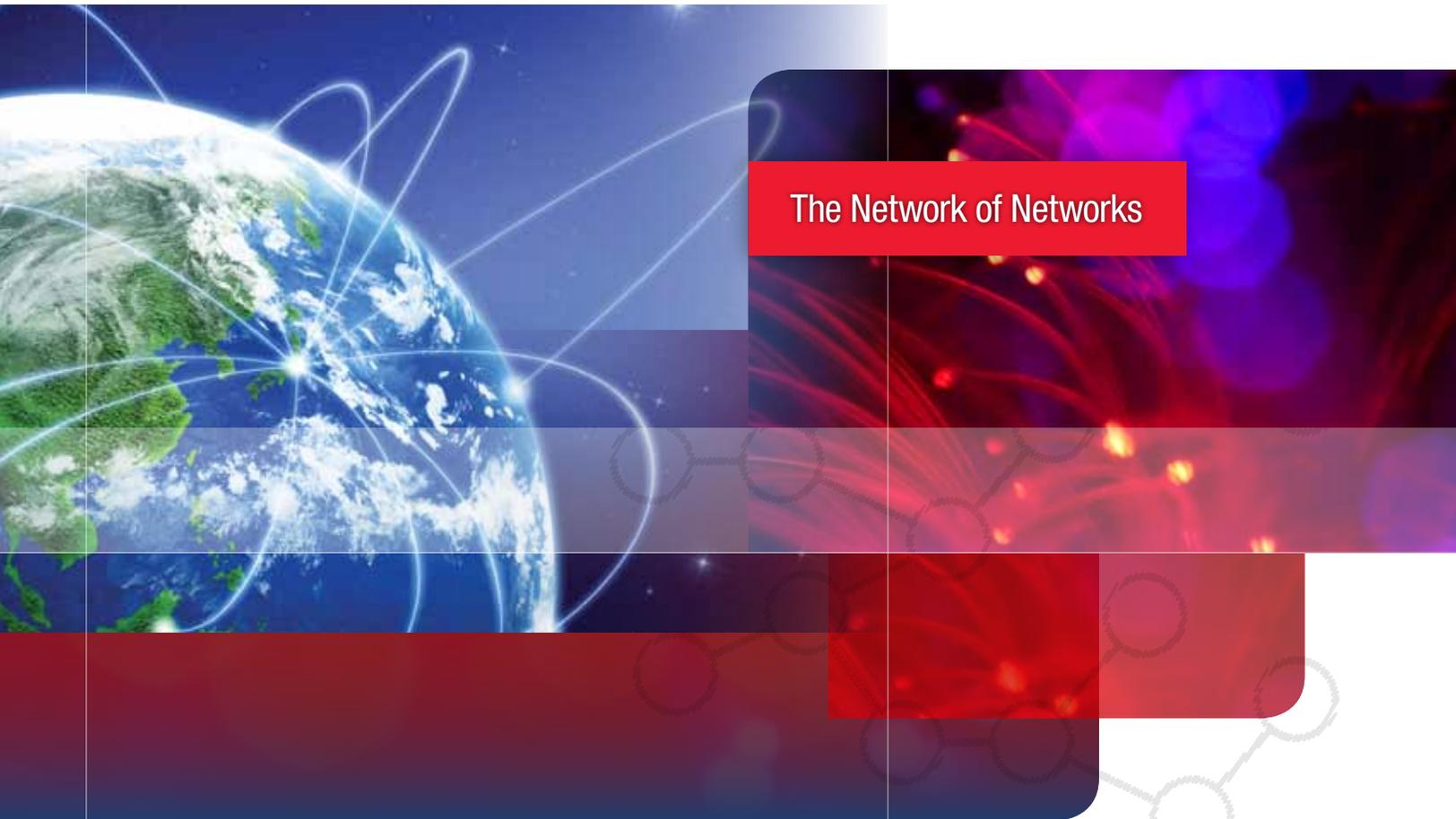


# Evolution of Weatherproofing Solutions for the Cell Site

Business White Paper



The Network of Networks

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# Introduction

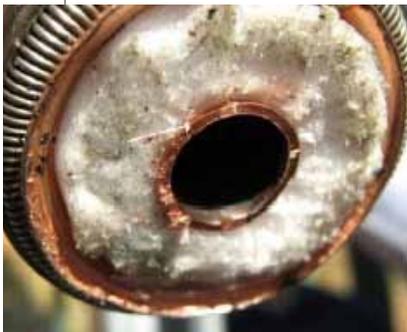
Weatherproofing options for coaxial connections at cell sites have changed and expanded along with the cell sites themselves. Today's more complex cell site designs demand a new type of weatherproofing solution to protect vulnerable connection points at the antenna and the remote radio unit (RRU). Suppliers have responded with products to meet the needs of these next-generation cell site architectures. The result is a wide range of commercially available weatherproofing solutions, ranging from traditional tapes and mastics to closures designed specifically for the latest fiber-to-the-antenna (FTTA) architectures. This paper explores available weatherproofing options, beginning with the most traditional methods and culminating with the newest products available to date.

## Why Weatherproof?

In FTTA systems, weatherproofing coaxial jumper cable connections is critical to delivering reliable communication services. Protecting the RF at the antenna and connection at the RRU can help mobile operators avoid costly repairs, ensure signal integrity and keep subscribers happy.

Water is the enemy of coax. It can intrude into coaxial cable through connectors and cause damage. One tiny droplet of rain can attenuate the high frequency RF signal, resulting in a service outage. Wireless operators don't need to be reminded that even a short service interruption can result in a loss of subscribers.

Moisture build up within the cable can also wreak havoc on a system's performance. The coaxial cable's dielectric is typically made of an open-cell foam, which can act like a sponge, absorbing and retaining moisture. Moisture encourages corrosion around the connector, potentially leading to a scenario where RF signals inadvertently mix and generate passive intermodulation (PIM) distortion. PIM can interfere with neighboring frequencies, prompting a host of legal and regulatory headaches for the operator.



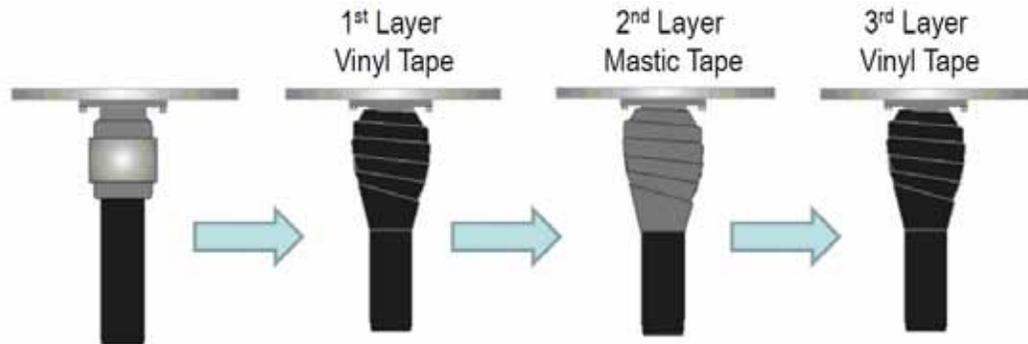
Moisture build up inside an RF connector can cause corrosion, leading to PIM distortion.

Even high-end weatherproofing products are a bargain relative to the cost of repairs, subscriber attrition and legal issues that damaged RF connections can prompt. A small investment in weatherproofing can help safeguard against expensive problems. It's no small wonder that mobile operators routinely require even so-called "sealed" RF connectors to be externally weatherproofed. The investment to properly seal is miniscule compared to the cost of signal impairment.

## Tapes and Mastics

Historically, weatherproofing at the cell site has been accomplished with a layer of mastic sandwiched between two layers of vinyl tape – a technique that has also been used for electrical insulation applications since the 1940s, when 3M invented vinyl electrical tape.

Typically, the taping process begins with an initial layer of vinyl tape, called the courtesy wrap, covering the connection to protect it from the viscous mastic. Then a layer of mastic, typically made of butyl rubber, is applied. The mastic forms a seal against water intrusion, completely covering the connection joint. Lastly, a second vinyl tape layer is applied to secure the mastic in place and protect it from UV rays. The end product should look like a smooth, round football.



When applied properly, tape and mastic wrap provides reliable, long-lasting protection from environmental elements. Many millions of yards of tape and mastic are deployed on coax connections around the world.

However, this method does have its drawbacks. A fair amount of technique goes into the tape wrapping process, and its efficacy depends highly upon proper application and, thus, the technician's skill and knowledge. It also takes time – about 20 to 30 minutes per connection, compared to a minute or less for cold shrink tubing or a weatherproofing closure. In addition, re-entering for repairs or testing is problematic with tape and mastic. Cutting off the tape wrap runs the risk of damaging the cable and connector body. Therefore, taping is best suited for permanent installations where re-entry is unlikely.



Properly wrapping connections with tape and mastic (left) requires skill. If done poorly (center and right, mastic layer was skipped) water can seep in, potentially resulting in service outages.

## Pre-stretched Tubing

Pre-stretched tubing marks a step up the weatherproofing technology chain from tape and mastic. Both heat shrink and cold shrink tubing can provide reliable, long-lasting seals, but cold shrink is more commonly found at cell sites.

Cold shrink tubing, first developed by 3M, offers safe, easy installation and reliable protection. Cold shrink technology eliminates the fire hazard associated with heat shrink products, which require heat to activate. Cold shrink tubing consists of a factory-expanded, open-ended rubber sleeve with a removable plastic core perforated in a spiral pattern. The core is removed by hand after the tube has been positioned over the connection. When the plastic core is pulled away, the sleeve collapses to form a tight, water-proof seal around the connection – no heat or tools required.

Heat shrink tubing is a mechanically expanded extruded plastic tube ordinarily made of nylon or polyolefin. The tube is placed over the connection and then heated, causing the diameter of the tubing to contract and conform to the connection, forming a snug fit. Some types of heat shrink contain a layer of thermoplastic adhesive on the inside to help provide a better seal and excellent adhesion.

However, the application of heat shrink products can be dangerous. A heat source, such as a gas torch, is required to activate the tubing, presenting a potential hazard for the tower hand installing it. While generally more expensive, operators tend to prefer cold shrink tubing because it eliminates the need for a heat source, lowering accident risk and installation costs. Cold shrink tubing's fast installation time and low skill requirement are also attractive. However, the tubing sometimes requires a build out of tape over the connection in order for the tubing to achieve a snug fit and offer effective protection, adding some installation time.

Pre-stretched tubing has a proven track record for providing reliable weatherproofing. However, neither cold shrink nor heat shrink products are reusable for testing and repair. In addition, both technologies require the RF cable to be disconnected in order for the tubing to be placed on the cable, thereby adding another potential issue with contamination of the opened and re-closed connection.



Cold shrink tubing is easy to install and provides reliable protection.

## First Generation Closures

Building on weatherproofing technology, suppliers developed a series of products that this paper refers to as first-generation closures. First-generation closures consist of a hard, hollow body that snaps around the connection and latches shut. A sealing gel around the edges (“perimeter seal”) forms an effective moisture barrier surrounding the connection. The closures are easy to install without tools. Typically, a tower hand can install one in a minute or less.

## Second Generation Closures

Taping and first-generation closures may no longer be workable options for some emerging cell site designs. Fiber-fed tower architectures that incorporate multiple in, multiple out (MIMO) or multiband antenna configurations, for example, have resulted in crowded connection points on the antenna and RRU. Very often, a grown man’s hand won’t fit between these connections in order to wrap tape. Similarly, first-generation closures may often be too bulky for congested areas.

Newly developed, second-generation closures sport a smaller footprint and are specifically designed to fit into crowded spaces. The closures retain all the features of earlier closures – quick and easy to install, no tools required, re-enterable and reusable – but are better suited for crowded connection points.

One new, innovative closure with a small form factor from 3M offers an added feature. The 3M™ Slim Lock Closure contains a highly compliant sealing gel inside that conforms to the entire connection rather than a perimeter seal, displacing air. In the absence of air, condensation cannot occur, so the connection is further protected from corrosive moisture.



3M™ Closures offer the ability to re-enter and reuse, a necessary feature for applications where testing is required.



Second-generation 3M™ Slim Lock Closures are designed for closely spaced connections.

# Summary

As fiber-fed cell site architectures have evolved, so have the weatherproofing solutions for vulnerable RF connection points. Traditional weatherproofing methods, such as tape and mastic wrap, have long proven their effectiveness and reliability. However, older methods don't always work for new cell site designs where connection points are spaced closely together or periodic re-entry is required. A new generation of small form factor closures can easily be installed on the crowded connections often found at the antennas and RRUs of FTTA installations. Yet, older methods are still good choices for more conventional applications, resulting in a broad range of weatherproofing options for the cell site. To learn more about cell site weatherproofing solutions from 3M, visit us at [3M.com/Wireless](http://3M.com/Wireless).

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