PIM Hygiene

After years of performing external passive intermodulation (PIM) measurements in the field, ConcealFab has identified recurring sources of PIM in high-risk PIM zones near antennas. Items such as metal snap-in cable hangers and stainless-steel hose clamps frequently generate service impacting PIM when installed near antennas. Paying highly trained crews with expensive test and measurement (T&M) equipment to identify which hose clamps and metal snap-ins should be replaced is a waste of time. In addition, paying those crews to sit idle while other crew members remove and replace this hardware is an inefficient use of T&M resources. A more cost-effective solution is to send crews armed with wrenches and low PIM cable support hardware to eliminate the obvious PIM sources first and then perform a PIM Hunt if necessary. This process has come to be known in the industry as performing "PIM Hygiene". If PIM Hygiene does not drop PIM interference to an acceptable level, the PIM hunting crew can be deployed to identify the remaining sources.

KEY

LOOSE
Loose Metal-to-Metal

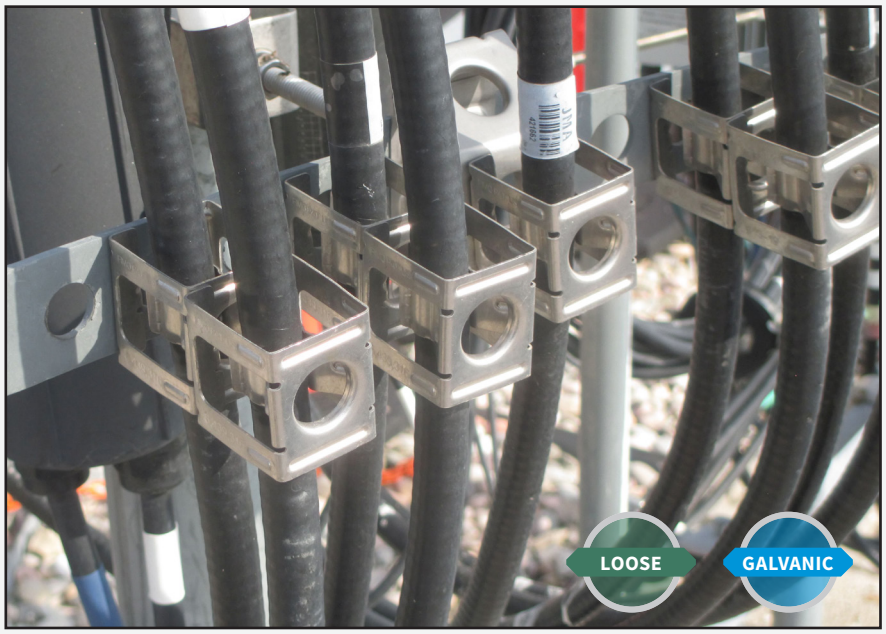
GALVANIC
Galvanic Corrosion

Most PIM sources found near base station antennas are caused by either loose metal-to-metal contact or by highly non-linear corrosion products. While many of these sources are obvious, some are not so obvious. This application note documents the common sources of PIM found in high-risk PIM zones near antennas and suggests corrective action to take when performing PIM Hygiene.

NOTE: Network operators may have different requirements for work to be performed during PIM Hygiene. Always follow the network operator's instructions when performing PIM Hygiene.

PIM Source	Resolution

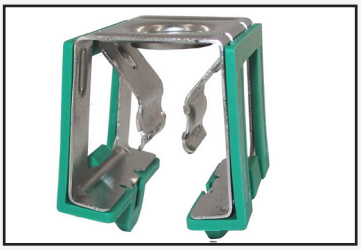
STAINLESS-STEEL SNAP-IN CABLE HANGERS



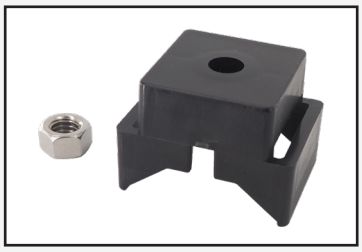
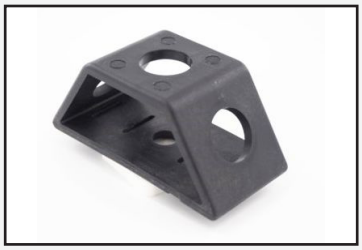
- Replace metal snap-in cable hangers with low PIM design using "all plastic" or "hybrid" plastic/metal construction

PSPS-XXXX-10

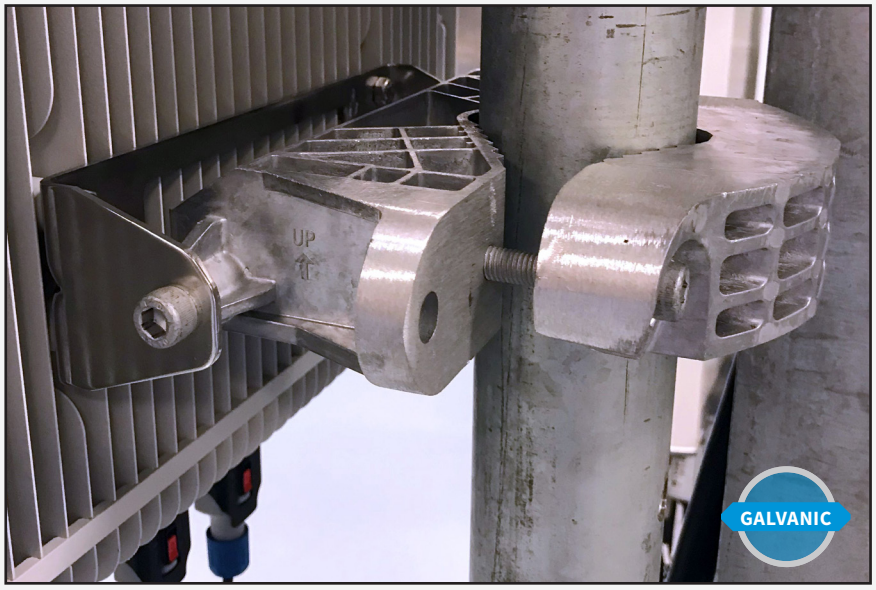
PSHS-XXXX-10



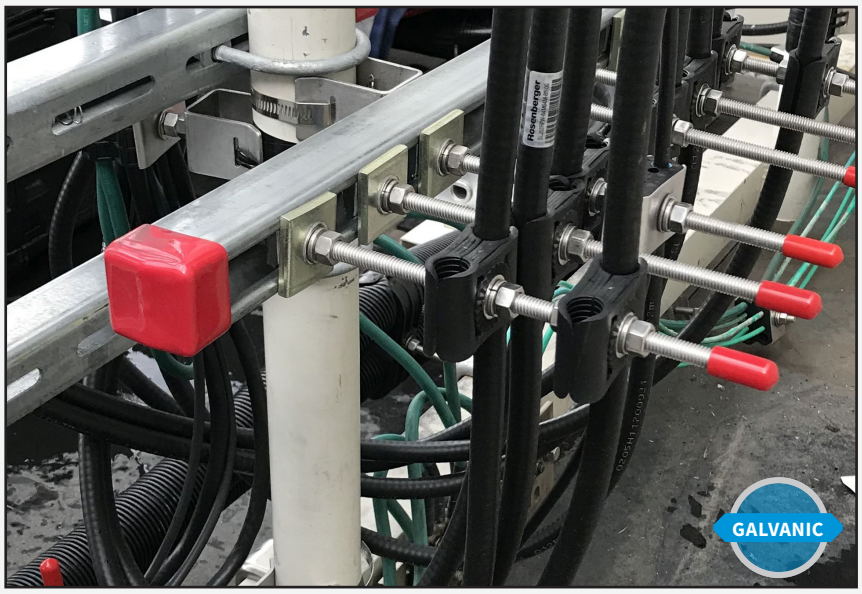
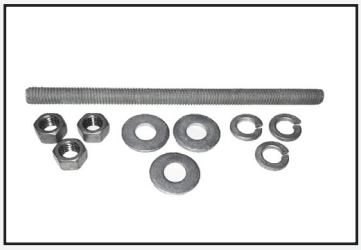
PIM Source	Resolution
STAINLESS-STEEL HOSE CLAMPS 	• Replace hose clamp with acetal plastic strap(s) **900443-XX-XX**

PIM Source	Resolution
STAINLESS-STEEL STAND-OFF ADAPTERS / SUPPORT BRACKETS 	• Replace stand-offs and support brackets with plastic alternatives **VARIOUS DESIGNS**  

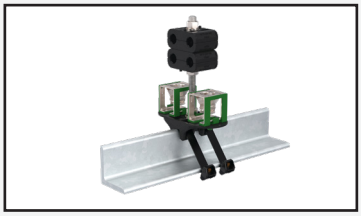
PIM Source	Resolution
STAINLESS-STEEL RADIO AND ANTENNA MOUNTING BRACKETS 	• If available, replace the stainless-steel brackets with new design provided by the OEM • If new brackets are not available, loosen hardware and apply No-Ox to surfaces where stainless steel touches galvanized steel. • Re-torque hardware per manufacturer's specifications when finished

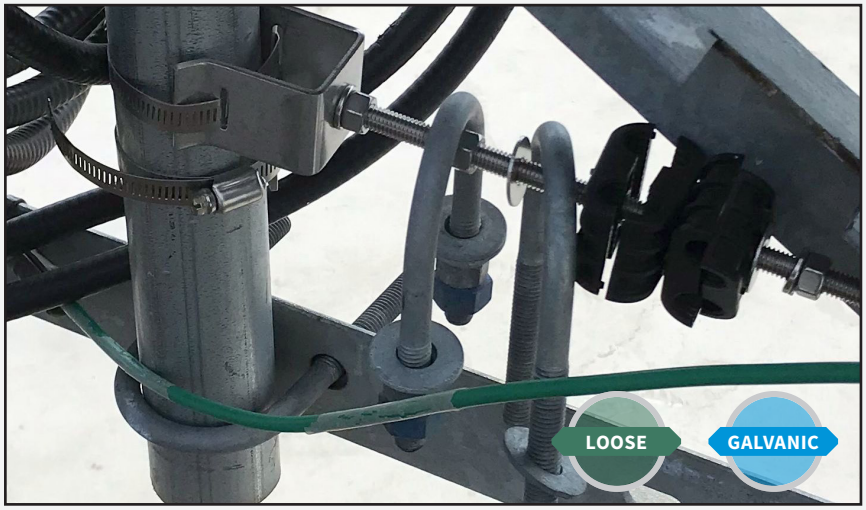
PIM Source	Resolution
ALUMINUM RADIO AND ANTENNA MOUNTING BRACKETS 	• Do nothing • Aluminum is closely matched to galvanized steel on the galvanic series. As a result, PIM producing corrosion products are unlikely • Only take corrective action (disassemble and apply No-Ox to surfaces) if PIM Hunting determines this connection is a problem

PIM Source	Resolution
STAINLESS-STEEL THREADED FASTENERS WITH ALUMINUM OR GALVANIZED STEEL BRACKETS (RADIOS, ANTENNAS, FILTERS, ETC) 	• If available, replace the stainless-steel hardware with galvanized steel hardware approved by the OEM • If new hardware is not available, do nothing • Only take corrective action (disassemble and apply No-Ox to surfaces) if PIM Hunting determines this connection is a problem

PIM Source	Resolution
MIXED STAINLESS-STEEL AND GALVANIZED STEEL (CABLE SUPPORT HARDWARE) 	• Replace threaded hardware with correct material / finish to eliminate galvanic mismatch • Replace support system with low PIM design if unable to eliminate all galvanic mismatches **THREADED ROD KITS** 

PIM Source	Resolution

STAINLESS-STEEL ANGLE ADAPTERS
 	
	• Replace steel angle adapters with plastic angle adapters
	• Replace stainless-steel angle adapters with galvanized steel angle adapters
	  • Set screw must also be galvanized steel
	  • Apply No-Ox to end of set screw at point of contact with the angle
	  • Be careful to install with gap between inside of adapter and top of angle flange
	MULTI-FUCTION MOUNTING SYSTEM
	 

PIM Source	Resolution
UNUSED MOUNTING HARDWARE 	• Remove any unused cable support hardware left on the support frame

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PIM Source	Resolution
LOOSE NUTS & BOLTS 	• Tighten all nuts and bolts on antenna mounting frame to OEM's specifications • Tighten all nuts and bolts on radio and antenna mounting brackets to OEM's specifications • For nuts and bolts securing plastic cable support blocks, visually verify that all split washers are compressed **TORQUE WRENCHES**

PIM Source	Resolution
METAL HARDWARE TOUCHING OTHER METAL HARDWARE 	• Re-position hardware to eliminate contact

PIM Source	Resolution
METAL TRASH / SCRAP LEFT ON SITE 	• Remove all metal trash (steel, aluminum, copper, etc.)

PIM Source	Resolution
SUPPORT FRAME MEMBERS TOUCHING EACH OTHER (LOCATIONS OTHER THAN BOLTED CONNECTIONS) 	• Loosen and re-position frame members to eliminate contact • Re-torque nuts and bolts on frame to OEM's specifications

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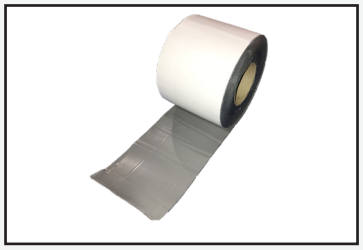
PIM Source	Resolution
SUPPORT FRAME INTERCONNECTS 	• Other than making sure the connections are tight, it is best to do nothing during hygiene • Only take corrective action (disassemble, clean and apply No-Ox to surfaces) if PIM Hunting determines this connection is a problem • LAST RESORT – install PIM tape to prevent RF energy from reaching the inconsistent points of contact **PIM TAPE** 

PIM Source	Resolution
ANTENNA MECHANICAL DOWNTILT BRACKETS 	• Eliminate mechanical tilt bracket (if sufficient electrical tilt is available) • Replace mechanical tilt bracket with new low PIM design available from the antenna manufacturer • Loosen bracket, adjust and re-tighten to eliminate surfaces touching at 0° tilt • Install vinyl tape between surfaces where metal is over-lapping metal • LAST RESORT – install PIM tape to prevent RF energy from reaching the inconsistent points of contact

PIM Source	Resolution

UNSHIELDED GROUNDING WIRES TOUCHING METAL SURFACES
 	
	• Re-route wire as required and provide secure insulation at all points where unshielded wire is able to touch other metal surfaces
	• Acceptable insulation methods may include:
	  • Rubber grommets
	  • Cable support blocks
	  • Plastic snap-ins
	• Installing PIM tape over thermal weld area will prevent direct radiation of an imperfect weld. The wire, however, may act like an antenna and channel energy to the weld. Since this is not a common issue, better to take correction action at the weld only when PIM Hunting determines this is a problem

PIM Source	Resolution
METAL SHAVINGS 	• Remove all metal shavings (handheld shop vacuums are useful to make sure no shavings are left behind inside and outside of structural members) • If aggregate is used to ballast roofing material below antennas, move rocks aside below antennas to make sure no shavings are present

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PIM Source	Resolution
RF SAFETY SIGNS INSTALLED NEAR ANTENNAS 	• Replace metal sign attachment with plastic, low PIM RF safety sign support **RF SAFETY SIGN KIT**

PIM Source	Resolution
RUSTY SURFACES 	• Remove rust using wire brush or sandpaper • Wipe surface with clean rag with solvent to remove metal dust • Apply zinc rich paint (Cold Galv.)

PIM Source	Resolution
BURS ON ENDS OF PIPES, ANGLE MEMBERS AND STEEL STRUT 	• Remove burs at ends of steel members using a file. • Wipe surface with clean rag with solvent to remove metal dust • Apply zinc rich paint (Cold Galv.)

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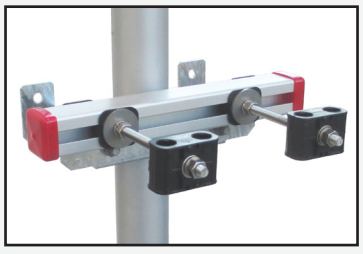
PIM Source	Resolution
STEEL STRUT – SPRING NUTS 	• The spring is typically press-fit into the nut and can be removed using pliers • If stainless-steel spring nuts are installed inside galvanized or zinc plated strut, replace the spring nuts with a galvanized steel nuts (with spring removed)

PIM Source	Resolution
STEEL STRUT – ANTENNA MOUNTING PIPE CONNECTIONS 	• If steel strut is used for cable support, replace strut with low PIM alternative • If steel strut is used for structural support of radios or other heavy equipment, do not replace with low PIM alternative without operator's approval • If existing mount is not replaced, disassemble and apply No-ox to all dissimilar metal surfaces. Re-torque hardware to insure tight connections **RAIL SYSTEM LOW PIM STRUT** 

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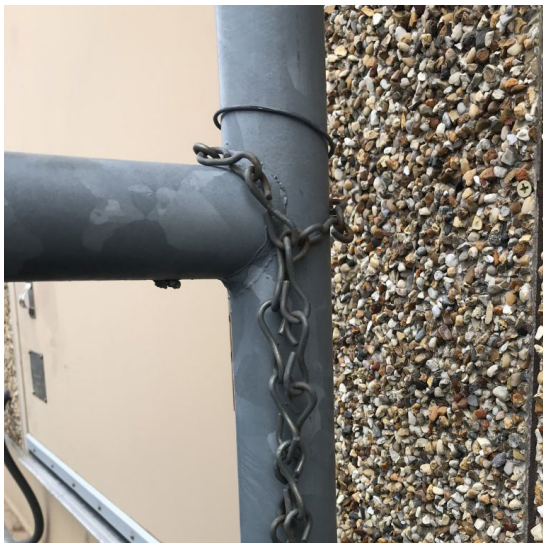
PIM Source	Resolution
METAL GRATES NEAR ANTENNAS 	• The best answer is to replace metal grates with FRP grates, but this is not something that can take place during hygiene • Best you can do during hygiene is make sure all clips securing the grate are tight • PIM Blankets can be placed over the grate while PIM Hunting to verify if the grate is causing PIM interference **PIM BLANKET**

PIM Source	Resolution
ANTENNA MOUNTING PIPE TOUCHING METAL GRATE 	• Loosen and re-position antenna mounting pipe to eliminate contact • Re-torque nuts and bolts on pipe support to OEM's specifications

OTHER PIM SOURCES

In addition to common problems, technicians doing PIM Hygiene should keep their eyes open and look for anything else near antennas that could be a source of PIM. It is impossible to list every possible scenario that might be encountered. Below are a few examples of "other" sources ConcealFab has run across in the field.



CHAIN ON ANTENNA MOUNTING PIPE USED TO HOLD NEARBY RADIO CABINET DOOR OPEN

SPRING CLIP ON ANTENNA MOUNTING BRACKET

RANDOM SITE HARDWARE LEFT IN UNEXPECTED PLACES

RUSTY COIL OF WIRE ON CABLE SUPPORT BAR

OTHER PIM SOURCES

STEEL BANDING SECURING RF SAFETY ROPE

LOW PIM BRACKET CONTACTING SUPPORT BRACKET

LOW PIM BRACKET INSTALLED WITH THREADED ROD TOUCHING THE PIPE

STACK OF LOOSE WASHERS INSTALLED ON SUPPORT

QUIZ

How many different PIM sources do you see in each of the images below?

ANSWER: 6

- Stainless-steel hose clamp on galvanized steel pipe (galvanic)
- Stainless-steel stand-off installed on galvanized steel pipe (galvanic)
- Stainless-steel stand-off securing galvanized steel Z-bracket (galvanic)
- Stainless-steel hardware securing galvanized steel Z-bracket (galvanic)
- Metal snap-ins (loose)
- Metal snap-ins installed in galvanized steel bracket (galvanic)

ANSWER: 8

- Stainless-steel angle adapter installed on galvanized steel angle (galvanic)
- Stainless-steel set screws digging into galvanized steel angle (galvanic)
- “Neck” of angle adapter touching top of angle flange (loose)
- Washers left behind touching angle (loose)
- Un-used hose clamp (loose)
- Stainless-steel clip installed on galvanized steel angle adapter (galvanic)
- Pipe resting on support frame
- Metal snap-ins

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