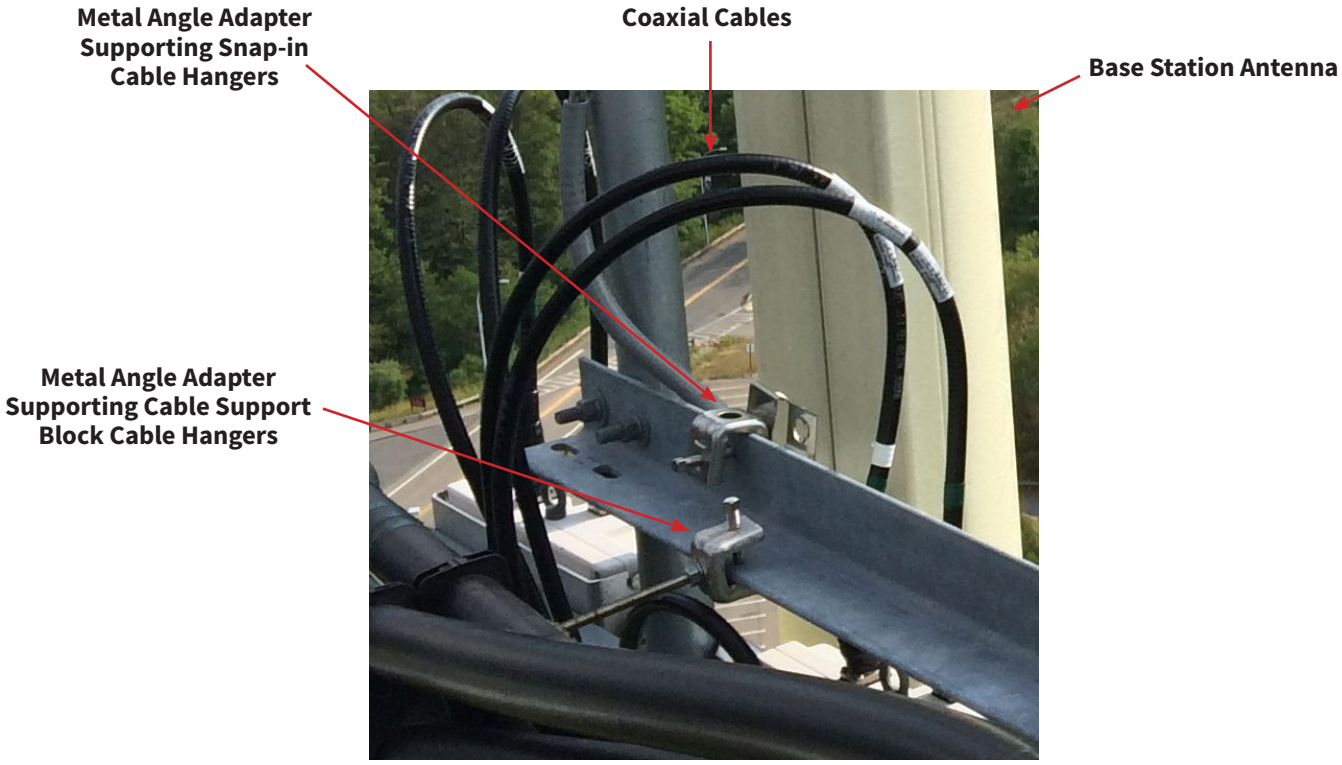
Low PIM Alternatives for Metal Angle Adapters

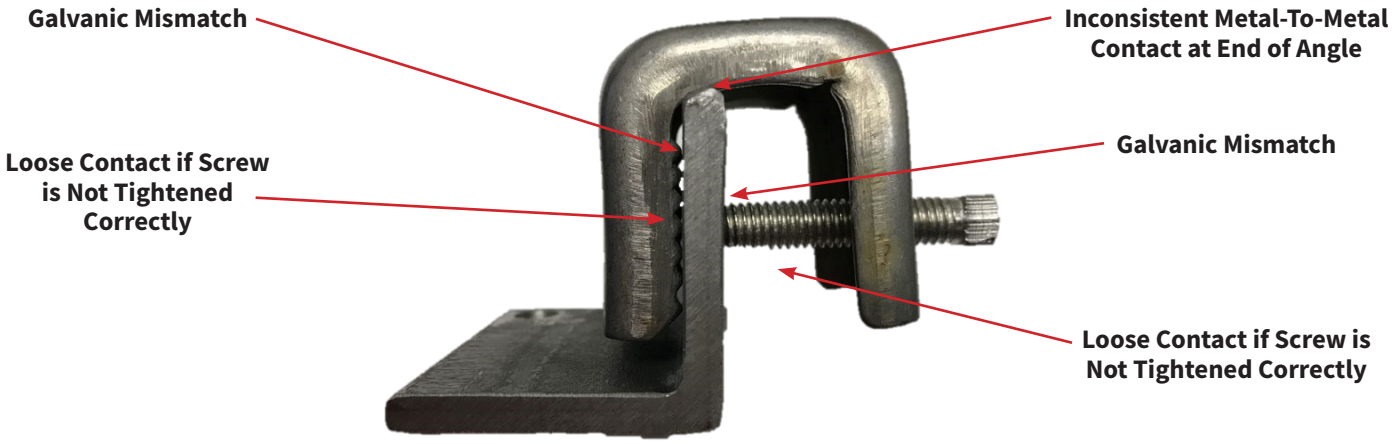
INTRODUCTION

ConcealFab is constantly studying PIM problems found in the field to understand the root cause of why PIM was generated and how PIM might be prevented in the future. Metal angle adapters are one such case. These adapters are used frequently in the high-risk PIM zone near base station antennas to secure cables to the steel mounting frame. If installed correctly, these adapters seem to work fine. But, after time, adapters that initially did not create PIM were later found to generate high levels of PIM interference. The following application note describes the testing conducted by ConcealFab to evaluate this problem and solutions introduced to eliminate this source of PIM going forward.



ISSUES IDENTIFIED

Upon inspection, metal angle adapters have multiple different means for creating PIM. First, if the set screw used to secure the angle adapter is not tightened sufficiently, PIM can be generated at the loose metal-to-metal contact between the adapter bracket and the metal angle. Second, even if tightened sufficiently, there is potential for PIM generation where the bracket touches the end of the angle flange. Third, angle adapter brackets are typically constructed from stainless-steel and antenna mounting frames are typically constructed from galvanized steel. Galvanized steel and stainless steel are dissimilar metals at opposite ends of the galvanic series. When these two metals touch, they create a battery effect that generates white, powdery corrosion at the metal-to-metal interface. These corrosion products are non-liner and can generate high levels of PIM when exposed to RF energy.



TEST PLAN

The loose metal-to-metal contact issues identified would likely be found and mitigated during site certification PIM tests. The galvanic corrosion issues, however, take time to develop and are likely the root cause of the time-related problems identified in the field. To test this theory, five angle adapter configurations were assembled and put through salt fog testing to simulate accelerated weathering. "Off-the-shelf" galvanized steel and stainless steel angle adapters were used for the test. Half were attached per the manufacturer's instructions and the other half were installed with NoOx conductive grease applied at the metal-to-metal interfaces. The thought here was that NoOx might protect the mating surfaces and prevent the formation of corrosion products. A fifth angle adapter concept was included in the tests that replaced the metal design with an all plastic design to prevent the possibility of galvanic corrosion.

All five samples were assembled and subjected to radiated PIM tests prior to salt fog testing. The radiated PIM tests were dynamic, near field tests conducted in accordance with preliminary specification IEC 62037-8. Measurements were made at both 700 MHz and 1900 MHz. After salt fog testing, the samples were washed with warm water to remove the salt residue, allowed to dry and re-tested using the radiated PIM process.

Plastic Concept	Galvanized Steel	Galvanized Steel with NoOx	Stainless Steel Concept	Stainless Steel with NoOx

RESULTS

An unexpected result was found during the pre-salt fog radiated PIM tests. A metal bur was created where the set screw dug into the galvanized finish of the steel angle. This bur did not fall off, resulting in a loose metal-to-metal contact, causing this sample to fail the radiated PIM test. The bur was removed to achieve a passing result prior to starting the salt fog tests. Burs of various sizes were observed on the other angle adapter samples at the same interface. These burs were not generating PIM so they were not removed prior to the salt fog test.

Metal Burr Created by Set Screw Digging into Galvanized Surface of Angle Caused PIM Failure

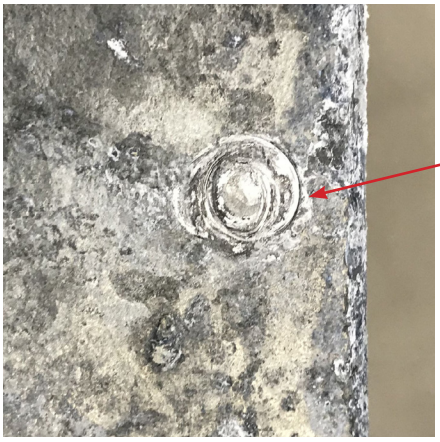
PRE-SALT FOG RESULTS

Configuration	Result
Plastic	PASS
Galvanized	FAIL
Galvanized NoOx	PASS
Stainless	PASS
Stainless NoOx	PASS

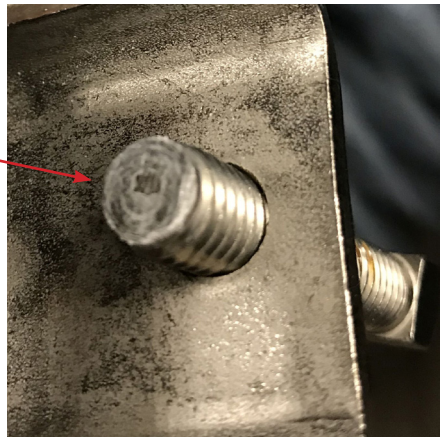
Post salt-fog, all samples passed the radiated PIM test except for the all stainless-steel adapter without NoOx. The failing sample was disassembled and there was clear presence of corrosion products occurring between the set screw, the angle adapter bracket and the galvanized steel angle.

POST-SALT FOG RESULTS

Configuration	Result
Plastic	PASS
Galvanized	PASS
Galvanized NoOx	PASS
Stainless	FAIL
Stainless NoOx	PASS



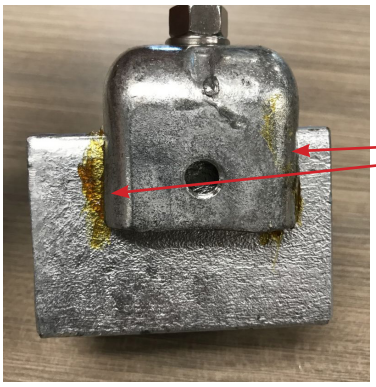
Corrosion Products Seen Where Stainless-Steel Set-Screw Contacted Galvanized Steel Angle



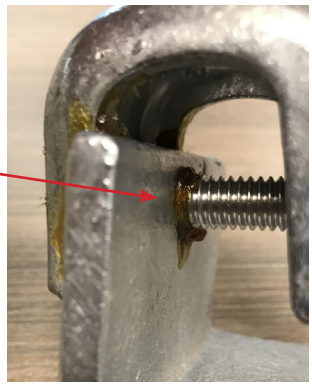
Corrosion Products Seen Where Teeth of Stainless-Steel Adapter Contacted Galvanized Steel Angle

CONCLUSION

Applying NoOx to the metal-to-metal interfaces between the metal angle adapter and metal angle did prevent PIM on the samples tested. Further testing is required to determine how long NoOx would remain effective after prolonged exposure to the elements.



NoOx Applied to Interfaces Between Adapter and Steel Angle



The all plastic angle adapter also performed well in the salt fog tests. An all-plastic design eliminates not only the galvanic mismatches but also eliminates all possibility of loose metal-to-metal contact between the angle adapter and the metal angle during installation.

LOW PIM SOLUTIONS FROM CONCEALFAB

ConcealFab has developed an all-plastic “Universal” family of cable support products to mitigate sources of passive intermodulation at cell sites. The system includes a universal base that securely interfaces with the metal angle. Bundles of cables can be strapped directly to the base or and adapter can be installed with the base to launch threaded rods or to secure snap-in style hangers. Each component within the system is a molded, UV stable, glass-filled Nylon part designed to eliminate metal-to-metal contact and prevent galvanic mismatches.

900639-10
Angle Adapter Base (1/4”)

900940-10
Angle Adapter Base (3/8”)

900713-10
Snap-in Adapter

900712-10
Threaded Rod Adapter