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RESEARCH AT THE ELECTROMAGNETIC SCIENCES LABORATORY OF SRI INTERNATIONAL

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The research of the Electromagnetic Sciences Laboratory deals with the study of the interaction of electromagnetic systems with the environment in which they operate. The initial work of the laboratory in the early 1950's involved aircraft and radar antenna research and development. As time passed however, the work evolved into three areas--space, ocean and interference.

One area, led by Dr. Joseph Nanevicz, is concerned generally with Electrostatics. Early work on charging of aircraft led to the design and development of the electrostatic dischargers which are now standard equipment on all commercial airlines. Current research in this area of flight vehicle electrification was initiated when users of satellites operating at synchronous orbit found that anomalies (such as inadvertent switching of circuits) occurred on these satellites. There appears to be a high degree of correlation between the frequency of these anomalies and the occurrence of geomagnetic substorms. The realization that satellites can charge to potentials of thousands of volts under substorm conditions has been verified by simulation in the laboratory. On-board instrumentation has recently been developed to measure the charging of satellites and to characterize the electromagnetic interference generated by breakdown of dielectric materials.

Another study in this area is the behavior of the electrical conductivity of high voltage insulating materials such as Teflon and Kapton in the presence of solar illumination and plasma in space. Laboratory measurements indicate that after six hours of illumination to light in a space environment, the conductivity of Kapton can be increased by five orders of magnitude. Since this material is being used as substrate for satellite solar cell arrays, prolonged exposure to sunlight may lead to degraded solar panel performance.

A NASA Learjet aircraft was instrumented by SRI to conduct measurements of electrostatic field levels over Pad 39 at Cape Kennedy prior to the launch of the Apollo/Soyuz to verify that there was no possibility of lightning strikes to the spacecraft after launch. In addition to the launch support activity, this aircraft was flow in the vicinity of thunderstorms to study the electrical development of thunderstorms. The electrical nature of the anvil top was measured for the first time as well as the nature of the electrical signal coupled into the aircraft electrical systems during a lightning strike.

Electromagnetic Pulse (EMP) is another area in which this laboratory has been actively involved since the underground nuclear tests were conducted at the Nevada Test Site. Work in this area has been led by Mr. Arthur Whitson and Mr. Edward Vance and has involved experimental as well as analytical studies into the coupling of signals into cables as well as into installations such as the AUTOVON system (telephone switching centers), Minuteman Missile System and the Safeguard Anti-Ballistic Missile System. At present, studies are being conducted for the design practices for intrasite cabling of communication facilities as well as for treating the various penetrations such as cables, wave guides, antennas and power lines through which signals can enter. As part of this effort, Mr. William Scharfman has made use of electromagnetic modeling to simulate the

EMP threat as well as to design an electromagnetic simulator to produce the desired threat field over scale models of the installation.

Ocean Wave Measurements. A wave staff using a series of resistive wires was designed to measure the height of waves and its frequency spectrum of waves. In essence, the wave staff provides the actual condition of the water surface, which is correlated with radar scatter observations. This program, under the guidance of Dr. Harold Guthart, provided sea truth for a series of radar infrared observation of the ocean surface. Measurements were made from the "flip" ship which is an experimental measurement ship which can be filled with water causing the ship to take a vertical attitude to provide a stable measurement platform.

Antennas for Guidance of Reentry Vehicles. Recently a study was made (under the direction of Mr. John Chown) to design an antenna system for a radar guided reentry vehicle. This study included a survey of the effect of the reentry environment such as ablation, plasma sheath, nose cone material and vehicle shape on antenna performance. During the program, antennas such as horns, lenses, and phased arrays, including conformal arrays, were considered for various flight regimes of the vehicle.

Satellite Antenna System Design. Modern satellite communication systems now involve power levels on the order of several hundred watts radiated. This has increased the possibility of the occurrence of multipacting discharges. If more than one frequency is being transmitted, the resultant plasma of the multipacting discharge can cause frequency mixing with sum and difference frequencies to be generated. Dr. Gerald August has been involved in the redesigning of components to maximize the threshold levels of antennas, baluns, filters and interconnecting cables. Care must be taken, however, to make sure that the multipacting breakdown will not transition to an arc discharge. The later can cause damage or even lead to catastrophic failure. Filling the transformers and baluns with dielectric material appears to be the simplest solution to this problem.

Effect of Rocket Plumes on RF Scattering. The radar cross section of a liquid rocket booster has been measured in a cryogenically cooled chamber in an Air Force facility in Tennessee. By measuring the electron density profile and scale of turbulence using electrostatic and microwave probes with the HP 2100 data acquisition system, a mathematical model of the rocket plume scatterer has been formulated. The model has been checked previously in the SRI low-pressure flame facility by Dr. Kurt Graf for the study of radar scattering from turbulent plasma.