Sealing Conduits for Resilient Electrical & Telecom Systems

In 2021 Global losses from extreme weather totalled USD$280bil (AUD$388bil), of which USD$120bil (AUD$166bil) was insured.

Source Munich RE – www.munichre.com

By Sheri Dahlke, Robin Francis, Chris Trevis & Lindsay Taylor

A mission-critical system or service is indispensable to a functioning community, the economy, and public safety. If the system or service fails or is disrupted due to power outage or damage, commerce and community life can be severely compromised or completely halted. Electrical grids and communication networks are at risk worldwide. Global demand for electrical power and data bandwidth is growing at an increasing pace. As demand increases, potential damage and risk to infrastructure also increases. In many countries, aging assets and unreliable funding further plague these systems' operational integrity. This paper focuses on how natural disasters compromise mission-critical assets in electrical and communication systems, and how strategies are developed to reduce the risk. Any strategy must begin with collaboration among key stakeholders, such as communities, utilities, and government agencies, and depends on commitments to include system resilience projects in annual operational plans and budgets.

Natural disasters such as hurricanes, cyclones, tsunamis, floods, tornados, and bushfires are examples of extreme weather that wreak havoc on people's lives, homes, and businesses and impose serious consequences on society. Consumers are typically unaware of behind-the-scenes work required to provide reliable power and digital access, but outages bring instant and unwanted focus.

Severe weather events are increasing the need to seal out water

Australia is very familiar to severe wet weather events, from very active cyclone and monsoonal zones to floods and storms that can cause weather to dump unseasonable amounts of rain in catchments. In fact, there have been 18 major flooding events in the past 12 years that have caused billions of dollars in damage, this is a rate of 1.5 per year over the 12-year period. Climate change scientists indicate that these events could become more frequent and intense. When combined with our growing population, this puts more people and infrastructure at risk by these weather events.

Examples of key weather events that had an impact on communities were:

the Brisbane floods of 2010/11, Townsville floods of 2019 and the 2021 floods of NSW, which resulted in a combined total of $9.84 Billion Dollars in damage claims. It is safe to say that in the past 12 years each state and territory has recorded a notable event.

Power and communication outages are costly not only due to the loss of the essential utility services during the disaster, which are considered mission critical, but require resources and time to make post disaster repairs. System reliability during floods to support critical infrastructures such as hospitals, police, fire and emergency and agencies like the State Emergency Services (SES) is important to public safety. The investment in systems that reduce risk and exposure and increase the resiliency of the system will be beneficial in both minimising direct cost and indirect cost of floods and storms on utility networks.

"Water events that cause major disruptions uncover systems that have not been properly sealed," said Lindsay Taylor - Group BDM – TEN Group Australia

System hardening for greater resilience and the payoff

The choice of storm hardening methods depends on a variety of factors and requirements. As weather volatility increases its impact on power systems and assets, budgeting for measures and products that enhance resilience must be augmented. There is a payoff to consider: the vicious cycle of costly annual repairs, service disruptions, and downtime can be mitigated with research and investment in technologies that reliably protect systems against extreme weather events, especially water events. Ideally, utilities and communities work in partnership to create cost-effective plans that provide optimal asset protection in severe weather events—ultimately safeguarding infrastructure, the economy, and people.

The Role of Proper Seals in System Hardening Projects

Water penetration causes costly damage that is difficult to repair. Whether a project is new construction or an upgrade, prevention of water penetration is essential. Durable sealing technologies provide powerful duct protection and play a vital role in a comprehensive system hardening program. Implementation of sealing technologies is a site-by-site activity that uses varied applications to achieve the goal: reducing or eliminating water penetration. As the frequency of water events increases, the permanent installation of sealing technologies pays for itself by saving on the cost of vital equipment restoration. The following section on sealant selection outlines a process to help match the appropriate sealant to a specific project providing long-term benefits.

Determining What Needs Protection

Proper sealing starts with an analysis of the complete project, its function and location, its requirements for success, and other variables. Setting clear objectives

Table 1. Cost of Power Infrastructure Hardening:

The cost of hardening power infrastructure depends heavily on the hazard and the infrastructure involved. Miyamoto (2019) estimated this cost for power sector infrastructure for floods, earthquakes, and cyclones, linking the cost of hardening the infrastructure with the change in damage probability.

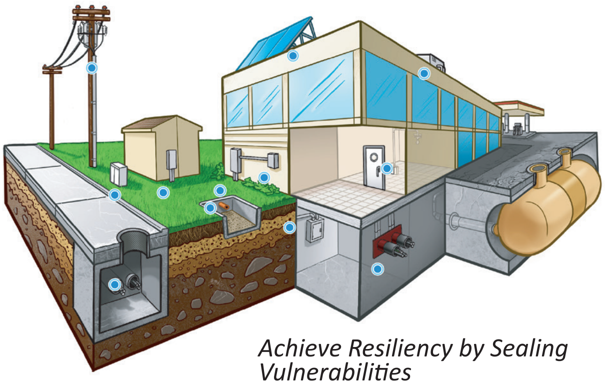
	Earthquakes		Cyclones		Floods	
	Cost Increase	Damage Probability is Reduced by	Cost Increase	Damage Probability is Reduced by	Cost Increase	Damage Probability is Reduced by
Thermal Plants	20%	10	10%	3	2%	Risk Very Low
Nuclear Plants	5%	10			2%	2
Hydropower Plants	20%	2			5%	1.3
Solar Plants	5%	5	15%	2.5		
Wind Farms	5%	1.2	5%	2		
T&D Lines	15%	Residual Risk Very Low	20%	2		

Table 1.

is important. Only then can the appropriate sealing technology be identified. What needs protection? Is it mission-critical, or is there system redundancy? What is the asset value? Is it exposed to outdoor elements or below grade? Is the goal to prevent moisture or repel a flood? Is physical asset degradation a concern? Each situation is unique and there is no one solution. Many factors must be considered in these situational analyses.

Defining The Situation

System hardening poses a variety of situations that require different sealing technologies. For example, cable raceways, wall penetrations, and wall cracks are scenarios that present a variety of materials, geometries, and other factors. It is common for a conduit to pass



Achieve Resiliency by Sealing Vulnerabilities

through the outside wall of a building or enclosure. Such conduits are often underground, so water ingress is problematic.

A thorough examination of the conditions raises many questions:

• Is the area hard to reach or partially obstructed?

• What materials are to be sealed? Plastic, metal, and cement are the most common materials.

• What is the condition of the conduit and the wall? Is this a new installation or an older existing entry?

• What kind of surface contamination can be detected?

• How much of the conduit is filled with cable, innerduct, or pipe?

• What are the physical dimensions of the space to be sealed? Is the installation horizontal or vertical?

• Are there specific codes or standards that the seal must meet? For example, in some situations, UL recognition may be required.

With so many questions, one gets the impression that seal technology selection is impossibly complex. However, such questions simplify selection. The combination of conditions present in the analysis quickly eliminates sealant candidates and narrows the search. Ensuring that needs are clearly defined allows the tailoring of solutions to meet the specific conditions. There is a solution to most situations.

In many cases, water ingress may be evident. In fact, water may be actively flowing into the enclosure or building. Specialty sealing solutions can be installed while the leak is active. What pressure must the seal withstand?

Measured as waterhead height, this is a key factor in selecting sealant technology. Under normal conditions, the seal may only need to withstand a few centimetres of waterhead.

During a water event, however, waterhead resistance requirements may rise to as high as 80 feet (25 meters). The requirements of a water event solution will define which sealant technology to use.

Planning and careful surface preparation are keys to a successful seal. Existing entries with aging materials pose a challenge. Metal rusts, concrete degrades, and plastic becomes brittle. Oxidation, grime, scum, and oil should be removed prior to seal installation. New installations can present

problems if materials were damaged during construction. Always inspect the area surrounding the seal and make repairs if necessary.

Determining Life Expectancy and Environmental Compatibility

The expected lifetime of a seal depends on numerous requirements and various factors:

• Seals can be engineered as permanent or temporary. Sometimes a seal is needed for a specific time interval. More commonly, the seal is intended to last the lifetime of the material receiving the seal.

• Before cable is run, conduits are often capped as a temporary seal. The cap can be removed at the time of cable pulling, when a more permanent seal is installed.

• Seals can be engineered to meet only the current configuration of the opening and the cables, innerducts, or pipes passing through. Other seals are engineered to be re-enterable, allowing future changes to the configuration.

• Seals must be compatible with the installation environment. The presence of water, salt, corrosive material, or solvents will dictate seal technologies. Additionally, the expected working temperature is important.

• Seal locations subject to vibration or flexing may require a specific seal type.

Testing To Verify Seal Strength and Integrity

Seals are installed to meet specific requirements. The varied requirements establish a road map to the proper choice of sealing technology.

Critical infrastructure assets are often placed underground for protection from falling trees, lightning strikes, and other weather events. These include transformers and sewage pumping stations. The water column pressures generated in such installations often exceed 6 to 10 feet (2 to 3 meters) and

can reach much higher peak pressures. Duct seals must resist these pressures to maintain the functionality of underground power cable installations.

Blocking Water by Choosing A Reliable Sealing Technology

Flooding causes more economic damage than all other types of weather events. Sealing underground networks from flooding is an effective means of protecting valuable electrical and communication assets. High winds, heavy rainfall, and storm surges generated by hurricanes and cyclones combine to produce large volumes of floodwater that degrade the operational capacity of a system. This is especially true in urban areas where underground networks are susceptible to flooding. Protecting these valuable networks from water penetration is a top priority.

FST Sealant Pumped into Duct

Sealing technology protects infrastructure from flooding and comes in many forms. There are advantages and disadvantages among sealant choices, which we explain below:

• Low-cost, mastic putty is an age-old sealant with limited sealing performance. It does not hold water or air pressure.
It is susceptible to sagging at higher temperatures and deforms when cables are moved.
• Cement/mortar, grout, and Plaster of Paris are also historical sealants. The lack of available water for onsite mixing makes them inconvenient. Their extended reaction or setting times can further complicate installation.
• Pre-engineered mechanical seals perform well. They resist high water head and gas pressure, are easily removed, and help support cables; but they can be challenging in complex cable or high-conduit-fill configurations.
• Two-part, closed cell expanding foam is an excellent choice. High-performance foams readily adapt to varied configurations, remove easily for future access, and offer robust chemical resistance. Foam selection is key, as the chemistry varies.
• Epoxy mortar can be used as a sealant or coating, particularly for cracks and small imperfections. It has strong water and chemical resistance. Epoxies are typically high in viscosity and require trowel application.

Making Sealant Technologies Work For You

Proper installation is, of course, vital for success when sealing. An important step in any seal deployment is surface preparation. Every seal technology works better if the site is cleaned and free of contaminants. Matching the requirements of the seal to the capabilities of available sealants increases the probability of success.

Summary

Natural disasters such as hurricanes, cyclones, tsunamis, floods, tornados, and bushfires are examples of extreme weather that wreak havoc on people's lives, homes, and businesses. These severe weather events challenge electrical and telecommunication systems, often resulting in serious adverse consequences to people, property, and economies. In this article, we explored the following:

• How extreme weather necessitates preventative system resilience measures. River flooding and other natural disasters are particularly dangerous and often result in water infiltrating electrical and digital systems;
• Described ways to protect these systems against water ingress with best practices, including the optimal choice of sealant and proper application techniques;
• Provided a road map of the many variables that enhance effective decision making; and
• Outlined the payoff from investing in system resilience, which includes the use of multiple sealing technologies, prevention of costly repairs, service disruption, and downtime in electrical and telecommunication systems.

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