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<th>6. AUTHOR(S)</th>
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<td>Mike Clelland and Joel Haines</td>
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<tr>
<td>Commander</td>
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<tr>
<td>Naval Air Warfare Center Aircraft Division</td>
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<td>1421 Jefferson Davis Highway</td>
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<td>• EMP Coupling</td>
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E-6
E³ HM/HS TOOLS

JOEL HAINES
MIKE CLELLAND

NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
PATUXENT RIVER, MARYLAND 20670-5304
E-6 AIRCRAFT

- The Design Is Based On The Commercial Boeing 707 And The Military E-3A Airframes
- Modifications And Special Equipment Installed To Support The Take Charge And Move Out (TACAMO) Strategic Communications Mission
• The TACAMO Mission Is To Provide A Survivable Communications Link Between The Joint Chiefs Of Staff And The Ballistic Missile Submarine Forces
EMP COUPLING

DISTANT NUCLEAR BURST

INCIDENT EMP

WINDOW OR APERTURE

RECEIVER

ANTENNA

CRITICAL SUBSYSTEMS

SUBSYSTEMS

INTERNAL CABLE SYSTEM

BOTH SHIELDED AND UNSHIELDED

SEAM OR BAD JOINT COUPLING TO NEARBY CABLE

EXPOSED CABLE WITH TEM MODE PENETRATION (CONTROL CABLES AND HYDRAULIC LINES)

- INCIDENT EMP CAUSES CURRENT AND CHARGES ON EXTERNAL SURFACE
- SURFACE CURRENTS AND CHARGES EXCITE ANTENNAS AND INADVERTENT PENETRATIONS
- PENETRATIONS COUPLE ENERGY TO INTERNAL CABLES
- CABLE SYSTEMS ROUTE ENERGY TO CRITICAL SUBSYSTEMS
TYPICAL AIRCRAFT HARDENING TECHNIQUES

Reduce Stress

Layer 1
Hull Hardening
- Antenna hardening
- External wire hardening
- Mechanical penetration hardening

Layer 2
Internal Shielding
- Wire shielding
- Cabinet shielding

Increase Strength

Layer 3
Box Hardening
- Harden interface circuitry with diodes, filters
- Parts control
TBNH-6F

• BACKGROUND
  - The Test Bench Nuclear Hardness (TBNH-6F) was procured to test the Terminal Protection Modules Installed on the E-6A. The TBNH-6F is a adaptation of the TBNH-160F which is used by the French Air Force with the mission equivalent to that of the E-6A.
TBNH-6F

• FUNCTIONAL CHARACTERISTICS
  – Test Bench Allows Two Testing levels:
    • Organizational Level (TPM installed on the aircraft)
    • Depot Level (TPMs removed form the aircraft)
  – TPM characteristics tested:
    • attenuation, capacitance, inductance, resistance, firing voltage and leakage currents.
TBNH-6F

- Transportable Cart
- Air-Conditioning System
- Test Assembly
TRANSPORTABLE CART

• Divided Into 5 Sections:
  – Section A - This Section Includes The Air-Conditioning System And Power Supply
  – Section B - Includes A Height Adjustable, Retractable Seat, Computer Keyboard And The Headset Audio-Panel (For Audio Communications With The Remote Unit)
  – Section C - This Section Is A Rigid, Waterproof, Air-Conditioned Enclosure. The Cabinet Contains Three Parts Where Test Fixtures Are Mounted
TRANSPORTABLE CART

• Divided into 5 Sections (Cont’d)
  – Section D - Includes The Lighting System, 2 Electrical Connectors, And Storage Space For Cables
  – Section E - Contains A Waterproof Main Power Control Cabinet, The Interface Panel, The Main Power Interface, And 2 Drums For Main Cables
TRANSPORTABLE CART

• 1st Part of Cabinet
  – Picoammeter HP4140B
  – Picoammeter Interface
  – Switching Unit HP75000-C VX 1
  – Interface Module Interface
TRANSPORTABLE CART

- 2nd Part of Cabinet
  - Bertan Power Supply
  - HP 8751A Network Analyzer
  - Network Analyzer Interface
  - HP4192A Impedance Analyzer
  - Impedance Analyzer
TRANSPORTABLE CART

- 3rd Part of Cabinet
  - Bertan Power Supply
  - HP D1194 Display
  - HP A2240A Computer
  - Non-interruptible Power System
TBNH-6F

- Testing System
  - Controlled by a HP 9000 model 362 through HPIB bus. HP basic software is used.
    - HP 8751A- Network Analyzer- allows TPM attenuation measurement (1dB accuracy) from 2kHz to 150 MHZ.
    - HP 4140B- pA meter allows measurement of total leakage current (components, connectors, etc.), measurement of firing voltage of non-linear components up to 100 v.
• Testing System (Cont’d)
  – HP 4192A - Impedance Analyzer- allows measurement of parallel capacitors and serial inductors with 1% accuracy.
  – Bertan H.V. PWR Supply - used for measurement of firing voltage of non-linear components for voltages higher than 100v.
TYPICAL TEST

- Over 110 TPMs On Each Aircraft
- 15 - 30 TPMs Tested As Part Of EPM
  - Only One Section Of The Aircraft Goes Through EPM At A Time
  - The TBNH-6F Plots A Hard Copy And Saves All The Measured Data To A Disk
4 CAPACITOR TPM

MIL-C-38999, SERIES IV CONNECTOR
INSTALLED PER BAC5121, BONDED
PER MIL-B-5087

CONDUCTIVE GASKET
& ADHESIVE INSTALLED
PER BAC5010

COAXIAL CAPACITOR
BONDED PER MIL-B-5087,
INSTALLED PER
BAC 5011

WIRE TYPE M22759/18 INSTALLED
PER BAC5116, SOLDERED TO
CAPACITOR PER BAC5044, HEAT
SHRINK TUBING APPLIED
PER BAC5155

J1 D38999/40WD5PN

J2 D38999/40WD5S

WIRING DIAGRAM
ALL BOLTS INSTALLED
PER BAC 5009
E-6 HM/HS RESULTS

- External TPM's Continue To Be A Problem
  - Water Intrusion Causes Corrosion Requiring Remove and Replace
  - Engineering Change In Process
E-6 HM/HS RESULTS (Cont’d)

• 10% Of External TPM’s Tested Fail “Initially”
  – Excessive Amount Of Water Displacement Compound Inside Connectors
  – Most TPM’s Check Good After Being Cleaned, Dried & Retested

• Failure Modes Are Generally Passive - Few Aircraft Downing Discrepancies
CONCLUSIONS

• The TBNH-6F Provides A Quick And Effective Method For Testing TPM’s For The E-6 Aircraft

• The Test Set Is A Valuable Tool In The HM/HS Process