SPECIALTY CONNECTORS

RELIABLE + VERSATILE
Recognized worldwide for cutting-edge exploration, drilling and production technology, DRIL-QUIP maintains its leadership in today’s demanding oil and gas industry.

While DRIL-QUIP’s state-of-the-art equipment, support and service give unique advantages to operators in the tough environments of today, our engineering staff brings proven skills and experience to bear on the complex needs of the future. The DRIL-QUIP quality system ensures that proper steps are taken to provide consistent high quality in accordance with industry standards. We employ the most modern equipment and techniques available to ensure dimensional accuracy and consistent high quality.
Quick-Thread® Connectors

Quik-Thread Connectors offer fast make-up, reliable sealing and versatility to excel in a variety of drilling applications. Their rugged thread form and automatic self-aligning profiles allow for quick and easy installation in the field. Quik-Thread Connectors can be outfitted with anti-rotation keys for added security in harsh drilling environments.

Recommended Applications

- For casing run from any floating rig where rig movement and deepwater current may be encountered
- For casing run from a dual-activity floating rig
- For “lost circulation” hole sections
- For riser casing strings in mudline suspension system wells

The Quik-Thread Connector provides a fast and reliable means of running large diameter tubulars in any application.
Quik-Thread Connectors make up in two-and-a-half turns and cannot be cross-threaded.

Regular Strength

- E-60
- S-60
- S-60D
- D-60

Extra Strength

- H-60
- H-60D
- H-100D
- HC-100D
Multi-Thread™ Connectors

The Multi-Thread Connector is a member of the Quik-Thread line of connectors. It maintains the field-proven performance of the Quik-Thread design with the advantage of making up in only 5/8 of a turn.

Recommended Applications

- Shallow water applications
- All bottom supported drilling vessels or moored floating drilling vessels
- Applications where casing will be run directly into the hole
- Suitable for jetting operations when used with anti-rotation devices

The Multi-Thread Connector provides a definite advantage for quick make-up of large diameter tubulars.

Multi-Thread Connectors make up in less than one turn and cannot be cross-threaded

Regular Strength

E-60  S-60  S-60D  D-60

Extra Strength

H-60  H-60D  H-100D  HC-100D

*also available in 90 ksi higher grade material
Benefits of Threaded Connectors

Features

- Easy stabbing
- Self-aligning
- No cross-threading
- Driveable
- Anti-rotation devices available
- Fast make-up
- Low torque
- Visual indication of make-up
- Reusable
- Fully tested
- Field-proven technology
- High strength
- High-pressure sealing
- Easily weldable

Exceptional Strength

DRIL-QUIP threaded connectors are manufactured from high-quality ring-rolled alloy forgings. The unique geometry of the connectors, combined with high-quality materials, provide for optimum bending, tension and pressure capacities.

Rugged Thread Form

The rugged thread forms of the Quik-Thread and Multi-Thread Connectors are designed with a negative 5° angle on the load flank of the thread. This feature provides an interlocking force, ensuring a positive radial mechanical lock between the box and pin that prevents thread jump-out. The pitch of the thread provides for higher load-carrying capacity while reducing stress concentration. The non-interference thread design reduces radial stresses in the connection. The steep thread taper provides thicker wall sections at the higher load-carrying first threads of the pin and box.

Reliable Sealing Capacity

A resilient seal located in the box provides reliable high pressure-sealing capacity. The seal is located below the threads to prevent pressure migration through the threaded area for increased pressure-sealing capacity. Dual metal-to-metal sealing is available as an option.

Positive Alignment

Alignment profiles above and below the threaded section provide alignment before thread contact occurs. This unique design assures perfect alignment every time and prevents cross-threading.
Optional Connectors for Fatigue Applications

DRIL-QUIP Quik-Thread Connectors can be used in deepwater conductor pipe and production platform riser applications where long-term fatigue life is crucial. For these riser applications, DRIL-QUIP offers a thread form with a full root radius that dramatically decreases the Stress Amplification Factor and increases fatigue life. Connectors best suited for long-term fatigue applications are the H-type with drive shoulder on the pin and the HC-type.

Connectors with Metal-to-Metal Seals

DRIL-QUIP offers a metal-to-metal sealing option on its Quik-Thread Connectors. Two metal-to-metal areas straddle the O-ring groove in the box connector with a corresponding metal seal area on the connector pin nose. By adding the metal seal, the connectors become suitable for gas service.

Fast Make-Up and Easy Handling

1. Pick up the pipe according to normal rig operations; no special handling is required.
2. Check pin connector for contamination or damage.
3. If needed, re-apply to the box connection a light coat of lubricant.
4. Stab the pin into the box and lack off full joint weight on the connection.
5. Rotate the joint to the right with power tongs or rig tongs.
   - **Quik-Thread:** Rotate approximately 2 1/2 turns to fully make up.
   - **Multi-Thread:** Rotate approximately 5/8 of a turn to fully make up.
6. Perform final make-up torque according to table below.
7. Confirm connector make-up by examining the visual indicator.

### Specialty Threaded Connector

<table>
<thead>
<tr>
<th>Size</th>
<th>Recommended Torque (ft-lb)</th>
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<tbody>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>16&quot;</td>
<td>16,000</td>
</tr>
<tr>
<td>18 5/8&quot;</td>
<td>19,000</td>
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<td>20&quot;</td>
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<td>22&quot;</td>
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<td>38&quot;</td>
<td>38,000</td>
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<tr>
<td>42&quot;</td>
<td>42,000</td>
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</tbody>
</table>

30" Quik-Thread installation
Threaded connectors are often used in applications that require the use of anti-rotation devices. These devices prevent connection back-out or over-torque that may occur as a result of torsional forces or impact loads.

Torsional forces, for example, could be applied to the connectors during make-up/release of mudline suspension running and tie-back tools and high-current conditions. Also, impact loads generated during driving applications can result in connector back-off or over-torque. Anti-rotation keys are available to prevent these types of rotation.

Dril-Quip offers two types of anti-rotation devices:

- **Horizontal Cam Key**
- **Vertical Slot Key**

The connector selected for a given application determines which key is used.

**Horizontal Cam Key**

Connectors designed with a secondary drive shoulder are designated D-type connectors. These connectors are equipped with horizontal cam-type anti-rotation keys.

Cam-style anti-rotation keys are installed into a mating cam-shaped slot on the OD of the pin. Diagonally opposed keys are installed in opposite directions to prevent right- or left-hand rotation. The hardened keys have serrations that bite into the top shoulder of the box. Any attempt to rotate the pin is immediately stopped by the camming action of the keys. The keys are retained in their slots by an Allen-head bolt and can be easily removed, if necessary.

**Vertical Slot Key**

Connectors that do not have a secondary drive shoulder require vertical slot keys. When the key is installed into a slot in the pin, the serrations bite into the ID of the box, preventing rotation of the pin relative to the box. The key is captured in the slot to prevent disengagement during driving operations. The key does not protrude past the OD of the box and can be easily removed, if necessary.
All Dril-Quip manufacturing facilities are equipped to fabricate connectors to casing joints in accordance with customer specifications, using qualified procedures that conform to industry standards.

**Welding**

Dril-Quip uses state-of-the-art welding equipment to ensure connectors are welded to the pipe in conformity with industry standards. DRIL-QUIP procedures and welders are qualified and certified in accordance with ASME Section IX and API Spec. 6A. Typical welding processes used are Gas Metal Arc Welding (GMAW) and Submerged Arc Welding (SAW).

**Inspection**

All connector welds are 100% radiographically inspected. Other alternative non-destructive testing procedures, such as ultrasonic inspection, can be performed upon customer request. The inspection procedures used by DRIL-QUIP conform to ASME Section V or API Spec. 1104.

**Traceability**

Data sheets that include inspection and material certification are prepared for each casing joint. This data, which is recorded by a unique serial number, is available to the customer upon request and provides 100% material traceability.

**Fast Turnaround**

DRIL-QUIP emphasizes quality production and fast turnaround for on-time delivery of casing joints.

**Inventory**

Inventory of connectors is maintained at every DRIL-QUIP facility worldwide to meet customer requirements.

Contact your nearest Dril-Quip representative for information on availability of casing joints for your specific application.

Mill certificates are available for all pipe in stock to ensure quality and traceability. DRIL-QUIP supplies connectors, pipe and fabrication for turnkey casing joints of consistent and verifiable high quality. This translates into timely deliveries and cost savings for the customer.
**ANALYSIS & TESTING**

API-RP-5C5 and ISO 13679 – *Procedures For Testing Casing and Tubing Connections* – are petroleum and natural gas industry codes that specify the required testing to be performed on specific small-diameter premium casing connections. As the industry continues to move into deeper water and drill wells to deeper depths, manufacturers are now being asked to perform similar rigorous testing for the large-diameter conductor and surface casing connections. Anticipated higher pressures and temperatures (HPHT), and heavier blowout prevention equipment have driven the need for enhanced product features that require more sophisticated design, structural and fatigue analysis.

The company validates the design methodology and manufacture of its threaded connectors in compliance with API 5C5 and ISO 13679 standards. The verification analysis methodology is validated with physical testing of the connectors.

**Verification Analysis Approach**

DRIL-QUIP has adopted a protocol that involves detailed and advanced 2-D and 3-D FEA verification analysis to determine connector capacities, considering torque, tension, compression, internal and external pressure, and bending at various load magnitude and temperature combinations, while monitoring the connector sealing performance. Some performance parameters, such as bending capacity, etc., are evaluated with full 3-D FEA models that include 3-D thread helix.

Using von Mises Equivalent Stress theory, the connector capacity envelope at yield is created for comparison with pipe yield capacity. Connector capacities at 90% and 95% of yield strength and any other desired design margins are generated to accommodate the connector validation testing program.

Pressure versus axial load capacity charts for both the connector and pipe provide crucial and verified information about windows of operation for various load combinations. When applicable, additional analysis is conducted with respect to fatigue life using stress amplification factors (SAF), fatigue loads, and appropriate S-N curves. It should be noted, however, that SAF numbers obtained from FEA are generally conservative.

Physical fatigue validation testing of connectors provides more realistic results and is considered a crucial step in DRIL-QUIP’s capacity evaluations.
Physical Validation Testing - Structural

DRIL-QUIP conducts connector validation testing in accordance with the guidelines of API RP SCS and ISO-13679, subjecting the connector to the extremes of performance parameters to ensure fit for service. The performance parameters considered include torque, internal and external pressure, axial loads, bending loads, temperatures, dimensional tolerances, mechanical properties, surface treatment, and the type and amount of thread compound. DRIL-QUIP has its own comprehensive and conservative testing scheme. The company is capable of testing all of its connectors to each of the four connector assessment levels (CAL I, II, III, and IV). Test plans and connector assessment levels are selected based on the connector type, application and customer requirements. In all cases, either full or portions of the capacity chart generated with FEA, in conjunction with connector sealing performance is validated with physical testing.

Additionally, physical testing is performed to validate the calculated bending capacities developed in advanced 3D FEA verification analysis. Test results are used to calibrate the FEA model input parameters.

The Company has designed and built a Horizontal Test Machine that is capable of performing all of the required product validation testing for all connector sizes and types to their limits with various load combinations applied simultaneously.

The Horizontal Test Machine is equipped with hydraulic cylinders and a control system that applies prescribed loads to a test specimen. The machine is capable of simultaneously applying the following loads:

- 20+ million ft-lbf of bending
- 13+ million lbf of tension
- 8+ million lbf of compression
- 6 million lbf of simulated casing weight
- Internal/external pressure and associated pressure end loads to equipment capacity
- Various combined load scenarios simultaneously to the limits of equipment

With these capabilities, multiple loading scenarios can be applied, and the connector can be tested to its limits in a manner that closely resembles field conditions. Strain gauges, position sensors and pressure transducers, as shown in are strategically placed to gather data while predefined system load combinations are applied to the connector. User input to the machine is menu-based and data files with tension or compression loads, bending loads, positions and timing events are processed by the custom control software. Data values are recorded and analyzed to verify correlation with the FEA analysis, and proper adjustments to the analysis methodology are made.
Physical Validation Testing - Fatigue

The oil and gas industry continues to develop hydrocarbon reservoirs in deep water, harsh environments. The expectation that equipment used in these environments will meet operating performance standards, have a longer service life with increased reliability becomes mandatory. DRIL-QUIP believes that physical validation testing of equipment for fatigue is a critical component of the overall validation methodology to achieve these goals. The aim of fatigue design is to ensure the structure considered, in this case specialty casing connectors, have adequate fatigue life to meet the customers performance standards.

An eccentrically loaded machine, designed and built by DRIL-QUIP was used in the testing to accelerate the fatigue phenomena. The test specimen used in the structural validation test (a pin and box connector set welded to a selected grade of casing) is installed in the machine. Strain gauges are applied and pressure introduced in the bore.

The machine is operated with an exciter applying an eccentric load to introduce stress at one of three different stress levels (High - 20 ksi, Medium - 10 ksi and Low - 5 ksi) to the specimen that simulates field conditions. Three specimens are tested at each level (total of 9 specimens). The corresponding vibration response spectrum is monitored for any indication of the onset of structural failure which would ultimately result in a pressure leak. Continuous cyclic stress is applied to the specimen until a leak is detected, indicating the failure point has been reached.

The data from the 9-specimen tested in this manner is plotted on charts from the DNVGL RP-C203 standard to assist in calculating an actual Stress Amplification Factor (SAF) which can be applied to customer well-site specific fatigue histograms. This aids the customer in determining if a particular connector selection has the necessary fatigue life characteristics to resist the specific wellsite loading conditions.

This verification and validation methodology is another example of DRIL-QUIP’s commitment to deliver technological innovation with predictable reliable performance.