

External PIM Remediation using PIM Shield™ roofing technology



Executive Summary

ConcealFab Corp has worked with Johns Manville, a global leader in the roofing industry (www.jm.com), to co-develop reliable roofing materials to reduce passive intermodulation (PIM) at rooftop cell sites. At the site described in this report, PIM levels were improved on average by >40 dB per line in the 700 MHz band by installing PIM Shield™ roofing material. Anritsu's PIM Hunter technology played an integral role in achieving the PIM improvements at this site.

Materials

The PIM mitigating material installed at this site was DynaLastic™ 180 FR PIM, Figure 1. This is a multiply Styrene-Butadiene-Styrene (SBS) modified bitumen roof membrane manufactured by Johns Manville and sold through ConcealFab. The material includes ceramic coated roofing granules bonded to the top surface with a special PIM mitigating layer sandwiched in the middle between two SBS modified bitumen layers. The material can be installed using industry-standard hot asphalt or cold adhesive processes.

For this installation, Johns Manville MBR bonding and flashing adhesives were used to attach the membrane to the existing roofing surface. Johns Manville TopGard 4000 acrylic elastomeric coating was applied after installation for added protection and to meet aesthetic requirements. The material system complies with the applicable ASTM standards, and carries both UL and FM approvals.

Remediation process

Vertical Limit Construction (www.verticallimit.com) performed the RF measurements on this site following the external PIM investigation process outlined in Figure 2. PIM source locations were identified using Anritsu's PIM Hunter probe as described in Anritsu application note 11410-00992. ConcealFab PIM blankets, part number 007640-120060, were used to cover the PIM sources once identified.



PIM Shield roofing system installed

Meets the requirements of ASTM D 6164, Type I, Grade G

Features and Components
PIM Shield™ Technology: Engineered to reduce passive intermodulation (PIM) interference on buildings supporting mobile communications infrastructure.
Ceramic-Coated Roofing Granules: Specifically engineered for optimal embedment in the SBS-blend sheet. The ceramic coating promotes excellent long-term adhesion. The granules, available in White or Black.
High-Quality SBS Rubber and Asphalt Blend: Lends elasticity and flexibility to the sheet. The elongation and recovery properties allow the product to easily accommodate the continual expansion and contraction experienced on all roofs. The FR blend contains additional fire-retardant additives.

System Compatibility *This product may be used as a component in the following systems. Please reference product application for specific installation methods and information.*

System	BUR				SBS			
	HA	CA	HW	SA	HA	CA	HW	SA
Compatible with the selected Multi-Ply systems above								

Key: HA = Hot Applied CA = Cold Applied HW = Heat Weldable SA = Self Adhered MF = Mechanically Fastened FA = Fully Adhered BA = Ballasted

Energy and the Environment

Test	Initial	3-Year Aged
Reflectivity* (ASTM C 1549)	0.28	0.27
Emissivity* (ASTM C 1371)	0.87	0.84
Solar Reflectance Index** (SRI - E 1980)	25	25
Pre-Consumer Recycled Content	0%	
Post-Consumer Recycled Content	0%	

*Standard White Granules only

Peak Advantage® Guarantee Information

System	Guarantee Term
When used in most 2-ply JM SBS systems.*	Up to 30 years

*Contact JM Technical Services for specific system requirements for guarantee lengths.

Codes and Approvals

Product Application

- May be installed in Type IV asphalt or in an approved JM adhesive
- Laps may be installed using heat-welding techniques
- Refer to JM SBS modified bitumen specifications and detail drawings for application and slope information

Packaging and Dimensions

Roll Coverage*	95.9 m ² (10.9 m ²)
Roll Length	32' 10" (10.01 m)
Roll Width	29 1/4" (1 m)
Roll Weight	101 lb (46 kg)
Rolls per Pallet	20
Pallet Weight	2,188 lb (997 kg)
Pallets per Truck**	22

*Assumes 4" site top **Assumes 41' flatbed truck.

Figure 1

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A significant percentage of the area in front of and directly below the sector antennas was found to be generating PIM. Covering those areas with PIM blankets reduced the sector PIM to better than -90 dBm on all ports. PIM Blankets are useful as an aide during the test and measurement process but are not suitable as a long-term mitigation solution.

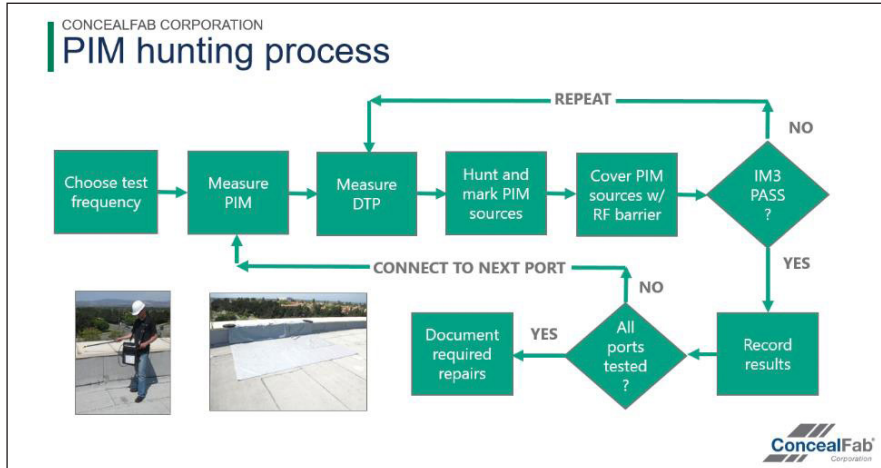


Figure 2

Initial results

Port identification	Starting PIM	PIM with blankets deployed	Improvement
1 Violet	-54.1 dBm	-90.1 dBm	36.0 dB
2 Violet	-55.9 dBm	-95.5 dBm	39.6 dB
3 Violet	-52.0 dBm	-97.2 dBm	45.2 dB
4 Violet	-62.2 dBm	-91.7 dBm	29.5 dB



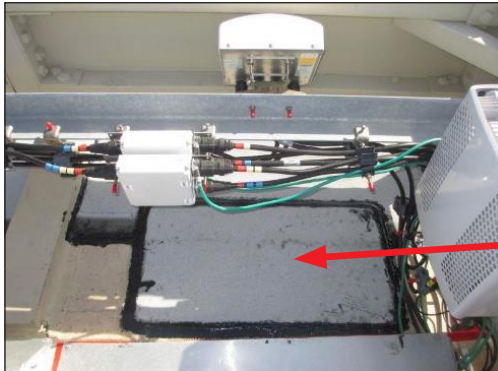
The PIM Shield roofing material was then permanently installed using MBR bonding and flashing adhesives per Johns Manville standard installation procedures. After installation, PIM was measured again to validate performance. A small area directly below one antenna required additional coverage to achieve the desired PIM performance. This area had been covered during the PIM blanket deployment but had accidentally not been covered with roofing material.

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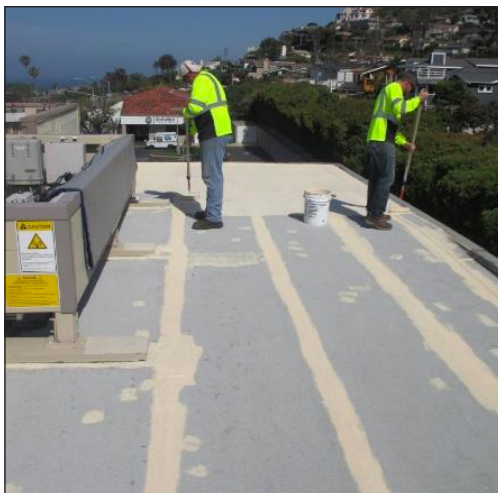
Results with PIM Shield roofing installed

Port identification	Starting PIM	PIM Shield Installed	Improvement
1 Violet	-54.1 dBm	-94.8 dBm	40.7 dB
2 Violet	-55.9 dBm	-99.3 dBm	43.4 dB
3 Violet	-52.0 dBm	-106.2 dBm	54.2 dB
4 Violet	-62.2 dBm	-101.2 dBm	36.2 dB



Additional material required under one antenna to achieve desired performance

For added protection and to meet local aesthetic requirements, a layer of TopGard 4000 acrylic elastomeric coating was applied over the PIM Shield roofing material.



Conclusion:

PIM Shield roofing material has proven its ability to significantly reduce external PIM on rooftop sites. The material is based on Johns Manville's standard SBS modified bitumen roofing membrane, a proven material capable of providing decades of reliable service in rooftop environments. The material can be installed using industry standard processes and meets applicable code requirements. The Anritsu PIM Hunting tools precisely identified the locations on the rooftop requiring repair, as well as those locations that did not need repair. The combination of Anritsu's test and measurement tools with ConcealFab's PIM Shield technology provides mobile operators a reliable method to improve network performance by reducing external PIM on rooftop sites.

