Solutions that Integrate

White Paper

EXTREME MATERIALS

ROBUST PERFORMANCE FROM CABLE TO CONNECTOR

EXTREME ENVIRONMENTS | COMPLEX REQUIREMENTS

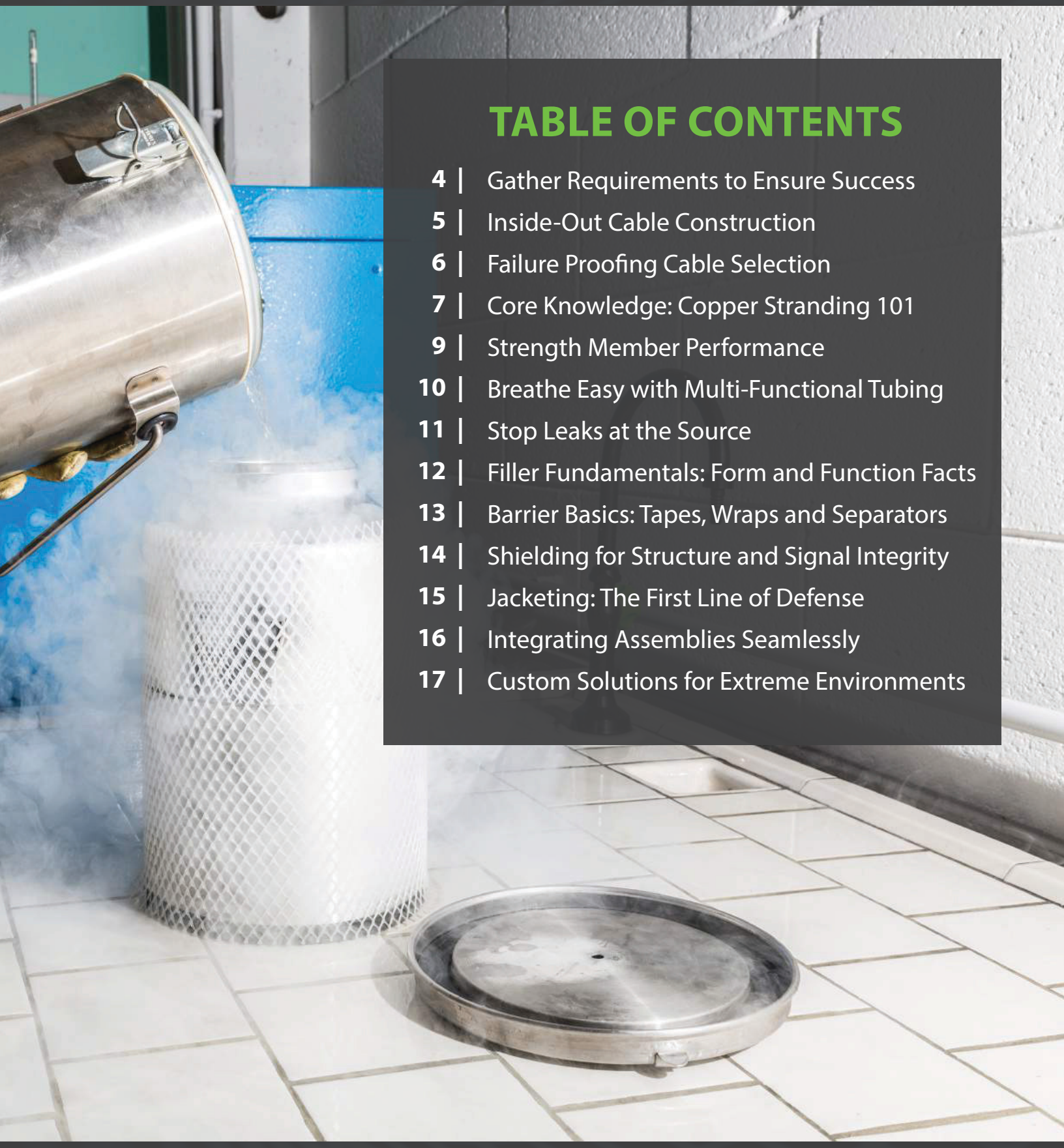
CUSTOM INNOVATIONS
CONNECTOR + CABLE

LEMO®

NORTHWIRE® INC
A LEMO Group Company

EXECUTIVE SUMMARY

Combining decades of field-proven life science experience, LEMO and Northwire credit their global success and reputation largely to their customers' positive experiences with their Subject Matter Experts (SMEs). Leaning on these experts, the manufacturing companies have supported customers in designing customized solutions for a diverse range of extreme applications. LEMO and Northwire SMEs dedicate their focus to developing cutting-edge products and materials that solve complex, new, and evolving challenges. This white paper offers insight into the deciding factors influencing tailored connectivity systems. From specifying the correct stranding configuration to creating specialty blends to ensure optimal jacket performance, selecting the right combination of variables plays a critical role in the success of products. By streamlining processes and communication between Northwire cable designers and the LEMO connector specialists, the connectivity resources ensure that precise products are manufactured for every customer, from *Concept to Completion.*



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GATHER REQUIREMENTS TO ENSURE SUCCESS

In all environments, especially extreme conditions, high reliability and zero down-time are imperative. The smallest factor can be the difference between a success or a costly failure. It is vital to consider every factor influencing performance. By conferring with Subject Matter Experts and experienced manufacturing companies, projects and programs have the best chance of successful performance.

Beyond vetting best-in-class materials, Subject Matter Experts identify attributes complimenting functionality needs. They anticipate environmental challenges and adhere to budgets and schedules.

LEMO and Northwire utilize new product introduction processes and project management in the design and manufacture of connectivity solutions. By understanding the core product functionality and factors contributing to customer goals, Subject Matter Experts begin the critical process of requirement gathering.

LEMO AND NORTHWIRE SUBJECT MATTER EXPERTS ASK KEY QUESTIONS

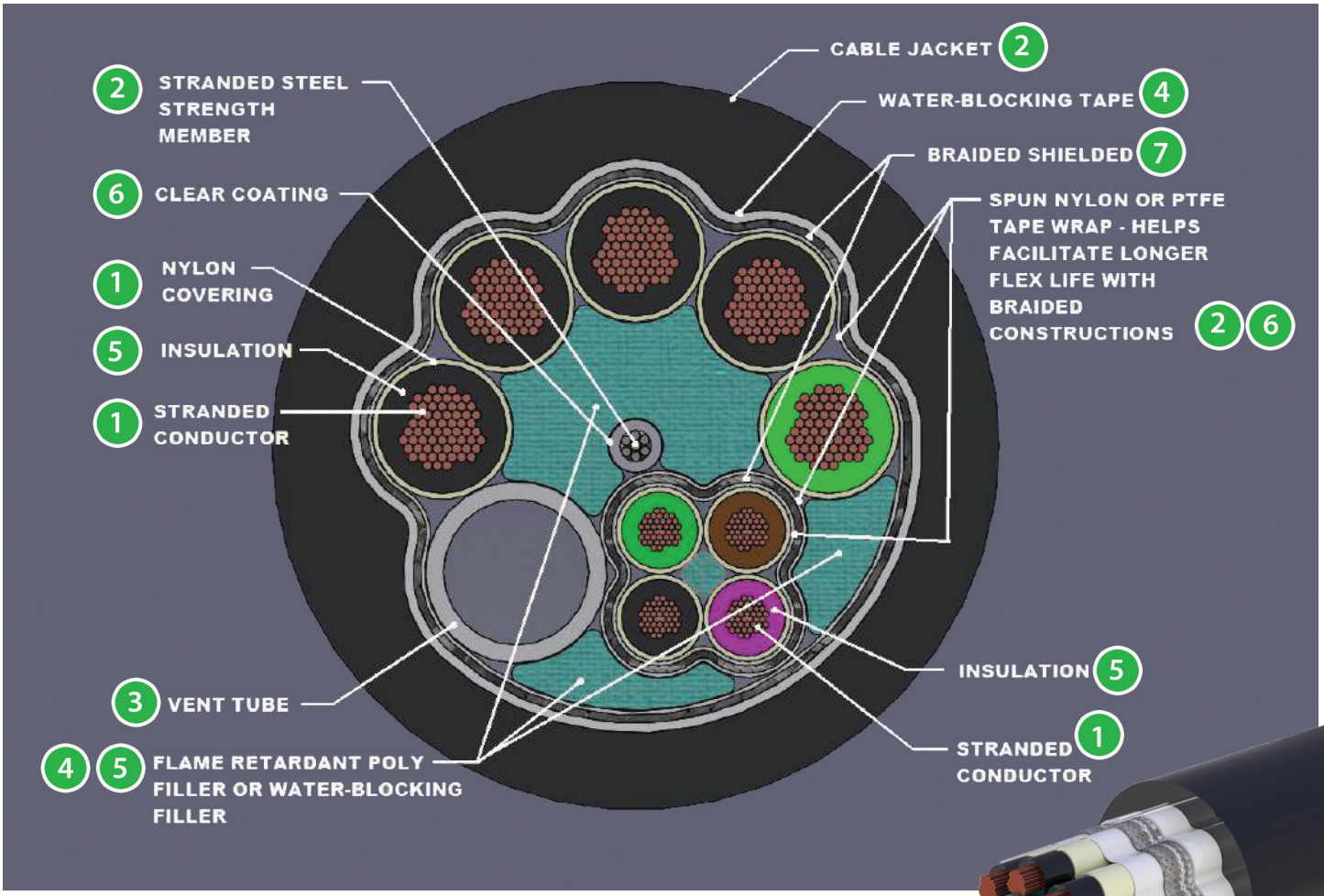
- What is the end-application of the product?
- Who are the users?
- In what environment(s) will this cable assembly need to perform?
- What element(s) will this cable assembly be exposed to (water, oil, chemicals, extreme heat, etc.)?
- What challenges could be encountered with transportation and installation?
- How will the connectivity solution be monitored and controlled?
- Will this product be subject to agency approvals or government regulations?
- What is the budget and schedule for this project?

LEMO and Northwire Subject Matter Experts and a global network of experienced professionals collaborate with colleagues for manufacturing, testing, approvals, and services to provide customers a one-stop shop experience.

VALUE ADDED SERVICES

- **Certifications with UL, CSA, cUL, cULus, CE, MSHA, NFPA, ANSI, ABS, IEEE, SAE, USP, ISO 10993-5:2009 and ISO 10993-10:2021, FDA and more.**
- **Compliance to RoHS3 and REACH directives**
- **Rapid prototyping and 3D prototyping capabilities**
- **Full testing with on and off-site independent facilities**
- **Maintenance and repair operations**
- **Integrated cable assembly services**

INSIDE-OUT CABLE CONSTRUCTION



1 | COPPER STRANDING
Copper strands conduct electric signals through the cable

2 | STRENGTH MEMBER
Strength members can add push strength, pull strength, and rigidity

3 | BREATHER TUBE
Breather tubes allow heat and pressure to vent and dissipate in addition to fluid management

4 | WATER BLOCKING MATERIAL
These materials expand on contact with moisture to stop a leak and protect essential electrical components from water damage

5 | FILLERS
Fillers add shape and can improve resistance to environmental factors

6 | BARRIERS
Tapes, wraps, and other separators provide protection, support, and insulation

7 | SHIELDING
Foils and braided shields protect signal integrity and add strength

8 | JACKETING
The outer jacket provides critical protection from environmental factors

FAILURE PROOFING CABLE SELECTION

If factors such as flex, temperature, and dangerous environments are not properly taken into account, a number of failures may occur.

Constant Motion or Twisting

Constant Motion or Flexing

Harsh Environments

CONSTANT MOTION OR TWISTING

If there is constant motion or twisting, internal conductor bundles may corkscrew and eventually one or more conductors may break.

CONSTANT MOTION OR FLEXING

If there is constant motion or flexing, inner conductor insulation may fail due to internal heating and/or abrasion and then short-circuit.

The presence of other additional environmental factors may accelerate cable failure in constant motion applications, such as oil or chemicals that may cause premature failure of the cable outer jacket. Welding slag introduces heat and highly abrasive material to the environment.

HARSH ENVIRONMENTS

If the cable operates in high heat or harsh environments, the outer jacket may fail due to heat and/or abrasion, exposing the inner conductors to the outside environment.

Water, sunlight and temperature extremes are additional hazards.

HOW TO PREVENT FAILURE

- **Know the specifications: Create a detailed list of needs**
- **Understand the environment of the application: What temperatures will the system operate in? Will motion and flex be constant? How many cycles? Will the cable be subject to damage from oil, chemicals, UV rays, or welding slag? How long will the cable be exposed to these elements?**
- **Create a plan for installing, connectorizing, and terminating the cable**
- **List all agency standards, government regulations, and other approvals/directives needed**
- **Are there aesthetic requirements for the finished cable assembly's look and feel?**
- **Discuss the project with an SME in a relevant field to determine how to best fit the requirements while staying on schedule and within budget**

LEARN MORE AT NORTHWIRE.COM/TECHNICAL-RESOURCES/FLEX

CORE KNOWLEDGE: COPPER STRANDING 101

Copper has been the conductor of choice for electrical wiring since the early 1800s. With a higher conductivity rating than any other non-precious metal, copper has become the standard for measuring conductive materials. Copper is uniquely suited for use in electrical wiring due to its relatively high tensile strength, flexibility, and ductility. The pliable property of copper allows it to be further processed without breaking or cracking. These properties make it the ideal material for wire and cable.

WHY COPPER?

- **High Conductivity**
- **Natural Flexibility**
- **Resists Corrosion**
- **High Tensile Strength**
- **Dissipates Heat Well**
- **Low Thermal Expansion**
- **High Ductility**
- **Resists Deformation**
- **Easy to Solder**

COPPER CONSTRUCTION

Copper stranding is defined by both its overall size and an individual strand's size. For example, a .75 mm2 construction would be defined as 32 ends of .2 mm. The .75mm2 would be the overall size, and then there are 32 strands of .2mm for each strand.

Application often determines the size of stranding needed. In a power application, the ampacity requirements for the stranding will define the size needed to handle the power load, taking into account all of the conductors that are in play.

Bare copper is preferred in most situations. Copper alloys are better suited in environments where excellent abrasion or corrosion resistance is needed. More commonly, copper strands have a coating applied to add the properties required for a given application.

Dennis Langer
Northwire Senior Design Engineer

COATING OPTIONS

"There are several coatings we can purchase stranding in," says Dennis Langer, Northwire Senior Design Engineer. "Silver plate and nickel plate are two of them, and tinned copper is always an option."

"Tin coating would be a preferred method when soldering is being used," says Langer. " The nickel plate and silver plate come into play when a higher temperature material is being used, such as a fluoropolymer. The nickel and silver melt and reflow at a higher rate, which is why we process those at higher temperatures."

NORTHWIRE COATING OPTIONS

- Temperature rated from 150ºC to 260ºC
- Tin
- Silver, Nickel
- High-strength alloys

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STRANDING CONFIGURATIONS

CONCENTRIC
In a concentric strand, there is a solid conductor running down the center surrounded by layers of rotating strands. Each layer is comprised of strands running the same direction, but the direction alternates for each layer.

UNILAY
The unilay configuration is similar to concentric, with layers of stranding around a center conductor. Unlike concentric, all layers rotate the same way; typically, these layers have a left-hand rotation.

ROPE LAY
With the rope lay configuration, there are a number of individual bundles of stranding twisted into groups making up one larger, solid configuration.

Stranding configuration selection depends on the end application of the cable and the environment the cable must perform. Key deciding factors are flex and movement requirements. Typically the more strands your cable has, the more flexible it will be and the longer its lifespan. From a movement and motion standpoint, a rope lay construction is the most flexible configuration. It is also the most expensive. This highlights the trade-offs buyers and engineers must consider when choosing materials.

For static in-situ applications, stranding matters less. Dramatic temperature fluctuation does not affect copper as much as movement does. It is important to consider the connection point and how the cable will be terminated. This could be a vulnerable area.

Other factors to consider are applicable regulatory agency requirements. As a North American company, Northwire adheres to many guidelines, including UL which requires twisted stranding in most applications. For other approvals and some agencies, manufacturers can run stranding without twisting it together.

QUESTIONS TO ASK WHEN SELECTING COPPER STRANDING

1 | What is the primary end-application and use for this cable?

2 | What environmental factors will this cable need to perform in successfully?

3 | What approvals or agency certifications are required for the application?

NORTHWIRE CABLE OPTIONS
- Copper stranding options
  - o 36-2 AWG (7,19 strands or higher)
  - o 18-16 AWG (19 strands or higher)
  - o 14-2 AWG (41 strands or higher)
- Up to 2" (50.8 mm) O.D.
- 0V to 5000V
- -200°C to 260°C
- UL listed, CSA certified and approved for CE Mark
- RoHS3 and REACH compliant

NORTHWIRE STRANDING OPTIONS
- Bunched
- Unilay
- Rope lay
- Concentric

NORTHWIRE COATING OPTIONS
- Temperature rated from 150°C to 260°C
- Tin
- Silver, Nickel
- High-strength alloys

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STRENGTH MEMBER PERFORMANCE

Strength members add both function and protection to connectivity solutions. Specific strengthening materials may be added for unique solutions such as pull strength, push strength, mechanical strength, or rigidity. Fiberglass rods, steel strength members, and aramid fiber are three of the more common types of strength members.

Kevin DePratter
Director of R&D

"One extreme application is for sewer system inspections where there is a camera and connector on the cable. The fiberglass rod enables the cable to stand straight out. This gives the cable great compressive properties and a lot of push/pull strength."
–Kevin DePratter, Director of R&D

FIBERGLASS RODS

Northwire uses fiberglass rods when a cable has to be extremely rigid, because the cable is being pushed through the pipe.

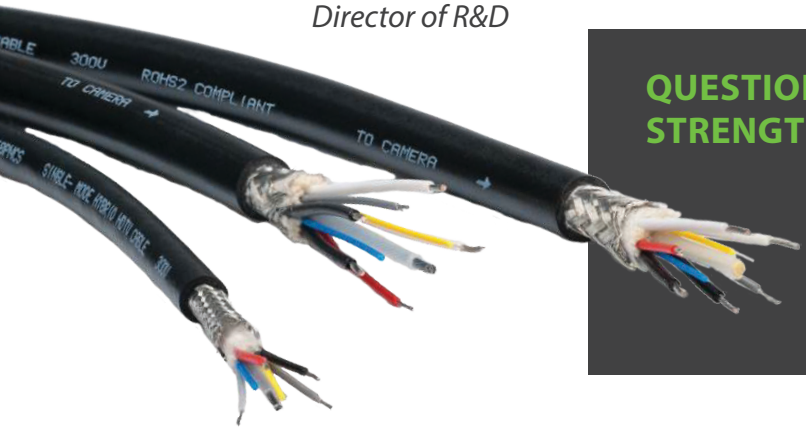
STEEL STRENGTH MEMBERS

There are different types of steel strength members that may be used depending on weight requirements and durability. Stainless steel strength members provide excellent strength at just 3/16". Galvanized steel provides pull strength of about 500 Newtons without breaking, along with superior compressive strength. Steel cords are used in applications such as LEMO and Northwire SMPTE HD AV product line where pulling strength and compressive strength are critical.

ARAMID FIBER

Aramid fiber, or DuPont Kevlar,® is an extremely strong material commonly used in bulletproof vests. A bundle of four aramid fiber strands provides 450-600 Newtons of pull strength. While it is not rigid, aramid fiber does offer high compressive strength without adding significant weight. Aramid fiber is ideal for extreme pulling strength in cable and can be stranded in a variety of configurations to achieve different levels of strength.

If aramid fiber is used in a cable system, special attention must be given to the cable termination. Incorrect termination can lead to weak points in the fiber.



QUESTIONS TO ASK WHEN SELECTING STRENGTH MEMBERS

1 | What type(s) of strength are required?
2 | Does this cable need to be rigid or flexible?
3 | What is the plan for termination and connectorization?

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BREATHE EASY WITH MULTI-FUNCTIONAL TUBING

Breather tubes are integral to functionality in some extreme environments. With a wide range of material types, sizes, and durometers, breather tubes can offer increased protection against high heat, pressure, oil, water, chemicals, flame, and abrasion.

APPLICATIONS

Breather tubes can be used in a variety of diverse applications:

- Automotive
- Food and Beverage
- Medical Equipment
- Fiber Optics
- Dental Equipment
- Liquid or Gas Transfer
- Oil and Gas Fields
- Factory and Automation

"Breather tubes can be used within a cable assembly for gas and fluid transfer and for dissipating heat, pressure or steam."

–Dennis Langer
Northwire Senior Design Engineer

BREATHER TUBE BENEFITS

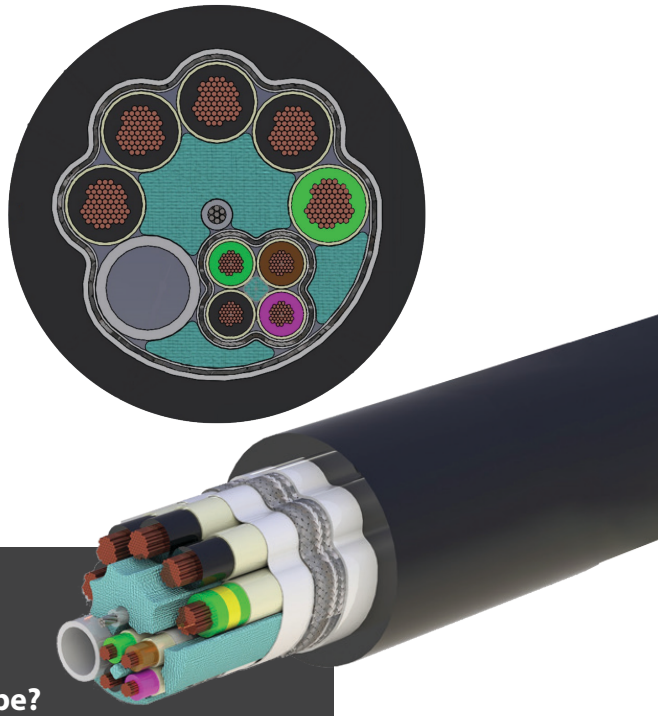
Breather tubes prevent damage caused by high temperatures and pressure while adding helpful functions to the cable system. Breather tubes provide heat venting in electrical equipment. Breather tubes can be used to house inner components of wire harness applications to help separate bundles and provide protection from abrasion. Optical fibers can be routed through tubing to protect the fibers from other components in the construction.

MATERIAL SELECTION

Breather tube materials include:

- PE: Polyethylene
- Nylon
- PVC: Polyvinyl Chloride
- PUR: Polyurethane
- PTFE: Fluoropolymers

Find the right breather tube for your application. Contact a Northwire Subject Matter Expert.



QUESTIONS TO ASK WHEN SELECTING BREATHER TUBES

1 | What is the primary purpose of the tube?

2 | Are there secondary desired functions for the tube?

3 | Will the cable be in high heat or wet environments?

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STOP LEAKS AT THE SOURCE

Even with resilient, durable cable assembly solutions, there is always the chance of cut, abrasion, or faulty termination. In wet environments, a small fissure could spell disaster. To mitigate epic failures, water blocking agents quickly react to moisture seeping into a damaged part of the cable, sealing off the leak and preventing migration of the liquid.

QUESTIONS TO ASK WHEN SELECTING WATER-BLOCKING MATERIALS

1 | **Will the cable be partially or fully submerged?**

2 | **Are there moving parts or high flex requirements for the cable system?**

3 | **What types of liquid will the cable encounter?**

WATER BLOCKING CAPABILITIES

Traditionally, cables meant for use in wet environments would have a layer of water-blocking gel throughout the cable or filling the ends only, where leaks are more likely to occur. Upon contact with moisture, the gel would block the moisture from moving further down the cable.

With effectiveness limited to the small area of gel coverage, gels are also difficult to apply and can add mess and complication down the line. Newer solutions are more advantageous, with the added benefit of easy installation and termination. These include dry yarns and tapes that are impregnated with water-blocking chemicals. If moisture comes into contact with these yarns and tapes, the chemicals activate to produce and release water-blocking gels. The moisture is unable to spread and the leak is trapped and sealed effectively.

NiCorAl was the second runner up in the 2016 i-NOVO Awards for the Tech Category, highlighting LEMO's continued commitment to high-performance products of recognized quality.

NORTHWIRE SOLUTIONS

Northwire field-proven solutions have been tested up to 15 PSI to ensure there is no further water penetration from the point of contact. These options may be selected and customized based upon additional factors such as the temperature and type of water (salt, fresh, sewer) in which the cable assembly must perform.

LEMO SOLUTIONS

NiCorAl™, LEMO's newest surface treatment for rugged connectors, provides exceptional protection to salt water corrosion for cable systems in wet environments. This treatment lengthens the life of aluminum components and passes the 500 hours salt spray test under AECTP 300 / MIL-STD-810 / MIL-STD-202 standards. It is also RoHS2 and REACH 2017 qualified.

FILLER FUNDAMENTALS: FORM & FUNCTION FACTS

A fillers primary function is to fill the space between other components in order to provide the desired form.

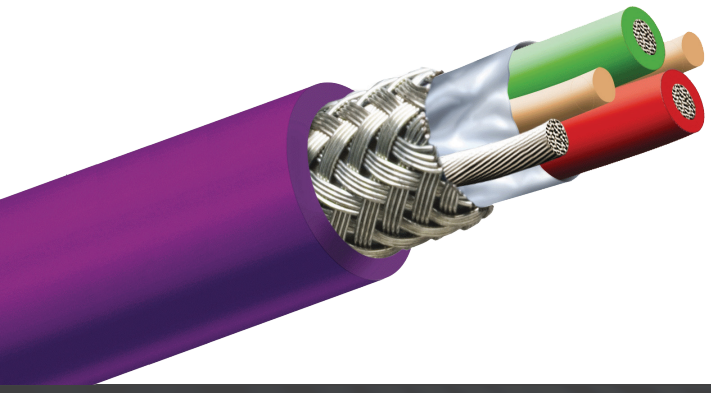
Fillers may seem like a simple aspect of cable and wire. However, various filler materials may be added to enhance functionality to a cable, such as additional strength and protection against environmental factors.

FILLER MATERIALS

Common fillers are made of polypropylene (PP), polyester (PES), nylon, and cotton. These materials can be bundled, twisted, or layered as needed. Materials may add benefits such as:

PVC OR POLYETHYLENE PLASTICS	• Common and easy to source • Available in any size
FOAMED POLYPROPYLENE	• Light weight • Adds insulation • Resists many environmental factors
FIBRILLATED POLYETHYLENE	• Common and easy to source • Primarily used for proper shaping
POLYETHYLENE OR POLYPROPYLENE RODS	• Adds push and pull strength
POLYESTER	• Provides insulation • Minimal shrinkage
NYLON	• Resists heat • Adds strength
COTTON	• Will not melt in high temperatures • Cost effective • Can be infused with water blocking chemicals
ARAMID FIBERS (KEVLAR®)	• Adds superior strength

Ensure performance by taking advantage of multi-functional filler materials. Keep inner components in place, add strength, and gain other benefits by working with a Subject Matter Expert to find the right filler for every application.



QUESTIONS TO ASK WHEN SELECTING FILLER MATERIALS

1 | What form is desired?

2 | How can filler impact the cable's function?

3 | Given the other cable components, what literal and practical gaps could filler materials address for this application?

BARRIER BASICS: TAPES, WRAPS AND SEPARATORS

Tapes, wraps, and separators serve as barriers between a cable's core components and the outer jacket material so that they do not bond together. However, like fillers, there are additional functions these layers can perform based on individual needs and applications.

"A number of different tapes are available. They can be applied at various operations to achieve a range of functions. Focus on the unique capabilities tape materials offer and the end-application requirements."

–Dennis Langer
Northwire Sr Design Engineer

FUNCTIONS AND ADVANTAGES

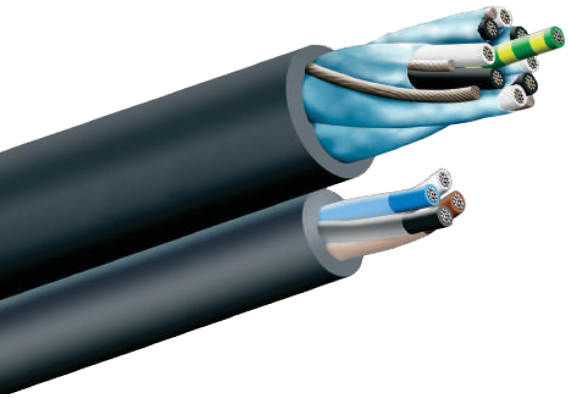
Beyond acting as a barrier, adding certain tapes, wraps, and separators can provide a number of helpful functions, such as:

- Aluminized backing can be used for shielding and insulation
- Binder wraps can hold components together to equalize tensions
- Tapes can increase flex life or rigidity based on coverage and material
- Materials like Kapton® tapes are designed specifically for high temperatures
- Polyester excels in low temperatures
- PTFEs and nylon can be used at any temperature
- Wraps and tapes can be designed to protect from moisture and chemicals

Configurations to isolate and separate internal components are customizable. Coverage can range from full to minimal depending on needs.

CONNECTOR CONSIDERATIONS

From a connector standpoint, the dimensional aspect of wraps and tapes is the most important. Some tapes, such as cloth tape, are thicker than a polyester tape and could affect the housing of the connector.



QUESTIONS TO ASK WHEN SELECTING TAPES, WRAPS, AND SEPARATORS:

1 | What internal components must be accommodated?

2 | What other functions would be helpful for this application?

3 | How will the cable be connectorized?

SHIELDING FOR STRUCTURE AND SIGNAL INTEGRITY

Selecting the right shielding materials and components can add strength, flexibility, and noise suppression.

MATERIALS AND ORIENTATION

Northwire offers a variety of shield types: foil shields; box weave or basket weave braid shields; and spiral shields. Shields can be made from aluminum, tin, stainless steel, aluminized polyester, and more.

- Aluminized backing can be used for shielding and insulation
- Binder wraps hold components together to equalize tensions
- Tapes can increase flex life or rigidity based on coverage and material
- Kapton® tapes are designed for high temperatures
- Polyester excels in low temperatures
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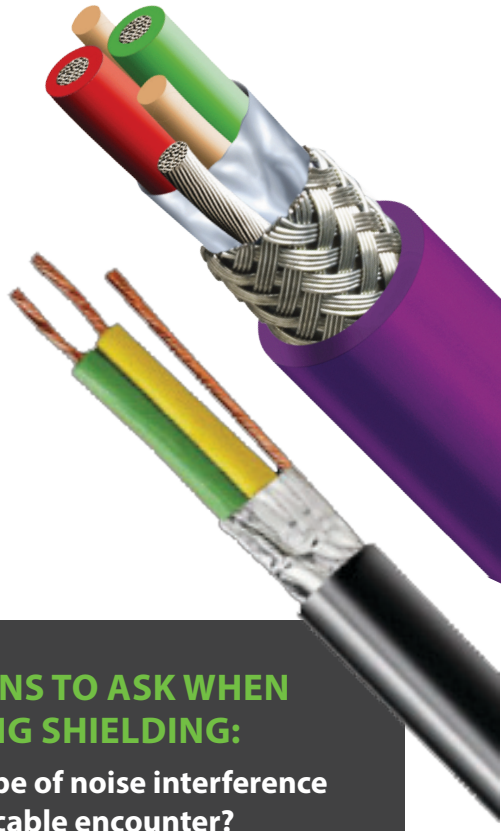

SHIELDING

- Aluminum foil tape
- Aluminized polyester tape
- Foil tape, braiding with tinned copper, and other materials
- Drain wire

BRAIDING STYLES

- Box weave
- Spiral

REDUCE INTERFERENCE

The most effective shielding against interference is a combination of braid and foil shields. From an electrical standpoint, foil guards against high-frequency noise and a braid guards against low-frequency noise. The combination is ideal for signal integrity.

INCREASE FLEX LIFE

When high-flex life is required, a spiral shield provides more flexibility, and a longer life span than a box weave. However, shield effectiveness may be affected in high flex applications. A box weave is stiffer and its interlocking nature allows it to stay together throughout the flex life of the application. However, a box weave has a shorter flex life than a spiral shield.

CONNECTOR CONSIDERATIONS

When connectorizing a cable, the shield must be terminated as effectively as possible on both ends. If there are multiple twisted pairs inside the cable having their own shield, it is most effective to terminate each shield independently without touching each other This allows noise to dissipate and not interfere with signal.

QUESTIONS TO ASK WHEN SELECTING SHIELDING:

1 | What type of noise interference will the cable encounter?

2 | What flex life demands will there be for the cable system?

3 | If there are multiple shields, what is the plan for connectorizing?

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JACKETING: THE FIRST LINE OF DEFENSE

The outer jacket is a cable's primary means of protection against environmental factors and application demands. For extreme environments, select the right jacket material and construction to protect critical inner components for your cable's life cycle.

"Northwire has a wide variety of commercial materials available and the resources to develop specialty compounds to meet your specific needs", says Director of R & D Kevin DePratter. "For extreme temperatures, Northwire has an assortment of fluoropolymers, thermoplastic urethanes (TPUs), and thermoplastic elastomers (TPEs), and for extreme cut, crush, and abrasion, we recommend our superior selection of TPUs, fluoropolymers, PVC, and TPEs."

These material families also meet your needs for oil, chemical, and UV resistance. Northwire is working on expanding LSZH offerings to withstand extreme environments while maintaining critical agency compliances.

EXTREME TEMPERATURES

Several materials excel in extreme temperatures. Northwire fluoropolymer jackets can be rated from -200°C to 260°C, and Northwire offers polyethylene jackets performing up to 125°C. A wide range of specialty PVC and TPE blends can be rated from -60°C to 105°C.

CUT, CRUSH, AND ABRASION

For extreme application requiring superior cut, crush, and abrasion resistance are Fluoropolymers, TPUs, and Hytrel® (thermoplastic polyester). Fluoropolymers are extremely rigid, even at high temperatures. TPUs are softer yet strong and rigid. TPUs and Hytrel® coil well while maintaining damage resistance.

A wide range of material alloys can be specially compounded to meet performance needs for extreme environments. Jackets with these material blends are available in shiny or matte finishes as well as variations for exposed run or direct burial when additional crush resistance is needed.

CABLE JACKET SPECIALTY BLENDS

Northwire works with boutique compounders to develop specific materials meeting unique needs.

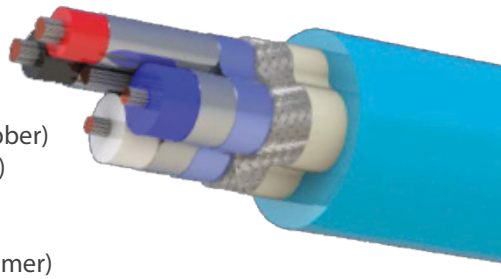
Specialty Blend: Direct Burial Rating

Northwire material engineers were tasked with creating a specialty blend cable jacket required to pass an intense direct burial rating: A 1,000 lb. weight was applied to the cable over a ½" steel rod and held for one minute while maintaining the integrity of the insulation and jacket material.

LOW SMOKE ZERO HALOGEN

The need for high performing Low Smoke, Zero Halogen (LSZH) products is increasing. Northwire offers a commercial TPU to fit these requirements. With new innovation and evolving requirements, the cable manufacturer is expanding this line to include additional characteristics such as rigidity, flexibility, oil and chemical resistance, and varying flame resistance.

JACKET MATERIALS



- USP Class VI approved
- Medical and Food Grade
  - o PUR (Polyurethane)
  - o TPR (Thermoplastic Rubber)
  - o PVC (Polyvinyl Chloride)
- Fluoropolymers
- PES (Polyester Elastomer)
- TPE (Thermoplastic Elastomer)
- TPU (Thermoplastic Urethane)

Given the importance of the right cable jacket material to its performance and lifespan, Northwire offers a wide range of standard and custom options to meet end application needs.

QUESTIONS TO ASK WHEN SELECTING CABLE JACKETING:

1 | What type of noise interference will the cable encounter?

2 | What flex life demands will there be for the cable system?

3 | What environment will the cable operate in?

4 | If there are multiple shields, what is the plan for connectorizing?

INTEGRATING ASSEMBLIES SEAMLESSLY

In addition to ensuring that cable assemblies can withstand extreme environments, consideration should be given to the connector and assembly manufacturing. The connection is often more vulnerable to the elements than other parts of the assembly, work instructions will detail the special attention needed in terminating and connectorizing the cable.

CONNECTORS

The connector itself must also provide protection and resilience to extreme environments. LEMO provides a broad range of connectors designed specifically for severe applications.

EXTREME TEMPERATURES

Extreme temperatures and temperature changes are one of the biggest considerations when choosing connectors. At LEMO, connectors are designed for temperatures ranging from 250°C down to -55°C. For these types of applications, LEMO B or K series connectors are commonly used. Extreme cold applications range from transportation and research to filming and photography.

Additional challenges come with fluctuating temperature changes, often even more so than the cold itself. Some plastic materials, such as insulators and gaskets, are more vulnerable to rapidly dropping temperatures. LEMO provides arcticgrade connector materials to hold up to these temperatures swings.

To further aid in these extreme expeditions and applications, LEMO designed an arctic grip connector for its M series connector, which is dedicated to robust performance in freezing temperatures. This grip uses a scallop shape for easy manipulation while wearing gloves.

Paralympic gold medalist Cato Zahl Pederson set out on a successful South Pole expedition in 1994. Included in his equipment were LEMO connectors. LEMO contributed to the solar cell panel design used to power the trekking equipment and the GPS satellite navigator – these connectors were also used in a heating device in Mr. Pedersen's mechanical arm.

EXTREME HEAT

For connectors that must perform in high temperatures, LEMO uses materials such as PEEK© insulation for applications up to 250°C. Teflon™ and PTFE are also excellent for high temperatures. For extremely high heat, LEMO has a range of thermocouple connectors dedicated to temperature measurement. Occasionally connectors use ceramic insulation materials that allow reaching extended temperatures. These connectors have been used to measure heat near engines, turbines, and even rocket launches.

LEMO connectors can be adapted for every application. Whether a project calls for waterproof or watertight connectors, performance in high-pressure or high-altitude environments, resistance against corrosion and chemicals, protection from noise and vibration, or harsh environments, LEMO leverages professionals around the globe to find ideal solutions for every customer.

The Arctic Trucks company manufactures and enhances vehicles for extreme freezing environments. When adapting their trucks, LEMO connectors are commonly used in equipment for temperatures as low as -40°C.

CUSTOM SOLUTIONS FOR EXTREME ENVIRONMENTS

Cable assemblies operating in extreme settings often have multiple environmental factors to overcome.

The number of variables taken into consideration when designing connectivity solutions, along with the number of challenges these products will face, usually mean the best course of action is to work with an experienced Subject Matter Expert.

LEMO and Northwire help you navigate complex requirements and elements:

"Northwire helps you ensure your critical project requirements are met, and your end application goals are achieved. We help each customer select critical wire and cable assemblies to offer superior performance in the toughest environments."

–Dennis Langer
Northwire Senior Design Engineer

Bring your next challenge to our Subject Matter Experts.

With a comprehensive suite of custom cable capabilities, our innovative TEAM looks forward to finding the ideal solution for your extreme environment application and complex requirements.

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ABOUT US

LEMO

LEMO is the acknowledged leader in the design and manufacture of precision custom connection and cable solutions. LEMO high-quality Push-Pull connectors are utilized in challenging application environments including medical, industrial control, test and measurement, audio-video, and telecommunications.

LEMO has been designing custom connectors for over 75 years. Offering more than 90,000 product combinations and growing through tailored, specific designs, LEMO and its affiliated sister companies REDEL, NORTHWIRE, and COELVER currently serve more than 100,000 customers in over 80 countries worldwide.

In 2014, LEMO Group acquired Northwire, Inc. to provide a seamless experience and expanded capabilities for valued customers by offering a comprehensive suite of custom connector, cable and assemblies. This means comprehensive product offerings for a diverse range of extreme applications and a wider range of resources for your project needs.

NORTHWIRE

Northwire celebrates over 50 years of innovative technical wire and cable manufacturing solutions for diverse applications in medical life sciences, industrial, off-road heavy equipment, test and measurement, aerospace and defence, and more. The corporate headquarters and manufacturing facility is in Osceola, Wisconsin and the engineering and manufacturing facility is in Santa Teresa, New Mexico.

Custom wire and cable, retractable cables, and cable assemblies from Northwire work seamlessly with the diverse selection of wire connectors produced by LEMO.

LEMO + Northwire make a great connection.

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