JOINT VERTICAL ENVELOPMENT AIRCRAFT READINESS IMPROVEMENT FOR THE MILITARY SERVICES

YOUR TASK

Since first assigned to overseas operations in 2007, requests to deploy the Joint Vertical Envelopment Aircraft (JVEA) in support of combat forces have continually grown. These aircraft have become the most frequently requested aircraft by the Department of Defense combatant commanders. The JVEA's range and speed on the battlefield and vertical lift and envelopment capabilities make it a near-perfect platform to meet the multiple combat support, troop transport, rapid insertion, and medical evacuation requirements of today's engagements. However, sustaining this platform has proven particularly challenging to the JVEA enterprise.

In a recent independent readiness review, the senior leaders of the military services that fly the JVEA wanted to (1) assess the JVEA sustainment enterprise to identify readiness gaps, (2) prioritize the gaps found that hinder JVEA availability, and (3) analyze their root causes in-depth. They have asked your team to analyze the results of that readiness review and recommend actions to minimize the impact of underlying root causes on JVEA availability while improving JVEA readiness.

Readiness improvement opportunities span all areas of JVEA sustainment. They include component reliability, supply support, aircraft maintenance, and technical training. Significant improvement in JVEA readiness and aircraft availability will require an integrated approach to these areas and others. Of particular note is that sustainment system challenges found during this review are consistent with those found during the previous Vertical Take-Off Attack Jet and the Heavy Hauler Helicopter independent readiness reviews. The overall JVEA sustainment system is challenged to adequately support the aircraft it is tasked to sustain.

A recent independent review identified the following major findings regarding JVEA support:

- Reliability improvements are critical to maintaining readiness at present levels; however, they are under-resourced, and attrition-based component replacement takes too long to achieve the expected improvements.
- The wholesale supply system can't keep pace with retail customer demands.
- Current and projected aircraft industrial depot maintenance capacity and throughput planning uses unrealistic planning factors and is inadequate to

meet the fleet's requirements for both aircraft and repaired component deliveries.

- There are no advanced technical training courses for military service maintenance personnel beyond the initial training schools they complete after basic training and before their first operational assignment.

Your team must review the included background information from the recently completed Independent Readiness Review, and recommend actions that the JVEA Military Service senior leaders can implement to improve JVEA readiness.

Your deliverable for this project is a briefing that your team will present to a group of senior leaders from the Military Services that fly the JVEA. The briefing must include specific recommendations to improve JVEA enterprise readiness, and the rationale for your recommendations.

All of the information that follows is excerpted from the recently completed JVEA Independent Readiness Review and is provided for your review and analysis. Your final brief should be based on this information.

NOT MISSION CAPABLE SUPPLY

Supply support is critical to JVEA fleet readiness. An aircraft is coded as Not Mission Capable Supply (NMCS) when it is not able to perform its primary mission(s) due to lack of consumable or reparable repair parts. Consumable parts are disposed of after removal from an aircraft or component; reparable components are removed, repaired, and made ready to re-install on an aircraft.

The information that follows provides analysis of the JVEA community based on operational data from two military services, referred to in the remainder of the background section as Service A and Service B.

Consumable Item Analysis

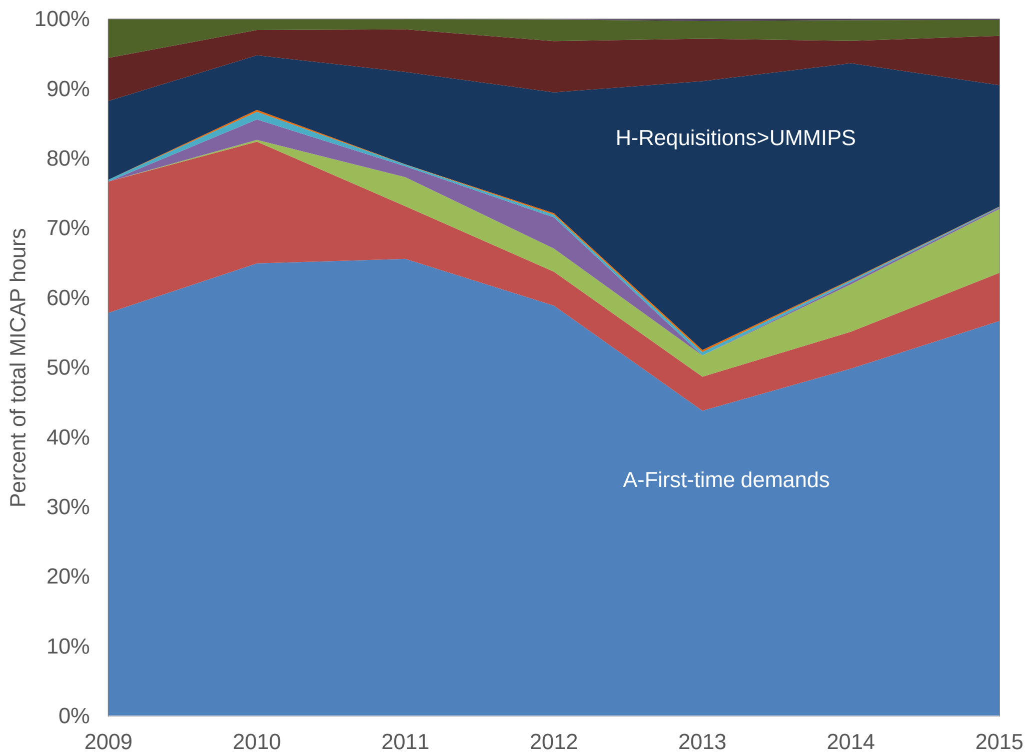
The root cause analysis that follows explores instances of worse-than-expected performance for consumable material across the supply chain.

The analysis of the JVEA NMCS data indicated the largest cause for poor consumable item performance was that the operating base lacked a part allowance because it had no previous demand for the part. The second most likely cause was that the wholesale source of supply—the Defense Support Agency (DSA)—did not resupply in the expected replenishment time frame. Next, the study team analyzed various approaches to address both major causes.

Figure 1 shows the stratification of NMCS hours by cause code for consumable items. Although Service A tracks numerous NMCS cause codes, this analysis focused on two primary codes:

- *Cause code A*. The system assigns this code when a specific location has no record of a past demand for the requested item. Because the Service A retail supply system truncates demand history at approximately 18 months, some cause code A NMCS demands may have actually experienced demand just outside this 18-month window.
- *Cause code H*. The system assigns this code when the operating base had an authorized allowance and had a stock replenishment requisition in the system, but the requisition had not been satisfied and already exceeded the Uniform Materiel Movement and Issue Priority System (UMMIPS) standards for delivery times.[1]

Figure 1. Service A NMCS Cause Code Stratification for Consumable Items



[1] The UMMIPS standard time for CONUS stock replenishment requisitions is 15 days. OCONUS standard times range from 43 to 97 days, depending on the difficulty of shipping to the specific location.

Analysis of Service A consumable item NMCS hours for 2015 found that cause code A incidents accounted for 59.7 percent of the hours and cause code H accounted for 18.3 percent.[2]

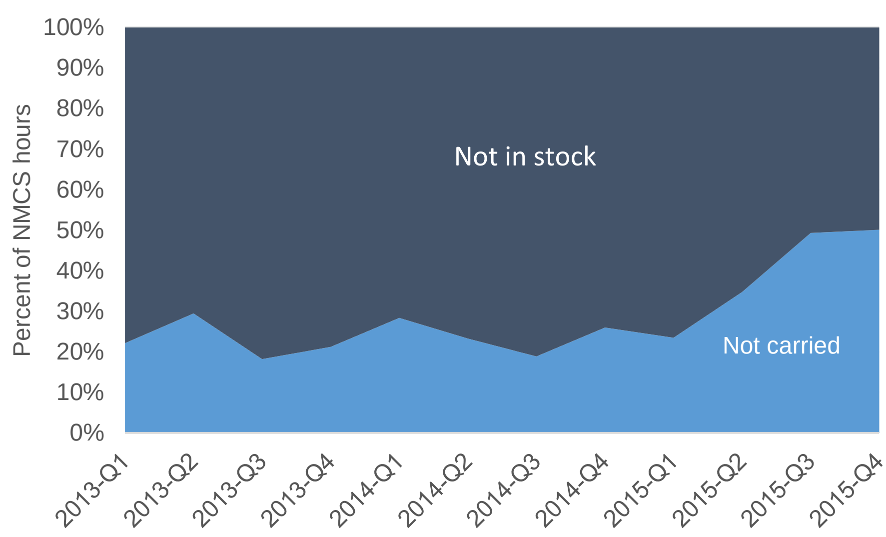
The study also drilled down into NMCS hours for Service B. Although Service B does not analyze its NMCS hours using the level of detail in Service A's cause codes, the analysis stratified Service B NMCS hours into the broader categories of not carried (NC) and not in stock (NIS):

- NC. Although NC includes more than what Service B would have categorized as NMCS cause code A, NC incidents reflect the same root cause—inadequate demand history or stockage policy to establish local allowances for items that eventually cause NMCS incidents.

- NIS. Although NIS includes more than what Service A would have categorized as NMCS cause code H, it reflects the same root cause—the inability of the system to satisfy identified stock replenishment requirements in a timely fashion.

Figure 2 shows the stratification of Service B NMCS hours for consumable items using NC and NIS.

Figure 2. Service B NMCS Stratification for Consumable Items



These cause codes and NC/NIS stratifications only reflect local conditions, not those enterprise-wide. Although there are many cause code A NMCS hours for the Service A JVEA and NC hours for the Service B JVEA, those items are not necessarily problems across the enterprise. In fact, Table 1 shows that over the past 3 years, lateral resupply from other Service A bases satisfied 30.3 percent

[2] For purposes of this case study, the terms Not Mission Capable Supply (NMCS) and Mission Impaired Capability Awaiting Parts (MICAP) are synonymous.

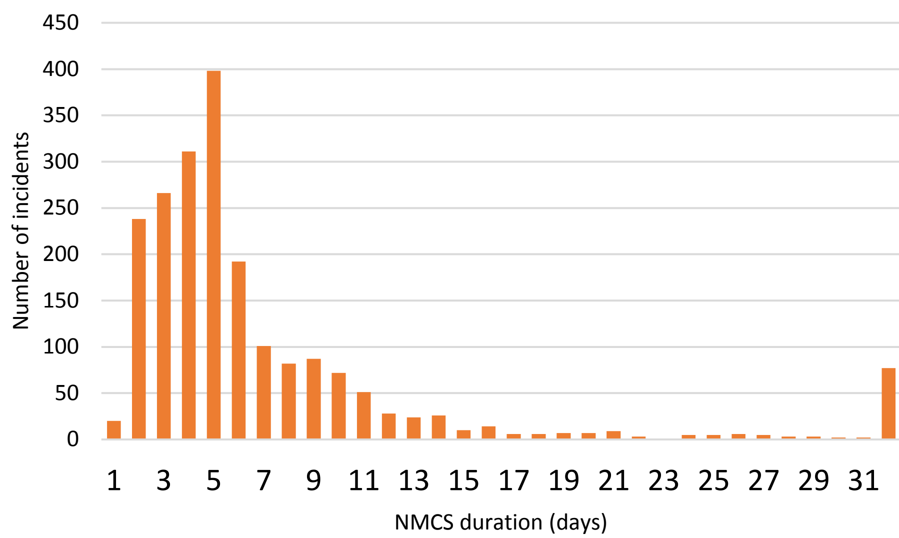
(597/1,973) of the cause code A NMCS incidents for consumable items. In these cases, other bases clearly do not have the same problem with these items—they had demand and even stock them. This highlights the local nature of the cause code A problem.

Table 1. Sources That Satisfied Service A NMCS for Consumable Items

Cause code	Service A depot	DSA	Lateral support	Other
A	92	1,244	597	40
H	2	408	510	30
Other	8	806	319	30
Total	102	2,458	1,426	100

Analysis of DSA response times for Service A NMCS incidents further validated this conclusion. Figure 3 shows the distribution of how long it took to satisfy Service A's cause code A consumable item demands.

Figure 3. NMCS Durations for Cause Code A Consumable Items



Analysis shows that the average duration was 7.5 days for the cause code A NMCS incidents, while the response time for all NMCS incidents was 9.5 days. This validates the observation that, in general, most of these cause code A items did not have enterprise-level support problems—assets were available, but not at the operating location with the NMCS condition.

Retail Consumable Supply Allowance Strategies

The large percentage of consumable item NMCS hours associated with cause code A NMCS incidents, as well as analysis highlighting the localized nature of the NMCS incidents, led to a potential solution using enterprise-wide demand data to set operating base stock levels.

Proactive Demand Leveling

The principle behind proactive demand leveling (PDL) is using a set of business rules to process demand data from bases with the same weapon system to proactively establish a stock level for an item with demands across the enterprise at a base that has not yet experienced demand for that item. Without these business rules, standard stockage policies would wait until that particular base experiences demand before the system will establish a level.

Service A already uses PDL to set consumable item levels. Under its current PDL business rules, Service A JVEA bases will stock items that experienced NMCS demands at one base at the other bases for items with a unit price of less than $100, thus preventing cause code A NMCS demands for these items at a reasonable increase in inventory levels.

So far, the results have been very positive. As of September 2015, Service A has invested $761,000 in consumable item stock levels for the JVEA using PDL and prevented an estimated 1,629 NMCS demands. Much of this initial investment represents stock levels in which the operating base would (eventually) invest when it experienced its own demand for the items. Only items that never experience a future demand (that would have resulted in the base's establishing a stock level) actually represent a long-term investment.

Study analysis examined NMCS data across the Service A JVEA fleet from January 2013 to December 2015. Table 2 stratifies Service A JVEA NMCS demands and hours by unit price. Table 3 summarizes Service B JVEA NMCS demands and hours by unit price.

Table 1. Service A JVEA Consumable NMCS Demands and Hours by Unit Price

Unit price range	Number of NMCS incidents	Percentage of NMCS incidents	Number of NMCS hours	Percentage of NMCS hours
Less than $100	1,316	37	4,404	19
$100 to $249	311	9	1,084	5
$250 to $499	271	8	1,771	8
$500 to $1,500	563	16	5,016	22
More than $1,500	1,062	30	10,859	47

Table 2. Service B JVEA Consumable NMCS Demands and Hours by Unit Price

Unit price range	Number of NMCS incidents	Percentage of NMCS incidents	Number of NMCS hours	Percentage of NMCS hours
Less than $100	7,333	62	75,181	50
$100 to $249	1,218	10	15,123	10
$250 to $499	583	5	7,302	5
$500 to $1,500	1,301	11	23,466	16
More than $1,500	1,369	12	29,544	20

This initial stratification of consumable NMCS demands showed that 37 percent of Service A NMCS demands and 62 percent of Service B NMCS demands have a unit price of less than $100. This translated into 19 percent of Service A NMCS hours and 50 percent of Service B NMCS hours for items with a unit price of less than $100. Because Service A is already using PDL, the percentage of NMCS demands and hours for items with a unit price of less than $100 for Service A is much lower than that for the NMCS demands and hours for Service B.

Analysis explored a range of alternative courses of action for applying PDL for the Service A and B JVEA fleets. These alternatives revolved around different combinations of changing the unit cost threshold (currently $100 for most Service A weapon systems) and including enterprise-wide NMCS data rather than using the data from just one service. Analysts assessed the investment required to implement each alternative PDL strategy and the number of NMCS demands the strategy would prevent.

PDL Analysis Results

For analysis of the Service A business rules, analysts applied alternative PDL strategies to demand data from August through October 2012 at multiple Service A operating bases. Analysts then assessed the costs and benefits using actual demand data for November 2012–December 2015.

Continuing the Service A baseline PDL policy with a unit price threshold of $100 would have cost $93,000. Changing the unit price threshold from $100 to $250 had a relatively small affect compared with that of including Service B JVEA demand data in addition to the current practice of using only Service A JVEA data. The alternative of using the current $100 unit price threshold, but adding Service B JVEA data to the PDL process, would require an additional investment of $146,000 across the Service A operating bases, but it could have avoided an additional 156 NMCS demands. The study team assessed other alternatives that showed an improvement in performance, but the incremental return on investment was lower (they cost more per NMCS demand avoided).

Implementing PDL at Service B JVEA operating bases with just the Service B JVEA data and the $100 unit price threshold could have avoided 816 NMCS incidents for an inventory investment of $97,000. Using the same $100 unit price threshold but adding Service A demand data to the process could have avoided 1,013 NMCS conditions for an investment of $160,000. These two alternative strategies were the most promising. The other alternatives showed a higher cost per NMCS incident avoided.

Linking Retail Levels to DSA Support Projections

Service A's Customer-Oriented Leveling Technique (COLT) sets stock levels for consumable items at the local level using multi-echelon inventory algorithms that account for the projected performance at the wholesale level. This is more efficient and effective than setting those levels in isolation. DSA provides a quarterly update on all the items it manages, with their projected fill rates and conditional delays (how long it will take them to satisfy a requisition not available off the shelf). Because COLT seeks to minimize customer wait time (CWT) for a given level of investment, it adapts to this information by stocking more spares at the base for items for which DSA is projecting poor support and stocking fewer spares for items for which DSA is projecting strong support. The mix of spares that COLT generates more accurately supports mission requirements.

Service A has reaped substantial benefits since implementing COLT in 2004. During initial implementation in 2004 and 2005, studies projected a 51 percent and 64 percent reduction in NMCS demands for the bases that made up the initial implementation. These same studies projected a 31 percent and 52 percent reduction in CWT across all requisitions for consumable items at the base level.[3] A subsequent 2009 study of actual performance data found that COLT had reduced expected backorders by 24 percent. That analysis estimated that it would cost an additional $200 million to achieve the same level of performance as the COLT levels produced if Service A were still using its retail supply system's previous leveling techniques.

COLT Analysis Results

In light of Service A's success using COLT to set base levels for consumables, the study team evaluated using COLT to set plane-side consumable item levels for Service B.

The study team captured data from two different Service B operating bases. At one base, 6,572 national stock numbers (NSNs) had demand between January 1, 2013, and January 31, 2016. At the other base, 7,931 NSNs had demand during the same period. The study team designed their analysis to match the current level of investment in consumable item allowances. At Base #1, the current allowances are valued at $13.1 million; Base #2 allowances are valued at $13.4 million.

[3] CWT is the average time that a plane-side user has to wait for the supply system to satisfy an issue request. The computations average in a CWT of 0 for immediate issues.

Item-level analysis results showed that COLT followed its basic principle of stocking larger safety levels for items where DSA projected poor performance, and larger levels for items with higher demand.

COLT algorithms increased levels on more than half of the NSNs, while only reducing levels on slightly more than 20 percent. The NSNs for which COLT increased the levels accounted for a significant portion of the demand. At Service B Base #1, COLT would have increased the quantity stocked for 59.7 percent of the NSNs and increased those levels by 81.3 percent. These NSNs accounted for 82.2 percent of the demand. At Service B Base #2, this trend was even more pronounced—COLT increased levels for 56.9 percent of the items, increasing the quantity by 97.5 percent, and these items accounted for 87.4 percent of the demand. By increasing the depth of stock for these fast-moving items, COLT was able to significantly reduce the average CWT. Table 4 summarizes the analysis of the performance of COLT levels and the current levels.

Table 3. Assessment of COLT Levels

Unit	Current levels	COLT levels	Current CWT	Projected CWT
Base #1	91,260	165,423	6.3	2.1
Base #2	109,560	216,430	5.0	2.6

After the study team ran the COLT analysis for both Service B bases, they captured a month of demand history (February 10 through March 9, 2016) and assessed how the COLT levels would have performed. In a single month, the COLT levels could have avoided 144 NMCS demands (with 25,170 associated NMCS hours) at Base #1 and 101 NMCS demands (with 19,536 associated NMCS hours) at Base #2. COLT potentially avoided these NMCS demands by stocking NSNs that the current method was not stocking and increasing the depth of stock for other items. Of the items that had an NMCS incident in the subsequent month, 95 percent were not even stocked in the baseline but were stocked by COLT.

Wholesale Consumable Supply Allowance Strategies

Although cause code A was the predominant cause of consumable item NMCS demands for the JVEA fleet, the percentage of cause code H NMCS demands (stock replenishment requisitions exceeding expected delivery time) was significant enough to warrant closer examination. The nature of cause code H NMCS demands suggests wholesale-level problems in satisfying stock replenishment requests in a timely manner. The large number of not-in-stock conditions for the JVEA fleet suggests a similar problem with wholesale support for requisitions from operational locations. The study's analysis explored support for DSA-managed consumables to identify possible root causes, and examined strategies to address these root causes.

HIGH-COST ITEMS

Initial descriptive analysis found that fewer than 5,000 individual items (NSNs) have caused JVEA NMCS demands in the past 3 years (2013–15). Most items are responsible for only a few NMCS demands each. However, a small population—just 4 percent of the NMCS population—is responsible for half of all NMCS demand days for both Service A (Figure 4) and Service B (Figure 5) JVEAs.

Figure 4. Cumulative Distribution of Service A NMCS Days

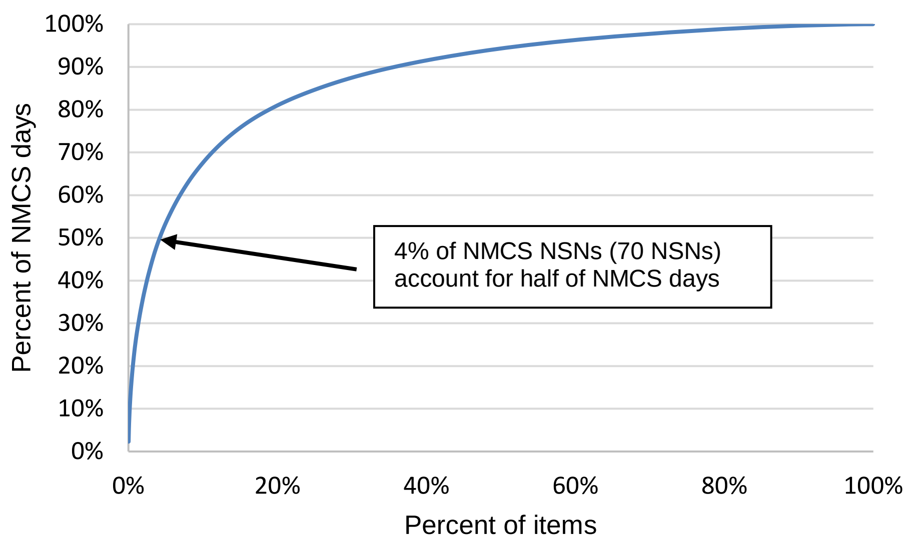
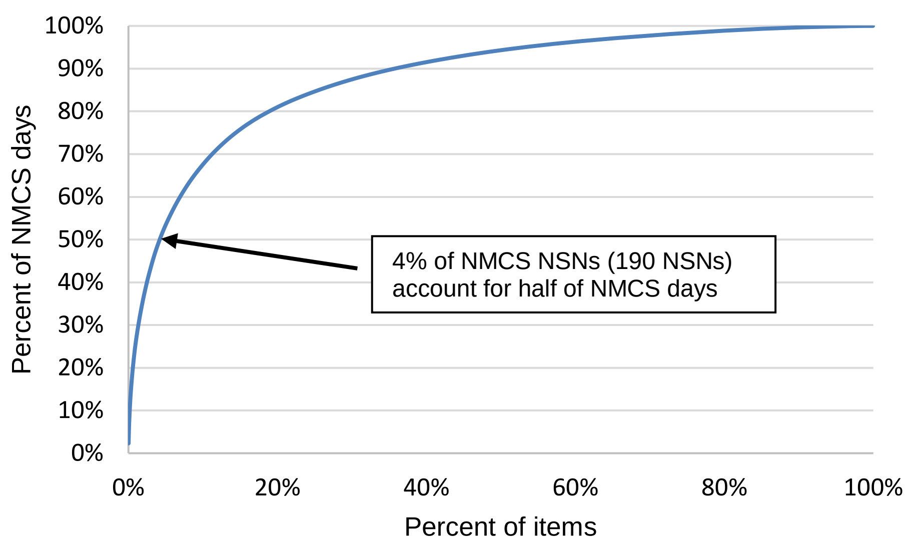


Figure 5. Cumulative Distribution of Service B NMCS Days



These items don't just get NMCS demands; they get long-duration grounding events. The average NMCS duration is about 13 days, but these items average 27 days per incident, and some of them last months, not days.

The study team examined these items to determine the reason for such long delays. One telling feature is their high cost. Inventory optimization models tend to avoid investing in high-cost items. When trying to minimize backorders within a cost constraint, concentrating inventory investment in low-cost, high-demand items is generally more effective.

For approximately 33 percent of the items coded to the JVEA, DSA computes levels with the Inventory Optimization (IO) model. Like most inventory models, IO prioritizes items and plans to support some more aggressively than others. One of the IO performance measures that expresses this prioritization is the projected fill rate for each item.[4] As part of the analysis on the items driving a disproportionate amount of the NMCS demands, the study team compared the IO projected fill rates for the entire JVEA item population, the subset of items with NMCS demands, and the focused group of "NMCS drivers" that accounted for approximately 50 percent of the NMCS demands.

Overall, IO calculates allowances for the JVEA items that are designed to achieve approximately a 94 percent fill rate. When the study team only looked at items that had caused at least one NMCS incident over the past 3 years, IO set allowances for those items that were designed to achieve an average fill rate of 90.8 percent. However, when examining the NMCS driver items that were causing approximately 50 percent of the NMCS demands, IO calculated levels that were only expected to achieve a fill rate of 85.7 percent. The reason lies in the nature of inventory optimization models, which generally invest less in high-cost items.

Because of some common items in the lists of driving items for both Service A and Service B, there were a total of 225 items in the combined list of driving items. Figures 6 and 7 compare the price distributions for JVEA items overall with the 225 items driving approximately 50 percent of the NMCS hours. While the overall population is dominated by low-cost items, the NMCS duration drivers are just the opposite. These items are at a clear disadvantage when competing for investment dollars.

[4] Fill rate is the percentage of time DSA can satisfy requisitions using inventory already in stock.

Figure 6. Price Distribution of All JVEA Items

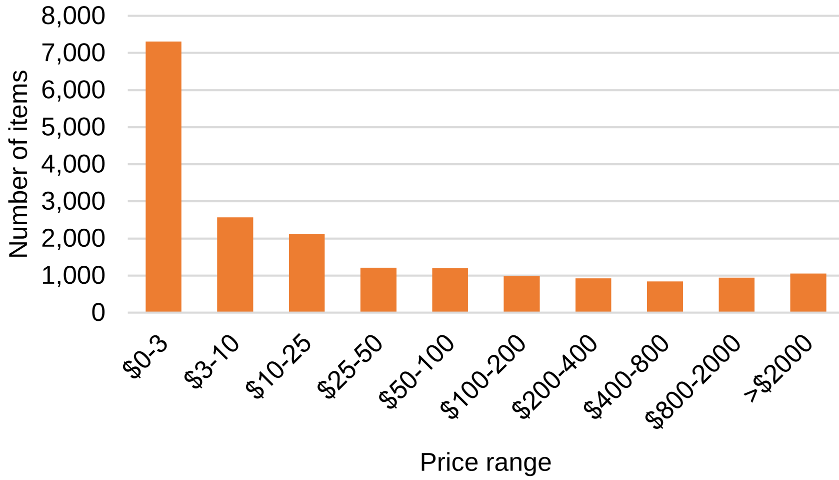
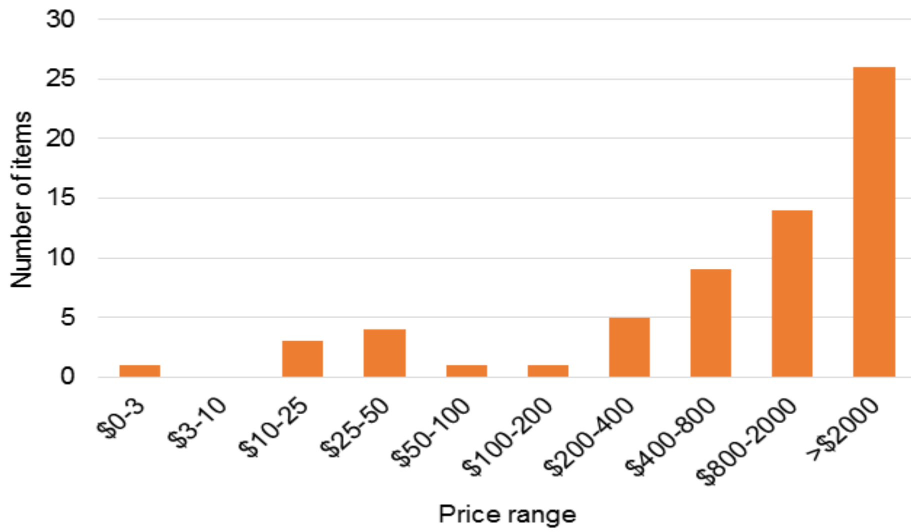


Figure 7. Price Distribution of JVEA NMCS Hour Drivers



Unfortunately, many of these high-cost items also have relatively high demand rates. Figures 8 and 9 stratify the demand rates for JVEA items as a whole, and for the NMCS drivers.[5]

[5] The X axis on Figures 8 and 9 reflects annual demand frequency, or the number of items that had between 1 and 3 demands during the year, between 4 and 10 demands during the year, etc.

Figure 8. Demand Distribution of All JVEA Items

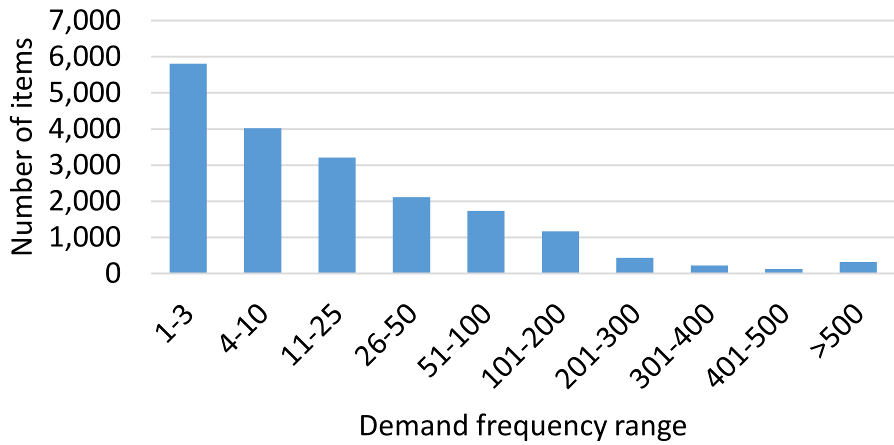
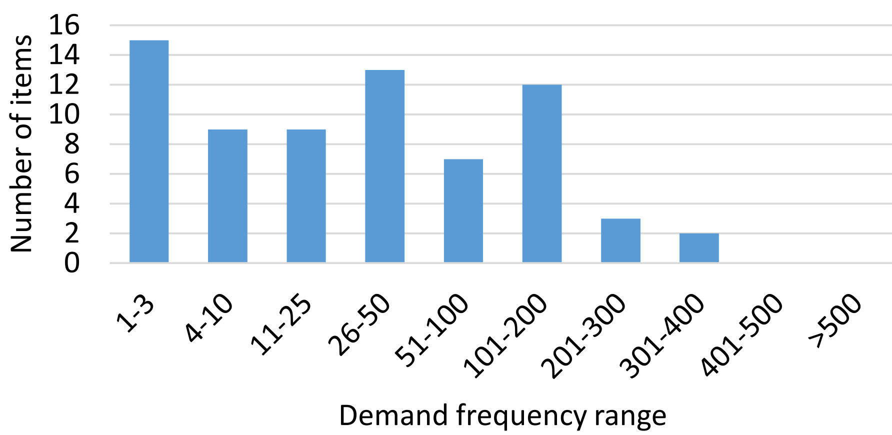


Figure 9. Demand Distribution of JVEA NMCS Hour Drivers



Items that are high-cost suffer from the traditional bias of economic-based models and items that are high-demand also pose a significant risk to readiness. It is inefficient for DSA to attempt to make across-the-board investments in high-cost items or even in NMCS-causing items. However, a targeted investment that considers a combination of cost and demand frequency can be both efficient and effective.

Reparable Item Analysis

Analysis of the Service A JVEA NMCS hours for the past 7 years indicated that the largest cause for reparable items was the wholesale source of supply's not satisfying stock replenishment requisitions in the expected time frame (cause code H). Similarly, for Service B, the overwhelming cause of NMCS hours over the past 3 years was items with established levels, but no inventory to support them. Analysis of reparable NMCS demands identified a variety of root causes and potential solutions.

The large percentage of NMCS hours associated with cause code H incidents for both Service A and Service B indicates that the system is unable to support requirements for a significant group of items. In these cases, there was a stock allowance, but no assets to fill the authorized level, and the replenishment requisition to fill the level had exceeded the expected replenishment time. Root causes explored included the following:

- Actual replenishment times (from either repair or shipment from wholesale) exceeding the forecasted times used to compute the levels
- Not enough assets available across the enterprise to satisfy the existing stock levels
- Component repair constrained by the unavailability of sub-component parts
- Inventory policies
- Inefficiencies in the intermediate-level and depot-level repair processes.

Wholesale Support

Service B's Weapons Systems Support Program (WSSP) has been unable to effectively establish and maintain a supply chain to sustain the JVEA fleet with required reparable components. The lack of wholesale spares created a backlog of more than 3,700 backorders for JVEA components as of January 2016. Supply chain shortages resulted in the Service A and Service B fleets waiting 28 days on average to receive a NMCS backorder. As a result, reparable requirements account for 45 percent of Service B NMCS hours and 50 percent of Service A NMCS hours, despite constituting only 15 percent of the total NMCS demand.

Several root causes created the dilemma that the WSSP faces and from which the JVEA fleet suffers. First, multiple components do not achieve planned reliability levels measured in mean time between removal (MTBR). The complexity of the JVEA required the design of several systems and components unique to this aircraft. As a result, reliability forecasts were based purely on engineering estimates. The engineering estimates were then used as planning factors to forecast demand and estimate inventory levels. In addition, Services A and B operate these aircraft in harsh environments. The JVEA's operational employment exposes aircraft systems to high heat, dust, moisture, and salt spray conditions. These factors combine to degrade system performance and accelerate component failures. In particular, the engine and rotor areas, including the infrared suppression and ice protection components and the wiring, are prone to failures.

Last, less than optimal maintenance personnel proficiency contributes to unplanned demand due to the lack of comprehensive troubleshooting procedures or inadequate technical data.

Table 5 lists several components and their corresponding desired and required design MTBR. Note that none of the components listed meet the *desired* design MTBR, and only three meet or exceed their *required* design MTBR. Note also that the design MTBR is tied to the main components (shown in "bold"); components listed below the main components are the problem subassemblies with their corresponding actual MTBR. Main components listed without subassemblies do not have subassemblies.

Table 5. MTBR Performance vs. Design Criteria

Actual MTBR performance vs. design criteria			
Component	Actual MTBR (hours)	Desired MTBR design criteria (hours)	Required MTBR design criteria (hours)
Swashplate actuator	1,068	5,000	1,500
Flaperon actuator	1,049	5,000	1,500
Rudder actuator	1,600	5,000	1,500
Rotor head assembly		3,000	1,500
Drive tube assy	1,013		
Hub assy	1,003		
Proprotor gearbox		3,000	1,500
PRGB, LH	1,959		
PRGB, RH	1,959		
PRGB dump value	1,289		
Nose landing gear		1,500	1,500
NLG shock strut	1,206		
Generator		6,000	1,500
Variable frequency	440		
Exhaust/IR suppressor		1,500	1,500
Centerbody assy, IRS	305		
Transition duct, IRS	440		
Side panels, IRS	880		

WHOLESALE DELAY ASSUMPTIONS IN REQUIREMENTS COMPUTATIONS

The study team examined how key factors in allowance calculations influence readiness. The method used to calculate JVEA retail reparable spares allowances assumes an artificially low wholesale delay time, which significantly affects NMCS. Most factors in the allowance calculation use actual historical information (demand rates, retail repair times, and percentage of items sent to wholesale) to provide the most realistic input to the spares model.

However, WSSP's current method applies a ceiling on order and ship time plus wholesale delay (O&ST+W) to limit it to approximately 21 days.[6] This ceiling is designed to prevent the procurement of additional spares to compensate for a broken supply process. The rationale is that the emphasis should be on fixing the process. Resolving the process problems is more efficient than buying additional spares—which will be excess once the problems are fixed. Because they're reparable, these spares will remain in the system until they attrite as a result of condemnations.

Table 6 shows the differences between the actual times the Services are experiencing and the time WSSP assumes in developing the allowance.

Table 6. Average O&ST+W (Days)

Part	Actual		Assumed
	Service B	Service A	WSSP
Reparable	104	68	21
Consumable	29	56	18

This differential between the actual and assumed pipeline is degrading readiness.

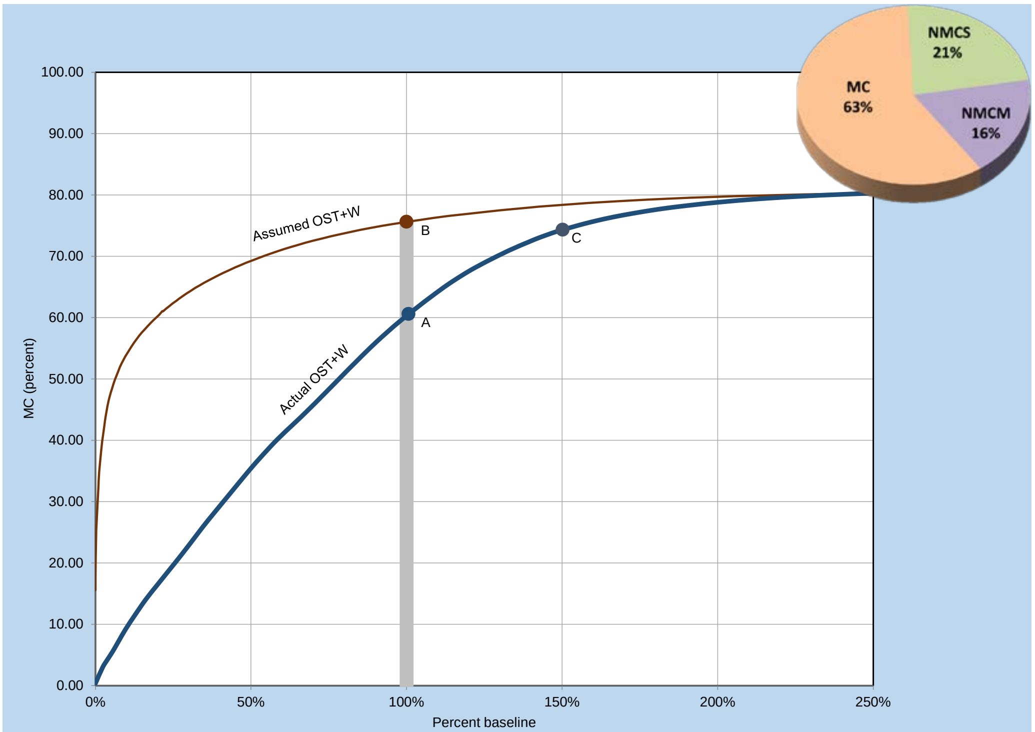
Readiness Impact on JVEA Fleet

The analysis calculated the impact of this mismatch between actual and assumed O&ST+W on the JVEA fleet. The study team recreated the wholesale allowancing computations using the existing rates and factors, except analysts used the actual O&ST+W values the JVEA fleet is experiencing.

Figure 10 is a "cost-performance" curve for the Service B JVEA fleet. The X-axis of the cost-performance curve reflects the investment in spares as a percentage of the cost of the current allowances. The Y-axis shows the corresponding mission capable (MC) performance of the Service B JVEA fleet for any level of investment. The blue cost-performance curve shows the tradeoff using the actual O&ST+W values. The red cost-performance curve shows the tradeoff between inventory investment and MC assuming the default (assumed) O&ST+W values.

[6] The O&ST+W value represents the time it takes from when retail places an order with wholesale (a replenishment or allowance change, for example) to when retail receives a spare.

Figure 10. Service B JVEA MC and Cost

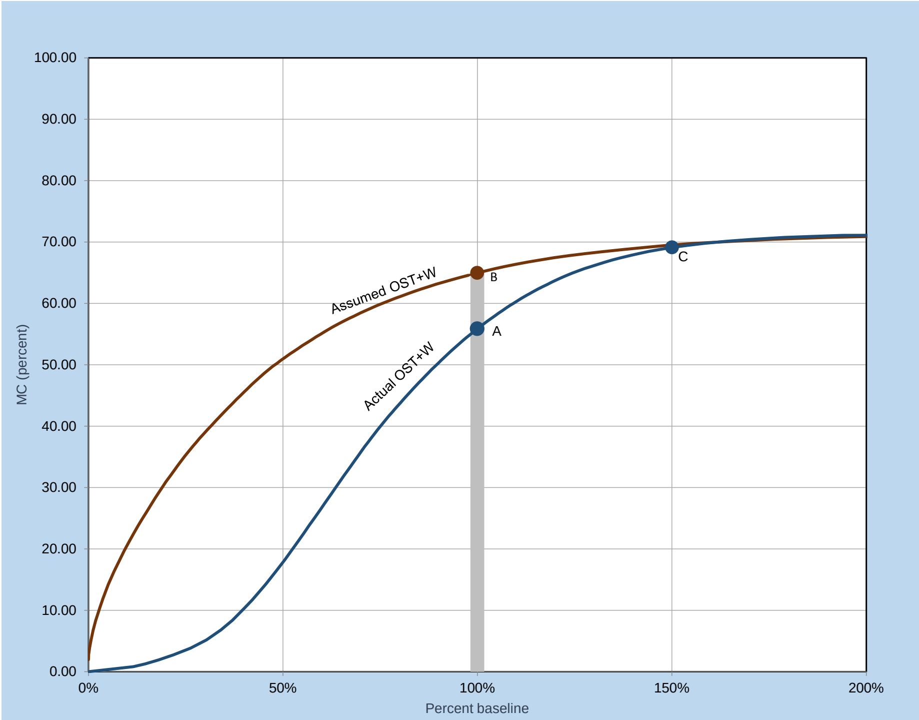


Using actual O&ST+W times (blue curve), the model shows that the current level of investment results in a 63 percent MC rate. The red curve shows the assessment using WSSP's O&ST+W assumptions. From this, the study team can draw several conclusions:

- If WSSP wholesale response could achieve the 21-day assumed O&ST+W times, MC rates would improve by 13 percent (moving from point A to point B).
- The impact of a 50 percent increase in inventory (spending more on spares) would result in a comparable 14 percent improvement in MC (moving from point A to point C).
- The impact of a 50 percent reduction in O&ST+W would result in 9 percent MC improvement (roughly halfway between points A and B).

In a similar analysis, the study team used inputs for the Service A JVEA aircraft. Figure 11 is a cost-performance curve for the Service A JVEA fleet.

Figure 11. Service A JVEA MC and Cost



From this, analysts conclude the following:

- Using actual O&ST+W values, the study team assessed the Service A JVEA MC rate at 56 percent. If WSSP could achieve the default values assumed in its allowancing computations, the MC rate would improve by 9 percent (moving from point A to point B).
- The impact of a 50 percent increase in inventory (spending more on spares) results in a 13 percent improvement in MC (moving from point A to point C).

Figure 11 shows the analysis results in terms of MC, which enables direct comparison with the Service B JVEA fleet, as well as the potential for an enterprise solution. Due to the conversion of components included in the measures of performance, availability is analogous to MC: for an actual O&ST+W of 48 percent availability, the assumed O&ST+W value is 56 percent (an 8 percent improvement).

Follow-On Analysis of Allowancing Computations

As discussed earlier, whenever actual pipeline times differ from the values and assumptions used to compute the requirements, readiness will be impacted. In the JVEA case, actual base and depot repair and order and ship time pipelines are longer than the model uses, and repair pipelines internal to the Services (i.e., shipping a component from one base to another for repair) are not even part of the requirements assumptions. For the amount of time that exceeds the requirements estimated pipeline, aircraft are at risk for parts shortages.

The study team's analysis observed multiple symptoms that the current process is not optimized across the enterprise:

- Repair nodes are making local decisions of what to repair and where to distribute the assets.
- Both Service A and Service B use local repair lines (such as the On-Site Quick Response Team) to solve process shortfalls, but these operations create a pipeline and operate outside the assumptions behind the requirements.
- Distributions from the centralized repair facilities are being made manually, outside standard procedures. The study team found numerous serviceable assets being held at these facilities for prolonged periods.

The study has identified the differences and estimated the impact of the differences on readiness. However, further analysis is necessary to determine an appropriate balance between improving the process and increasing spares investment.

Not Mission Capable Maintenance

Aircraft must be maintained on a daily basis to remain operational; maintenance support is critical to JVEA fleet readiness. An aircraft is coded as Not Mission Capable Maintenance (NMCM) when it is not able to perform its primary mission(s) because it is waiting for some type of maintenance to be performed, due to lack of consumable or reparable repair parts. NMCM reasons include time spent inspecting aircraft, conducting standard / planned maintenance, not having the right tools, not having trained maintenance personnel, waiting for technical assistance, and other factors as identified below.

Service A JVEA NMCM Causal Factors

During the study team's site visits to the Service A JVEA operational squadrons, training squadrons, and maintenance squadrons, Service A personnel identified the following issues as some of the primary NMCM drivers:

- Time spent on phase maintenance and inspections (the top maintenance driver across the Service A JVEA fleet)
- Component reliability, particularly that of infrared suppression system components, hydraulic lines, engine link mount bushings, and gear boxes

- Troubleshooting wiring throughout the airframe, but particularly in the wings and engine areas
- Cannibalization rates double those normally seen on other aircraft
- Excessively long and numerous technical assistance request (TAR) process issues
- Compared with other Service A aircraft, too many serial-number-tracked items requiring mandatory time limit changes
- Excessive time spent troubleshooting discrepancies, driven by out-of-date and wrong technical data in the electronic technical manuals and other technical publications, many extremely junior, inexperienced maintainers, and not enough experienced maintainers
- The complex nature and design of this aircraft, which makes just doing maintenance extremely hard (some wiring harnesses take 12+ hours to remove and replace)
- Composite repairs that take a long time, particularly with inexperienced maintainers
- Maintenance task saturation—the operational tempo and constant demand for Service A JVEAs reduces available maintenance time, leading to an excessive amount of required maintenance when maintenance can be performed.

Service B JVEA NMCM Causal Factors

During the study team's site visits to the Service B JVEA operating squadrons, training squadron, and maintenance squadrons, Service B personnel identified the following issues as some of the primary NMCM drivers:

- Poor component reliability, driving increased component removals
- Updates to electronic maintenance manuals and publications published only 3 times per year, requiring maintainers to submit numerous TARs to determine proper maintenance procedures
- No data load manual or structural repair manual for the community, thus delaying what are routine repairs in other communities
- Maintainer experience levels that have gradually decreased due to an increasing number of junior maintainers compared with experienced maintainers

- Insufficient actual maintainer touch time on the aircraft due to time spent getting ready to actually do maintenance (researching what needs to be done, searching for tools, verifying the aircraft configuration in the electronic technical manuals, etc.) and other non-maintenance related duties (medical appointments, watch stander, mandatory classes for non-maintenance related topics, etc.)

- Insufficient collateral duty inspector and quality assurance maintainers, particularly for deployed units that are multi-sited

- The complex aircraft design, particularly in the engine area, which drives approximately 20 hours of maintenance time per aircraft per month due to work required for facilitate other maintenance (FOM) actions (removal of another component or part to perform maintenance on the failed part)

- Lack of comprehensive troubleshooting procedures, due to maintenance publications not being updated more frequently and not having data load or structural repair manuals

- Multiple aircraft configurations within the same squadron and across the fleet.

Fundamentally, many of today's Service B operational squadron maintenance personnel have grown up in a constant combat deployment, post-deployment stand-down, pre-deployment preparation environment. They haven't built the habit or routine of performing all scheduled and unscheduled operational squadron level maintenance tasks. During operational squadron site visits, when asked about aircraft going to depot level maintenance events with outstanding operational squadron level maintenance tasks, many Service B maintenance personnel commented, "The depot will take care of it."

Impacts

The collective impacts of these NMCM causal factors manifest in multiple areas across the fleets:[7]

- Increased component removal drives increased NMCM hours.

- Too many time-driven inspections cause higher NMCM hours; one Service A operational squadron noted that it spent 33 percent of its maintenance time conducting scheduled maintenance.

- Because maintenance manuals and other publications are not updated more frequently, maintainers must submit more TARs and wait on technical publication deficiency report incorporation, driving increased

[7] Unless otherwise specified, these impacts apply to both the Service A and Service B JVEA fleets.

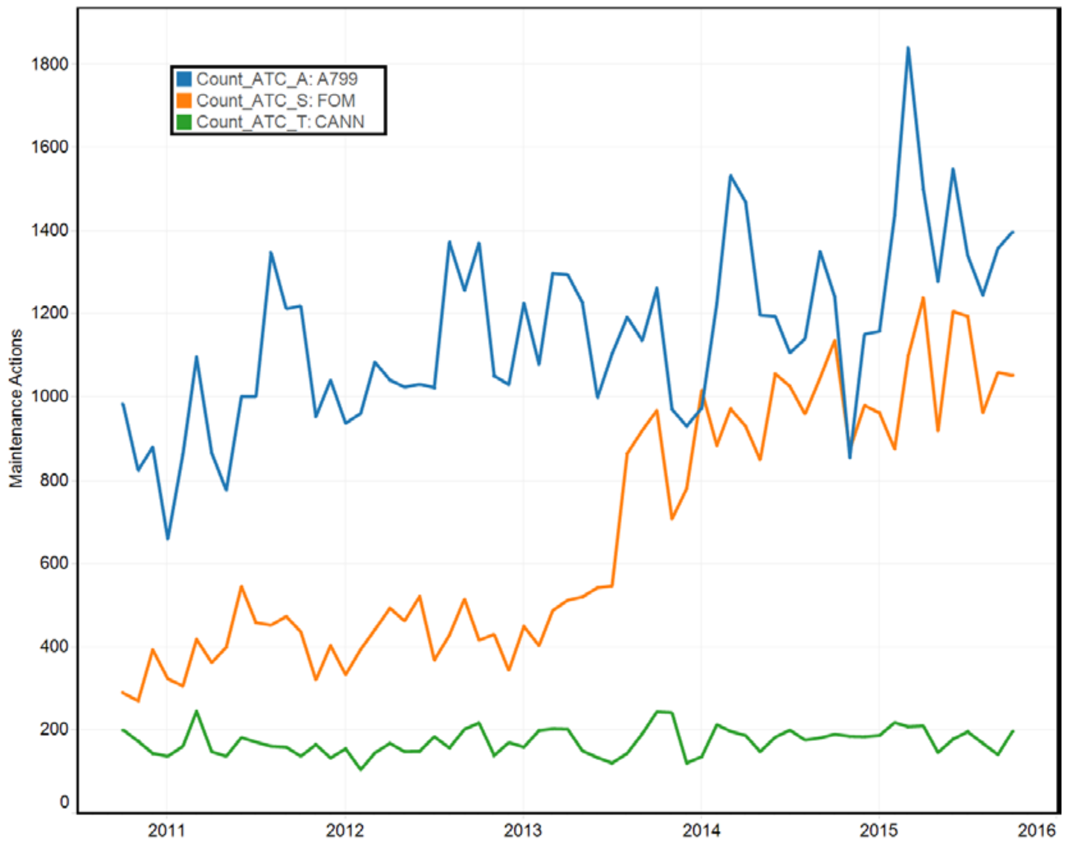
NMCM hours. One Service A maintenance squadron accumulated 25 days of TAR wait time in 1 year, and a Service A structural repair shop amassed over 2,000 hours in 1 year awaiting TAR disposition.

- Lack of structural repair and data load manuals for standard repairs drive increased NMCM hours while maintainers wait for depot-level engineering technician responses to maintenance procedure questions.
- Not having enough Service B collateral duty inspectors or quality assurance maintenance personnel increases NMCM hours while waiting for an inspector to sign off that a maintenance action is complete.
- Lack of comprehensive troubleshooting procedures increases NMCM hours by lengthening the time it takes maintainers to troubleshoot the problem and determine how to fix it, particularly when troubleshooting wiring discrepancies.
- Multiple aircraft configurations, to the point where almost every aircraft seems unique, increase NMCM hours because maintainers must first determine the configuration on which they are working, and then determine whether the maintenance manual procedures are current, before conducting maintenance.
- Service B JVEA aircraft go to depot-level maintenance with outstanding operational squadron level (O-level) maintenance actions. Because the depot plan does not include nor is it funded to work off these O-level tasks, the Service B JVEAs are returned to the squadron, after completion of the depot work, with the same outstanding maintenance actions—known as noted but not corrected (NBNC) discrepancies. As a result, most of these aircraft go back into an NMCM status upon return from depot maintenance—rather than onto the flight schedule—pending completion of these NBNC tasks.
- Reduced maintainer experience levels make fundamentally routine maintenance tasks take longer, increasing NMCM time, as reflected in Figures 12 and 13.
- Increasing trends in A799 maintenance discrepancy resolutions for components. A799 is a code indicating either ‘could not duplicate’ or ‘no defect found.’ This means that components were removed as failed, but were found not to be failed at the repair activity and thus were an unnecessary removal (Figure 12).
- Service B FOM actions across the fleet have risen steadily since 2013 (Figure 12), primarily driven by component reliability problems and increasing component failures; FOM hours account for almost 3 percent of an operational squadron’s total NMCM hours. The requirement to do FOM actions is a function primarily of aircraft design. FOM is a concern

because it increases NMCM hours without actually fixing what's wrong with the airplane, and it's another potential chance to break a good component while removing it to get to an already broken component.

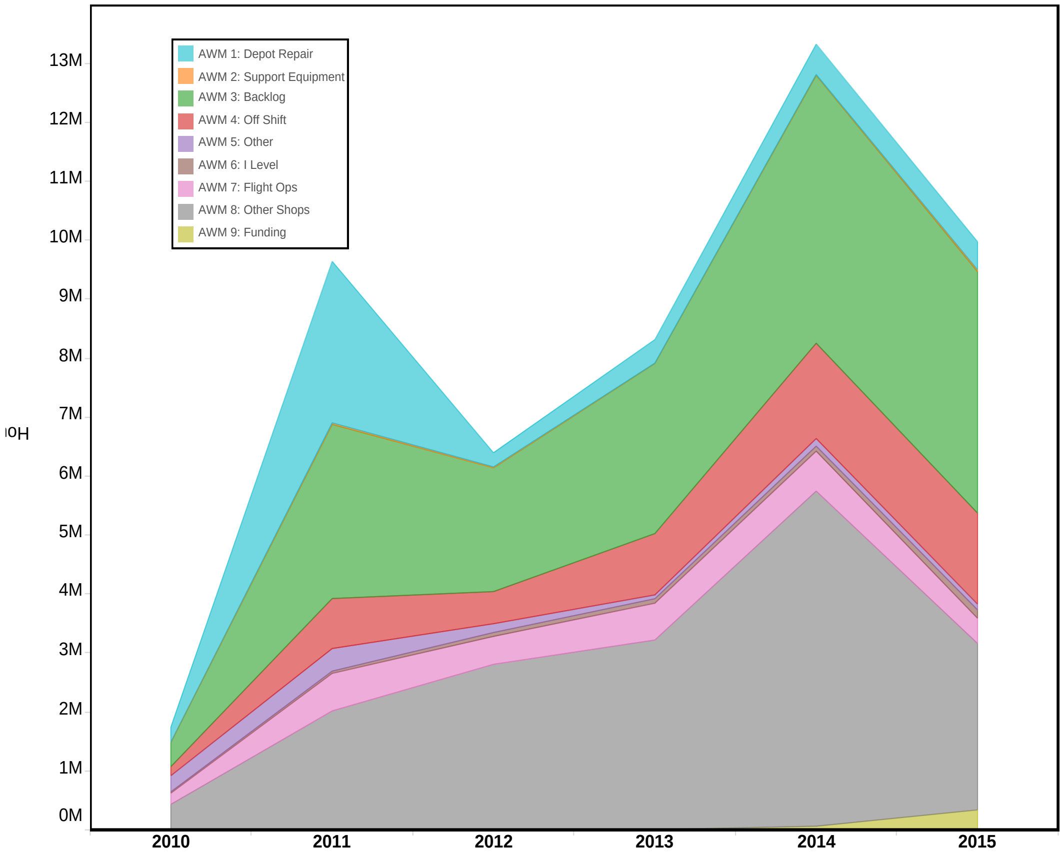
- Cannibalizations double NMCM hours because maintainers have to do the work twice—removing and reinstalling both the original and the replacement component. Service B cannibalization actions, though undesirable, have remained relatively steady since 2011 (Figure 12).

Figure 12. A799, FOM, and Cannibalization Actions, by Month (Service B Fleet)



- Increasing trends in Service B Awaiting Maintenance (AWM) time—primarily in the AWM codes for maintenance backlog (AWM 3), other shops (AWM 8), and off shift (AWM 4—outside normal working hours)—cause increased NMCM. While all AWM is not NMCM time, if the original maintenance discrepancy downs the aircraft, the accrued maintenance time will be NMCM (Figure 13).

Figure 13. Total AWM Hours per Year, by AWM Category (Service B Fleet)



MAINTENANCE TRAINING

All Service A and B maintenance personnel must go through basic maintenance training courses upon completion of their recruit training and prior to assignment to their first operational squadron. However, both Services lack sufficient advanced training courses to maintain and improve maintenance personnel skills beyond their basic maintenance training.

Training Courses Lacking

No service-level “craftsman” or “journeyman” technical training courses are available for Service A or B JVEA maintainers.

Service A maintenance technicians undergo initial skills training via in-residence apprentice-level schools at a Midwest training base. Service B maintenance technicians receive equivalent initial skills training at a Southeast training base. Both Services send their JVEA maintenance technicians to the final training course at an east coast Service B JVEA operating base. (Service A refers to this course as the Aerospace Maintenance Apprentice training course.) This final training program uses on-the-job training (OJT) in the operational squadrons; this training is based on a specific syllabus for each maintenance specialty skill set.

In keeping with the 1999 Joint Systems Training Program, no “service-level” curriculums have been developed for JVEA post-final technical training; however, depot-level engineering teams have created a Maintenance Readiness Enhancement Team in conjunction with the Service B Technical Data and Engineering Service Center to provide some in-service training for JVEA maintainers. This training, though helpful, is not consistently applied or prioritized by all commands. Most importantly, no institutional provisions are made for advanced JVEA systems training that goes beyond the capabilities of local squadrons or field service teams to develop and manage.

Service A maintenance technicians generally require advanced training courses to enable them to progress to the craftsman level (highest qualification level) in the Service A qualification standards aligned with their career field. Table 7 lists examples of advanced technical courses available for other Service A aircraft; however, no similar courses are available for Service A or B JVEA maintainers.

Table 7. Examples of Advanced Technical Courses

Course number	Course title
J4AMP2A6X5 A04A	Heavy Hauler Hydraulic Systems Craftsman
J4AMP2A6X5 F18A	Refueler Hydraulic System Troubleshooting
J4AMP2A6X6 A30A	Tactical Helicopter Electrical Systems Craftsman for Operational Maintenance
J4AMP2 A6X6 A17A	Combat Transporter Electrical Systems Craftsman

The relationship between maintenance training and maintainer productivity increases is intuitive, but no metrics currently in use tie training impact to aircraft availability. As a result, the negative impact of having no post-final technical training is impossible to identify.

Because they have no dedicated service-level curriculums beyond final technical training, both Service A and B maintainers have been limited to localized training courses to meet their need for advanced technical instruction. In conjunction with local depot-level support teams, they have, commendably, developed training courses for advanced technical schooling on JVEA systems, but these courses are informal, locally funded, and based on perceived location requirements. They are not funded or developed as dedicated curriculums, nor are they generally exported outside the local commands.

Maintenance Management Skills

In addition to maintenance technical training requirements, effective maintenance management training is equally needed. Ongoing development of advanced maintenance management training will give enlisted maintenance leaders required planning and management skills. Service B has initiated an advanced maintenance management program to improve planning and decision-making skills for senior enlisted maintenance leaders. This advanced training course shows great promise in the development of rising maintenance leaders and likely will produce a high return on investment as best practices are more easily replicated throughout the aircraft maintenance communities.

The advanced training course curriculum remains in development, but the intent is to focus training on the following core maintenance skills:

- Maintenance planning
- Manpower management
- Service B maintenance program management
- Deployment planning
- Operational risk management
- Safety
- Culture of compliance
- Human factors.

Hours Consumed by Non-Maintenance Training

In addition to their primary JVEA maintenance duties, both Service A and Service B maintainers have important military responsibilities and collateral duties for which they must also be well trained. Non-maintenance training reduces available hours that can be dedicated to maintenance tasks. For example, a series of studies conducted by Service B's training and education organization starting in 2013 evaluated non-maintenance training requirements listed in various Service B documents. These studies noted that noncommissioned officer (NCO) training that is not related to maintenance duty consumes an estimated 650 to 725 hours during a normal 3-year assignment. This amounts to approximately 12 percent of possible maintenance man-hours being lost each year to non-maintenance training.

Another consumer of available maintenance hours is the time spent on professional military education career courses that must be completed before promotion. These classes add to the overall leadership and management skills of enlisted maintainers, but they are not designed to improve maintenance management or technical skills and, in that respect, they consume time otherwise available for maintenance-related technical training. If these courses could be completed while in transit from one duty assignment to another, or otherwise consolidated to minimize the impact on primary job assignments, they would enable both Service A and Service B NCOs to work in their primary job skill when assigned to a squadron.