Electrical Penetrator Systems for Oil and Gas Wells

Products and Services
For more than four decades, BIW Connector Systems has been the industry-leading supplier of electrical penetrator systems used by the upstream oil and gas market. Applications include safety barriers for electric submersible pump (ESP) systems, oil reservoir monitoring instruments, downhole heaters and ESP isolation systems. We operate on a global basis serving customers in every major oil center in the world.

At BIW Connector Systems, our commitment to designing and delivering quality products, solutions and services is unwavering. We also certify our products through recognized test laboratories to worldwide specifications for hazardous location environments, including the National Electric Codes of the USA and Canada, ATEX and IEC, among others. BIW Connector Systems is certified to ISO9001:2008.

In 2001, BIW Connector Systems became part of ITT Inc., a diversified leading manufacturer of highly engineered critical components and customized technology solutions for the transportation, industrial, and oil and gas markets. Together, ITT and BIW Connector Systems foster a culture of innovation, resourcefulness and continuous improvement that helps us solve our customers’ most pressing business challenges.

Advanced Products

BIW Connector Systems supplies the oil and gas industry with a breadth and depth of innovative products and breakthrough solutions. Our state-of-the-art engineering, testing and production capabilities, combined with high-performance elastomeric, thermoplastic and pressure-balanced technologies, allow us to deliver robust products that perform continuously and reliably in the harshest environments.

Reliability

Product reliability is critical in the upstream oil and gas production market. If any part of the production string fails, the well goes down and valuable revenue opportunity is lost. BIW Connector Systems invests significant resources in design and testing to ensure our products withstand the extreme, harsh environment of a production well.

Responsive Partner

Our customers need partners and suppliers that move at the speed of their business. That’s where BIW Connector Systems comes in. When an oil well is down, we help you quickly get it back into service. When deliveries need to arrive sooner, our infrastructure is nimble and flexible enough to accommodate. And when there are last minute design changes, we have both the expertise and production facilities to execute. At BIW Connector Systems, we move at the speed of business—and then some.

Innovation

When quality design and engineering are at the core of your DNA, innovation, performance and reliability become the standard. At BIW Connector Systems, we carefully balance the development of new solutions and technology with improvements to existing products, ensuring that our customers receive value at every touch point.

Wellhead Applications

Electrical Penetrators for Wellheads
A wellhead provides the most critical safety barrier between the oil well and the surrounding environment. The electrical wellhead penetrator is designed to safely deliver electrical energy through this critical barrier to operate electric submersible pumps deep in the well. Requirements for relatively high voltage and current, together with wide variation in operational temperatures of wellhead systems, add significant challenges.

Length variations and physical characteristics of the wellhead penetrator are the result of differences in wellhead designs and the need to seal against wellhead sealing structures, the tubing hanger and the top flange or “bonnet.” General configurations of wellhead penetrators can be divided into three groups. The shortest penetrators are used in wellheads that do not employ a top flange. Medium sized penetrators are used in wellheads that have top flanges, and the longest penetrators are used in wellhead with long tubing hangers and/or large top flange structures.

BIW’s wellhead penetrator systems have provided important sealing protection for the oil and gas industry over the last four decades. Our products are installed in thousands of wellheads around the globe and have a proven track record in meeting the requirements of each application.

Wellheads with Bonnet
A bonnet or adapter flange is used in high pressure applications. These applications are rated for 5000 psi or greater and all off-shore installations will include a bonnet. BIW’s penetrator systems for this application are designed to work in the harshest environments, and in most cases, the system is made up of three pieces: surface connector, penetrator/mandrel and lower connector. These three pieces provide the complete pressure block insuring the integrity of the wellhead.

Wellheads without Bonnet
Wellheads that do not have a bonnet are typically used in lower pressure applications and are sometimes referred to as non-API or independent wellheads. These wellheads are typically rated for 3000 psi or lower. BIW has designed 1, 2, and 3-piece penetrator systems that all provide a complete safety block while delivering reliable power. These systems are a safe and reliable replacement for cable packoffs.

Wellheads with Long Hanger
Long hangers are typically used when the wellhead has extended length. These wellheads usually require special penetrator systems that have a small penetrator bore profile. BIW’s solutions to these types of wellheads are 2-piece systems that consist of a surface connector and mandrel/lower connector made up as 1-piece. These systems are easy to install and provide the same safety and reliable power as all of BIW’s other systems.
Wellhead Penetrator Systems

Metal-Lok™ High Temperature

The Metal-Lok High Temperature Wellhead Penetrator System is rated 450°F (232°C) and 3000 psi and is suitable for some of the most challenging downhole conditions. This product has been subjected to BIW Connector Systems’ qualification regimen, proving its robustness and reliability. This product is provided with a field attachable lower, which eliminates the need for a rig splice, making installation both quick and easy. It is designed to be used in higher temperature well applications on wellheads with bonnets.

Specifications

<table>
<thead>
<tr>
<th>Environmental</th>
<th>450°F (232°C), 3000 psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical</td>
<td>5000 VAC, 20 to 120Hz, 140 Amperes</td>
</tr>
<tr>
<td>Approvals</td>
<td>CSA approved for Class 1, Division 1, T-Code T4A, Groups C and D Hazardous Locations. IEC and ATEX Certification Exd IIB T4 G</td>
</tr>
<tr>
<td>Decompression-Resistant</td>
<td>Increased product lifetime and reliability downhole</td>
</tr>
<tr>
<td>Field Attachable</td>
<td>Eliminates need for a rig splice and is highly adaptable to your ESP cables</td>
</tr>
<tr>
<td>High Temperature Materials</td>
<td>Suitable for use in applications with a maximum conductor temperature of 450°F (232°C)</td>
</tr>
<tr>
<td>Metal-Lok™ Keying</td>
<td>Prevents damage that could result from inadvertent turning or mishandling of the surface connector</td>
</tr>
</tbody>
</table>

Features

Metal-Lok™

This is the workhorse of the Metal-Lok family. Rated and tested to 300°F (149°C) and 5000 psi, it covers the majority of ESP well applications and is designed and tested to handle harsh environments. The use of PEEK and the minimal use of elastomers make it highly resistant to downhole pressure decompression. This product has been subjected to BIW’s qualification regimen, proving its robustness and reliability. This system is designed to work in wellheads with or without bonnets.

Specifications

<table>
<thead>
<tr>
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<tr>
<td>Approvals</td>
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<tr>
<td>Decompression-Resistant</td>
<td>Decompression resistant</td>
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<td>Prevents damage that could result from inadvertent turning or mishandling of the surface connector</td>
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Features

Metal-Lok™ Slimline

The Metal-Lok Slimline is a versatile new product in the BIW line. It is designed to fit into a smaller sealing bore, as small as 2.25”, and is suitable for 300°F, 5000 psi service. The system comes with BIW’s innovative crimp-free contact, completely eliminating the need for crimp tools. This new contact withstands a minimum of 1000 pounds of pull force, making it stronger than most crimped contacts. The crimp-free contacts will reduce the installation complexity, saving precious rig time. The product also includes a new sealing design that requires just one kit for each cable size, eliminating the need for cable-specific sealing elements and reducing stocking inventory and confusion. You can rely on Metal-Lok Slimline, like you do all BIW products, because it has passed rigorous qualification testing at temperature, pressure and decompression in environmental well fluids and gas while under electrical monitoring.

Specifications

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<tr>
<td>Approvals</td>
<td>CSA approved for Class 1, Division 1, Groups C and D Hazardous Locations</td>
</tr>
<tr>
<td>Slim profile</td>
<td>Fits in tight annular spaces and in smaller bore tubing hangers (2.25” diameter)</td>
</tr>
<tr>
<td>Field Attachable</td>
<td>Field attachable design eliminates a downhole splice and is highly adaptable to all ESP cables</td>
</tr>
<tr>
<td>Quick and Easy Assembly/ Installation</td>
<td>Connector is preassembled making it the quickest installation offered by BIW</td>
</tr>
<tr>
<td>Metal-Lok™ Keying</td>
<td>Prevents damage that could result from inadvertent rotation or mishandling of the surface connector</td>
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</table>
Wellhead Penetrator Systems

### Metal-Lok™ Ultra with k-PaC™ Technology

This system features a new high temperature feedthru and lower connector design that is suitable for use to 500°F (260°C) and pressures of up to 3000 psi. The downhole field attachable connector features BIW Connector Systems’ groundbreaking k-PaC Technology, a pressure-balanced design that compensates for normally destructive thermal expansion pressure variation and operates over a wide temperature range. Metal-Lok Ultra was designed to withstand extended exposure to steam and multiple temperature cycles. This product is the solution to your SAGD wells.

**Specifications**

- **Environmental**: 500°F (260°C), 3000 psi
- **Electrical**: 5000 VAC, 140 Amperes
- **Approvals**: CSA Approval for Hazardous Location Installation, Class 1, Division 1 Groups C and D

**Features**

- Decompression-Resistant
- Field Attachable
- High Temperature
- Metal-Lok™ Keying

**EFT®**

EFT penetrator products have been safely sealing and passing power through 5000 psi-rated wellheads for more than 20 years. With more than 10,000 installations, the EFT Wellhead Penetrator System has proven that it is a mainstay in the ESP market. The surface and lower connector can be provided in a field attachable kit and configured to your cable preference, making it a quick, flexible and cost-effective option. These systems can also be provided with cable pigtails and are designed to work in systems with or without bonnets.

**Specifications**

- **Environmental**: 300°F (149°C), 5000 psi
- **Electrical**: 5000 VAC, 20 to 120Hz 180 Amperes

**Features**

- Thousands Installed
- Field Attachable
- Standard Size
- Three-Piece Versatility

**Rubber Molded 3-Piece and Rubber Molded 2-Piece (FTLM)**

BIW Connector Systems’ Vulcanized Elastomer Electric Penetrator designs have long been recognized for superior performance. These products are manufactured using a variety of metallurgies. Internal pressure blocking elements are made from high performance epoxy resins and include vulcanized elastomer seals. Throughout the years, these products have been meticulously improved. Modern epoxy resins retain their mechanical properties at very high temperatures and elastomers offer superb electrical and sealing characteristics.

Today’s products are optimized for long life and utmost safety, with approvals for use in hazardous locations from ATEX, IEC, CSA and Factory Mutual. We offer more than 2,000 part numbers, a product range unmatched by all other suppliers combined. Our vulcanized elastomer solutions are just one of several technologies that meet your needs for safe, reliable, and easy-to-use penetrator systems.

Most Surface Connectors are supplied with coupling rings retained by ball bearings. This retention method ensures longer life, better resistance to corrosion, and easier engagement.

Many connectors are also supplied with replaceable sealing elements. These new seals consist of O-rings that are easily replaced with a special tool.

**Specifications**

- **Environmental**: 300°F (149°C), 5000 psi
- **Electrical**: 5000 VAC, 20 to 120Hz up to 215 Amperes
- **Approvals**: CSA and FM for Class 1, Division 1 Hazards Locations; ATEX for Hazardous Locations; IEC for Hazardous Locations

**Features**

- 2- and 3-Piece Penetrator Systems
- Ball Bearing Coupling Ring on Surface Connectors
- Field Attachable, Factory Molded
- Lip Seal Design
- Replaceable Sealing Elements on Surface Connectors
Wellhead Penetrator Systems

E-ZEE Feed®

The E-ZEE Feed Wellhead Penetrator System is designed for easy conversion from cable pack-off with minimal wellhead modifications. It is supplied as a field attachable kit. This two-piece, “stab-in” design reduces cable handling issues by permitting fast coupling of the surface cable to the penetrator, making it easy to install or to pull during workovers. The E-ZEE Feed comes in both 3000 psi and 5000 psi versions to accommodate most wellhead pressure ratings. The E-ZEE Feed is available for applications requiring certification for hazardous locations and for applications where this is not required.

**Specifications**

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<th>300°F (149°C), 3000 or 5000 psi</th>
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<tr>
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<td>Approvals</td>
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<tr>
<th>Features</th>
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<tbody>
<tr>
<td>Bottom-fed Field Attachable Installation</td>
</tr>
<tr>
<td>Full Qualification</td>
</tr>
<tr>
<td>High Performance Materials</td>
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</tbody>
</table>

Uni-Lok™ Wellhead Penetrator

The Uni-Lok Wellhead Penetrator System is designed to provide the quickest and easiest pass-through of ESP power at a very competitive price. Unlike other products, the Uni-Lok system offers a complete verified pressure block inside the tubing hanger ensuring that downhole fluids stay downhole. This field attachable system is designed as a single plug-and-play pressure barrier that fits into sealing bores as small as 1.75” and to have the flexibility to fit/re-use any existing surface cable infrastructure. It has passed BIW’s rigorous testing protocol and is available for applications requiring certification for hazardous locations and for applications where this is not required.

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<thead>
<tr>
<th>Features</th>
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<tbody>
<tr>
<td>Slim profile</td>
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<tr>
<td>Field Attachable</td>
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<tr>
<td>Well Control</td>
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<tr>
<td>Versatility</td>
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Safe-T-Lok®

The Safe-T-Lok Wellhead Penetrator System is a one-piece design that is a safe, reliable and an inexpensive replacement for cable packoffs. Unlike packoffs, the Safe-T-Lok provides a complete pressure block. This is done through a mandrel design with factory cable molded on both ends. The Safe-T-Lok requires splicing below the tubing hanger and is intended for use with independent wellheads, suitable for 3000 psi service.

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<table>
<thead>
<tr>
<th>Features</th>
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</thead>
<tbody>
<tr>
<td>Safe-T-Lok Feedthrus &amp; Tubing Hangers</td>
</tr>
<tr>
<td>Compatible with most ESP Cable Sizes</td>
</tr>
<tr>
<td>Slim Design</td>
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</table>

Kwik-Lok™

The Kwik-Lok Wellhead Penetrator System offers a safe, explosion-proof option to a cable pack-off wellhead penetration. This robust design and construction ensures reliable performance and long run life. The slim feedthru OD needs only a small penetrator bore. The bottom fed, stab-in feedthru design with downhole molded cable makes it fast and easy to install.

**Specifications**

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<tr>
<td>Electrical</td>
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<td>Approvals</td>
<td>CSA approved for Class I, Division 1 Hazardous Location installation</td>
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<table>
<thead>
<tr>
<th>Features</th>
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<tbody>
<tr>
<td>Reliable Wellhead Sealing</td>
</tr>
<tr>
<td>Slim Design</td>
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</table>
Tri-Lok® 3-Bore

The Tri-Lok 3-Bore Wellhead Penetrator Systems are designed to provide safe and reliable ESP power transfer through wellheads with minimal space. The design of these systems are ideal for concentric wellheads, with or without bonnets, where there is not enough room for a standard mandrel system. The Tri-Lok system also provides the ultimate safety providing a complete pressure block and cable termination in the wellhead. The Tri-Lok 3-Bore Wellhead Penetrator System now comes with an improved surface connector, making it the most flexible and easiest to install 3-Bore product on the market. The new BIW Quick-Thread Technology connection eliminates tedious wrench turns, and the flexible leads make installation easy even in the tightest of locations. It can also be retrofitted to keep the surface cable in place. The new higher rating of 160 Amperes enables the use of this product with larger motors. The surface connector is available in field attachable or cable-molded configurations and is ATEX approved for hazardous locations.

Specifications

Environmental 300°F (149°C), 5000 psi
Electrical 5000 VAC, 20 to 120Hz 160 Amperes
Approvals ATEX approved for Hazardous Locations

Features

Flexible Surface Connector Multiple surface mounting configurations, which provides the flexibility to fit most wellheads, even those where space is limited
Field Attachable, Cable Molded Flexibility to meet your specific installation
Wellhead Pressure Block & Seal The complete pressure block and seal at wellhead keeps the well fluids in the well, which provides the ultimate safety and peace of mind without requiring a vent
Quick and Easy Installation New patent pending quick-connection/disconnection technology that greatly reduces the installation time

Packer Applications

Packer Penetrator Systems

BIW Connector Systems offers electrical power penetrator solutions for all types of downhole pressure barriers, including mudline packers, deep-set packers and electric submersible pump pods. Packer penetrators are specifically engineered to withstand pressure from both sides. All packer penetrator systems are designed to withstand repeated pressure cycles, and qualification testing for these devices includes a severe regimen of pressure cycling.

Packer Penetrators for Dual-String Retrievable Packers

When used with dual-string retrievable packers, penetrators are installed directly into the packer. Field attachable connectors or downhole connectors with cables are used to make the electrical connection between ESP cable above and below the packer.

Packer Penetrator Systems with Cross-over Adapters

In many wells, there is not sufficient space for a twin-seal packer. Often, cross-over adapter solutions are used to provide reliable sealing at the packer, but with the pressure barrier device (“penetrator”) actually located below or above the packer itself.

Field Attachable Packer Penetrator Systems

Using PEEK technology, we offer field attachable packer systems. These systems can be easily installed above or below the packer, without requiring a cable splice. Systems are exceptionally robust, and they are suitable for temperatures up to 450°F.

3-Bore Packer Penetrator Systems

With enhanced production methods, it may be desirable to use a packer in wells with just 7-inch casings – or even smaller. In those cases, BIW Connector Systems can offer a Tri-Lok 3-Bore packer feedthru, where steel-encased power conductors pass through the wellhead with positive seals to ESP cables located above and below the packers.

High Performance Packer Penetrator Systems

Most packer penetrator systems are intended for 5000 psi maximum pressure, at a temperature of 300°F. However, there are installations which require higher performance. Downhole conditions with temperatures in excess of 300°F, sour wells with high concentrations of corrosive gases and production techniques that result in high numbers of pressure decompression cycles are examples. BIW’s k-PaC Technology was developed specifically for these harsh conditions.
Packer and POD Penetrator Systems

Molded Cable
Molded Cable Packer Penetrator Systems are widely used in both mudline applications and deep-set applications. Molded Cable Penetrators are supplied with cable factory installed both above and below the penetrator. Cable splicing is a widely available skill, and penetrators with cable may be preferred for remote installations that may not have technical support available for field attachable solutions.

When used with deep-set packers, these penetrators are often supplied with motor lead extension cables and pothead connectors. In these cases, the penetrators are mounted below the packer, and there is no need for a field splice to the MLE below the packer.

Specifications

Environmental 500°F (260°C), 5000 psi
Electrical 5000VAC, up to 160A

Features

- Cross-over Adapters
- Ease of installation — not necessary to rotate penetrators during installation
- Test Ports
- Permits hydraulic testing of O-ring Seals
- Adjustment Slot
- Ease of installation — helps to manage cable slack
- Wide thread selection
- Cross-over Adapters are supplied with both pin and box threads in the following sizes: 1.90NU-10RD • 2 3/8 EU 8 RD and 2 3/8 EU10 RD • 2 7/8 EU 8 RD • 2 7/8 EU10 RD

HEZF Field Attachable

The HEZF Field Attachable Packer Penetrator System is intended for convenient installation above or below the packer. The systems consists of three major components: 1) Packer Penetrator, Field Attachable; 2) Downhole Power Connector, Field Attachable; and 3) Cross-over Adapter. Installation consists of separately installing the ESP cable end and the Motor Lead Extension cable end to the Packer Penetrator assembly and to the Field Attachable Power Connector, respectively. The system can be ordered for installation above or below the packer, depending on local preference.

Specifications

Environmental 500°F (260°C), 5000 psi
Electrical 5000VAC, up to 160A

Features

- Cross-over Adapters
- Ease of installation — not necessary to rotate penetrators during installation
- Test Ports
- Permits hydraulic testing of O-ring Seals
- Adjustment Slot
- Ease of installation — helps to manage cable slack
- Wide thread selection
- Cross-over Adapters are supplied with both pin and box threads in the following sizes: 1.90NU-10RD • 2 3/8 EU 8 RD and 2 3/8 EU10 RD • 2 7/8 EU 8 RD • 2 7/8 EU10 RD

Tri-Lok® 3-Bore

Packer installations can boost ESP performance in many wells, including those with casing diameters of 7-inches or less. For these wells, it is necessary to use the smallest possible diameters for electrical penetrations in the packer. The Tri-Lok 3-Bore Packer Penetrator System meets this need. High performance electrical conductors are encased in 3/8-inch Duplex tubing and the three tubes penetrate the packer. Below the packer, three mechanical splice tubes are used to connect the Duplex-encased conductors to the Motor Lead Extension cable. Similar splice tubes are used above the packer to connect the ESP cable above.

Specifications

Environmental 500°F (260°C), 5000 psi
Electrical 5000VAC, up to 140A

Features

- Tubing Encased Cable
- 3/8-inch Duplex Tubing fits into all ESP packers, even when bores in the packer are not straight
- 75-inch Duplex Tubes
- For use with a variety of packers. Tubing is trimmed to the required size at time of installation
- Metal-to-metal seals
- Reliable sealing to the packer
- Splice Tube Technology
- Easy, reliable sealing to ESP cable above and below the Packer

Tri-Lok® Ultra with k-PaC™ Technology

The Tri-Lok Ultra Packer Penetrator System is designed for high performance applications where long life is a requirement. Pressure blocking is achieved using redundant electrical power contacts brazed into ceramic blocks. Connections to cables are made using patented pressure-balanced technology. This unique system applies virtually no mechanical stress on ESP cable insulation and barriers over a wide range of pressure and temperature.

Tri-Lok Ultra Penetrators are designed for 400°F (204°C) service at pressures up to 7500 psi (absolute or differential). The system is designed to withstand harsh and repetitive pressure cycles.

The system is delivered pre-assembled. On-site work requires minimal cable preparation and inserting cable ends into the packer penetrator.

Specifications

Environmental 400°F (204°C), 7500 psi
Electrical 5000VAC, up to 140A

Features

- Ceramic Pressure Block
- Withstands extremely high pressures, with no harmful effects from high temperature exposure
- Metal-to-metal seals
- Reliable sealing to the packer with pressure test ports
- Pressure Balanced Cable Termination
- Pressure cycling and the presence of gas do not harm the cable termination. Suitable for round cables, flat cables, lead-sheathed cables and tube encapsulated MLEs

Metallurgy

- Tubing – Duplex 2205; Hardware – 316 corrosion resistant steel
- Insulators – PEK and VDM-1000
- Metallurgy – 17-4 corrosion resistant steel, 410 corrosion resistant steel, 316 corrosion resistant steel

Adjustment Nut

- Ease of installation
- Helps to manage cable slack

Wide thread selection

- Cross-over Adapters are supplied with both pin and box threads in the following sizes: 1.90NU-10RD • 2 3/8 EU 8 RD and 2 3/8 EU10 RD • 2 7/8 EU 8 RD • 2 7/8 EU10 RD

Termination

- Pressure Balanced Cable

Splice Tube Technology

- Easy, reliable sealing to ESP cable above and below the Packer
Mechanical Splices

Presta™ GS Splice
The Presta GS Mechanical Splice is designed to make uniform, reliable splices quickly and with minimal training. Using the Presta GS splice requires only easy cable preparation. The prepared cable ends are then inserted into the Presta GS splice, where they are permanently retained. Presta GS replaces taped splices, and allows splices to be completed in 45-60 minutes.

Specifications
- **Environmental**: 400°F (204°C), 5000 psi
- **Electrical**: 5000VAC, up to 160A
- **Dielectric Leakage Current**: Less than 1 micro-ampere at 24VDC

Features
- **Plug & Play Assembly**: Field Attachable. Requires only that cable ends must be prepared and inserted into the pre-fabricated device.
- **Boots Seal Technology**: Reliable sealing with minimal cable preparation.

Presta™ Splice with k-PaC™ Technology
The Presta® Splice with k-PaC Technology is designed to allow difficult splices to be made easily, quickly and uniformly by rig personnel with minimal training. Using the Presta splice requires only easy cable preparation. The prepared cable ends are then inserted into the Presta splice, where they are permanently retained. Presta replaces complex taped splices, and allows severe service splices to be completed in 60 to 90 minutes.

The Presta Splice with k-PaC Technology is designed for Deep Water Offshore applications rated for 350°F and 7500 psi and for Extreme Service applications rated for 400°F and 5000 psi. Both have performance headroom for even more severe applications.

Specifications
- **Environmental**: 300°F (149°C), 5000 psi
- **Electrical**: 5000VAC, up to 160A
- **Dielectric Leakage Current**: Less than 1 micro-ampere at 24VDC

Features
- **Plug & Play Assembly**: Field Attachable. Requires only that cable ends must be prepared and inserted into the pre-fabricated device.
- **Boots Seal Technology**: Reliable sealing with minimal cable preparation.

Instrumentation Feedthru Systems

Products for permanent downhole gauges
Permanent downhole gauges (PDG) have an important role for optimizing oil production. PDGs are always installed using metal-tubing encased cable, using both the conventional 1-conductor, and the newer 7-conductor cable types. BIW Connector Systems offers a variety of products to make the installation of these systems safer and easier. The safest installations of PDG cables require the use of a pressure-proof electrical penetration system. If an accidental breach of the PDG cable should occur downhole, the tubing encapsulated cable could provide a conduit for hazardous fluids. When a penetrator is used, this risk is averted.

PDG Penetrators for 7-conductor cables and 1-conductor cables
These penetrators are designed to be installed either atop the wellhead bonnet or on the side of the wellhead bowl. Pressure-proof sealing is provided by electrical contacts in a glass-to-metal sealed barrier. These systems have replaceable surface connectors for easy work-over. Our products have ATEX approvals for installation in hazardous locations.

PDG Penetrators for 1-conductor cables for tubing hanger installations
These penetrators are long electrical connectors, designed to seal both to the tubing hanger and the top flange. Pressure-proof sealing is provided either with glass-to-metal barriers or by elastomer/epoxy resin barriers. Surface connectors are removable, and may be either 1- or 2-conductor. Connection to the PDG cable is by field attachable lower connectors, with verifiable metal-to-metal sealing. The feedthru and surface connectors of these systems have Class 1 Division 1 approvals for installation in Hazardous Locations.

Splices for 1-conductor PDG cables
Splices are used to join single conductor PDG cables downhole. Splices attach to cable ends using verifiable metal-to-metal seals. Each splice includes a pressure block element within the splice, to prevent fluid migration past the splice junction. Should the PDG cables become breached.

**Connector Systems** offers a variety of products to make the installation of these systems safer and easier. The safest installations of PDG cables require the use of a pressure-proof electrical penetration system. If an accidental breach of the PDG cable should occur downhole, the tubing encapsulated cable could provide a conduit for hazardous fluids. When a penetrator is used, this risk is averted.

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Design Approach

Product reliability is critical in the upstream oil and gas production market. If any part of the production string fails, the well goes down and valuable revenue opportunity is lost. BIW Connector Systems invests heavily in design and testing to ensure our products can withstand the extreme, harsh environment of a production well.

Test Environmental testing that closely replicates downhole conditions is essential to prove product reliability. BIW Connector Systems offers multiple test chambers capable of up to 600°F/10,000 psi with temperature and pressure cycling, and electrically monitors every qualification test to ensure operation in all conditions.

Forensic Analysis

We analyze every returned product to determine root cause. This information is then fully documented and uploaded to our Knowledge Database.

Informed Design

We have experienced oilfield product designers with the best tools and technology. In addition, we have invested in a significant material science lab and created a common electronic Knowledge Database that is mined for information from past designs, engineering tests and forensic analysis. We apply all this learning to each and every design.

BIW Connector Systems’ reliability and long product lifetimes are realized via a three-fold engineering strategy. The first is to **test exhaustively**. The second is to conduct extensive **forensic analysis** on all field returns to identify root cause. Finally, we maintain an **electronic Knowledge Database** of all technical data to practice “Informed Design.”
BIW Connector Systems designs and manufacturers a wide range of products to support specialized requirements. The following are examples of these products:

**Specialized Application Products**

**Coiled Tubing Penetrators**
ESP installation with coiled tubing has specialized requirements. ESP cable is protected inside of the coiled tubing, and production flows either through the well bore annulus or through a second coiled tube. At the wellhead, the tubing is suspended in a coiled tubing hanger, and a short length of ESP cable is available above the hanger. BIW penetrators are supplied with lengths of extra flexible 5KV insulated cable conductors. These conductors are easily terminated to the ESP cable conductors. Penetrators are installed in the wellhead wall above the hanger.

**Cross-overs Adapters and Y-Adapters**
Dual ESP completions often require specialized packer feedthru methods. Using a Y-Adapter, an operator can supply power to two ESPs using a conventional packer design, with two packer feedthrus installed using a Y-adapter system.

When there is a need for multiple injection and control lines to the ESP, the design of a specialized cross-over adapter will allow these lines to pass through the bore together with ESP cable.

**Penetration Systems for Cable Deployed ESP and Electrothermic Heating**
These systems often have unique wellhead designs and special considerations for delivering power. BIW Connector Systems supplies field installable feedthru systems and penetrators with flexible high voltage power conductors to make installation easy.

**Side Entry Feedthru Systems**
Side entry penetrator systems are designed to enter the wellhead on the side instead of through the bonnet. This configuration has many advantages, including shorter work-over times and the ability to easily test an ESP while a BOP is still in place during work-over. Our side entry systems have three components: (1) a Horizontal Feedthru, which enters through the side of the wellhead and tubing hanger and engages with (2) the Vertical Feedthru, and (3) a conventional downhole connector that is used to connect the Vertical Feedthru to the ESP cable.

**Pothead Connectors and Motor Housing Penetrators**
Large geothermal ESPs and specialized ESPs for gas wells may require specialized motor lead systems. BIW Connector Systems supplies connectors for these applications.

**8KV Power Feedthru Systems**
With ever-longer cable runs and high power motors, BIW meets the need for 8KV Power Penetrator Systems.

**Penetration Systems for Geothermal Wells**
Electric submersible pumps in geothermal wells have many special requirements. BIW supplies equipment specifically designed to fit geothermal wells.
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Quickly find your product by application.

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Why ITT
ITT is a diversified leading manufacturer of highly engineered critical components and customized technology solutions for the transportation, industrial, and oil and gas markets. Building on its heritage of innovation, ITT partners with its customers to deliver enduring solutions to the key industries that underpin our modern way of life. ITT is headquartered in White Plains, N.Y., with employees in more than 35 countries. For more information, visit www.ITT.com.

About BIW Connector Systems
BIW Connector Systems supplies the industry with the widest range of electrical feedthru products, with more than 3,000 available active part numbers. BIW Connector Systems has set the standard for quality, reliability and ease of installation. BIW Connector Systems has a strong culture of forward-looking innovation. With a foundation of quality engineering and focus on reliability, BIW Connector Systems’ legacy of continuous improvement drives the development of its products. These systems help deliver power to the submersible pumps in wells on frozen tundras and in sun-bleached deserts, keeping workers and environments safe and global economies running 24-hours a day. For more information, visit www.ittbiw.com.

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