

AIR COMMAND AND STAFF COLLEGE

AIR UNIVERSITY

How accurately do leading and lagging indicators predict F-16 aircraft availability (AA)?

by

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## PREFACE

As the F-16 fleet continues to age, and budgets continue to shrink, United States Air Force (USAF) leadership strives to accurately predict how many aircraft are available to accomplish all tasked missions on a daily basis. The old way of measuring a fleet's effectiveness to support the mission was monitoring the mission capable (MC) rate. There is now a shift to using the aircraft availability (AA) rate to see how the fleet is performing instead of MC. The AA rate has been calculated for quite a while, and according to the Maintenance Metrics USAF Handbook published by the USAF Logistics Management Agency<sup>1</sup> it is now the reference standard utilized by senior leadership to monitor the health of the F-16 fleet.

While many USAF systems were used to gather the data and information to compile this project it could not have been completed without the help of a few very knowledgeable individuals. I would like to start with a thank you to Dr. Dennis Duffin; you provided much needed guidance on compiling and structuring this project. Special thanks to Mr. Joe Smith, GS-13, F-16 AA Program Manager in the F-16 System Program Office (SPO), who helped design the AA program for the F-16 that is now the benchmark for all other platforms. Other Subject Matter Experts (SMEs) include Colonel (USAF Ret.) Ray Lindsey, previous AFLCMC Logistics Program Lead and Colonel James "Chris" Baird, F-16 System Program Manager. Other experts include Mr. Greg Brown, GS-15, F-16 Deputy Director, as well as other assorted individuals in the F-16 Analysis Section. These additional SMEs helped because of their daily interaction with the AA program data and its effect on the fleet itself.

## ABSTRACT

How accurately do leading and lagging indicators predict F-16 aircraft availability (AA)?

In today's environment of doing more with less, aging aircraft and shrinking budgets, it is imperative for maintenance leaders to use all tools available to them to improve the amount of aircraft available for operations. One of the leading ways to gauge a unit's effectiveness was and still is the mission capable (MC) rate. This rate is a lagging indicator of how a unit is performing. This metric is very valuable to measure how a unit is doing, but it focuses more on the tactical level of operations. Emphasis has switched to how that unit is fitting into the overall AF mission or the operational level of doing business. How many aircraft a unit has available is the metric for that emphasis. There has been a major shift from using MC to using Aircraft Availability (AA) to gauge how the unit is performing. This research project used a mixed method approach to evaluating the data compiled to test the thesis that using leading and lagging indicators is the most accurate way to measure AA for the F-16 aircraft.

Although the concept of AA has been around for quite a while, it is only recently that it is now the standard on how leadership appraises their fleets. The ability to predict AA of a fleet has always been a goal of leadership and is now more important than ever with budget cuts that affect the way the AF has to do business. The use of lagging indicators to predict and leading indicators to monitor these predictions is critical to the AF being ready to meet all commitments and taskings. Data shows that this method is accurate to 99.92 percent for F-16 AA prediction.

This graduate research project focuses on the leading and lagging indicators used in the F-16 AA prediction, and the processes and variables that affect this metric. This research builds upon previous research conducted on AA and shows just how important and accurate the current process for predicting AA for the F-16 fleet is. This research project has led to the conclusion

AU/ACSC/2016

that the current process of using lagging indicators to predict and leading indicators to monitor those predictions is the most accurate way to predict AA for the F-16 fleet. The recommendation derived from this project is to keep using the current process.





## Chapter I: INTRODUCTION

How accurately do leading and lagging indicators predict F-16 aircraft availability (AA)?

Initial analysis of data and feedback from subject matter experts leads to the thesis that using leading and lagging indicators is the most accurate way to predict AA for the F-16 fleet. The purpose of this research is to demonstrate the accuracy of this thesis. A mixed method approach is used to analyze the data compiled for this project.

In 2003 at The Corona Top meeting for senior AF leadership, Enterprise Logistics (eLOG) 21 goals of improving AA by 20 percent and reducing operations and support costs by 10 percent led to the development of the AF AA program. Leading (predictive) and lagging (historical) indicators are used to establish and predict AA for the F-16 fleet. Lagging indicators predict AA and leading indicators monitor the predictions for authenticity.<sup>2</sup> Maintenance performance indicators are separated into two categories - aircraft availability and flying execution.

During this project, the data concentrated primarily on the aircraft availability portion of these indicators and how they help predict AA. The rest of the information presented in this project expands on these indicators and their ability to predict AA. The report starts with a short introduction of this project and then moves to a literature review of the sources, information and methodology used to compile data. An analysis of the compiled data follows and finally conclusions and recommendations completes this research project. *Note:* A list of acronyms and definitions are contained in appendix I and II.

## Chapter II: USAF Metrics and Formulas

### Background

AA is an enterprise fleet view with a forward (strategic) methodology of looking at weapon system readiness by monitoring aircraft metrics. Generally these metrics should be used to identify trends and not as pass or fail indicators. Good metrics focus the maintenance manager's attention to areas where there is the possibility for improvement.<sup>3</sup> The three most desirable characteristics of a good metric are, first, it should be understandable – ease of understanding by the intended user. It must have a clearly documented and operational definition. Second, it should apply to the issue facing the maintenance manager and to the metric of interest. A good metric directly links to a stakeholder's satisfaction. The third desirable characteristic of a good metric is that it should be comparable. It is important to make sure standards exist to compare against the metric. Another way to say this is that a good metric is able to show the results of any process improvement efforts.<sup>4</sup> The most important outcome of these metrics is the AA attainable/threshold. This attainable/threshold bases the realistic AA which has been negotiated and agreed upon by the Program Manager (PM) and Lead Command. It is based on known factors discussed later in this chapter. Conclusions and any recommendations found during this research are the final part that wraps up this project.

The formula for AA is MC hours divided by the total aircraft inventory (TAI) hours. This mixed indicator formula takes the total time for possessed aircraft, minus depot possessed, not-mission capable for maintenance, not-mission capable for supply, not-mission capable for both (maintenance and supply combined) and unit possessed not reported hours (unit has the aircraft but it is not possessed, i.e. awaiting engineer repair disposition)<sup>5</sup> for all aircraft. “Depot possessed” is the amount of hours that an aircraft is actually assigned to depot. “Not mission

capable for maintenance” is the number of hours an aircraft is worked by maintenance to fix it. “Not mission capable for supply” are how many hours an aircraft is awaiting parts to get it fixed. “Not Mission capable both” is when maintenance is still working an aircraft and there are still parts on order to fix it.

To illustrate the difference in MC and AA on showing the health of the F-16 fleet, consider these statistics from the F-16 AA Manager, “The average MC rate for the F-16 for fiscal year (FY) 15 was 73% while the AA for the same period was 65%. To clarify, on average 65% of the F-16 fleet was available and ready to perform the mission at any given time. Of the unit possessed aircraft, 73% of those were capable of performing at least one of their assigned missions.”<sup>6</sup> The unit-possessed aircraft are not including the aircraft in the statuses discussed earlier in this paragraph. The AA is a percentage of the whole fleet and MC is a percentage of the fleet that is possessed at any given time. The F-16 AA Manager gives an example of how these rates show a significant difference. “Base X has 20 TAI, three of those aircraft are at depot getting repaired, and two are in depot status awaiting engineer advice on a fix at the local base (107), one aircraft is in phase for maintenance and two are in scheduled time changes. The AA for this base is 15/20 or 75% and the MC rate is 12/15 or 80%”. This example gives a good idea of how these statistics can differ. USAF leadership for war planning does not care if the base is 80% MC if they only have 15 aircraft available and 18 are needed for a real world tasking.<sup>7</sup> Surprisingly, the AA for the F-16 fleet has increased, or at least remained statistically steady since the beginning of measurement for this program. This is remarkable considering the overall F-16 fleet shrinking at a steady pace (see table 2 for information). AA is one of the most critical factors that leadership uses to formulate a budget to sustain the fleet in the future. A timeline for annual development of the AA derived from the AA Business Rules is as follows:

Step	Rule	Timeline	OPR	Comments
1	Presidential Budget (PB) released to Centralized Asset Management (CAM) office/funds holders	Mid Jan. prior to upcoming execution Fiscal Year (FY)	Office of the Secretary of Defense (OSD) releases the PB	N/A
2	PB proposals sent to Program Managers	End of Jan. prior to upcoming execution FY	AFMC CAM office	CAM will load the proposals in the Funded Requirements Management (FRM) module of Centralized Access for Data Exchange (CAFDEx) as soon as possible based upon receipt of PB.
3	Lead Commands provide Standard Presidential Budget Objectives (PBOs) to PMs into CAFDEx PBO module	updates due NLT 15 Aug.	Lead Command for weapons systems	This should be an update to previous PBOs
4	Spread funding in FRM module of CAFDEx	Upon receipt of bogey through 15 Mar.	PMs for CAM funds during Program Objective Memorandum (POM) and execution/fund holders for their funds during execution.	CAFDEx must have the latest requirements (published Dec. of prior year) as well as latest published Depot Purchased Equipment Maintenance (DPEM) factors.

5	Secretary of the Air Force (SAF)/Financial Management Branch (FMB) releases updated funding proposals	Typically, mid Apr.	SAF/FMB	Updated proposals are a result of SAF adjustments to pay Air Force bills. Changes are typically on the margins and not major changes to programs. Not all programs will have changes
6	CAM/fund holders provide updated proposals to impacted programs	End of May, upon receipt of FMB execution proposals	AFMC CAM office	CAM will update FRM targets
7	Program Offices (PO) input their attainable standard into the CAFDEx PBO module; NMCS, NMCM, NMCB, Depot Possessed and UPNR goals provided to AFMC/A4US for WSER	End of May, upon receipt of FMB execution proposals	PM	PO attainables are due by the end of Sep.. However, changes can be input prior to signature of WSA/AAIP occurring end of Oct.
8	MAJCOMs provided AA standards by 15 Aug.			
9	Signed AAIP and CAM Weapons System Annex due for upcoming execution FY	NLT 31 Oct.	PM	

10	AAIP plans added as attachment to the WSA within CAFDEx with the exception that these products be staffed into a single coordinated package NLT 31 Oct.			
11	Quarterly performance monitoring during execution FY.	Jan., Apr., Jul., Oct.	PM	

Figure 1<sup>8</sup>

Due to the importance of AA, there are initiatives to help improve this metric. This led to the development of the Aircraft Availability Improvement Program (AAIP). The AAIP and all of its initiatives are critical to predicting AA because all of the initiatives focus on using leading and lagging indicators as their base. AFMC/A4 administers the AAIP program and verifies that plans are prepared in accordance with (IAW) current policy. AFMC/A4 also ensures that cross cutting initiatives get shared throughout the enterprise, across the commands, and between weapon system platform managers. This program is a chance to share ideas, best practices, possible cost reduction initiatives, as well as initiatives to lower the overall cost of ownership for the F-16 fleet. The vision of the AAIP incorporates the full array of transformation and programmatic initiatives, including Lean, systems and process engineering, structural changes, modifications, and operational flight plans etc. into a weapons system specific, actionable plan to optimize availability and reduce cost. Improvements can facilitate increased availability with reduced inspections, increased mission capability rates, extended flying times, reduced labor

standards, labor allocations and consolidated sources of repair that all lead to reduced cost to operate.<sup>9</sup>

One of the most important outcomes of the AAIP was the establishment of Weapons System Supply Chain Manager (WS SCM) office. The primary objective of the WS SCM is to improve supply chain performance in order to achieve improved weapon system availability. In addition to monitoring and working supply issues, WS SCM addresses maintenance issues through two key programs. Health of the Fleet (HoF) and Maintenance Reliability Council (MRC) briefings address what is affecting fleet maintainability rates. These programs identify systems or components responsible for increases and decreases in “total not mission capability” (TNMC) status hours for either a month or quarter. The HoF also attempts to correlate TNMCS hours to “mission capability” (MICAP) drivers to determine overall impact components have on fleet availability.

In many cases, maintenance issues identified by these programs only require monitoring. The MRC selects system, sub-system or components by work unit code (WUC), which effect the fleet over an extended period. The MRC forum works with process owners to develop and implement long-term solutions that address specific performance issues. The MRC uses multiple approved Air Force algorithms to look at a program over a five-year period to select projects. These include total not mission capable for supply (TNMCS), total not mission capable for maintenance (TNMCM), maintenance man-hours (MMH) and mean time between failure (MTBF). See more about the HoF and MRC Programs below.

The F-16 SPO maintains and runs the AAIP program. Examples of initiatives that are in process are making a different ejection seat pin/rail combination to install in the aircraft so maintenance can be accomplished in the cockpit without seat removal. This initiative can

potentially save over 12 person-hours for canopy and seat removal and associated follow-on maintenance. Another initiative is a rotating maintenance stand for holding the F-16 landing gear while removed from the aircraft. This stand would save person-hours and allow for ease of access to critical areas that require maintenance during landing gear overall.



# AA INITIATIVE SUMMARY



F-16 System Program Office

## Total Aircraft Sustainment Initiatives

		Funds Type	Funds Status	FY12	FY13	FY14	FY15	FY16	FY17	FY18	Total
<b>Depot Possessed</b>											
	\$\$ M	3400	Funded		5.10						5.10
341 Bulkhead Repair	ROI			2.10	1.50	0.78	0.00	0.00	0.00	0.00	4.38
	\$\$ M	DMAO	Funded		7.00						7.00
EXPANDED IFDHS reflects estimates if implemented for PSP and other avionics	ROI		N/A		1.25	1.25	1.25	1.25	1.25	1.25	7.50
<b>NMCM Based on number of aircraft</b>											
	\$\$ M		Funded	0.644	0.654	0.338	0.341	0.000	0.000	0.000	1.977
Fleet Scheduling System (FSS)	ROI		N/A	0.000	0.130	0.130	0.130	0.130	0.130	0.130	0.780
	\$\$ M	3400	Funded	0.450	0.450	0.450					1.350
Leak Detection	ROI		N/A	0.090	0.110	0.130	0.150	0.150	0.150	0.000	0.780
Maintenance Analysis	\$\$ M	3400	Funded		2.50			1.50			5.00
	ROI		N/A	1.230	1.230	1.230	1.230	1.230	1.230	1.230	11.980
	\$\$ M	3400	Funded	1.10	1.30	1.60					4.20
Pylon Rib Repair	ROI		N/A	3.673	3.673	3.673	3.673	3.673	3.673	3.673	27.81
											24.00
											41.25

✦ - Enterprise View of Aircraft Inspections (EVAI) Initiative

✦ - New Initiative

As of: Jul 15

*Fighter of Choice!*

Figure 2<sup>10</sup>

As previously mentioned, two other enterprise process initiatives that have come about with AA are the MRC and the HoF Council.



The MRC is an AAIP initiative born in 1998 in the F-16 SPO. This council meets quarterly and discusses findings in the maintenance data for the previous quarter. The System Program Manager (Col.) or the Lead Engineer (GS-15) chairs this meeting for the F-16 program. The overall tasking for this council is to monitor the maintenance metrics (leading and lagging indicators) for trends and issues that may be looming on the horizon in the maintenance of the F-16 fleet. The analysts look at the maintenance data from a WUC standpoint. Data for all individual WUCs is downloaded and processed through a database algorithm designed by Joe Smith of the F-16 SPO. This algorithm is now the benchmark that all airframes in the AF inventory use for their MRC analysis. The analysts present their findings to subject matter experts from MAJCOMs, Engineering, (SPO and Supply Chain), Equipment Specialists (ES) and Program Managers (PM) that own the WUCs. After discussion with the applicable SME, if the data does indeed indicate a problem then Integrated Process Teams (IPTs) and action items are assigned to the cognizant owner of the problem. The assignee provides updates to the IPT or AIs, through the MRC PM, quarterly, until the chair of the MRC, in conjunction with the applicable SMEs closes the item. The F-16 is a benchmark by MAJCOM leadership and all other platforms are tasked to base their MRC from this program.

The HoF is another enterprise program that came about as an AAIP initiative in 1998. The HoF is similar to the MRC in that it monitors the metrics (leading and lagging indicators) of the F-16. The HoF concentrates on the supply metrics to monitor what issues in the supply system are affecting individual WUCs. Just as with the MRC if a problem is suspected in the data, the HoF council discusses the findings with SMEs that also include SPO and Supply Chain Engineering, ESs and PMs, MAJCOMS and cognizant owners of the part number or National Stock Number that the problem is associated to. IPTs and AIs are established and feedback from

the process owner is provided to the HoF PM in the F-16 SPO. The HoF is a monthly meeting held at Hill AFB in the SPO. The F-16 HoF is also deemed a benchmark program by MAJCOMS that all other platforms are tasked to emulate.

AAIPs will support the Future Years Defense Program (FYDP) thresholds. AAIPs will include the last complete FY actuals, the current FY projections, the current FY plan year, and the next five-year period. For example, FY15 plans will contain confirmed data for FY13, FY13 current attainable, plan execution year FY14, and the next five-year projections, FY16-20. Each plan looks at the future and takes into account future requirements as well as current operational and logistical needs. Changes in plans may be the result of TAI increases/reductions, changes in requirements, budget changes, aircraft modification schedules, etc. Plans state programs or issues with possible impacts to the projected AA standard. AAIP should be closely related and integrated with the Weapon System Life Cycle Management Plan (WS LCMP) or Life Cycle Sustainment Plan (LCSP).<sup>11</sup>

In a thesis in 2001, Captain Steven Oliver talks about five categories that affect AA other than the F-16 aircraft: Personnel, Environment, Reliability and Maintainability, Funding and finally Aircraft and the associated Logistics Operations.<sup>12</sup> The bottom line is that the A4 community in ACC is pursuing a model to help predict aircraft availability and right now using analysis of leading and lagging indicators is that model.

## **Research Focus and Objectives**

This research focused on the USAF F-16 aircraft to include Active Duty, Air National Guard and Air Force Reserve components. The objective is to see if the current policy of using leading and lagging indicators is valuable for predicting future AA used by leadership for decision-making.

## **Methodology**

Since this project is based on other research completed on this subject, numerous different data processes are used. A mixed method with quantitative data analysis/interpretation framework was used to determine if using leading and lagging indicators correctly predicts AA for the USAF.

## **Data Sources and Analysis**

Aircraft reliability, maintainability and operational data collected from the Air Force's Reliability and Maintainability Information System (REMIS), Logistics Installation and Mission Support Enterprise View (LIMS-EV) and the Global Combat Support System AF (GCSS-AF) are used for this research. Each of these data sets are used, as well as subject matter expert testimony to analyze whether AA is predicted accurately.

## **Assumptions and Limitations**

This research focuses only USAF F-16 aircraft and does not consider the Foreign Military F-16 fleet. While this data is limited to one type of aircraft, it also provides a basis for an AF-wide enterprise AA prediction. The assumptions are that the data derived from the data systems and the SMEs is accurate and valid.

## **Implications**

The purpose of this project was to analyze whether the current process of using leading and lagging indicators is effective to predict the AA of the F-16 fleet for the future. With the shrinking size of the F-16 fleet and ever shrinking budgets, it is critical for AF leadership's accurate prediction of AA for the planning of tasked missions and training.

## **Chapter Summary**

In Chapter II, the difference in using MC and AA as fleet health indicators is discussed and the data that is used to gather each of these indicators. It was also discussed that during these fiscally constrained time that utilization of all tools available to maximize resources is critical. The AAIP program and its associated initiatives (WS SCM, HoF, and MRC for example) are critical programs helping to increase the overall AA, and predictability in future AA for the F-16 fleet. Being able to predict AA is one of those tools and the use of leading and lagging indicators is the basis for deriving that data set. The next chapter discusses an AF switch from using MC as the lead indicator of the fleet health to using AA.

### **Chapter III: Literature Review**

#### **Chapter Overview**

How accurately do leading and lagging indicators predict F-16 aircraft availability (AA)? Initial analysis of data, and feedback from subject matter experts leads to the thesis that using leading and lagging indicators is a very accurate way to predict AA for the F-16 fleet and is very beneficial for leadership to make FYDP budget decisions.

“We use both leading and lagging indicators to assess fleet performance. However, AA metrics are all lagging indicators and leading indicators are used to confirm predictions. These lagging indicators are used for historical trending. Those trends are used along with other known variables to predict the future performance of a weapon system. Annually, a prediction on how the fleet is suspected to perform during the next 5 years in each AA category is submitted to the Chief of Staff Weapons System Enterprise Review (WSER). To emphasize how accurate this prediction typically is, during FY16 the AA rate is within .08% of what was predicted. So the method of using historical trends to predict future performance is extremely accurate as long as you can identify any variables.”<sup>13</sup> These variables are discussed later in this project.

To answer this research question and show whether the use of leading and lagging indicators is accurate for predicting F-16 AA, an understanding of the make-up of AA is required. First, is a look at AA with examples and algorithms used, and the standards for F-16 AA currently used. Next, a look at previous research conducted on AA and those results. Finally, a look at leading and lagging indicators used to compile AA metrics and how they improve aircraft readiness for the F-16 fleet concludes the literature review.

## The History of AA and standards

AA is the metric utilized by AF leadership to monitor the health of their fleets and the ability to meet the requirements across all spectrums of readiness. AA has not always been the metric used to see how a fleet is performing. Mission Capable (MC) was the metric to monitor how a fleet was performing. The MC rate is a lagging indicator, or shows how performance has been in the past. Leadership wanted a more real time way to track the status of all aircraft and predict AA, so AA and its associated process was developed. The benefit over using the traditional MC rate is, analyst now have visibility of the entire fleet. This includes aircraft that require engineering dispositions as well as those possessed by the Depots. The statement that information is power is true. Because it is no longer stove-piped (where only the process owner can see it) and everyone can retrieve all pieces of the data analysts identify negative trends and address them early in the process.

AA is a process that uses not only lagging indicators to show past trends but uses leading indicators to prognosticate performance of the future. The algorithms for MC and AA are:

$$\mathbf{MC} = (\text{FMC hours} + \text{PMC hours}) / (\text{Possessed hours}) \times 100^{14}$$

FMC = Fully Mission Capable, FMC hours / possessed hours x 100

PMC = Partially Mission Capable (can perform at least one of its assigned missions), PMCB hours + PMCM hours + PMCS hours/ possessed hours x 100

PMCB/PMCM/PMCS = partially mission capable maintenance and supply, maintenance, supply.

$$\mathbf{AA} = \text{MC hours} / \text{TAI hours} \times 100^{15}$$

Total Aircraft Inventory (TAI) hours = hours of total aircraft inventory for a unit

The biggest difference in these two metrics is that the AA takes into account the total aircraft inventory hours for the established period and MC only takes into account the possessed hours accrued for that same period. While this may seem very similar, the possessed hours do not take into account aircraft that are in depot status or unit possessed not reported aircraft along with assorted other aircraft statuses. The TAI hours and the possessed hours can vary significantly.

In 2009, Headquarters AF established an AA Standards Integrated Project Team to develop a process for lead commands to develop AA standards and link them to operational requirements. This is how the AA standard is developed. AA Standards are a computed goal based on war plan support and other operational and military planning obligations. Operational Requirements drive the Mission Capable (MC) and AA requirement. Designed Operational Capability (DOC) statements, which define both the crews required and generation timing should be the common operational requirement from which these standards derive. These goals reflect an unconstrained value of aircraft requirements without consideration of financial, labor, or logistics constraints that may limit AA in the short or long term. The AA Standard is considered a long-range goal for program planning. A “worst case” Defense Planning Committee (DPC) tasking may be used, however, MAJCOMs are not authorized to use additives (i.e., multiple DOC tasking, all potential contingencies generate simultaneously) in AA standard development.<sup>16</sup> Plans are measured and each AA prediction is subject to through presentation of the Weapon System Enterprise Review. The WSER is scheduled and presented by AFMC/A4, with the assistance of tasked program offices and supporting AFLCMC and AFSC offices. The Chief of Staff Air Force (CSAF) WSER provides a comprehensive look at Aircraft Availability (AA) for more than 30 weapon systems currently in the Air Force inventory. The metrics reviewed are AA Standards (set by MAJCOMs), AA Attainable (computed by Program Office),

and standard Mission Capability indicators. The AA Attainable projections are developed by the program office using their Aircraft Availability Improvement Plans, or for Contractor Logistics Support platforms, using contracted MC rates. The program offices brief their platforms to CSAF during the VTC. Center commanders and MAJCOM A4s are included. The algorithm for the AA standard process is:<sup>17</sup>

$$\left[ \frac{(So)}{Fdays \times Tu \times (1-a)} \right] + \left[ \frac{(St)}{Fdays \times Tu \times (1-a)} \right] + G + S + A + R = OR$$

- So – Sorties required; contingency*
- St – Sorties required; training*
- F – Days available to fly*
- Tu – Turn rate*
- a – Attrition rate*
- G – Ground schedule requirements*
- S – Spare requirements*
- A – Alert requirements*
- R – Reserve and Guard requirements*
- OR – Operational Requirements*

Figure 3

For most units the operational flying variable is 365 days a year, 24 hours a day. If the time window is less than one year then the fly days need calculation as applicable. Calculating this OR is a base to calculate the AA standard for a unit. The algorithm for this AA standard is:<sup>18</sup>

$$\frac{OR}{TAI} = AA \text{ std}$$

Figure 4

The AF desires an Aircraft Availability (AA) standard tied to operational requirements, and has the same readiness implications for all weapon systems to enable risk trade-offs at the enterprise level. AA standards reflect the unconstrained value of aircraft requirements without consideration of financial, work force, or logistics constraints that may limit the AA. These



constraints are considered by the PM when they project their attainable that is submitted to AFMC/A4 for the FYDP predictions.

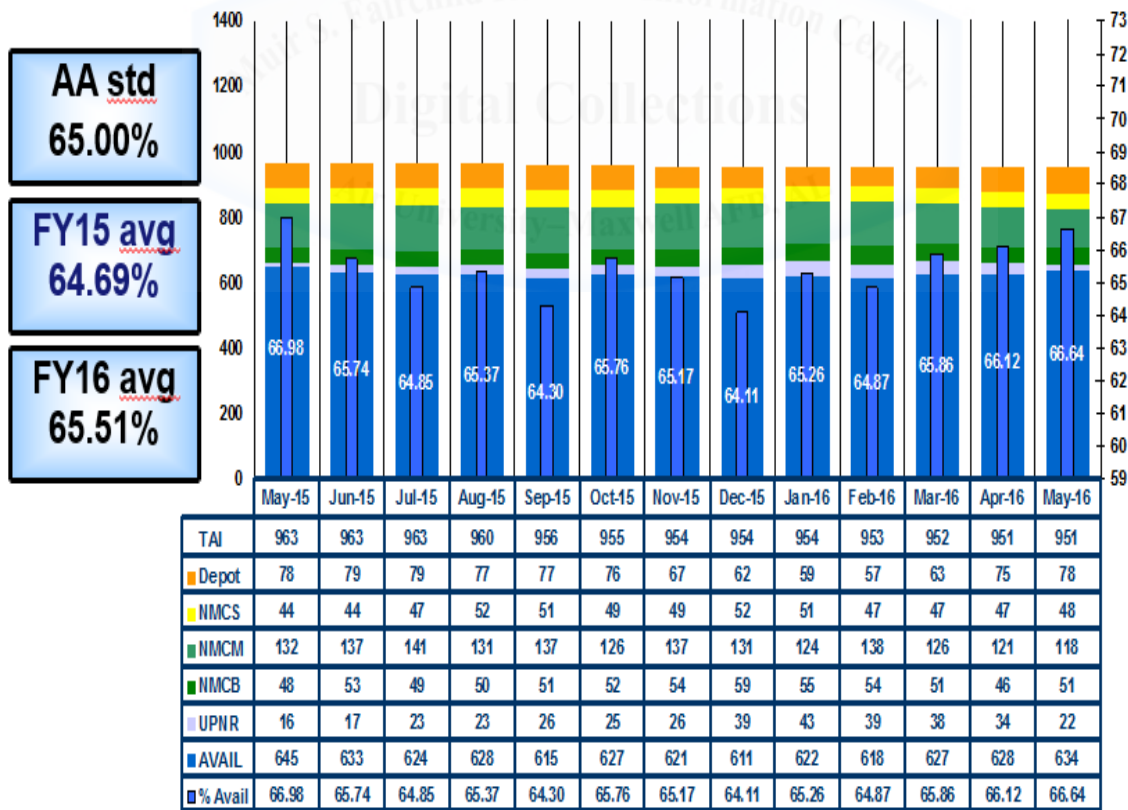
The current AA standard for the F-16 fleet is 65% and the fleet is currently maintaining a 65.41% average for FY 16 to date. Even though the F-16 fleet has decreased in TAI recently the rate of the AA shows that the F-16 fleet is managing to attain the required standard. See the following chart for a non-classified, current overall AA health for the F-16 fleet.<sup>19</sup>



## F-16 Aircraft Availability Improvement Program



F-16 System Program Office



Source: LIMS-EV

Figure 5

Determining the health of the fleet, and to assess a flying unit's capability is a continuing goal of AF leadership. Previously MC rate was used, but now the strategic view of AA is the metric of choice. Over time, other research about factors that affect the AA rate have been conducted. That research forms a basis for this project.

### **Previous research on AA**

Before AA was the metric of choice, Captain Steve Oliver did an analysis on the MC rate and what factors affected it. The reason behind his research is the MC rate had gone from all-time highs in the early 1990s to at least a 10 percent drop by the close of the decade.<sup>20</sup> Captain Oliver concluded that six categories affected the MC rate at any given time. The six categories are personnel, environment, reliability and maintainability of aircraft, funding and finally the ways that the aircraft and its supporting logistics system is operated.<sup>21</sup> Many of these factors are beyond the control of the leadership and are inherent in operating a combat aircraft, but they must be calculated and planned for when making decisions. This is what led to moving from MC to AA as the metric of choice. One important factor of Captain Oliver's categories is the reliability and maintainability of the fleet.

In 2001, when he proposed his thesis, the average age of the F-16 fleet was over 20 years old. Because of retirements and changes to the F-16 fleet, as of June 2016, the average age of the F-16 fleet is 25.6 years with an average of 6391.4 airframe hours on a planned 8,000-hour airframe.<sup>22</sup> As the F-16 ages and the austere operating environment, they have operated in since 2001 the reliability of the systems and components of the aircraft decrease and the cost to maintain increases. This advanced age and reliability and maintainability challenges also has the issue of more person-hours needed to maintain. Budget cuts have led to shrinking work force in this same timeframe. This section has just touched on the previous research on AA and much

more research is available to those who are interested. Now the focus changes from issues that affect the MC rates to the new process of predicting AA and the associated forecasting metrics used to compile this metric.

### **Aircraft Availability Forecasting Metrics**

As discussed earlier, leading and lagging indicators are used to predict AA for the F-16 fleet. A semi-comprehensive list<sup>23</sup> of the leading and lagging indicators used to show aircraft availability for the F-16 are:

#### **Leading**

- Ground abort rate
- Air abort rate
- Code 3 break rate
- 8-/12-hour fix rate
- Repeat rate
- Recur rate
- Logistics departure reliability
- Average deferred/delayed discrepancies per aircraft
- Discrepancies awaiting maintenance (AWM) or awaiting parts (AWP)
- FSE rate
- Aircraft phase rate
- Functional check flight (FCF) release rate

#### **Lagging**

- Sortie Utilization (UTE) rate
- Hourly UTE rate
- Fully Mission Capable (FMC) rate
- Total Non-Mission Capable for Maintenance (TNMCM) rate
- Total Non-Mission Capable for Supply (TNMCS) rate
- CANN rate

This is not an all-encompassing list but gives a nice view of the indicators that are used to predict the aircraft availability of the F-16 fleet. Air Force T.O. 00-20-2 is the official source for

all of the algorithms that are used to compile the above indicators.<sup>24</sup> These indicators are used to monitor the health of the F-16 fleet and any trends that may be developing so that leadership can be proactive instead of reactive.<sup>25</sup> Air Combat Command Instruction 21-118 tells that leading indicators show a problem first, as they directly impact maintenance's capability to provide resources to execute the mission. Lagging indicators follow and show firmly established trends. Maintenance leaders must review sortie production and maintenance health constantly and be knowledgeable about maintenance indicators that highlight trends before they become problems.

### **Chapter Summary**

This chapter has looked at the history of MC and how the AF has evolved to the new metric of choice, AA. We also delved into some of the history of AA and looked at snippets of previous research conducted. The importance to leadership of having a way to forecast the AA of a fleet to their decision-making ability is next. The final part of this chapter is a look at some of the metrics used in the calculation of AA. The next part of this report looks at the methodology used in collecting and analyzing the leading and lagging indicators for predicting AA.

## **Chapter IV: Methodology**

### **Chapter Overview**

Many variables affect the AA rate prediction for the F-16 as shown in the literature review. The goal of this project is to identify these variables and analyze if they are accurately predicting AA for the F-16 fleet. In order to interpret these parts a working understanding of the data that make up these parts is useful. The purpose of Chapter IV is to describe these parts and the method used to analyze the data that they provide. Lastly, a thorough explanation of the multiple analysis method used in this research and the creation of an AA predictive tool ends this chapter.

### **Scope of Data Collection and Research**

Aircraft AA is a living management tool used to achieve, improve, and measure lifecycle support of weapon systems while effectively and efficiently supporting the warfighter and associated operational requirements. The AA is a collaboration between the PM and Lead Command/A4 to sustain, improve, and document changes to AA and recognize cost restraints.

Previous research has been conducted on AA at the fleet level, thus encompassing all aircraft of a certain Mission Design, i.e. F-16. An example of this previous research already used in this project is Captain Oliver's thesis.<sup>26</sup> The scope of this project follows Oliver to a certain extent as it focuses on the F-16. This project focuses more on whether the use of indicators to predict AA is accurate or if other processes would be more successful. A hypothetical example of the accuracy of AA is; a unit is showing an 89 percent FMC rate for its fleet of F-16s. A tasking from higher headquarters comes down to prepare to deploy an 18 aircraft contingent to base x within 72 hours. The unit only has 17 aircraft available, because of depot repairs not

scheduled to be completed for over a month, despite that they have an 89 percent FMC rate.

Where will they get that other aircraft and what will they do for spares to ensure they can meet their mission? This is why AA is critical and why this research was completed. The following algorithm data is compiled from various resources to include the Maintenance Metrics Handbook and AF TO 00-20-2 and SMEs from the F-16 SPO. This data is what the SPO uses to calculate the AA availability predictions submitted to the FYDP. It lets the AF know what the attainable for AA is for the future of the weapons system. See pages four and five of this research project for a detailed look at the process of predicting AA for the AF as established by AFMC/A4.



Algorithm Examples/definitions: See Appendix II for additional definitions

Metric	Description	Things to Look For
MC Rate	The percentage of possessed hours for aircraft that can fly at least one assigned mission.  Desired Trend ↑	Workers putting off repairs to other shifts, inexperienced workers, lack of parts from supply, poor in-shop scheduling, high cannibalization rates, training deficiencies—formal or OJT. High commitment rates may also contribute to a lower MC rate.
NMCM Rate	The percentage of possessed hours for aircraft that cannot fly any assigned mission due to maintenance.  Desired Trend ↓	Workers putting off repairs to other shifts, inexperienced workers, lack of manpower, lack of tools, lack of support equipment, training issues, environmental factors. Look at the impact of scheduled versus unscheduled maintenance.
NMCS Rate	The percentage of possessed hours for aircraft that cannot fly any assigned mission due to lack of parts.  Desired Trend ↓	Backshops slow turning out parts, lack of in-shop technical repair data, lack of shop replaceable units and bits and pieces, stock level problems, transportation issues affecting delivery of parts.
FSE Rate	The percentage of sorties scheduled minus deviations.  Desired Trend ↑	Last minute aircraft being added to the schedule, frequent configuration changes, frequent changes to the flying schedule, lack of discipline on who is authorized to change the flying schedule.
CANN Rate	The number of cannibalizations that occur per sortie (per 100 sorties for MAF) or for supply kit deployment.  Desired Trend ↓	Reliability of parts, problems at shop or depot repair facility, lack of discipline or supervision, poor sense of urgency, supply problems, kit fill rates, parts that never had to be CANNed before (old airplanes breaking for new reasons, insufficient stockage levels on base, having to manage parts for deployments). Analyze the cause codes of CANNs. Are the parts being CANNed authorized to be on hand?

Figure 6<sup>27</sup>

Metric	Description	Things to Look For
Abort Rate	The number of air aborts plus ground aborts occurring per total number of sorties.  Desired Trend ↓	Quality of maintenance decreasing, especially if aborts caused by R/R write-ups or aircrews not proficient on newer systems (leading to erroneous write-ups), reliability problems, or issues.
Break Rate	The number of aircraft landing with a grounding write-up per total number of sorties.  Desired Trend ↓	Reliability of parts, training deficiency, poor technical data, test equipment, or insufficient tools.
Fix Rate	The number of grounding write-ups repaired per the total number of grounding write-ups that occurred.  Desired Trend ↑	Training, lack of experienced technicians, poor technical data, lack of tools, or lack of test equipment.
R/R Rate	The number of R/R write-ups per the total number of write-ups.  Desired Trend ↓	Component reliability, maintenance practices, or experience of maintenance technicians.
Maintenance Scheduling Effectiveness Rate	The number of maintenance actions started as scheduled per total number of maintenance actions scheduled.  Desired Trend ↑	If either the unit or individual tail number rates decrease, look for: <ol style="list-style-type: none"> <li>1. Shortages in equipment or personnel,</li> <li>2. Problems with a particular type of maintenance action being accomplished later than scheduled, and</li> <li>3. Resources being over committed.</li> </ol>
Deferred Discrepancies	Depicts how well your unit is keeping up with required minor repairs.  Desired Trend ↓	The total number increasing or one tail number with a great deal more than the others, look for: <ol style="list-style-type: none"> <li>1. Actions being deferred for convenience or</li> <li>2. Crew chiefs follow-up on AWP and shop chief awareness of backlogs.</li> </ol>

Figure 7<sup>28</sup>



**AVERAGE FMC AIRCRAFT**

Average FMC Aircraft = FMC Rate \* Average Aircraft Possessed

**AVERAGE POSSESSED AIRCRAFT**

Average Possessed Aircraft =  $\frac{\text{Total Possessed Hours}}{\text{Number of Clock Hours}}$

**MISSION CAPABLE (MC)**

MC Hours = FMC + PMC Hours

**NOT MISSION CAPABLE (NMC)**

NMC Hours = NMCBU + NMCBS + NMCMU + NMCMS + NMCS

**NOT MISSION CAPABLE BOTH (NMCB)**

NMCB Hours = NMCBU + NMCBS

**NOT MISSION CAPABLE MAINTENANCE (NMCM)**

NMCM Hours = NMCMU + NMCMS

**NOT MISSION CAPABLE SUPPLY (NMCS)**

NMCS Hours = Number of Hours Status Code E

**PARTIAL MISSION CAPABLE (PMC)**

PMC Hours = PMCB + PMCM + PMCS

**FMC RATE**

$$\text{FMC Rate} = \frac{\text{OPERATIONAL HOURS}}{\text{POSSESSED HOURS}} * 100$$

**NOTE:** Where OPERATIONAL HOURS is POSSESSED HOURS - (NMC hrs + PMC hrs).

**NMC RATE**

$$\text{NMC Rate} = \frac{\text{NMC HOURS}}{\text{POSSESSED HOURS}} * 100$$

**NMCM RATE**

$$\text{NMCM Rate} = \frac{\text{NMCM HOURS}}{\text{POSSESSED HOURS}} * 100$$

**NMCS RATE**

$$\text{NMCS Rate} = \frac{\text{NMCS HOURS}}{\text{POSSESSED HOURS}} * 100$$

**PMC RATE**

$$\text{PMC Rate} = \frac{\text{PMC HOURS}}{\text{POSSESSED HOURS}} * 100$$

**HOURS UTILIZATION (UTE) RATE**

$$\text{UTE Rate} = \frac{\text{Total Flying Hours}}{\text{Possessed Aircraft}}$$

ABORT AIR RATE

$$\text{ABORT AIR RATE} = \frac{\text{ABORT AIR}}{\text{SORTIES FLOWN}} \times 100$$

ABORT GROUND RATE

$$\text{ABORT GROUND RATE} = \frac{\text{ABORT GROUND}}{\text{SORTIES FLOWN} + \text{ABORT GROUND}} \times 100$$

8 HOUR FIX RATE

$$\text{8 HOUR FIX RATE} = \frac{\text{BREAKS FIXED WITHIN 8 HOURS AFTER LANDING}}{\text{BREAKS}} \times 100$$

$$\text{CANNIBALIZATION RATE} = \frac{\text{CANNIBALIZATIONS}}{\text{SORTIES FLOWN}} \times 100$$

UNIT POSSESSED - NOT REPORTED (UPNR)

$$\text{UPNR RATE} = \frac{\text{UPNR HOURS}}{\text{TAI HOURS}} \times 100$$

**NOTE**

UPNR hours are the sum of the number of possessed hours in the following PPCs: BJ, BK, BL, BN, BO, BQ, BR, BT, BU, BW, BX, XJ, XW, and XZ.

TAI hours are the possessed hours of the following PPCs: BJ, BK, BL, BN, BO, BQ, BR, BT, BU, BW, BX, CA, CB, CC, CF, EH, EI, DJ, DK, DL, DM, DO, DR, IF, PJ, PL, PR, TF, TJ, XJ, XW, XZ, ZA, and ZB.

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While this is not a complete list, it is included as a reference for the basis of this research project. If more information is required, see Air Force Technical Order 00-20-2, Appendix L.

## **Predicting AA**

AA monitors problems or changes in ratings of five primary categories that impact AA: Not Mission Capable Maintenance (NMCM), Not Mission Capable Supply (NMCS), Not Mission Capable Both (NMCB), Depot Possessed (DP), and Unit Possessed Not Reported (UPNR). For an example of how all of these factors are used together to show the AA of an aircraft for a certain month see Figure 2 above. To predict AA, analysts from the SPO look at the past performance for a five-year period and look for major fluctuations and other factors that may affect the indicators. If those numbers are within a certain range, they are used in a proprietary algorithm to predict the future AA. “Those predictions are input in to the Future Years Defense Program (FYDP), to prognosticate for how we believe the fleet will perform during the next 5 years in each AA category.”<sup>31</sup> This data goes to DoD and is ultimately approved by the Secretary of Defense (SecDef). Analyst constantly monitor this prediction and look for any trends or changes, they use this information along with other known variables to predict the future performance of a weapon system. “To prove how accurate this is, data used during FY16 are within .08% of what was predicted back in FY11. So the method of using historical trends to predict future performance is relatively accurate as long as you can identify any variables.”<sup>32</sup> The other variables can be anything that can not be planned for in the prediction. Some examples of these variables are unplanned requirements at depot, budget cuts, sequestration, aircraft attrition rates higher than anticipated. All of these examples, and more, could cause for incorrect prediction of AA, but the “F-16 analysis section has been very good at compensating for variables and overcoming the obstacles associated.”<sup>33</sup> The Aircraft Attainable Projection tool (AAPT) is a tool that the PM can use to help predict the AA for a fleet. It contains several algorithms which are locked to maintain functional capability. The PM can

populate data only on open white cells in the AAPT. This maintains the integrity of the tool for each input provided. The following figures are examples of the outcome of using the indicators to predicting AA.

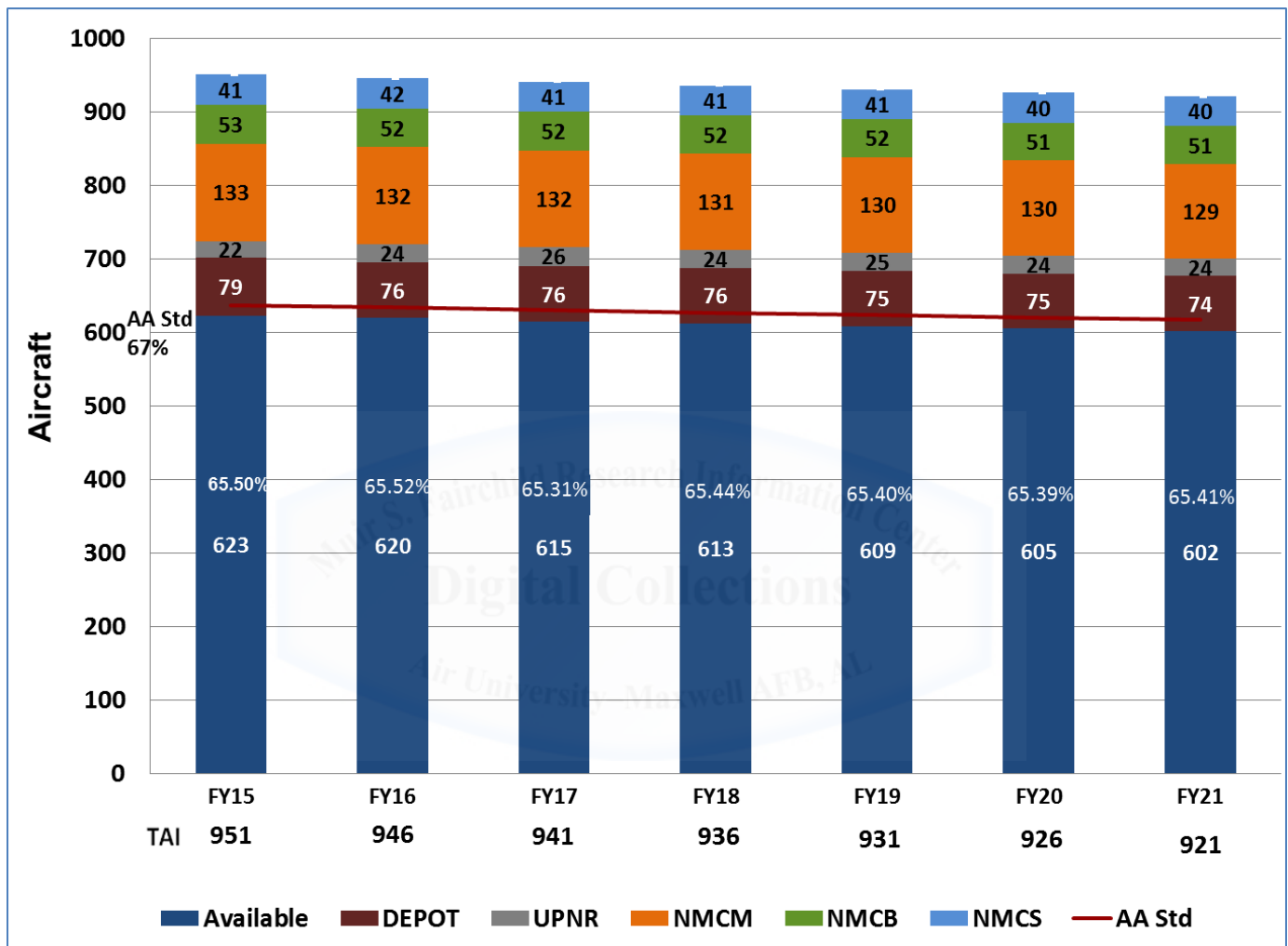


Figure 8<sup>34</sup>

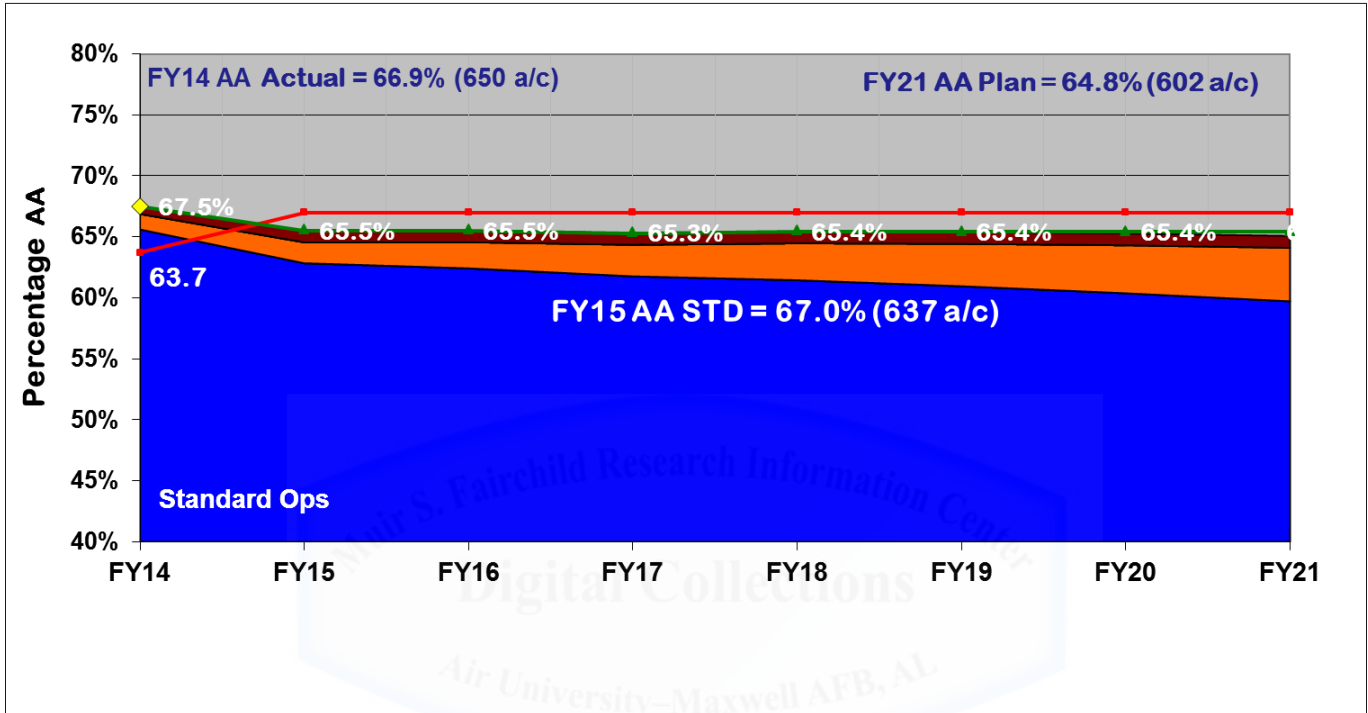


Figure 9<sup>35</sup>

There are inherent risks and variables that can affect these predictions. Some of the risks that the F-16 SPO accepts are;

Near term – AA stabilizes or improves as a result of major modification completions.

Mid term – Increased issues due to aging fleet

Funding shortfalls

Manpower reductions

Long term – Service Life Extension Program (SLEP) will temporarily increase depot possessed rate and decrease AA.<sup>36</sup>

AA standards and attainable AA levels are used to apportion risks between weapon systems and portfolios by providing or withholding resources, both during normal programming and execution phases of the year. Since the AA-standards do not reference a common baseline, resourcing decisions based on AA-standards may not produce the balanced readiness risks the AF has corporately accepted.

### **Chapter Summary**

Chapter IV allowed examination of various algorithms, definitions and examples of how and what data is used in the prediction of AA. Next is a reference back to Figure 5 to see a compilation of this data in real-world use. Finally, there is a discussion of how this all comes together and is used to predict AA in the FYDP and submitted to AF leadership for decisions for the F-16 fleet and its future use. Examples of the FYDP submissions are included. In the next chapter discussions will focus on the conclusions formulated on whether the current process of using lagging indicators to predict, and leading indicators to authenticate the AA of the F-16 fleet is accurate. The final part of this research project focuses on the recommendations that have developed from this data study.

## **Chapter V: Conclusions and Recommendations**

### **Chapter Overview**

This chapter discusses the conclusions and recommendations that have been formulated on the original research question, “How accurately do leading and lagging indicators predict F-16 aircraft availability (AA)?” Facts established in this project are, the current AA standard for the F-16 fleet is 65% and the USAF F-16 fleet is averaging 65.41% in FY 16 as of July 2016. The standards are established by lead commands with guidance from Headquarters AF. Algorithms for this process are included in this document (figures 3 and 4). One of the first variables that affects the AA is the AAIP program. This program provides a chance to share ideas, best practices, possible cost reduction initiatives and any suggested initiatives to lower the total ownership cost of operating the F-16 fleet. See Figure 2 for an example of some of these improvement initiatives. Other variables are discussed in the Methodology chapter, as well as near, mid and long term risks that the F-16 SPO accepts in their program. Budget, changes in work force and unplanned worldwide events are also variables that can affect the AA that sometimes need to be overcome. Many different variables are used by the F-16 SPO AA Program Manager to compile the data that is submitted yearly for the Future Years Defense Program (FYDP) to formulate a budget for the F-16 fleet. In the past, the F-16 has been very successful with the five-year forecast for AA. In FY 16 is within .08% of predicted in FY 11. See figures eight and nine for a forecasted AA for the F-16 fleet.

### **Personal and Expert Conclusions**

The research question that drove this project was how accurately do leading and lagging indicators predict F-16 aircraft availability (AA)? After researching this project and being



directly involved in the formation of the F-16 AA program, the current program is the best way to predict F-16 AA, and is very accurate.

This research question has been answered and the use of leading and lagging indicators to predict AA for the F-16 is very accurate and proven in this research project. While lagging indicators are the tools used to predict AA for the F-16 fleet, leading indicators confirm and monitor the accuracy of that prediction. In the opinions of the SMEs used in this research all came up with the same conclusions, this process works. Col. Baird, F-16 System Program Manager, said, “This program is so much better and accurate than previous programs that I have been part of that the AF should make this a benchmark”. Joe Smith, F-16 AA Program Manager, also said that “Unless someone comes up with a new way to predict AA (discussed in recommendations) that the tools he uses are the best available and the F-16 AA is the most accurate fleet each time he presents to the AF Chief of Staff in the Weapons System Review (WSR)”. See the following chart for proof of the accuracy of the F-16 data from a past WSR.

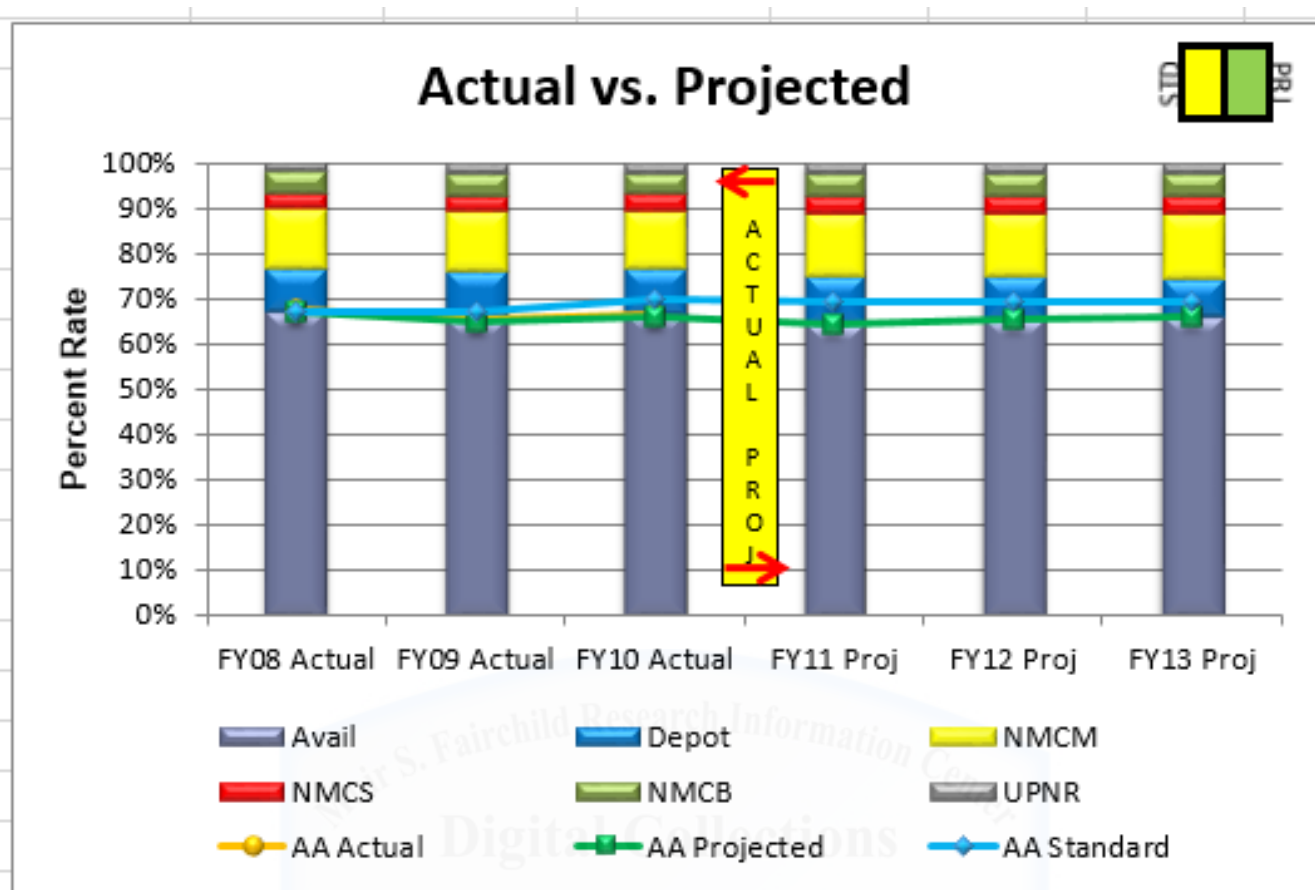


Figure 10<sup>37</sup>

### Limitations and Significance of this Research Project

As previously mentioned, this research only applies to the F-16. In addition, this research was limited to the data available and knowledge that the F-16 AA experts were willing or capable of sharing. With that said, Col. Ray Lindsey, AFLCMC Logistics Program lead, and leadership in Air Combat Command stated during a meeting that “The F-16 AA program and the associated initiatives that have come from it, is a program that other commands should emulate and incorporate”. The leadership also went on to say, the F-16 program should become the benchmark for the AF to follow. The variables of Depot percentage, MC rate, NMCM, NMCS,

UPNR and sorties flown are some of the most critical data that this research discusses. See figures 3, 4 and 5 for these and other variables that are taken in to account.

The limitations of this project are that other data and creditable variables that affect the AA of the fleet could be available, but it is as complete as possible. However, this research is significant in that it does offer the methodology and contacts for any AA Program Manager to duplicate and mirror this very successful program. This research reveals techniques and procedures that an AA program can use and build on to create a strong AA program of their own. It also provides another credible source of information for leaders to base their critical day-to-day decisions on how to task their fleets to accomplish the overall AF mission of Fly, Fight and Win.

### **Recommendations**

The current process of using indicators to predict AA for the F-16 is the most accurate process available and the only recommendation made is that as technology improves and communication between legacy systems increases, the unforeseen variations in the data that is used should be mitigated. This in itself could strengthen the current accuracy of forecasting AA for the F-16 stronger. As Col Baird discussed above, “The F-16 AA prediction process should be the benchmark for the AF. With its proven .08 percent accuracy over a five year period, it is the process that the F-16 will use in the immediate future.”<sup>38</sup>

### **Chapter Summary**

In today’s environment of less manning, older aircraft and shrinking budgets, USAF leaders must use all options in their capabilities to improve the amount of aircraft that are available to conduct operations. With the shrinking size of the USAF F-16 fleet, this is

especially critical. The conclusions and recommendations in this chapter show that using the lagging indicators to predict and leading indicators to monitor and confirm the F-16 AA play an important role and give leaders another tool to improve the overall number of aircraft available to the AF for daily operations and contingencies. The current system of AA prediction is very accurate and is the best way available.



## Appendix I Abbreviations and Acronyms

AA – Aircraft Availability

AAIP – Aircraft Availability Improvement Program

A/C – Aircraft

AF – Air Force

AFGLSC – Air Force Global Logistics Support Center

AFMC – Air Force Material Command

CAM – Central Asset Management

CLS – Contractor Logistics Support

CSAF – Chief of Staff of the Air Force

eLog21 - Expeditionary Logistics for the 21<sup>st</sup> Century

DP – Depot Possessed

D&SWS – Develop and Sustain Warfighter System

DLA – Defense Logistics Agency

EN – Engineering Staff

eSSS – Electronic Staff Summary Sheet

FY – Fiscal Year

FYDP – Future Years Defense Program

HAF – Headquarters Air Force

IAW – In Accordance With

IPR – Integrated Program Review

LCMP – Life Cycle Management Plan

LIMS-EV – Logistics, Installations and Mission Support Support-Enterprise View

MAJCOM – Major Command

MC – Mission Capable

NMCB – Not Mission Capable Both

## AU/ACSC/2016

NMCS – Not Mission Capable Supply

NMCM- Not Mission Capable Maintenance

O&S – Operations and Support

PAA - Primary Aerospace Vehicle Authorization

PAI – Primary Aircraft Inventory

SPM – System Program Manager

SPO – System Program Office

SSM – System Sustainment Manager

TAI – Total Aircraft Inventory

TNMCS – Total Not Mission Capable Supply

UPNR – Unit Possessed Not Reported

VTC – Video Teleconference

WS – Weapon System

WSER – Weapon System Enterprise Review



## Appendix II Definitions

A common understanding of terms is essential to effectively establish an AAIP plan and/or to understand the associated uses of terminology. In terms relative to AA and AAIP planning the following applies:

**Aircraft Availability (AA):** The percent of a fleet's A/C that is available to meet mission requirements. Calculation =  $(MC \text{ hours} / TAI \text{ hours}) \times 100 = AA\%$ .

**AA Attainable (Threshold) - Constrained:** A collaboratively negotiated and agreed upon planned value of expected AA between the PM and Lead MAJCOM. Taking into account impacts to the fleet based on "known factors" not included in standard calculations, i.e. depot modifications, increases and decreases in TAI, changes in requirements, budget changes, etc. Individual NMCM, NMCS, NMCB, DP and UPNR values that would enable the weapon system to achieve the AA standard. The AAIP plan total for the FYs between the past actual and the last year of the FYDP; has been replaced by "attainable" in CSAF WSER.

**AA Standard (Objective) - Unconstrained:** (FY12/FY13) minimum number of aircraft required to fulfill operational and maintenance requirements. AA standard developed to represent a defined operational requirement that does not include budget and maintenance capability limitations in the calculation.

**Baseline Availability** – see Standard Ops

**Depot:** The percentage of a WS fleet's TAI that are in depot possession. Calculation =  $(\text{Depot hours} / TAI \text{ hours}) \times 100$ . Also referred to as Depot Possessed (DP)

**Designed Operational Capability (DOC) Statement:** The document summarizes the DOC of a unit and contains unit identification, mission tasking narrative, mission specifics and resources to be measured. It provides unit commanders a clear definition of their unit's wartime capability, based upon the authorized manpower and material strength of the unit

**Mission Capable Rate (MC):** Percentage of unit possessed (reported) aircraft that are either Fully Mission Capable (FMC) or Partially Mission Capable (PMC). Calculation =  $((FMC \text{ Hours} + PMC \text{ Hours}) / (\text{Possessed Hours})) \times 100$ .

**Not Mission Capable Both Rate (NMCB):** The percentage of a fleet's TAI that is NMCB. The A/C can't perform assigned missions due to both maintenance and supply. Calculation =  $(NMCB_{NA} \text{ hours} / TAI \text{ hours}) \times 100$ .

**Not Mission Capable Maintenance (NMCM):** The percentage of a fleet's TAI that is NMCM. The A/C can't perform assigned missions due to maintenance. Calculation =  $(NMCM_{NA} \text{ hours} / TAI \text{ hours}) \times 100$ .

**Not Mission Capable Supply (NMCS):** The percentage of a fleet's TAI that is NMCS. The A/C can't perform assigned missions due to supply. Calculation =  $(\text{NMCS}_{\text{NA}} \text{ hours} / \text{TAI hours}) \times 100$ .

**Primary Aircraft Authorization (PAA):** A/C authorized to perform a unit's mission. The PAA forms the basis for allocating operating resources to include manpower, support equipment, and flying hour funds. The operating command determines the PAA required for assigned missions. "Authorized" refers to the number and type of A/C an organization is programmed to possess.

**Primary Aircraft Inventory (PAI):** The aircraft assigned to meet the primary authorization.

**Standard Operation (Ops):** Represents the baseline AA projection if no AA improvement initiative exists. Taking into account future impacts to the weapon system, i.e. cracks, inspections, modifications, etc.

**Total Aircraft Inventory (TAI):** A/C assigned to operating forces for mission, training, test, or maintenance functions.

**Total Non-Mission Capable Supply (TNMCS):** The A/C cannot perform assigned missions due to supply. Also includes NMCS time.

**Total Not Mission Capable Maintenance (NMCM):** The A/C cannot perform its mission for maintenance

**Unit Possessed Not Reported (UPNR):** A/C in the unit's possession but not reported; (vehicle transfers, depot level maintenance, etc) or an A/C for which AFMC has been requested to provide repair assistance beyond the possessing commands ability (107 processes). This metric is referred to as Base Possessed Not Reported (BPNR).



**Notes**

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- 6 *ibid.*, 2.
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- 24 *ibid* 4, p 29 para A2.3.
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- 30 *ibid* 15, Appendix L
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- 33 *ibid.*

34 *ibid.*, 2.

35 *ibid.*

36 Mr. Greg Brown, GS-15, Deputy System Program Manager, F-16 System Program Office, Hill AFB. UT, June 2016.

37 *ibid.*, 2.

38 *ibid.*, 19.



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- [3] Air Force TO 00-20-2, Maintenance Data Documentation, Appendix L, 2009.
- [4] Air Force Logistics Management Agency, *Metrics Handbook for Maintenance Leaders*, Maxwell AFB, Gunter Annex, AL: AF Logistics Management Agency, 2001.
- [5] Air National Guard Pamphlet 21-106, *Maintenance Data Systems Analysis*, 2011
- [6] *Aircraft Availability Improvement Program Business Rules*, Directorate of Logistics and Sustainment, Headquarters Air Force Materiel Command, Wright Patterson AFB, OH, 2014.
- [7] Capt. Bradley A. Beabout USAF, *Statistical Process Control: An Application in Aircraft Maintenance Management*, Air Force Institute of Technology, 2003.
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