Possible reasons why your ICD705 Aluminum Foil RF shielded SCIF room is not meeting the required shielding performance level

Definition: In RF (radio frequency) shielding, a decibel (dB) is a logarithmic unit used to measure shielding effectiveness (SE) or signal attenuation. It expresses the ratio between the power of a radio wave hitting the outside of a shield and the power that leaks through to the inside. Higher dB values mean the RF shield blocks more signal, both entering and exiting the Intelligence Community Directive (ICD) 705 SCIF (Sensitive Compartmented Information Facility).

A 40dB RF shield reduces signal power by a factor of 10,000 (blocking 99.99%), whereas a 60dB shield reduces power by a factor of 1,000,000 (blocking 99.9999%). An 80dB RF shield reduces signal power by a factor of 100,000,000 (blocking 99.999999%). The 20dB difference means 60dB provides 100 times more signal reduction than 40dB. **The 40dB difference between a 40dB and 80dB RF shielded SCIF room is the 80dB provides 10,000 times more RF signal reduction, than the 40dB shield.**

1) You are using the wrong RF shielded foil in the walls and ceiling of your SCIF.

A) The RF shielding foil does not contain enough metal to meet the desired shielding attenuation.

Vapor Barriers with aluminum, Typically, are made up of below:

.00035” to .0005” aluminum on 2 sides of plastic (0.001” (1mil) at best of actual aluminum)

.0035” scrim fibers in the center (strengthens the plastic core)

.001” to .006” polyethylene (PE) film (the plastic core) **Plastic does not block any RF signal**

.002” acrylic adhesive (aluminum is attached to plastic core with an acrylic transfer)

These vapor barriers are typically 0.009” (9mil) to 0.012” (12mil) thick overall.

The example above is a 25dB to 40dB RF shielding effectiveness vapor barrier.

The most common RF shielding attenuation level is 60dB from 10MHz to 10GHz. It takes a minimum of ≥ 0.003” (3mil) of ≥ 98% pure aluminum to meet this requirement.

2) The RF shielding foil manufacturer is doing the IEEE-299 shielding effectiveness test incorrectly.

A) The IEEE-299 test sample needs to replicate how the RF shielded foil and tape are actually installed in the SCIF room walls and ceiling.

i) If the IEEE-299 test was done with only the foil covering the complete opening, the resulting performance is much better than it should be. How do you install 48” wide foil rolls on to the

SCIF wall without seams and tape? Even with Z-fold installation there are seams and you need to tape across it with electrically conductive PSA (Pressure Sensitive Adhesive) foil tape.

Example of how NOT to do the IEEE-299 test (no seams & no tape)

ii) The correct way to perform the IEEE-299 testing is to have the seams and tape included in the test sample. This way you get an accurate result of the RF shielding effectiveness of the SCIF, if installed correctly.

Example of how to do the IEEE-299 test correctly (with seams and tape)

B) The ASTM D4935 test method should NOT be used for architectural RF shielding effectiveness.

i) ASTM D4935 provides a procedure for measuring the electromagnetic shielding effectiveness of a planar material for a plane, far-field electromagnetic wave. From the measured data. near-field shielding effectiveness values may be calculated for magnetic sources for electrically thin specimens. Electric field shielding effectiveness values may also be calculated from this same far-field data. Small sample is tested using a coaxial transmission-line fixture.

ii) ASTM D4935 Specimen Size Limits: Outer Ring / Load Specimen: Outer diameter 133.1 mm (**5.24 in**), inner diameter 76.2 mm (**3.00 in**). Inner Disk (Reference part): Diameter 33 mm (**1.30**

in). Material Thickness: Must be "electrically thin" relative to the wavelength and typically limited to a thickness that can be securely clamped in the coaxial fixture without distorting or damaging the material (generally under 1.5 mm to several millimeters depending on rigidity).

Example of an ASTM D4935 Test Setup

iii) The ASTM D4935 test validity and applicability have not been established. **Calculated ASTM D4935 RF shielding effectiveness results DO NOT correlate to actual measured IEEE-299 RF shielding effectiveness results.**

3) You are using the wrong electrically conductive PSA foil tape.

A) The PSA on the foil tape is not electrically conductive.

i) Conductive foil tape can be electrically conductive or thermally conductive. Electrically conductive PSA foil tape must be used.

ii) Aluminum HVAC (Heating, Ventilation, and Air Conditioning) duct tape is thermally conductive, but is not correct for RF shielding.

B) The thickness of the foil in the tape is too thin.

i) 2mil (0.002”) aluminum tape is good for 40dB – 45dB RF shielding attenuation system.

ii) 5mil (0.005”) aluminum tape is good for 80dB – 85dB RF shielding attenuation system.

iii) The RF shielded seaming tape and the RF shieling foil are not made out of the same material.

iv) The tape manufacturer only gives you the total thickness of the tape and the adhesive combined. Most tapes have a minimum 2mil (0.002”) adhesive layer.

4) You are using the wrong RF shielded floor system.

A) It is not a good idea to put a laminate vapor barrier product in to a cement floor structure.

i) The vapor barrier will delaminate very easily.

ii) Concrete installed on top of the vapor barrier (#1 above) WILL crack.

B) You did not install a fully warranted and performance guaranteed, RF shielded floor system.

i) Xalon offers the SCIF-USx fully warranted 60dB & 80dB RF shielded floor systems.

5) You are not installing EMI filters on all the metallic wires that penetrate the RF shielded wall.

A) EMI filters need to be installed on every metallic wire (line) that penetrates the RF shielded barrier.

i) EMI (Electro-Magnetic Interference) filters eliminate the conducted RF emissions from entering or exiting the RF shielded SCIF.

ii) Unfiltered metallic line act as an antenna, bring RF signals into and out of the shielded SCIF.

iii) EMT electrical conduit is not guaranteed to be RF shielded.

iv) It is NOT good practice to put metallic lines through a pipe penetration. The RF signal on the metallic lines can travel inches (high frequency) to several hundred feet (low frequency). Your unfiltered power wiring can be carrying an RF signal from inside the SCIF out of the building and onto the power line.

6) You are not installing the correct waveguide air vents in the HVAC ducting.

i) The waveguide honeycomb air vents have the wrong hexagonal cell width or length.

ii) Zinc coated steel and brass are the most common honeycomb air vents.

iii) Waveguide aluminum honeycomb air vents are often a poor choice because they bend easily, trap moisture that causes corrosion, and can create high airflow noise. They also fail in high-temperature or harsh chemical settings.

7) You are using incorrect sized waveguide pipe penetrations.

i) For circular waveguides:

fc = c/3.412r

where:
fc = cutoff frequency
c = speed of light, 1.181 x 1010 in/s
r = radius of circular waveguide in inches
General Rule of Thumb: For circular waveguides, make sure the waveguide length is at least four times the diameter.

ii) You installed a pipe penetration with a large inside diameter, that has a cutoff frequency lower than your required RF shielding effectiveness frequency.

iii) Example a 3 inch ID pipe penetration has a cutoff frequency of 2.31GHz, but you are required to meet 60dB to 10GHz. The pipe penetration will leak RF from 2.31GHZ to 10GHz (and up).

8) Your RF shielded system is not grounded correctly.

A) For the multipoint ground RF shielding system like, Xalon's AL5, the perimeter wall studs, top and bottom wall plates, and ceiling joists were not all tied to earth ground.

i) Earth ground is the best, followed by building ground and then electrical ground at a minimum. Per NEC they are supposed to all be tied together at your main electrical service panel. The grounding was not verified before and after the RF shielding foil was installed.

ii) ALL of the SCIF perimeter metal plates, studs and joists were not verified they were tied to ground.

ii) Interior wall studs and plates that are RF shielded walls were not tied to ground.

9) Your RF Shielded Door Assemblies are No Longer RF Sealed.

i) Worn or dirty finger stock gaskets, misaligned latching hardware, or damaged drop seals allow RF signal to leak out around the door leaf to door frame area.

ii) The RF shielded door frame was not anchored correctly, causing the door frame to vibrate or move in and out. This motion may eventually cause a tear in the RF shielded foil from the door frame to the surrounding wall, causing an RF leak.

10) The RF Shielding Foil was Punctured or Torn During Installation.

i) Drywall screws, mounting screws for surface mounted electrical, fire, HVAC or clips that over-penetrate or missed structural grounded studs can tear or compromise the RF foil/barrier layers.

ii) When the interior layer of sheetrock was installed, the wall to wall or wall to ceiling corners, tore the RF shielding foil in the corners due to the radius bend of the foil, not being addressed during foil or sheetrock installation. The use of metal corner flashing eliminates this problem.

Eric Evans
CEO/Physicist
R. A. Mayes Company, Inc.
Telephone: 303-761-9447
Email: sales@ramayes.com
Website: www.ramayes.com
IEEE Life Member (EMC Society)
39 Years of RF Shielding Expertise
Follow us on LinkedIn https://www.linkedin.com/company/ra-mayes-company