

Scorpion Connectors

Scorpion™ and ScorpionDrive connectors are the latest innovation in our large-bore casing and conductor connector product line. The Scorpion family of connectors are designed to provide robust connector strength and proven sealability in a compact and cost-efficient connector design.

Target applications for this connector have moderately severe service conditions and include onshore wells and shallow-water offshore projects.

The Scorpion connector features weld-on pins and boxes designed to match full pipe body strength. Advanced finite element analysis and full-scale physical testing demonstrate that Scorpion connector tension, compression, and bending capacities meet or exceed full pipe body strength in most pipe and connector grade combinations.

Scorpion connectors are designed for robust sealability with an elastomeric O-ring primary pressure seal. Combined loading sealability tests to API 5C5 CAL I criteria demonstrate that Scorpion connectors seal liquid pressure for the full pipe body internal pressure and external pressure envelopes.

Scorpion connectors are available in two thread configurations. Scorpion-1ST connectors have a single-start thread and make-up in 1.68 turns. Scorpion-3ST connectors have a triple-start thread and make-up in 0.56 turns. All Scorpion connectors feature a mechanical anti-rotation device to prevent unintended connector back-off.

A special connector configuration called ScorpionDrive is used for conductors installed by pile driving. This connector is run pin-up, box-down for easier interface with the pile driving hammer.

Scorpion connectors are available in 16- to 30-inch sizes suitable for onshore and offshore conductor and surface casing applications.

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Typical Applications

- Scorpion is a multipurpose connector suitable for large-bore conductor and surface casing applications in moderately severe environments
- Platform conductors or ‘drive pipe’
- Surface casing strings and liner strings for onshore and offshore wells

Scorpion Connectors

Unique Features and Benefits

Compact design

Advanced design and analysis tools were used to optimize the connector profile, targeting a minimum-dimension connector body envelope that still meets full pipe body strength ratings. The resulting connector design is optimized for economics: robust performance envelopes at moderate connector cost.

Designed for easy running

Deep-stabbing tapered threads, quick makeup, integral self-aligning profiles, low-torque spin-up, and an integral lift shoulder make for quick and easy pipe handling on the rig.

Built on experience

Important performance features such as the Scorpion threadform, O-ring primary pressure seal design, and connector forging materials are borrowed from our premium connector products which have many years of successful field service.

Family-of-parts design

Consistent geometric design rules applied across all connector sizes mean consistent and predictable connector performance for the full Scorpion connector product line.

Proven performance

Targeted full-scale physical testing of the product line verifies connector strength ratings and sealability envelopes. Testing includes API 5C5 CAL I sealability tests, full-scale bending tests in multiple connector sizes, and fatigue testing.

Slim OD/ID design

Compact connector body dimensions allow for generous ID and OD clearances.

Anti-rotation resistance

All Scorpion and ScorpionDrive connectors feature a mechanical anti-rotation device to prevent unintended connector back-off.

Suitable for pile driving

A heavy-duty connector configuration called ScorpionDrive is used for conductors installed by pile driving.



Scorpion Connectors

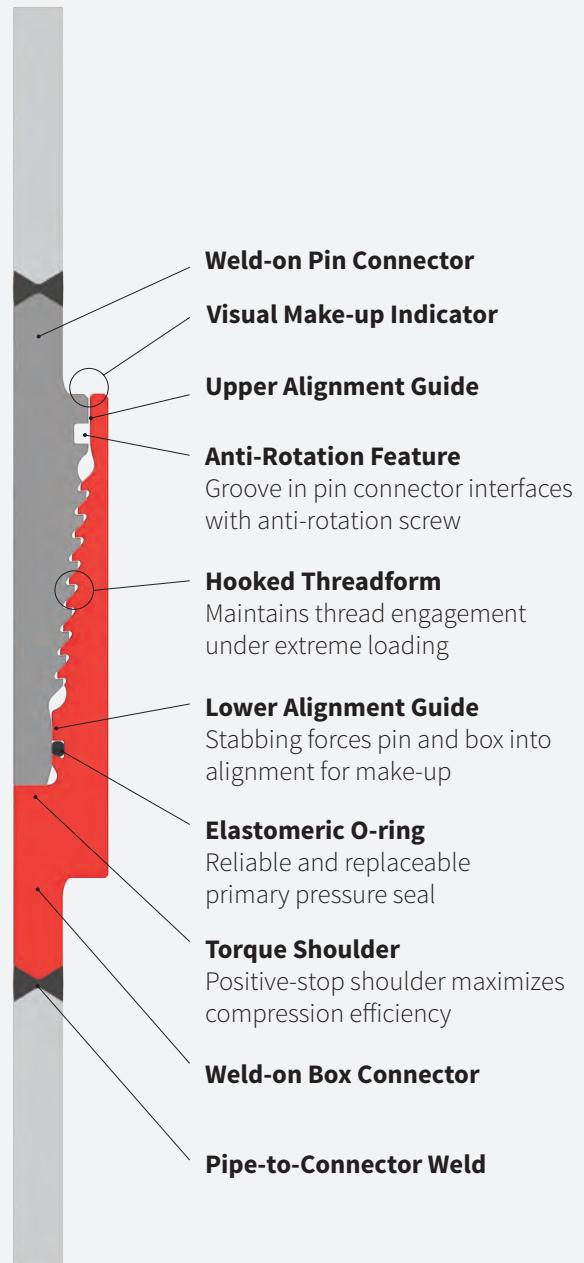
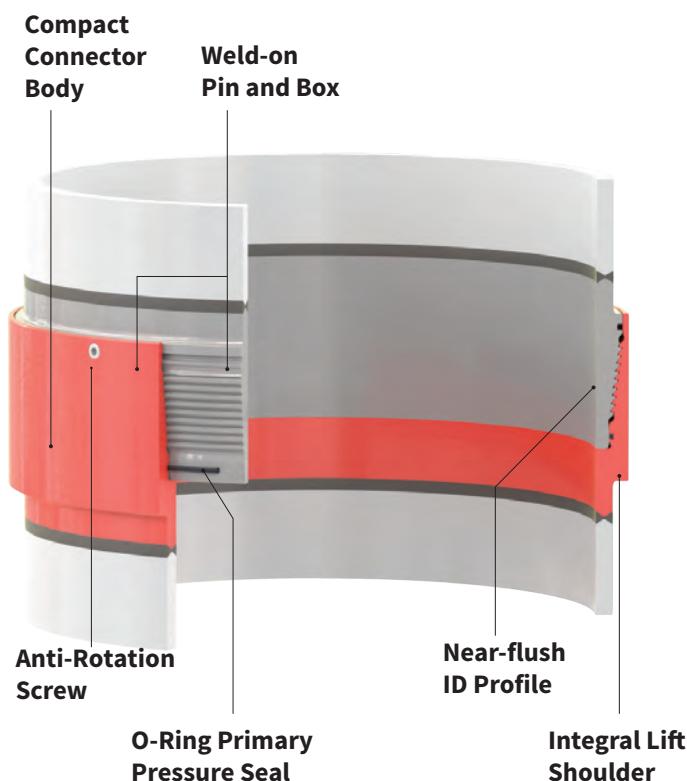
16- to 30-inch Sizes

Scorpion connectors were developed to be a robust yet economical full pipe-body-strength solution for projects in moderately severe environments. Scorpion connectors are well-suited for onshore and shallow-water offshore surface casing and conductor applications.

Scorpion connectors are designed for quick and easy running and handling on the rig. The integral box lift shoulder is compatible with standard casing elevators and is sized to support full string weights. Integral alignment guides force the pin and box into perfect alignment as the connector is stabbed together. The tapered threads allow for a deep stab and fewer turns for full connector makeup.

The Scorpion connector design incorporates proven performance features found in our large-bore premium connectors, including the hooked threadform, a replaceable elastomeric O-ring pressure seal, and stress redistribution grooves to manage peak stresses in the load path.

All Scorpion connectors feature a mechanical anti-rotation device to prevent unintended connector back-off.



ScorpionDrive Connectors

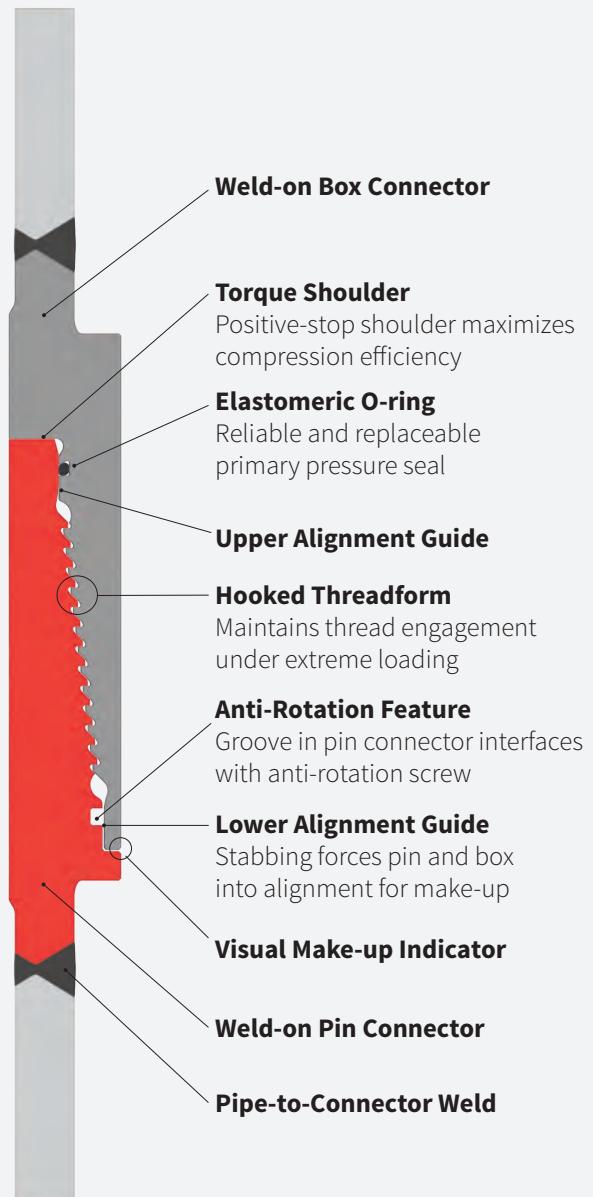
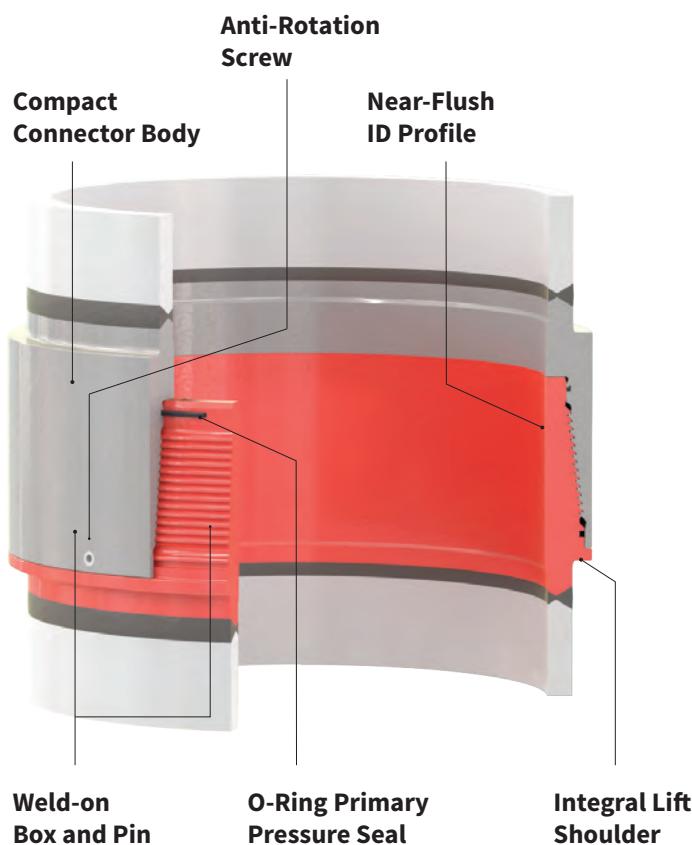
16- to 30-inch Sizes

For conductors installed by pile driving, a heavy-duty connector configuration called ScorpionDrive is used. This connector has improved compression strength compared to standard Scorpion connectors.

ScorpionDrive connectors are run in the pin-up, box-down orientation for easier interface with the pile driving hammer. A simple stab-in drive adapter transmits pile driving forces across the generous pin end face surface facing upward.

ScorpionDrive connectors feature the same robust design features as standard Scorpion connectors: deep-stabbing tapered threads, a self-aligning profile, hooked threadform, a reliable and replaceable elastomeric O-ring primary pressure seal, and stress redistribution grooves to manage peak stresses in the load path.

All ScorpionDrive connectors include a mechanical anti-rotation device to prevent unintended connector back-off during pile driving and in-service.



Scorpion Connectors

Physical Testing Summary

XL Systems strongly believes in the value of full-scale physical testing to demonstrate large-bore connector performance. For Scorpion connectors, this testing was particularly important since an optimized connector body geometry was a primary target in the development project.

The Scorpion and ScorpionDrive product lines each currently include 33 separate connector geometric designs. It is not practical to complete physical testing to confirm strength ratings for each connector design. We adopted a ‘product line qualification’ approach, which has previously been used successfully. In this approach, all connector designs are developed simultaneously as a ‘family of parts’ with enforced geometric similarity across connector sizes. These designs are all analyzed using advanced digital simulation tools to predict connector structural strength limits and to predict connector seal performance. Physical testing is then completed on select connector sizes to benchmark the digital simulations. The result is a ‘calibrated’ digital simulation tool that can accurately predict connector performance for both tested and untested connector sizes. For Scorpion, three commonly used connector sizes were selected for benchmark physical testing.

The table below is a summary of the final set of full-scale physical tests used to benchmark Scorpion and ScorpionDrive connector performance models. XL Systems Engineering Technical Briefs are available with detailed information for each test series. The criteria for each test series are summarized as follows:

- API 5C5 combined loading sealability tests are an industry-standard testing protocol for defining connector pressure

sealability envelopes. Scorpion connectors were tested to 5C5 CAL I (liquid) criteria. Two test samples are required for CAL I testing, Specimen 1 and Specimen 5, which are each machined to specific worst-case geometric tolerance conditions. Testing includes multiple make-and-break cycles, Series B testing (tension + compression + internal pressure + bending), Series A testing (tension + compression + internal pressure + external pressure), and limit load tests. Full 5C5 CAL I tests have been completed for three Scorpion connector sizes.

- Bending tests are full-scale static bending overload tests to ‘failure.’ These tests are used to demonstrate that connector bending strength exceeds pipe body strength and that the connector demonstrates a stable, ductile failure mode with no catastrophic thread jumpout failures observed.
- Anti-rotation testing is used to measure the effectiveness of the Scorpion mechanical anti-rotation device.
- Pile driving testing demonstrates the ScorpionDrive connector design is suitable for conductors installed with a pile driving hammer.
- Fatigue testing measures the response of the Scorpion connector to cyclic stresses such as in-service exposure to ocean waves.

Physical test type and number of Scorpion and Scorpion Drive samples tested

| Connector | Pipe size (inch) | Pipe wall thickness (inch) | API 5C5 CAL I combined loading sealability | Bending | Anti-Rotation | Pile driving | Fatigue |
|---------------|------------------|----------------------------|--|---------|---------------|--------------|---------|
| Scorpion | 20 | 0.625 | 2 | 1 | 5 | | |
| Scorpion | 24 | 0.688 | 2 | 1 | 6 | | 6 |
| Scorpion | 30 | 0.750 | 2 | 1 | 8 | | |
| ScorpionDrive | 30 | 1.000 | | | | 2 | |

Scorpion Connectors

Connector Performance Data Sheets

XL Systems maintains a library of connector performance data sheets or 'spec sheets' for all of our connector products on the nov.com website. Select the **SpecsDirect** link from the XL Systems homepage at nov.com/xlsystems. Pipe and connector performance data change from time to time and users are encouraged to obtain up-to-date product data for each project.

Connector Material Grades

Scorpion and ScorpionDrive connectors are produced to NOV XL Systems material specifications in three primary grades: M70, M80, and M95. The table below shows recommended connectors grades matched to API 5L pipe grades. Other standard connector grades with higher strength or special alloying are available.

| Connector Grade | Connector Yield Strength | API 5L Pipe Grade | | | | | |
|-----------------|--------------------------|-------------------|-----|-----|-----|-----|-----|
| | | X52 | X56 | X60 | X65 | X70 | X80 |
| M70 | 70.0 ksi = 483 MPa | R | R | R | R | NR | NR |
| M80 | 80.5 ksi = 555 MPa | O | O | O | O | R | R |
| M95 | 95.0 ksi = 655 MPa | O | O | O | O | R | R |

R Recommended pipe and connector grade combination

O Optional grade combination for higher connector strength

NR Not recommended

Connector Thread Configurations

Scorpion and ScorpionDrive connectors in all sizes are available in two thread configurations as described below. Connector strength ratings and dimensions are identical for the -1ST and -3ST configurations of Scorpion and ScorpionDrive connectors. The -1ST and -3ST connector configurations are not interchangeable and will not thread together. Scorpion and ScorpionDrive connectors are separate products, are not interchangeable, and are not intended to be threaded together.

| Product name | Number of thread starts | Number of turns from stab to full makeup |
|-----------------------------------|-------------------------|--|
| Scorpion-1ST ScorpionDrive-1ST | 1 | 1.68 turns |
| Scorpion-3ST ScorpionDrive-3ST | 3 | 0.56 turns |

Field Service Procedures

See the following XL Systems field service procedures for additional information on running and handling pipe with Scorpion and ScorpionDrive connectors:

FSPXL0016 ScorpionDrive-1ST and ScorpionDrive-3ST connector field service procedure

FSPXL0019 Approved thread compounds

FSPXL0021 Scorpion-1ST and Scorpion-3ST connector field service procedure

FSPXL0022 Scorpion connector storage, inspection, and repair

FSPXL0023 Scorpion connector O-Ring installation procedure

FSPXL0025 Scorpion anti-rotation tool kit procedure

Scorpion Connectors

Connector Groups

Scorpion and ScorpionDrive connectors are weld-on designs and the same connector body can be used with multiple pipe wall thicknesses. Connector design groups are summarized in the table below. Each color block within a given diameter column identifies a unique connector design. Connectors within a color block group will thread together without specially fabricated crossover joints.

| | Diameter (inch) | | | | | | | |
|-----------------------|-----------------|--------|----|----|----|----|----|----|
| Wall thickness (inch) | 16 | 18-5/8 | 20 | 22 | 24 | 26 | 28 | 30 |
| 0.438 | | | | | | | | |
| 0.468 | | | | | | | | |
| 0.500 | | | | | | | | |
| 0.625 | | | | | | | | |
| 0.688 | | | | | | | | |
| 0.750 | | | | | | | | |
| 0.812 | | | | | | | | |
| 0.875 | | | | | | | | |
| 1.000 | | | | | | | | |

■ Scorpion Design Group 1 ■ Scorpion Design Group 2 ■ Scorpion Design Group 3 ■ Scorpion Design Group 4 ■ Scorpion Design Group 5