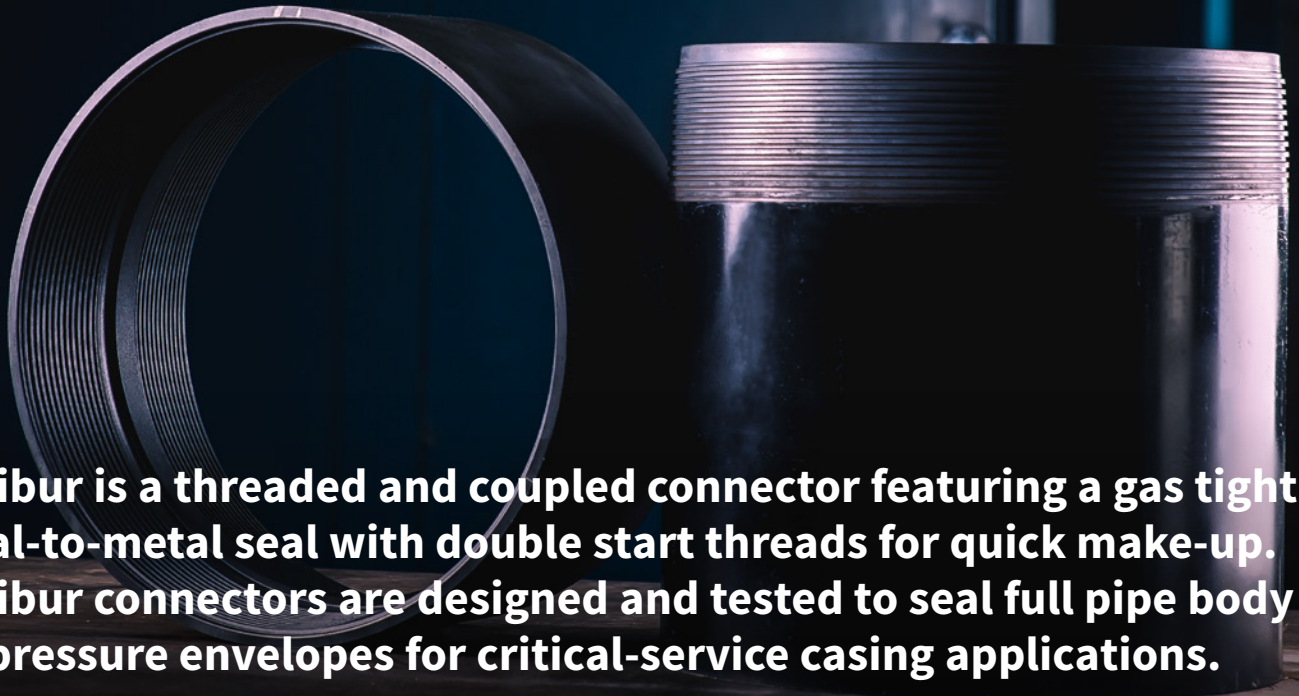


XL Systems

XCalibur Connectors



XCalibur is a threaded and coupled connector featuring a gas tight metal-to-metal seal with double start threads for quick make-up. XCalibur connectors are designed and tested to seal full pipe body gas pressure envelopes for critical-service casing applications.

XCalibur connectors were designed to utilize an integral pin and high strength forged coupling, it delivers robust performance for challenging onshore and offshore wells. Features include: full pipe body strength, gas tight metal seal, torque shoulder, and double start hooked threads.

XCalibur has been successfully tested to API RP 5C5 CAL I (Liquid and Gas) testing protocols. These rigorous tests demonstrate that even at worst-case geometric tolerance conditions, the connectors match full pipe body gas pressure envelopes.

**XCalibur connectors
are available in**

**16- to 24-inch
sizes**

for onshore and offshore gas-tight
surface casing applications

Typical Applications

- A multi-purpose connector for severe applications.
- Casing strings and liner strings with gas pressure sealing requirements
- Casing for deviated wells
- Gas storage wells

XCalibur Connectors

Unique Features and Benefits

Family of Parts Design Philosophy

The XCalibur product line was designed using the family of parts design approach, ensuring maximized performance for every size configuration. This approach is used to guarantee that no size configuration is under or over designed. Each size configuration shares geometric design similarities and performance targets, making it easier to verify and predict performance characteristics using digital design and simulation tools.

High Strength Forged Coupling

XCalibur connector couplings are threaded on forgings which provide uniform geometry and mechanical properties for reliable and predictable performance characteristics.

No Welding Required

Economical alternative to weld-on connectors, XCalibur delivers high strength options for non-weldable pipe grades. Pins are integral, meaning they are machined directly onto the ends of the pipe.

100% Pipe body strength

Connector strength meets or exceeds pipe body for all strength ratings: tension, compression, bending, internal pressure, and external pressure.

Metal-to Metal Seal

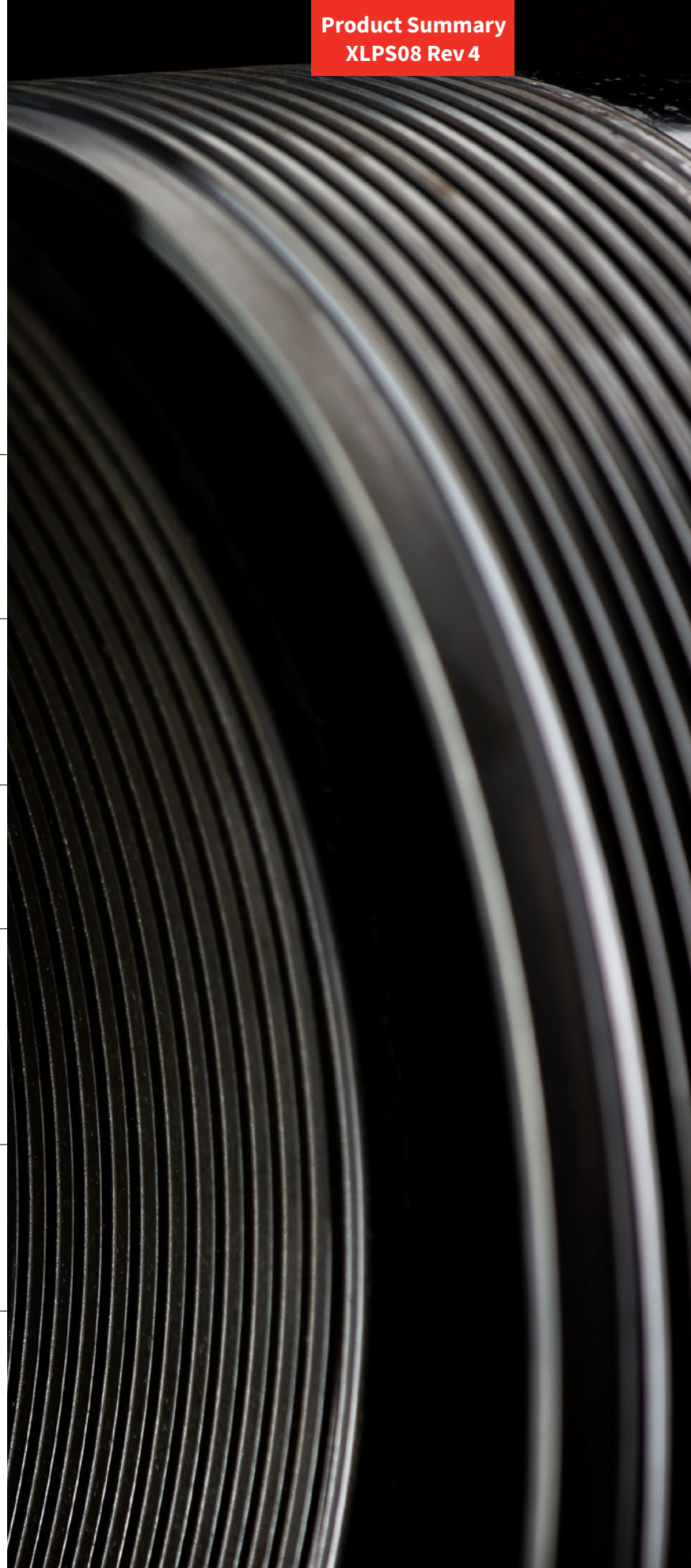
Industry experience is that metal-to-metal seals are preferred for long-term gas pressure containment, but not all metal seals are gas-tight designs. XCalibur's metal-to-metal seal is designed and tested to API RP 5C5 CAL I (Liquid and Gas) for proven reliability under high combined loads.

Engineered Threadform

Double start, deep stabbing thread design delivers fast, reliable make-up, and eliminates cross-threading. Hooked thread-form design maintains engagement under extreme loading conditions.

No Mechanical Anti-Rotation Device

Unique thread design and interference contact builds torque energy over half a revolution. Make-up torque energy stored as interference over the full thread length prevents unintended connector back-off during installation.



XCalibur Connectors

16- to 24-inch Sizes

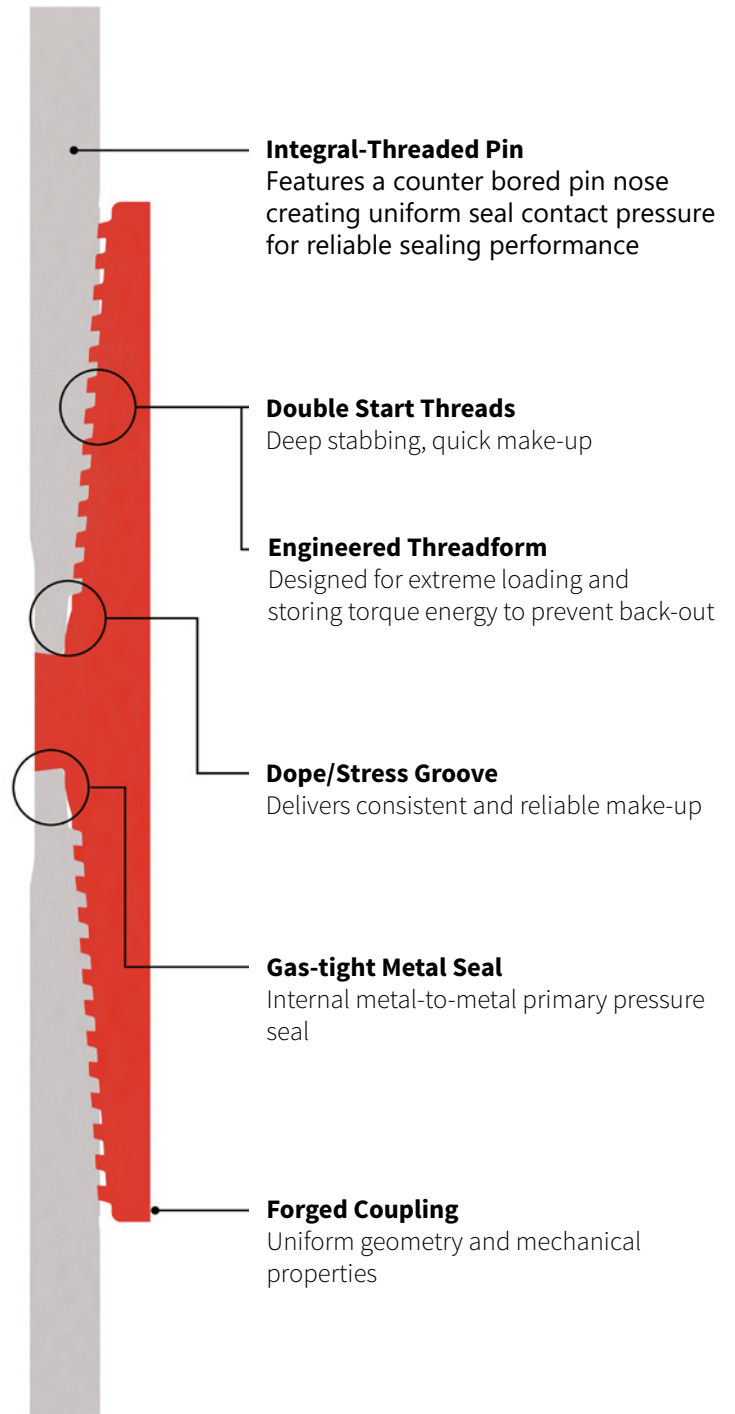
XCalibur connectors are designed for robust and reliable performance in the most demanding onshore and offshore surface casing, liner string, and conductor applications.

The primary and only pressure seal for the connectors is a metal-to-metal seal on the ID side of the threads. This seal maintains robust gas-tight sealability at full pipe body pressure ratings.

XCalibur connectors match full pipe body structural strength in a compact connector profile. XCalibur connector thread technology eliminates the need for a thick torque shoulder by absorbing compressive loads in the threads, simultaneously providing robust connector strength and generous ID and OD clearances.

The box coupling provides an integral lift shoulder for easy running and handling on the rig using standard casing elevators.

XCalibur connectors share favorable field make-up characteristics: deep stabbing, fast make-up, low-torque spin-up, high torque capacity and built-in resistance to unintended back-off.



Analysis and Physical Testing Summary

Digital design and simulation tools such as finite element analysis (FEA) were extensively used to develop the XCalibur connector design. These tools were particularly used to design the new thread and metal seal design, and associated dimensional tolerances.

However, the most reliable measure of connector sealability performance is a full-scale test under combined axial, bending, and pressure loads. XL Systems has completed testing to API RP 5C5 CAL I (Liquid and Gas) for the XCalibur connector.

The table below is a summary of the XCalibur connector physical testing scope completed to date. XL Systems Engineering Technical briefs are available with detailed information for each test series.

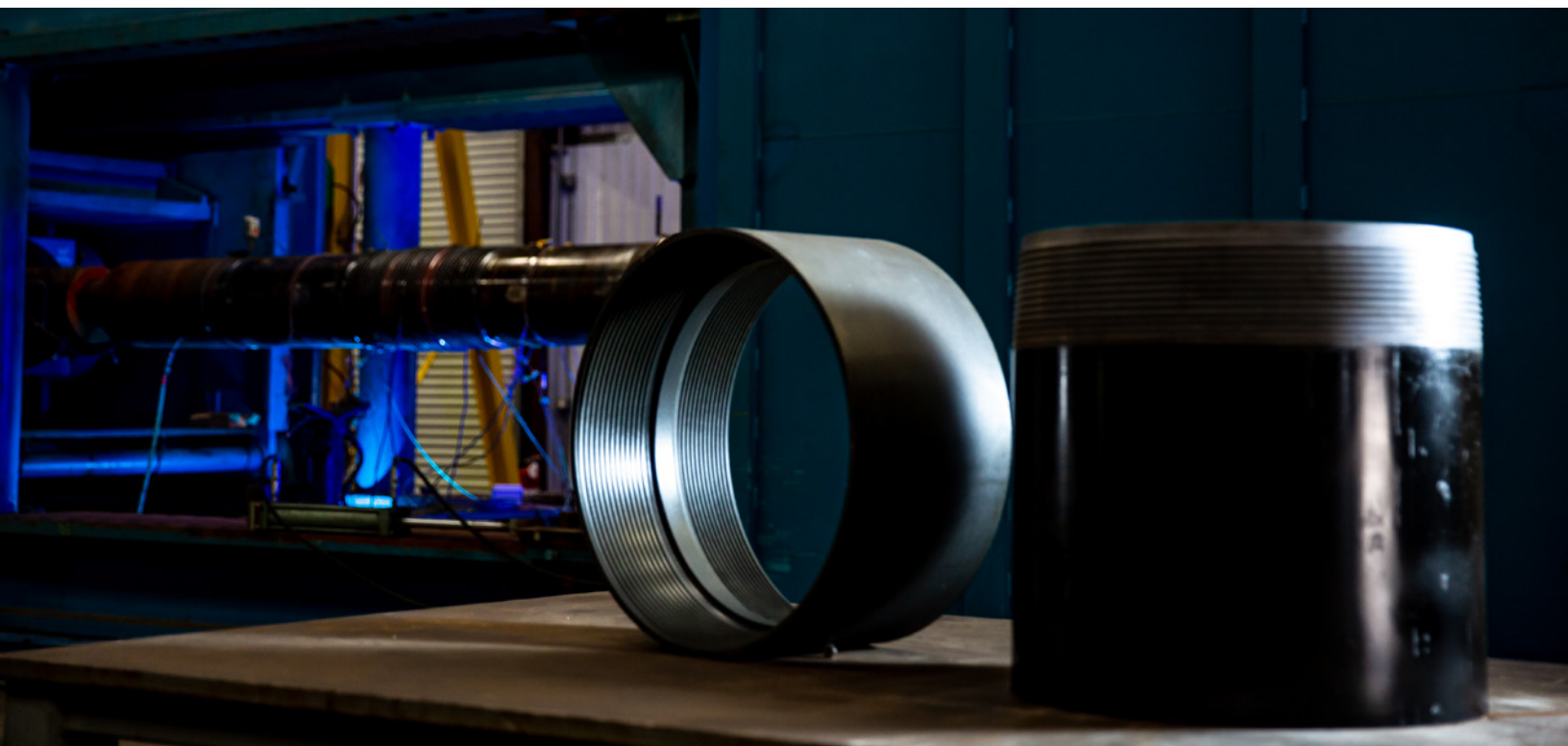
Highlights of the tests include:

- Test followed API RP 5C5 CAL I (liquid and gas) testing protocols.
- CAL I consisted of two Specimen 1 samples (1 liquid pressure, & 1 gas pressure) and one Specimen 5 sample.

- Each machined to the worst-case dimensional tolerance combinations as defined in API RP 5C5 criteria.
- Make and break testing was completed as defined per API RP 5C5 for make-up torque targets, and number of make and breaks per end.
- Connection test load envelopes were based on 95% pressure ratings for the pipe body using actual (measured) material yield stress. This is the rigorous ‘full pipe body’ testing envelope.
- Make and Break tests plus combined loading sealability tests were completed as required by the standard for CAL I testing. Series A test included tension, compression, internal, and external pressure. Series B tests included tension, compression, bending, and internal pressure. Limit load testing included tension to failure and 50% tension with internal pressure to failure.
- All test samples successfully completed the full testing protocol with no leaks or catastrophic connector failures.

Physical test type and number of XCalibur Connector samples tested

Pipe Size (Inch)	Pipe Grade	Coupling Grade	CAL I- Liquid Sealability Combined Loading	CAL I - Gas Sealability Combined Loading
20 x 0.750	X80	M90N	1	2



XCalibur Connectors

Connector Performance Data Sheets

XL Systems maintains a library of connector performance data sheets or “spec sheets” for all our connector products on the nov.com website. Select the Specs Direct 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.

Field Service Procedure

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

- FSPXL0028 XCalibur Field Service Procedure
- FSPXL0029 XCalibur Storage, Inspection, and Repair Procedure

Connector Material Grades

XCalibur connectors are produced to NOV XL Systems material specifications in three primary grades: M70, M80, and M90. The table below shows recommended connector grades matched to API 5L pipe grades. Other standard connector grades with higher strength or special alloying are available upon request. Contact XL Systems sales or engineering for more information on possible availability.

Connector Grade	Connector Yield Strength	API 5L Pipe Grade					
		X52	X56	X60	X65	X70	X80
M70	70.0 ksi = 483 MPa	R	R	R	NR	NR	NR
M80	80.5 ksi = 555 MPa	NR	NR	O	R	R	NR
M90	90.0 ksi = 621 MPa	NR	NR	NR	NR	O	R

R Recommended pipe and connector grade combination **O** Optional grade combination for higher connector strength **NR** Not recommended

Connector Groups

The XCalibur connector profile geometry is used on some similar 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.

Wall thickness (inch)	Diameter (inch)				
	16	18-5/8	20	22	24
0.435	XCaliber Design Group 1	XCaliber Design Group 1			
0.468	XCaliber Design Group 1	XCaliber Design Group 1			
0.485	XCaliber Design Group 2	XCaliber Design Group 2			
0.500	XCaliber Design Group 2	XCaliber Design Group 2	XCaliber Design Group 2	XCaliber Design Group 2	
0.625	XCaliber Design Group 3	XCaliber Design Group 3	XCaliber Design Group 3	XCaliber Design Group 3	XCaliber Design Group 3
0.635	XCaliber Design Group 3	XCaliber Design Group 3	XCaliber Design Group 3	XCaliber Design Group 3	XCaliber Design Group 3
0.709	XCaliber Design Group 4	XCaliber Design Group 4	XCaliber Design Group 4	XCaliber Design Group 4	XCaliber Design Group 4
0.750	XCaliber Design Group 4	XCaliber Design Group 4	XCaliber Design Group 4	XCaliber Design Group 4	XCaliber Design Group 4
0.812			XCaliber Design Group 5	XCaliber Design Group 5	XCaliber Design Group 5
1.000			XCaliber Design Group 6	XCaliber Design Group 6	XCaliber Design Group 6