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IMPROVING NAVAL AVIATION MAINTENANCE OPERABILITY IN SUPPORT OF CONUS DETACHMENTS

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December 2021

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Naval Aviation currently operates as complete, internally supported squadrons responsible for their own maintenance equipment for operations. In this capacity, a squadron conducting training detachments away from its home station is required to transport all imperative equipment and personnel via contracted ground and government air transport. Because there is no additional equipment capacity to draw from for detachments, flight operations at the home station are reduced during the ground transportation period. This proposal assesses if it is beneficial for the Naval Aviation enterprise to continue the current transportation procedures of aviation maintenance equipment to detachments within the continental United States.

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IMPROVING NAVAL AVIATION MAINTENANCE OPERABILITY IN SUPPORT OF CONUS DETACHMENTS

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Naval Aviation currently operates as complete, internally supported squadrons responsible for their own maintenance equipment for operations. In this capacity, a squadron conducting training detachments away from its home station is required to transport all imperative equipment and personnel via contracted ground and government air transport. Because there is no additional equipment capacity to draw from for detachments, flight operations at the home station are reduced during the ground transportation period. This proposal assesses if it is beneficial for the Naval Aviation enterprise to continue the current transportation procedures of aviation maintenance equipment to detachments within the continental United States.

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LIST OF ACRONYMS AND ABBREVIATIONS

CAA	Concepts Analysis Agency
CSFWP	Commander, Strike Fighter Wing Pacific
CVN	aircraft carrier, nuclear powered
CVW	carrier air wing
CVWP	Electronic Attack Wing, Pacific
EWARP	Electronic Warfare Advanced Readiness Program
FLC	Fleet Logistics Center
GAO	Government Accountability Office
HADR	humanitarian assistance and disaster relief
HSC	helicopter sea combat squadron
HSM	helicopter maritime strike squadron
NAMP	Naval Aviation Maintenance Program
NAS	naval air station
OCO	overseas contingency operations
SFARP	Strike Fighter Advanced Readiness Program
SHARP	Sierra-Hotel Aviation Reporting Program
VAQ	Electronic attack squadron
VAW	carrier airborne early warning squadron
VFA	strike fighter squadron
TCM	Tool Control Manager
TCP	Tool Control Program
T/M/S	Type/Model/Series
WRS	war reserve stocks

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—CDR Beaman

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productive work in the future. I hope we get to work together again out in the fleet someday.

—LT Traylor

I. INTRODUCTION

As the United States closes out nearly two decades of support for Operation Enduring Freedom in Afghanistan, it has already begun to focus on the Great Power Competition developing in the western Pacific Ocean and East Asia. Japan and the Republic of Korea host U.S. military bases, and war reserve stocks (WRS) are already positioned throughout the globe. In preparation for potential future conflicts, these WRS, pre-positioned equipment, have come under renewed focus for expansion to new locations and to hold more significant supplies.

With Overseas Contingency Operations (OCO) funds forecasted to be eliminated and the U.S. defense budget request for 2022 rising only 1.6%, the prioritization of critical defense programs and thoughtful logistics planning will be essential for the future (Austin, 2021). While the focus of logistics planning is often geared towards the timely replenishment of combat forces on deployment at the "tip of the spear," streamlining the shaft of the spear in the sustainment and training phases could yield dividends in the form of reduced expenses and more funding available for the strategic competitions of the future.

A. BACKGROUND AND MOTIVATION

For an aircraft carrier to project power globally, the Carrier Air Wing (CVW) embarked on the carrier must complete an intensive "work-up" cycle that begins over a year before deployment. Presently, a CVW includes four strike fighter squadrons (VFA), with all squadrons flying the F/A-18E/F Super Hornet or with one of the four flying the F-35C Lightning II. Currently, only one of 10 CVW's includes a squadron of F-35C's. Making up the rest of the CVW is one airborne early warning squadron (VAW) flying either E-2C or E-2D Hawkeye, two helicopter squadrons (HSM or HSC) flying the MH-60R Seahawk and MH-60S Knighthawk, and one electronic attack squadron (VAQ) flying the EA-18G Growler, a follow-on derivative of the Super Hornet that utilizes the same airframe and engines.

During the work-up phase for deployment, squadrons will conduct training programs at their home base, from the CVN, and on detachments to bases throughout the country. Additionally, detachments can occur during readiness and sustainment phases. Detachments are conducted away from home bases for several reasons. These locations provide increased and dedicated airspace for flight operations. Additionally, many training flights require added support from aggressor aircraft simulating an opponent, and these aggressor squadrons are based at the detachment locations. In some cases, the instructor cadre is also based at the detachment sites. Finally, detachment locations typically provide more clear weather days.

Focusing on the F/A-18 and E/A-18, squadrons will conduct a two-week detachment to NAS Fallon, Nevada, during the Strike Fighter Advanced Readiness Program (SFARP) or Electronic Warfare Advanced Readiness Phase (EWARP) phase, respectively. Additionally, the VFA squadrons will conduct a two-week, air-to-air focused detachment typically to NAS Key West, FL, but occasionally to NAS Fallon. The four VFA squadrons will typically pair up to conduct two-week detachments, meaning four straight weeks of two squadrons each detached. Finally, all CVW squadrons will conduct a simultaneous detachment to NAS Fallon for the four-week CVW Fallon detachment.

Regardless of location, the logistics execution is similar for every detachment, exercise on a CVN, and deployment. One week to ten days before the detachment begins, large cardboard tri-wall containers will be constructed in the squadron hangar. Over the next roughly three days, squadron work center personnel will place all necessary equipment for detachment into the tri-walls for shipping. This will include predominantly aviation maintenance equipment and government laptops, office equipment, flight gear, spare parts, and non-essential gear if space is available. Based on estimated travel times, all tri-walls will be sealed four to seven days before the detachment start date, loaded onto freight trucks, and driven to the detachment site. During this transit period, the squadron will be operating with reduced equipment and conducting limited flight operations as a result.

Several days ahead of the detachment starting, an advance party will travel either via commercial air or rental vehicle to the detachment site in preparation for the main body of personnel to handle administrative tasks and accept shipment of the squadron equipment. Squadron aircraft will depart as necessary to arrive the day before the detachment starts. The main body of squadron personnel, approximately 150–180 people, will also depart via government passenger aircraft the day before, usually the C-40 Clipper.

Upon completing the detachment, equipment will be repacked and returned via freight trucks to the home base. The transit time to the home base is similar to the transit time to the detachment location. As a result, the squadron will operate on a limited schedule at their home base until the shipment arrives.

Requests for freight shipments are handled by the regional Fleet Logistics Centers (FLC). FLC San Diego is responsible for west coast-based FA-18 squadron requests from NAS Lemoore, California, and FLC Norfolk is responsible for east coast-based FA-18 squadrons at NAS Oceana, Virginia. Finally, FLC Puget Sound is responsible for requests from EA-18 squadrons, which are all based at NAS Whidbey Island. Table 1 details the travel distances between the three home bases and two detachment locations of NAS Fallon and NAS Key West. Figure 1 provides a visual depiction of the locations with home bases in blue and detachment sites in green.

Table 1. Distances between home bases and detachment sites

	NAS Fallon, NV	NAS Key West, FL
NAS Lemoore, CA	330	3,020
NAS Oceana, VA	2,717	1,129
NAS Whidbey Island, WA	854	3,526

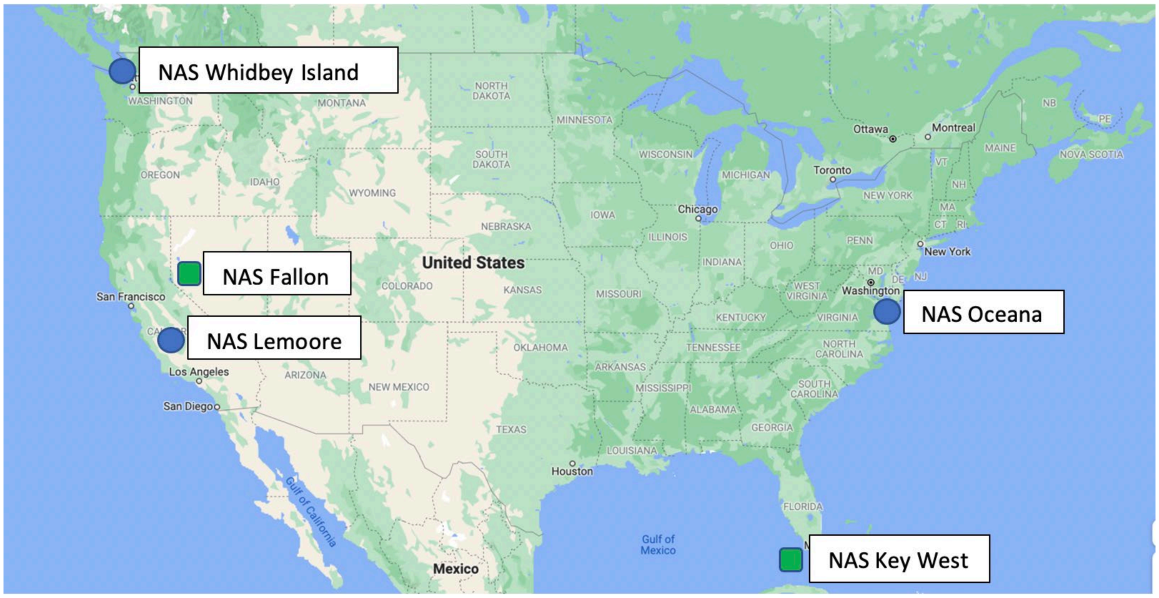

Figure 1. Detachment locations

B. OVERVIEW

Our research questions are as follows:

- Is it beneficial for squadrons to continue the current model of transporting aviation maintenance equipment to detachments within the continental United States?
- Furthermore, will strategically positioning essential maintenance equipment for the F/A-18E/F and E/A-18G increase operational availability at a lower cost?
- What is the appropriate level of support at detachment locations?

Chapter II provides a literature review of relevant material and gaps in the literature. The chapter also assesses existing methodologies and models relevant to our research questions. Chapter III details our selected methodology and model and includes a review of reference data and sources. Chapter IV analyzes the data and model and reviews the cost-benefit analysis. Finally, Chapter V concludes with any areas for further research and provides a recommendation for execution.

C. SCOPE OF RESEARCH

As readily available data required to conduct the research was difficult to acquire, we have limited the scope of our research to a single Type/Model/Series (T/M/S) of aircraft. The F/A-18E/F and EA-18G share the same platform, with limited differences in maintenance tools allocated to squadrons. This shared platform is also the most common in a CVW, with five of eight squadrons operating it currently. Additionally, the scope was limited to the two detachment locations. NAS Fallon and NAS Key West are the predominant detachment sites for deployable squadrons. While the model may be beneficial at other locations, we limited our research to bases most likely to provide a benefit to assess usefulness. Lastly, our research focused on the viability of pre-positioning equipment to provide cost savings, rather than including cost-effective options such as additional equipment at home bases or process improvements in the packing or shipping of existing equipment.

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II. LITERATURE REVIEW

Prepositioning equipment to reduce transportation times and costs is well-documented. Much of the recent focus has been on humanitarian assistance and disaster relief (HADR). Turkeš et al. (2017) focused optimization efforts on meeting unmet demand rather than minimizing costs. Additional efforts have focused on assessing transportation modes to reduce time. Wilberg and Olafsen (2013) analyzed the commercial transportation modes, and Chirgwin and Katakura (2020) optimized military vertical lift platforms.

A. MILITARY PRE-POSITIONING CONCEPTS

Historically, the majority of military pre-positioning literature is focused on the support of potential conflicts. Willie (1992) highlighted the concept of pre-positioning as one part of the strategic mobility triad, along with airlift and sealift. Referencing a potential great power competition, Harkavy (1982) wrote of the aspects of pre-positioning in history through the Cold War and the basing requirements required to support pre-positioning.

The GAO's (1998) report on military pre-positioning focuses on the increased reliance on pre-positioning in the post-Cold War period to allow rapid deployment into conflicts. The vital point of the GAO report was the two primary criteria for readiness should be (1) on-hand supply and (2) supply condition. In evaluating the pre-positioning of essential gear for detachments, having reliable supplies and the means to replenish them as rapidly as a squadron would if using their equipment is essential if the reliance will be shifted to a shared pool of equipment utilized by detached squadrons.

B. APPLICATIONS AND MODELS

Hollis et al. (2008) addressed pre-positioning to achieve cost-savings through transportation cost reduction related to the FA-18. They evaluated the idea of purchasing tools that would remain on the CVN for use by squadrons when deployed. However, this option was not cost-effective for three reasons. First, the plan would include duplicating all tools, including expensive items on the Individual Material Readiness List. But the purchase of expensive tools could be avoided by relying on squadrons to transport through methods that would already be planned, since low weight, high-dollar items can be carried on personnel transports.

Second, the primary cost-cutting items were detention costs and freight shipment costs. Detention costs are idle-time charges applied when freight trucks are required to arrive early without a shipment to immediately load and transport. The freight shipment costs are the primary cost reductions in our study. Freight shipment costs have increased dramatically in the thirteen years since this study was conducted. Additionally, the number of shipments has increased. With today's shipment volumes and costs, tool duplication may prove cost-effective.

Finally, Hollis' plan was not cost feasible because of the equipment's usage level. As the equipment would permanently reside on the CVN, a single toolset would only be utilized by the squadron assigned those tools and only when embarked. Thus, the plan would essentially call for all operational F/A-18 and E/A-18 squadrons to receive an additional complement of tools, one for land-based use and one for when embarked on the CVN. Our study will focus on common-use toolsets capable of being used by any squadron operating the same T/M/S that is detached to the location.

Addressing pre-positioning to reduce costs for training exercises, Simmon's (1987) report for the U.S. Army Concepts Analysis Agency (CAA) focused on a pre-positioned supply for common usage. M1 Abrams tanks and M2 Bradley Fighting Vehicles would be positioned at the National Training Center solely for training and avoiding the need to transport a unit's vehicles to support their training. The methodology utilized in his cost-benefit analysis will also be used in our analysis.

In reviewing applicable models, Welser et al. (2010) provided a decision framework ideal for military applications focused on medical distribution. In an austere funding environment where performance improvements must be measured against cost-effectiveness, Welser et al. (2010) provides an ideal methodology for assessing option viability.

III. METHODOLOGY

Our thesis focuses on a cost-benefit analysis of purchasing, maintaining, and storing aircraft maintenance tools and essential equipment at commonly utilized detachment locations. Our analysis is based on data compiled from multiple sources to ascertain the actual cost of the current model utilized by naval aviation and proposed pre-positioning to reduce costs and improve operational availability, both in monetary and opportunity costs. We posit that, in identifying expenses, not all costs can be dollarized.

Operational availability, or losses to availability regarding downtime for aircraft, does not have a direct monetary cost. With squadrons receiving a quarterly and annual allowance for flight hour expenditure, the unavailability of one aircraft or a whole squadron of aircraft not currently deployed for one day or even a week does not immediately result in lost opportunities that cannot be regained. To assess the quantifiable and nonquantifiable costs, we borrowed the methodology and model of Simmons (1987) and Welser et al. (2010) to conduct our analysis.

First, in line with Simmons (1987), we identified our major cost elements involved in equipment transportation and pre-positioning. Continuing, we identified potential alternatives both in the logistics and procurement realms. Next, we gathered costs and subsequently compared and analyzed our alternative.

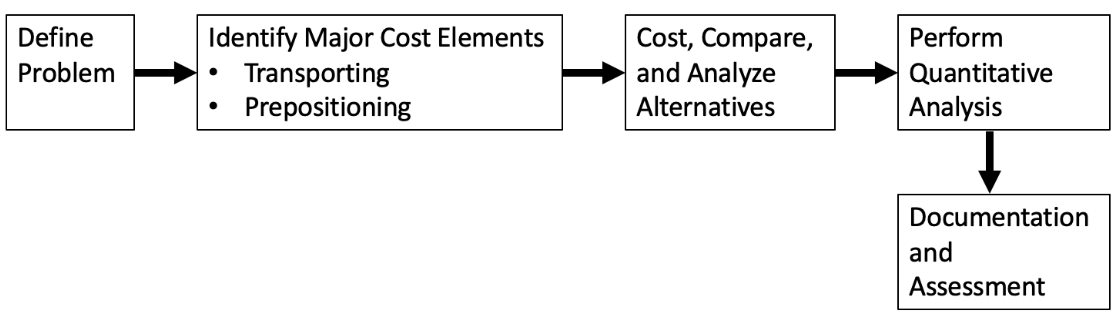

Figure 2. Methodology framework

Finally, referencing the decision framework of Welser et al. (2010), we evaluated our potential options using a two-step confirmation. We asked ourselves first whether our option maintained or improved performance over the status quo. If the answer was no, we rejected this option wholly. Next, we asked if the option reduced cost and offered a better alternative. Again, if the answer was no, the option was rejected. Only if the answer was "yes" to both questions did we consider the option a viable solution to our problem.

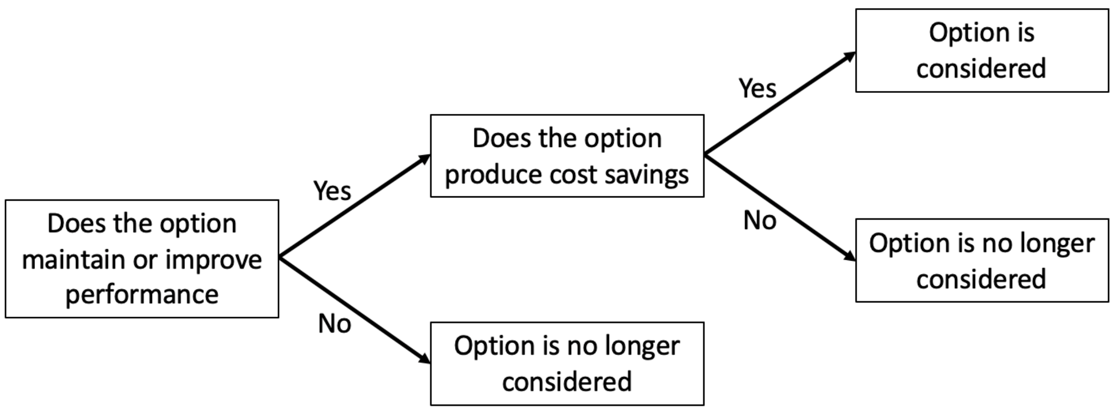

Figure 3. Decision matrix

A. CONUS DETACHMENT LOCATION USAGE

Most military airfields in the continental United States have the runway and facility requirements to support a squadron detachment, and there are nearly one hundred military bases with airfields. Given this broad list, we limited our initial research to the two bases we believe have the highest occurrences of operational squadron detachments: NAS Fallon and NAS Key West. With a focus on two commonly used locations, we would be able to analyze available data to determine if a pre-positioned supply of equipment would even be feasible given our two fundamental criteria of cost savings and readiness increases.

NAS Fallon is located in the high desert of northern Nevada, approximately sixty miles east of Reno. The base serves as a primary location for air-to-ground training during SFARP/EWARP and CVW composite training while also seeing heavy utilization due to the airspace and ranges capable of supporting weapons delivery. We received data from the Fleet Liaison Office at the base for squadron and CVW detachments covering 2016 to 2021. The provided data included detachment dates and participating units.

NAS Key West is located on Boca Chica Key, six miles east of the southernmost point in the United States. It is the primary location for air-to-air detachment training in the SFARP phase and a heavily utilized base for squadron detachments outside of deployment preparation. While the facilities can support more squadrons, civilian traffic congestion from nearby Key West International Airport normally limits support to a local maximum of two complete squadrons at one time. The NAS Key West Base Operations Office provided detachment data from 2018 to 2021, including detachment dates and participating units.

We first organized the provided detachment data by aircraft series and detachment location in separate spreadsheets using Microsoft Excel. Then, each spreadsheet was organized by start and end dates, participating squadrons, overlap periods, and cost of transportation for the squadron equipment. The detachment periods follow an "XX-Y" format, with the "XX" digits representing the detachment year and the "Y" representing the chronological detachment period. The shipment cost data, compiled separately, includes transporting squadron equipment to and from the detachment site. A sample is provided in Table 2.

Table 2. Sample of NAS Key West VFA detachment table

DET START	DET END	UNIT	DETACHMENT PERIOD	COST
3-Jan-18	28-Jan-18	CVW-9	18-1	15347.36
3-Jan-18	28-Jan-18	CVW-9	18-1	15347.36
3-Jan-18	28-Jan-18	CVW-9	18-2	15347.36
3-Jan-18	28-Jan-18	CVW-9	18-2	15347.36
2-Mar-18	23-Mar-18	CVW-8	18-3	6516.84
2-Mar-18	23-Mar-18	CVW-8	18-3	6516.84
2-Jun-18	23-Jun-18	CVW-7	18-4	6516.84
2-Jun-18	23-Jun-18	CVW-7	18-4	6516.84
19-Sep-18	29-Sep-18	VFA-32	18-5	6516.84
4-Jan-19	18-Jan-19	VFA-113	19-1	15347.36
4-Jan-19	18-Jan-19	VFA-22/94	19-1	15347.36
23-Jan-19	7-Feb-19	CVW-3	19-2	6516.84
23-Jan-19	7-Feb-19	CVW-3	19-2	6516.84
1-Apr-19	19-Apr-19	CVW-11	19-3	15347.36
1-Apr-19	19-Apr-19	CVW-11	19-3	15347.36
1-Apr-19	19-Apr-19	CVW-11	19-4	15347.36
1-Apr-19	19-Apr-19	CVW-11	19-4	15347.36
29-May-19	22-Jun-19	CVW-3	19-5	6516.84
29-May-19	22-Jun-19	CVW-3	19-5	6516.84
29-May-19	22-Jun-19	CVW-3	19-6	6516.84
29-May-19	22-Jun-19	CVW-3	19-6	6516.84
7-Aug-19	6-Sep-19	CVW-17	19-7	15347.36
7-Aug-19	6-Sep-19	CVW-17	19-7	15347.36
7-Aug-19	6-Sep-19	CVW-17	19-8	15347.36
7-Aug-19	6-Sep-19	CVW-17	19-8	15347.36
21-Oct-19	6-Nov-19	VFA-37	19-9	6516.84

We took this data and recompiled it into Table 3. Columns are labeled "Set 1" through "Set 4" to represent complete toolsets, each capable of supporting one squadron on detachment. Rows are labeled in the "XX-Y" format to represent chronological detachment periods. This format allowed us to organize the usage of potential sets and determine incremental cost savings for each set. The Key West detachments for 2018 are shown in Table 3, indicating that nine squadrons conducted detachments to the site.

Table 3. NAS Key West detachment transportation savings

TRANSPORT SAVINGS PER TOOL KIT				
DETACHMENT PERIOD	**BOX 1**	**BOX 2**	**BOX 3**	**BOX 4**
18-1	15347.36	15347.36		
18-2	15347.36	15347.36		
18-3	6516.84	6516.84		
18-4	6516.84	6516.84		
18-5	6516.84			

B. SHIPMENT DATA

With detachment dates and participating squadrons determined, we coordinated with the Fleet Logistics Center (FLC) San Diego to acquire shipment requests and costs. The SYNCADA database provided us with 36,828 ground shipping requests between the three home bases and two detachment sites over the five years of 2016 to 2020. In Microsoft Excel, we filtered the original data based on comparisons of detachment dates from Table 2; SYNCADA shipping request dates, origins, and destinations; and shipment weights to reduce the relevant shipment transactions down to 212.

As every shipment request could not be provided by SYNCADA, we utilized the 212 transactions to calculate an average one-way cost per transaction for each route, shown in Table 4. The costs from Table 4 were doubled to account for round-trip shipments to arrive at the total shipment cost per detachment. These costs can be found in the “COST” column of Table 2 and in Table 3. For example, detachment 18–1, which included two squadrons from NAS Lemoore conducting a detachment to NAS Key West, had one shipment per squadron, each costing $7,673.68 one-way or $15,347.36 round-trip.

Table 4. One-way average shipment cost

Average cost per shipment between home bases and detachment sites		
	NAS Fallon, NV	NAS Key West, FL
NAS Lemoore, CA	$ 2,211.45	$ 7,673.68
NAS Oceana, VA	$ 6,886.99	$ 3,258.42
NAS Whidbey Island, WA	$ 3,202.69	$ 10,176.44

C. EQUIPMENT AND STORAGE COSTS

To calculate the cost of each set of equipment, we referenced General Service Administration cost pricing for each toolbox that would be included in the set. The number of toolboxes required is delineated in the Naval Aviation Maintenance Program (NAMP) instructions, COMNAVAIRFORINST 4790.2D and NAVAIR 17–1FA18EF-1. Each toolbox is designed to service one work center or a specific number of aircraft, depending on the toolbox's purpose. Figure 4 provides an example toolbox for an F/A-18 E/F squadron's 220 work center, indicating that four maintenance boxes of this type will be allocated to a squadron of twelve aircraft.

F/A-18 E/F 220-1 MAINTENANCE BOX
B-BOX (ONE PER EACH THREE AIRCRAFT)

PANEL A

FIGURE	ITEM		MOUNTING
14-1	1	Finger, Mechanical, Flexible, 17-1/2"	5-6, 5-16
14-1	2	Scriber, Machinist's, 8"	5-6, 5-16
14-1	3	Screwdriver, Phillips, #2, 4"	5-6, 5-16
14-1	4	Puller, Cotter Pin, 8-1/2"	5-6, 5-16
14-1	5	Retrieving Tool, Magnetic, Flexible, 21"	5-16
14-1	6	Wrench, Ratchet, Reversible, Box, 1/4" x 5/16", Spline, #8 x #10	5-16

PANEL B

FIGURE	ITEM		MOUNTING
14-1	1	Handle, Socket Wrench, Speeder, 3/8" Drive	5-16

PANEL C

FIGURE	ITEM		MOUNTING
14-1	1	Adapter, Socket Wrench, 3/8" Female to 1/4" Male	5-15
14-1	2	Socket Wrench Attachment, 3/8" Drive, Phillips, #2	5-15
14-1	3	Socket Wrench Attachment, 3/8" Drive, Hex, 7/32"	5-15
14-1	4	Socket Wrench Attachment, 3/8" Drive, Hex, 7/32"	5-15
14-1	5	Socket Wrench Attachment, 3/8" Drive, Hex, 3/16"	5-15
14-1	6	Holder, Screwdriver Bit, 1/4" Drive, 1/4" Hex with Bit, Screwdriver, 1/4" Hex Shank, Torx, #20, Long	5-15

Figure 4. NAVAIR 17–1FA18EF-1 maintenance box contents and allotment

To determine the cost of each toolbox to be included in a toolset, we utilized General Service Administration (GSA) prices provided to us by the Tool Control Managers (TCM) at Electronic Attack Wing, Pacific (CVWP) and Strike Fighter Wing Pacific (CSFWP). Table 5 depicts the cost of each box that would be included in a toolset for an E/A-18G.

Table 5. GSA maintenance box cost list

	A	B	C	D	E	F
20	ITEM NUMBER / SKU		DESCRIPTION / NOMENCLATURE	QTY.	UNIT PRICE	EXT. PRICE
21	TL3AEA18G-210-3-PR	77WR31	210-3 TROUBLESHOOTER POUCH KIT	1	$1,458.13	$1,458.13
22	TL3AEA18G-220-1-PR	77WR35	220-1 MAINTENANCE BOX KIT	1	$4,238.55	$4,238.55
23	TL3AEA18G-230-2-PR	77WR39	230-2 MAINTENANCE BOX KIT	1	$4,424.64	$4,424.64
24	TL3AEA18G-12C-4-PR	77WR21	12C-4 SHOP EQUIPMENT	1	$12,353.96	$12,353.96
25	TL3AEA18G-13A-1-PR	77WR26	13A-1 SHOP BOX KIT	1	$11,342.35	$11,342.35
26	TL3AEA18G-120-9-PR	77WR16	120-9 SHOP EQUIPMENT	1	$3,728.62	$3,728.62
27	TL3AEA18G-12C-3-PR	77WR20	12C-3 PAINTING/PAINT GUN MAINT BOX KIT	1	$9,857.52	$9,857.52
28	TL3AEA18G-12C-2-PR	77WR19	12C-2 CORROSION REMOVAL BOX KIT	1	$9,459.86	$9,459.86
29	TL3AEA18G-120-10-PR	77WR17	120-10 GREASE GUN BOX KIT	1	$2,045.54	$2,045.54
30	TL3AEA18G-13B-3-PR	77WR23	13B-3 TROUBLESHOOTER POUCH KIT	1	$1,247.80	$1,247.80
31	TL3AEA18G-230-3-PR	77WR40	230-3 MAINTENANCE POUCH KIT	1	$1,562.12	$1,562.12
32	TL3AEA18G-13B-1-PR	77WR22	13B-1 MAINTENANCE BOX KIT	1	$6,292.70	$6,292.70
33	TL3AEA18G-310-3-PR	77WR45	310-3 BATON BOX KIT	1	$2,177.77	$2,177.77
34	TL3AEA18G-310-1-PR	77WR43	310-1 PLANE CAPTAIN POUCH KIT	1	$943.37	$943.37
35	TL3AEA18G-310-2-PR	77WR44	310-2 BATON TRAFFIC POUCH KIT	1	$666.39	$666.39
36	TL3AEA18G-210-6-PR	77WR34	210-6 SHOP EQUIPMENT	1	$6,134.63	$6,134.63
37	TL3AEA18G-13B-5-PR	77WR24	13B-5 SEAT REMOVAL/INSTALLATION BOX KIT	1	$4,709.40	$4,709.40
38	TL3AEA18G-320-2-PR	77WR50	320-2 HOOK POINT CHANGE POUCH	1	$815.61	$815.61
39	TL3AEA18G-020-1-PR	77WR52	020-1 MAINT CONTROL LAUNCH BOX KIT	1	$1,847.81	$1,847.81
40	TL3AEA18G-230-5-PR	77WR41	230-5 TEAM LEADER POUCH KIT	1	$803.64	$803.64
41	TL3AEA18G-310-5-PR	77WR47	310-5 SHOP EQUIPMENT	1	$1,411.25	$1,411.25
42	TL3AEA18G-13A-2-PR	77WR27	13A-2 OXYGEN BOX KIT	1	$2,686.43	$2,686.43
43	TL3AEA18G-320-1-PR	77WR49	320-1 TROUBLESHOOTER POUCH	1	$1,661.11	$1,661.11
44	TL3AEA18G-220-4-PR	77WR38	220-4 WIRE REPAIR BOX KIT	1	$3,728.62	$3,728.62
45	TL3AEA18G-310-6-PR	77WR48	310-6 FUEL SAMPLE TOOL BOX KIT	1	$2,363.23	$2,363.23
46	TL3AEA18G-210-1-PR	77WR29	210-1 MAINTENANCE BOX KIT	1	$4,149.95	$4,149.95
47	TL3AEA18G-310-4-PR	77WR46	310-4 WASH BOX KIT	1	$3,373.68	$3,373.68
48	TL3AEA18G-230-6-PR	77WR42	230-6 SHOP EQUIPMENT	1	$2,704.55	$2,704.55
49	TL3AEA18G-320-3-PR	77WR51	320-3 TIRE CHANGE BOX KIT	1	$5,211.76	$5,211.76
50	TL3AEA18G-220-3-PR	77WR37	220-3 COMPASS CALIBRATION BOX KIT	1	$2,399.68	$2,399.68
51	TL3AEA18G-220-2-PR	77WR36	220-2 TROUBLESHOOTER POUCH KIT	1	$1,246.06	$1,246.06
52	TL3AEA18G-210-4-PR	77WR32	210-4 POD BOX KIT FOR EA-18G AIRCRAFT	1	$1,458.13	$1,458.13
53	TL3AEA18G-210-2-PR	77WR30	210-2 SHOP BOX KIT	1	$11,079.70	$11,079.70
54	TL3AEA18G-13B-7-PR	77WR25	13B-7 OBOGS BOX KIT	1	$2,395.33	$2,395.33
55	TL3AEA18G-210-5-PR	77WR33	210-5 WIRE CHECK POUCH KIT	1	$919.57	$919.57
56	TL3AEA18G-13A-3-PR	77WR28	13A-3 SHOP EQUIPMENT	1	$8,076.00	$8,076.00
57	TL3AEA18G-12C-1-PR	77WR18	12C-1 MAINTENANCE BOX KIT	1	$3,013.19	$3,013.19

Since permanent storage for the toolsets may not be available at both detachment locations, an additional cost for a container capable of storing all equipment was included for each set. Also included was the cost of a container chassis to allow for the toolset to be transported if necessary. To derive the costs of the 20-foot container and accompanying container chassis shown in Table 6, we used an average cost from five American commercial companies: Conexwest, TITAN Containers North America LLC, Interport Maintenance Co. Inc., Port Containers USA, and Container Technology, Inc.

Table 6. Container and chassis cost

20' Containers	$ 5,000
20' Flatbeds	$ 7,500
total	**$ 12,500**

Utilizing the allocations in Figure 4 and the costs in Tables 5 and 6, we calculated the cost of a complete toolset at each detachment location for the F/A-18 in Table 7 and the E/A-18G in Table 8. The allocations were based on both data provided by NAS Lemoore-based squadrons detailing what they would take on detachment and, in the absence of data, the NAVAIR 17–1FA18EF-1 allocations based on a six-aircraft detachment of F/A-18's to NAS Key West and an eight-aircraft detachment to NAS Fallon.

Finally, we received the cost of upkeep for a squadron's complete tool allocation, \$17,142, which was derived from the FY2020 average of fourteen NAS Whidbey Island squadrons. This upkeep average was provided by the CVWP TCM at NAS Whidbey Island, who is responsible for screening and approving the requests for replacement tools due to them breaking or wearing out. With this number, we applied a usage rate factor to the cost based on the average annual usage for pre-positioned toolsets at NAS Fallon and NAS Key West.

Table 7. F/A-18 toolset cost list

Toolbox #	Allotment	Total in VFA	KW DET #	NFL DET #	COST PER	TOTAL COST KW	TOTAL COST NFL
13A-1	1 PER WORKCENTER	1	1	1	$ 11,342.35	$ 11,342.35	$ 11,342.35
13A-2	1 PER 6 A/C	2	2	2	$ 2,686.43	$ 5,372.86	$ 5,372.86
13A-3	1 PER WORKCENTER	1	1	1	$ 8,076.00	$ 8,076.00	$ 8,076.00
13B-1	1 PER 4 A/C	3	1	2	$ 6,292.70	$ 6,292.70	$ 12,585.40
13B-3	1 PER 4 A/C	3	1	2	$ 1,247.80	$ 1,247.80	$ 2,495.60
13B-5	1 PER 4 A/C	3	1	1	$ 4,709.40	$ 4,709.40	$ 4,709.40
13B-7	1 PER 4 A/C	3	1	1	$ 2,395.33	$ 2,395.33	$ 2,395.33
040-1	1 PER 6 A/C	2	1	1	$ 3,199.00	$ 3,199.00	$ 3,199.00
110-1	1 PER 3 A/C	4	2	3	$ 3,199.00	$ 6,398.00	$ 9,597.00
110-2	1 PER 6 A/C	2	1	1	$ 3,199.00	$ 3,199.00	$ 3,199.00
110-3	1 PER 4 A/C	3	1	1	$ 3,199.00	$ 3,199.00	$ 3,199.00
110-7	1 PER 3 A/C	4	1	2	$ 3,199.00	$ 3,199.00	$ 6,398.00
120-1	1 PER 3 A/C	4	2	3	$ 3,199.00	$ 6,398.00	$ 9,597.00
120-2	1 PER 4 A/C	3	1	2	$ 3,199.00	$ 3,199.00	$ 6,398.00
120-3	1 PER 6 A/C	2	1	2	$ 3,199.00	$ 3,199.00	$ 6,398.00
210-1	1 PER 3 A/C	4	1	2	$ 4,149.95	$ 4,149.95	$ 8,299.90
210-4	1 PER 3 A/C	4	3	3	$ 1,458.13	$ 4,374.39	$ 4,374.39
210-5	1 PER 4 A/C	3	1	2	$ 919.57	$ 919.57	$ 1,839.14
210-6	1 PER 4 A/C	3	1	2	$ 2,284.16	$ 2,284.16	$ 4,568.32
220-1	1 PER 3 A/C	4	1	2	$ 4,238.55	$ 4,238.55	$ 8,477.10
220-2	1 PER 3 A/C	4	2	3	$ 1,246.06	$ 2,492.12	$ 3,738.18
220-4	1 PER WORKCENTER	1	1	1	$ 3,728.62	$ 3,728.62	$ 3,728.62
230-1	1 PER 4 A/C	4	1	2	$ 1,641.94	$ 1,641.94	$ 3,283.88
230-2	1 PER 2 A/C	6	1	2	$ 4,424.64	$ 4,424.64	$ 8,849.28
230-3	3 PER 2 A/C	18	6	10	$ 1,562.12	$ 9,372.72	$ 15,621.20
230-5	1 PER 4 A/C	3	2	3	$ 803.64	$ 1,607.28	$ 2,410.92
310-1	1 PER 1 A/C	12	5	10	$ 943.37	$ 4,716.85	$ 9,433.70
310-2	2 PER 1 A/C	24	5	10	$ 666.39	$ 3,331.95	$ 6,663.90
310-6	1 PER 4 A/C	3	1	1	$ 2,363.23	$ 2,363.23	$ 2,363.23
					TOTAL COST	$ 121,072.41	$ 178,613.70

Table 8. E/A-18 toolset cost list

Toolbox #	Allotment	Total in VAQ	KW DET #	NFL DET #	COST PER	TOTAL COST KW	TOTAL COST NFL
13A-1	1 PER WORKCENTER	1	1	1	$11,342.35	$ 11,342.35	$ 11,342.35
13A-2	1 PER 5 A/C	2	2	2	$ 2,686.43	$ 5,372.86	$ 5,372.86
13A-3	1 PER WORKCENTER	1	1	1	$ 8,076.00	$ 8,076.00	$ 8,076.00
13B-1	1 PER 5 A/C	3	1	2	$ 6,292.70	$ 6,292.70	$ 12,585.40
13B-3	1 PER 5 A/C	3	1	2	$ 1,247.80	$ 1,247.80	$ 2,495.60
13B-5	1 PER 5 A/C	3	1	1	$ 4,709.40	$ 4,709.40	$ 4,709.40
13B-7	1 PER 5 A/C	3	1	1	$ 2,395.33	$ 2,395.33	$ 2,395.33
040-1	1 PER 5 A/C	2	1	1	$ 3,199.00	$ 3,199.00	$ 3,199.00
110-1	1 PER 2 A/C	4	1	2	$ 3,199.00	$ 3,199.00	$ 6,398.00
110-2	1 PER 5 A/C	2	1	1	$ 3,199.00	$ 3,199.00	$ 3,199.00
110-3	1 PER 5 A/C	3	1	1	$ 3,199.00	$ 3,199.00	$ 3,199.00
110-7	1 PER 2 A/C	4	1	2	$ 3,199.00	$ 3,199.00	$ 6,398.00
120-1	1 PER 2 A/C	4	1	2	$ 3,199.00	$ 3,199.00	$ 6,398.00
120-2	1 PER 5 A/C	3	1	2	$ 3,199.00	$ 3,199.00	$ 6,398.00
120-3	1 PER 5 A/C	2	1	2	$ 3,199.00	$ 3,199.00	$ 6,398.00
210-1	1 PER 2 A/C	4	1	2	$ 4,149.95	$ 4,149.95	$ 8,299.90
210-4	1 PER 2 A/C	4	2	2	$ 1,458.13	$ 2,916.26	$ 2,916.26
210-5	1 PER 5 A/C	3	1	2	$ 919.57	$ 919.57	$ 1,839.14
220-1	1 PER 2 A/C	4	1	2	$ 4,238.55	$ 4,238.55	$ 8,477.10
220-2	1 PER 2 A/C	4	2	2	$ 1,246.06	$ 2,492.12	$ 2,492.12
220-4	1 PER WORKCENTER	1	1	1	$ 3,728.62	$ 3,728.62	$ 3,728.62
230-2	1 PER 2 A/C	6	1	2	$ 4,424.64	$ 4,424.64	$ 8,849.28
230-3	3 PER 2 A/C	18	6	6	$ 1,562.12	$ 9,372.72	$ 9,372.72
230-5	1 PER 5 A/C	3	2	3	$ 803.64	$ 1,607.28	$ 2,410.92
310-1	1 PER 1 A/C	12	5	10	$ 943.37	$ 4,716.85	$ 9,433.70
310-2	2 PER 1 A/C	24	4	8	$ 666.39	$ 2,665.56	$ 5,331.12
310-6	1 PER 5 A/C	3	1	1	$ 2,363.23	$ 2,363.23	$ 2,363.23
					TOTAL COST	$ 108,623.79	$ 154,078.05

D. MANPOWER COSTS

Additional personnel will be required at the detachment site to meet NAMP TCP guidelines for control and care of the toolsets. These personnel would need to meet paygrade and qualification requirements outlined in the TCP instruction. We assumed that leadership responsibilities could be undertaken by a qualified officer already assigned to the base. However, daily management would be controlled by a Petty Officer Second Class, as this is the minimum paygrade authorized in the TCP requirements. The annual DOD composite standard rate, derived from Table 9 for an E-5 in the Navy, is $95,232 (McAndrew, 2020).

Table 9. Military composite standard pay and reimbursement rates

MILITARY PAY GRADE	AVERAGE BASIC PAY	ANNUAL DOD COMPOSITE STANDARD RATE [1/]	AMOUNT BILLABLE TO OTHER DOD ENTITIES [2/ 5/]	AMOUNT BILLABLE TO OTHER FEDERAL AGENCIES [3/ 6/ 8/]	AMOUNT BILLABLE TO FMS ENTITIES [4/ 7/ 9/]
O-10	$198,780 [10/]	$339,710	$334,799	$345,390	$350,301
O-9	198,780	337,675	332,764	343,355	348,266
O-8	191,450	334,772	329,861	340,452	345,363
O-7	166,777	294,867	289,956	300,547	305,458
O-6	143,718	269,371	264,460	275,051	279,962
O-5	115,887	229,434	224,523	235,114	240,025
O-4	97,393	203,359	198,448	209,039	213,950
O-3	78,167	173,981	169,070	179,661	184,572
O-2	60,857	139,854	134,943	145,534	150,445
O-1	43,991	110,208	105,297	115,888	120,799
WO-5	$116,947	$220,391	$215,480	$226,071	$230,982
WO-4	100,419	196,274	191,363	201,954	206,865
WO-3	85,434	174,384	169,473	180,064	184,975
WO-2	70,238	152,888	147,977	158,568	163,479
WO-1	45,408	109,070	104,159	114,750	119,661
E-9	$86,019	$169,856	$164,945	$175,536	$180,447
E-8	68,524	145,060	140,149	150,740	155,651
E-7	58,646	130,655	125,744	136,335	141,246
E-6	47,300	112,977	108,066	118,657	123,568
E-5	37,738	95,232	90,321	100,912	105,823
E-4	30,745	76,655	71,744	82,335	87,246
E-3	25,961	63,322	58,411	69,002	73,913
E-2	23,928	56,831	51,920	62,511	67,422
E-1	20,300	49,707	44,796	55,387	60,298
CADETS	$14,402	$20,260	Not applicable	Not applicable	Not applicable

Notes:

1/ The annual DoD composite standard rate shall be used when determining the military personnel appropriations cost for budget/management studies, but should not be considered as a fully-burdened costs of military personnel for the purposes of workforce-mix decisions. **Includes** a per capita normal cost of $4,911 for Medicare-Eligible Retiree Health Care (MERHC) accrual -- see Tab K-1.

Without a manpower analysis and to account for the workload associated with managing the toolsets that would only be in use during the execution of detachments, we assumed that one person could manage two toolsets. These individuals would assume all responsibilities outlined in the NAMP TCP while reasonably assessing the workforce mix. We based this assumption on only one person being assigned to the task at the squadron level with a full allotment of tools, which is approximately twice the amount as would be included in the detachment toolsets. This assessment of two sets per individual assigned will be referred to as the maximum manpower allotment. Additionally, as the toolsets will not be in use year-round, but only during detachments, we chose to also look at a reduced manpower allotment of one individual assigned to the maximum of five toolsets, which we will refer to as the minimum manning allotment. Both maximum and minimum manning allotments can be found in Table 10.

Table 10. Manpower requirements

	# of Tool Sets					
	0	1	2	3	4	5
	Max Manning					
Fallon Manpower	0	1	1	2	2	3
Key West Manpower	0	1	1	2	0	0
	Min Manning					
Fallon Manpower	0	1	1	1	1	1
Key West Manpower	0	1	1	1	0	0

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IV. COST BENEFIT ANALYSIS

We created a cost-benefit analysis matrix using Microsoft Excel, outlining and organizing all the foreseen costs associated with purchasing, storing, and maintaining spare sets of F/A-18 and E/A-18 tools. Tables 11 and 12 show the total number of F/A-18 and E/A-18 sets and the total cost of ownership, including toolset maintenance and replacement costs on an annual basis. These costs were derived from the total costs of toolsets found in Tables 7 and 8, the usage-adjusted upkeep cost, the storage costs in Table 4, and the DOD composite standard rate for an E-5 in the Navy, $95,232 annually, found in Table 9.

Table 11. Maximum manpower, storage, and toolset costs

Max Manpower / Storage / Tool Set cost combination matrix							
# of Tool Sets		Fallon					
		0	1	2	3	4	5
Key West	0	$ -	$ 609,831	$ 1,124,429	$ 1,734,260	$ 2,248,859	$ 2,858,690
	1	$ 609,831	$1,219,661	$ 1,734,260	$ 2,344,091	$ 2,858,690	$ 3,468,520
	2	$1,124,429	$1,734,260	$ 2,248,859	$ 2,858,690	$ 3,373,288	$ 3,983,119
	3	$1,734,260	$2,344,091	$ 2,858,690	$ 3,468,520	$ 3,983,119	$ 4,592,950

Table 12. Minimum manpower, storage, and toolset costs

Min Manpower / Storage / Tool Set cost combination matrix							
# of Tool Sets		Fallon					
		0	1	2	3	4	5
Key West	0	$ -	$ 298,463	$ 472,557	$ 672,901	$ 873,245	$ 1,073,589
	1	$ 235,342	$ 533,805	$ 707,899	$ 908,243	$ 1,082,338	$ 1,282,682
	2	$ 360,117	$ 658,580	$ 832,674	$ 1,033,018	$ 1,233,362	$ 1,433,706
	3	$ 497,340	$ 786,573	$ 953,151	$ 1,170,242	$ 1,370,586	$ 1,570,930

Using all these data entries, our model calculated the manpower cost, storage cost, manpower/storage cost, toolset cost, storage/toolset cost, and manpower/storage/toolset cost. We will expand on the significance of these costs, but Tables 13 and 14 depict the breakdown of the toolset costs by quantity per location and distinguished by the maximum and minimum manpower allotments.

Table 13. Maximum manpower cost matrices for F/A-18

	Max Manpower Cost					
	# of F-18 Tool Sets					
	0	1	2	3	4	5
Fallon	$ -	$ 95,232	$ 95,232	$ 190,464	$ 190,464	$ 285,696
Key West	$ -	$ 95,232	$ 95,232	$ 190,464		
	Storage Cost					
	# of F-18 Tool Sets					
	0	1	2	3	4	5
Fallon	$ -	$ 12,500	$ 25,000	$ 37,500	$ 50,000	$ 62,500
Key West	$ -	$ 12,500	$ 25,000	$ 37,500		
	Max Manpower / Tool Storage Cost					
	# of F-18 Tool Sets					
	0	1	2	3	4	5
Fallon	$ -	$ 107,732	$ 120,232	$ 227,964	$ 240,464	$ 348,196
Key West	$ -	$ 107,732	$ 120,232	$ 227,964		
	Tool Set Cost					
	# of F-18 Tool Sets					
	0	1	2	3	4	5
Fallon	$ -	$ 502,099	$1,004,197	$ 1,506,296	$ 2,008,395	$ 2,510,494
Key West	$ -	$ 502,099	$1,004,197	$ 1,506,296		
	Storage Cost / Tool Set Cost					
	# of F-18 Tool Sets					
	0	1	2	3	4	5
Fallon	$ -	$ 514,599	$1,029,197	$ 1,543,796	$ 2,058,395	$ 2,572,994
Key West	$ -	$ 514,599	$1,029,197	$ 1,543,796		
	Max Manpower / Storage Cost / Tool Set Cost					
	# of F-18 Tool Sets					
	0	1	2	3	4	5
Fallon	$ -	$ 609,831	$1,124,429	$ 1,734,260	$ 2,248,859	$ 2,858,690
Key West	$ -	$ 609,831	$1,124,429	$ 1,734,260		

Table 14. Minimum manpower cost matrices for F/A-18

	Min Manpower Cost					
	# of F-18 Tool Sets					
	0	1	2	3	4	5
Fallon	$ -	$ 95,232	$ 95,232	$ 95,232	$ 95,232	$ 95,232
Key West	$ -	$ 95,232	$ 95,232	$ 95,232		

	Storage Cost					
	# of F-18 Tool Sets					
	0	1	2	3	4	5
Fallon	$ -	$ 12,500	$ 25,000	$ 37,500	$ 50,000	$ 62,500
Key West	$ -	$ 12,500	$ 25,000	$ 37,500		

	Manpower / Tool Storage Cost					
	# of F-18 Tool Sets					
	0	1	2	3	4	5
Fallon	$ -	$ 107,732	$ 120,232	$ 132,732	$ 145,232	$ 157,732
Key West	$ -	$ 107,732	$ 120,232	$ 132,732		

	Tool Set Cost					
	# of F-18 Tool Sets					
	0	1	2	3	4	5
Fallon	$ -	$ 178,614	$ 357,227	$ 535,841	$ 714,455	$ 893,069
Key West	$ -	$ 121,072	$ 242,145	$ 363,217		

	Storage Cost / Tool Set Cost					
	# of F-18 Tool Sets					
	0	1	2	3	4	5
Fallon	$ -	$ 191,114	$ 382,227	$ 573,341	$ 764,455	$ 955,569
Key West	$ -	$ 133,572	$ 267,145	$ 400,717		

	Min Manpower / Storage Cost / Tool Set Cost					
	# of F-18 Tool Sets					
	0	1	2	3	4	5
Fallon	$ -	$ 286,346	$ 477,459	$ 668,573	$ 859,687	$ 1,050,801
Key West	$ -	$ 228,804	$ 362,377	$ 495,949		

The second half of the cost-benefit analysis calculates the payback in years. Using the raw data from above, we calculated a payback point for the costs incurred by purchasing, storing, and maintaining spare sets of F/A-18 and E/A-18 toolsets at NAS Fallon and NAS Key West. In the example payback chart in Table 16, we used the cost of the current shipping method and an arbitrary choice to implement zero sets at NAS Fallon and three sets at NAS Key West.

Then, calculating the current cost minus the new annual cost, we arrive at our savings per year and over a twenty-year life cycle. Our initial investment cost is the sum of the minimum manpower cost, the cost of two F/A-18 toolsets and one E/A-18 toolset, storage costs, and upkeep costs. Next, the matrix will calculate the cost savings per month by implementing the pre-positioned toolsets, given their location and manning levels.

Table 15. Cost table for zero NAS Fallon toolsets and three NAS Key West toolsets with minimum manning

0f-kw3 ANALYSIS Example

Prepositioning Model Annual Costs	Q	Cost per	Costs
Man power	1	$ 98,119.00	$ 98,119.00
Gear up-keep F F-18	0	$ 9,230.31	$ -
Gear up-keep F E/A-18	0	$ 7,516.11	$ -
Gear up-keep KW F-18	2	$ 3,650.92	$ 7,301.83
Gear up-keep KW E/A-18	1	$ 2,678.44	$ 3,650.92
Total			$ 109,072

Current Annual Trucking Costs	Costs
Fallon	$ -
Key West	$ 200,775
Total	$ 200,775

Current Cost	$ 200,775
New Annual Cost	$ 109,072
Savings Per Year	$ 51,230
Savings Per Year	$91,703

Set Cost Per Loc	# of F-18 Tool Sets	# of E/A-18 Tool Sets	Costs
Fallon	0	0	$ -
Key west	2	1	$ 350,768
Storage Items	**Q**	**Cost per**	**Costs**
20' Containers	3	$ 5,000	$ 15,000
20' Flatbeds	3	$ 7,500	$ 22,500
Total Initial Investment			$ 388,268

Initial Investment	Year	Cumulative Savings
$ 388,268	0	$ -
	1	$ 91,703
	2	$ 183,407
	3	$ 275,110
	4	$ 366,814
	5	$ 458,517
	6	$ 550,221
	7	$ 641,924
	8	$ 733,628
	9	$ 825,331
	10	$ 917,035
	11	$ 1,008,738
	12	$ 1,100,442
	13	$ 1,192,145
	14	$ 1,283,849
	15	$ 1,375,552
	16	$ 1,467,256
	17	$ 1,558,959
	18	$ 1,650,663
	19	$ 1,742,366
	20	$ 1,834,070

Payback (in years)
4.23

Total savings over a 20 year life
$ 1,445,802

Lastly, we analyzed the 23 different combinations (e.g., the number of sets of tools at (Key West, Fallon). As shown in Table 17, a pre-positioning plan utilizing maximum manpower has limited opportunities for cost savings. The pre-positioned tool program would result in savings in nine of the twenty-three combinations. Table 18 details the annual savings that every combination would see of toolsets pre-positioned at NAS Fallon and NAS Key West. The red highlighted cells depict toolset combinations that would never reach a breakeven point. For example, with two toolsets purchased and assigned to both NAS Fallon and NAS Key West, annual savings would be $66,856 and require a payback period of 9.16 years at the current annual average of detachments conducted. The shortest payback period would require the purchase of two toolsets for NAS Key West, resulting in a payback period of 5.6 years but with reduced annual savings.

Table 16. Payback (in years) for maximum manpower

Payback (in years) tool set combinations matrix with maximum manpower							
# of Tool Sets		Fallon					
		0	1	2	3	4	5
Key West	0			16.75		29.87	
	1						
	2	5.60	15.78	9.16	18.22	14.15	
	3			46.89		58.37	

Table 17. Annual savings for toolset combinations with maximum manpower

Annual savings with maximum manpower							
# of Tool Sets		Fallon					
		0	1	2	3	4	5
Key West	0			$ 21,353.14		$ 24,771.88	
	1						
	2	$45,503.22	$28,253.73	$ 66,856.36	$ 44,097.28	$ 70,275.10	
	3			$ 15,910.10		$ 19,328.84	

The number of detachments utilized to calculate these losses was based on an annual average, of which Table 2 is a sample. Therefore, the detachment locations could see an increased number of visits annually in the future. With this in mind, we assessed the increase in detachment visits that would be required annually for the Table 18 combinations highlighted in red to reach a breakeven point. The black cells represent combinations already reaching a breakeven point under maximum manning. The green cells highlight combinations that would need the number of detachments to increase less than 4% annually.

Table 18. Percent increase in detachments required with maximum manpower

Increase (%) in annual detachments, per combination, required to cover manning costs							
# of Tool Sets		Fallon					
		0	1	2	3	4	5
Key West	0		19.1%		0.6%		16.5%
	1	64.8%	37.7%	9.4%	14.7%	0.9%	20.5%
	2						0.6%
	3	3.2%	7.8%		1.6%		10.9%

Table 20 depicts the number of years required to recoup the costs spent purchasing and managing the toolsets with minimum manning levels. The red highlighted cells show that, with one person assigned, a breakeven point is achieved in nineteen of twenty-three combinations. With manpower costs spread to multiple boxes at a location, sufficient savings could be achieved. The green highlighted cells identify the shortest times to break even.

By purchasing three toolsets, two F/A-18 and one E/A-18G, for use at NAS Key West, the toolsets costs could be recouped through freight shipment savings in 4.23 years. Additionally, purchasing three sets for NAS Fallon and three for NAS Key West would still result in a payback period of fewer than five years. The increase to 5.26 and 5.5 years for an additional one and two toolsets purchased at NAS Fallon, respectively, results from the lower number of opportunities available to utilize the maximum number of boxes possible at that location: an opportunity only achieved during CVW Fallon detachments.

Table 19. Payback (in years) with minimum manpower

Payback (in years) tool set combinations matrix with minimum manpower							
# of Tool Sets		Fallon					
		0	1	2	3	4	5
Key West	0			16.75	5.67	6.02	6.283
	1				12.04	8.91	8.562
	2	5.72	16.34	9.29	5.69	5.94	6.153
	3	4.23	6.92	5.75	4.97	5.26	5.500

Additionally, Table 21 depicts the annual cost savings that could be achieved for each combination of toolsets in use. As in Table 19, the red highlighted cells indicate that not all combinations would achieve cost savings, even with assigned personnel reduced to one. The manpower costs must be spread over multiple toolsets to achieve savings, and more toolsets will achieve greater annual savings. The combination of five toolsets at NAS Fallon and three at NAS Key West would achieve the greatest annual savings, $239,887.60, even though this combination is only the fourth lowest in terms of time to pay back the initial investment.

Table 20. Annual savings for toolset combinations with minimum manpower

Annual savings with minimum manpower							
# of Tool Sets		Fallon					
		0	1	2	3	4	5
Key West	0			$ 21,353.14	$ 96,713.06	$122,890.88	$ 148,184.11
	1				$ 56,698.90	$ 95,301.53	$ 121,479.35
	2	$ 44,530.74	$ 27,281.25	$ 65,883.88	$141,243.80	$167,421.62	$ 192,714.85
	3	$ 91,703.48	$ 83,684.30	$129,803.04	$188,416.55	$214,594.36	$ 239,887.60

Finally, Figures 5 and 6 graphically depict the payback times for all sets and the sets we believe should be considered. The x-axis depicts the combinations of toolsets to be purchased at NAS Fallon (f) and NAS Key West (k). All sets to be considered with maximum manning have a payback period of fewer than twenty years, allowing for savings to be accrued over the forecasted twenty-year remaining service life of the F/A-18. Any E/A-18 toolsets that would be purchased could accrue savings beyond twenty years as the end of service life for the Growler has not been released. Sets to be considered with minimum manning have a payback period of fewer than ten years, achieving even greater cost savings.

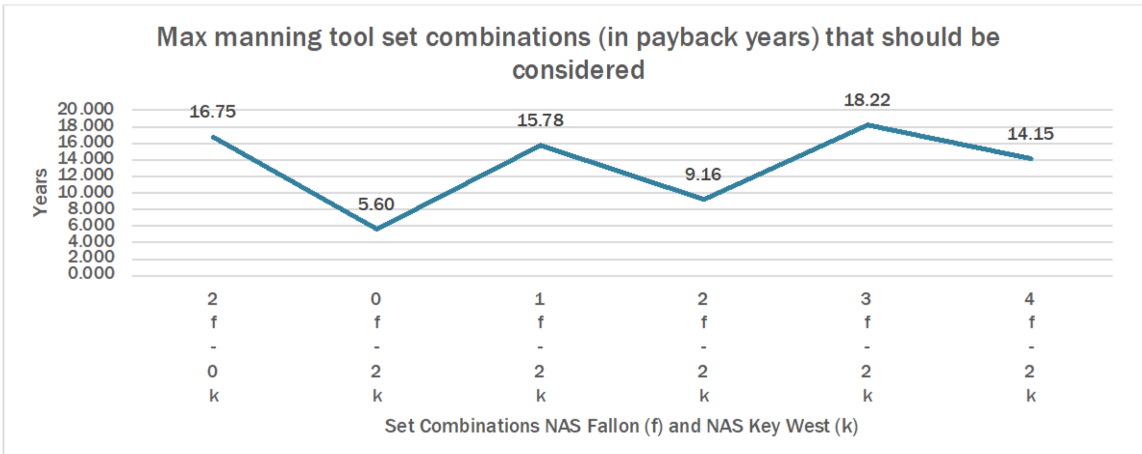

Figure 5. Maximum manpower toolsets to be considered

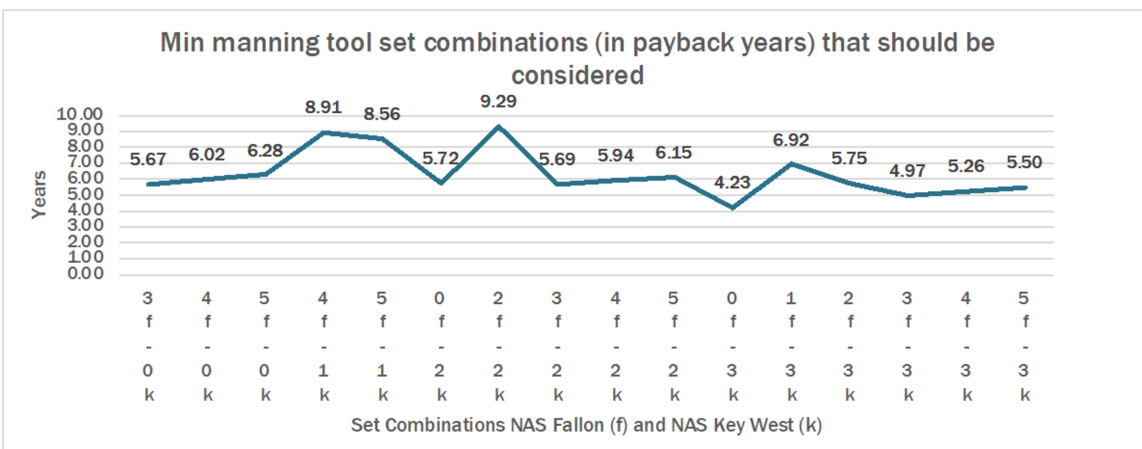

Figure 6. Minimum manpower toolsets to be considered

V. CONCLUSION

A. PREPOSITIONING

Based on the research, the current practice of transporting squadron equipment to detachment locations is not the most efficient. Adopting a pre-positioning model would improve operations and provide the opportunity to continue flight operations at a normal rate prior to a detachment at locations with pre-positioned tools. Additionally, a pre-positioning model would remove the uncertainties of weather along transportation routes and the availability of contracted transportation.

Our research is incomplete because we cannot conduct a manpower analysis for a system that does not exist. However, the model shows that pre-positioning can achieve cost savings in limited cases with our maximum manning model and most cases with our minimum manning model. Separately, if deployment rates and, as a result, pre-deployment detachment rates were forecasted to increase, cost savings could be achieved even with our higher manpower assumptions.

B. FURTHER RESEARCH

Several areas exist for further research on the topic of pre-positioning aviation equipment at detachment sites. First, manpower analysis should be conducted in conjunction with a pilot program, utilizing a successful combination from Figure 6 with minimum manning, to assess the time required to manage the pre-positioned equipment accurately. This would need to include daily responsibilities when toolsets are not in use and in preparation to transfer to a visiting squadron.

Second, as the goal of our research was to assess the feasibility of pre-positioning tools, we focused on the most common aircraft model. Since the model showed efficiency and operational availability increases with the potential for cost savings dependent on personnel, the research could be expanded to include other platforms within the CVW, such as the MH-60R/S, E-2C/D, and the F-35C, and throughout the Department of Defense. Each of these aircraft's squadrons is allocated toolsets required to maintain its aircraft model, resulting in different toolset costs.

Third, our research focused on the detachment sites used most often by F/A-18 squadrons. However, NAS Fallon and NAS Key West are not the only detachment locations utilized by the platform, and other aircraft models may have their own detachment sites most often used. One cost included in our analysis was for a wheeled chassis. One possible option is to locate toolsets at beneficial locations permanently. Another option is to assess the feasibility of transporting the sets to nearby detachment sites to minimize periods when toolsets are not in use and potentially increase cost savings through greater use.

Finally, because our data showed a decrease in detachments conducted in 2020 due to COVID-19 restrictions, future year detachment plans that we did not have access to could achieve the annual detachment increases depicted in Table 18. With five combinations requiring an increase of less than 4% in order to be economically efficient, adding even one detachment annually would increase the viable options.

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