



# Reducing Lifecycle Cost Through Aircraft Modernization

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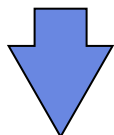
# Background



- The Navy procured 22 F-5 Jets from Switzerland to complement the training fleet
- The jets will require scheduled maintenance and an upgrade to make them airworthy and compatible with the training program
- The purpose of the estimate is to proceed to a Milestone C decision as an ACAT IV program
- After initial fielding, the jets will have a 20 year lifespan



# ARTEMIS Overview



## Safety Improvements

- Synthetic HUD w/NVG Compatibility
- Fully Digitized Aircraft/Engine Instruments
- Moving Map/TAWS I
- Precision Approach Capability
- Cabin Pressure Warning System
- Fuel State Notification
- Turn/Slip Indication
- Modern NVG Compatible Digital Cockpit
- ADS-B In
- VHF Radios + CPDLC

## Threat Representation Additions

- Advanced MSA Radar
- Radar Warning Receiver
- Helmet Mounted Cueing System
- High Off-Boresight Capability
- Integrated RedNET
- Link-16
- RedWEZ Overlay
- Jammer Range Overlay
- Future Growth Capacity (IRST, CATM-9X)



# Scope



- Estimate includes the following CES elements
  - Non-Recurring Engineering
  - Recurring production and installation
    - Block Upgrade
    - Aircraft Conversion
    - Engine Performance and Monitoring System (EPAMS)
    - MK16
    - Radar
  - Maintenance
    - Programmed Depot Maintenance (PDM)
    - Engine Overhaul
- Estimate includes risk and sensitivity analysis



# Program Schedule



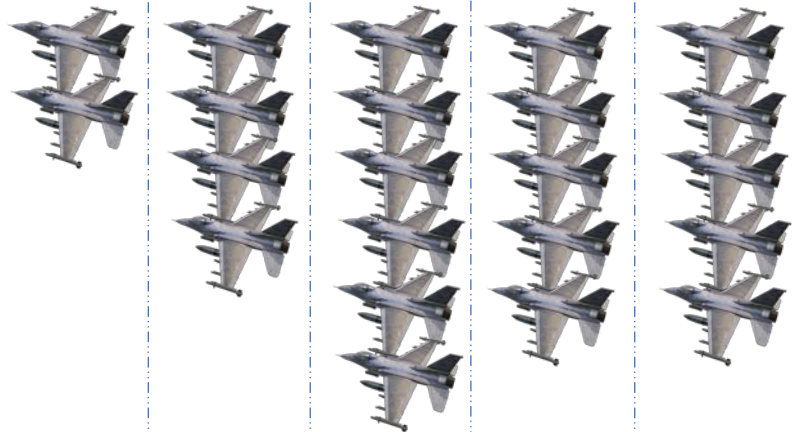
R&D Block Upgrade (BUP) &  
AC Procurement (Phase 1)



Material  
Procurement



Aircraft Induction



FY19

FY20

FY21

FY22

FY23

FY24

FY25

# Ground Rules and Assumptions



- **Technical Baseline**

- Technical inputs including parts, quantities, and labor hours provided by the lead engineer
- Unit prices for material rely primarily on DLA and historic contract pricing
- Unit pricing excludes material overhead and general and administrative cost (G&A)
- Labor hours included in the technical baseline are touch labor only
- The total cost per airframe/engine and hours per airframe/engine have been scaled downward based on an engineering assessment conducted by PMA-226

- **Rates**

- Non-Prime Mission Product (nPMP) rate of approximately 13% from AIR 4.2 database
  - Over 330 production programs included in the database
  - Applicable to block upgrade, conversion, EPAMS, MK16, and radars
  - Not applicable to maintenance events (engine, PDM)
- Material Overhead and CoM/FCCM are consistent with the E-6B and E-2D upgrade programs. Rates are approximately 8% and 0.5% respectively
- G&A rate is approximately 15% based on industry data

# Ground Rules and Assumptions Cont'd



- Fee is established at 13.5% per PMA-226 guidance
  - Material procurements are determined to be CFE, therefore Fee is applicable
- Radars will be installed at the ramp based on available units and aircraft ready to receive them
  - No radar installation inputs collected, and no unique radar installation cost is identified
- Non-Recurring Engineering (NRE) is minimal and assessed to be similar in effort to the E-2D upgrade program
  - NRE to RE ratio is approximately 7.5%
  - Note: NRE is a small placeholder for delta efforts. Majority of NRE was conducted prior to development of this estimate
- Learning curve is not assessed due to the nature of the contracting strategy
  - Firm Fixed Price per unit will require the contractor to bid a single rate applicable to all aircraft
  - Contractor will be risk averse when bidding
- Risk is assessed based on available data, joint agency schedule and cost risk and uncertainty handbook (JASCRUH), and SME inputs as appropriate



# Cost Methodology



Cost Element	Methodology	Data Source	Comments
NRE	Analogy	E-2D	Calculated as a ratio of NRE to RE
Prime Mission Product			
Procurement	Engineering Build Up	PMA-226 Tech Baseline	
Installation	Engineering Build Up	PMA-226 Tech Baseline	
Non Prime Mission Product aka SEPM	Parametric	AIR 4.2 SEPM Database	Calculated as a ratio of SEPM to PMP; does not apply to maintenance efforts (PDM or Engine)
General and Administrative	Historic Actuals	Contractor Data	
Cost of Money	Analogy	E-2D / E-6B Actuals	
Fee	N/A	AIR 2.0 Guidance	Fee applied to all cost elements including materials based on understanding that materials are CFE

- All data received from the program office treated as “Most Likely” values



# Prime Mission Product Details Material



- 949 line item parts and subsystems identified for the airframe and cockpit
  - 43% Pricing from DLA/Haystacks
  - 54% Pricing from contracts or vendor direct quotes
  - 3% Prices from SMEs
  - Percentages relative to the most likely unit cost for a complete aircraft
- 475 line items parts identified for engine maintenance and conversion
  - Engine maintenance based on 1800 hour overhaul requirements for J85-GE-21B
  - 100% Pricing from DLA/Haystacks
- Maintenance quantities based on engineering analysis of previous maintenance events for the existing F-5 fleet
- All other quantities are knowns
- Assume no material overhead included in unit price



# Prime Mission Product Labor



- Maintenance labor hours based on engineering assessment of previous maintenance events for the existing F-5 fleet
- Block upgrade labor hours based on historic actuals from test units
- Conversion labor hours based on engineering assessment
- All labor rates based historic actuals from the intended performer and are appropriately burdened

# Non-Prime Mission Product



- Non-Prime Mission Product cost element is a collective of:
  - Systems Engineering
  - Program Management
  - Integrated Logistics
  - Initial Spares
  - Configuration Management
  - Common and Peculiar Support Equipment
  - Production Testing
- Analysis of two previous mid-life upgrades was conducted from archived 1921 reports – E-6B and E-2D
  - E-6B rates were found to be too high for a production and maintenance program
  - Further investigation revealed a variety technical challenges and schedules slippages by the prime contractor, resulting in E-6B being removed from the analysis

# Non-Prime Mission Product (Cont'd)



- Additional data was analyzed via the AIR 4.2 SEPM database
  - Over 300 observations were analyzed resulting in a final SEPM rate of 13%
  - Not applicable to maintenance items
- Initials Spares and Support Equipment are included in the FMS procurement
- E-2D non-PMP cost reporting had non-zero cost for SEPM only at a rate lower than 13%, therefore the analysis of SEPM costs were determined sufficient to cover non-PMP for ARTEMIS



# Risk and Sensitivity



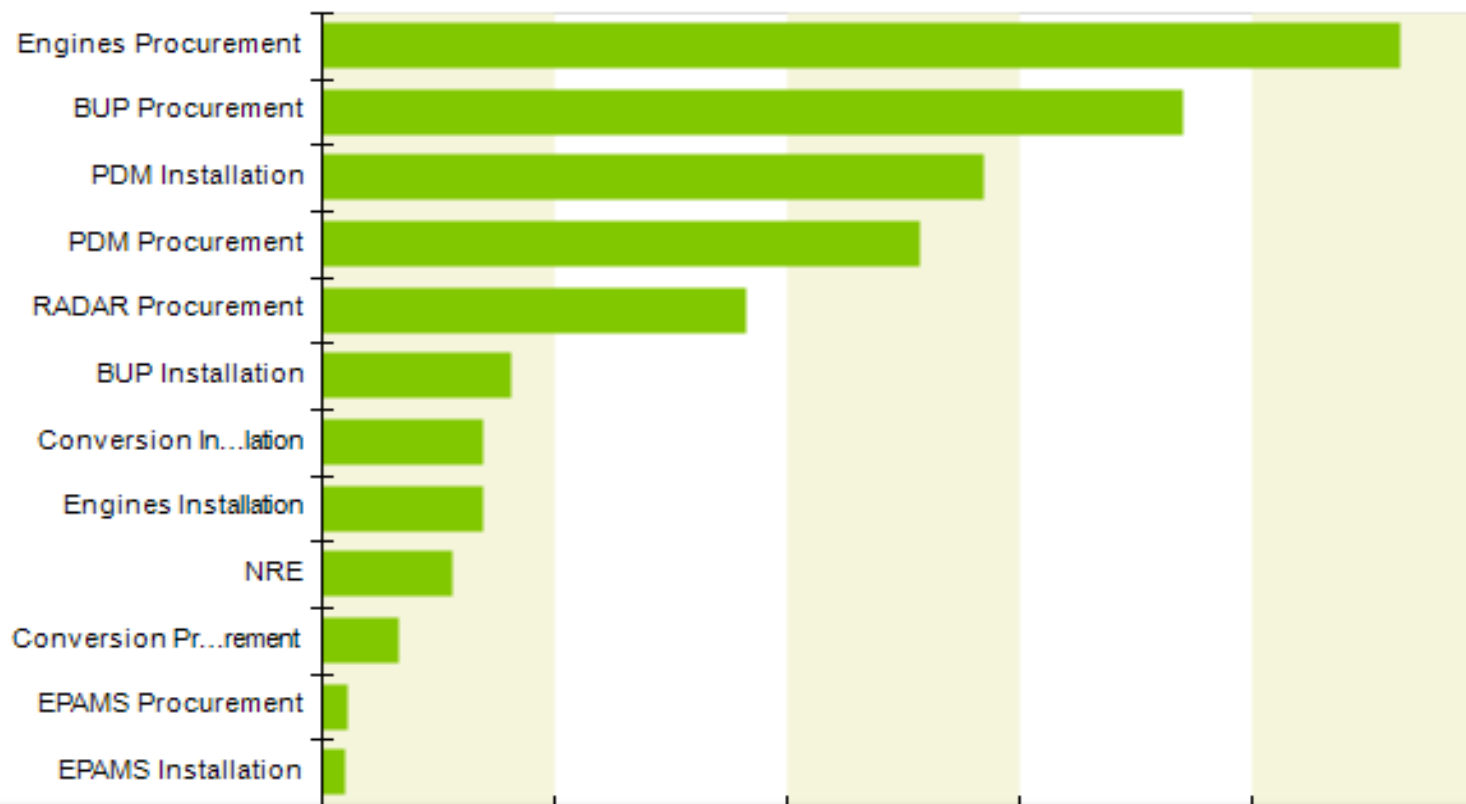
- Engineering assessments focused on most likely quantities required or most likely labor hours required
- The program was determined to be low risk
- For PDM, best, most likely, and worst case scenarios were developed
  - Best case – only mandated parts are replaced
  - Worst case – nearly all inspected parts are found unserviceable and require replacement
- For remaining work packages, the risk and sensitivity tables from the JASCRUH were followed for recommended variance



# Pareto Chart w/Risk

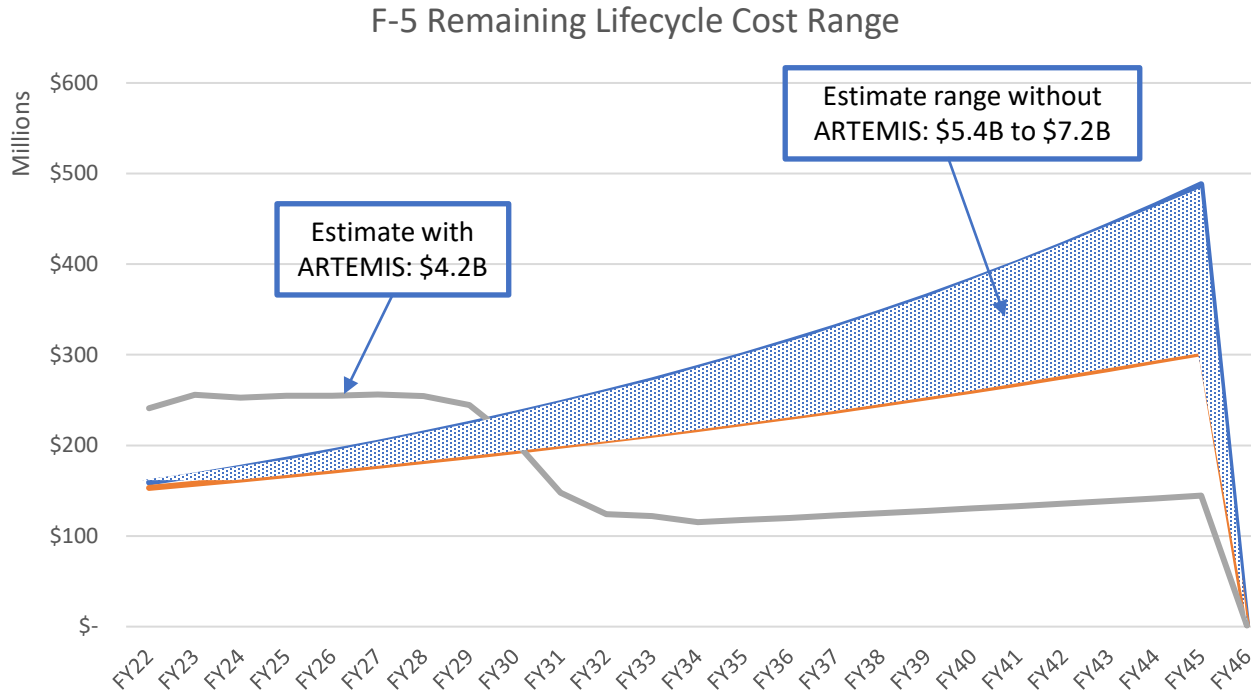


Most Likely  
CAIV Model





# F-5 Lifecycle Cost



**Cost avoidance achieved through ARTEMIS is estimated to be \$1.2B to \$3B**



# Challenges



- What are the best tools and processes for data management?
  - Estimate includes over 1,500 line items for parts
- Unable to develop learning curve
  - Is a learning curve even appropriate?
- What is the cost to sustain an aging fleet?
- ARTEMIS risk analysis resulted in CV of 13.5%. Is this too low?





# Questions?