Rooftop antenna mount and passive intermodulation

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One challenge wireless operators face is the need to meet subscribers' data requirements. An independent study from RCR Wireless shows the growing number of data service subscribers with smartphones has shaped the wireless data explosion we are seeing today. As wireless operators increase network capacity with 5G technology and beyond, they must deal with this data traffic burst.

Studies show that most data traffic stays in business areas during work-week daytimes and moves toward residential areas in mornings and afternoons. The availability of supporting antenna deployment sites in business areas generates equal challenges for wireless operators. Roof-mounted structures are increasingly in demand across the U.S., as available space in metropolitan areas for fully developed tower sites becomes more challenging.

These site designs typically include antennas that are mounted on the building face or roof, supported very close to the edge. However, sometimes due to zoning ordinances or building restrictions, antennas often get installed far away from the building edges. In this scenario, antennas could face metal structures or structures with metal fasteners that create a reflected passive intermodulation (PIM) problem.

PIM is like active intermodulation but occurs in passive devices. It appears as new frequencies created by the mixing of two or more signals in a passive, non-linear device such as a loose or low-pressure connection, too many junctions or parts, dissimilar metals, sharp corners, or corrosion, which is evident in these applications. PIM is a rising problem in communications systems. Consequences from PIM include poor performance or dropped calls. There are basically two types of reflected PIM that affect us all: near- and far-field PIM.

PIM generated in non-linear objects or junctions close to the antenna is called "near-field PIM," where the near-field PIM is stronger than far-field PIM. Many non-linear PIM-producing objects are typically located in close proximity to the front and back of the antennas. Near-field PIM is often created by low contact pressure in metal-to-metal contact points frequently found in locations near antennas. Following are a few examples of these types of objects that can produce near-field PIM:

- Loose metal parts laying about, such as metal shavings, nuts, bolts, and washers
- Metal cable mounting clips
- Ground bar connections
- Radio unit mounting brackets
- Antenna mounts
- Antenna pipe bracket connection
- Rust or corrosion

There are some solutions that can be implemented to minimize near-field PIM, such as:

- Removing unneeded (affixed) hardware from the site, e.g., policing the area
- Keeping site clean; removing loose hardware and metal debris around the area
- Minimizing metal-to-metal junctions by using alternative material connections
- Properly tightening all connections (nuts and bolts) and periodically (annually) inspecting them, since they may loosen over time due to vibration
- Mounting or positioning antennas on the rooftop; proper location is crucial to minimize interference from structures or other equipment such as air handling equipment, vents, etc.
- Installing radios, OVPs and other equipment behind and away from the antenna
- Periodically maintaining and replacing corrosive bolts, nuts, cable tray, roof flashing, vent pipes, guy wires, etc.

External reflected PIM is generated externally due to the occurrence of external high-power emitters around the site from nearby corroded objects such as rusty bolts, pipes or brackets. External PIM can occur as far out as 60-100 feet in front of the antenna. As rooftop applications are one of the key macro sites designed to cover a wide geographic area, they are affected by intermodulation products. Typically, panel antennas with 65-degree azimuth beamwidth and 5- to 15-degree elevation beamwidth are deployed on these sites and affected by external PIM. The most effective way to minimize external PIM in these sites is to police the site—cleaning or removing the metal objects within the antenna's beam widths to create a “no metal zone.” One approach to achieve this is to install the antenna above the parapet height toward the edge of the building, with a clear view of the sector being served. The farther away the antenna gets installed from roof edges, the greater the chance of reflecting PIM.

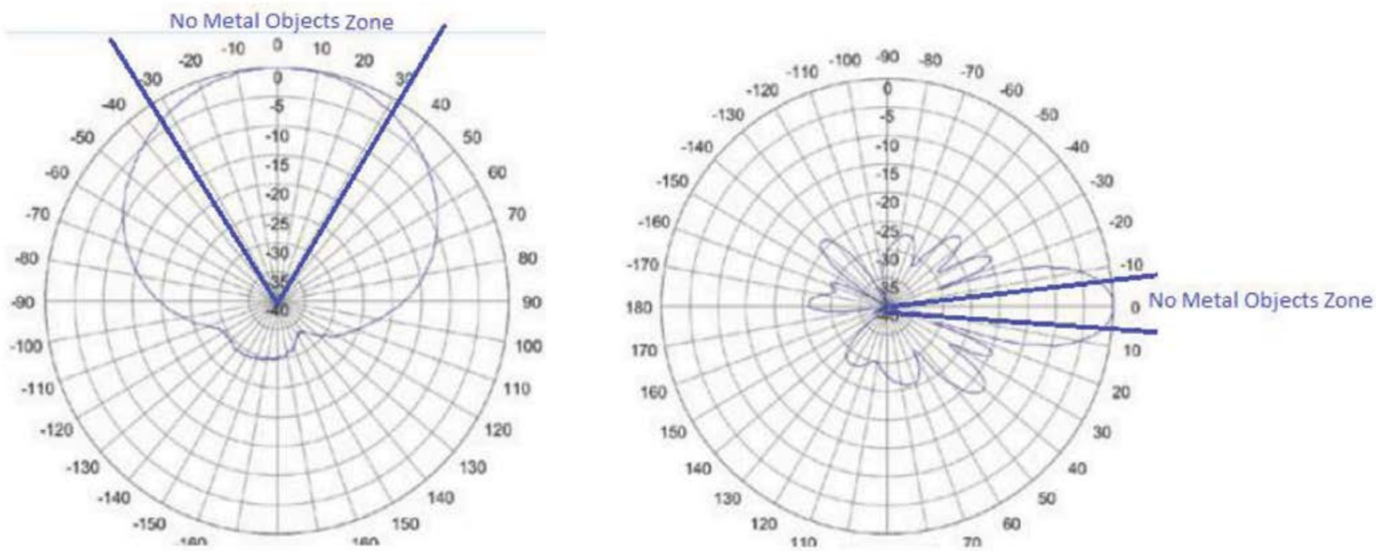

Figure: Azimuth and elevation patterns for typical sector antenna with “no metal zones”

External PIM can be mitigated during the design and construction phase not only by creating a “no metal zone” but also having the proper spacing between each affected antenna. Studies show that antennas wider than 12 inches still need a minimum clearance of 24 inches on the back side. Repositioning the antenna farther away from another antenna clears the azimuth path, reducing the intermodulation products.

One of the issues for structural engineers is providing assurance to the rooftop building owners that the roof can withstand the additional loads imposed by these roof-mounted structures. Installations with antennas on the exterior surface of the building, penthouse, or parapet external walls may have an adverse effect on antenna-supporting structures and building components. Finding proper antenna mount options, such as high, eccentric antenna mount frames along with longer face width to accommodate antenna separation requirement can be challenging, but CommScope offers a variety of roof-mounted sector frames that meet and exceed these new challenging requirements.

Our industry is seeing a burst of rooftop site builds and—more than ever—PIM concerns are becoming prevalent. Our industry has become sensitive to PIM, and it will be our collective challenge to provide innovative solutions to an overcrowded rooftop architecture. For more information on our PIM-friendly rooftop frames, please visit our website.

Jyoti Ojha graduated with Magna Cum Laude honors in bachelor's degree (2009) and master's degree in Civil Engineering (2012) from The University of Texas at Arlington. She has about 13 years of professional working experience in the Telecommunication Industry. She is licensed in multiple states and worked as "Engineering Technical Director" before joining CommScope as "Principal Structural Engineer" in early 2019. Currently she supports several A&E, carriers, and customers answering technical questions and performing educational presentations. Having in depth knowledge of end user of steel products, she develops custom mounts solutions meeting client's unique requirements. She has served industry working as "Young Member Chair" for Society of Structural Engineers of Texas Fort Worth chapter. Currently she is serving TIA committee working as active chairperson for TIA Rooftop Ad Hoc group. Staying active in the industry, she has working knowledge of the latest telecom codes and requirements.

Jyoti now resides in Southlake, TX with her husband and two sons.

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