft repair and can be separated into two distinct categories: non-powered and powered. The equipment may or may not be static in nature. Currently, there is a total of 2,433 pieces of GSE in use at the OC-ALC in direct support of depot-level maintenance. The GSE is tracked through user input captured by a database known as Maximo. Of the 2,433 pieces of GSE, 73% are considered non-powered assemblies (NPA) and 27% are considered powered assemblies (PA).

## A. NON-POWERED ASSEMBLY

The non-powered (NPA) GSE includes a variety of equipment used for aircraft repair. The key characteristic that defines NPA is that there is no engine and it is non-motorized. If the GSE has a hand-cranked hydraulic adjustment mechanism, it is still listed as NPA because the equipment is manually powered. The average cost for a piece of NPA equipment is approximately $9,000. Figures 1–3 and Table 1 and their corresponding information outline the top three critical pieces of non-powered GSE identified by the leadership at the OC-ALC.

**Aircraft Tow Bars**

**B-52 TOW BAR**

**NSN: 1730-01-061-4444**

Nomenclature: TOW BAR, AIRCRAFT

Current Replacement Cost: $59,872.46

Count at OC-ALC: 2

(Defense Logistics Agency [DLA], 2011)

**Figure 1. Aircraft Tow Bar**

**<u>B-4 Maintenance Stand</u>**

**NSN: 1730-00-294-8883**

Nomenclature: MAINTENANCE PLATFORM, AIRCRAFT

Current Replacement Cost: $3,584.00

Count at OC-ALC: 193

(DLA, 2011)


**Figure 2. B-4 Maintenance Stand**

**<u>30-Ton Hydraulic Tripod Jack</u>**

**NSN: 1730-00-516-2017**

Nomenclature: JACK, HYDRAULIC, TRIPOD

Current Replacement Cost: $4,819.00

(DLA, 2011)

This hydraulic jack is modified upon entering the OC-ALC, depending on the length of the extension attached to it. The extension length is dependent on the job it is expected to perform. Based on the extension length, it is given a different nomenclature. The quantities of the different lengths are listed as follows:

**Table 1. Types of Hydraulic Jack Stands**
(DLA, 2011)

| Nomenclature | NSN | Replacement Cost | Count |
|---|---|---|---|
| Jack Tripod 30T 1X | 1730-00-516-2017 | $4,819.00 | 128 |
| Jack Tripod 30T 2X | 1730-00-516-2017 | $4,819.00 | 84 |
| Jack Tripod 30T 0X | 1730-00-516-2017 | $4,819.00 | 80 |
| Jack Tripod 30T 4X | 1730-00-516-2017 | $4,819.00 | 75 |
| Jack Tripod 30T 3X | 1730-00-516-2017 | $4,819.00 | 57 |

**Figure 3. 30-Ton Hydraulic Jack Stand**

## B. POWERED ASSEMBLY

The powered assembly (PA) GSE includes equipment that is run by either an engine or an electric motor. The average cost of a piece of PA GSE is $50,000. Figures 4–10 and their corresponding information outline the top seven critical pieces of non-powered GSE identified by the leadership at the OC-ALC.

**<u>135 Cabin Pressure Tester</u>**

**NSN: 4920-01-123-7247**

Nomenclature: TESTER, PRESSURIZED CABIN LEAKAGE, AIRCRAFT

Current Replacement Cost: $81,156.79

Count at OC-ALC: 193

(DLA, 2011)


**Figure 4. 135 Cabin Pressure Tester**

**<u>Hydraulic Test Stand</u>**

**NSN: 4920-01-279-4762**

Nomenclature: TEST STAND, HYDRAULIC SYSTEM COMPONENTS

Current Replacement Cost: $190,000.00

(DLA, 2011)


**Figure 5. Hydraulic Test Stand**

**<u>Diesel Generator-86</u>**

**NSN: 6115-00-118-1240**

Nomenclature: GENERATOR SET, DIESEL ENGINE

Current Replacement Cost: $14,891.00

(DLA, 2011)

**Figure 6. Diesel Generator**

**<u>Air Starter-95</u>**

**NSN: 2835-01-390-1807**

Nomenclature: POWER UNIT, GAS TURBINE ENGINE

Current Replacement Cost: $145,686.54

(DLA, 2011)


**Figure 7. Air Starter**

**<u>Low Air Compressor (MC-2A)</u>**

**NSN: 4310-01-370-6351**

Nomenclature: COMPRESSOR UNIT, ROTARY

Current Replacement Cost: $6,862.22

(DLA, 2011)


**Figure 8. Low Air Compressor**

**<u>Nitrogen Service Cart</u>**

**NSN: 3665-01-463-3338**

Nomenclature: GENERATING PLANT, OXYGEN-NITROGEN, SEMITRA

Current Replacement Cost: $85,000.00

(DLA, 2011)


**Figure 9. Nitrogen Service Cart**

<u>**Diesel Air Conditioner (DAC)**</u>

**NSN: 4120-01-368-8258**

Nomenclature: AIR CONDITIONER

Current Replacement Cost: $50,040.99

(DLA, 2011)


**Figure 10. Air Conditioner**

## C. GSE TRACKING AND DATABASE MANAGEMENT

The data utilized in this study was extracted from the Maximo database at the OC-ALC. Maximo is an Enterprise Asset Management System developed by IBM and is a computerized asset maintenance system that provides asset management, work management, materials management, and purchasing capabilities at Tinker. Maximo is used to support asset management and service performance of production, facility, transportation, and IT assets. Maximo is designed to allow Tinker management to create a strategy for maintenance, repair, and operations. Built on a service-oriented architecture (SOA), Maximo software is used to provide a comprehensive view of all asset types, their conditions and locations, and the work processes that support them (Computerized Facility Integration [CFI], 2007).

The initial data provided by OC-ALC personnel managing the Maximo database covered two fiscal year (FY) periods: from October 1, 2008, through September 30, 2010. We chose a two-year time frame because we believed that two years of data would provide a clearer picture of the GSE operations and maintenance actions. We then requested additional data to refine our research. This data request covered a three-year period, from March 2008 through February 2011.

We requested data to be drawn from the Maximo database under different header fields located in the Electronic Facilities Management System (eFMS) interface. eFMS is the user input system used by OC-ALC personnel, which then uploads to the Maximo database. Figure 11 shows examples of some of the available header fields. The authors submitted a request for information (RFI) using the headers provided and received the data in a Microsoft Excel spreadsheet format.

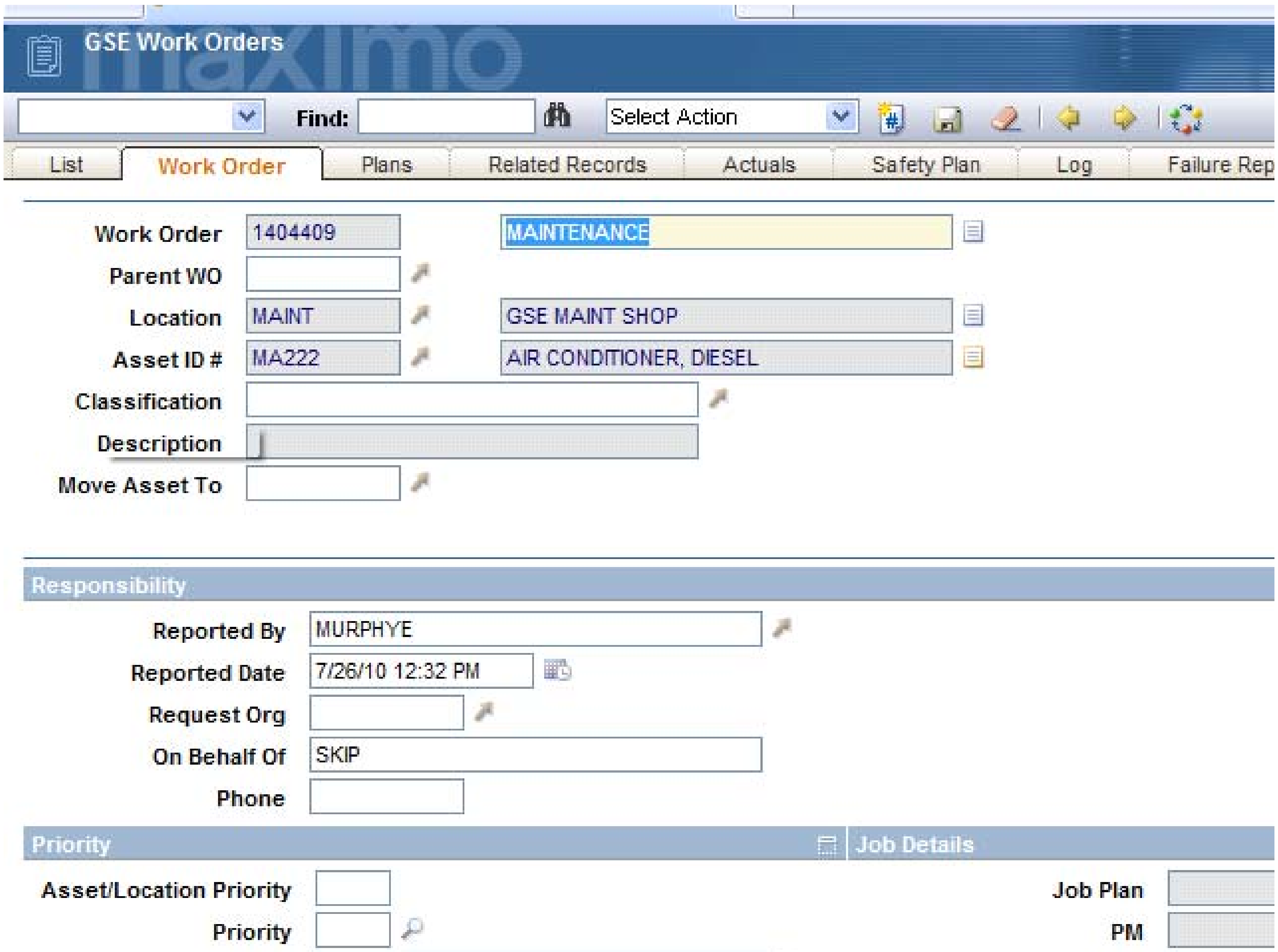


**Figure 11. Example Header Fields**

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# V. RESEARCH QUESTIONS

There are two fundamental questions of interest regarding the management of GSE at the OC-ALC. The first is whether there is excess GSE at the center. The second is whether there are certain types of equipment whose demand, and therefore maintenance requirements, are greater than others.

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# VI. RESEARCH METHODOLOGY AND FINDINGS

## A. DESCRIPTIVE ANALYSIS

The first step in the analysis of GSE operations at the OC-ALC was to determine the operational processes that are currently in place. There are currently four custodians (assigned by weapon system) who are accountable for GSE at the OC-ALC. However, the management of GSE is not their primary responsibility. Because GSE management is a collateral duty for these four custodians, it is difficult for them to completely focus on the maintenance and accountability of GSE. These custodians interact with the contractor logistics support team to ensure that maintenance is performed when scheduled or required. The GSE management process includes the dispatch of GSE to different locations within the OC-ALC, scheduling of preventative maintenance, as well as reaction to corrective maintenance. This section explains the major operational processes.

### 1. Ground Support Equipment Maintenance and Dispatch Process Flow

When a piece of GSE is received at the OC-ALC, the contractor will input the equipment into eFMS. A sample of the eFMS interface with Maximo is shown in Figure 11. The eFMS interface feeds information directly into the Maximo database. On the initial input into eFMS, the equipment will be assigned the following:

- equipment description,
- location of equipment,
- field number, and
- schedule for planned maintenance.

Once the equipment is entered into the system, it becomes available for use by an organization or work center. It is at this point the GSE is sent out to the ready line for issue. After the GSE is on the ready line, work centers will call up the dispatch office for delivery, re-spot, service and return, or pickup. At this time, the work centers will use the GSE for its intended purpose. When the equipment is done being used by the work center or due for its maintenance cycle, the contractor will pick the piece up and drop the GSE off for maintenance or to be available for reissue from the ready line. Whether the GSE is sent to get maintenance or straight to the ready line, the eFMS system will be updated to reflect the current status of the equipment (see Figure 12).

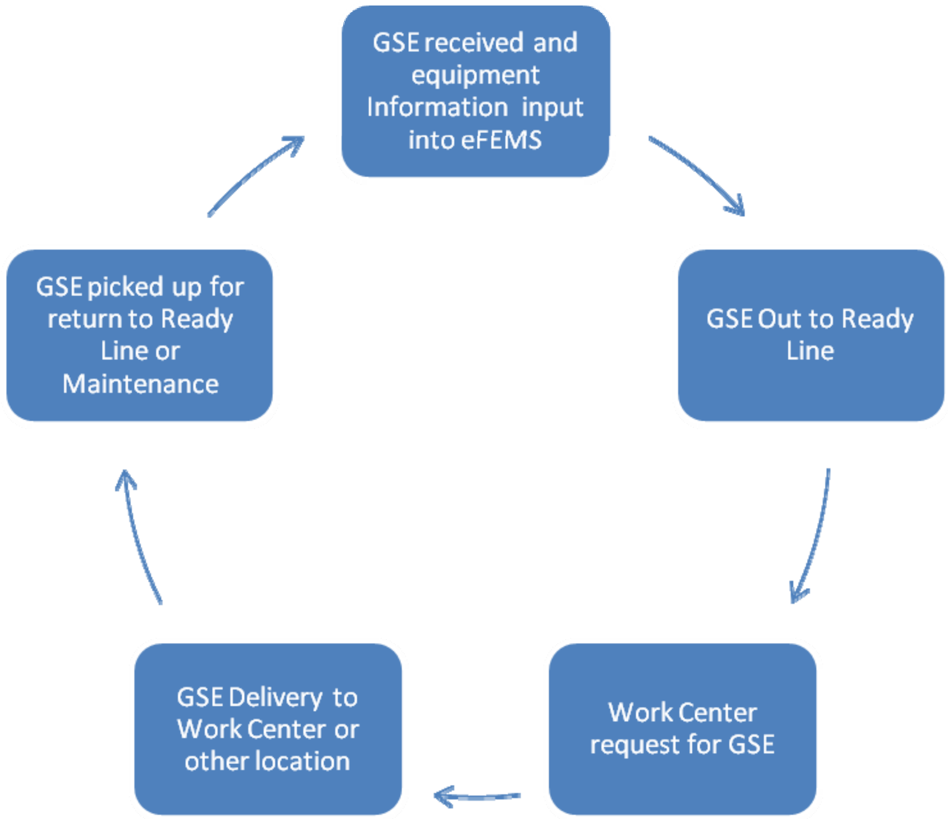


**Figure 12. GSE Management Flow Diagram**

Once we received the data from the Maximo database, we focused in on several key variables of interest (e.g., the total number of maintenance actions, the length of time each one took to complete, and the number of GSE that had not been dispatched in the last two years).

The first step in the analysis determined the total amount of time that GSE spent in maintenance during FY2009 and FY2010. There were a total of 19,186 different maintenance actions at the OC-ALC. Of these 19,186 different actions, analysis showed that almost 50% of the maintenance was completed in fewer than five days, as depicted in Figure 13. It may be that the contractor is consistently providing service in a relatively quick manner and that long periods of maintenance downtime is the exception rather than the norm.

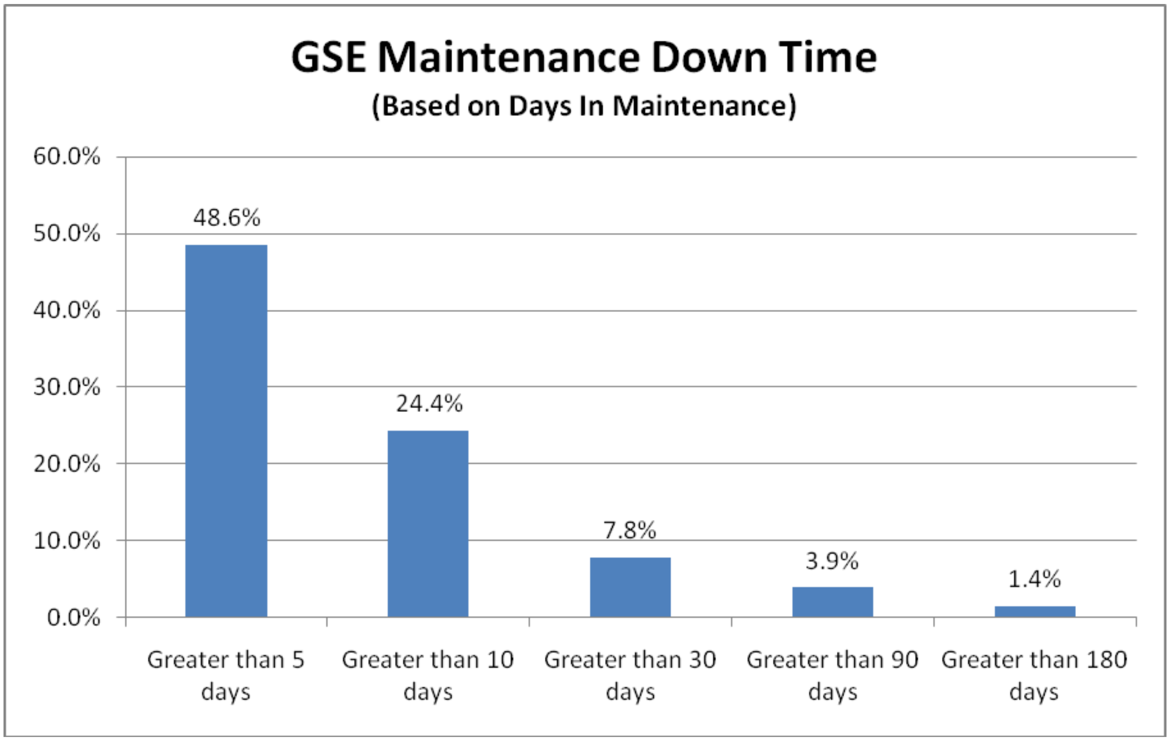


**Figure 13. GSE Maintenance Downtime (Percent Based on Days in Maintenance)**

The next step in the analysis determined the total number of locations to which the GSE can be dispatched. A dispatch is considered to be a move from one location to another. In other words, if a piece of GSE were available on the ready line and subsequently requested by a work center, the movement from the ready line to the work center would be considered a dispatch. Using the data provided, we determined findings that showed 337 different locations within Maximo to which the GSE could be dispatched. There are two critical deficiencies in the way the locations are created within the Maximo database. First, as shown in Table 2, not all locations include a description of the geographic location of the drop-off point. Second, some of the locations are very generic in terms of where the GSE is located. For example, one location references a drop-off location that is adjacent to one of the doors leading to Building 3001, which is almost one mile long. A manager would have difficulty tracking the equipment when its specific geographic location is unknown.

**Table 2. Sample Database Locations of GSE**

| LOCATION | DESCRIPTION |
|---|---|
| 210 | |
| 2101 | |
| 2101-SS06 | DISPENSER BLDG 2101 |
| 2121N | Hangar 2121 North |
| 2121S | Hangar 2121 South |
| 2121W | Hangar 2121 West |
| 2122 | Bldg 2122 |

The final step in this portion of the analysis involved quantifying the total number of pieces of GSE as well as their purchase cost. The GSE is separated into three categories: NPA, PA, and silhouettes. Calculations show the total amount of GSE to equal 4,009 total pieces of equipment. Of the 4,009 pieces of GSE, 664 are classified as powered, 1,779 are classified as non-powered, and the remaining 1,566 are classified as a silhouette. Using the purchase price of the equipment (listed in Maximo), the combined total of GSE came in at over $36 million dollars, with almost $25 million in powered GSE alone, as shown in Table 3.

**Table 3. Total Procurement Cost of GSE**

| | Number of GSE | **Total Cost** | Average Cost |
|---|---|---|---|
| Powered | 664 | **$25,785,475** | $38,833.55 |
| Non-powered | 1,779 | **$10,888,046** | $6,120.32 |
| Silhouettes | 1,566 | **0** | 0 |
| Total GSE | 4,009 | **$36,673,521** | $9,147.80 |

## B. GSE DISPATCH ANALYSIS

### 1. Methodology

We performed an analysis to determine the number of times a piece of GSE was dispatched. Our assumption was that if preventative maintenance was performed twice per year, GSE should be relocated a minimum of two times per year to the maintenance area and then returned to either a lay-down area or some other point of use. Additionally, the data would indicate if a piece of GSE is in high demand by listing a high number of dispatches. We ascertained that 158 individual pieces of GSE listed under the current maintenance contract were dispatched only once during a two-year period, as shown in Table 4. In addition, we determined that in 20 separate instances, GSE not listed under the maintenance contract was dispatched. This lack-of-movement data suggests that not all GSE is tracked when moved. Accurate tracking information would assist in a better evaluation of actual usage times based on whether a piece of equipment is in use at a specific work center or in a lay-down area awaiting demand. It would also allow managers to look at usage trends, including the effect that seasonality has on the demand of specific GSE items. It also provides the ability to correctly determine the number of moves required per year to optimize manpower levels in the contract to ensure that the correct number of personnel is available to move equipment as needed. If this data is correct and the items have not been moved, they may be excess items that could be disposed of.

### 2. Findings

Table 4 shows the types of equipment that did not move during a 24-month period.

**Table 4. List of GSE Not Dispatched in a 24-Month Period**

| Nomenclature | Number of GSE not moved | Nomenclature | Number of GSE not moved |
|---|---|---|---|
| BLOWER CRASH | 30 | AIRCRAFT LIFT TRAILER | 1 |
| TRAILER FLATBED | 13 | B2 - MAINT PLATFORM | 1 |
| TRAILER ENGINE | 9 | B4 - MAINT PLATFORM | 1 |
| AIR CONDITIONER, LARGE | 8 | CABIN PRESS TEST VESSEL | 1 |
| NACELLE WORKSTAND | 8 | CART GAS OXYGEN | 1 |
| TRAILER LOWBOY | 8 | CART HYD SERVICE | 1 |
| JACK TRIPOD 30T 3X | 6 | CART LIQUID NITRO | 1 |
| AEB AFT TAIL STAND | 4 | CART OIL SERVICE/HAND | 1 |
| CART LIQUID OXYGEN | 4 | FLOOR HOIST COWL | 1 |
| CART OIL SERVICE | 4 | HYDRAULIC RECOVER UNIT | 1 |
| JACK FLOOR 10 TON | 4 | JACK AXLE 35T | 1 |
| JACK WING SWEEP | 4 | JACK AXLE 40T | 1 |
| DOLLY WEAPONS BAY DOOR | 3 | JACK AXLE 50T | 1 |
| FIXTURE AIRCRAFT MAINT. | 3 | JACK TRIPOD 30T 2X | 1 |
| JACK AXLE 20T | 3 | JACK VERT FIN | 1 |
| TRAILER BAGGAGE | 3 | LIFT TR.BOAT-TAIL ADAPTER | 1 |
| TRAILER JACK | 3 | POSITIONING ASSY | 1 |
| AIRCRAFT BOMB HOIST | 2 | SCISS0OR LIFT STD | 1 |
| DOLLY NOSE GEAR | 2 | TOOL SET COMPRESSION | 1 |
| DOLLY WHEEL CHANGE | 2 | TRAILER ACCESS0ORY | 1 |
| JACK TIP 5T | 2 | TRAILER COWL | 1 |
| JACK TRIPOD 20T 36I | 2 | TRAILER DUCT | 1 |
| JACK TRIPOD 5T | 2 | TRAILER FLAP | 1 |
| ROTODOME PLATFORM | 2 | TRAILER LOADING | 1 |
| ADAPTER LIFT | 1 | TRAILER RING | 1 |
| ADAPTER RADOME | 1 | | |

The following GSE was dispatched but is not listed in the maintenance contract. GSE in Table 5 is listed by serial number.

**Table 5. GSE Dispatched But Not Listed on Contract**

| | Total Movements 2009-2010 | Frequency per month | Times Per year |
|---|---|---|---|
| 1-GR018 | 1 | 0.0417 | 0.5 |
| 1-GR029 | 1 | 0.0417 | 0.5 |
| 1-OR008 | 1 | 0.0417 | 0.5 |
| 1-OR009 | 1 | 0.0417 | 0.5 |
| 1-OR023 | 1 | 0.0417 | 0.5 |
| 1-OR057 | 1 | 0.0417 | 0.5 |
| BN015 | 1 | 0.0417 | 0.5 |
| BT331 | 1 | 0.0417 | 0.5 |
| MC025 | 1 | 0.0417 | 0.5 |
| MC192 | 1 | 0.0417 | 0.5 |
| ML009 | 1 | 0.0417 | 0.5 |
| ML010 | 1 | 0.0417 | 0.5 |
| ML061 | 1 | 0.0417 | 0.5 |
| MT006 | 1 | 0.0417 | 0.5 |
| OR004TO | 1 | 0.0417 | 0.5 |
| MPR001 | 2 | 0.0833 | 1 |
| MA275 | 6 | 0.25 | 3 |
| MG001 | 6 | 0.25 | 3 |
| MC205 | 9 | 0.375 | 4.5 |
| SC218 | 9 | 0.375 | 4.5 |

## C. MAINTENANCE ACTIONS ANALYSIS

### 1. Methodology

Work orders are required to be tracked in the Maximo database and are divided into four different categories:

- **Preventative maintenance:** Semi-annual routine maintenance that is required by contract. The type and extent of maintenance is defined in an Air Force Technical Order (TO).

- **Unscheduled maintenance:** Maintenance that arises from equipment failures during regular use or from failures discovered during routine inspections during preventative maintenance.

- **G-ABOVE:** Maintenance in which the contractor is asked to perform maintenance that is not specifically accounted for in the contract. Maintenance actions can include AFMC TO equipment changes, equipment modifications, as well as any repair to unspecified silhouette stands or equipment.

- **G-LPAMB:** Maintenance performed on a specific group of engine stands. These stands are used to hold and transport aircraft engines during the overhaul process. While these stands are used by the OC-ALC, they belong to the DLA.

This section of the analysis focused on determining what type of maintenance—preventative or corrective—was dominant over a three-year period to quantify the validity of the current contract maintenance program. Additionally, the analysis examined the number of days GSE is down for maintenance to determine the effectiveness of the contract maintenance program. There are a total of 3,678 pieces of GSE currently under the maintenance contract at the OC-ALC. The powered and non-powered GSE is grouped into one equipment category, which totals 2,433 individual pieces of equipment, and is managed by the OC-ALC. A secondary equipment group, silhouettes, is managed by DLA but used by personnel at the OC-ALC. Maintenance is performed under the current OC-ALC maintenance contract.

## 2. Findings

- If each piece of GSE is maintained twice per year, the number of maintenance actions should total 14,712. Only 14,229 maintenance actions were recorded—a difference of 483 maintenance actions. Figure 14 shows the total number of maintenance actions performed over the two-year period. Corrective maintenance includes the "unscheduled maintenance" and "G-ABOVE" groupings. The "PM" grouping accounts for the corrective maintenance actions. The "G-LPAMB" grouping covers GSE managed by DLA and is not included in this study.
- Unscheduled maintenance actions account for 31.63% of all maintenance performed on GSE at the OC-ALC, as shown in Figure 15.
- Preventative maintenance actions account for 66.18% of all maintenance performed on GSE at the OC-ALC, as shown in Figure 15. The remaining 2.19% of maintenance actions are associated with the G-LPAMB equipment centrally managed by DLA.
- 48.6% of GSE maintenance is completed within fewer than five days. Additional information is shown in Figure 16.
- A differentiation between the actual hours required to perform preventative and corrective maintenance and the hours used to perform the maintenance cannot be made using the data provided.

Analyses of maintenance closeout dates show that a large number of maintenance actions were closed out during June and July 2010, as shown in Figure 17. 59.84% of all maintenance actions for the preceding two-year period were closed out during these months. It appears that a system reset may have been performed during these months, and further investigation is recommended to determine the root cause of this apparent spike.

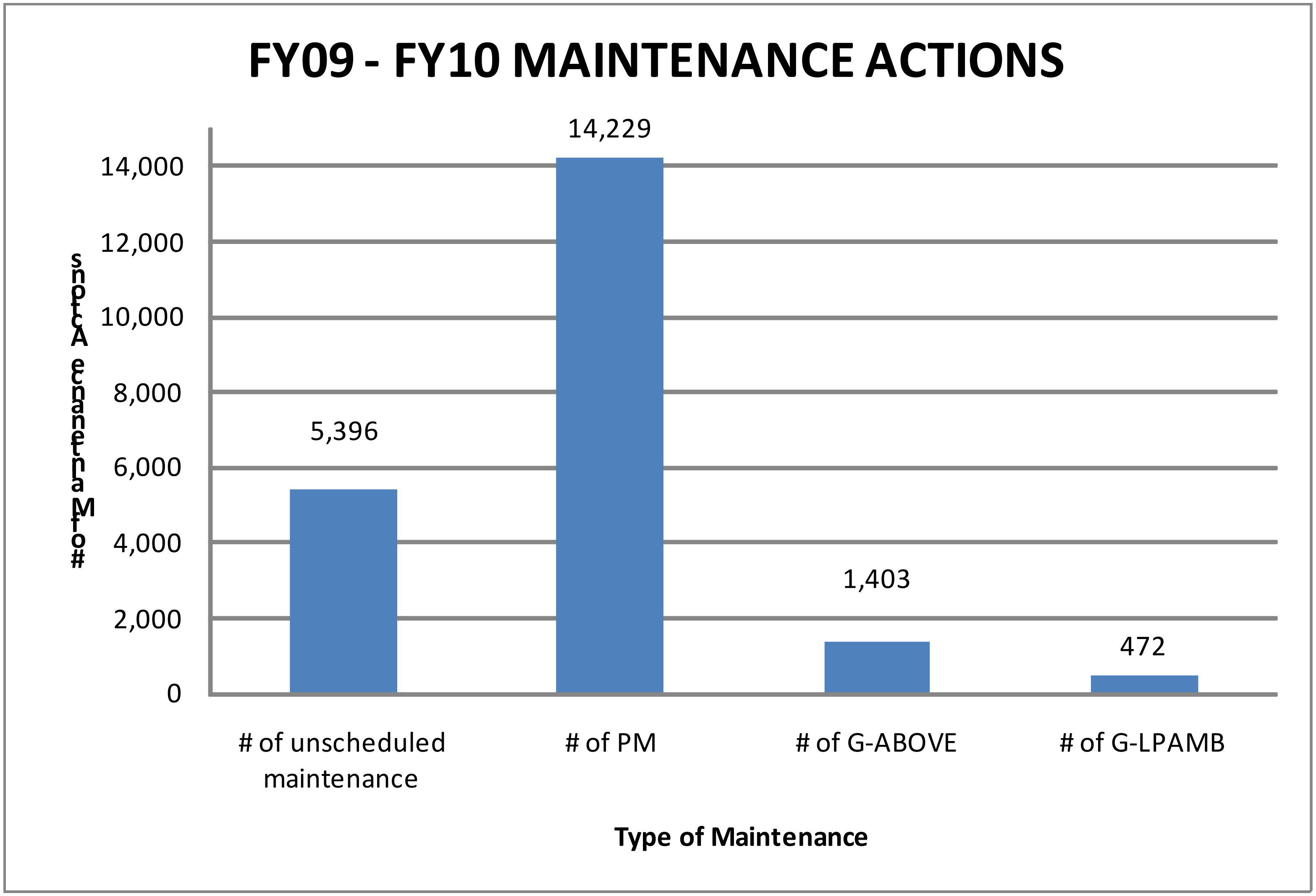


**Figure 14. FY2009–FY2010 Maintenance Actions (by Type and Number of Actions)**

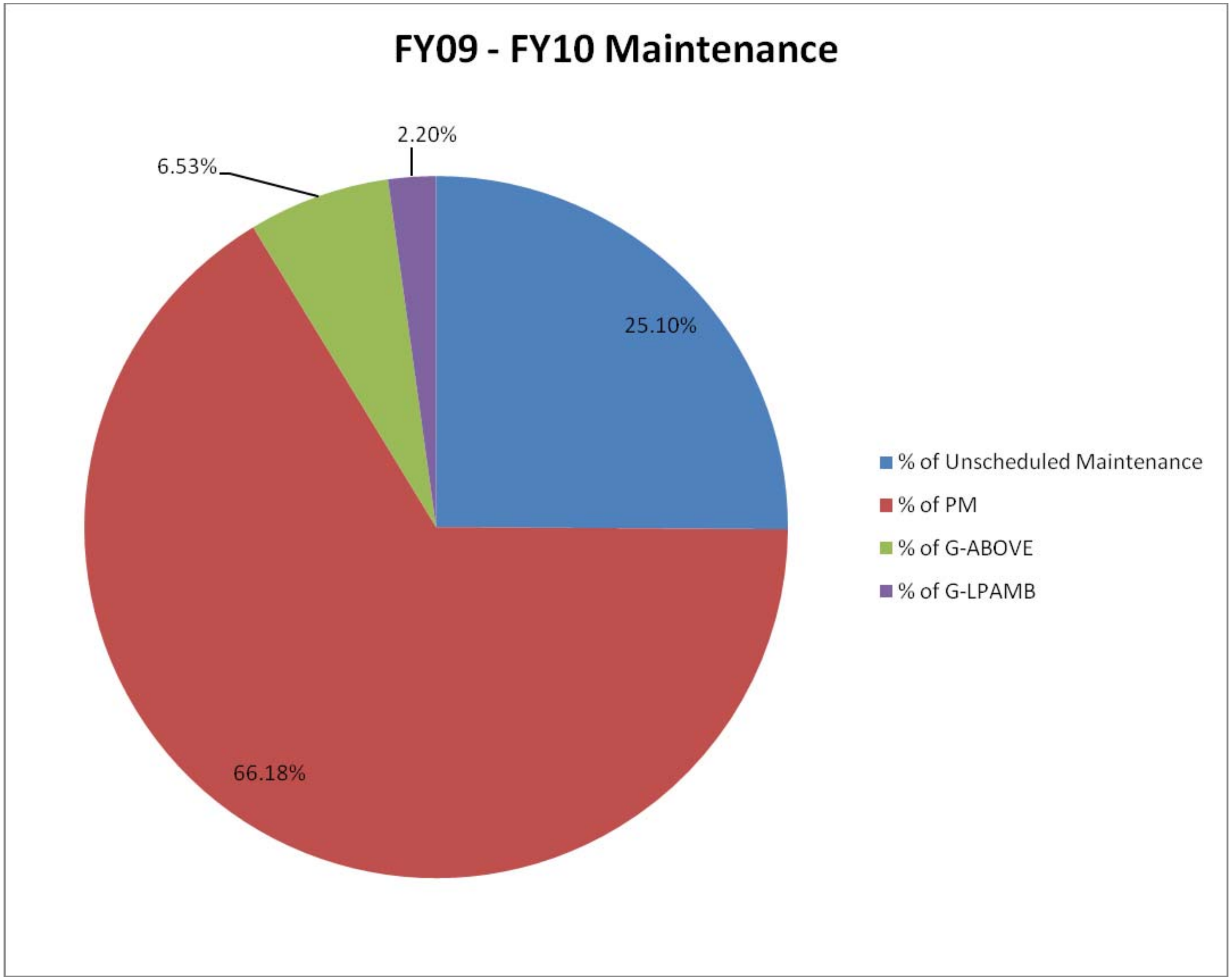


**Figure 15. FY2009–FY2010 Maintenance Actions (by Percentage and Type)**

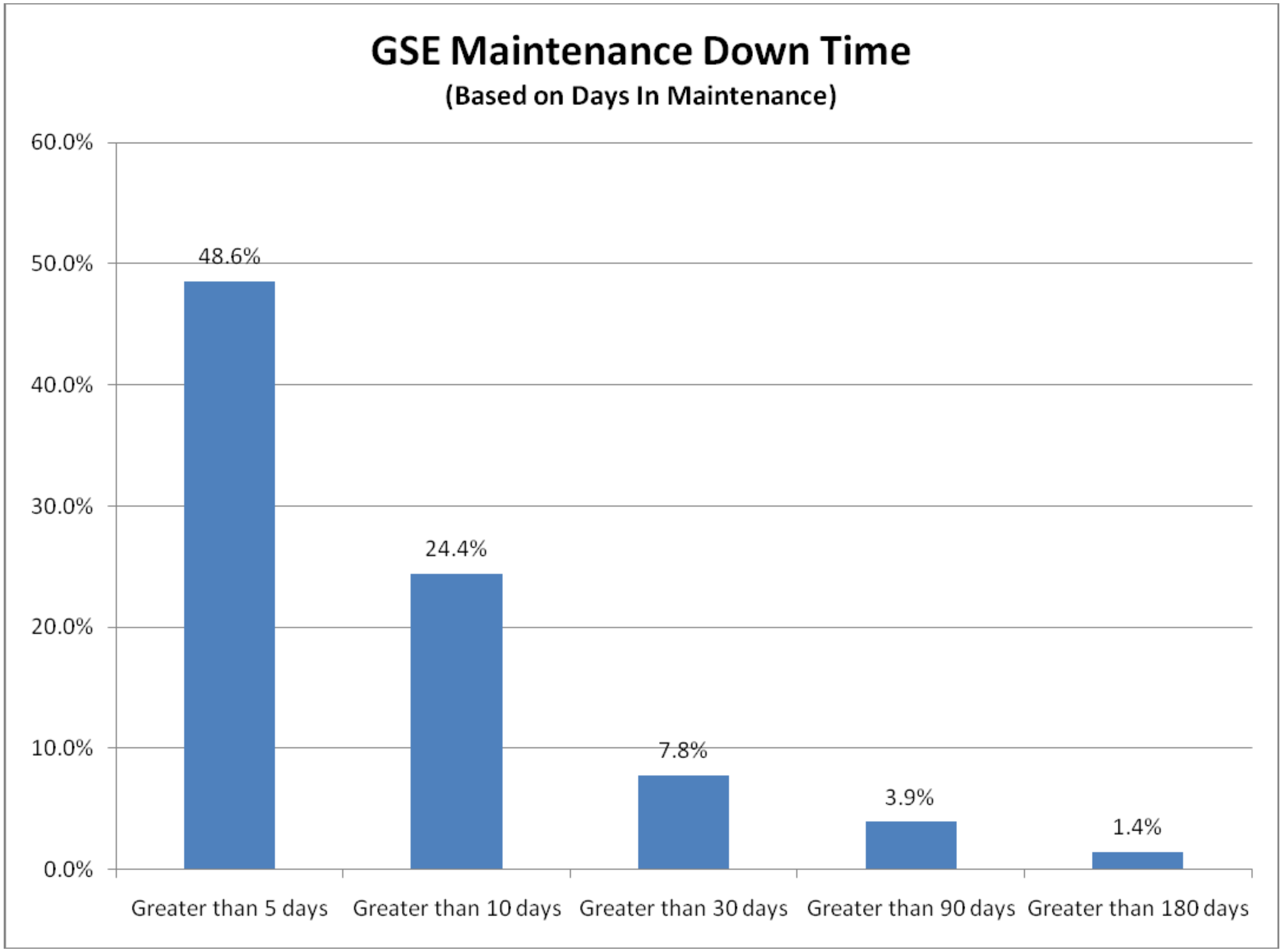


**Figure 16. GSE Maintenance Downtime (Based on Days in Maintenance)**

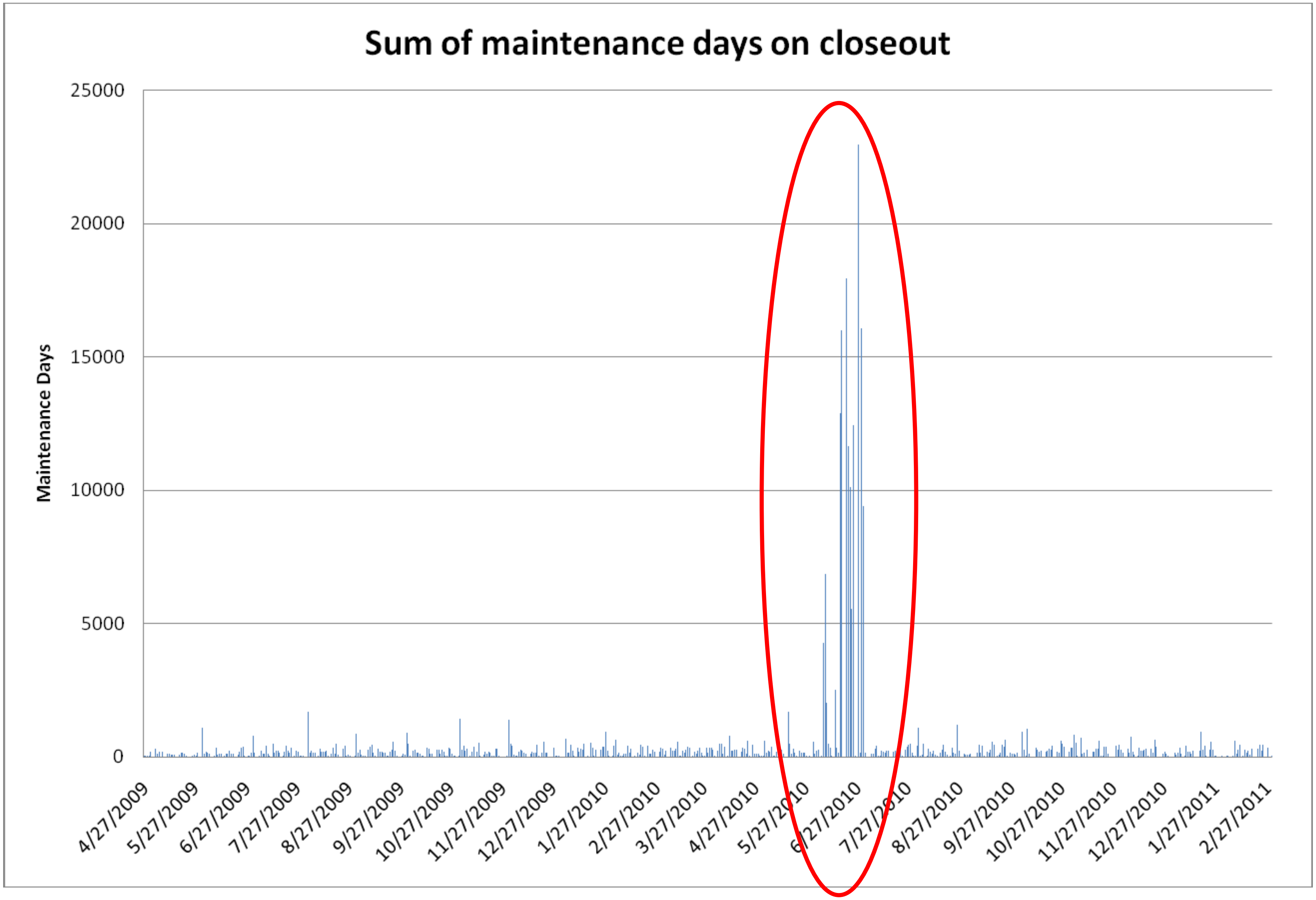


**Figure 17. Possible Reset of Maintenance Actions**

## D. OPERATIONAL AVAILABILITY AND EXPECTED NUMBER OF FAILURES ANALYSIS

### 1. Methodology

The purpose of this section of the analysis was to determine the operational availability (Ao) and the expected number of maintenance actions for the ten most critical equipment groups, as defined by personnel at the OC-ALC. Operational availability provides a method of predicting and assessing system performance and readiness during the acquisition process and then becomes the performance benchmark during initial operational capability, deployment, and operations/maintenance cycles (Chief of Naval Operations [CNO], 2003, p. 4). Ao can be used outside of the acquisition process to calculate GSE usage rates, levels of readiness, and other metrics. These metrics can then be used to effectively manage the pool of GSE at the OC-ALC. GSE Ao is vital to the OC-ALC and will become increasingly important as the total number of airframes in maintenance increase.

The Ao of a particular equipment group is derived from the following simple equation:

$$\text{Ao} = \text{System Uptime} / \text{Total Time (where Total Time} = \text{Uptime} + \text{Downtime)} \qquad (1)$$

System uptime is equal to 3 years or 1080 days, which corresponds to the time frame of the data analyzed for this study. We determined the system downtime by obtaining either the average number of days in maintenance for an equipment group or the total number of days in maintenance for individual pieces of equipment. We compiled the data under the assumption that multiple maintenance actions can be performed within the same time period and that maintenance activities recorded as 0 days are adjusted to equal 1 day. Each maintenance action is therefore treated as a unique event. The analysis started at the macro level to determine the Ao of each equipment group. We then refined the analysis to look at specific pieces of GSE. Figure 18 shows the Ao for each equipment group.

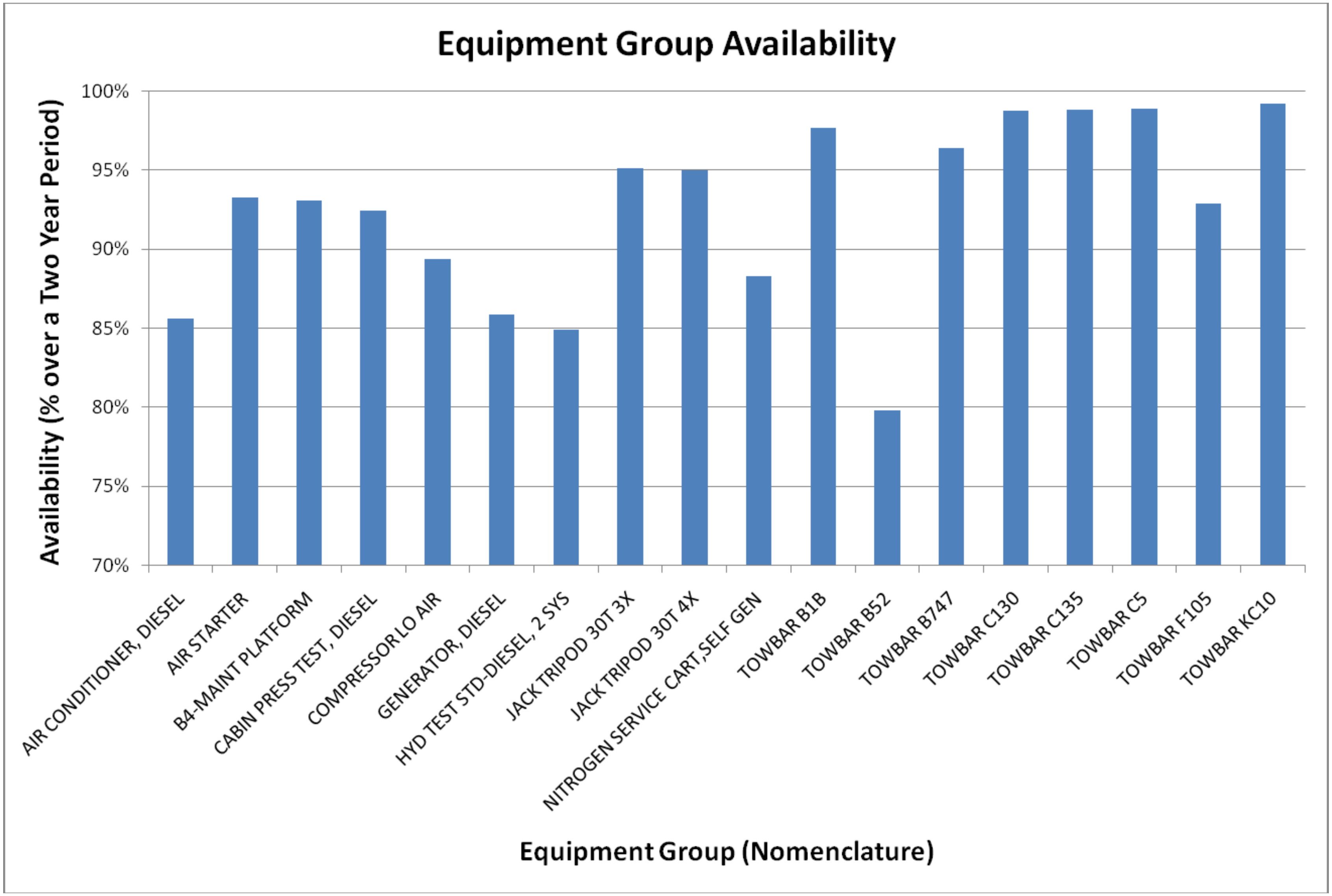


**Figure 18. Availability by GSE Group**

The second portion of this section of the analysis determined the expected number of maintenance actions over a given time period (30, 90, and 360 days, respectively) for each equipment group and predicted the required number of spare equipment needed to maintain a desired service level. The expected number of maintenance actions is derived using the following equation:

$$k\lambda t = \text{expected number of maintenance actions} \quad (2)$$

where k equals the number of pieces of equipment within an equipment group; $\lambda$ equals the equipment failure rate (This is based on the reciprocal of the Mean Time Between Repair [MTBR], which is calculated by averaging the total maintenance time for each equipment group [1/MTBR].); and t equals a specified time period.

The expected quarterly numbers of maintenance actions required for each GSE equipment group are shown in Figure 19.

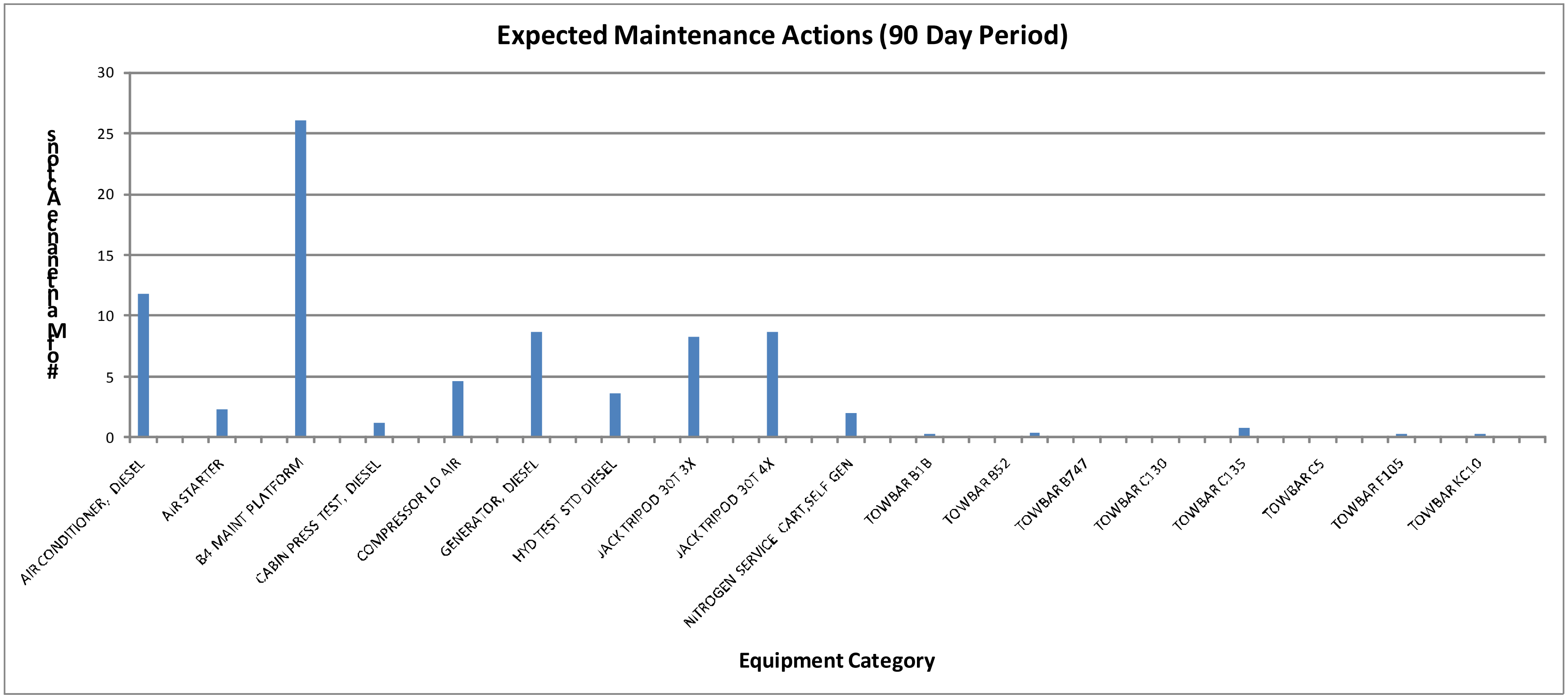


**Figure 19. Expected Maintenance Actions Based on a 90-Day Period**

The next step in the analysis determined the number of spares recommended to have available in order to maintain a set service protection level. This information can assist the OC-ALC leadership in managing the GSE pool by determining the required numbers of equipment needed to maintain a target service level. The number of spares required is determined using a Poisson distribution function in Microsoft Excel, which is designed to account for the unpredictability and variability associated with real-world situations. The estimate provided in Table 6 is based on a 30-day time period, shows the amount of additional equipment based on three distinct service levels—85%, 90%, and 95%—and can be used as a baseline estimate for additional equipment purchases.

**Table 6. Estimated Number of Spare Equipment Required in a 30-Day Period (Based on Service Level)**

| Equipment Description | # of Equipment in Category | Group MTBM | Lambda | Protection Level | Spares (30 days) |
|---|---|---|---|---|---|
| AIR CONDITIONER, DIESEL | 77 | 598.9870 | 0.0017 | 85% | 6 |
| | | | | 90% | 7 |
| | | | | 95% | 7 |
| AIR STARTER | 17 | 668.0588 | 0.0015 | 85% | 2 |
| | | | | 90% | 2 |
| | | | | 95% | 2 |
| B4-MAINT PLATFORM | 193 | 666.7254 | 0.0015 | 85% | 12 |
| | | | | 90% | 13 |
| | | | | 95% | 14 |
| CABIN PRESS TEST, DIESEL | 9 | 661.2222 | 0.0015 | 85% | 1 |
| | | | | 90% | 1 |
| | | | | 95% | 2 |
| COMPRESSOR LO AIR | 32 | 634.6563 | 0.0016 | 85% | 3 |
| | | | | 90% | 3 |
| | | | | 95% | 4 |
| GENERATOR, DIESEL | 57 | 601.7719 | 0.0017 | 85% | 5 |
| | | | | 90% | 5 |
| | | | | 95% | 6 |
| HYD TEST STD-DIESEL | 24 | 592.0833 | 0.0017 | 85% | 2 |
| | | | | 90% | 3 |
| | | | | 95% | 3 |
| JACK TRIPOD 30T 3X | 61 | 682.8525 | 0.0015 | 85% | 4 |
| | | | | 90% | 5 |
| | | | | 95% | 6 |
| JACK TRIPOD 30T 4X | 64 | 682.0313 | 0.0015 | 85% | 5 |
| | | | | 90% | 5 |
| | | | | 95% | 6 |
| NITROGEN SERVICE CART,SELF GEN | 14 | 624.7857 | 0.0016 | 85% | 1 |
| | | | | 90% | 2 |
| | | | | 95% | 2 |
| TOWBAR B1B | 2 | 703.0000 | 0.0014 | 85% | 0 |
| | | | | 90% | 0 |
| | | | | 95% | 1 |
| TOWBAR B52 | 2 | 538.0000 | 0.0019 | 85% | 0 |
| | | | | 90% | 1 |
| | | | | 95% | 1 |
| TOWBAR B747 | 1 | 693.0000 | 0.0014 | 85% | 0 |
| | | | | 90% | 0 |
| | | | | 95% | 0 |
| TOWBAR C130 | 1 | 711.0000 | 0.0014 | 85% | 0 |
| | | | | 90% | 0 |
| | | | | 95% | 0 |
| TOWBAR C135 | 6 | 711.6667 | 0.0014 | 85% | 1 |
| | | | | 90% | 1 |
| | | | | 95% | 1 |
| TOWBAR C5 | 1 | 712.0000 | 0.0014 | 85% | 0 |
| | | | | 90% | 0 |
| | | | | 95% | 0 |
| TOWBAR F105 | 2 | 665.0000 | 0.0015 | 85% | 0 |
| | | | | 90% | 0 |
| | | | | 95% | 1 |
| TOWBAR KC10 | 2 | 714.5000 | 0.0014 | 85% | 0 |
| | | | | 90% | 0 |
| | | | | 95% | 1 |

## 2. Findings

Top Ten List

A quick analysis of the given data showed that the top ten based on the number of maintenance actions did not match the list provided by the OC-ALC leadership. As shown in Figure 20, the only match in terms of sheer number of maintenance actions is the air conditioner with the equipment number MA 236. The top two largest numbers of maintenance actions are associated with asset number and description as follows: O&A/Over and Above Maintenance with 7,905 maintenance days and Dummy Equipment Record/BARDES with 964 maintenance days. It is difficult to tell what pieces of GSE these two groups are accounting for, and both groups total 8,869 maintenance days over a three-year period. This type of grouping of maintenance actions without specific reference to a single piece of GSE can skew any analysis because it represents 3.32% of the total number of maintenance actions that occurred during the three-year period.

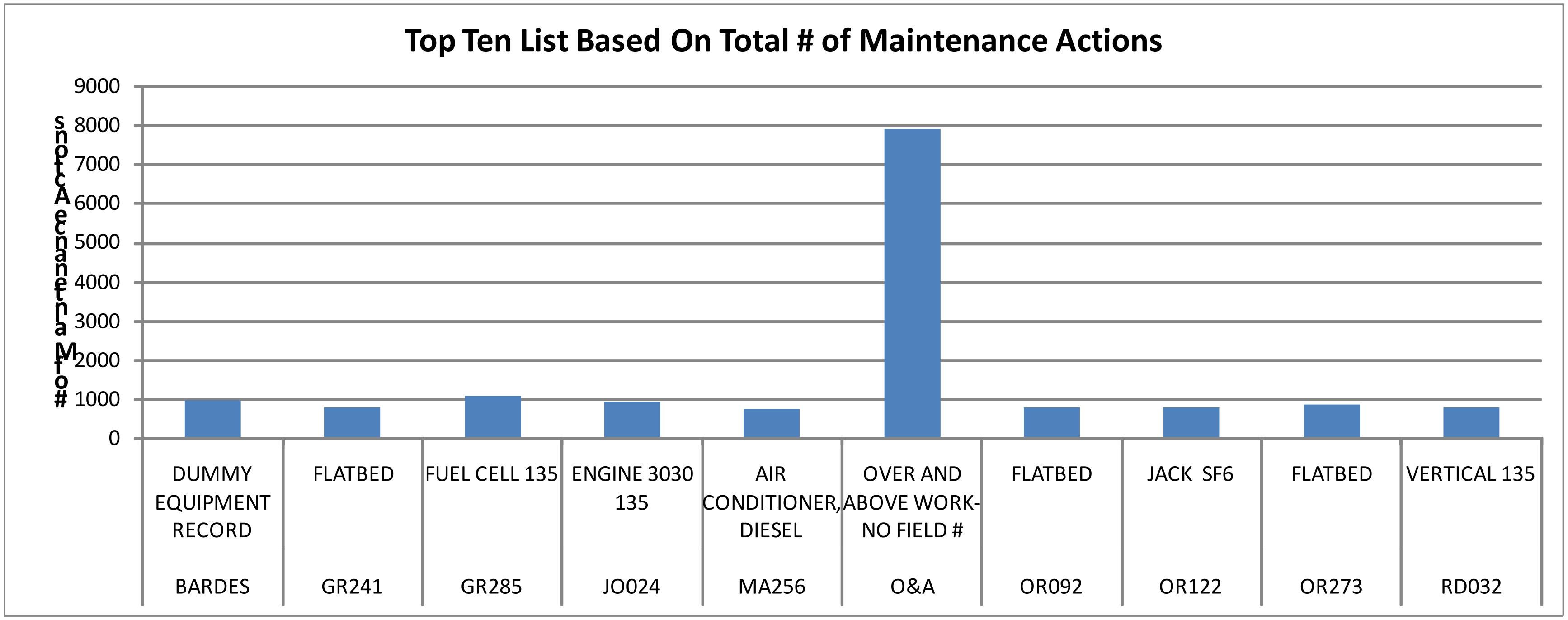


**Figure 20. Top Ten Equipment List Based on Total Number of Maintenance Actions**

## Operational Availability

### *Critically Low Ao Equipment Groups (less than 90%)*

A review of the operational availability of each equipment group showed that six of the OC-ALC–designated top ten equipment groups—the Diesel Air Conditioner, Hydraulic Test Stand (Diesel and Electric), Low Air Compressor, Nitrogen Service Cart, Diesel Generator, and Tow Bar B-52—have an operational availability of less than 90%. This means that for a given review period (which can be set by management), on average, 10% of the GSE in the equipment group is not available for use at a given point in time. For example, out of ten pieces of GSE in an equipment group, only nine will be available at any given time. This is most likely the reason for the identification of these particular equipment groups as potential problem areas. If the customer—for example, the maintenance floor—experiences that type of gap in equipment, it could cause a detrimental effect on OC-ALC operations, which would compound exponentially as the airframe throughput increases. The OC-ALC currently experiences an approximate $50,000.00 per airframe per day loss due to maintenance delays if required GSE is not available to support maintenance actions. Having the GSE available at the right place and the right time is critical to OC-ALC operations. Figures 21–26 depict the Ao for the six equipment groups that fall below the 90% threshold.

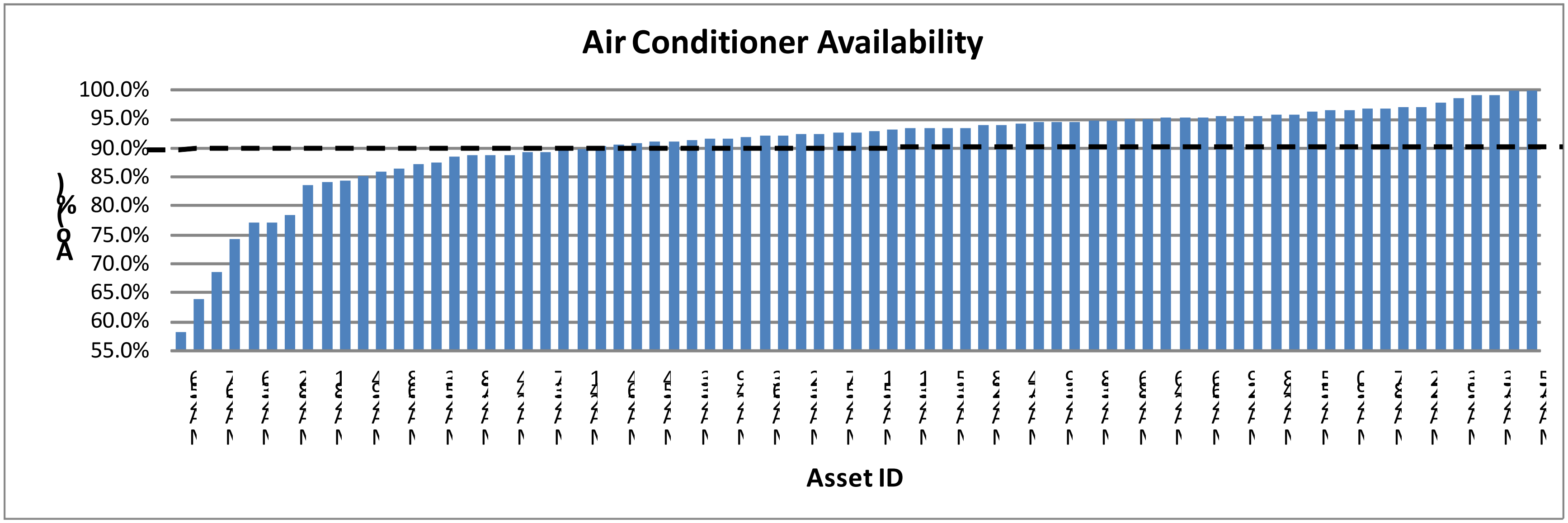


**Figure 21. Air Conditioner Availability**

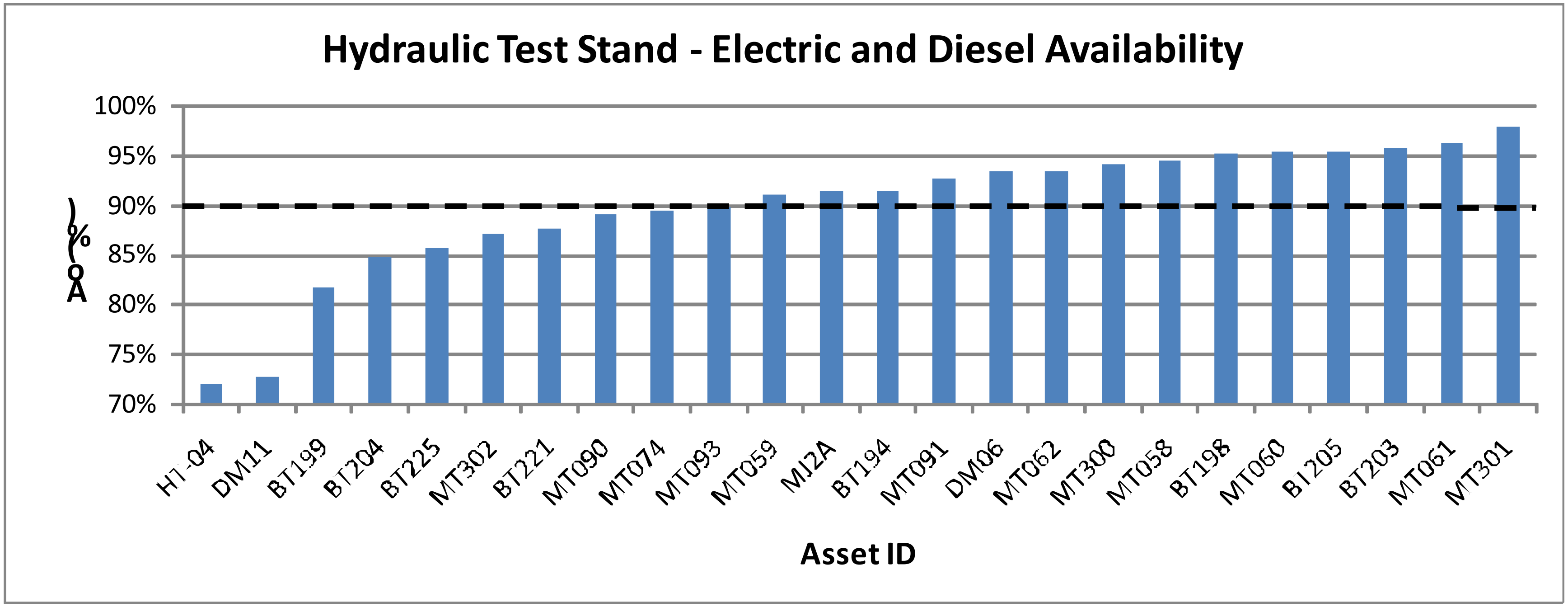


**Figure 22. Hydraulic Test Stand—Electric and Diesel Availability**

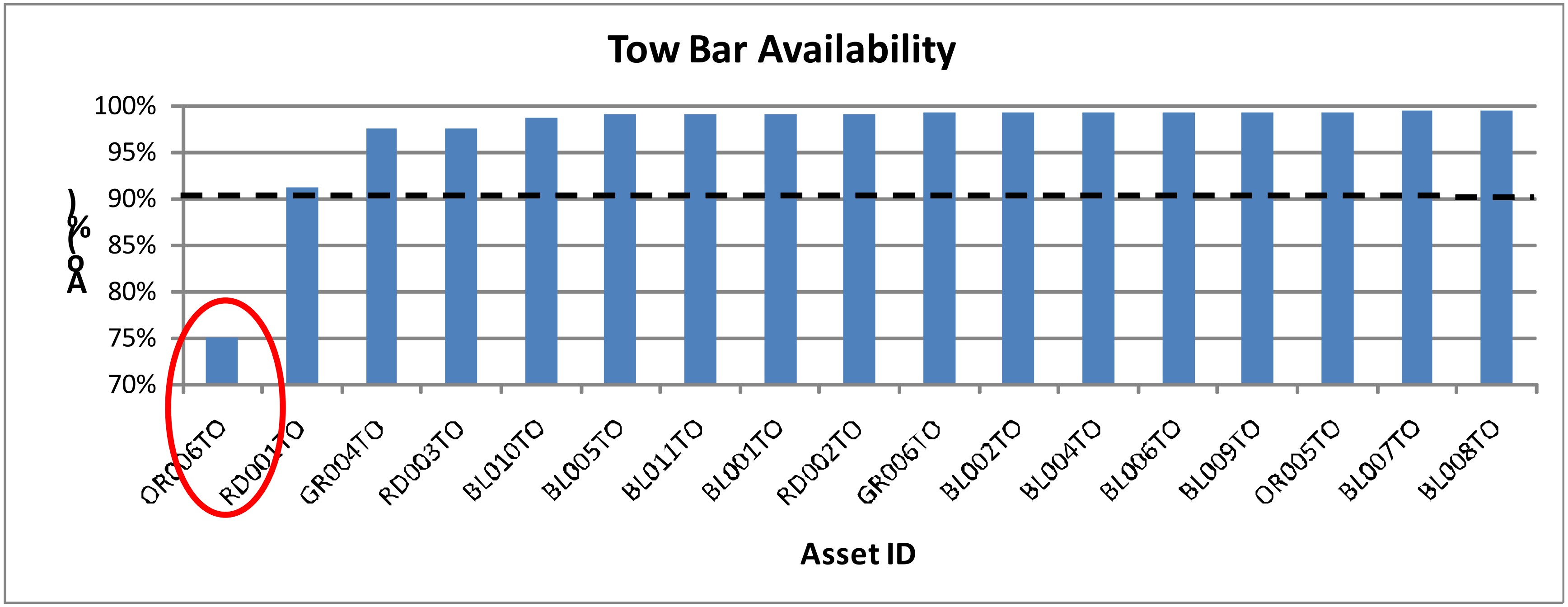


**Figure 23. Tow Bar Availability**

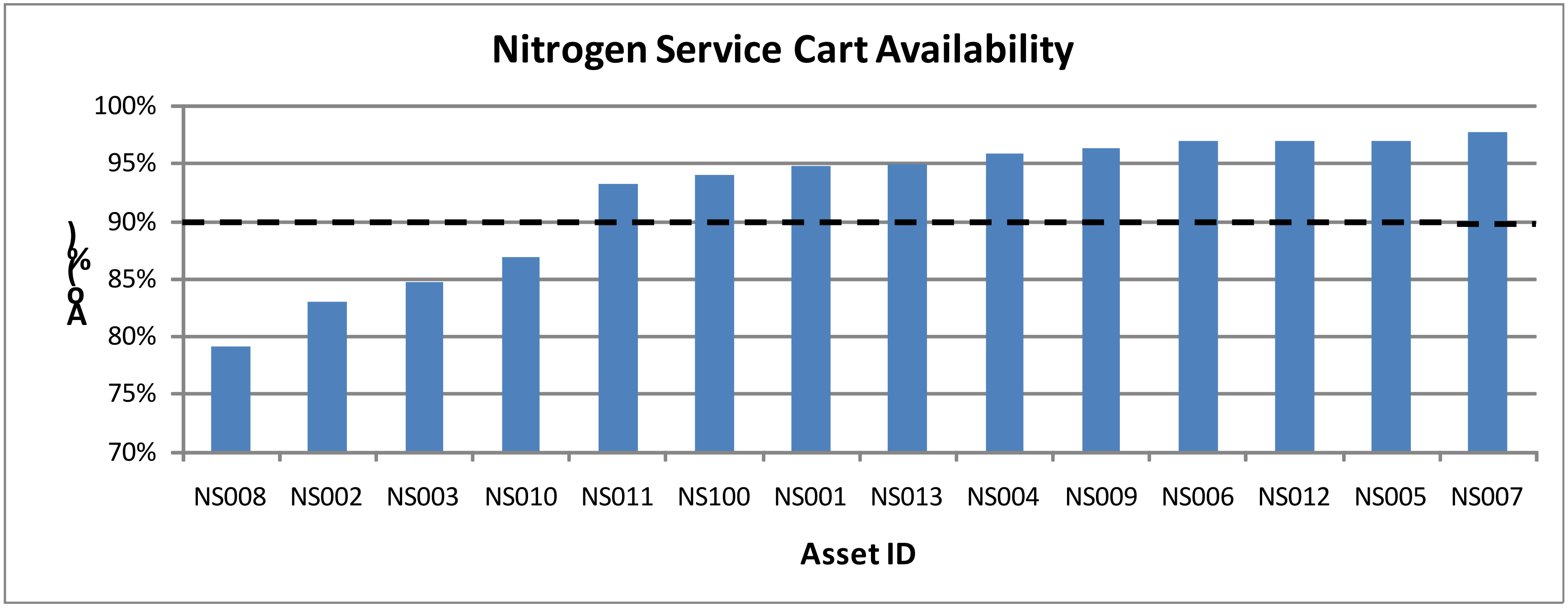


**Figure 24. Nitrogen Service Cart Availability**

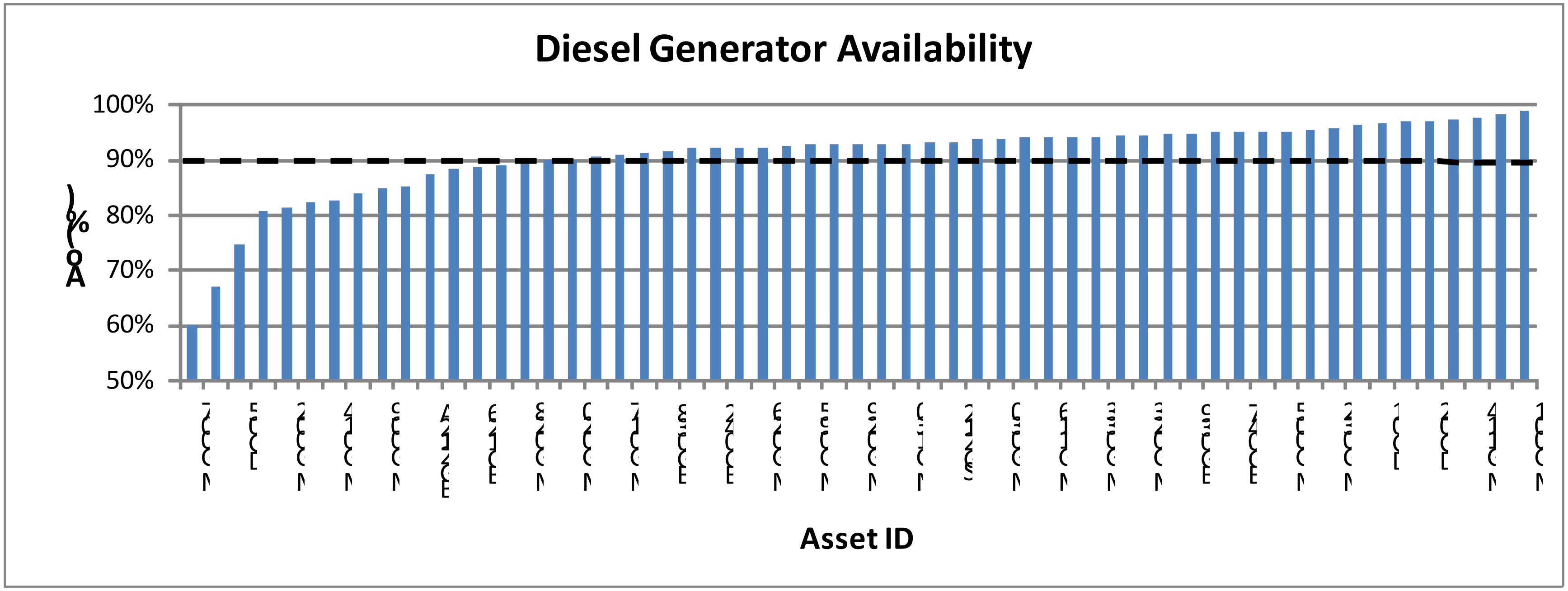


**Figure 25. Diesel Generator Availability**

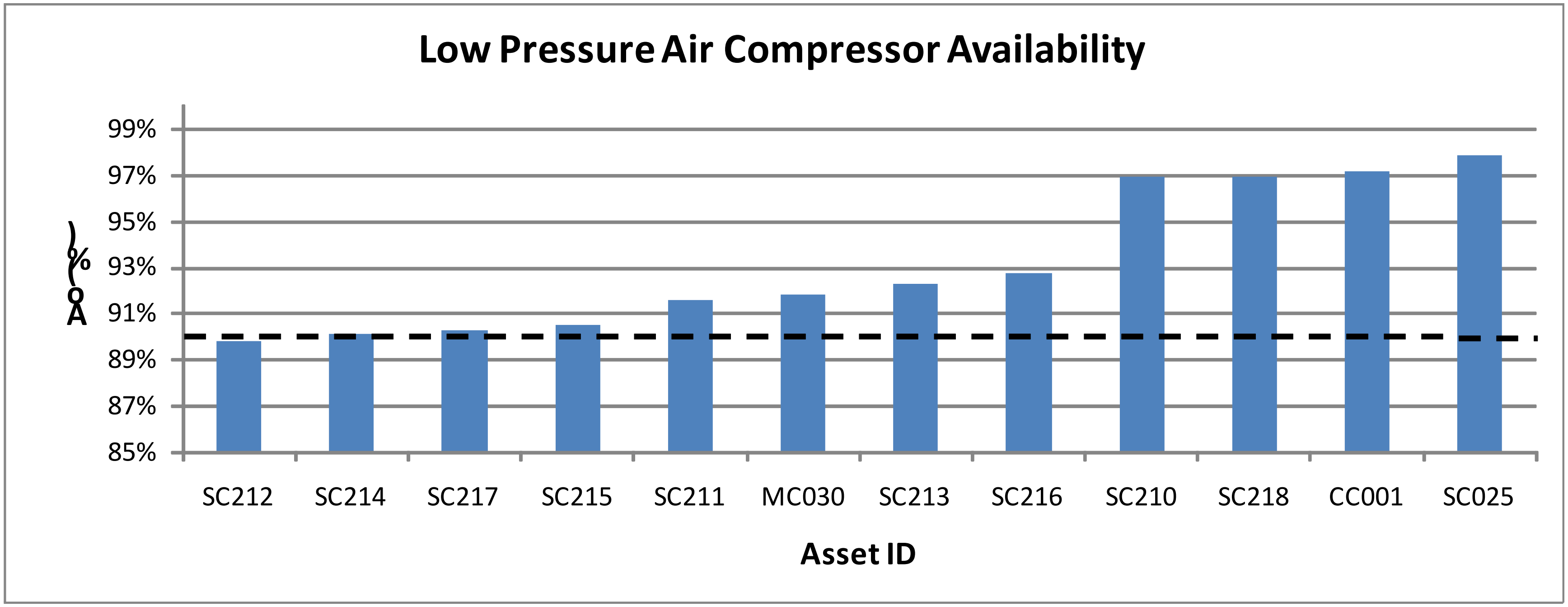


**Figure 26. Low Pressure Air Compressor Availability**

The dotted line on the figures represents a 90% availability standard, while the red circle on Figure 23 shows the one piece of equipment that caused the entire tow bar equipment group to fall below the 90% threshold. The equipment listed in Table 7 falls under the 90% threshold and contributes significantly to the low equipment group Ao. Of particular importance is the number of critical GSE that falls below the 90% threshold, proving that there is a legitimate need to investigate the root cause(s) of the downtime or to determine the quantity needed to offset this poor maintenance record. We could not determine the root cause(s) for the failure based on current data and doing so would require further investigation.

**Table 7. Contributors to the Critically Low Availability Equipment Group**

| DESCRIPTION | ASSETNUM | Ao | DESCRIPTION | ASSETNUM | Ao |
|---|---|---|---|---|---|
| AIR CONDITIONER, DIESEL | AC05 | 78.89% | TOWBAR B52 | OR006TO | 75.10% |
| | MA221 | 85.99% | COMPRESSOR LO AIR | MC037 | 86.96% |
| | MA223 | 89.48% | | MC059 | 73.47% |
| | MA224 | 88.82% | | BC020 | 83.98% |
| | MA225 | 88.45% | | BC021 | 87.80% |
| | MA226 | 87.31% | | SC212 | 89.85% |
| | MA236 | 77.09% | GENERATOR, DIESEL | BG125 | 83.85% |
| | MA237 | 89.26% | | BG126 | 88.74% |
| | MA241 | 89.78% | | BG212A | 87.38% |
| | MA244 | 88.89% | | DG05 | 74.53% |
| | MA253 | 87.59% | | MG002 | 81.45% |
| | MA256 | 58.28% | | MG007 | 60.13% |
| | MA258 | 89.18% | | MG009 | 84.91% |
| | MA265 | 84.51% | | MG010 | 66.96% |
| | MA267 | 68.70% | | MG012 | 85.24% |
| | MA268 | 86.54% | | MG013 | 80.72% |
| | MA278 | 88.67% | | MG014 | 82.76% |
| | MA279 | 77.09% | | MG015 | 88.96% |
| | MA280 | 74.38% | | MG022 | 82.25% |
| | MA281 | 84.18% | | MG028 | 89.93% |
| | MA282 | 78.49% | | MG117 | 88.45% |
| | MA285 | 63.98% | NITROGEN SERVICE CART,SELF GEN | NS002 | 83.08% |
| | MA289 | 83.53% | | NS003 | 84.77% |
| | MA294 | 85.17% | | NS008 | 79.24% |
| HYD TEST STD-DIESEL | BT221 | 87.73% | | NS010 | 86.96% |
| | BT225 | 85.78% | | | |
| | HT-04 | 72.00% | | | |
| | BT199 | 81.69% | | | |
| | DM11 | 72.78% | | | |
| HYD TEST STD-ELEC | BT204 | 84.77% | | | |
| | MT074 | 89.55% | | | |
| | MT302 | 87.24% | | | |
| | MT090 | 89.11% | | | |
| | MT093 | 89.85% | | | |

*Identified Problems for Equipment Groups with Ao Greater than 90%*

Figures 27–30 show the operational availability of the remaining top ten pieces of critical equipment, which include the Air Starter, B-4 Maintenance Stand, Cabin Pressure Tester, and Hydraulic Jack equipment groups. These remaining equipment groups are at or well above the 90% availability threshold as a whole and appear to be regularly available for use. This signifies that these critical pieces of GSE are not affected on average by preventative maintenance cycles or unscheduled maintenance.

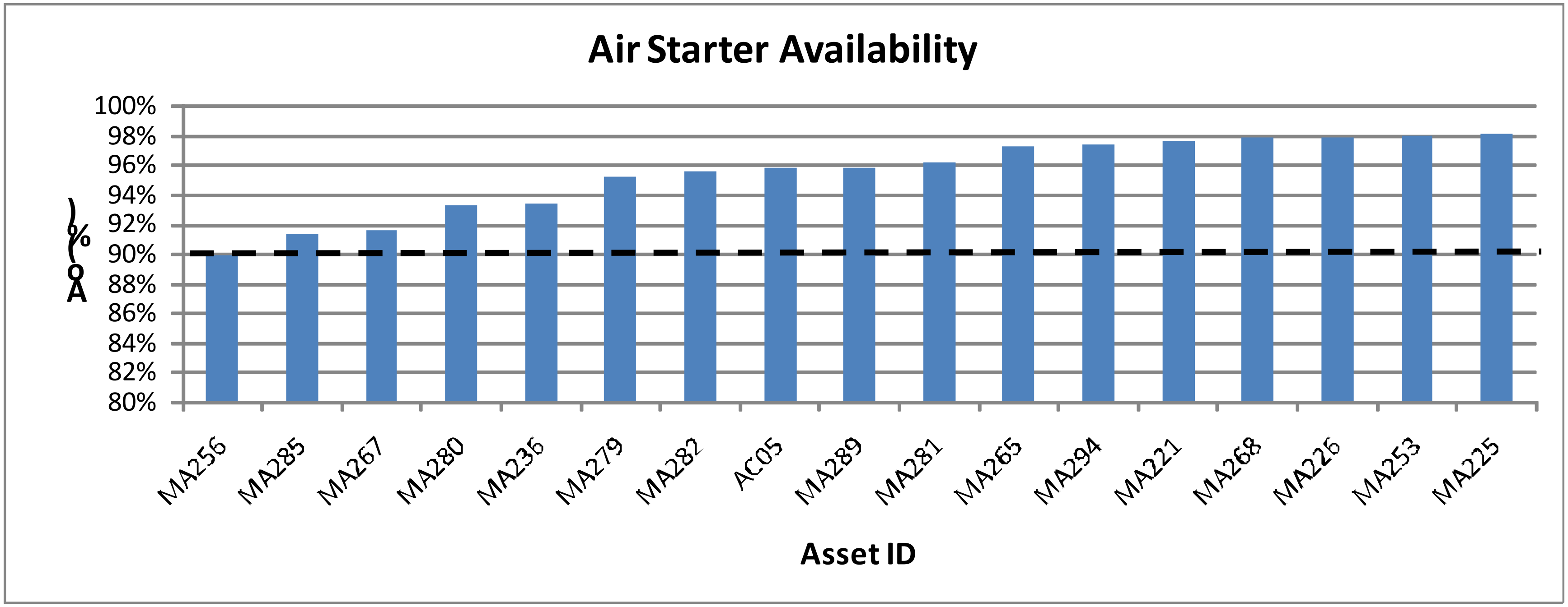


**Figure 27. Air Starter Availability**

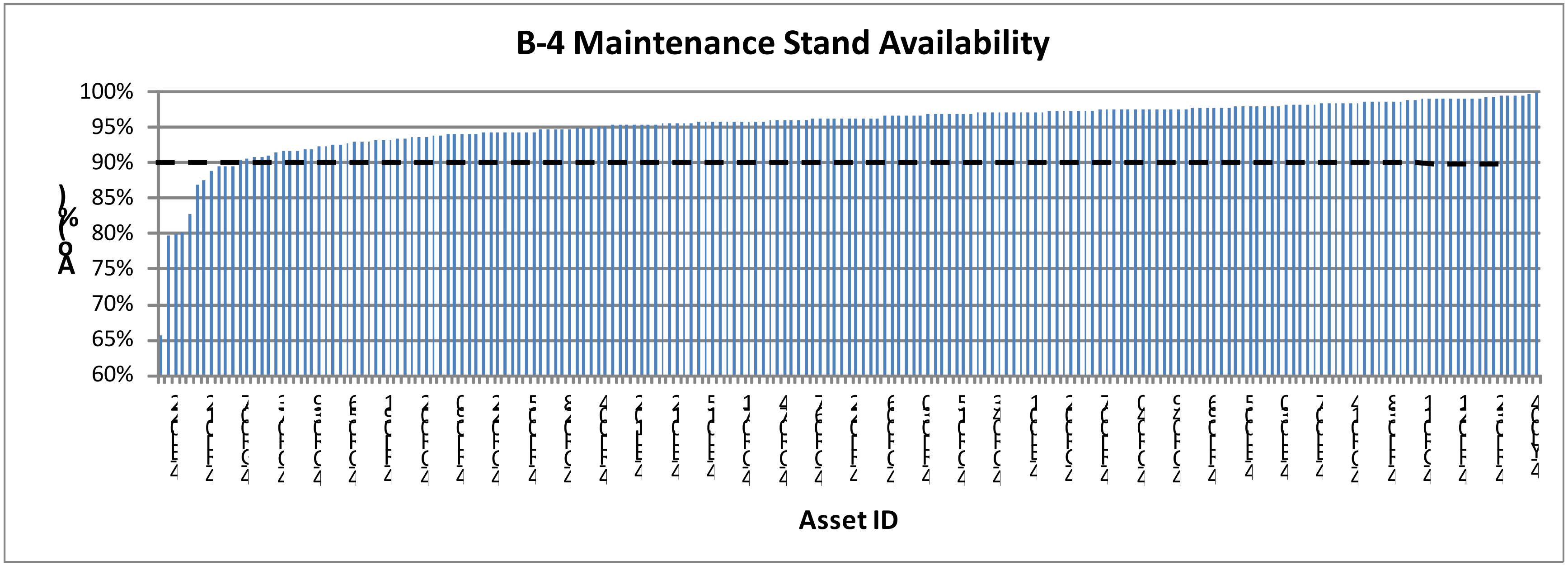


**Figure 28. B-4 Maintenance Stand Availability**

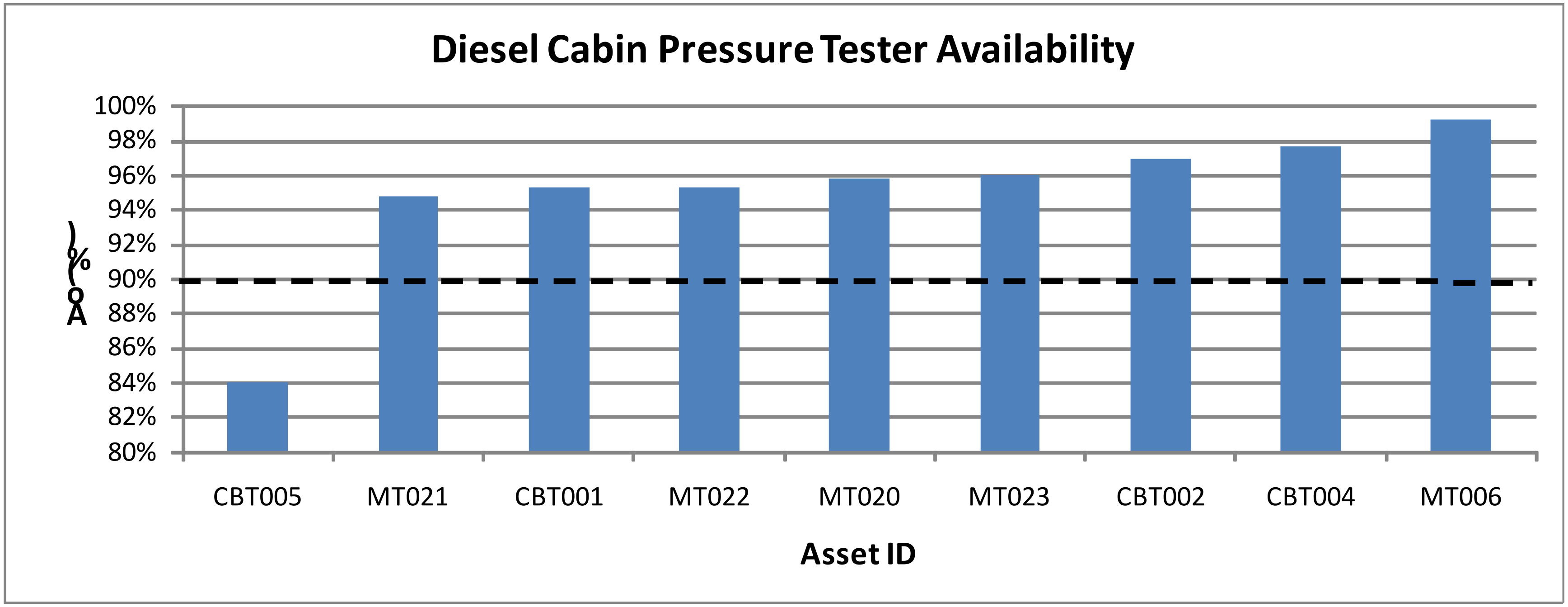


**Figure 29. Cabin Pressure Tester Availability**

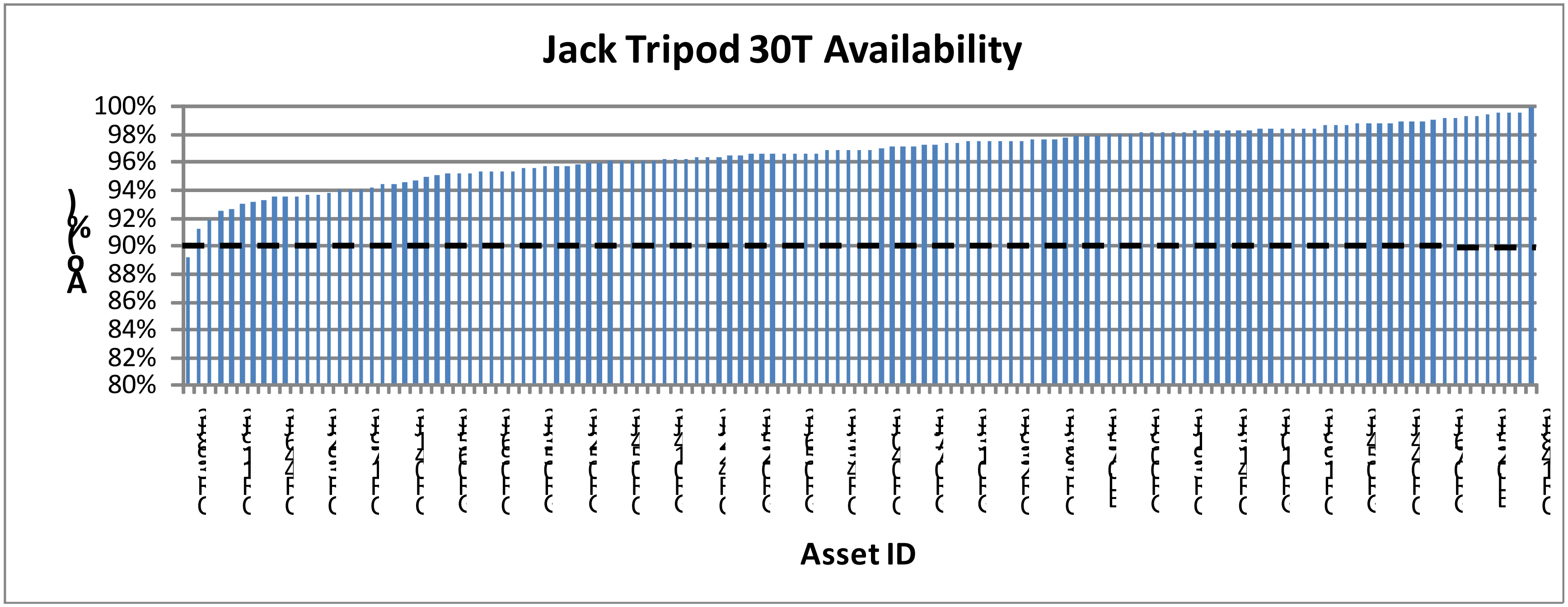


**Figure 30. Jack Tripod 30T Availability**

While the remaining equipment groups show an Ao of greater than 90%, there are certain GSE assets that fall within those equipment groups that require a closer analysis to determine the root cause of the significant maintenance downtime. The reader should pay particular attention to the equipment asset numbers that fall below the 90% threshold (denoted by the dotted line on each previous figure). The root cause cannot be derived from the data fields provided. Table 8 displays the equipment requiring further scrutiny and its respective Ao.

**Table 8. GSE That Falls Under the 90% Ao Threshold (From the Equipment Groups with a 90% Ao or Higher)**

| DESCRIPTION | ASSETNUM | Ao |
|---|---|---|
| B4-MAINT PLATFORM | 4-BL014 | 79.94% |
| | 4-BL021 | 82.82% |
| | 4-BL022 | 65.61% |
| | 4-GR007 | 89.63% |
| | 4-GR009 | 88.89% |
| | 4-GR018 | 87.59% |
| | 4-OR011 | 89.55% |
| | 4-OR017 | 79.82% |
| | 4-OR068 | 89.48% |
| | 4-RD012 | 87.03% |
| | 4-RD093 | 80.12% |
| CABIN PRESS TEST, DIESEL | CBT005 | 84.05% |
| JACK TRIPOD 30T 3X | OR398J3 | 89.26% |

# VII. RECOMMENDATIONS

## A. REQUIREMENT FOR A FULL-TIME GSE MANAGEMENT TEAM

Given the size of the investment in GSE (almost $37 million), the complexity of the process associated with these assets, and the importance of GSE for ensuring that aircraft flow through the overhaul and repair process as quickly as possible, we recommend that a manager be assigned full-time to oversee GSE. Benefits would include improved asset visibility, increased equipment availability, and improved management processes. First, he/she will be able to develop daily, weekly, monthly, and annual metrics designed to assess the effectiveness of the CLS maintenance program for GSE at the OC-ALC. Specific recommendations for the establishment of metrics will be addressed in Section B of this chapter. Second, a full-time manager would be able to effectively manage and employ a two- to four-person team responsible for the daily, weekly, monthly, quarterly, and annual accountability of the GSE (to include tracking maintenance actions performed on and the location of GSE). This team would work to reduce the number of labor hours lost in tracking down GSE, resulting in increased throughput and decreased costs.

## B. BUSINESS PROCESS IMPROVEMENTS

We recommend the following business process improvements:

- Revise the procedures for tracking contractor-supported maintenance and the dispatch of GSE at the OC-ALC. The data, in its current form, does not provide an accurate picture of the true state of the GSE maintenance program or the dispatch program. Specific examples of accurate information are as follows:
    - Maintenance start and completion dates and times are not correctly accounted for. The data provided showed that in many cases, the two dates and times were the same. Specificity and clarity of the data will provide an accurate picture of the operational availability and improve the capabilities of the OC-ALC.
    - Develop an organization chart and position descriptions that outline the roles and responsibilities of managers and their relationship to work centers. This should

be one of the first tasks assigned to the GSE management team in order to delineate the workflow process.

    - Revise locations to include specific areas within the OC-ALC area of operations. Dispatch locations are currently not specific enough to determine where the equipment is actually located. Specific locations and the use of Radio Frequency Identification (RFID), Item Unique Identification (IUID), or a combination of the two technologies will improve the accountability and operational capability of the OC-ALC.
    - Combine both preventative and corrective maintenance actions under one master maintenance action record to accurately account for total maintenance downtime.
        - Preventative maintenance and corrective maintenance are tracked separately, even when performed at the same time. For example, an air conditioner undergoes a three-day preventative maintenance action. During that preventative maintenance action, it is determined that two corrective repairs are required that would consume two consecutive days, leaving the GSE in maintenance for a total of seven days. The three maintenance actions are recorded individually in eFMS yet performed concurrently. This can provide an incorrect impression of the true maintenance performed. Even though the GSE was actually in maintenance for a total of seven days, the data tells a different story, indicating that there were three separate maintenance actions totaling three, two, and two days, respectively. By combining the preventative and corrective maintenance actions under one master maintenance action—with individual data fields to track the type of maintenance—an accurate maintenance picture can be obtained.
- Develop a set of critical metrics. The recommended metrics should include the following at a minimum:
    - Weekly Metrics
        - Perform weekly random spot-checks of GSE physical locations to verify the accuracy of the contractor-maintained database. These spot-checks

will ensure that the contractor is adequately tracking dispatches and maintenance actions and will show discrepancies in actual GSE location, which will reduce the amount of time lost locating equipment. Report the daily spot-check findings and the findings listed below to the chain of command.

    - Perform weekly random spot-checks of both scheduled and unscheduled maintenance actions in progress. Report the results to the commander of the OC-ALC.

- Monthly Metrics
    - Develop a monthly report that outlines the status of GSE. The report should include the following:
        - The status of any equipment that will be (or has been) in maintenance for greater than thirty days.
        - The status of GSE that has not been dispatched in the previous month.
        - A summary of monthly activity for GSE supporting maintenance operations.
        - Any areas of concern in respect to the management of GSE (by Government personnel).
        - Any areas of concern in respect to the management of GSE (by the contractor).
- Quarterly Metrics
    - Perform a quarterly inventory and verification of location and maintenance status on 25% of the GSE located at the OC-ALC.
    - Report the amount and type of GSE that has remained in maintenance or that has not been dispatched to the chain of command. An explanation should be required for why the GSE is still in maintenance or has not been dispatched, along with the reason that the GSE does not need to be replaced or removed from inventory.
- Annual Metrics

- Perform a 100% verification of all GSE maintenance, dispatches, and locations. The information should be compared to the data in Maximo to ensure full accountability of all maintenance actions and dispatches.

- Develop a "dashboard system" that measures previously mentioned key metrics using color codes such as a stoplight chart (green = good, yellow = marginal, red = problem). The actual meaning of the color codes will have to be defined by the management team at the OC-ALC. This dashboard system should identify potential problem areas within both the CLS maintenance system and the availability of GSE to support the currently expected increase in airframe maintenance operations at the OC-ALC.

## C. USE OF ITEM UNIQUE IDENTIFICATION DEVICES TO INCREASE VISIBILITY OF GSE

On July 29, 2003, the DoD mandated the use of IUID throughout the *Policy of Unique Identification (UID) of Tangible Items—New Equipment, Major Modifications, and Reprocurements of Equipment and Spares* (Office of the Under Secretary of Defense [OUSD(AT&L)], 2009, p. 1). Additional guidance on the implementation and use of IUID was issued on December 3, 2010 (OUSD[AT&L], 2010). IUID utilizes individual identification tags attached to each unique piece of GSE. The tags utilize bar code scanners to interface with the Maximo database. Use of IUID could provide improved asset visibility for the OC-ALC at a relatively low cost. The use of IUID is a low cost complement to the RFID system currently being procured by the OC-ALC and would improve the ability of the management team to quickly locate GSE. Not only would asset visibility be increased through near real time tracking but the amount of labor required to manually track and input information (e.g., type of maintenance being performed, true start/end date and time stamps, information that could be used to manage the GSE at the OC-ALC more effectively for a cheaper cost than current RFID systems) could be reduced. IUID implementation will be a step in the right direction for establishing 100% visibility and accountability of GSE located at the OC-ALC. The OC-ALC GSE management team can obtain further information on the DoD implementation of IUID by accessing the following link:

http://www.acq.osd.mil/dpap/pdi/uid/docs/IUID_101_The_Basics_v3_05_2010_v2.pdf

## D. RECOMMENDATIONS FOR FURTHER RESEARCH

This exploratory study provided a top-level analysis of current GSE operations at the OC-ALC. Further research is required to continue to assist the leadership in refining GSE maintenance and accountability processes. Recommendations for further research are the following:

- Development and implementation of an IUID system that complements both the current information systems and the integration of RFID for the maintenance and tracking of GSE.
- A top-level review of eFMS and its Maximo database to determine the best way to use the current data to develop strategic management reports that will assist in improving the management of GSE.
- Optimization of GSE locations to maximize airframe throughput at the OC-ALC. This change could permit pooling GSE in work packages designed to decrease the amount of equipment required per airframe.

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# APPENDIX A. KEY LEGISLATION, DOD DIRECTIVES, AND AF DIRECTIVES AFFECTING THE USE OF CLS

## A. TITLE 10 AUTHORITY

The use of CLS (Contractor Logistics Support) by the DoD is authorized by three key pieces of legislation. First, Centers of Industrial and Technical Excellence Act of 2010, 10 U.S.C. § 2474(a)(2) and (b), states that "the Secretary of Defense [SECDEF] shall establish a policy to encourage the service Secretary, in this case the Secretary of the Air Force, to reengineer industrial processes and adopt best-business practices at their Centers of Industrial and Technical Excellence" (Centers of Industrial and Technical Excellence: Designation; Public-Private Partnerships Act of 2010, § 2474(a)(b)), which are defined as each service depot-level activity (e.g., the OC-ALC). "Private-public partnerships," such as the use of CLS to maintain and track GSE, fall under this definition. Second, according to the Core Logistics Capabilities Act of 2010, 10 U.S.C. § 2464(a)(1), the DoD is required to "maintain a core logistics capability that is Government-owned and Government-operated (including Government personnel and Government-owned and Government-operated equipment and facilities) to ensure a ready and controlled source of technical competence and resources necessary to ensure effective and timely response to a mobilization, national defense contingencies, and other emergency requirements" (Core Logistics Capabilities Act of 2010, § 2464(a)(1)). This law does not, however, apply to a majority of the GSE support provided at the OC-ALC. The Core Logistics Capabilities Act of 2010 (§ 2464(a)(3) and (a)(5)) states that commercial items that have been sold or leased in substantial quantities to the general public and are currently being used by the DoD are exempt from the governance of the law (Core Logistics Capabilities Act of 2010, § 2464). Third, the amount of CLS that can be used is limited by the Limitations on the Performance of Depot-Level Maintenance of Material Act of 2010, which stated the following:

> Not more than 50% of the funds made available in a fiscal year to a military department or a Defense Agency for depot-level maintenance and repair workload may be used to contract for the performance by non-Federal Government personnel of such workload for the military department or the

Defense Agency. (Limitations on the Performance of Depot-Level Maintenance of Material Act of 2010, § 2466)

The importance of these three key pieces of legislation to this study is simple. The DoD and, in this case, the Department of the Air Force (DAF) are encouraged to use CLS to offset costs in areas that are not considered inherently governmental and are restricted in the amount of funding that can be used to procure CLS to offset those costs. The leadership and the OC-ALC has determined that the contractor-performed maintenance and tracking of GSE to support the core activities at the OC-ALC is the most cost-effective and least restrictive cost-saving solution that fits within the top-level restrictions set forth in law.

## B. DOD DIRECTIVES AND INSTRUCTIONS

The preceding section identified the U.S. Government's encouragement to use CLS as well as the restrictions as set forth by law. The DoD has directed its service components to implement these public laws through DoD Directive (DoDD) 4151.18, *Maintenance of Military Materiel*, and DoD Instruction (DoDI) 4151.20, *Depot Maintenance Core Capabilities Determinations Processes*. DoDD 4151.18 disseminates the requirements of the Core Logistics Capabilities Act of 2010 for inherently governmental, core capability, and non-core capability requirements under the Reports on Public-Private Competition Act of 2010 and the Limitations on the Performance of Depot-Level Maintenance of Material Act of 2010 (Boito et al., 2009, p. 13). In the case of this study, GSE maintenance is a non-core capability performed on commercially available equipment and is not considered inherently governmental; therefore, services should be performed by the lowest-cost provider (in this case, an independent contractor). The OC-ALC is satisfying the requirements set forth in DoDD 4151.18 because the current contractor can perform the same level of service as organic personnel would for a lower cost.

DoDI 4151.20 implements policy, assigns responsibilities, and prescribes procedures in accordance with DoDD 4151.18 and the Core Logistics Capabilities Act of 2010 (Boito et al., 2009, p. 13). The importance of this instruction is that it outlines the size of the core workforce needed to respond to any of the contingency scenarios generated by the Joint Chiefs of Staff (JCS) and that those requirements are to be reviewed on a biennial basis. This review is important to this study for one reason: it may determine that GSE, although commercial in nature, may in fact be a core competence that should be maintained by organic personnel because of its criticality to the mission of the OC-ALC.

## C. AIR FORCE DIRECTIONS AND INSTRUCTIONS

The Air Force (AF) has implemented the policies set forth in the preceding section through a series of Air Force Policy Directives (AFPDs) and Air Force Instructions (AFIs). AFPD 63-1/20-1, *Acquisition and Sustainment Life Cycle Management*, provides an AF acquisition and sustainment integrated life cycle management (ILCM) framework for AF systems, sub-systems, end items, and activities. This AFPD, dated April 3, 2009, supersedes 15 AFPDs and consolidates information in those AFPDs to outline a life cycle integrated framework for acquisition and sustainment. Although this publication is more focused on high-level weapons systems and their life cycle support, its framework can be used on a micro level to examine the effectiveness of the Public-Private Partnership (PPP) that currently supports and maintains GSE at the OC-ALC. For example, Section 3.8 of this AFPD stated the following:

> All acquisition and sustainment execution requirements, processes, procedures, documents or activities not required by statutes, executive orders, DoD directive issuances, Air Force directive issuances, or previously approved through the programmatic chain of command, which require resources, must add appropriate value to the mission. (Department of the Air Force, 2009)

The maintenance and support of GSE at Tinker falls under this category due to the commercial nature of the equipment. One purpose of this study was to determine what value is being added to the core capabilities of the OC-ALC.

The AF further refines its guidance on the use of CLS in AFI 63-107, *Integrated Product Support Planning and Assessment*, and AFI 21-102, *Depot Maintenance Management*. AFI 63-107 implements AFPD 63-107 and provides policy for integrated product-support planning and assessment for the implementation of performance-based logistics (PBL), life cycle support concept, PPP, Source of Repair Assignment Process (SORAP), and migration planning. This AFI discusses the use of PBL, Condition-Based Maintenance Plus (CBM+), PPP, and SORAP to determine and obtain the most advantageous supply sources and maintenance programs and make them available to the warfighter. While the current firm-fixed-price (FFP) contract in place at the OC-ALC implements certain aspects of these initiatives, further review of AFPD 63-107 may prove beneficial to obtain a higher level of service for the core capabilities of the OC-ALC. AFI 21-102 directs Air Force Materiel Command (AFMC) to develop and maintain a depot maintenance support programming system for depot maintenance planning during peacetime, periods of increased tension, and emergencies. This AFI outlines business planning processes (BPPs) to identify Sources of Repair (SOR) assignments for equipment and material. SORs can come from two basic sources: organic DoD facilities and private sector contractors. The OC-ALC uses private sector contractors to augment its core maintenance capabilities by shifting its responsibility to track and maintain its GSE to the private sector contractors.

## D. SUMMARY

This appendix discussed the laws, directives, and instructions set forth by Congress, the DoD, and the AF that outline the requirements for the procurement and use of CLS for major weapons systems and, in particular, their support equipment. Additionally, it described the decision process used to determine whether CLS or organic support is used to maintain a weapons system. This study used the laws and regulations listed in this appendix to determine if the OC-ALC has currently entered into a PPP that provides the correct level of service to maintain and track GSE, which ultimately supports the warfighter.

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- Model for Optimizing Contingency Contracting, Planning and Execution
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- Transforming DoD Contract Closeout
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- USAF IT Commodity Council
- USMC Contingency Contracting

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- Lessons from Private Sector Capital Budgeting for DoD Acquisition Budgeting Reform
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- Tuition Assistance

## Logistics Management

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- Naval Aviation Maintenance and Process Improvement (2)

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- Outsourcing the Pearl Harbor MK-48 Intermediate Maintenance Activity
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- PBL (4)
- Privatization-NOSL/NAWCI
- RFID (6)
- Risk Analysis for Performance-based Logistics
- R-TOC AEGIS Microwave Power Tubes
- Sense-and-Respond Logistics Network
- Strategic Sourcing

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- Knowledge, Responsibilities and Decision Rights in MDAPs
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