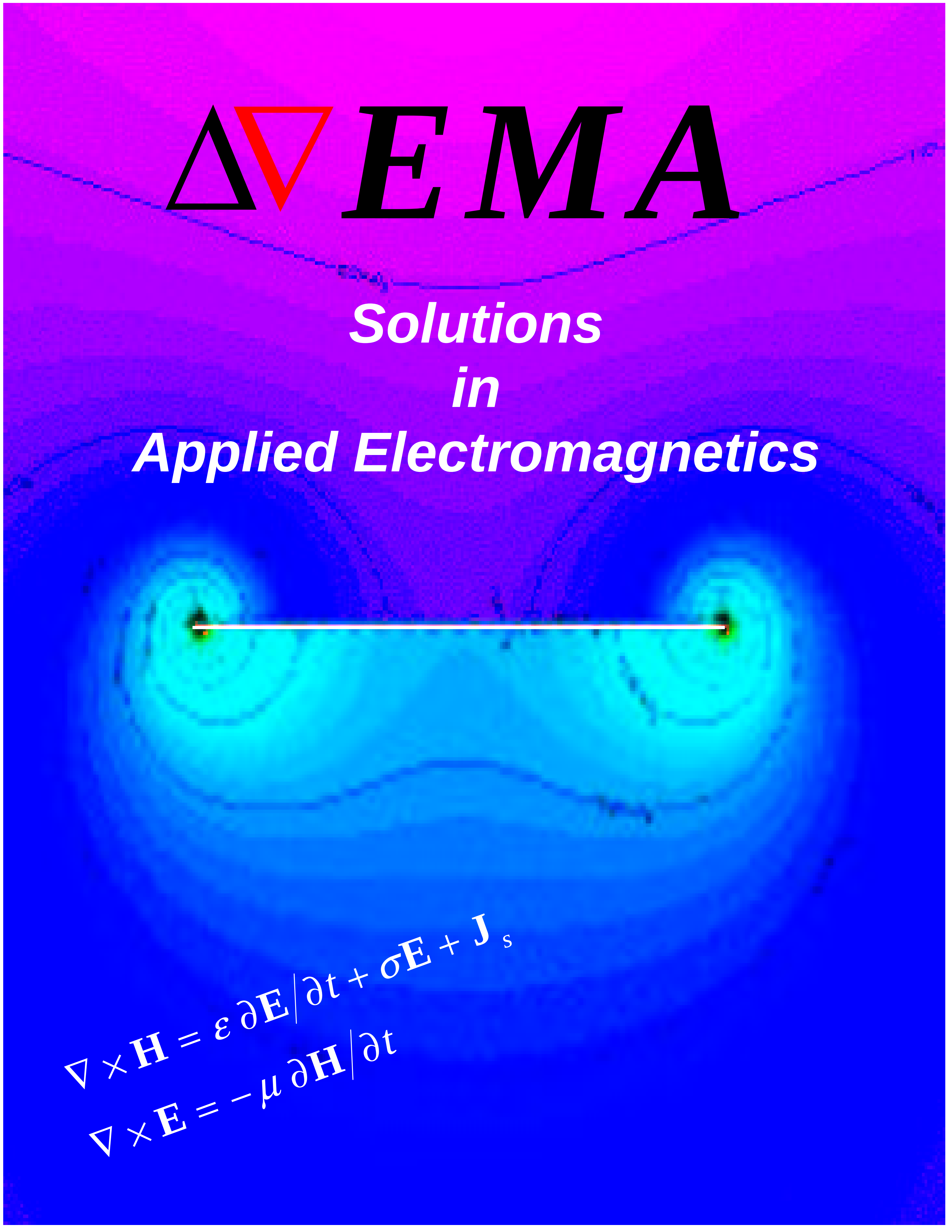
Δ∇EMA



Solutions in Applied Electromagnetics

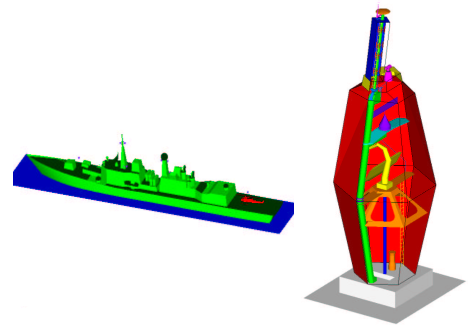
$$\nabla \times \mathbf{H} = \varepsilon\, \partial \mathbf{E} / \partial t + \sigma \mathbf{E} + \mathbf{J}_s$$

$$\nabla \times \mathbf{E} = -\mu\, \partial \mathbf{H} / \partial t$$

Computational Electromagnetics and Software

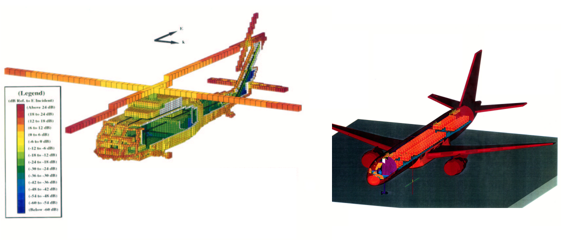
EMA is well known for its capability in computational electromagnetics. Since our beginning, we have developed numerical EM algorithms and codes, and applied them to real systems, military, civilian, and commercial. We have developed our own time domain and frequency domain algorithms for solutions of many types of problems. Most of these usually involve electromagnetic effects on systems such as aircraft, antennas, ground vehicles, electronic systems, and cables. Although *EMA* uses many numerical methods, the Three Dimensional Finite Difference Method, has been extensively developed and applied since 1977. A practical result of these activities has been the development of commercial versions of some of this software, called *EMA3D* and *MHARNESS*, which are described elsewhere. EMA also has done custom EM software development for customers, ranging from specialized algorithm development to development of graphical user interface access to EM tools.

Numerical Electromagnetic Simulation of Systems



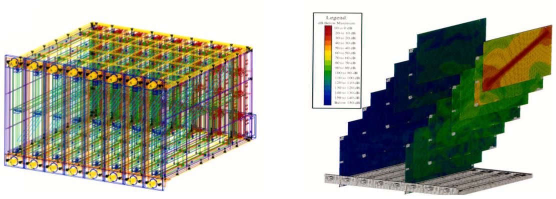
EMA has modeled ships and ship components, such as phased array antennas and this mast.

From its beginning, EMA has applied itself to understanding the interaction of electromagnetic fields with a wide variety of systems. Environments of interest include nuclear electromagnetic pulse (NEMP, both ionizing and non-ionizing radiation), lightning, static electricity, electromagnetic interference (EMI), high power microwave (HPM), High Intensity Radiated Fields (HIRF), electrostatic discharge (ESD), and ordinary signal propagation. Systems have included Space Shuttle, military and civilian aircraft, various missiles (e.g., Minuteman, Peacekeeper, Trident, Pershing, and many smaller systems), ships, tanks, armored personnel carriers, Strategic Command and Control (C^3) facilities, satellites, and mobile C^3 equipment. Smaller systems include electronic boxes, printed circuit boards, waveguides, cavity filters, conformal antennas, electromagnetic test fixtures, and strip lines. The scope of the activities include vulnerability assessments, radiated emissions, intra system EMC, *S*-parameter analysis, and antenna patterns.

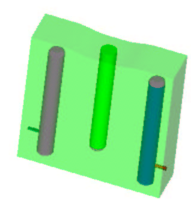


Aircraft models can be derived from paper drawings or CAD files.

In conjunction with EMA's commercial software, EMA has and can also provide not only the software, but also a numerical model of the customer's product, such as an aircraft. The model can be derived from CAD files, or from paper drawings. The customer therefore not only gets the software, but a well developed model which he can then use for further analysis and modification.



Electronic enclosures can be modeled and evaluated for radiated emissions, intra-system EMC, and susceptibility.

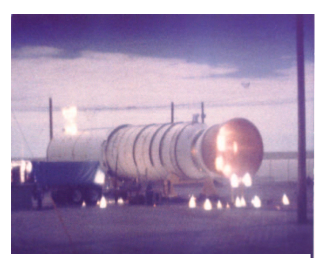


S-parameters and power flow can be modeled for two-port networks, such as strip lines and the cavity filter shown above.

Specialized Measurements, Testing, and Instrumentation

EMA also provides specialized measurements, testing, test fixture development, test method development, instrumentation development, and fundamental research experiments. Our experiments usually have one of two objectives. First, we may wish to perform electromagnetic effects evaluation of a system, such as an aircraft, missile, railroad signal house, printed circuit board or facility. Second, we may wish to understand basic physical processes in order to asses electromagnetic effects and to develop accurate models. In pursuit of these objectives, we also develop the hardware to provide EM sources and environments, as well as appropriate instrumentation control and data acquisition systems.

Data loggers in railroad wayside locations collect lightning and induction environments.



Full scale lightning testing of space shuttle solid rocket booster engines.

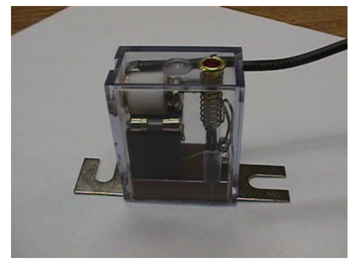
Measuring AC leakage currents in transmission line towers.

Examples include development, fielding, and use of full scale lightning test facilities, EMR (Electromagnetic Radiation) test facilities, High Power Microwave Sources, including instrumentation for control and data acquisition. We have developed helicopter borne systems for measurement of fields radiated by HF transmitters near airports, test methods for measurement of the transfer impedance of seams in electronic shelters, cabinets, and boxes, and data loggers for measurement of lightning and power line induction environments in railroad signal houses. We have also measured the effects of static electric fields on solid rocket propellants, and have measured the transport of electrical charges in the plumes of solid rocket engines exposed to static electric fields, such as the earth's fair weather field.

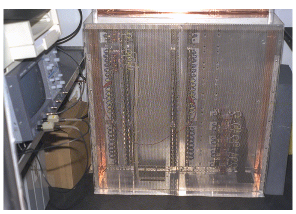
Measurements of the charging of solid rocket engines exposed to static electric fields gives insight into charge transport in rocket plumes and lightning hazards to launch vehicles.

Electromagnetic Effects on Railroad Signal and Communication Systems

EMA has established itself as a leader in railroad electromagnetic effects. These effects include both lightning protection and power line induction. EMA is well familiar with lightning protection issues for wayside, dispatch center, and hump yard applications. Railroad C&S systems have become more susceptible in recent years because of the migration of technology from electromechanical systems to those which are microprocessor based. EMA has found that the lightning issues, particularly for wayside and hump yard systems, revolve around wiring practices and equipment installation practices, which are ineffective for modern C&S systems.



A new arrester significantly reduces the exposure of signal electronics to lightning.

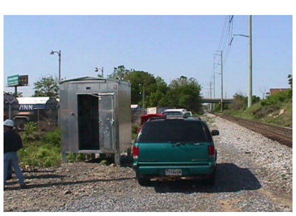


A Faraday cage system has been designed to vastly improve lightning protection of railroad signal systems.

As a result, EMA, together with some of the largest railroads in the USA, have developed new wiring and equipment installation practices providing vastly improved lightning protection and the resulting increase in system reliability. This includes a new Faraday cage design, improved arrester installation practices, and a new low voltage arrester which reduces the let through voltage on signal electronics by more than a factor of 10 over commonly used devices. Retrofit kits have also been developed for improving legacy installations, and engineering practice manuals and regulations have been rewritten.

Lightning protection of hump yards is an important part of EMA's expertise.

EMA has also much experience with lightning protection of hump yard process control systems (PCS). EMA personnel have surveyed many hump yards in the USA and Canada, and have provided detailed recommendations for improvement. These improvements include the Faraday cage and wiring and installation practices described above, plus the use of fiber optic isolation, and the protection communication and signal system interfaces. These recommendations are currently being widely implemented in some of the major railroads.



Induction effects on shared corridors can greatly affect signal systems.

EMA has also provided significant expertise in power line induction effects for shared corridors, including both power line transient fault issues as well as so-called steady state induction. *EMA* has performed significant analysis and measurements in these areas, including innovative ways to measure AC currents in transmission towers. EMA has worked together with railroads and power companies, conducting coordinated measurements to define the induction levels and scenarios. EMA has also been involved in induction mitigation design and verification testing.

EMA has evaluated the effectiveness of impedance bonds for induction mitigation.

EMA has also developed a course on railroad electromagnetic effects, which can be given at a customer site.

EMA

Electro Magnetic Applications, Inc. was incorporated in New Mexico in 1977. The President is Dr. Rodney A. Perala, a recognized authority in electromagnetic effects (EME). Corporate head quarters are located in Denver, Colorado.

In the early years, EMA focused on the electromagnetic effects of nuclear weapons (NEMP) and lightning on a wide variety of military and civilian systems. EMA was involved in the analysis, testing, and hardening of systems such as the Space Shuttle, military and civilian aircraft, various missiles (e.g., Minuteman, Peacekeeper, Trident, Pershing, and many smaller systems), ships, tanks, armored personnel carriers, Strategic Command and Control (C^3) facilities, satellites, and mobile C^3 equipment. EMA also performed a critical role in the understanding and prevention of ignition of solid rocket propellants to static electric fields. In all of these activities, EMA was widely involved both in the USA and in Western Europe. During these years, EMA personnel were also involved in several international related committees, such as the SAE AE4L Lightning Committee, the SAE AE4R High Intensity Radiated Fields (HIRF) Committee, Space Shuttle Lighting Committee, and others.

Since the end of the Cold War, EMA has changed its focus to commercial activities, including computational electromagnetics, specialized testing, electromagnetic simulation of systems, railroad electromagnetic effects, and commercial electromagnetic simulation software.

EMA's customers include aircraft developers, aerospace corporations, major railroads, defense corporations, electronics corporations, power companies, automotive industries, testing laboratories, aircraft certification agencies, military laboratories and agencies, cellular phone manufacturers, NASA, and the FAA. EMA's customer base includes North America, Western Europe, and the Pacific Rim.

EMA is dedicated to providing competent applied electromagnetic research and development by combining theoretical understanding, innovative thinking, and common sense. Our staff, all having advanced degrees, includes theoreticians, experimentalists, and those practically oriented. EMA has a worldwide reputation in the application of the understanding of electromagnetics to practical problems of real interest. In our activities, we try to optimize the mix of theory, analysis and experiment whenever possible.

EMA

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