Successful First AESA Deployment through Application of Systems Engineering

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Outline

- Background
- Approach
- Systems Engineering Activities
- Results of Analyses
- Readiness Assessment
- What Happened
- Lessons Learned
Background

- Raytheon developed a new AESA radar for the F/A-18E/F aircraft under contract to Boeing for the US Navy.

- After completion of OPEVAL and training, US Navy planned to deploy two full squadrons of 12 jets each with new AESA radars for a six month deployment in support of OIF/OEF.
  - One squadron on the USS Reagan deployed from San Diego, CA and one on the USS Roosevelt deployed from Norfolk, VA.

- US Navy/Boeing/Raytheon Team dedicated to deployment success!
Used a Systems Engineering Approach to Address All Aspects of First Deployments

- Created a joint team of Navy, Boeing and Raytheon representing the various disciplines required for a successful deployment
  - Squadron Commanders, pilots, maintainers, engineers, software engineers, field support technicians, repair management, etc

- Determined Success Criteria
  - Stability of hardware
  - Tactical performance
  - Inputs from Commanders
  - Inputs from Navy Maintainers
  - Inputs from USN PMO/DAPML

- Visited each of the 2 squadrons on each coast to conduct pre-deployment readiness review/coordination sessions

- Assessed all Logistics Elements

- Developed Action Plan
  - Developed a readiness checklist
  - Spares, repairs, retrofits, IETMs, etc

- Worked Plan

- Supported Deployment

- Prepared Lesson Learned
Using Systems Engineering Techniques Was Able to Assess the Hardware/Software Readiness of the New Radar

- Hardware Readiness
  - Evaluate maturity of hardware to be deployed
  - Determined the minimal configuration of each radar LRU (WRA).
  - Identified hardware that needed to incorporate retrofits for radars to be deployed

- Evaluate Performance of Tactical Software
  - Analyzed OPEVAL and training data of various mission profiles
  - Analyzed data on various tactical software releases
  - Analyzed current problems/anomalies reported from fleet and pilots
  - Developed procedure to work-around critical anomalies

- Evaluate performance of BIT software
  - Ability to accurately Fault Detect
  - Ability to accurately Fault Isolate
  - False Alarm rate
Systems Engineering Assessment of All Logistics Elements

- Maintenance Concept
- Supply Support
- Repairs
- Depot Status
- Tech Reps
- IETMS
- PHST
- Maintenance Training
- Reliability
- Support Equipment
- Tools
## Results of Analyses

<table>
<thead>
<tr>
<th>H/W List of Items</th>
<th>Comment</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Antenna Filter</td>
<td>Special tools and training will be needed. Difficult to do on airplane</td>
<td>High</td>
</tr>
<tr>
<td>2 Reload Spares with H4 OFP</td>
<td>GPP, ARI, PPM, SNBC, and MFA/BSC need to be loaded with H4, 8P</td>
<td>Med</td>
</tr>
<tr>
<td>3 Check busbar torques</td>
<td>Should check for torque value</td>
<td></td>
</tr>
<tr>
<td>4 Spare IRR Attach bolts</td>
<td>Top and bottom bolts (different bolts) have been know to strip and bind</td>
<td></td>
</tr>
<tr>
<td>5 MFA Attach bolts</td>
<td>- check torque value</td>
<td>Low</td>
</tr>
<tr>
<td>6 FC Cables</td>
<td>extra set of FC cables for IQ and AL between CISP and REX</td>
<td></td>
</tr>
<tr>
<td>7 Spare RF Green Y Cable</td>
<td>RF cable between Antenna and REX</td>
<td></td>
</tr>
<tr>
<td>8 MFA Busbar Screws</td>
<td>see parts list</td>
<td></td>
</tr>
<tr>
<td>9 PCU Repair kit</td>
<td>upper bolt repair kit</td>
<td></td>
</tr>
<tr>
<td>10 Spare IRR's</td>
<td>When the MSS bolts fail, there are ways to fix. 1- swap IRR 2- complete teardown of the IRR (risk of break if maintained improperly)</td>
<td></td>
</tr>
<tr>
<td>11 Cover Hinge Loctite</td>
<td>CISP, REX, RPS</td>
<td></td>
</tr>
<tr>
<td>12 WRA Shipping containers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 BIT Tool</td>
<td>Laptop which contains the BIT Tool to help troubleshoot</td>
<td></td>
</tr>
<tr>
<td>14 Check CAL information</td>
<td>Run the BIT CST and TR Element tests on the airplanes to trend performance</td>
<td></td>
</tr>
<tr>
<td>15 Subrack Spare Parts</td>
<td>Special tools and parts will be needed~1/4 Turn Cover Fasteners, Attach bolts, EMI gasket, QD's (module and subrack)</td>
<td></td>
</tr>
<tr>
<td>16 Review A/C &quot;Grey&quot; failures</td>
<td>Some A/C were having issues at power up (FCAL not connecting) and Arrays failing and healing itself. It hasn't officially failed.</td>
<td></td>
</tr>
<tr>
<td>17 Cable assembly for support pan</td>
<td>in case it breaks</td>
<td></td>
</tr>
</tbody>
</table>

### Mitigation:
- Recommend a spare radar
- Provide consumable parts for deployment
AESA Maintenance Concept

Organizational Level

- Ashore
- Afloat

Depot Level

- OEM
- Commercial Warehouse
- Boeing STL Asset Managers
- Repair Agents/Suppliers

Failures WRA

- Base/Ship Supply (Spares)
- Direct ship (as needed)

RFI WRA

- Repair Agents/Suppliers
- Boeing/Raytheon Rep

FIRST SCM Rep

MOB/Embarkation

Boeing/Raytheon Rep

USN Activity
- Industry Activity
- NRFI Asset Flow
- RFI Asset Flow
- Requisition Flow

DAAS

NAVICP

Req

Status

Boeing STL Asset Managers
Developed Plan to Address Items in the Readiness Assessment

- Hardware upgrades
  - Plan for retrofitting Hardware
- Software Upgrades
  - Identified required version of tactical software (OFP)
  - Identified issues with software performance
  - Published new instructions for Pilots to mitigate or eliminate problems
- Generated a minimal Spares List
  - WRAs
  - Consumables
  - Special tools
- Ensured adequate repair contract in place
  - Arranged for surge capacity
- Identified Additional Maintainer Training
- Established a 24 hour help desk
- Established contract for tech reps to go to sea
- Provided list of required Support Equipment
- Communicated plan and status to all stakeholders weekly/daily
24 Hour Help Desk/Repair Communication Flow Process Implemented

Reagan (Nichols)  Roosevelt (Moore)

Raytheon ROR Team

ROR Team Prioritize Repairs

Coordinate with AESA Prod/Ops Team

Minimized RTAT (Repair Turn Around Time) during deployment and set priorities for key spares needs

Repair Priorities

Production Priorities

AMR & CET RPT

CET RPT

Status of Spares

Fleet Concerns
Results of VFA-22 Squadron Deployment

- Deployed on cruise with 12 F/A-18F aircraft
- 6 month deployment (May to November)
  - 1,713 sorties flown
  - 3,773 hours flown
  - 19 Radar Parts (WRAs) ordered
  - 137 Maintenance Discrepancies written against the radar

Radar Reliability Exceeded Predictions and Maintainers Complained of Nothing to DO
Results of VFA-213 Squadron Deployment

- Deployed on cruise with 12 F/A-18F aircraft
- Over 7.5 month deployment (September to April)
  - 2,120 Sorties flown
  - 6,536 Hours flown
  - 24 Radar Parts (WRAs) ordered
  - 245 Maintenance actions written against the radar
Lessons Learned - The Good

- Communications throughout the planning & deployment crucial
- Getting all the stakeholders involved early led to better planning and execution
- The work-around procedures eliminated the previously experienced pilot problems
- Had the right set of Support Equipment to perform majority of required maintenance actions
- Had sufficient spares on board
- Broken Non-Classified Hardware was quickly removed and sent back to Raytheon for repair
- Additional tools and consumables were useful
- Great support from 24 hour help desk
- Prior to deployment, the verification of spares, consumables and support equipment paid huge dividends while deployed!
  - Inventory discrepancies
  - Incorrect NIIN’s
  - Wrong location
  - Missing quantities

Did it but could have been easier
Lessons Learned – The Not so Good

- Was very difficult and time consuming to perform pre-deployment verification of spares, consumables and support equipment.
- Lacked ability to remove Integrated Radar Rack without improvising a stand and using extra bodies.
- Process to get broken classified hardware off the ship and back to depot was inconsistent and slow.
- Didn’t identify all the consumables that were needed.
  – Missing one cable
VFA-22 & VFA-213 and AESA

- First AESA squadrons to:
  - Complete the workup cycle
  - Fly Combat Missions
  - Drop ordnance in Combat
  - Fire the gun in Combat
  - Complete a successful CVN deployment
  - Numerous AESA articles written
    - Defense daily
    - Stars and Stripes
    - Sea Power Magazine
Question and Answer