

LEMO AND
NORTHWIRE

SOLUTIONS THAT INTEGRATE

WHITE PAPER SERIES – PART I:

UNDERWATER CONNECTIVITY

EXTREME ENVIRONMENTS | COMPLEX REQUIREMENTS

CUSTOM INNOVATIONS
CONNECTOR + CABLE



EXECUTIVE SUMMARY

Published in collaboration by LEMO and Northwire, this white paper represents the first in a series focused on the critical to quality requirements of connector and cable assembly applications in extreme environments. Ranging from underwater to oil and gas, the series will address key specifications that are as diverse as their markets. Since more than 71% of the earth's surface is covered by water, it is no surprise that there are an abundance of application failures associated with this dominant element. To ensure your success, rely on our subject matter experts to improve your risk assessment of off-the-shelf parts, learn how custom designs improve protection, and navigate complex environmental factors.

Table of Contents

- 3 | Total Cost of Ownership
- 4 | Expensive Lessons Learned
- 5 | Fit vs. Function
- 7 | Environmental Factors
- 8 | Critical-to-Quality Factors
- 11 | Conclusion

Total Cost of Ownership

Avoid the inherent hazards of a narrow-minded bottom line focus

Sometimes focusing on hurdle rates, internal rate of return, and the short-sighted bottom line can lead to disaster. This is often the case when making “apples to oranges” comparisons. While engineered products can have a marginally higher price vs. off-the-shelf parts and appear more attractive initially, it is vital to be aware of the longer-term hidden dangers of decision-making based on price alone. There are actually [29 cost factors](#) to consider, including service quality, risk management, total landed cost, labor, training, and much more.

The importance of specifying products based upon quantitative critical-to-quality requirements cannot be over-stressed. Price alone cannot be the deciding factor; decision-makers should evaluate subject matter expertise, domestic and international standards, agency compliance, environmental regulations, and electrical, mechanical, ergonomic, aesthetic, harsh duty, and end-user requirements to name a few.

Third-party testing will add assurance to an “apples to apples” comparison. Make sure an independent Nationally Recognized Testing Laboratory (NRTL) certifies to the standards of IP68, CE Mark, UL, CSA, cUL, CE, MSHA, NFPA, ABS, USCG, IEEE, SAE and more as appropriate.

Employ additional selection criteria to avoid the pitfalls of expensive lessons from judging apples and oranges by the same criteria:

Cheap alternatives could create:

- Safety Issues
- Equipment Damage
- Productivity Downtime
- Loss of Revenue
- Reputation Harm

Be sure to research:

- Are the products counterfeit?
- Are the copper bases identical (e.g., \$4.14 vs. \$3.82)?
- Is the copper quality similar?
- Are the combination of approvals possible?

Expensive Lessons Learned

When cheap commodities cost a lot

When it comes to spectacular displays and incredible entertainment, few places rival the casino. A huge amount of work goes into powering, programming, controlling, and maintaining the shows and attractions seen at these sites.

In 2011, a contractor at one of the world's largest casinos contacted Northwire. One of the large underwater entertainment venues at the facility, a water theater housing a multimillion dollar production, experienced massive destruction due to an underwater cable system that failed to properly block water – resulting in an equipment loss to the tune of \$250,000 USD.



The original cable assembly was designed to control and power water jets, lighting, moving platforms, and more as directed by a central control computer. When the system broke down, it was not only unsuccessful in stopping water leaks, but siphoned water back into the central control computers. In addition to the equipment damage, all operations had to be shut down in the venue.

As with this contractor, many project managers struggle to find reliable cable and connectors for underwater use. Another layer of factors comes into play when mixing electronics and liquids, so precision, quality, and safety are of the utmost importance.

Avoid liquidated damages associated with commodity parts that are not engineered and designed to meet the exact function!

Fit vs. Function

Custom designs for your protection



From time to time a standard part is installed and operates without obvious problems. This short-term “fit” can have defects that are hard to detect, like inferior materials or manufacturing non-conformances. While not immediate, selecting products on “fit” alone increases the likelihood of early failure. Custom engineered OEM solutions, on the other hand, are designed to meet exact product specifications, ensuring that both fit and function are achieved. And, they are tested and field-proven to the identical application and subjected to their intended life cycle.

One size does NOT fit all

With the diverse range of underwater applications, there truly is no “one size fits all” cable assembly system. When a customer comes to LEMO or Northwire with a project in mind, the goal is to find the most effective connector or cable or cable assembly for that specific use.

Therefore, no off-the-shelf product is standardized for underwater applications. Instead, a customer will meet with a subject matter expert to discuss the challenges and requirements of each individual project. Working closely with the customer, the experts employ rapid prototyping and testing capabilities to design and manufacture each component to the customer’s needs.

Northwire met with the casino’s contractor and identified the root cause of the failure. Meanwhile, the team gathered all of the critical-to-quality requirements from key stakeholders. Then, NWI’s subject matter experts rapidly designed, tested, and prototyped a cable specifically for the venue’s rugged requirements. The custom cable system was tested to withstand 100 PSI (6.985 bar) and delivered high performance when fully submersed in chlorinated water. Reinforced tensile strength, abrasion resistance, and flexibility enabled the cable to wrap around concrete pylons while preserving signal integrity.



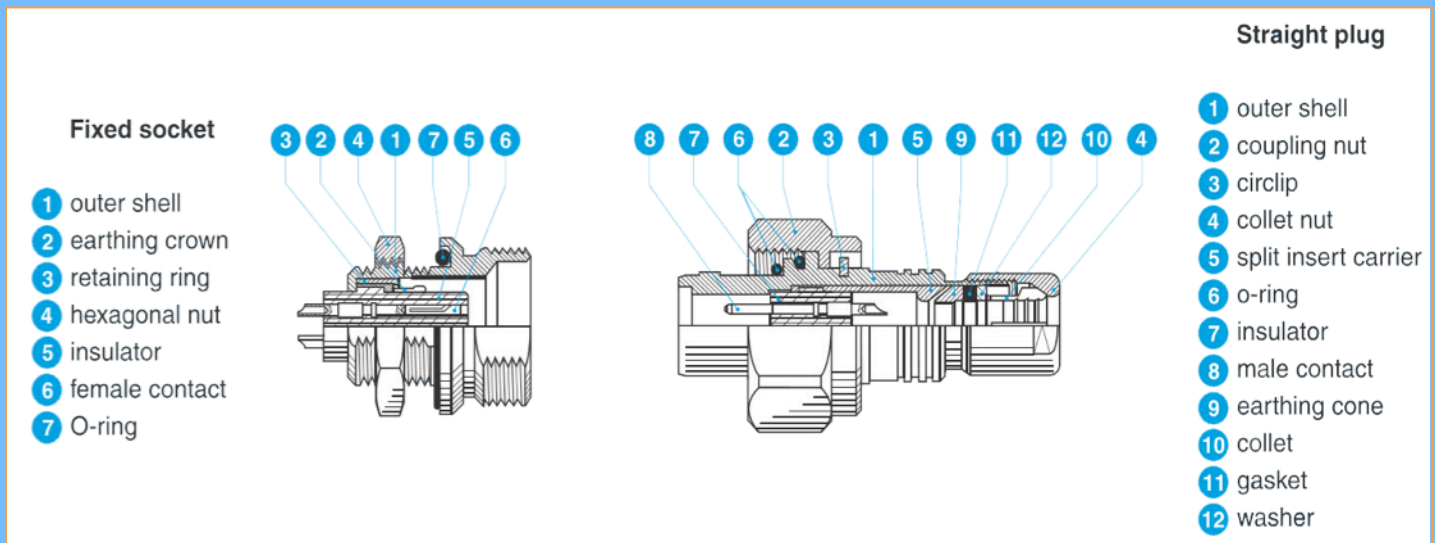
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Solution-oriented and application-driven, the cable and connector design, engineering, and manufacturing processes all become tailored for the individual project, giving customers a best quality, highly effective, long lasting system.

LEMO's Cable Connectors are designed and tested to exact specifications

From shallow waters to ocean depths of 1000 meters (3280 feet), LEMO's precisely manufactured watertight connectors have been the answer for clients across the world.

With a guaranteed IP68 rating, the line of shallow-use connectors is built off LEMO's pioneering Push-Pull connection system that has been perfected over the last six decades. The manufacturer's line for deep sea connectors, also called high pressure connectors, are based on a screw coupling design. Both lines can be made with chrome-plated brass or stainless steel materials, chosen as appropriate for the length of immersion and risk of corrosion or oxidation.



LEMO's primary connector lines for underwater use consist of the V Series, W Series, and 03 Series:

- **V Series.** Available in multiple contact types, including coaxial, triaxial, and multipole, these connectors perform in pressures up to 30 bar (435.11 PSI).
- **W Series.** Also for pressures up to 30 bar (435.11 PSI), the W Series is designed for multipole and fiber optics contact configurations.
- **03 Series.** This small connector has been tested for extensive salt spray corrosion resistance up to 1000 hours. Additionally, the 03 Series is tested for depths of 1200 meters (3937 feet) and high voltage for absolute waterproofing to ensure a reliable, high performing connection.

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These connector series are ideal for applications from underwater cameras and telecommunications to unmanned submersibles and bathyscaphes. For example, LEMO connectors can be found in the Delphin 2 Autonomous Underwater Vehicle created for subsea environments by the University of Southampton (UK).

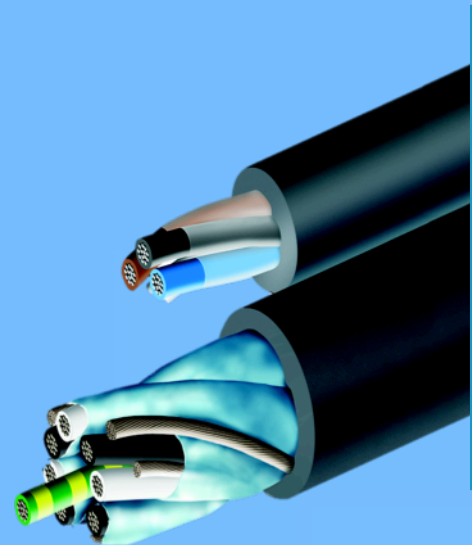
Additionally, the leading quality of LEMO connectors enables these components to meet and exceed the requirements of critical applications such as sea wind power, offshore oil rigs, oceanographic science, and military defense systems.



Environmental Factors

The wide variety of environmental factors drives the broad scope and need for high-quality connectors and cable assemblies' precision engineered and designed for underwater applications. Field-proven, LEMO and Northwire address challenges in nearly limitless industries and functions beyond the entertainment world, such as:

- Offshore or fixed oil rigs
- Fixed or floating offshore structures
- Underwater lighting
- Inspection and monitoring
- Vision systems
- American Bureau of Shipping (ABS)
- United States Coast Guard (USCG)
- Marine Shipboard
- Umbilical cables
- Sensors and transducers
- Buoy systems
- Fishing equipment
- Tracking and locators
- Military and marine
- Aquatic research
- Industrial water systems



Critical-to-Quality Factors

When evaluating underwater cable systems, consider these critical-to-quality factors:

1. **Application.** Underwater vision systems may require a fundamentally different type of cable than underwater lighting or monitoring and research applications.
2. **Compliance.** Ratings, agency listings, government certifications and environmental standards: UL, ANSI, CSA, CE, IEEE, ABS, RoHS2, REACH, and 1,000 hour weatherometer requirement.
3. **Features.** Signal, control, instrumentation and power.
4. **Water Type.** Different options exist for salt, fresh, brackish, chemical-treated, waste, and potable water. For example, cable in contact with potable water may need to be made of FDA-approved, food-grade materials.
5. **Cable Depth.** Cable systems at greater depths require heavy-duty materials and pressure resistance. NWI's underwater cable capabilities extend to a depth of 30 meters (98.43 feet).
6. **Flex.** Cold bend, torsional, rolling, variable, bend, and continuous flex options exist for cables whose applications require regular motion.
7. **Environment.** Knowing whether a cable must function in an industrial pipe, ocean, or rocky riverbed determines many design factors.
8. **Temperatures.** From Arctic to high rating, cable systems are designed for specific temperatures ranges.
9. **Buoyancy.** Special considerations must be taken when a cable is required to have a negative, neutral, or positive buoyancy.

Northwire's Custom Cable Expertise

Underwater applications are subject to extreme engineering challenges; you can rely on subject matter experts at LEMO and Northwire to meet your product specification:

- Cut and abrasion resistance
- Flame resistant
- Cold impact and bend
- Oil, chemical and UV resistance
- Weld flash and weld slag resistance
- FDA-approved materials
- Kevlar® integrated for strength and stability

Navigate requirements from domestic and international regulations to electrical, mechanical and aesthetic standards and end-user requirements. For wet use and submersed cable systems, NWI subject matter experts work one-on-one with customers to determine factors such as:

- Jacket, insulation, and fluid blocking materials
- Strength members and temperature resistance
- Buoyancy, depth, and pressure needs
- Labeling and color coding
- Electrical performance requirements
- Application-unique factors

Partnering with NWI cable experts gives customers access to the ideal cable set-up, whether for vision systems, sonar and tracking, power and control, sewer pipes and wells, geophysical applications, or far beyond. For immediate needs or challenging projects, Northwire has an answer.

Unique Designs for Your Protection

One of the most important factors when designing and manufacturing underwater cables and connectors is the level of water resistance. Beyond basic protection to keep the system from damage, there must be an intrinsically safe measure in play. In the case of the casino, when the first degree of protection failed, the compromised cable acted as a hose, syphoning the leak efficiently and directly to the control center.

In order to ensure absolutely watertight components in a variety of uses, LEMO and Northwire use top-quality materials with purposeful design.

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For cable systems, a choice of water-blocking conductors, tapes, and fillers work to not only prevent leaks, but to create a barrier in case of cut, abrasion, or severe damage. Unlike many cable assemblies, which use a gel filler as a barrier for the first few inches of the cable, Northwire implements a dry component throughout the entire length of the cable that only activates when wet. Highly effective in preventing and mitigating leaks, this unique alternative also allows for a much more convenient and cleaner process when installing and handling the cable.

Find a full selection of wire and cable, cable assemblies, retractable cords, cable connectors, and other key components with the complete line of products and custom capabilities from LEMO and Northwire. The strong cooperation between these companies results in integrated offerings that guarantee high performance and quality, ultimately saving customers time, money, and downtime.



Conclusion

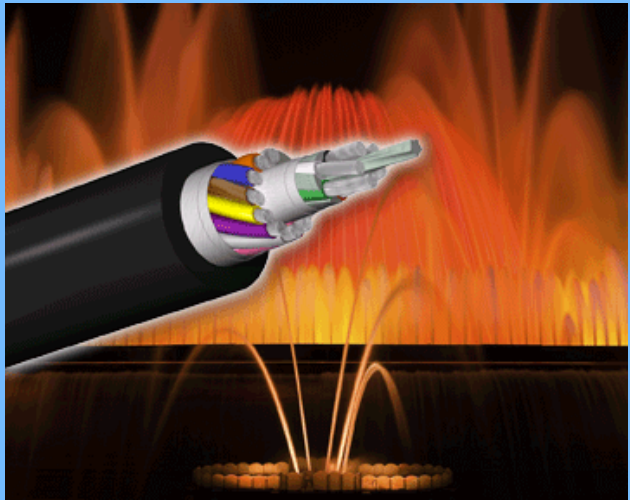
In response to his urgent request, the casino's contractor had an effective, custom cable and connection solution on site within five days, saving the casino from further loss and downtime.

"The customer called late on Friday in need of an urgent solution," explained a Northwire team member. "Our engineering team translated the customer's critical-to-quality requirements into several designs, test and development protocols and rapid prototypes. Results were reported to the customer the following business day. He selected one of several custom solutions. Two days later, our production team shipped his product."

Gain a comprehensive solution for underwater systems by leveraging LEMO's best-in-class connectors alongside cable components and contract manufacturing services by Northwire.

The integration of LEMO, an international connector leader, and Northwire, an innovative supplier of exceptional wire and cable, benefits the customer by acting as a one-stop shop for any project. Take advantage of:

- Quotes in 24 hour or less
- No minimum quantity or length requirements
- Same day custom cable products
- Free wire and cable samples
- Rapid prototyping
- Full testing capabilities



For essentially limitless underwater applications, partner with LEMO and Northwire to design and manufacture ideal cable and connection solutions that prevent system failure, accomplish innovative goals, and reliably last many years into the future.

ABOUT US

LEMO is the acknowledged leader in the design and manufacture of precision custom connection and cable solutions. LEMO's high quality push-pull connectors are found in a variety of challenging application environments including medical, industrial control, test and measurement, audio-video, and telecommunications.

LEMO has been designing custom connectors for six decades. Offering more than 75,000 combinations of products that continue to grow 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 around the world.



In 2014, LEMO Group acquired Northwire, Inc., a top custom cable manufacturer in the U.S., for the purpose of better serving both companies' customers through fully integrated, comprehensive cable connector solutions.

Northwire, celebrating over 42 years of innovation, has corporate headquarters and manufacturing in Osceola, Wisconsin and engineering and manufacturing in Santa Teresa, New Mexico. The cable supplier is the premier partner for the

design, manufacture and contract services of custom technical products including wire and cable, retractable cable, cable assemblies, connectors, harnesses, injection molding, over-molding and contract engineering and OEM (Original Equipment Manufacturer) for diverse applications in life sciences, energy, MIL-Spec, industrial, machine vision, architectural lighting, underwater, and more.

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

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The Original Push-Pull Connector



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