The DXe Wellhead Connector delivers a long service life with reliable field performance.

**FEATURES**
- 20 Ksi DXe-30 is API 17TR8 approved by 13P and BSEE
- Full scale load tested to API 16A 4th Edition PR2 and API 17TR7 qualification requirements
- DXe gaskets qualified to API 6A PR2 20,000 psi (with gas), 35° to 400 °F and 11,000 ft water depth
- Unique proprietary highly engineered mandrel locking profile provides longest and unmatched fatigue life and highest load capacity proven through full scale testing

**BENEFITS**
- Tested with no bolts installed - load path is through the connector upper body, latch segments and wellhead and not the bolts
- Maximizes the drilling vessel watch circle
- No gasket leaks during worst case survival load testing (all load cases) at 20,000 psi bore pressure
- Increased hub face contact area provides high bending capacity
- Self-aligning primary and secondary DXe ring gaskets standard
- Design is compatible with existing blowout preventer hydraulic control systems
- Can be configured for H4 and SHDH4 locking profile
**DXe-27 Connector**

Ideally suited for standard and deepwater drilling applications, Dril-Quip’s DXe-27 Wellhead Connector is designed for 27” O.D. wellhead and is available in a 15,000 psi working pressure.

<table>
<thead>
<tr>
<th>Rated Working Pressure (Ksi)</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swallow (inches)</td>
<td>23.32</td>
</tr>
<tr>
<td>Minimum Added Stack Height (inches)</td>
<td>22.13</td>
</tr>
<tr>
<td>Maximum Outside Diameter (inches)</td>
<td>54.88</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td>17,800</td>
</tr>
<tr>
<td>Fluid Volume to Latch (gal)</td>
<td>7.39</td>
</tr>
<tr>
<td>Fluid Volume to Unlatch (gal)</td>
<td>11.26</td>
</tr>
<tr>
<td>Fluid Volume for Secondary Unlatch (gal)</td>
<td>13.66</td>
</tr>
<tr>
<td>Max Latching Pressure (psi)</td>
<td>3,000</td>
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</tbody>
</table>

Contact Dril-Quip Engineering for capacities with various levels of tension/compression

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**DXe-30 Connector**

Ideally suited for standard and high bending deepwater applications, Dril-Quip’s DXe-30 Wellhead Connector is designed for a 30” O.D. wellhead and is available in a 20,000 psi working pressure rating. An adapter kit is available to configure a DXe-30 to mate with a 15,000 psi 27” O.D. wellhead.

<table>
<thead>
<tr>
<th>Rated Working Pressure (Ksi)</th>
<th>15 or 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swallow (inches)</td>
<td>27.49</td>
</tr>
<tr>
<td>Minimum Added Stack Height (inches)</td>
<td>27.50</td>
</tr>
<tr>
<td>Maximum Outside Diameter (inches)</td>
<td>64.53</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td>38,500</td>
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<tr>
<td>Fluid Volume to Latch (gal)</td>
<td>14.53</td>
</tr>
<tr>
<td>Fluid Volume to Unlatch (gal)</td>
<td>20.50</td>
</tr>
<tr>
<td>Fluid Volume for Secondary Unlatch (gal)</td>
<td>25.64</td>
</tr>
<tr>
<td>Max Latching Pressure (psi)</td>
<td>3,000</td>
</tr>
</tbody>
</table>

Contact Dril-Quip Engineering for capacities with various levels of tension/compression
Primary and Secondary Metal-to-Metal Sealing

DRIL-QUIP DXe™ series Connectors is a unique profile that mates with a proprietary DXe ring gasket. This DXe sealing profile features a pair of independent metal-to-metal sealing surfaces, a primary and second independent sealing surface.

The primary DXe gasket is used during normal operations and protects the secondary metal-to-metal sealing surface. In the event of damage or leak, a secondary DXe ring gasket can be installed. The secondary ring gasket utilizes the secondary sealing surface for a reliable metal-to-metal seal.

Internal Pressure Rating - 20,000 psi
External Pressure Rating - 5,000 psi
Water Depth Rating - over 11,000 ft
Temperature Range - 35° F to 400° F

Ring Gaskets are Self-Aligning

The DXe Connector ring gasket has been designed with a self aligning feature, while protecting the primary and secondary sealing surfaces. This is accomplished with a unique metal sealing surface that features upper and lower alignment guidance. The ring gasket Retainer Mechanism is spring loaded for automatic ring gasket retention. The retention mechanism releases the ring gasket with hydraulic pressure. Ideal for installing gaskets onto wellheads using ROV.

The DXe ring gasket has alignment guides that engage the ring gasket surface in the upper body of the connector. These alignment guides assist alignment while protecting the metal sealing surfaces.

Downward movement of the connector and the alignment guides automatically adjusts the ring gasket into the proper sealing position. Both alignment guides assure the sealing surfaces are not touched as this movement occurs.

As the connector lands out, the ring gasket settles into the sealing position and is preloaded when the connector is locked and the latch segments are energized.
Some wellhead connectors used in the subsea drilling industry have a load path that drives applied preload through a series of bolts required for assembly. These bolts are exposed to sea water and experience cyclic loads from the drilling riser and tension loads generated by internal pressure. Fatigue cycles coupled with material imperfections, material strength, toughness and coating variations come together to form cracks that can propagate through the threads on the bolt, causing it to break. Being exposed to sea water accelerates the corrosion process.

In recent years, bolts integral to subsea equipment have failed due to this phenomenon. In 2013, the U.S. Department of the Interior (DOI) started an investigation after numerous bolts on in service connectors were found to be broken. Additional industry groups investigated metallurgical data to determine if alloys used in the heavy steel bolts are ductile enough to survive harsh subsea environments. As a result API has released API 20E to mandate bolt traceability and establish standards for quality.

The DXe Connector design addresses this problem. It features radial latch segments that are driven into mating load profiles with an annular piston/cam ring. This action provides the necessary preload required between wellhead hub face and the upper body of the connector. When the connector is locked and in operation, the load path travels through the connector, the wellhead main body and the latch segments via the locking profile. As the segment latches to the wellhead, it clamps to the connector upper body simultaneously and creates a closed loop with a near straight load path. Any loads applied to the connector travel only through the segments that are made from ductile alloy steel and do not pass through bolts. Bolts in the DXe Connector do not see cyclic stresses at the operating loads and are not subjected to the failed bolt problems associated with other industry connectors.

**NO BOLTS TEST**

To demonstrate the DXe Connector has no bolts in the load path, a combined load test following API 16A specifications was performed. This test consisted of locking a connector to a test stump with standard locking pressure. The test stump had a 30” O.D. DXe wellhead locking profile. Locking pressure was bled off and the locking circuit was vented. All external attachment bolts were removed, including bolts in the upper and lower bodies. A structural load test was performed, which included tension / compression to 1.0MM Lbs combined with bending, and pure bending to as much as 8.2MM ft-lbs. The load tests were performed both without bore pressure and with bore pressure applied in increments of 5,000 psi up to 20,000 psi. The "no-bolts" connector successfully passed each test and demonstrated identical performance with the standard connector tested with all of the bolts installed.
**Connector Verification and Validation Testing**

**Verification Analysis**

Highly sophisticated design tools, an extensive 3-D advanced finite element analysis (FEA) were used to optimize every detail of the connector locking profile. The analysis simulates connector installation and operating conditions which includes preloading and application of internal and external loads (pressure, bending, tension/compression, and load combinations) while observing the stress behavior throughout the connector components. Particular attention has been paid to achieve uniform load distribution and minimizing peak surface stresses that are directly related to the fatigue performance of the connector. This methodology has allowed the company to develop the DXe™ locking profile. The analysis and the results have enabled the company to create a wellhead connector design with high load capacity and high fatigue resistance, all within the smallest possible dimensional envelope.

**Validation Testing - Structural**

DRIL-QUIP utilizes its own Horizontal and Vertical Test Machines to perform physical validation testing of its wellhead connectors. A test specimen that consisted of a wellhead connector, 18-3/4” wellhead, locked into a 36” conductor housing was assembled and installed into the company’s Horizontal Test Machine. Tests were conducted using normal, extreme and survival load conditions, per API17TR7 requirements.

Strain gauges were installed at all critical locations of the test specimen and data collected for comparison to strains from the FEA at same locations. Bending moments were applied to the specimen with a variety of combined loads. Test results were collected and a comparison of 3-D FEA and validation test results indicate close correlation between analysis and test data. Variations between analysis and testing results were attributed to several idealized assumptions made in the original 3-D FEA. Factors such as strain gauge error, gauge orientation/alignment, component tolerances, out-of-roundness effects,
positioning of components related to the plane of bending, non-uniformity in material properties and friction contributed to the variations recorded.

The 3-D FEA was performed to generate capacity charts when Normal (66.7% of yield), Extreme (80% of yield) and Survival (100% of yield) load conditions are applied to the wellhead system. These three load conditions are applied in both the verification analysis and physical validation testing of the wellhead system and is believed to be the most accurate representation of connector performance to date.

Structural testing is only one component of the Company’s overall validation program. The second validation component is a rigorous fatigue testing program.

**Physical Validation Testing - Fatigue Resistance**

The aim of fatigue resistant design is to ensure the structure considered, in this case a wellhead connector locked to a wellhead system, has an adequate fatigue life to meet the customers performance standards throughout the life of the project.

To properly evaluate fatigue characteristics of the wellhead system and wellhead connector, met-ocean data (wave and current profiles), drilling vessel motions and soil conditions were collected on specific well sites from several severe drilling cases around the world. A global riser analysis was performed to identify a representative fatigue spectrum and a predicted failure point. The data was used to develop and conduct a full scale fatigue test program.

A fatigue test machine, designed and built by DRIL-QUIP was used to accelerate the fatigue phenomena. The same test specimen used in the structural validation test (a complete wellhead system including the wellhead connector) was used for this test. The specimen was installed in the machine, strain gauges were applied and pressure was introduced in the bore.

The machine was operated with an eccentric load that introduced an alternating stress level to the specimen. A change in the vibration spectrum was monitored for any variation that would indicate the onset of a fatigue crack that would ultimately result in a pressure leak. Continuous cyclic stress was applied to the specimen until the predicted failure point was reached in the 5th week of testing. There was no change in vibration spectrum or leakage occurrence, so the test was continued until 60 million cycles were applied, a number that far exceeded any maximum fatigue conditions evaluated. The test specimen was disassembled, and inspection of all components indicated no fatigue damage was found.

It is believed that DRIL-QUIP is the first company to apply rigorous fatigue test program to a complete wellhead system and connector. This validation methodology is another example of DRIL-QUIP’s commitment to deliver technological innovation with reliable performance.