February 1994

EMC TEST & DESIGN

- Designing EMC into the FAA Registry Building
- The Case for NVCASE
- EMC/ESD International Technical Program

EMC Design of The FAA Registry Building

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He received the Passive Solar Cooling Design Award from the Department of Energy. In 1991 he received the Outstanding Member Award from AIA Central Oklahoma. In 1993, he received a Special Award for Work in Education from AIA Central Oklahoma. He may be contacted at FSB, 5701 North Shartel, Suite 210, Oklahoma City, OK 73118. Phone (405) 840-2931.

The Registry Building is located at the Federal Aviation Administration (FAA) Mike Monroney Aeronautical Center in Oklahoma City. This new facility at the aeronautical center campus is used by the FAA Airmen and Aircraft Registry to issue and maintain aircraft registrations and airmen certification records for all U. S. civil aircraft and airmen. The 95,000 square-foot facility shown in Figure 1 houses five FAA branches, accommodates more than 300 people, and provides computerized record storage and retrieval.

The Mike Monroney Aeronautical Center is expanding as a result of its importance for air traffic control training and information management. As part of the FAA's campus master plan, the facility is linked with above and below grade pedestrian circulation systems to existing buildings. The exterior of the Registry Building expresses a clean, contemporary image reflecting its highly sophisticated program.

The majority of the building accommodates open plan computer workstations accessing high resolution images of licenses and diplomas which serve as legal documents and meet courtroom scrutiny. Walk-in customer traffic is planned, but most usage will be through world-wide telecommunications. The first floor public areas are secured from the equipment rooms and the second floor open plan workstations.

Due to the proximity of the radar used by an adjacent air traffic controller training facility, the building "skin" has been designed to shield the computer system from external electromagnetic fields. Special metal covered gaskets provide a "metal bridge" between sections of steel wall paneling. To provide natural daylight to those who work in the building, interior light wells extending through the two levels of the building are centrally positioned in open office areas and designed to shield glare from computer screens.

By using special design details, the surrounding electromagnetic field of 400 V/m was attenuated to 1 V/m. This significant reduction of outside interference protects the sensitive computers housed inside the Registry Building. Housed at the Registry Building are nine OSAR #280 optical storage and retrieval computers. Each of these computers holds 280 12" laser disks, each holding 50,000 pages of documents. They are operated internally by robots which automatically select and place requested laser disks into the disk drive. To protect this state-of-the-art computer system, FSB designed static grounding and lightning protection systems, temperature and humidity controls, and an uninterruptible power source capable of providing electrical power until the building's emergency generator is started and serving the laser disk storage units and servers.

This building, which was designed in 1991 by Frankfurt Short Bruza working with the Aeronautical Center Architectural and Engineering Division, met an aggressive schedule requiring occupancy in November 1992. Construction started in January 1992 and was completed on December 29, 1992.

Figure 1. The FAA Registry Building in Oklahoma City, Oklahoma.

Electromagnetic Shielding

The Registry Building is shielded from a broad spectrum of electromagnetic waves by reflective or conductive materials that also provide continuous electrical grounding. Specific details which demanded innovative design solutions included electromagnetic sealing of all joints. Every joint in the building is sealed with a copper tape which has conductive adhesive and maintains electrical conductivity. The copper tape serves as an "electrical tie" between joints as do the "metal fingers" which are bronze metal weather stripping materials used around entrance doors. A metallic barrier is also provided among the flutes of the metal deck by bronze wool which was applied in the space between the flutes.

Implementing Glass in EMI Shielding

FSB commissioned tests which determined that the highest level of electromagnetic energy impacting the Registry Building was 400 V/m at a height of 12 meters above the ground. The strongest signal, occurring at the skylights, required an innovative solution for shielding.

Since glass does not reflect electromagnetic energy, designers initially considered windows and doors to be "weak links" in the EMI shielding of the Registry Building. But buildings without windows and exterior views are not desirable working environments. Psychologically, windowless workplaces

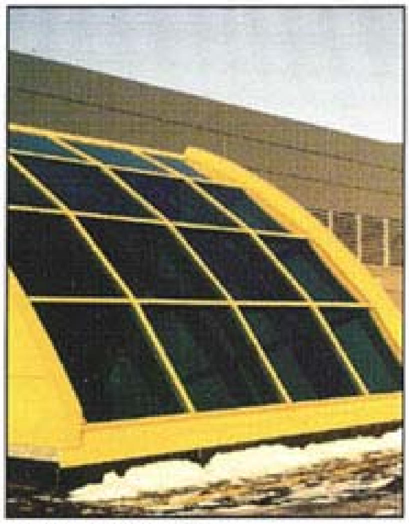

Figure 2. Skylights.

Figure 3. Open areas.

Figure 4. Natural lighting.

produce environments which are claustrophobic and do not promote worker productivity. It has been shown that those who work in daylighted spaces are less depressed and more motivated employees.

Responding to the need for glass to be used in the construction of the Registry Building, FSB specified the use of Pilkington Architectural's Datastop glass. This glass has been specifically designed to reduce the transmission of electromagnetic radiation while transmitting natural daylight to those who work in the building. Four skylights above interior light wells extend through the building with open office areas positioned around the naturally daylighted wells. The Registry Building lighting is shown in Figures 2, 3 and 4.

Shielding at Points of Egress

Two main grade-level entrances to the Registry Building provide primary entrance access. Additional access is provided by a below-grade tunnel from the adjacent Aircraft Records Building. The two grade-level entrances to the Registry Building, like the skylights, were identified by project designers as "weak links" in the EMI shielding of the building.

To provide continuous shielding when entrance doors are open as people come and go, the designers lengthened the travel distance in the vestibules from the standard 8 feet to 12 feet. This allows enough time to elapse between the opening of the doors that the first door closes before the second opens. The interior walls of the vestibules are lined with eight inches of electromagnetic absorbing cones and both sets of doors are sealed with special metal gaskets and bronze metal weather-stripping.

The building was permitted few openings on the sides that faced the radar antennas directly. Utility penetrations into the building were kept to a minimum, and the rooms housing the most sensitive computer equipment use specially shielded glass for windows and skylights to achieve the required shielding.

Datastop Glass

The signal attenuation of Datastop Glass is achieved by the use of several layers of specially developed coatings which reflect electromagnetic radiation. The attenuation provided depends on the characteristics of the radiation and the electrical connection at the glass edge. These glasses can be used as windows or glazed panels in shielded external walls, internal partitions or cubicles designed to provide good attenuation using the Faraday Cage Principle.

A Faraday Cage is an enclosure, all of whose external surfaces are electrically conducting. For maximum attenuation the special coatings on the Datastop Glass must be conductively connected to the window frame all around its periphery, which in turn should be connected to the wall screening of such an enclosure. Pilkington Glasses provide good clear vision and light transmission. Additional advantages of the Datastop double glazed glass is its inherently high solar heat rejection and exceptional thermal insulation.

The application of Pilkington Datastop Glass in the Registry Building is the biggest installation of this type of glass in the United States. The glass was shipped to the U.S. from the United Kingdom.

The Role of Elite

Elite Electronic Engineering acted as EMC consultants for the design and fabrication of the Registry Building. First, Elite made an electromagnetic survey from 10 kHz to 20 GHz at the proposed building site. The results of this survey were used to formulate an electromagnetic shielding specification for the building with respect to RF interference levels generated by the radar systems and other RF sources at the FAA Training Facility.

The shielding objective was to reduce the signal strengths present to less than 1 V/m inside the building. High-power microwave RF signal strengths were a concern because transmit antennas for various training radar systems were located within 300 meters of the proposed site for the Registry Building. To determine these and other RF field strengths, Elite personnel selected five locations around the perimeter of the site for measurements. Readings were taken at 3, 6, 9, and 12 meters above grade level, since the two-story building would rise 15 meters above the grade level at its highest point.

The measurement antennas were pointed directly at each radar tower and the spectrum analyzer center frequency was tuned to the transmit frequency of the subject radar. Because the radar was pulse modulated and mounted on a rotating antenna fixture, the signal had to be monitored at some length to ensure that the maximum levels were detected. Elite personnel used a wide bandwidth (3 MHz) setting and a small frequency span to detect the true signal levels. After analyzing the signal, its frequency and maximum signal level were recorded. This process was repeated at each of the five locations.

Elite personnel analyzed the survey data and presented their results and recommendations to FSB in the test report. Since the measured RF field strengths were well in excess of the desired objective, the building required at least 52 dB of shielding effectiveness in the 1–3 GHz range to reduce the field strengths present to 1 V/m. This would be a formidable task, since the building required doors, windows, and other penetrations necessary for daily use and physical plant management. During construction, Elite personnel supervised the critical installation of shielded windows and skylights.

The final building surveys were performed in two phases. Phase I of the RF survey was performed after the building's outer skin had been completed, but prior to the installation of foil faced insulation of the walls. Phase II of the RF survey was performed after the foil-faced wall insulation was installed, and all exterior openings, including shielded windows, skylights and shielded doors were in place. For Phase I of the final testing, Elite selected 42 locations for the indoor measurements. Phase II measurements were made at the 16 locations that showed the highest levels of field intensity during Phase I.

The building exhibited shielding effectiveness up to 76 dB. Throughout most of the building, the 1 V/m goal was achieved, with levels well below 1 V/m in the rooms where the most sensitive equipment would be housed. This survey can be used by the FAA building staff to determine where to locate future sensitive equipment as required.

Design Team

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