METATECH CORPORATION CAPABILITIES

INTRODUCTION

Metatech Corporation is a small veteran-owned and operated business of highly-qualified scientists and engineers with broad experience (many employees with 30 - 40 years of experience) in developing technically sound and innovative solutions to problems in all areas of electromagnetic environmental effects, including: electromagnetic interference and compatibility (EMI/EMC), geomagnetic storm assessments and protection, nuclear electromagnetic pulse prediction, assessments, protection and standardization (e.g. HEMP and SREMP), and intentional electromagnetic interference (IEMI) assessments, protection and standardization.

This brochure has been prepared to familiarize current and potential customers with our services, products, and resources.

SERVICES

Electromagnetic Interference (EMI)

Definition: "Degradation of the performance of a piece of equipment, transmission channel, or system caused by an electromagnetic disturbance." (ANSI C63.14, 1992; IEC 60050 (161), 1990)

What We Do: Metatech provides analysis services for the various EM disturbances and their effects, including combined effects on systems, subsystems and equipment.

Example: The Geomagnetic Storm Data Project

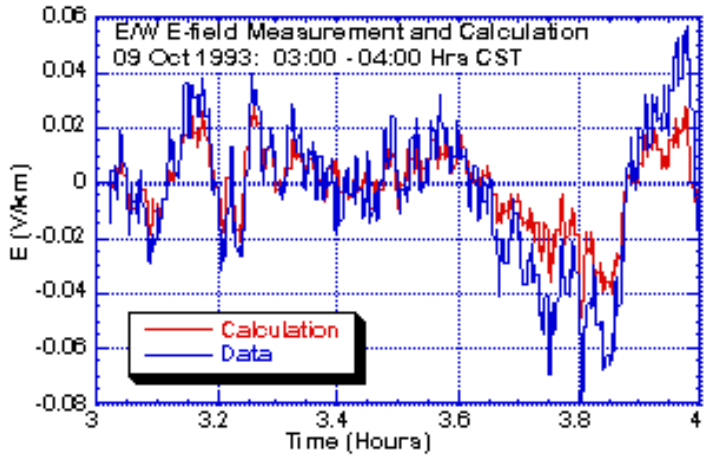
Metatech began working in 1991 to study magnetic storm effects on power and communications lines. The objective of the project was to understand the relationship between geomagnetic field fluctuations and the resulting electric fields, which couple to long lines. Metatech supplied the measurement equipment and data analyses, and Minnesota Power provided access to the Forbes facility (a high voltage power substation located in northern Minnesota). This project ended in 2008, when enough data had been collected.

The Forbes facility was unique in that it had two insulated communications lines available that were oriented in approximately N/S and E/W directions and were about 60 km in length. Given the line resistances and the load parameters, we were able to compute the average electric field over the length of the line from the measured current. The experiment also provided a measurement of the

geomagnetically induced current (GIC) on the neutral of a 500-kV power line originating near Winnipeg, Canada, which is 500 km north of Forbes. A 3-axis fluxgate magnetometer was used to measure the geomagnetic field variations at the Forbes facility at a sample rate of 1 sample every 2 seconds. At the time this was one of the fasted time-resolution measurements made in the U.S.

Since measurements of the geomagnetic field components, the average electric fields in two directions and the currents flowing on two power transformer neutrals in a high voltage substation were all available on a time-tied basis, it was possible to examine the relationship between the calculated and measured electric fields and the induced quasi-dc power line currents. Measurements were made on a continuous basis, and data were collected each month. The data were downloaded for immediate examination when severe magnetic storm activity occurred or when an electrical power anomaly had been reported.

Metatech developed the data acquisition system, its controlling software, and analysis tools for studying the data. Results can still be displayed in a number of ways. The accompanying figure shows a comparison of a measured electric field with a calculated electric field derived from the measured geomagnetic field and a deep-earth model of the earth conductivity in the region.



Comparison of the measured E/W electric field and the calculated electric field using local magnetic field measurements and a deep-earth conductivity model.

After the physics of the geomagnetic storm coupling model was fully understood in the late 1990s, Metatech performed assessments of high-voltage power grids in the UK, Norway, Sweden, and Japan. From 2001 to 2007 Metatech personnel provided severe geomagnetic storm assessment information for the overall U.S. power grid to the U.S. EMP Commission. From 2009 to 2011 Metatech performed assessments of the vulnerability of U.S. regional power grids for power companies. In addition, work was done for FERC to establish both the threat of geomagnetic storms to the power grid and also to offer solutions in

terms of hardening and operational measures; the report is Meta-R-319 and is published at http://web.ornl.gov/sci/ees/etsd/pes/ferc_emp_gic.shtml.

Electromagnetic Compatibility (EMC)

Definition: "The capability of electrical and electronic systems, equipment, and devices to operate in their intended electromagnetic environment within a defined margin of safety, and at design levels of performance, without suffering or causing unacceptable degradation as a result of electromagnetic interference." (ANSI C63.14, 1992)

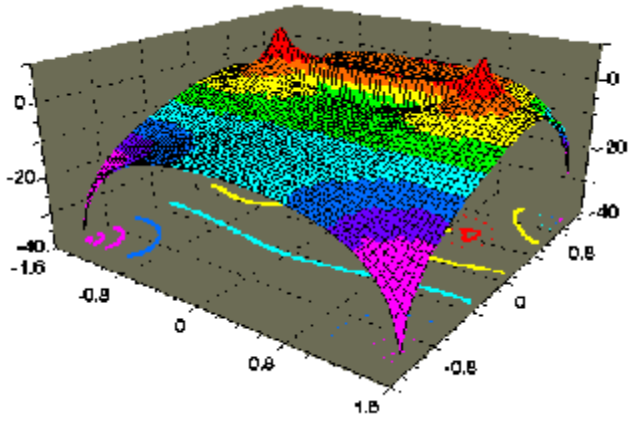
What We Do: Metatech provides EMC services to customers seeking reliable analyses of electromagnetic emissions or immunity in support of EMC protection and/or testing.

Example: Analysis of GTEM Fields

In early 1994 Metatech began an analysis program to study the response of small electronic systems exposed to EM fields in GTEM test cells. The purpose of this effort was to provide a better understanding of the interaction of test objects with the GTEM fields through a series of 3D calculations performed with advanced computer codes developed by Metatech. Results from this study have been used to evaluate the fidelity of box tests in the GTEM cell.

GTEM (Gigahertz Transverse Electromagnetic Mode) was a relatively new development in the field of EMC testing in the 1990s. The cell was developed by Diethard Hansen and Dietrich Koenigste in 1984 at the EMI Control Center of Asea Brown Boveri Ltd. in Baden, Switzerland. More than 200 GTEMs had been installed worldwide.

Metatech has performed 3D calculations over a range of parameters, and plots were generated showing contours of peak fields at a number of ranges from the source and at specific frequencies between 50 to 500 MHz. The example shown below is a three-dimensional contour of the maximum peak predicted total electric field strength in dBV/m in a plane perpendicular to the GTEM longitudinal axis. These types of computations were later extended to pulse measurements, and it was found that the GTEM waveguide is an excellent method to test equipment to HEMP and IEMI field environments.



In recent years Dr. William Radasky has served as co-convenor of the IEC Joint Task Force on TEM Waveguides. This JTF is developing a new edition of a test standard for industry (IEC 61000-4-20) to allow the use of TEM waveguides for EMC compliance testing and also for testing fast transients such as those related to HEMP and IEMI.

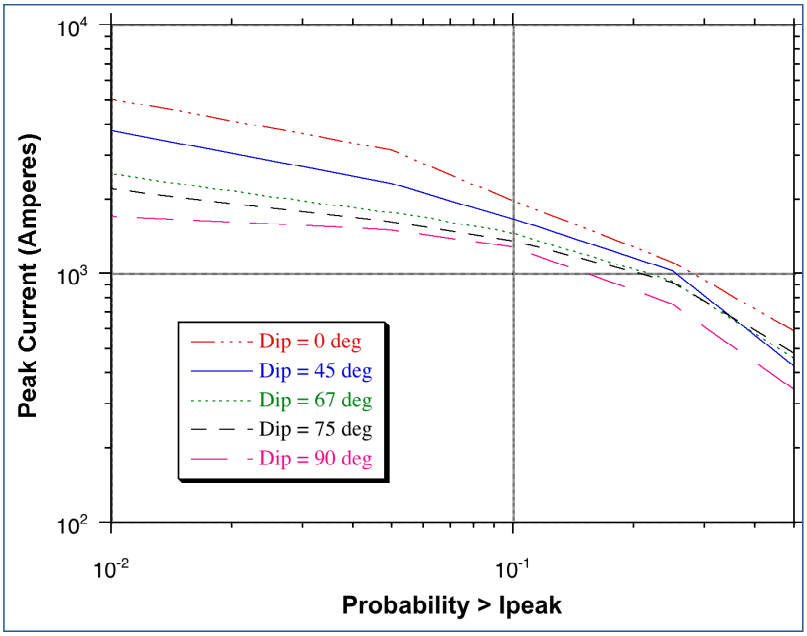
High-Altitude Electromagnetic Pulse (HEMP) and Intentional Electromagnetic Interference (IEMI)

***HEMP Definition*:** "The electromagnetic radiation caused by Compton-recoil electrons and photoelectrons from photons scattered in the materials of the nuclear device or in a surrounding medium as the result of a nuclear explosion. The resulting electric and magnetic fields may couple with electrical and/or other electronic systems to produce damaging current and voltage surges." (ANSI C63.14, 1992)

IEMI Definition: "Intentional malicious generation of electromagnetic energy introducing noise or signals into electric and electronic systems, thus disrupting, confusing or damaging these systems for terrorist or criminal purposes." (IEC 61000-2-13, 2005)

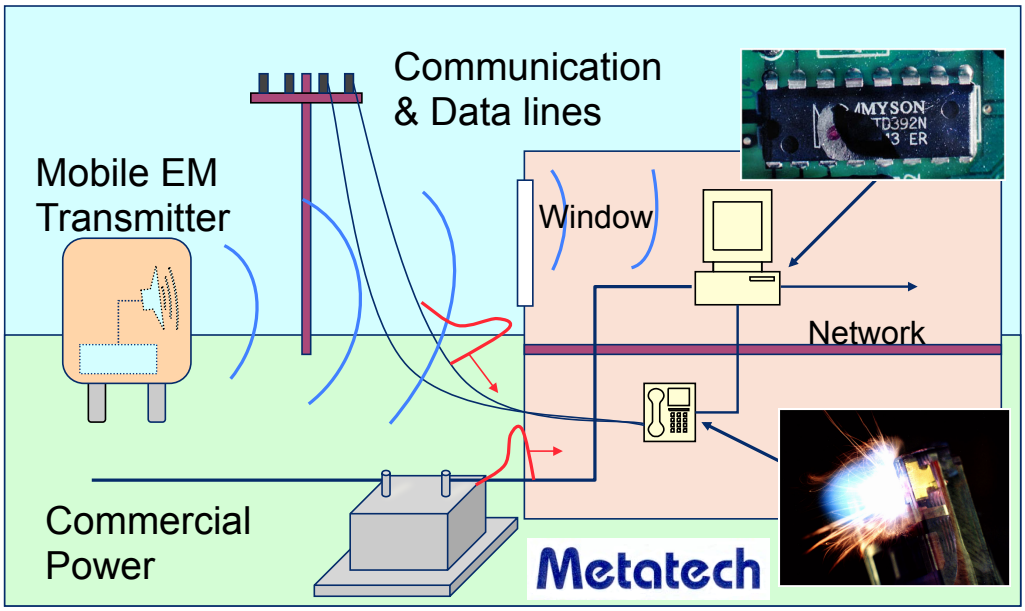
***What We Do*:** Metatech is a key contributor to EMP research in the areas of High-altitude and Source Region EMP environments and coupling and in the development of hardening and testing technologies including military standards, specifications, and handbooks. Major programs include SREMP testing and analyses at flash x-ray simulators, SREMP and HEMP standards development, HEMP environment and long-line coupling calculations and direct support for the design of facilities to achieve HEMP hardening. Our IEMI activities have involved performing assessments of facilities, performing tests to determine the IEMI susceptibility of equipment and designing protection for the high-frequency portions of HEMP and IEMI together. In 2010 Metatech evaluated the threat of IEMI to the U.S. power grid for FERC and published its work in Meta-R-323, which is found at: http://web.ornl.gov/sci/ees/etsd/pes/ferc_emp_gic.shtml.

HEMP Example: Metatech personnel have participated along with other international researchers to develop long-line coupled stresses resulting from the new IEC HEMP environment waveform for civil systems. In particular, Dr. Radasky was the project leader for the development of the IEC conducted environment standard for commercial systems (IEC 61000-2-10). A recent paper at APEMC 2012 illustrated the fact that HEMP coupling to above ground power lines is a probabilistic phenomenon (based on random orientation and interaction geometries) as shown below. This can be an important factor in the design of power line entries to shielded commercial buildings.



The probability that the peak induced HEMP current on an aboveground power line will exceed the indicated value. The dip angle is for the Earth's magnetic field and varies according to one's location on the Earth.

IEMI Example: Metatech personnel have led the standardization effort in the IEEE with the development of a standard to protect commercial computers against IEMI and in Cigré C4 to develop a guide to protect power substation electronics from IEMI.

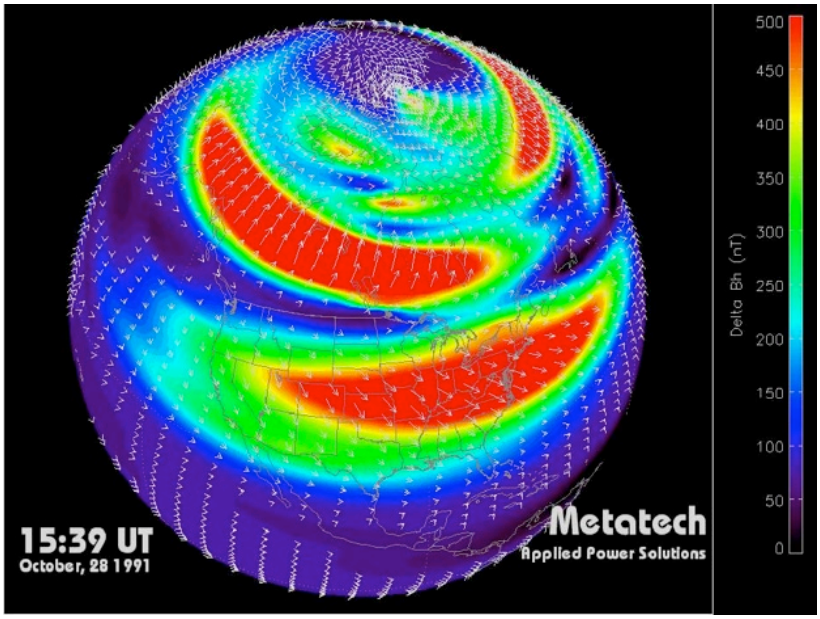


Qualitative geometry for creating IEMI through external and internal interactions.

Computer Code and Analysis Tool Development

Metatech has extensive expertise in the development of computer codes and analysis tools to support a constantly expanding range of problems. Much of this work involves special purpose applications. Computer codes and analysis tools have been developed to perform calculations in all areas of electromagnetic environmental effects including EMC, geomagnetic storms, IEMI and nuclear EMP (HEMP and SREMP). In particular Metatech has designed computer models to evaluate the generation and coupling of EM transients with rise times and pulse widths on the order of hundreds of picoseconds.

Examples include HEMP and SREMP first principle environment codes, time and frequency domain transmission line codes, special purpose codes tailored to geomagnetic storm studies, and calculational techniques, which provide 3D outputs for coupling studies.



Graphical display of the magnitude of the disturbed geomagnetic B-field (nT) based on measurements throughout North America at 15:39 UT on 28 October 1991.

SUMMARY OF EXPERIENCE, SERVICES AND PRODUCTS AVAILABLE FROM METATECH

• Development of EM environment and protection standards and specifications for government (e.g. MIL-STD-461 and MIL-STD-188-125-1, 2).

• Development of IEC HEMP and IEMI standards for protecting civil facilities from high power EM environments.

• Development of IEEE and Cigré IEMI standards and guides for protecting computer equipment and substation electronics from IEMI, respectively.

• Consulting support for the design and construction of high-frequency EM shielded buildings for civil applications to HEMP and IEMI.

• Susceptibility assessments for existing buildings and electronics to cover the threats of HEMP and IEMI.

• Evaluations of the susceptibility of high voltage power grids to severe geomagnetic storms.

• Electromagnetic test and evaluation program planning, coordination and documentation.

• Susceptibility testing of low-voltage equipment to HPEM threats including HEMP, IEMI and geomagnetic storms.

• Research into the threat, impacts and protection of the U.S. power grid from HEMP, IEMI and severe geomagnetic storms. An executive summary and 6 reports may be found on the web at: http://web.ornl.gov/sci/ees/etsd/pes/ferc_emp_gic.shtml.

• Development and maintenance of user-friendly PC-based codes to display complex calculations and/or data.

• Breaker Blankit™ product for dealing with cold temperature impacts on SF6 circuit breakers.

FACILITIES

Metatech Facilities

Metatech has offices in Goleta, CA and Albuquerque NM. All Metatech facilities contain state-of-the-art equipment required to perform research for government, commercial and international clients.

EM Test Laboratory

Metatech has a test research laboratory at its Goleta, California facility. The laboratory is capable of performing high-speed transient measurements and electronic immunity tests using the IEC 61000-4-4 Electrical Fast Transient generator, the IEC 61000-4-5 Surge generator, and the 61000-4-13 Harmonics generator, among other test sources.

Computers

Metatech uses the latest state-of-the-art 64-bit microcomputers for scientific computing, desktop publishing and remote access to customer computers. These microcomputers include both the latest PC compatibles with large memory capacity and Apple Macintosh computers with enhanced color graphics and video editing capability. Metatech facilities have color laser printers and utilize high-speed communications between offices and with customers, other researchers, and remote computing facilities.

Publication Production

Metatech offices have modern color laser printers, copy machines, binding equipment, and scanners, which enable us to produce high-quality publications. All Metatech offices have complete color capabilities for producing high-quality briefings. The Goleta office has the capability to create computer-generated

video and DVDs. The publications staff provides editing, layout, and planning support to ensure the quality of our documents. Metatech primarily employs Macintosh computers for word processing, report layout, and graphics.

Libraries and Databases

Metatech maintains extensive libraries on electromagnetics and related subjects at each of its offices. These libraries are cataloged on an in-house database system. Through subscription services and the close proximity of university libraries, Metatech has fast access to technical publications it may need for its research efforts.

PEOPLE

Excellent performance depends on excellent people. Metatech prides itself on attracting and maintaining a technical and support staff of the most qualified personnel available. Metatech is nearly unique in that the 100% employee-owned company is successfully managed by experienced scientists and engineers. Rapid response to our customers' needs is "our calling card".

GOALS AND APPROACH

The goals set for Metatech are to:

- provide government and industry with technically sound and responsive research services, and products,

- provide Metatech employees with a technically satisfying and financially rewarding career experience, and

- provide Metatech stockholders with an attractive return on investment.

While job satisfaction and profitability are important goals at Metatech, these goals are viewed as natural consequences of providing value to our customers and of exercising prudent management of corporate resources.

METATECH OFFICES

Metatech's Corporate Office is located in Goleta, California (Santa Barbara County). This office is managed by Dr. William A. Radasky and is located at 358 S. Fairview Avenue, Suite E, Goleta, California 93117. The Goleta office can be reached by telephone at (805) 683-5681 or by FAX at (805) 683-3023.

Metatech's Southwestern Facility is located in Albuquerque, New Mexico (Bernalillo County). This office, managed by Mr. Christopher W. Jones, is located

at 2340 Alamo Ave., S.E., Suite 300, Albuquerque, New Mexico 87106-7378. The Albuquerque office can be reached by telephone at (505) 243-0681 or by FAX at (505) 243-0683.

Our email address is: info@metatechcorp.com.

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