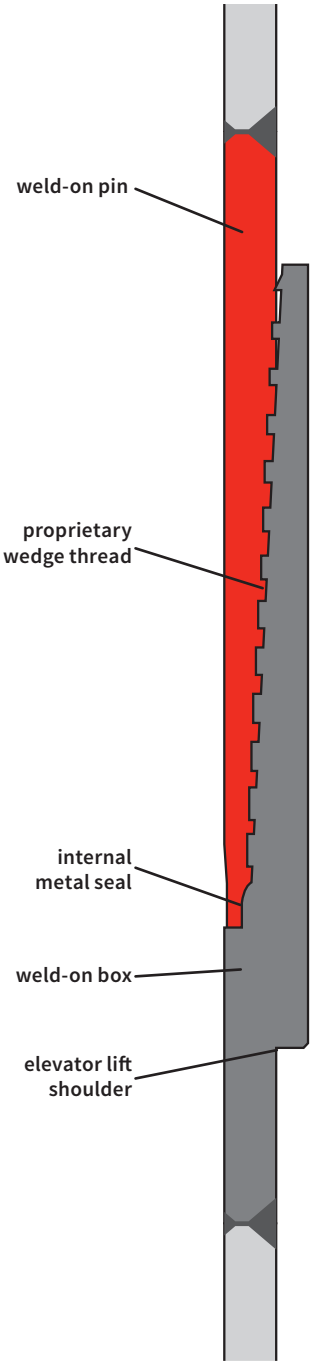
XLW-GT Connector

Design and qualification program for offshore surface casing applications

Overview

The XL Systems XLW-GT connector design combines a gas tight, internal metal seal with wedge thread technology to create a high performance, low risk solution for extreme surface casing operations. Engineered connector geometry machined on high strength pin and box forgings provides connector capacities that exceed 100% of pipe body ratings in all sizes. This document summarizes the connector design, the comprehensive ISO 13679 gas testing qualification, and the harmonic fatigue testing program completed on the XLW-GT connector.

Connector:	**XLW-GT**
Thread type:	**Wedge**
Primary seal:	**Internal metal seal**
Secondary seal:	**Wedge thread fit seal**
Turns to make-up:	**3**
Anti-rotation:	**Wedge thread technology**
Available sizes:	**20” to 30” diameter**



Applications

- gas tight pressure containment
- high fatigue surface casing
- deviated wells
- deepwater strings run in open water
- drilling with casing
- storage wells

XLW-GT: The next generation XLW connector

The XLW connector, XL Systems' first weld-on wedge thread product, has been very successful in a large variety of applications around the globe since the early 1990s. XLW-GT utilizes the same threadform geometry as XLW - this means that make-up characteristics and field service requirements for XLW-GT remain unchanged from the field proven XLW product.

Feature	Benefit	XLW-GT	XLW
Wedge thread technology	Provides high torque capacity and excellent fatigue performance	✓	✓
Connector ratings meet or exceed full pipe body strength	Predictable performance under extreme loading conditions	✓	✓
Integral, slim OD lift shoulder	Easier handling and running offshore with better clearance inside conductor	✓	✓
No anti-rotation feature installation required	Faster make-up, especially with power tongs	✓	✓
Internal metal seal with secondary thread fit seal	Reliable seal integrity with liquid pressure	✓	✓
Gas tight metal seal	ISO/FDIS 13679:2011 CAL I-E (with gas) qualified to 95% of actual X80 pipe body internal pressure ratings	✓	
High strength pin and box forging design	Improved performance ratings, excellent fatigue performance, and interchangeability	✓	

The primary difference between XLW-GT and XLW is that the XLW-GT metal seal was improved to effectively seal gas pressure. XLW is rated to 100% of pipe body internal pressure ratings and historically has been very successful with liquid sealability. However, to reliably seal gas pressure under extreme ISO 13679 machining tolerance and loading conditions, two major modifications were required from the XLW design: a pin forging and optimized metal seal geometry.

Weld-on Pin Forging

Machining the XLW-GT thread on high strength pin and box forgings creates two distinct advantages:

1. The pipe body long seam weld is eliminated from the XLW-GT connector profile. A metal seal with uniform geometry and metallurgical properties is critical for sealing gas pressures to 95% of actual pipe body internal pressure ratings.
2. The recommended connector forging grades have a higher yield strength than the pipe. This means that the XLW-GT connection will always have connector performance ratings greater than the pipe body.

Redesigned Metal Seal Geometry

The XLW-GT internal metal seal design was improved for gas tight casing applications. Using the latest engineering design tools and analysis techniques, the metal seal geometry was optimized to meet 95% of pipe body internal gas pressure requirements while minimizing the risk of seal galling.

XLW-GT

Design Interchangeability

XLW-GT utilizes a weld-on pin and weld-on box design that allows for interchangeability between connectors of different wall thicknesses. In the table below, each color block within a given diameter column identifies a unique design. Connectors within a color block group will thread together without specially fabricated crossover joints.

Wall Thickness	Diameter					
	20"	22"	24"	26"	28"	30"
0.500						
0.625						
0.750						
0.812						
1.000						
1.125						
1.250						
1.500						

Design Group A

Design Group B

Design Group C

Design Group D

Enhanced ISO 13679 CAL I-E Sealability Test Program

To thoroughly verify the seal performance of the XLW-GT connector, XL Systems selected a qualification program that exceeds ISO/FDIS 13679:2011 CAL I-E (with gas) requirements. The program was chosen to encompass the extreme requirements of most XLW-GT surface casing applications.

This test program included an ISO Specimen 1 and an ISO Specimen 5 per CAL I-E requirements. In addition, an ISO Specimen 4 was machined and combined load sealability tested. A total of three XLW-GT sizes were tested to these parameters as shown below.

Tested XLW-GT Connector	Required test per ISO 13679	Required per ISO 13679 CAL I-E		Additional specimen per ISO 13679 CAL II
		Specimen 1	Specimen 5	Specimen 4
20 x 0.750 X80 M95	Make-and-break	✓	✓	✓
	Series A (95% actual internal gas pressure)	✓		✓
	Series B (95% actual internal gas pressure)	✓		✓
	Limit load	✓		✓
22 x 1.00 X80 M95	Make-and-break	✓	✓	✓
	Series A (95% actual internal gas pressure)	✓		✓
	Series B (95% actual internal gas pressure)	✓		✓
	Limit load	✓		✓
22 x 1.25 X80 M95	Make-and-break	✓	✓	✓
	Series A (95% actual internal gas pressure)	✓		✓
	Series B (95% actual internal gas pressure)	✓		✓
	Limit load	✓		✓
22 x 1.50 X80 M95	Make-and-break	✓	✓	✓
	Series A (95% actual internal gas pressure)	✓		✓
	Series B (95% actual internal gas pressure)	✓		✓
	Limit load	✓		✓

For both ISO Series A and ISO Series B tests, all internal pressure testing was with gas to 95% of actual X80 pipe body ratings. This is an extreme test that represents the maximum allowable pressure on the highest yield strength pipe commonly supplied for surface casing applications. Any axial load and external pressure truncations within the connection test envelope were required because of testing equipment limitations.

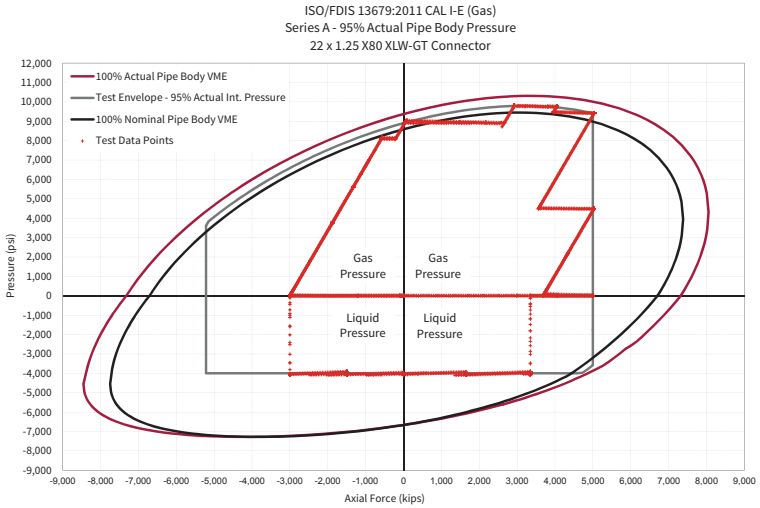
Example: 22 x 1.25 X80 M95 XLW-GT Sealability Test Data

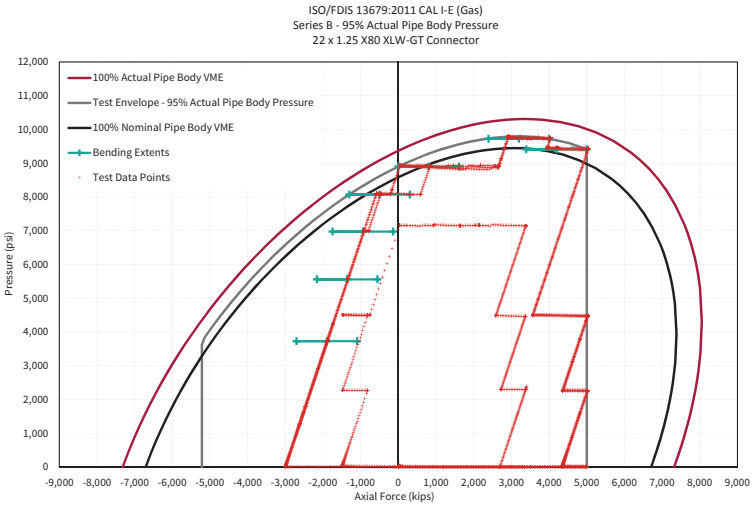
Below are plots for each combined load test completed on 22 x 1.25 X80 M95 XLW-GT as part of the CAL I-E test program. Additional CAL I-E sealability data for other tested sizes as well as test data for the CAL II Specimen 4 tests completed for each size can be provided.

ISO Series A

Four quadrant combined load testing included maximum loads of:

- tension to 5,000 kips
- compression to 3,000 kips
- internal gas pressure to 9,800 psi
- external water pressure to 4,000 psi





ISO Series B

Two quadrant combined load testing included maximum loads of:

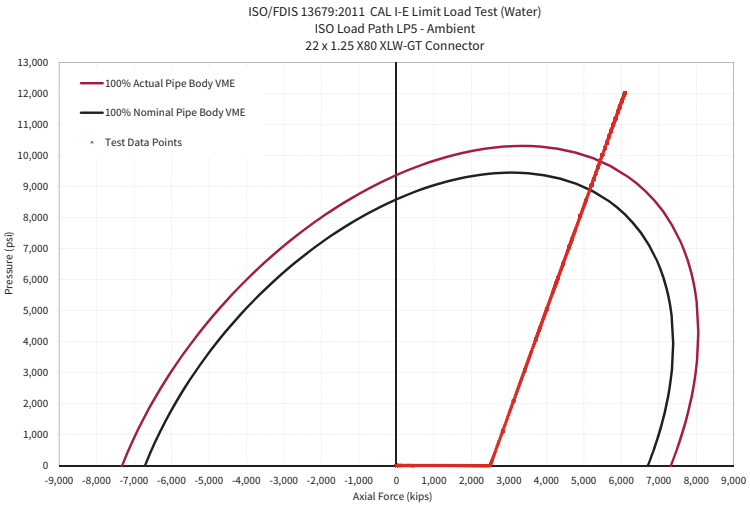
- tension to 5,000 kips
- compression to 3,000 kips
- internal gas pressure to 9,800 psi
- bending to 2 degrees per 100 feet

Limit Load

The load to failure test included:

1. applied tension to 2,500 kips
2. internal liquid pressure to failure

Testing was stopped after yielding occurred in the pipe body - the connection never leaked. The maximum pressure exceeded 12,000 psi which is far greater than actual pipe body capacity.

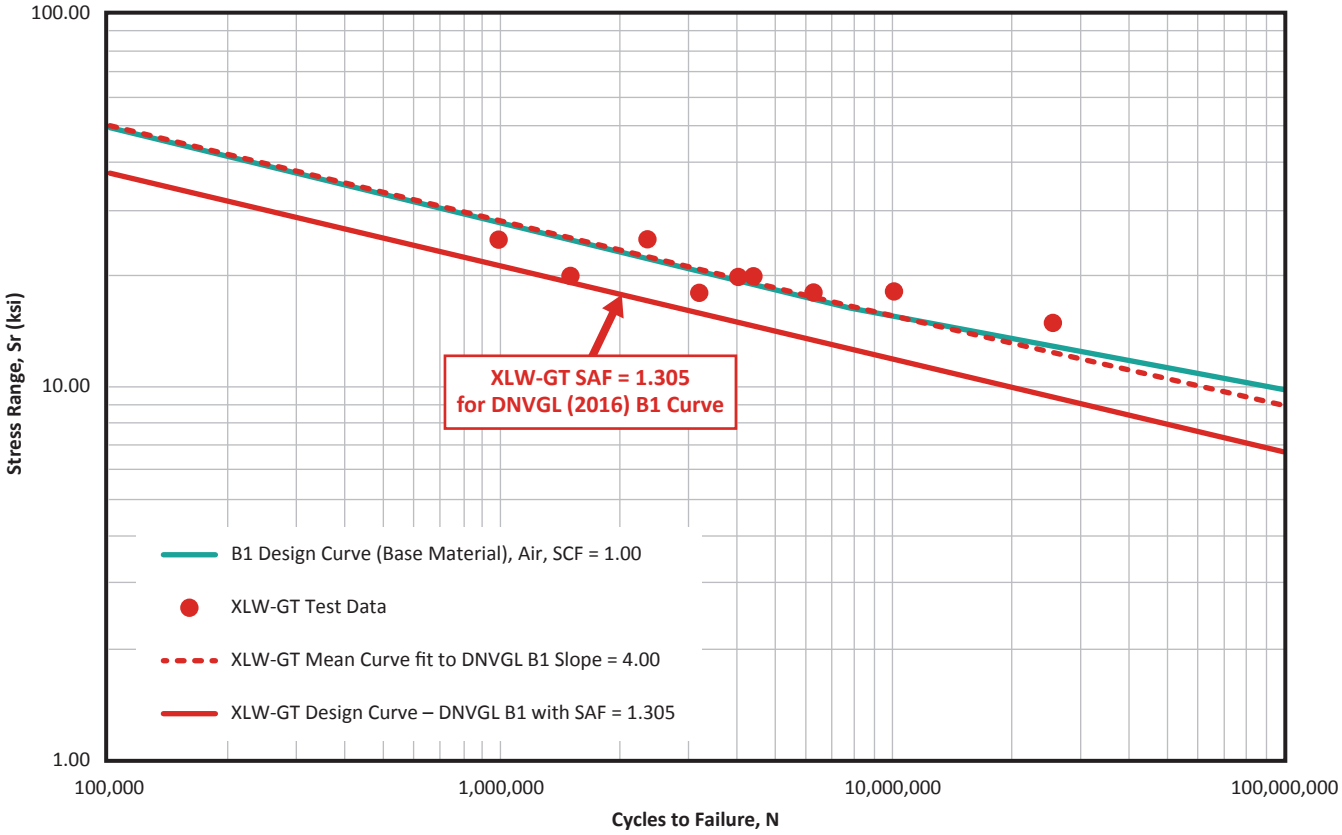


Harmonic Fatigue Testing

For offshore surface casing strings, fatigue resistance in the uppermost connections located closest to the high pressure wellhead can be critical in order to maintain the expected casing performance througout the life of the well. XL Systems completed a thorough harmonic fatigue test program on 22 x 1.00 X80 M95 XLW-GT to characterize the performance of the connection and weld to help operators better manage risks associated with cyclic loading of the conductor and surface casing strings.

A total of nine connection samples were tested at four different stress ranges. For each test sample, XLW-GT pin and box connectors were welded to API 5L Grade X80 line pipe using XL Systems standard welding, grinding, and inspection procedures for high fatigue applications. Samples were harmonic fatigue tested to failure - testing was stopped when a through-wall crack was detected in either the connection, the pipe, or the pipe-to-connector weld. Of the nine failures, seven occurred in the pin connector, one in the pipe-to-connector weld, and one in the pipe long seam weld.

Test data was plotted and measured against the DNVGL-RP-C203 (2016) 'B1' design curve. The low variability in the test data demonstrates predictable fatigue performance in the XLW-GT connector design. An SCF of 1.305 is very competitive for a threaded connector and weld package, especially for large diameter sizes.



Fatigue Test Data

T2 x 1.00 X80 M95 XLW-GT connector fatigue testing compared to DNVGL -RP-C203 (2016) 'B1' design curve.