Military Qualification Process
Outline

- MIL Acquisition Process
- EMC Process
- Environmental Stress & Reliability
- Information sources
Range of Military Equipment
Range of Considerations

- Functional and Operational Requirements
- Information Technology
- Logistics
- NBC
- Environmental Stresses & RAM
- EMC & Spectrum Management
Complex Electromagnetic Environment

- New technology
  - Global Information Grid (GIG)
  - Future Combat System (FCS)
  - Counter IED
  - High Power Microwave (HPM) & Directed Energy Weapons
    - Active Denial System
FOTE = Follow-On Test and Evaluation
OT = Operational Test
IOTE = Initial Operational Test and Evaluation
DT/OT = Development Test/Operational Test
LUT = Limited User Test
FOT = Follow-on Test
IOT = Initial Operational Test

Source: DoD RAM Guide
March 2007

DEFENSE ACQUISITIONS

Assessments of Selected Weapon Programs

<table>
<thead>
<tr>
<th>Program</th>
<th>Latest Quantity</th>
<th>Percentage of Unit Cost Increase</th>
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</thead>
<tbody>
<tr>
<td>Joint Strike Fighter</td>
<td>2,458 aircraft</td>
<td>32.8</td>
</tr>
<tr>
<td>Future Combat Systems</td>
<td>15 systems</td>
<td>54.1</td>
</tr>
<tr>
<td>V-22 Joint Services Advanced Vertical Lift Aircraft</td>
<td>458 aircraft</td>
<td>170.2</td>
</tr>
<tr>
<td>Evolved Expendable Launch Vehicle</td>
<td>138 vehicles</td>
<td>134.7</td>
</tr>
<tr>
<td>Space Based Infrared System High</td>
<td>3 satellites</td>
<td>311.6</td>
</tr>
<tr>
<td>Expeditionary Fighting Vehicle</td>
<td>1,025 vehicles</td>
<td>33.7</td>
</tr>
</tbody>
</table>
Where Does the Process Start?
• Ideas and initial concepts from defense companies, government laboratories, academia, etc.

• Military and Political Leadership
DoD 5000

- Defense Acquisition Framework
  - DOD 5000.1, 5000.2

Army Acquisition Procedures 70-3

Navy SEC NAV INST 5000.2C
DoD 5000 Acquisition Framework

User Needs & Technology Opportunities

A
Concept Refinement

B
Technology Development

C
System Development & Demonstration

TEMP
SOW
CDRL

Design Readiness Review

LRIP/OT&E
FRP Decision Review

Pre-System Acquisition

Solicitations & Contracts

Systems Acquisition

Solicitations & Contracts

Prime Contractor

Subcontractors

IOC
FOC
Operations & Support

MDA= Milestone Decision Authority
PM= Program Manager

TEMP= Test & Evaluation Master Plan
SOW= Statement of Work
CDRL= Contractor Data Requirements List

Prime Contractor

Solicitations & Contracts
E3 & Spectrum Support Commands

Acquisition Support and Test Facilities

- **NAVAIR- Naval Air Systems Command**
  - Naval Air Warfare Center Aircraft Division, Lakehurst New Jersey, Patuxent River Maryland.
  - Naval Air Warfare Center Weapons Division, China Lake & Point Mugu California

- **NAVSEA-Naval Sea Systems Command**
  - Naval Surface Warfare Center, Dahlgren Division (NSWCDD)
  - Naval Undersea Warfare Center Newport (NUWC Newport)

- **SPAWAR Space and Naval Warfare Systems Command**
  - SPAWAR Systems Center San Diego (SSC SD)

- **ATEC- Army Test and Evaluation Command**
  - Redstone Test and Technical Center
  - White Sands Missile Range
  - Aberdeen Proving Grounds
  - Ft. Huachuca Electronic Proving Ground (EPG)

- **TACOM- Tank Automotive Command**

- **JSC- Joint Spectrum Center**
DoD 5000 Guide Book

7.6.3.11. Spectrum Supportability and Electromagnetic Environmental Effects (E3) Control Requirements in the Statement of Work (SOW)

MIL-HDBK-237

6.6.3.3 Statement of Work (SOW)
The SOW sample wording addressing the E3/SS area that might be included in a contract for a system follows:

“The contractor shall design, develop, integrate, and qualify the system such that it meets the E3/SS performance requirements of the system specification. The contractor shall perform analyses, studies, and testing to establish E3/SS controls and features to be implemented in the design of the item. The contractor shall perform inspections, analyses, and tests, as necessary, to verify that the system meets its E3/SS performance requirements.

The contractor shall prepare and update the DD Form 1494 throughout the development of the system for spectrum-dependent equipment and shall perform analysis and testing to characterize the equipment, where necessary. The contractor shall establish and support an E3/SS WIPT to accomplish these tasks. MIL-HDBK-237 may be used for guidance.”
Contract Data Requirements List

Data Item Requirements for Spectrum Supportability and Electromagnetic Environmental Effects (E3) Control Requirements in the Contract Data Requirements List (CDRL)

The following are examples of data item requirements typically called out for spectrum supportability and E3 control requirements in the CDRL:

- DI-EMCS-80199B EMI [Electromagnetic Interference] Control Procedures
- DI-EMCS-80201B EMI Test Procedures
- DI-EMCS-80200B EMI Test Report
- DI-EMCS-81540 E3 Integration and Analysis Report
- DI-EMCS-81541 E3 Verification Procedures
- DI-EMCS-81542 E3 Verification Report
- DI-MISC-81174 Frequency Allocation Data
Test and Evaluation Master Plan

- Operational Testing
- Communications and Interoperability Testing
- EMC Testing
- Environmental Stress and RAM Testing
E3 Requirements

- Program Manager Develops the TEMP
- Command support personnel identify contract requirements
- Platform & Ordnance Requirements are set
  - MIL-STD-464
  - ADS-37A-PRF
- Flow down Equipment & Subsystems Requirements
  - MIL-STD-461
MIL-STD-464A

- Radiated Immunity
- Lightning
- EMP
TABLE 1B. External EME for shipboard operations in the main beam of transmitters

<table>
<thead>
<tr>
<th>Frequency Range (MHz)</th>
<th>Electric Field (V/m - rms)</th>
<th>Peak</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 - 2</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2 - 30</td>
<td></td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>30 - 150</td>
<td></td>
<td>20</td>
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<td>150 - 225</td>
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<td>10</td>
<td>10</td>
</tr>
<tr>
<td>225 - 400</td>
<td></td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>400 - 700</td>
<td></td>
<td>1940</td>
<td>260</td>
</tr>
<tr>
<td>700 - 790</td>
<td></td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>790 - 1000</td>
<td></td>
<td>2160</td>
<td>410</td>
</tr>
<tr>
<td>1000 - 2000</td>
<td></td>
<td>2600</td>
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</tr>
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<td>2000 - 2700</td>
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<td>6</td>
</tr>
<tr>
<td>2700 - 3600</td>
<td></td>
<td>27460</td>
<td>2620</td>
</tr>
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<td>3600 - 4000</td>
<td></td>
<td>9710</td>
<td>310</td>
</tr>
<tr>
<td>4000 - 5400</td>
<td></td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>5400 - 5900</td>
<td></td>
<td>3500</td>
<td>160</td>
</tr>
<tr>
<td>5900 - 6000</td>
<td></td>
<td>310</td>
<td>310</td>
</tr>
<tr>
<td>6000 - 7900</td>
<td></td>
<td>390</td>
<td>390</td>
</tr>
<tr>
<td>7900 - 8000</td>
<td></td>
<td>860</td>
<td>860</td>
</tr>
<tr>
<td>8000 - 8400</td>
<td></td>
<td>860</td>
<td>860</td>
</tr>
<tr>
<td>8400 - 8500</td>
<td></td>
<td>390</td>
<td>390</td>
</tr>
<tr>
<td>8500 - 11000</td>
<td></td>
<td>13380</td>
<td>1760</td>
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<td>11000 - 14000</td>
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<td>2800</td>
<td>390</td>
</tr>
<tr>
<td>14000 - 18000</td>
<td></td>
<td>2800</td>
<td>310</td>
</tr>
<tr>
<td>18000 - 40000</td>
<td></td>
<td>7060</td>
<td>140</td>
</tr>
<tr>
<td>40000 - 45000</td>
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<td>570</td>
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</table>
TABLE 1E. External EME for Army rotary wing aircraft

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<th>Frequency Range (MHz)</th>
<th>Electric Field (V/m - rms)</th>
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</thead>
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<tr>
<td></td>
<td>Peak</td>
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<tr>
<td>0.01 - 150</td>
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<tr>
<td>249 - 500</td>
<td>2830</td>
</tr>
<tr>
<td>500 - 700</td>
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<tr>
<td>700 - 790</td>
<td>1550</td>
</tr>
<tr>
<td>790 - 1000</td>
<td>3480</td>
</tr>
<tr>
<td>1000 - 2000</td>
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<td>4000 - 6000</td>
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<td>11000 - 14000</td>
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<td>2800</td>
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<tr>
<td>18000 - 40000</td>
<td>7060</td>
</tr>
<tr>
<td>40000 - 45000</td>
<td>570</td>
</tr>
</tbody>
</table>
Whole Platform Testing

Army - White Sands Missile Range
Army - Aberdeen Proving Grounds
Navy - Patuxent River
Air Force - Eglin Air Force Base
TABLE 1D. External EME for ground systems

<table>
<thead>
<tr>
<th>Frequency Range (MHz)</th>
<th>Electric Field (V/m - rms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peak</td>
</tr>
<tr>
<td>0.01 - 2</td>
<td>25</td>
</tr>
<tr>
<td>2 - 250</td>
<td>50</td>
</tr>
<tr>
<td>250 - 1000</td>
<td>1500</td>
</tr>
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<tr>
<td>10000 - 40000</td>
<td>1500</td>
</tr>
<tr>
<td>40000 - 45000</td>
<td>-</td>
</tr>
</tbody>
</table>
FIGURE A2. Unclassified free-field EMP environment (IEC 61000-2-9)
5.6 Subsystems and equipment electromagnetic interference (EMI). Individual subsystems and equipment shall meet interference control requirements (such as the conducted emissions, radiated emissions, conducted susceptibility, and radiated susceptibility requirements of MILSTD-461) so that the overall system complies with all applicable requirements of this standard.

Compliance shall be verified by tests that are consistent with the individual requirement (such as testing in accordance with MIL-STD-461).
MIL-STD-461E

- CE - Conducted Emissions
- CS - Conducted Susceptibility
- RE - Radiated Emissions
- RS - Radiated Susceptibility
# Equipment and Subsystems Requirements from MIL-STD-461E

## Sec 5. TABLE V. Requirement matrix.

<table>
<thead>
<tr>
<th>Equipment and Subsystems Installed In, On, or Launched From the Following Platforms or Installations</th>
<th>CE</th>
<th>CS</th>
<th>RE</th>
<th>BS</th>
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</thead>
<tbody>
<tr>
<td>Surface Ships</td>
<td>CE101</td>
<td>CE102</td>
<td>CE106</td>
<td>CS101</td>
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<tr>
<td>Submarines</td>
<td>A</td>
<td>A</td>
<td>L</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Army, Including Flight Line</td>
<td>A</td>
<td>A</td>
<td>L</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Navy</td>
<td>L</td>
<td>A</td>
<td>L</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Air Force</td>
<td>A</td>
<td>L</td>
<td>A</td>
<td>S</td>
</tr>
<tr>
<td>Space Systems, including Launch Vehicles</td>
<td>A</td>
<td>L</td>
<td>A</td>
<td>S</td>
</tr>
<tr>
<td>Ground, Army</td>
<td>A</td>
<td>L</td>
<td>A</td>
<td>S</td>
</tr>
<tr>
<td>Ground, Navy</td>
<td>A</td>
<td>L</td>
<td>A</td>
<td>S</td>
</tr>
<tr>
<td>Ground, Airforce</td>
<td>A</td>
<td>L</td>
<td>A</td>
<td>S</td>
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</table>
# Equipment and Subsystems Requirements from MIL-STD-461E

<table>
<thead>
<tr>
<th>Equipment and Subsystems Installed In, On, or Launched From the Following Platforms or Installations</th>
<th>CE101</th>
<th>CE102</th>
<th>CS101</th>
<th>CS103</th>
<th>CS104</th>
<th>CS105</th>
<th>CS109</th>
<th>CS114</th>
<th>CS116</th>
<th>RE101</th>
<th>RE102</th>
<th>RE103</th>
<th>RS101</th>
<th>RS103</th>
<th>RS105</th>
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</thead>
<tbody>
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<td>L</td>
<td>A</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>A</td>
<td>L</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>L</td>
<td>A</td>
<td>A</td>
<td>L</td>
</tr>
<tr>
<td>Submarines</td>
<td>A</td>
<td>A</td>
<td>L</td>
<td>A</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>L</td>
<td>A</td>
<td>L</td>
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<td>L</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Army, Including Flight Line</td>
<td>A</td>
<td>A</td>
<td>L</td>
<td>A</td>
<td>S</td>
<td>S</td>
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<td>S</td>
<td>S</td>
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<td>L</td>
<td>A</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space Systems, including Launch Vehicles</td>
<td>A</td>
<td>L</td>
<td>A</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>A</td>
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<td>L</td>
<td>L</td>
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<td></td>
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<tr>
<td>Ground, Navy</td>
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<td>L</td>
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<td>S</td>
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<td>A</td>
<td>L</td>
<td>A</td>
<td>A</td>
<td>L</td>
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</tr>
<tr>
<td>Ground, Airforce</td>
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<td>L</td>
<td>A</td>
<td>S</td>
<td>S</td>
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<td></td>
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</tbody>
</table>

A= Applicable     L= Limited  S= Specified

## Sec 5. TABLE V. Requirement matrix.
Conducted RF Emissions

<table>
<thead>
<tr>
<th>Equipment and Subsystems Installed In, On, or Launched From the Following Platforms or Installations</th>
<th>CE101</th>
<th>CE102</th>
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<tbody>
<tr>
<td>Surface Ships</td>
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</tr>
<tr>
<td>Submarines</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Army, Including Flight Line</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Navy</td>
<td>L</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Air Force</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Space Systems, including Launch Vehicles</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Ground, Army</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Ground, Navy</td>
<td>A</td>
<td></td>
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<tr>
<td>Ground, Airforce</td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOMINAL ZUT SOURCE VOLTAGE (AC&amp;DC)</th>
<th>LIMIT RELAXATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>25V</td>
<td>6dB</td>
</tr>
<tr>
<td>115V</td>
<td>6dB</td>
</tr>
<tr>
<td>220V</td>
<td>10dB</td>
</tr>
<tr>
<td>440V</td>
<td>12dB</td>
</tr>
</tbody>
</table>

Limit Level (dBuV)
## Conducted Transient Susceptibility

<table>
<thead>
<tr>
<th>Equipment and Subsystems Installed In, On, or Launched From the Following Platforms or Installations</th>
<th>CS101</th>
<th>CS114</th>
<th>CS115</th>
<th>CS116</th>
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</tr>
<tr>
<td>Submarines</td>
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<td>L</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Army, Including Flight Line</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Navy</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Air Force</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Space Systems, including Launch Vehicles</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Ground, Army</td>
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<td>A</td>
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<tr>
<td>Ground, Navy</td>
<td>A</td>
<td>A</td>
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</tr>
<tr>
<td>Ground, Airforce</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
</tbody>
</table>

![Graph showing current and time relationship](image-url)

![Image of equipment and subsystems](image-url)
Conducted RF Susceptibility

### Equipment and Subsystems Installed In, On, or Launching From the Following Platforms or Installations

<table>
<thead>
<tr>
<th>Platform</th>
<th>Frequency Range</th>
<th>Equipment</th>
<th>Safety Critical</th>
<th>Aircraft Internal</th>
<th>Aircraft (External or Above Decks)</th>
<th>Submarines (Internal)</th>
<th>Submarines (Below Decks)</th>
<th>Ships (Non-Metallic Below Decks)</th>
<th>Ships (Metallic Below Decks)</th>
<th>Key</th>
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<tr>
<td></td>
<td>10 kHz</td>
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<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
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</tr>
<tr>
<td></td>
<td>2 MHz</td>
<td>N</td>
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<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>AF</td>
<td>5</td>
<td>3</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td></td>
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<td>5</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AF</td>
<td>5</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td></td>
<td>30 MHz</td>
<td>A</td>
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<td>5</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
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</tr>
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<td></td>
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<td>5</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AF</td>
<td>5</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
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</tr>
<tr>
<td></td>
<td>100 MHz</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

**Key:**
- A = Army
- N = Navy
- AF = Air Force

*For equipment located external to the pressure hull ships (metallic/below decks).

The appropriate limit curve shall be determined from Table VI.
Radiated Emissions

<table>
<thead>
<tr>
<th>Equipment and Subsystems Installed In, On, or Launched From the Following Platforms or Installations</th>
<th>RE01</th>
<th>RE02</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Ships</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Submarines</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Army, Including Flight Line</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Navy</td>
<td>L</td>
<td>A</td>
</tr>
<tr>
<td>Aircraft, Air Force</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Space Systems, including Launch Vehicles</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Ground, Army</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Ground, Navy</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Ground, Airforce</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>
Radiated Susceptibility

<table>
<thead>
<tr>
<th>Platform or Installation</th>
<th>Aircraft (External or Safety Critical)</th>
<th>Aircraft Internal</th>
<th>All Ships (Above Decks) and Submarines (External)</th>
<th>Ships (Metallic) (Below Decks)</th>
<th>Ships (Non-Metallic) (Below Decks)</th>
<th>Submarines (Internal)</th>
<th>Ground</th>
<th>Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 MHz - 30 MHz</td>
<td>N</td>
<td>-</td>
<td>200</td>
<td>10</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>AF</td>
<td>200</td>
<td>200</td>
<td>10</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>30 MHz - 1 GHz</td>
<td>L</td>
<td>200</td>
<td>200</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>1 GHz - 18 GHz</td>
<td>N</td>
<td>200</td>
<td>200</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>18 GHz - 40 GHz</td>
<td>AF</td>
<td>200</td>
<td>200</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>40 GHz - 100 GHz</td>
<td>N</td>
<td>200</td>
<td>200</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Space Systems, including Launch Vehicles</td>
<td>A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ground, Army</td>
<td>L</td>
<td>A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ground, Navy</td>
<td>A</td>
<td>A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ground, Air Force</td>
<td>A</td>
<td>A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Shipboard DC

MIL-STD-1399
DC Magnetic Field Environment.
Shipboard AC Power Quality & Surges
Lightning Requirements & Testing

- Primarily Follow RTCA DO-160E
  - Direct Effects
  - Secondary Effects
Power Systems Requirements

MIL-STD-704

MIL-STD-1399

DEPARTMENT OF DEFENSE
INTERFACE STANDARD

AIRCRAFT ELECTRIC POWER
CHARACTERISTICS

MIL-STD-704

MIL-STD-1399

NOT MEASUREMENT SENSITIVE

MIL-STD-704F
11 MARCH 1994
SUPERSEDING
MIL-STD-704E
1 MAY 1991

MIL-STD-704

INTERFACE STANDARD FOR SHIPBOARD SYSTEMS

MIL-STD-1399

DISTRIBUTION STATEMENT A
Approved for public release; distribution unlimited
Vehicle Power Requirements

MIL-STD-1275

28VDC Electrical Systems

- Surges
- Spikes
- Ripple
- Transient Emissions
Automotive Requirements

12VDC Electrical Systems

• 12VDC Vehicle Conducted Transient Test
  • SAE J1113, ISO 7637
  • Load Dump
  • Inductive Switching
• 12VDC Electrical Systems Tests
  • Alternator Ripple
  • Voltage variations
  • Dips, Drops, Reverse Polarity
• Electrostatic Discharge
## Non-Military Tailoring Process

### Table 2: EMC Test Selection Matrix

<table>
<thead>
<tr>
<th>Test</th>
<th>Paragraph Numbers</th>
<th>Others</th>
<th>Electronic Components</th>
<th>Motors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions 3.3</td>
<td>ALSE 3.3.1, 3.3.2</td>
<td></td>
<td>X X X X X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CE, Artificial Network</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immunity 3.4</td>
<td>Bulk Current Injection 3.4.1</td>
<td></td>
<td>X X X X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anecho Chamber 3.4.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reverb, Mode Tuning 3.4.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Magnetic Field 3.4.4</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Transients 3.5</td>
<td>Conducted Emissions 3.5.1</td>
<td></td>
<td>X X X X X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CI, Power Lines only 3.5.2</td>
<td></td>
<td>X X X X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cl, Coupling to I/O Other than Power Supply Lines 3.5.3</td>
<td></td>
<td>X X X X X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cl, Direct Capacitive Coupling to Sensor Lines 3.5.4</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Optional) Cl, 85V Direct Capacitor Coupling 3.5.5</td>
<td></td>
<td>X X X</td>
<td></td>
</tr>
<tr>
<td>ESD 3.6</td>
<td>Powered-On Mode 3.6.1</td>
<td></td>
<td>X X X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remote I/O 3.6.2</td>
<td></td>
<td>X X X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Handling of Devices 3.6.3</td>
<td></td>
<td>X X X X X</td>
<td></td>
</tr>
</tbody>
</table>

Note: Applies only to motors with integral Hall Effect sensors.

GMW 3097  July 2006
Figure 2: Requirement Levels for the Immunity to Electromagnetic Fields for Components and Subsystems Measured Using the CBCI and DBCI Method
**GMW 3097 RI**

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Level 1 (V/m)</th>
<th>Level 2 (V/m)</th>
<th>Modulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 to 800</td>
<td>50</td>
<td>100</td>
<td>CW, AM 80%</td>
</tr>
<tr>
<td>800 to 1000</td>
<td>50</td>
<td>100</td>
<td>CW, AM 80%</td>
</tr>
<tr>
<td>1000 to 2000</td>
<td>50</td>
<td>70</td>
<td>PM PRR=217 Hz, PD=0.57 ms^Note 2</td>
</tr>
<tr>
<td>1200 to 1400</td>
<td>600</td>
<td>Radar pulse packets PRR=300 Hz, PD=3 μs (+3/-0 us), with only 50 pulses output every 1 s</td>
<td>^Note 2</td>
</tr>
</tbody>
</table>

^Note 1: Only Momentary, resettable deviations are allowed up to and including Level 2
^Note 2: Pulsed field strength requirements are peak V/m (maximum RMS) levels

---

**MIL-STD 461 RS 103**

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Aircraft (External or Safety Critical)</th>
<th>Aircraft Internal</th>
<th>All Ships (Above Decks) and Submarines (External)</th>
<th>Ships (Metallic) Below Decks</th>
<th>Ships (Non-Metallic) Below Decks</th>
<th>Submarines (Internal)</th>
<th>Ground</th>
<th>Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 MHz - 30 MHz</td>
<td>A</td>
<td>200</td>
<td>200</td>
<td>10</td>
<td>50</td>
<td>5</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>200</td>
<td>200</td>
<td>10</td>
<td>50</td>
<td>5</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>AF</td>
<td>200</td>
<td>20</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>30 MHz - 1 GHz</td>
<td>A</td>
<td>200</td>
<td>200</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>200</td>
<td>200</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>AF</td>
<td>200</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>1 GHz - 18 GHz</td>
<td>A</td>
<td>200</td>
<td>200</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>200</td>
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<td>10</td>
<td>10</td>
<td>10</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>AF</td>
<td>200</td>
<td>60</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>18 GHz - 40 GHz</td>
<td>A</td>
<td>200</td>
<td>200</td>
<td>10</td>
<td>10</td>
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<td>50</td>
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<td>200</td>
<td>60</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>AF</td>
<td>200</td>
<td>60</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>
Environmental Conditions and Reliability

User Needs & Technology Opportunities

Pre-System Acquisition
- Concept Refinement
  - Concept Decision

Technology Development
- Design Readiness Review

System Development & Demonstration
- LRIP/OT&E
- LRIP Decision Review

Production & Deployment
- FRP Decision Review

Operations & Support

Environmental Test and Evaluation Master Plan (ETEMP)
- Life Cycle Environmental Profile (LCEP)
- Operational Environment Documentation (OCD)
- Environmental Issues Criteria List (ECIL)

Contract Requirements
- Statement of Work
### Induced Environmental Stresses

<table>
<thead>
<tr>
<th>Road Shock (Large Bumps/Potholes)</th>
<th>Rail Shock (Humping)</th>
<th>In-Flight Vibration (Engine/Turbine Induced)</th>
<th>Wave-Induced Vibration (Sinusoidal)</th>
<th>Road Shock (Large Bumps/Hotels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Vibration (Random)</td>
<td>Rail Vibration Handling Shock (Dropping/Overturning)</td>
<td>Landing Shock (Dropping/Overturning)</td>
<td>Wave Sine Shock Mine/Blast Shock Handling Shock (Dropping/Overturning)</td>
<td>Road Vibration (Random)</td>
</tr>
<tr>
<td>Handling Shock (Dropping/Overturing)</td>
<td></td>
<td></td>
<td></td>
<td>Handling Shock (Dropping/Overturing)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Thermal Shock (Air Drop)</td>
</tr>
</tbody>
</table>

### Natural Environmental Stresses

<table>
<thead>
<tr>
<th>High Temperature (Dry/Humid)</th>
<th>High Temperature (Dry/Humid)</th>
<th>High Temperature (Dry/Humid)</th>
<th>High Temperature (Dry/Humid)</th>
<th>High Temperature (Dry/Humid)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Temperature/Freezing</td>
<td>Low Temperature/Freezing Rain/Hail</td>
<td>Low Temperature/Freezing Rain/Hail</td>
<td>Low Temperature/Fire Fighting Rain/Freezing</td>
<td>Low Temperature/Fire Fighting Rain/Freezing</td>
</tr>
<tr>
<td>Sand/Dust</td>
<td>Sand/Dust</td>
<td>Sand/Dust</td>
<td>Sand/Dust</td>
<td>Sand/Dust</td>
</tr>
</tbody>
</table>

- Reduced Pressure
- Thermal Shock (Air Drop Only)
- Temporary Immersion
- Salt Fog
- Solar Radiation
- Reduced Pressure
- Fungus Growth
- Chemical Attack
- Fungus Growth
- Chemical Attack
### Induced Stresses

<table>
<thead>
<tr>
<th>Handling Shock</th>
<th>Firing/Blast</th>
<th>Shock</th>
<th>Acoustic Noise</th>
<th>Explosive</th>
<th>Atmosphere</th>
<th>EMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road/Off-Road Vibration (Surface Irregularities/Tread Laying)</td>
<td>Engine-Induced Vibration</td>
<td>Acoustic Noise Handling Shock (Induced Bench)</td>
<td>Road/Off-Road Shock (Large Bumps/Holes)</td>
<td>Land Mine/Blast Shock</td>
<td>Weapon Firing Shock/Vibration Explosive Atmosphere EMC</td>
<td>Wave Induced Vibration (Sinusoidal) Engine-Induced Vibration Acoustic Noise Wave-Slam Shock Mine/Blast Shock Weapon Firing Shock Explosive Atmosphere EMC Increase Pressure (Submarine)</td>
</tr>
<tr>
<td>Natural Stresses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>-----------------</td>
<td>-----------------</td>
<td>-----------------</td>
<td>-----------------</td>
<td>-----------------</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Diagram showing various environmental stresses including high temperature, low temperature/freezing, thermal shock, rain, hail, sand/dust/mud, salt fog, solar radiation, fungus growth, and chemical attack.
Environmental Test Program Tailoring Process

**Natural Environments Characteristics**
- Identify the natural environment characteristics for regions in which item is to be deployed.
  - Document Service Use Profile
  - Identify Applicable Environmental Conditions
  - Consider Storage, Transit, and Operational Environments

**Prepare Life Cycle Environmental Profile (LCEP)**

**Item Platform Characteristics**
- Identify Characteristics of Platforms on which item is to be carried or operated.
  - Document real-world platform characteristics
  - Obtain data from databases, models, simulations
  - Obtain remaining data by measuring realistic platform environment

**Prepare Operational Environment Documentation (OED)**

**Platform Environments**
- Define platform Environments based on Natural environments forcing functions transformed by Platform dynamics
- Forcing functions induced by platform itself
  - Base on results from LECP and OCEL
  - List all tailored issues & criteria
  - Provide rationale for their derivation

**Prepare Environmental issues/Criteria List (EICL)**

**Design Requirements**
- Tailor design requirements to platform environment characteristics which will affect item, item effectiveness and integrity

**Prepare Detailed Environmental Test Plan**
- Laboratory test plans: Use MIL-810 methods selected and tailored to the specific test item.
- Field/Fleet test plans: Development/ operational test agencies use their own plan requirements formats. Tailored to the specific test item.
- Alternatives: Explain methodology

**Perform Testing**

**Prepare Environmental Test Reports**
Failure Mechanisms

Overstress Damage - A single excursion exceeds strength

Time Dependent Cumulative Damage – When continued use exceed the endurance limit.
Example: Fatigue, Aging, Corrosion, Wear

500 Low Pressure (Altitude)
502 Low Temperature
504 Contamination by Fluids
506 Rain
511 Explosive Atmosphere
512 Immersion
513 Acceleration
516 Shock
517 Pyroshock
521 Icing/Freezing Rain
522 Ballistic Shock

501 High Temperature
503 Temperature Shock
505 Solar Radiation
507 Humidity
508 Fungus
509 Salt Fog
510 Sand and Dust
514 Vibration
515 Acoustic Noise
518 Acidic Atmosphere
519 Gunfire Vibration
520 Temp Humidity, Vibe, Alt
523 Vibro-Acoustic Temperature
Tailoring Is Essential

MIL-STD-810F

NOTE: Tailoring is essential. Select methods, procedures, and parameter levels based on the tailoring process described in Part One, paragraph 4.2.2, and Appendix C. Apply the general guidelines for laboratory test methods described in Part One, paragraph 5 of this standard.
Vibration

4.1.3.2.3  Test VII — Equipment mounted on sprung masses (vehicle body)

4.1.3.2.3.1  Purpose

The vibration on sprung masses is random vibration induced by rough-road-driving. Failure mode is rupture due to fatigue.

4.1.3.2.3.2  Test

Perform the test according to IEC 80065-2-34. The test duration shall be 32 h for each plane of the DUT.

The r.m.s. acceleration values shall be

— 57.9 m/s² for the standard profile, and
— 33.7 m/s² in the case of DUT natural frequencies < 30 Hz.

See Figure 11 and Tables 12 and 13.

Figure 11 — PSD vs. frequency

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>frequency, Hz</td>
</tr>
<tr>
<td>Y</td>
<td>power spectral density (PSD) of acceleration, (m²/s²)/Hz</td>
</tr>
<tr>
<td></td>
<td>standard random test profile</td>
</tr>
<tr>
<td></td>
<td>additional profile for &lt; 50 Hz</td>
</tr>
</tbody>
</table>
Environmental Tailoring

AECTP 100
ENVIRONMENTAL GUIDELINES FOR DEFENCE MATERIEL

(January 2006)

NOT MEASUREMENT SENSITIVE
MIL-HDBK-310
23 JUNE 1997
SUPERSEEDING
MIL-STD-210
09 JANUARY 1987

DEPARTMENT OF DEFENSE
HANDBOOK

GLOBAL CLIMATIC DATA FOR DEVELOPING MILITARY PRODUCTS

This handbook is for guidance only.
Do not cite this document as a requirement

FSA ENVR

UNCLASSIFIED
Initial Evaluation Functional and Parametric Test.

**Leg 1**
- 3 Parts
  - Method 501.4 Procedure II
    - High Temperature Durability
    - 1000 Hours at Tmax
    - (Approx. 42 Days)
  - Method 516.5 Proc I
    - Functional Mechanical Shock
    - 50G-11ms 60 sawtooth shocks
    - (Approx. 1 Day)
  - Method 520.2 Procedure III
    - Vibration with Thermal Cycling
    - Test Level = 18G; Sine on Random
    - Duration = 96 hours/axis
    - Thermal Cycle = 8 hours
    - Tmin = 40C; Tmax = +105C
    - (Approx. 15 Days)
  - Method 516.5 Proc V
    - Crash Hazard
    - 100G-6ms 12 sawtooth shocks
    - (Approx. 1 Day)
  - Functional and Parametric Test
    - Visual Inspection and Dissection
    - (Approx. 2 Days)

**Leg 2**
- 4 Parts
  - Method 503.4 Procedure I
    - Thermal Shock (Non Powered)
    - 1000 Hours
    - Test: +15C; Tmin = -40C
    - Ext. Dwell = 30 min per extreme
    - (Approx. 42 Days)
  - Method 503.4 Procedure II
    - Powered Temperature Cycle
    - 250 Cycles
    - Test: +105C; Tmin = -40C
    - Dwell: 10 min each extreme
    - Test Cycle = 50 min
    - (Approx. 13 Days)
  - Method 520.2 Procedure III
    - Vibration with Thermal Cycling
    - Test Level = 18G; Sine on Random
    - Duration = 96 hours/axis
    - Thermal Cycle = 1 hour
    - Tmin = -40C; Tmax = +105C
    - (Approx. 2 Days)
  - Functional and Parametric Test
    - Visual Inspection and Dissection
    - (Approx. 2 Days)

**Leg 3**
- 1 Part
  - ASTM B117-03
    - Corrosion Salt Fog
    - 1000 Hours Exposure
    - (Approx. 42 Days)
  - Method 501.4 Procedure I
    - High Temp Heat Soak
    - for 1 Hr at +150C
    - (Approx. 1 Day)
  - Method 504 Altitude Proc I
    - Storage (26,000ft) for 1 Hour
  - Method 504 Fluid Susceptibility
    - (Approx. 5 Days)
  - Functional and Parametric Test
    - Visual Inspection and Dissection
    - (Approx. 2 Days)
C.13.34 Reliability and Maintainability (R&M) Program Requirements.

C.13.34.1 Reliability. The objective Reliability point estimate for the Repower kit is 20,000 Mean Miles Between Hardware Mission Failure (MMBHMF). The objective Engine durability (i.e. component replacement or overhaul) is 200,000 miles. The system shall demonstrate a 0.5 probability at 50% confidence that the powertrain (i.e. engine, transmission, t-case, and differentials) will operate without a durability (i.e. component replacement or overhaul) failure for 20,000 miles.
# Reliability Metrics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure Rate ($\lambda$)</td>
<td>The total expended number of failures within an item population, divided by the total time by that population, during a particular measurement interval under stated conditions.</td>
</tr>
<tr>
<td>Hazard Rate</td>
<td>Instantaneous failure rate. At any point in the life of a n item, the incremental change in the number of failures per associated incremental change in time.</td>
</tr>
<tr>
<td>Mean Time Between Failure (MTBF)</td>
<td>A basic measure of reliability for repairable items. The average time during which all parts of the item perform within their specified limits during a particular measurement period under stated conditions.</td>
</tr>
<tr>
<td>Mean Time Between Repair (MTBR)</td>
<td>A basic measure of reliability for repairable fielded systems. The average time between all system maintenance actions requiring removal and replacement or in-situ repairs of a box or subsystem.</td>
</tr>
<tr>
<td>Mean Time Between Operational Mission Failure (MTBOMF)</td>
<td>A measure of operational mission reliability for the system. The average time between operational mission failures which cause a loss of the system's mission as defined by the customers.</td>
</tr>
<tr>
<td>Mean Time to Failure (MTTF)</td>
<td>A basic measure of reliability for non-repairable systems. Average failure free operating time during a particular measurement period under stated conditions.</td>
</tr>
</tbody>
</table>
RAM Defined

- **R- Reliability** is the probability of an item to perform a required function under stated conditions for a specified period of time.

- **A- Availability** is a measure of the degree to which an item is in an operable state and can be committed at the start of a mission when the mission is called for at an unknown (random) point in time. Availability as measured by the user is a function of how often failures occur and corrective maintenance is required, how often preventative maintenance is performed, how quickly indicated failures can be isolated and repaired, how quickly preventive maintenance tasks can be performed, and how long logistics support delays contribute to down time.

- **M- Maintainability** is the ability of an item to be retained in, or restored to, a specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair.
System Reliability

Static Reliability

\[ R = (95.10) \times (98.61) \times (93.50) \times (99.10) = 86.89 \]
System Reliability
Quantifying Reliability

- Analysis of Field Data
  - Measure performance of test item
  - Evaluate similarity of similar devices

- Accelerated Testing
  - Based on operational data
  - Test to Failure
    - Weibull Analysis
  - Success-Run Testing
Vibration Life Profile
Reliability Demonstration using Success Run Testing

- Establish Life Requirement
  - Vibration life; based on vehicle characteristics at location
  - 100,000 miles

- Success Run Equation
  - Determine sample size, reliability, and confidence.

- Develop Test Acceleration Factors
  - \[ TAF = \left( \frac{G_{\text{accelerated}}}{G_{\text{normal}}} \right)^m = \left( \frac{T_{\text{normal}}}{T_{\text{accelerated}}} \right) \]
Success Run Equation

\[ N = \frac{\ln(1-C)}{\ln(R)} \]

Ex. \( R = 0.97 \), \( C = 0.5 \), \( N = 23 \)
Vibration Test Acceleration Factor

\[ TAF = \left( \frac{G_{\text{accelerated}}}{G_{\text{normal}}} \right)^m = \frac{T_{\text{normal}}}{T_{\text{accelerated}}} \]

\( m = \) Material Fatigue Constant:

- 6.4 for aluminum leads in electronic assemblies,
- 5 for an overall usage value
- 10.4 for connector fatigue or fretting Corrosion problems,
- 3.3 for highly accelerated vibration for metal fatigue (greater than 3X original stress).

Source: GMW 3172
Four Steps to Achieve RAM

1) Understand user needs and constraints
2) Design and redesign for RAM
3) Produce reliable and maintainable systems
4) Monitor field performance
C.25 RELIABILITY, AVAILABILITY, MAINTAINABILITY (RAM) PROGRAM

C.25.1 The Contractor shall maintain a comprehensive RAM program to ensure that the MMPV meets the RAM standards set forth in the performance specification. The design shall be monitored throughout the entire period of performance to identify and assess any changes, which would impact RAM. The Contractor shall develop reliability analysis and predictions as required to ensure compliance with the performance specification. The program shall encompass all aspects of reliability with respect to design selection of components, predictions, and testing. If it is determined that an item is a throwaway, an analysis shall be performed at the next higher indenture level. The Contractor shall maintain and make available to the Government all RAM data on any vendor or subcontractor supplied item and shall inform the Government of any part or component which will degrade system RAM requirements. The RAM program shall minimally include the following:

C.25.1.1 Procedures and Controls: The Contractor shall maintain procedures and controls, which ensure products, obtained from suppliers, vendors and subcontractors meet reliability requirements. The Contractor shall (a) establish, implement, and maintain documented procedures, which detect and/or preclude the use of substandard or counterfeit parts in the production process, and impose similar requirements on subcontractors; and (b) Provide the Government with reasonable notice of any special RAM program review meetings scheduled with subcontractors so Government representatives may attend at their discretion.

C.25.1.2 Reliability Predictions: The Contractor shall provide detailed design reliability predictions based on a defined configuration and associated models. The predictions shall be allocated down to the lowest indenture level and updated each time significant design or mission profile changes significantly impact the MMPV or any of its subsystems. The reliability modeling method shall mathematically relate the reliability block diagrams of the MMPV to time-event relationships. These tasks shall be performed in consideration of the end-user operational environment including sun load thermal, shock and vibrations.
Why systems fail to achieve RAM requirements:

- Poorly defined or unrealistically high RAM requirements.
- Lack of Priority for Achieving RAM
- Too little engineering for RAM. Among engineering process failures, these stand out:
  - Failure to design-in reliability early in the development process.
  - Inadequate lower level testing at component or subcomponent level.
  - Reliance on predictions instead of conducting engineering design analysis.
  - Failure to perform engineering analyses of commercial-off-the-shelf (COTS) equipment.
  - Lack of reliability improvement incentives.
  - Inadequate planning for reliability.
  - Ineffective implementation of Reliability Tasks in improving reliability.
  - Failure to give adequate priority to the importance of Integrated Diagnostics (ID) design influence on overall maintainability attributes, mission readiness, maintenance concept design, and associated LCC support concepts.
  - Unanticipated complex software integration issues affecting all aspects of RAM.
  - Lack of adequate ID maturation efforts during system integration.
  - Failure to anticipate design integration problems where COTS and/or increment design approaches influence RAM performance.

- Source: DoD Guide to Achieving RAM
| 1) Assess the Design | Conceptual Model of system or design plans | Identify similarities and differences with current system. Identify failure modes know to similar systems. | Failure Modes and Effects Analysis  
Fault Tree Analysis (FTA)  
Finite Element Analysis (FEA)  
Thermal Analysis  
Electromagnetic Interference Analysis (EMI)  
Worst Case Circuit Analysis  
Durability Assessment  
Software Architecture  
Testability Analysis  
Comparative Analysis |
|---|---|---|---|
|  |  | Calculate the RAM using similar components or expert judgment | Reliability Predictions  
Durability Assessment  
Simulation  
Maintainability Analysis  
Dormancy Analysis |
| 2) Mature the Design | Design plans and candidate components | Component testing in realistic environment | Reliability Testing  
Maintainability (BIT) fault insertion testing |
|  | Component choice | Screen components to eliminate latent part and manufacturing process defects | Environmental Stress Screening (ESS)  
Highly Accelerated Stress Screening (HASS) |
| 3) Implement the Design | Prototype or breadboard | Test functional operation to identify design limits, constrains and integration anomalies | Highly Accelerated Life Testing (HALT)  
Thermal HALT  
Vibration HALT  
Combined (Thermal/vibration/ shock/ humidity/ dust / electrical power instability)  
System integration and software development laboratories |
|  |  | Additional screening and test for quality control | HALT  
HAS  
Integration and software development laboratories |
|  | Prototype initial production items | Quantify reliability improvement for redesigned components, etc. | Reliability Growth Testing (RGT) |
|  |  | Verify the ease of maintenance for production systems. Verify fault detection and isolation design attributes  
Verify production systems. | Maintainability Demonstration  
Initial VIT assessments  
Fault insertion testing.  
Durability testing |
Sources of Information

- DoD-5000.1, DoD-5000.2
- MIL-STD 461E, 464A, 810F
- MIL-HDBKs
  - MIL-HDBK-235, 237D
  - MIL-HDBK-338, DoD Guide for Achieving RAM
  - MIL-HDBK-189, 781
- AETP Series NATO Documents

- Global Engineering Documents
  - GMW 3097 & GMW 3172
  - SAE J1455, ISO 16750
Sources of Information

http://assist.daps.dla.mil/quicksearch/
http://www.nato.int/docu/standard.htm
https://akss.dau.mil
Summary:
- Qualification process is tailored from start to finish
- Military is incorporating RAM requirements
- Can rely on MIL and Non-MIL information to build test plans

Questions on the Process

Thank you.