



# ***UNDERSTANDING EMP TESTING***

***Presented By:  
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## ***EMP Yield***

For a 1 megaton explosion at high altitude,  
the total energy release radiated as EMP is  
roughly  $10^{11}$  joules (hundred's of GigaJoules).

***1977 DoD/DoE Report***



## ***E-6B During EMP Testing at Pax River***



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## ***EMP Testing Considerations***

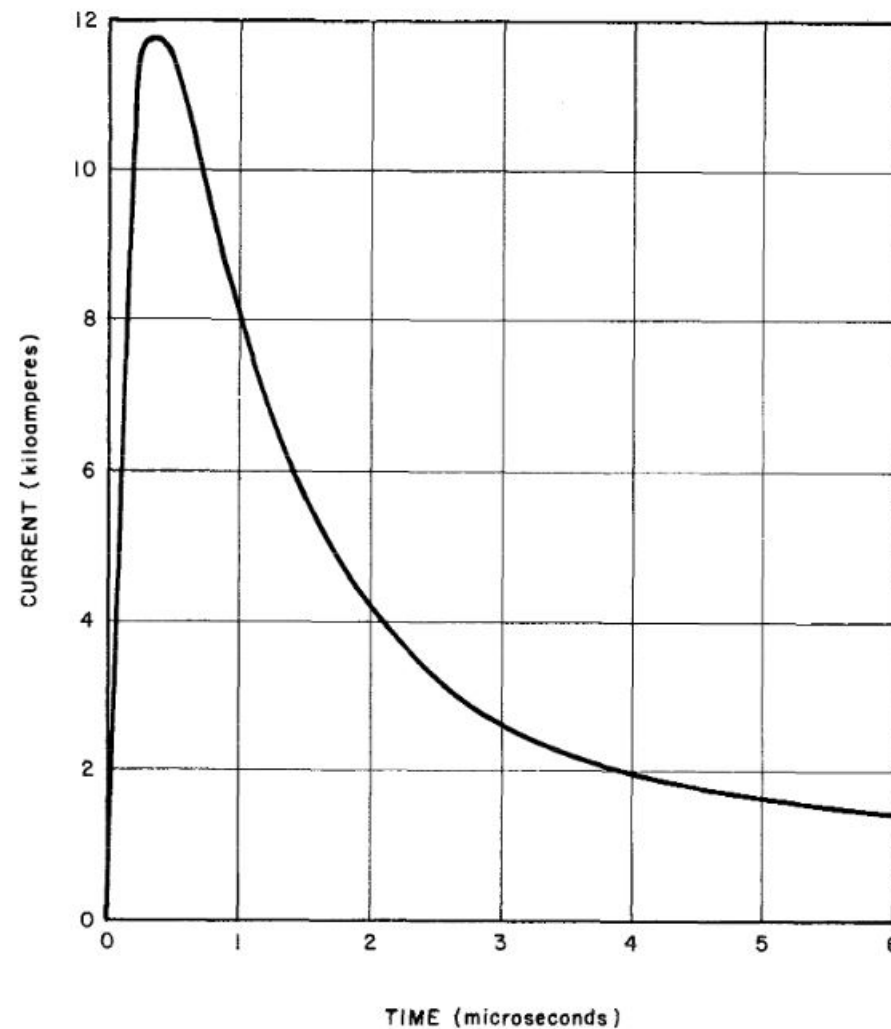
- Accurate testing for EMP susceptibility is a non-trivial activity
- Indoor vs Outdoor Testing:
  - Size of test cell (must be large enough to avoid echo problems)
  - Legality of outdoor testing
    - A radiated E Field is limited to 0.5 Volts / meter at edge of property. Difficult to achieve with true EMP pulse as near field extends for 10's to 100's of km
    - Significant Hazard to passing aircraft and satellites
    - Interference with government radio services
    - “Never been a problem”, then they probably aren't testing at power.
    - **ALL USG outdoor EMP ranges have aircraft and satellite deconfliction**
- Instrumentation: D Dot, B Dot, Free Field, Rogowski, etc.
- Calibration
- Simultaneous testing of parameters
- If you can pickup the source, it isn't big enough, no matter what the manufacturer says. A real EMP source weighs tons.



## ***Where There's an E Field, There's a B Field***

- The fundamental physics governing the generation of EM pulses says that an E Field is always accompanied by a B Field orthogonally disposed to it.
- At frequencies below 100 MHz, the ratio of energy distributed between the E field and the B field shifts to be heavily weighted towards the B field
- The bulk of the energy in an EMP pulse falls well below 100 MHz and thus the B field portion of the pulse is extremely important and cannot be ignored.
- Conventional Faraday shielding is ineffective against B fields
- Most labs ignore testing for B field and focus solely on the E field, yet a glance at the magnitude of the current pulse associated with NEMP shows why this is a fallacious approach to testing.

## ***EMP Current Pulse in Overhead Power Line***



**Source:  
DoD & DoE  
1977**

## EM Waveforms

**NNEMP Regime**

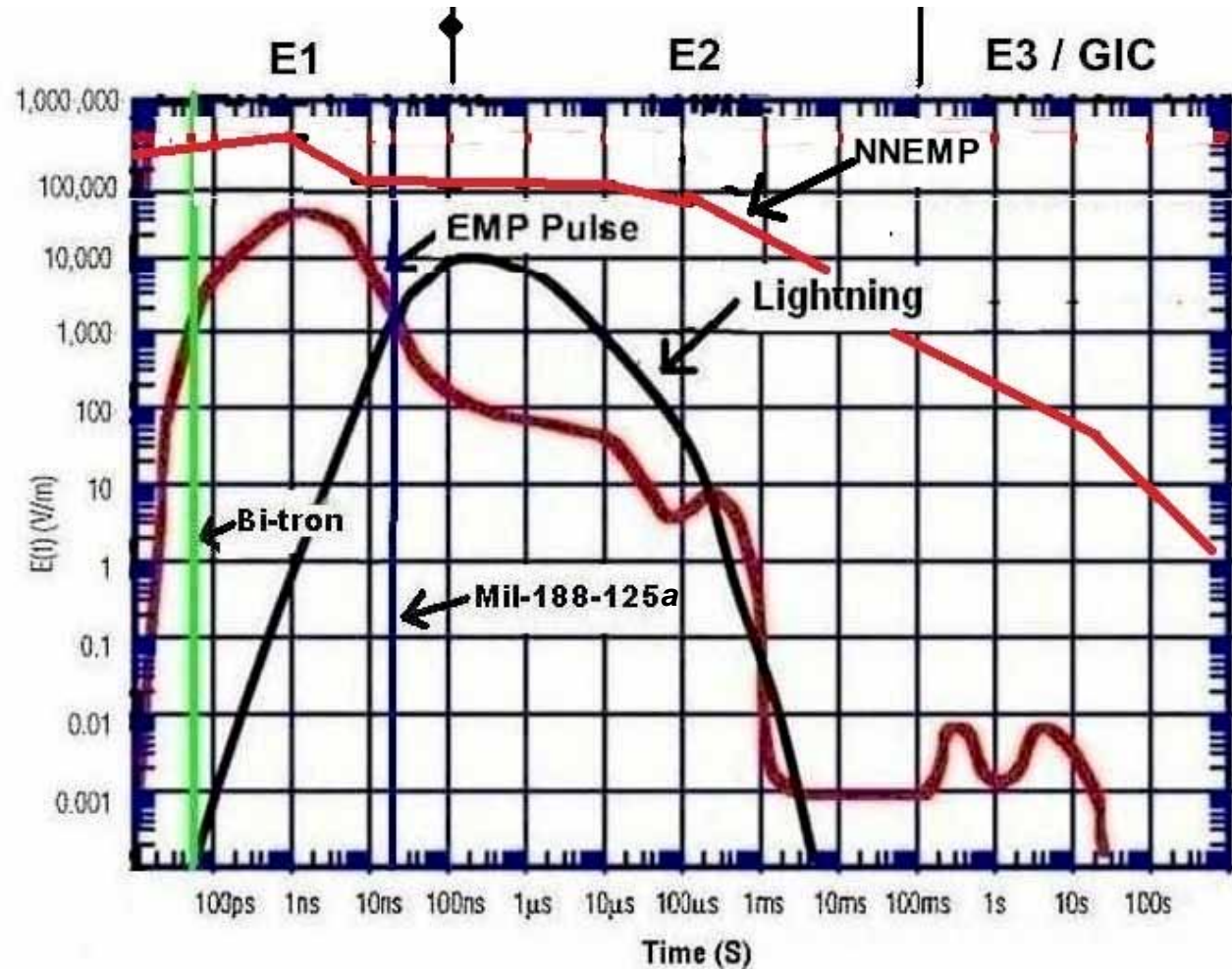
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**Green line shows  
when AFS  
protection occurs**

>>>>>

**Blue line shows  
when Mil-188-125a  
protection occurs**

>>>>>





## ***Non-Nuclear EMP***

- The non-nuclear EMP threat (NNEMP) arises from the ability to build extremely powerful radio transmitters that can duplicate the waveforms and intensities of the EMP portion of a nuclear explosion.
- The technology exists to build transmitters of this nature that can be portable and still produce effects many times that of a large nuclear EMP pulse.
- Shown is a 35KV/m systems built in a collaborative program with the US Army.



***35 KV/m NNEMP Source***





## ***EMP/GIC Test Facility***

- It is essential that all devices be tested under realistic conditions. As part of our commitment to the EMP protection arena, AFS has constructed a world-class EMP test facility.
- This facility has sources designed to give  $>350\text{KV/m}$  + electric fields with sub-nanosecond risetimes
- This facility can inject arbitrary simulated E3/GIC fault signals.
- This facility will be capable of testing devices at line voltages up to 1.2 million VAC or VDC (currently 250VAC) under load conditions of up to 10MW.
- While the facility is primarily for AFS production use, AFS the fully staffed and instrumented facility to outside users under appropriate circumstances.
- This facility will test in excess of the Mil-188-125D standard so as to provide realistic HEMP, NNEMP, and GIC conditions.
- This facility can successfully create SGEMP pulses.



## *Control Room Console*





## *Patch Panel, Host Computer, Safety Scope, Auxiliary Equipment*





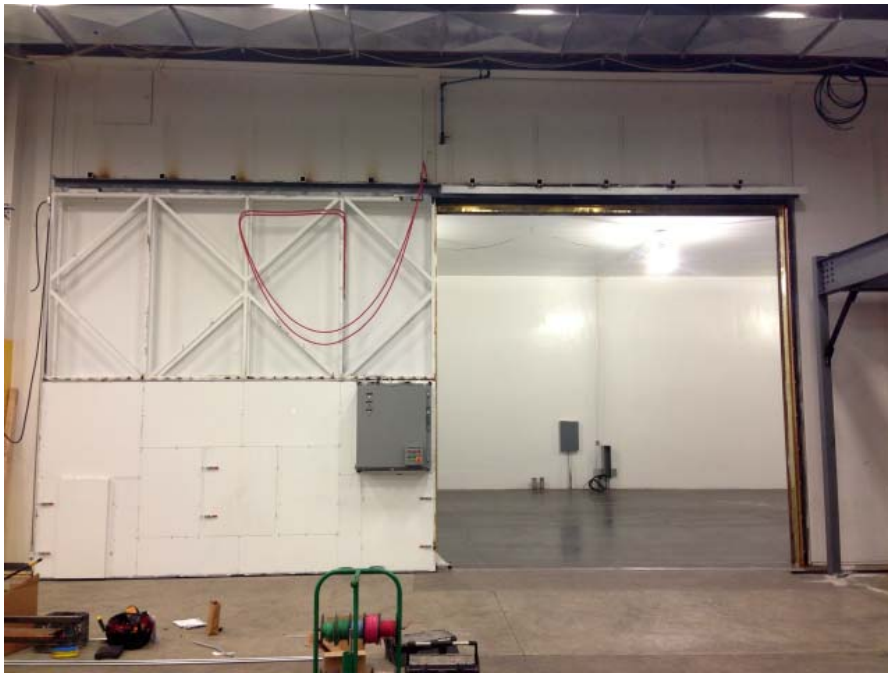
## ***EMP Test Cells***

- AFS Has 2 dedicated EMP Test cells
  - EMP 1: 80' x 40' x 20'
  - EMP 2: 94' x 34' x 20'
- Onsite sources can test to >350KV/M
- Test cell can duplicate magnetic field conditions of the largest transmission lines.
- Digital instrumentation:
  - >50 GS/sec/channel (8) simultaneous channels;
  - <20 picosecond resolution.





## ***AFS EMP Test Cell #1***



***Test Cell = 80' x 40' x 20'    Door = 16' x 16'***  
***(8) 25 GHz Instantaneous Bandwidth Instrumentation Channels***

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# ***LAT350 Pulser***







***11 Edmond Road,  
Newtown CT***



- ***250,000 sq ft***
- ***80' x 40' x 20' EMP Test Cell***
- ***94' x 34' x 23' Radiation Lab***
- ***EM, Circuit, & Mechanical Simulation***
- ***Precision Manufacturing***
- ***60,000 sq ft EM Test Dept.***



## *Senior Management*

- ***Dr. William H. Joyce:*** Chairman of the Board, CEO: Dr. Joyce is formerly Chairman and CEO of Union Carbide, Hercules Chemical, and Nalco. He has started 7 other businesses, some of which have grown to billion dollar size. He was awarded the National Medal of Technology from President Clinton in 1993. He sits on a number of Boards including the University Research Association.

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- ***Curtis Birnbach:*** President, CTO: Mr. Birnbach is the inventor of the entire AFS technology suite. He is an expert in electromagnetics, electron tubes, pulse power systems, materials science, manufacturing methods, intellectual property development, registered export agent.

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