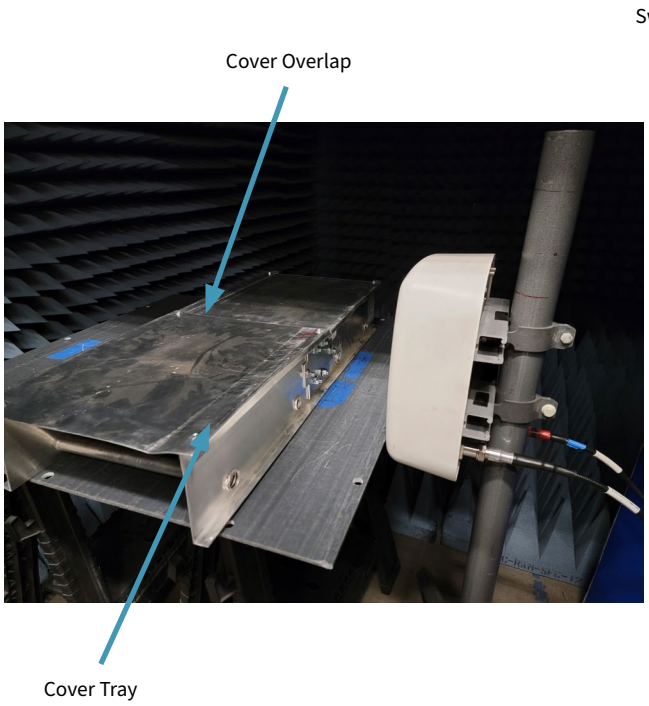
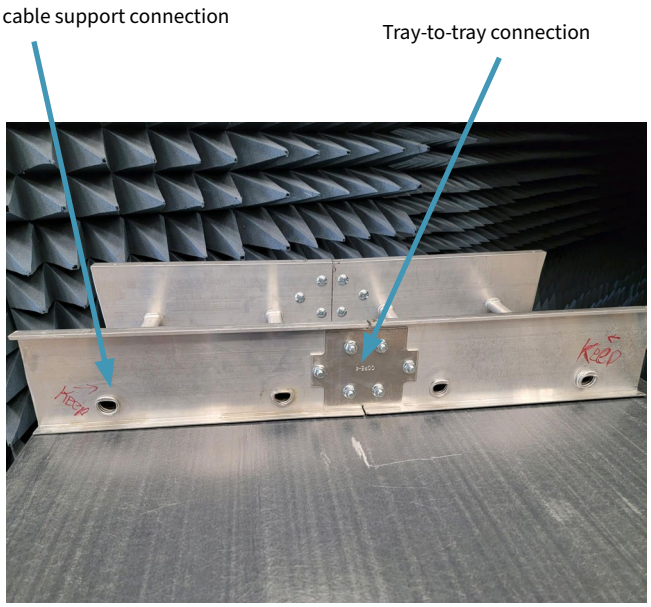
Low PIM Rooftop Cable Trays

INTRODUCTION

Cable tray assemblies are often used on rooftop cellular base station sites to protect RF, fiber optic and power cables. When cable trays are installed in front of or below the site antennas, they have been found to generate significant passive intermodulation (PIM). This is due to the loose metal-to-metal contacts found in typical cable tray assembly designs as shown in the images below. Loose contacts can occur where the covers touch the tray, where trays connect together and where the metal cable support bars are swedged to the cable tray sides. In addition, some designs have galvanic mismatches between metal types which can also generate PIM.

Photo of operator PIM-hunting near a cable tray at a base-station site





Several options are available for mitigating PIM generated by cable trays. The first is to reduce the power of the downlink signals arriving at the tray (by either adjusting antenna electrical tilt or installing RF barrier materials). The second is to improve the linearity of the tray itself. This could be accomplished by ensuring high contact pressure at all metal-to-metal contacts, or by insulating contacting surfaces, or by eliminating metal-to-metal contacts altogether.

Before launching a project to develop a low PIM cable tray option, ConcealFab collected and measured the PIM performance of commercially available options. Measurements were made on the typical **aluminum ladder style cable** tray currently found at cell sites. Measurements were also made on an **all-fiberglass cable tray** available from Atkore. (Thank you Atkore for providing the sample trays for testing!)

RADIATED PIM TESTING: METHOD AND COMPONENTS TESTED

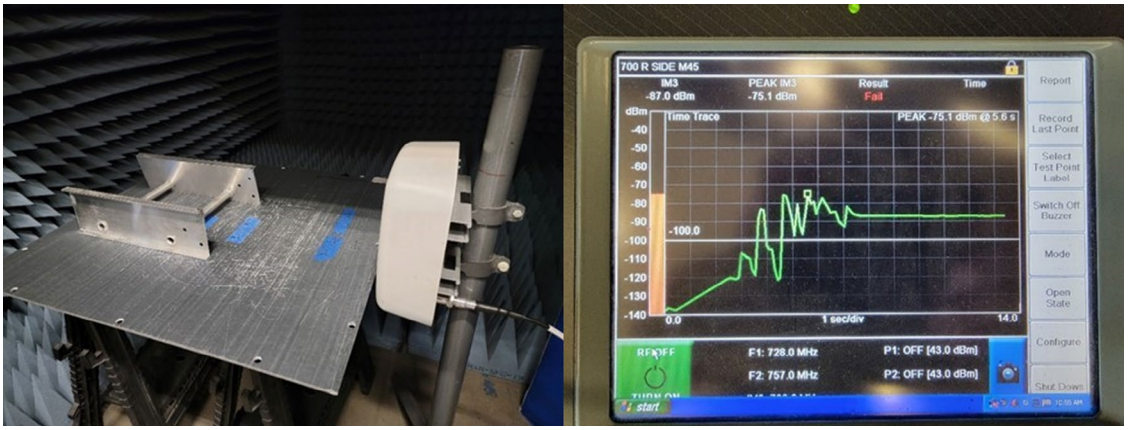
Radiated PIM testing was performed on each assembly in both the 700 and 1900 MHz bands, using the test set-up as described in IEC 62037-8. The peak third-order intermodulation (IM3) level was measured while tapping on the assembly using a fiberglass rod to provide dynamic stimulus. PIM-testing was conducted for exploratory purposes instead of certification and therefore was done using a single polarization and only a few orientations (i.e. fewer than the number specified in the IEC specification). A pass/fail limit of -100 dBm when radiated with 2x 20W test tones (-143 dBc) was used to evaluate all configurations. The table below shows the tests conducted and the results achieved.

TEST RESULTS:

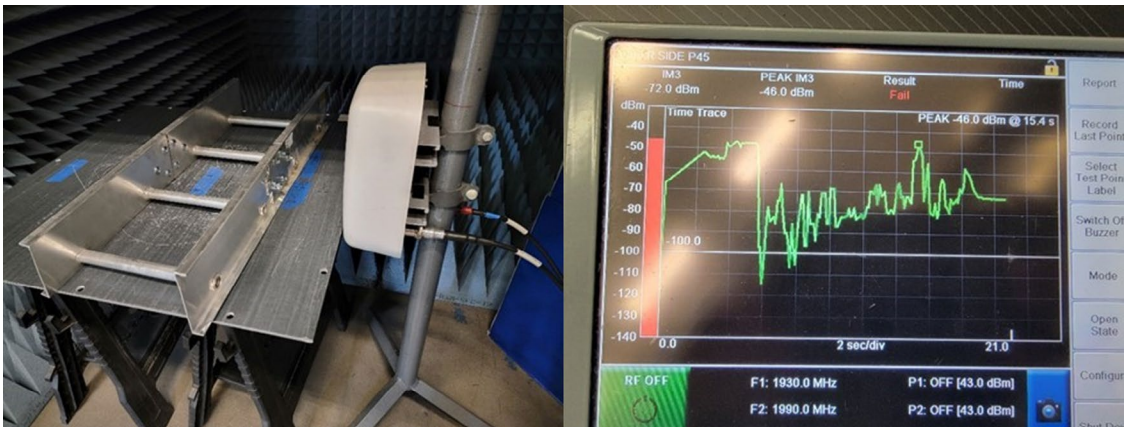
TRAY	CONNECTING PLATE	COVER	700 MHZ IM3 (DBM)	1900 MHZ IM3 (DBM)	COMMENT
Aluminum	None	None	-75.1	-74.2	“Swedged” cable tray construction causes PIM
Aluminum	Aluminum	None	-116	-46	Metal cable tray sections touching each other cause PIM
Aluminum	Aluminum	Aluminum	-83.8	-55	Metal covers touching metal cable trays cause PIM
Fiberglass	Fiberglass	None	-117.9	-113.6	Metal hardware used to secure connection plate
Fiberglass	Fiberglass	None	-118.8	-114.6	Fiberglass hardware used to secure connecting plate; metal hold-down bar added
Fiberglass	Fiberglass	Metal	-117.6	-74.5	Plastic rivets used to secure metal covers. PIM occurred where metal covers overlapped.
Fiberglass	Fiberglass	Fiberglass	-117.9	-113.9	Metal hardware used to secure fiberglass covers

TEST IMAGES:

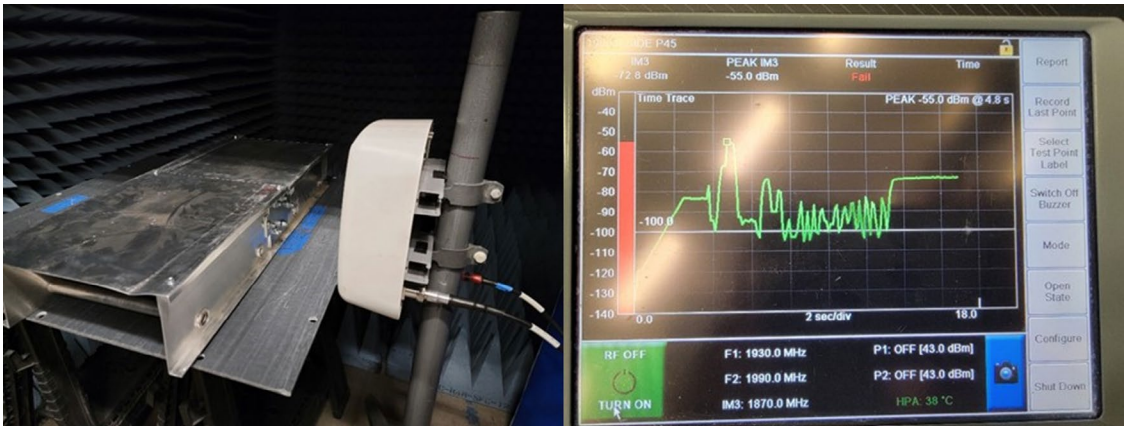
Aluminum cable tray, single section:



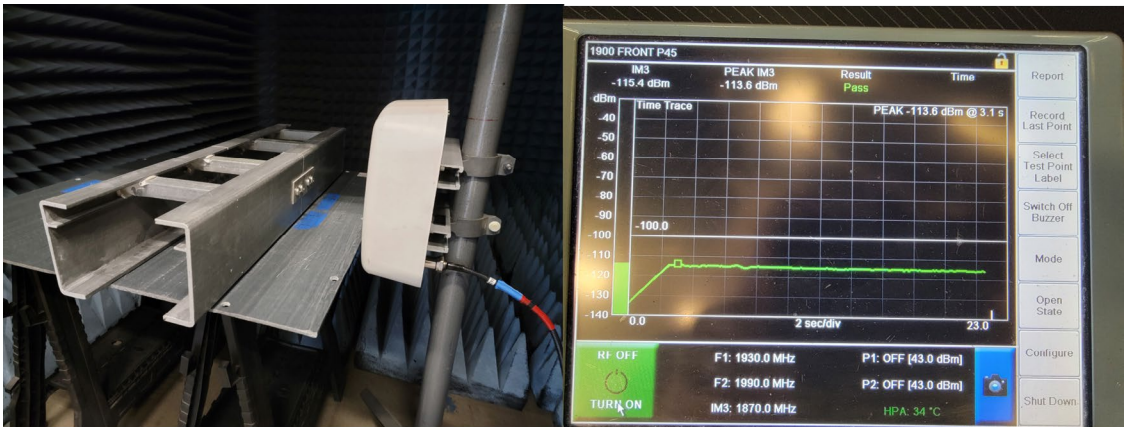
Aluminum cable trays, merged with metal connecting plates:



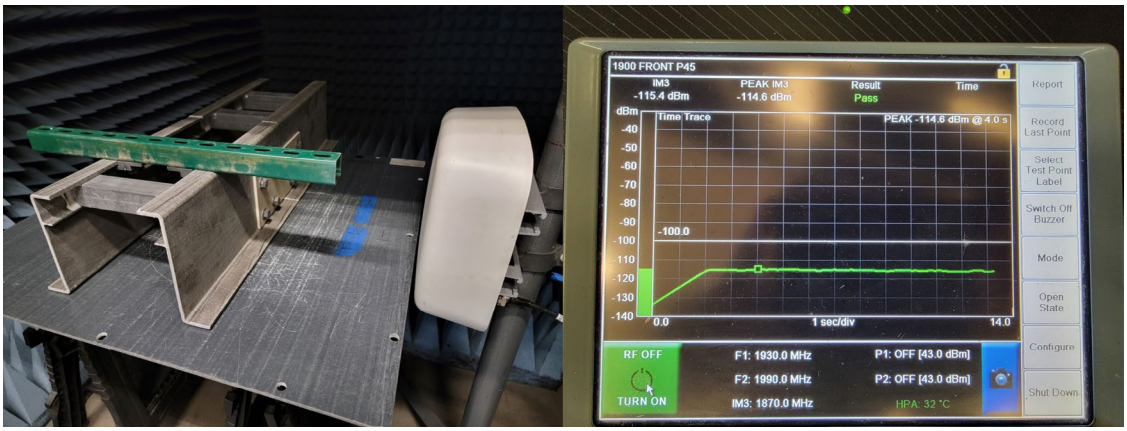
Aluminum cable trays with metal covers and connecting plates



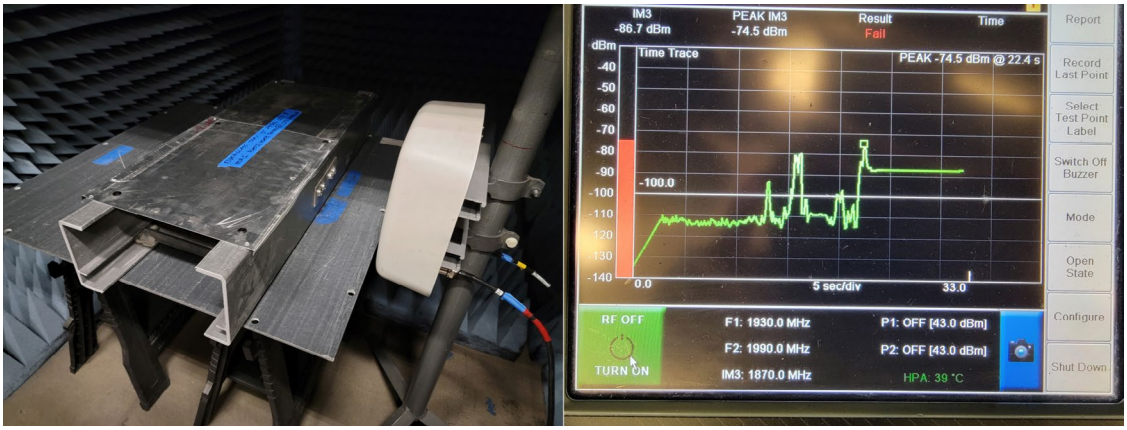
Fiberglass cable trays and connecting plates (secured with stainless steel hardware)



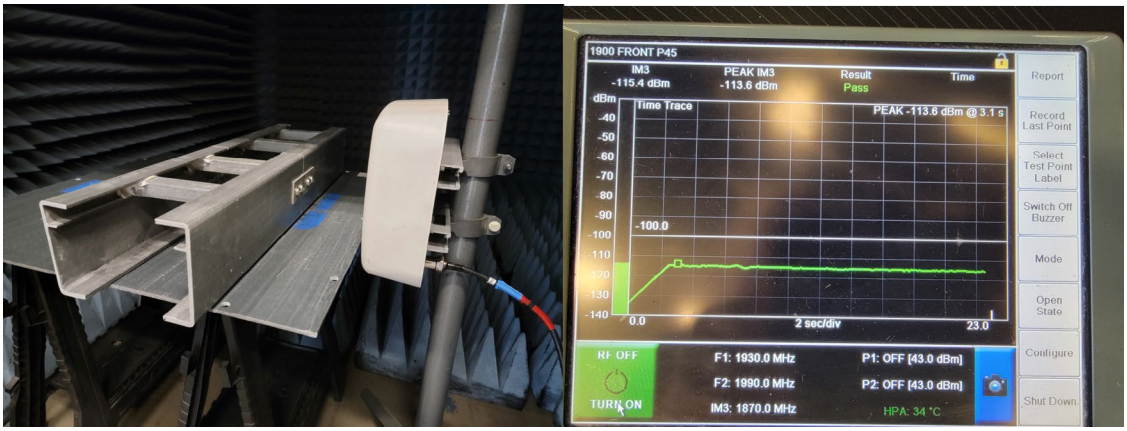
Fiberglass cable trays, plates, and hardware with metal hold-down bar



Fiberglass cable trays and connecting plates with metal covers (secured with plastic rivets)



Fiberglass cable trays, plates, and cover (secured with metal screws)



CONCLUSION

ConcealFab testing verified what we have seen in the field—that existing aluminum ladder style cable trays are capable of generating high PIM. Testing conducted on Atkore's all-fiberglass cable tray assemblies showed that these assemblies are a reliable low-PIM alternative to metal cable trays. Best results are achieved when the tray, cover and connecting plates are all produced from non-metallic materials. Metal mounting hardware to join the Fiberglass components performs well as long as the connections are torqued correctly.