Reducing Lifecycle Cost Through Aircraft Modernization

Presented by:
Jeremy Goucher, MCR, LLC
Senior Cost Analyst, Naval Air Systems Command, Cost and Schedule Analysis Department

May 17, 2021

Distribution Statement A: Approved for Public Release. Distribution Unlimited
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

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

- 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
• 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
• 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%, therefor 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

- Engines Procurement
- BUP Procurement
- PDM Installation
- PDM Procurement
- RADAR Procurement
- BUP Installation
- Conversion In...lation
- Engines Installation
- NRE
- Conversion Pr...rement
- EPAMS Procurement
- EPAMS Installation
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?