



“Cradle-To-Grave” E³ Survivability Capabilities and Facilities

**Survivability, Vulnerability and Assessment Directorate
White Sands Test Center
White Sands Missile Range, New Mexico**

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OPSEC REVIEW CONDUCTED
ON: 23 October 2008**

White Sands Missile Range



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SVAD

Introduction



The SVAD at White Sands Missile Range (WSMR), New Mexico, began operation in 1957 as the Nuclear Effects Laboratory (NEL) and consisted of Electro-Mechanical and Electromagnetic Radiation Effects (EMRE). In 1964, it became an arm of the United States Army Test and Evaluation Command for nuclear weapons effects testing, evaluation, and assessment with EMRE becoming a separate entity. In 1992 the EMRE Test Facility was placed under the Directorate for Applied Technology, Test and Simulation (DATTS) (for the second time). Now SVAD has evolved into a recognized center of expertise for nuclear effects, electromagnetic environmental effects (E3), and directed energy weapon effects (DEW) test and evaluation. SVAD has the in-house capability for turnkey testing of virtually any system or component in any potential nuclear, E³, or DEW radiation environment, as well as the ability to conduct all MIL-STD-810F environmental tests (climatics and dynamics).

DISCUSSION



- ★ SVAD Facilities and Capabilities Overview
- ★ SVAD E3 Mission and Life-Cycle Electromagnetic Survivability
- ★ Directed Energy Weapons Capabilities and Facilities (with the addition of Joint Directed Energy Test Site and High Power Microwave)
- ★ Electromagnetic Environmental Effects Capabilities and Facilities
- ★ External RF EME and HERO Test Compliance
- ★ Conclusions

SVAD Capabilities



- ★ Nuclear Weapons Effects (NWE)
 - Initial Nuclear Radiation (*ISO 9001-2000 Certified*)
 - Thermal Radiation
 - Airblast
 - Electromagnetic Pulse
- ★ Space Radiation Effects (SRE)
 - Natural Radiation
 - Prompt Nuclear Radiation (*ISO 9001-2000 Certified*)
 - Enhanced Low Dose Rate Sensitivity (*ISO 9001-2000 Certified*)
- ★ Radiation Tolerance Assured Supply and Support Center (RTASSC) (*ISO 9001-2000 Certified*)
 - Radiation Tolerance Assured Parts
 - Monitoring and Tracking – Documentation and Database
 - DMSMS Engineering Solutions and Program Management
 - Third-Party Manufacturing
 - Procurements and Delivery
 - Certified Long-Term Storage (Wafer, Die, and Packaged)
 - White Sands Drawings
 - Classified Long-Term Storage
 - HCI and Life-Cycle NWE Database

SVAD Capabilities (Cont)



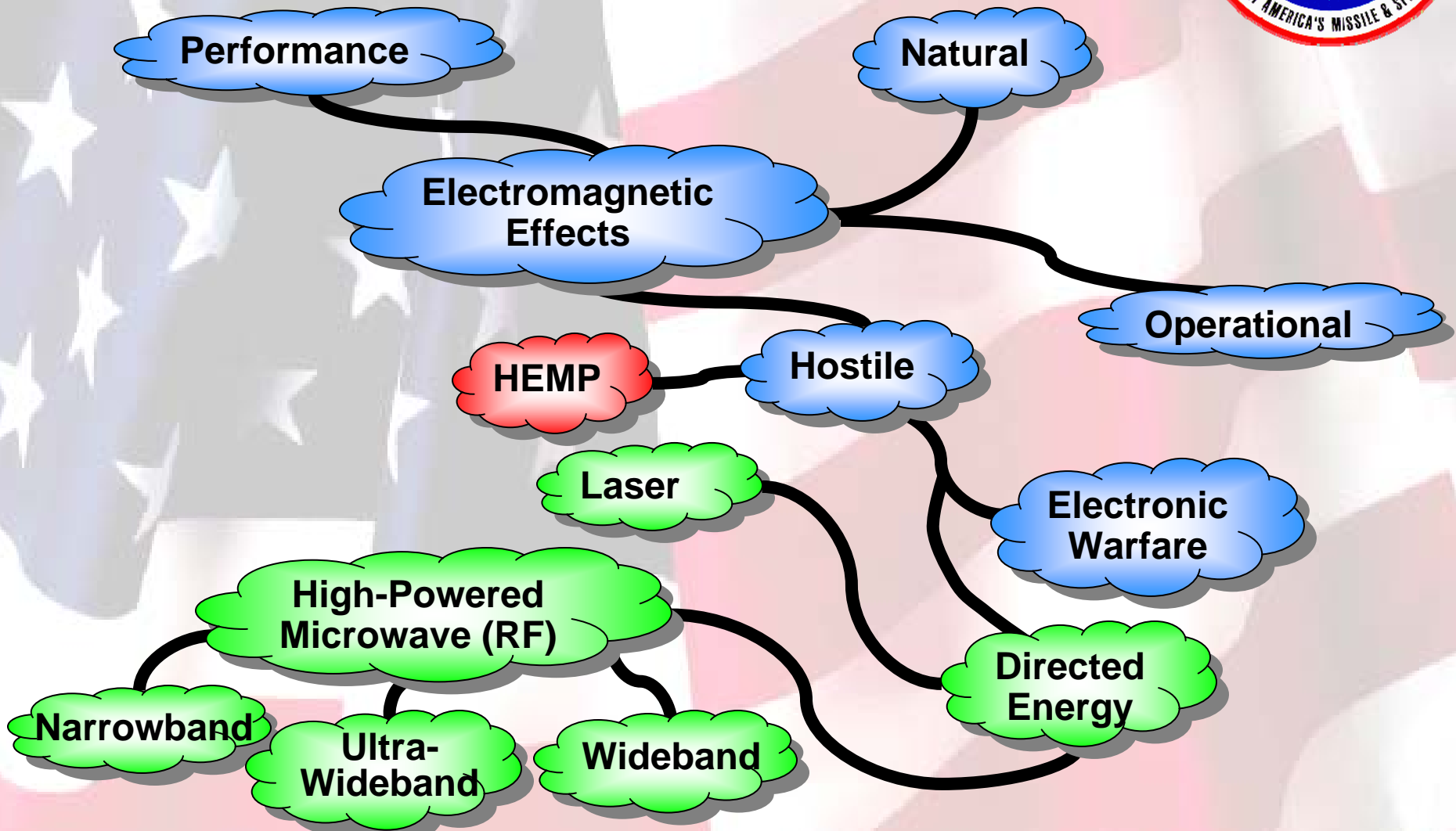
- ★ Semiconductor Test Laboratory (*ISO 9001-2000 Certified*)
 - Eight mainframe characterization machines
 - Rapid Response Laboratory
- ★ Electromagnetic Environmental Effects (E³)
 - Natural (Lightning, Electrostatic Discharge)
 - Operational (Intra- and Inter-System EMC, EMRADHAZ, EMI)
 - Hostile (SREMP, SGEMP, HEMP, N²EMP, EW, EA, ECM)
- ★ Directed Energy Weapons (DEW)
 - Lasers
 - High Power Microwave (HPM) –Narrowband (NB)
 - HPM -Wideband (WB) and Ultra-Wideband (UWB)
- ★ Climatic, MIL-STD-810
 - Temperature Test Facility – 105'L x 40'W x 50'H
 - Environmental Test Area II
 - Multi-Purpose Chamber
 - Portable Chambers
- ★ Dynamic, MIL-STD-810
 - Vibration
 - Shock
 - Centrifuge
 - Acceleration

SVAD Capabilities (Cont)



- ★ Chemical – (*Oregon Certified*)
 - Conformance
 - Environmental Analysis
 - Explosive and Analysis
 - Toxic Gas Analysis
- ★ Failure and Material Analysis on Metallic, Non-Metallic and Advanced Materials
 - Corrosion
 - Non-Destructive
 - Microbiological Degradation
 - X-ray: 4 MeV, 420 keV, 320 keV and 300 keV
- ★ Propulsion Testing of Solid Propellant Rocket Motors
- ★ Expertise
 - 130+ Engineers and Technicians
 - >1300+ Manyears Experience
 - >400+ Systems Tested and Assessed
- ★ **All Facilities and Engineering Support Co-Located**

SVAD/WSTC E³ Mission



METHODOLOGY



Provide quality and efficient Electromagnetic Environmental Effects (E³) Verification/Qualification Testing for airborne, sea, space and ground systems, including their associated ordnance.

In turn, utilizing mitigation/redundancy, then hardening (based upon susceptibility thresholds and margins) to provide hardware selection and fixes through engineering and validation testing.

Develop and Implement Life-Cycle E³ Survivability Management programs to include production and deployment assurance training and surveillance, as well as establishing a database for monitoring and tracking systems.

Methodology



DEW

- ★ Simulating laser or HPM environments
- ★ Testing electronics, electro-optics, and munitions
- ★ System Level Survivability

DEW Capabilities

Pulsed Laser Vulnerability Test Systems (PLVTS) Facility



- ★ 10.6 micron wavelength
 - 1000 Joules Pulse Energy
 - Peak Power – 35 MW
 - PRF – Single Pulse to 30 Hz
 - Transportable
- ★ Tunable Frequency Agile Lasers
- ★ 60 cm Transportable Advanced Pointer Tracker (APT)
- ★ Eye-Safe lasers

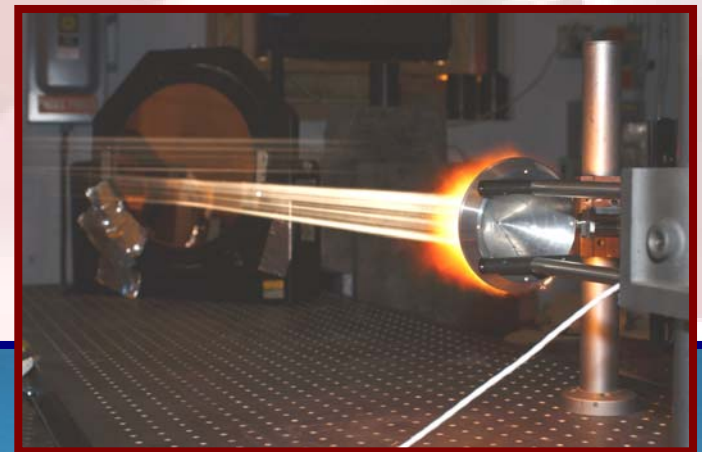


DEW Capabilities

Pulsed Laser Vulnerability Test Systems (PLVTS) Facility



- ★ Piece-part and coupon tests are conducted in the Test Cell-3 Laboratory
- ★ Full systems are tested statically or dynamically down-range using the APT for precision aim-point control



DEW Capabilities

Radio Frequency (RF) Weapons

HPM-NB and -WB

Overview



- ★ Narrowband
 - HPM Threat Simulator
 - DETEC NBTS A (*Future*)
- ★ Narrowband – *Future*
 - *DETEC NBTS A*
 - *DETEC NBTS A Prime*
 - *DETEC NBTS B*
 - *DETEC NBTS C*
- ★ Wideband
 - DETEC SWBTS
 - DETEC WBTS (*Future*)
- ★ Ultra-Wideband
- ★ Data Acquisition
 - Sensor Suite
- ★ Threat Hazard Prediction



DEW Capabilities

Radio Frequency (RF) Weapons

HPM –WB and -UWB



- ★ Wideband (WB)
 - WBTS
 - 100 - 3000 MHz
- ★ Ultra-Wideband (UWB)
 - 600 - 4000 MHz
 - 30,000 V/m @ 30 meters
- ★ Small-Wideband
 - SWBTS
 - 150 – 280 MHz



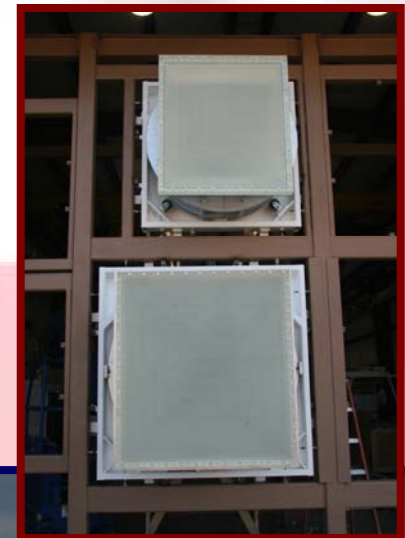
DEW Capabilities

Radio Frequency (RF) Weapons

HPM –NB



- ★ Super Reltrons, High Energy
 - 750 – 3000 MHz
 - 590 ns Pulsewidth
 - 5 pps
 - Up to 50,000 kV/m @ 15m, 3m x 4m
- ★ NBTS Suite A
 - 20 Hz Rep Rate
 - 1000 – 1700 MHz
- ★ NBTS Suite A Prime
 - 1700 – 2660 MHz
- ★ NBTS Suite B
 - 9500 – 10,500 MHz



DEW Capabilities

Radio Frequency (RF) Weapons

HPM –NB – *Small Systems*



- ★ High Power Microwave (HPM) – Small Systems
 - 31 Magnetrons, 125 – 3000 MW
 - 350, 1000 and 2000 ns pulsewidth
 - 4 - 6 kV/m @ 6 m
 - 1.25 – 40 GHz
 - Amplifier System, 140 – 1000 MHz, 150 kW
 - Containerized, Transportable



DEW Capabilities

Radio Frequency (RF) Weapons Sensor Suite



★ Sensor Suite

- Integrated HPM Automated Data Acquisition System
- Full Calibrated Measurement Capability
- Free-Field Sensors and Aperture Antenna Measurements
- 40 Digitization Channels up to 40 GSa/s
- 50 MHz to 10 GHz Direct Measurement
 - WB Measurements with Down Mixing

★ Video Recording System Capable of Producing DVR Movies in Synchronization with Firing of a Source.

- Visible Light and Infrared Cameras included.



Electromagnetic Test (E³) Capabilities



- ★ SVAD operates extensive Electromagnetic (EM) Environmental Effects (E³) Test Facilities to support the requirements for test and evaluation of systems while being subjected to electromagnetic environments (EMEs). SVAD E³ test and evaluation capabilities include:

- Electromagnetic Radiation (EMR) – Operational (External RF EME)
- Electromagnetic Compatibility (EMC)
- Electromagnetic Interference (EMI)
- Electrostatic Discharge (ESD)
- Electromagnetic Pulse (EMP)
- EM Radiation Hazards (Fuel, Ordnance and Personnel)
- Lightning Effects (LE)

- ★ MIL-STD-464A, MIL-STD-461E/F and ADS-37A
- ★ NARTE



Methodology

External RF EME



- ★ Open Air Testing
- ★ Uniform Entire-system Illumination at Full Threat
 - 3 MHz to at least 500 MHz for MLRS size system
 - 10 kHz to 45 GHz for HMMWV size system
- ★ Average or Peak Power, 10 kHz - 45 GHz
- ★ CW, AM, FM, and PM Modulations
- ★ Swept to Selected Frequency Steps of 30-180 seconds/frequency
- ★ Operational Testing – Test System Manned and Operated throughout each Illumination
- ★ Three 72-ton, 33-foot diameter Turntables; each Located at a Major Test Site that is separated for Simultaneous Testing
- ★ 70-ton Hydraulic Positioner for Peak Pulsed Power Testing
- ★ 300-foot Tower with Elevator for Azimuth Angle Testing

E³ Test and EME Capabilities

EMC



- ★ MIL-STD-464A, MIL-STD-461E/F and ADS-37A Compliant
- ★ Open-Air Testing, Restricted Air Space
- ★ Average and Peak Power
- ★ Entire Body Uniform Illuminations @ Full Threat
 - 10 kHz – 500 MHz for MLRS size system
 - 10 kHz – 45 GHz for HMMWV size system
 - AM, FM, PM and CW Modulations
- ★ Localized Illumination @ Full Threat
 - 500 MHz – 45 GHz
 - AM, FM, PM and CW Modulations
- ★ Three Separate 72-ton, 33' Diameter Turntable Sites
- ★ One 70-ton, hydraulic Positioner @ PP Site
- ★ Seven Simultaneous Test Capabilities
- ★ Very Large EM Shielded Test Cell
 - Radiated Emissions / EMI
 - Shielding Effectiveness
 - Interior Dimensions of 60' long by 40' wide and 40' high
 - Exhaust System for Diesel and Turbine Engines
- ★ RS105
- ★ MIL-STD-188-125 Pulsed Current Injection



E3 Test and EME Capabilities

Average Power



- ★ Entire-System Uniform Full-Threat Illumination
 - 3 MHz – 500 MHz, MLRS size
 - 10 kHz – 45 GHz, HMMWV size
 - Up to 50 kW
- ★ Localized Full-Threat Illumination
 - 500 MHz – 45 GHz
 - Up to 4 kW
- ★ Routinely three, up to six Simultaneous Tests

E3 Test and EME Capabilities

LF and HF Transmitter Site



- 72-Ton, 33' Turntable
- 3 – 30 MHz
- >200 V/m @ CTT (Avg Pwr)
- Vertical Polarization
- 50 kW Transmitter
- Frequency Flexibility
- Fully Automated
- Uniform Entire System Illumination @ Full Threat



Antenna to CTT varies at fixed sites.



E3 Test and EME Capabilities

ULF and LF Transmitter Site

- Water-cooled Amplifier
- Semi-ridged 1- 5/8" Transmission Line.
- Strip Line Antenna
- E-field > 200 V/m (Avg Pwr)
- 10 kHz – 30 MHz
- Fully Automated
- Vertical Polarization
- Receiver De-Sensitization
- Electronic Attack / Information Warfare



Antenna to CTT varies at fixed sites.



E3 Test and EME Capabilities HF and VHF Transmitter Site



- Vertical & Horizontal
- >200 V/m (Avg Pwr) @ CTT
- 30 – 100 MHz
- 72-Ton, 33' TT
- Log Periodic Antenna
- 50 kW Transmitter
- Fully Automated
- Uniform Entire System Illumination @ Full Threat
- Frequency Flexibility



Antenna to CTT varies at fixed sites.

E3 Test and EME Capabilities

UHF Transmitter Site



72-Ton Turntable - 33' diameter

- Vertical and Horizontal
- E-field > 100 V/m @ CTT (Avg. Pwr)
- 72-Ton, 33-ft Turntable
- 100 – 500 MHz
- 32 kW Transmitter
- Frequency Flexibility
- Uniform Entire System Illumination @ Full Threat
- Fully Automated



Antenna to CTT varies at fixed sites.

E3 Test and EME Capabilities Mobile Assets



★ E1 VAN

- L, S, C, X, Ku and Ka Bands



- Frequency Flexibility
- AM, FM, PM and CW
- Transportable
- Stepped & Discrete
- Access to 72-Ton, 33-ft Turntable



★ E3 VAN

- VHF and UHF



- V & H Polarization
- AM, FM, PM and CW
- Transportable
- Stepped & Discrete
- Access to 72-Ton, 33-ft Turntable



★ E4 VAN

- All VLF and Up

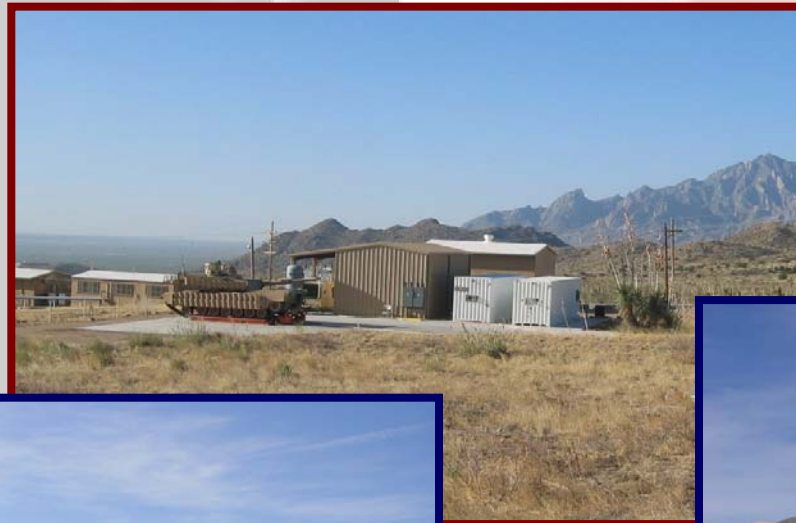


- V & H Polarization
- AM, FM, PM and CW
- Transportable
- Stepped & Discrete
- Access to 72-Ton, 33-ft Turntable



E3 Test and EME Capabilities

Peak Power - Overview (140 – 40,000 MHz)



70-ton Hydraulic Positioner for Peak Pulsed Power

E3 Test and EME Capabilities

Peak Power



- ★ MIL-STD-464A and ADS-37A Compliant
- ★ Open-Air Testing
- ★ Peak Power No. 1
 - 40' x 8' ISO Transportable Container
 - L-K Band Pulsed System
 - Variable Frequency: 1 – 18 GHz
 - 15 Magnetrons, most 1 MW
 - Pulse Forming Network - 1-2 μ s and optional 350 ns pulse width (FWHM)
 - Peak Power up to 3-5 kV/m @ 6m
 - Fully Automated
 - Each Magnetron has 50 Programmable Frequencies



E3 Test and EME Capabilities

Peak Power



★ Peak Power No. 2

- 40' x 8' ISO Transportable Container
- L-K Band Pulsed System
- Variable Frequency: 1 – 9 GHz
- 8 Magnetrons, all >125 kW, most 1 MW
- Capability to drive 3 MW Magnetrons
- Pulse Forming Network – 1-2 μ s and optional 350 ns pulse width (FWHM)
- Peak Power up to 3-55 kV/m @ 1 m
- Fully Automated
- Each Magnetron has 50 Programmable Frequencies



★ Peak Power No. 4

- 20' x 8' ISO Transportable Container
- Pulsed Universal Magnetron System
- Variable Frequency: 18 GHz – 40 GHz
- Average 130 kW
- 12 Magnetrons
- 500 ns - 2 μ s pulse width
- Each Magnetron has 50 Programmable Frequencies



E3 Test and EME Capabilities

Peak Power



★ Peak Power No. 3

- Pulsed UHF System
- Variable Frequency: 140 MHz – 1 GHz
- Average 150 kW
- 2 - 250 μ s pulse width

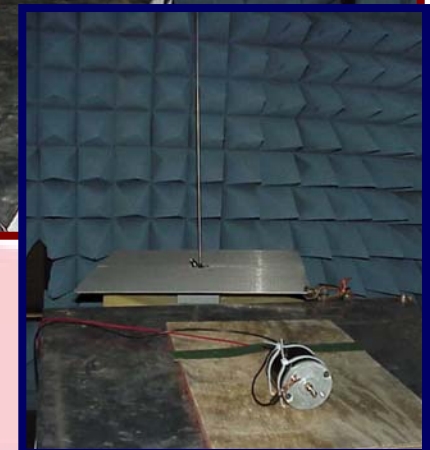
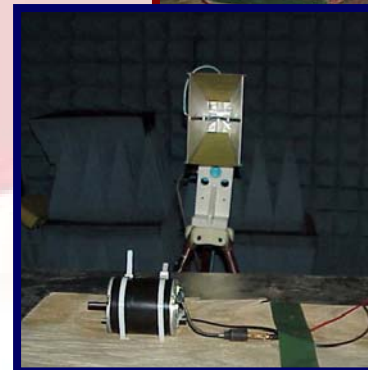
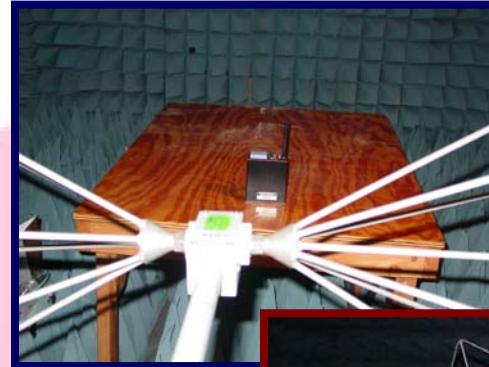


E³ Test and EME Capabilities

EMI



- ★ MIL-STD-461E/F Compliant
 - Anechoic Chamber
 - Radiated Susceptibility
 - 0.1 MHz – 45 GHz (200 V/m Intensity)
 - Radiated Emissions, 3 MHz - 40 GHz
 - Conducted Emissions
 - Conducted Susceptibility
- ★ TEMPEST – Cooperative Agreement
- ★ RS105 Facility
- ★ Shielding Measurements



E³ Test and EME Capabilities

EMI

RS105



- ★ MIL-STD-461E/F, RS105 Simulator

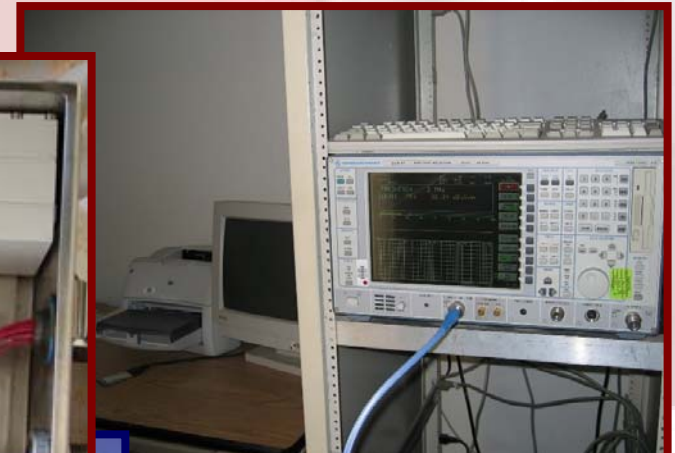
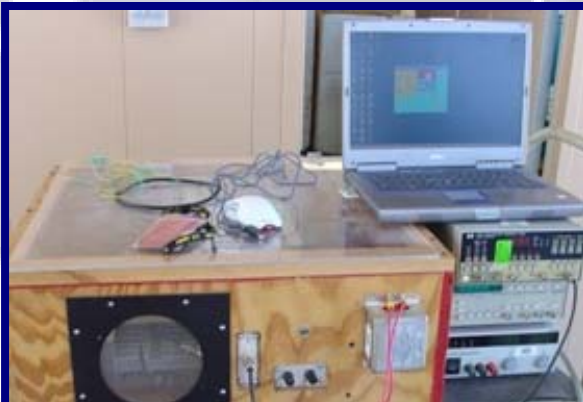


E3 Test and EME Capabilities

EME Test Cell



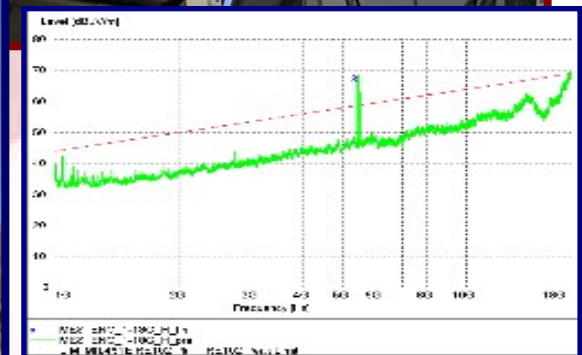
- Semi-Anechoic Chamber
- 40' x 60' x 40' Test Volume
- 150 Cubic ft/m Air Flow
- Conducted Susceptibility and Emissions



Millimeter Wave Testing



MIL-STD-188-125 PCI



RE System-Level
MIL-STD-461E/F - RS105

E³ Test and EME Capabilities

ESD and EMRAD HAZ



- ★ MIL-STD-464A Compliant
- ★ Helicopter ESD
 - Up to 300 kV DC/Positive and Negative
 - Up to 400 kV DC/Positive
- ★ Personnel ESD
 - Up to 30 kV DC/Positive and Negative
- ★ HERO – Hazards of Electromagnetic Radiation to Ordnance
- ★ HERF – Hazards of Electromagnetic Radiation to Fuel
- ★ HERP – Hazards of Electromagnetic Radiation to Personnel



E3 Test and EME Capabilities

Helicopter ESD



★ Established System

- One Polarity
- 400+ kV Output



★ Upgraded System

- Bipolar
- ± 300 kV Output



E³ Test and EME Capabilities

HERO Instrumentation



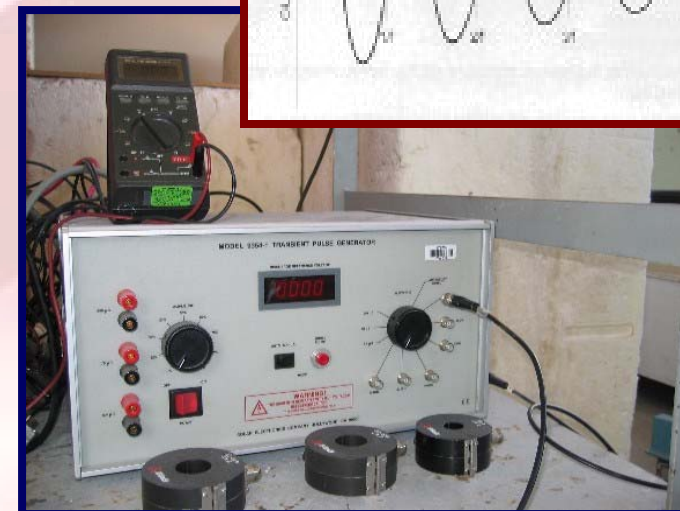
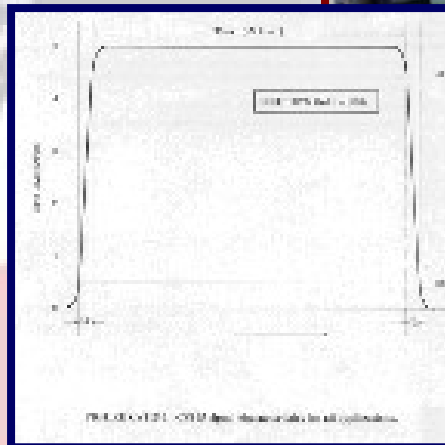
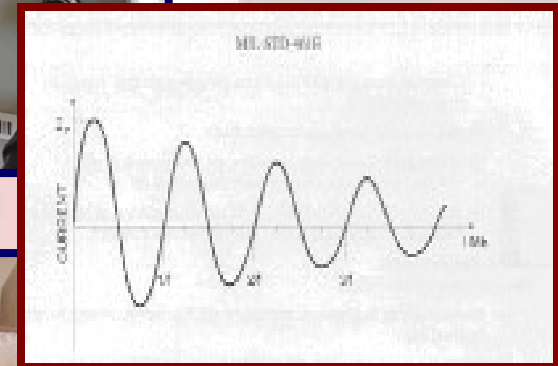
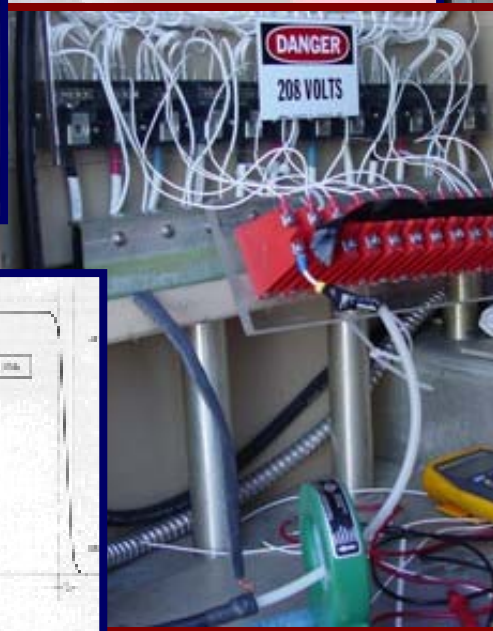
- ★ MIL-STD-464A and Mil-Hdbk-240
- ★ FISO
- ★ OpSens
- ★ Firing Circuit monitor
- ★ Real-Time Automated Data Collection



E3 Test and EME Capabilities Conducted Transient



MIL-STD-188-125 Pulsed Current Injection
CS114, CS115 and CS116



E³ Test and EME Capabilities

HPD-II Facility

Technical Data



- ★ MIL-STD-2169B, E1 System Tests
- ★ 30 X 30 m Test Area
- ★ Peak E-field – 70 kV/m
- ★ Rise time - <2 nsec
- ★ FWHM – 20 nsec
- ★ Mobile
- ★ Pulse Power Current Injection
- ★ Multiple Methods for data collection
- ★ 24 Channels of instrumentation



E³ Test and EME Capabilities

HPD-II Facility



- ★ **The Horizontally Polarized Dipole II (HPDII) High-Altitude Electromagnetic Pulse (EMP) simulator** is a MIL-STD-2169B Early-Time Waveform type free field HEMP simulator. The HPD-II is located at WSMR, but is a mobile EMP simulator and routinely requested to be transported to remote sites. The mobile HPD-II consists of a lowboy trailer used to transport the pulser, antenna and a 24-channel data acquisition trailer.

- ★ Two Simulators available

- ★ EMP & Lightning Facility are co-located for greater use of DAS system & personnel.



E³ Test and EME Capabilities Lightning Facility



Technical Data

- ★ MIL-STD-464A Compliant
- ★ 50 X 50 m Test Area
- ★ Peak E-Field – up to 150 kV/m
- ★ Rise time – 2 μ sec
- ★ FWHM – 20 μ sec
- ★ Separate Direct and Indirect Strike Capabilities

E³ Test and EME Capabilities

Lightning Facility



- ★ **The Lightning Test facility (LTF)** is capable of simulating both the direct and indirect lightning strike characteristic required in lightning effect testing.
- ★ The LTF is also capable of simulating the characteristic of a direct strike. A high current bank is capable of producing components A and D. The “A” component is 200,000 Amps.



E³ Test and EME Capabilities Compliance to Documents



MIL-STD	Description	Frequency Range (MHz)	Compliance with all ranges	Expanded Capability
MIL-STD-464A, Table 1A	External EME for deck operations on ships	0.01 - 45000	X	X
MIL-STD-464A, Table 1B	External EME for shipboard operation in the main beam of transmitters	0.01 - 45000	X	X
MIL-STD-464A, Table 1C	External EME for space and launch vehicle system	0.01 - 40000	X	
MIL-STD-464A, Table 1D	External EME for ground systems	0.01 - 40000	X	
MIL-STD-464A, Table 1E	External EME for Army rotary wing aircraft	0.01 - 45000	X	X
MIL-STD-464A, Table 1F	External EME for fixed wing aircraft excluding shipboard operation	0.01 - 40000	X	X
MIL-STD-464A, Table 3A	External EME for HERO	0.01 - 45000	X	X
ADS-37A, Table 1 Part A	External EME for aircraft	.014 - 40000	X	X
ADS-37A, Table 1 Part B	Pulse Modulation Parameters	Several in range 2 - 40000	X	X

Conclusion



WSTC/SVAD has the assets and resources for the full gamut of E3 testing for DOD and commercial systems; specifically EMRAD HAZ, DEW-Laser, DEW-HPM, ESD, Lightning, HEMP, External RF EME, and hardening protection, as well as analysis and assessment to support MIL-STD-464, MIL-STD-461, and ADS-37; and MIL-STD 2169B and MIL-STD-188-125.