



SEAL-LOCK XD TUBING
4.500 OD 15.10 lb/ft P110 CAL IV
Extrapolation
Connection Brief
Industry Standard Connection Qualification
Testing and Evaluation
API RP 5C5:2017 4th ed.

Hunting Energy Services
Connection Technology Division
www.hunting-intl.com

June 2019



SEAL-LOCK XD is a threaded and coupled premium connection designed to provide internal and external pressure integrity under extreme loads. SLXD utilizes a negative load-flank thread form, advanced connection geometry, and a metal-to-metal seal to provide performance ratings that equal or exceed pipe body ratings in tension, compression, internal and external pressure. SLXD is designed and tested for HPHT wells and critical service applications.

Experimental testing and analytical evaluation of these loads are essential to validating a connection performance envelope. Hunting Energy Service Connection Technology Division has standardized on API RP 5C5 Fourth Edition, January 2017 for the experimental testing and validation of tubing connection performance.

As experimental testing in accordance with API RP 5C5 is costly and time consuming, product line validation and extrapolation/interpolation of connection designs fully tested have significant benefits. API recognizes that full-scale physical testing on every diameter, mass, and grade within a product line is not practical and not necessary to define connection performance. Hunting Energy Service Connection Technology Division has established guidelines for product line validation through the interpolation and extrapolation of completed full scale physical connection testing compliant with API RP 5C5 Annex F. Refer to the HES “Premium Connection Product Line Validation and Extrapolation Connection Brief” for an example of these guidelines.

The foundation for the SEAL-LOCK XD tubing product line validation is centered on the full scale API RP 5C5 4ed: 2017 CAL IV Qualification testing of 4.500 15.10 lb/ft on API P110 material. The 4.500 SLXD connections are fully interchangeable from 18.8 lb/ft (.430” wt) down through 13.50 lb/ft (.290” wt). The 4.500 SLX connections are also interchangeable between the 12.60 lb/ft (0.271” wt) and 11.60 lb/ft (0.250” wt). The critical dimensions including thread geometry, seal geometry, and connection interferences are identical. Other critical dimension such as the pipe body to shoulder area ratio are parametrically scaled to the wall thickness. The 4.000 SLXD connections are also fully interchangeable from the 16.10 lb/ft (.415” wt) down through the 9.50 lb/ft (.226” wt). As the SLXD product line incorporates a parametric design methodology, the 4.000 and 4.500 connections share many features that are identical while the remaining are parametrically scaled to the wall thickness or diameter of the tube. Refer to Table 1 for the product design criteria elements and the comparison to the 4.500 15.10 lb/ft connection. The significant amount of geometric similarities makes these connections ideal for extrapolating the CAL IV validation testing results.

To extrapolate these testing results, Finite Element Analysis (FEA) was completed on the 4.500 15.10 and 11.60 lb/ft as well as the 4.000 13.20 and 9.50 lb/ft sizes to confirm the consistency of the galling tendency, sealing performance and structural integrity. Key parameters such as the actual material strengths, material properties, and friction factors from the 4.500 15.10 lb/ft CAL IV validation were incorporated into the FEA to bound the analysis. Structural integrity of the connections can be displayed from the VME stress plots of the connections. Galling tendency of the seal can be described by the maximum seal contact stress at the fully made up position. Seal performance can be evaluated by the seal energy and the maximum contact stress. The seal energy and contact stress were normalized by the applied pressure for comparison of the different weights, sizes and applied loads. Refer to Figure 1 and Tables 2, 3, and 4 for the VME Stress Plots, the contact stress at MU, the normalized seal energy, and the normalized seal contact stress.

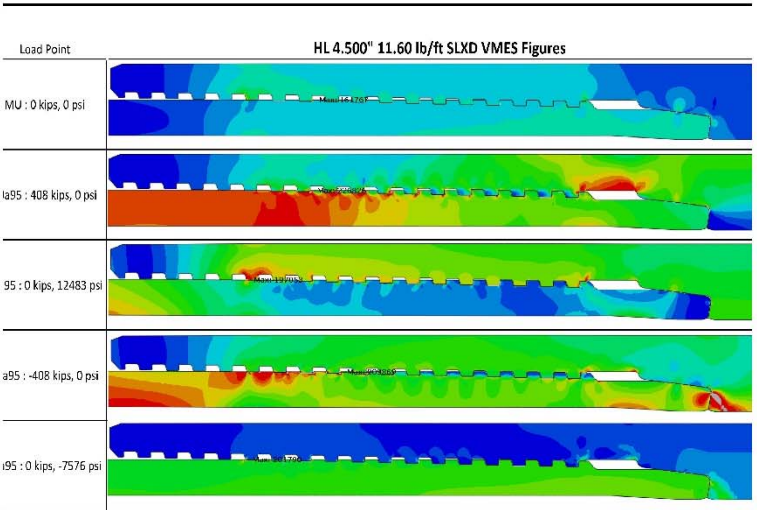
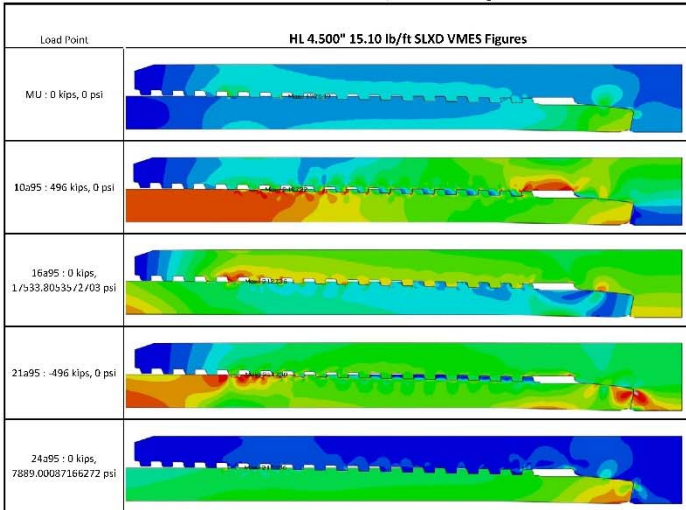
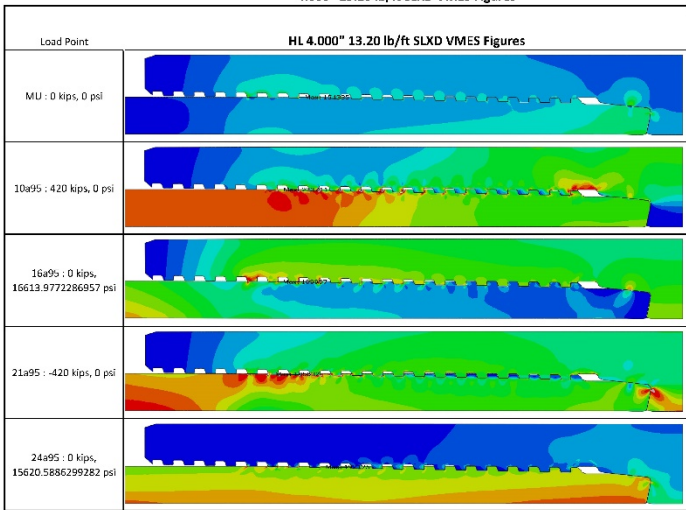
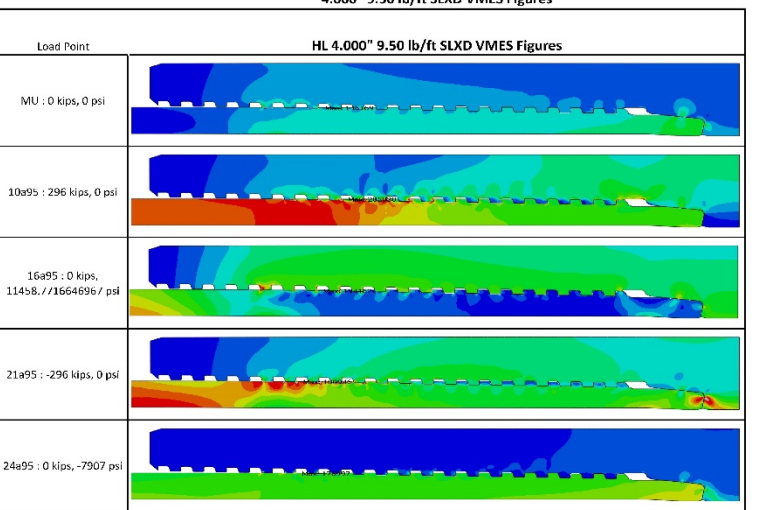
Concluding the FEA, the products show remarkable consistency. The VME Stress plots exhibit similar stress concentrations with only the integral shoulder as the highly stressed feature. The low maximum contact stress at the made up position for all of the connections show the risk for galling tendency is the same or less than the validation testing. The normalized seal energy and contact stress plots show the seal performance is equivalent



or greater than the validated product. FEA confirms the extrapolation of the 4.500 15.10 lb/ft API RP 5C5 4ed: 2017 CAL IV Qualification testing can be extended through the 4.500 11.60 lb/ft as well as the 4.000 13.20 lb/ft through the 9.50 lb/ft SLXD connections.

A.1.1 Connection Identification		Seal Lock XD						
Product Description		Size, Weight	Wall Thickness	Size, Weight	Wall Thickness	Size, Weight	Wall Thickness	
Threaded & Coupled Premium Connection		4.000 9.50- 13.20	0.226- .330	4.500 13.50- 15.10	0.290- .375	4.500 11.60- 12.60	0.290- .375	
Connection Assessment Level		API RP 5C5:2017 CAL IV						
A.1.2 Connection Geometry		Coupled Connection						
A.1.5 Connection Manufacturing Specifications		SEAL-LOCK XD SPECIFICATION MANUAL REV 005						
Process Control Plan No.		HCTD-QPP-RND-002						
Pin Drawing No.		M09737 REV NR		M09473 REV C		M09737 REV NR		
Box Drawing No.		M09738 REV NR		M09474 REV B		M09738 REV NR		
Pin Thread Drawing No.		M08097-0008		M08097-0001		M08097-0001		
Box Thread Drawing No.		M08098-0008		M08098-0001		M08098-0001		
Pin Surface Treatment Specification No.		As Machined						
Box Surface Treatment Specification No.		PHOSPHATE COATING/PHOS REV 007						
Gauge Calibration Procedure No.		Seal Lock XD Gaging Procedures: Thread Element Gage Calibration R0						
Gauging and Inspection Procedure No.		SEAL-LOCK XD PIN/BOX Inspection Procedure REV 000						
Seal Ring Inspection Procedure No.		N/A						
Swage/Stress-relief Procedure No.		FORMED REV 000 and Stress Relieve REV 004						
First/Last Article Procedure No.		SLXD PIN INSP REV 000/SLXD BOX INSP REV 000						
A.1.6 Connection Field/Mill Assembly and Field Repair Procedures								
Coupling/Accessory Makeup Procedure No.		SLXD Field Running and Handling Procedure REV 000						
Connection Field Running Procedure No.		SLXD Field Running and Handling Procedure REV 000						
Connection Field Repair Procedure No.		SLXD Visual Thread Inspection Procedure REV 000						
Thread Compound		BOL 72733 & Banner Moli-G Lube						
Product Design Criteria Elements	4.000 9.50 SLXD		4.000 13.20 SLXD		4.500 11.60 SLXD		4.500 15.10 SLXD	
Threaded and Coupled Premium Connection	Size, Weight	Wall	Size, Weight	Wall	Size, Weight	Wall	Size, Weight	Wall
	4.000 9.50	0.226	4.000 13.20	0.330	4.500 11.60	0.250	4.500 15.10	0.337
Lead	N/C		N/C		N/C		N/C	
Taper	N/C		N/C		N/C		N/C	
Thread Height	N/C		N/C		N/C		N/C	
Thread Form	N/C		N/C		N/C		N/C	
Torque Shoulder Angle / Shoulder to Pipe Body Ratio	N/C / 56.8%		N/C / 67%		N/C / 58.8%		N/C / 62.2%	
Seal Taper	N/C		N/C		N/C		N/C	
Seal Lengths	N/C		N/C		N/C		N/C	
Pin Nose Length	N/C		N/C		N/C		N/C	
Distance Between Face of Pin Nose to Thread Start	N/C		N/C		N/C		N/C	
Thread Interference	N/C		N/C		N/C		N/C	
Primary Seal Interference	N/C		N/C		N/C		N/C	
Pin Seal Area to Pipe Body Area Ratio	69.71%		75.27%		75.64%		74.60%	
Coupling OD / SC OD	4.750 / 4.149		4.750 / 4.579		5.000 / 4.963		5.145 / 5.081	
Critical Cross Section Area Box to Pipe Body Area Ratio	194%		137%		113%		115%	
Distance from Pin Nose to Centerline of Seal.	N/C		N/C		N/C		N/C	

Table 1: Product Design Criteria Elements

4.500" 15.10 lb/ft SLXD VMES Figures

4.000" 13.20 lb/ft SLXD VMES Figures

4.000" 9.50 lb/ft SLXD VMES Figures

Figure 1: FEA VME Stress Plots

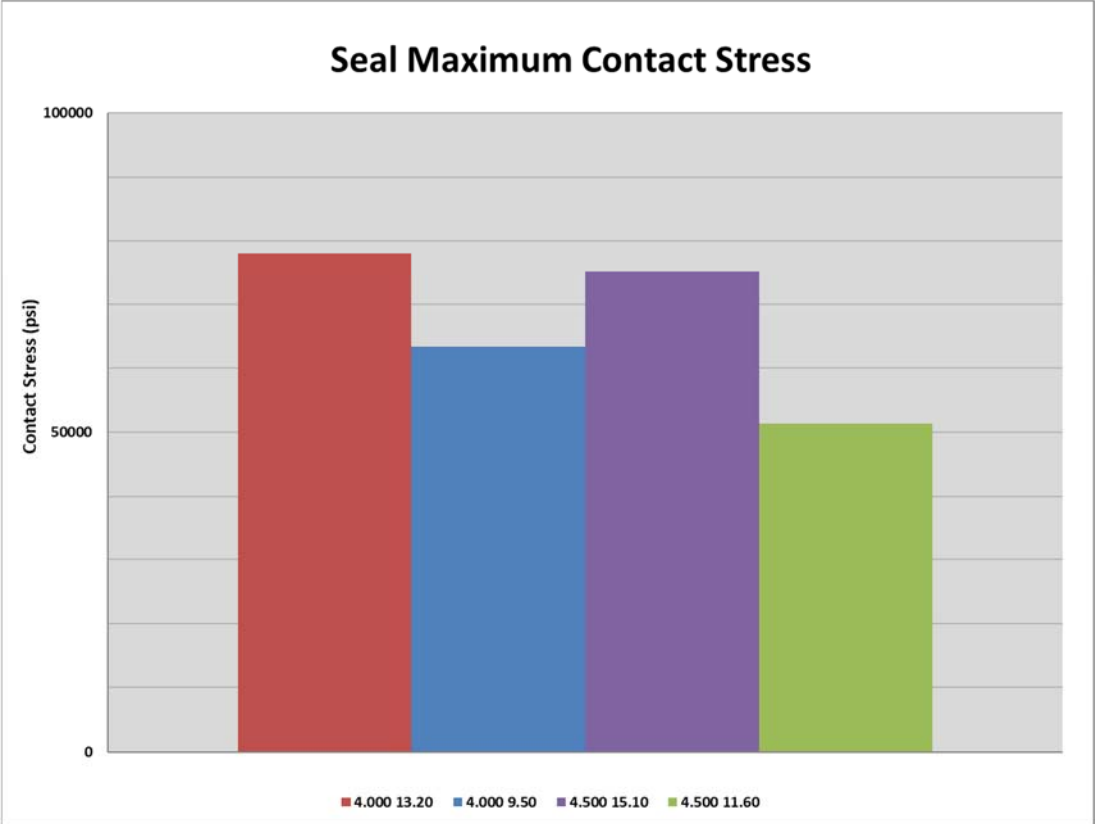


Table 2: MU Contact Stress

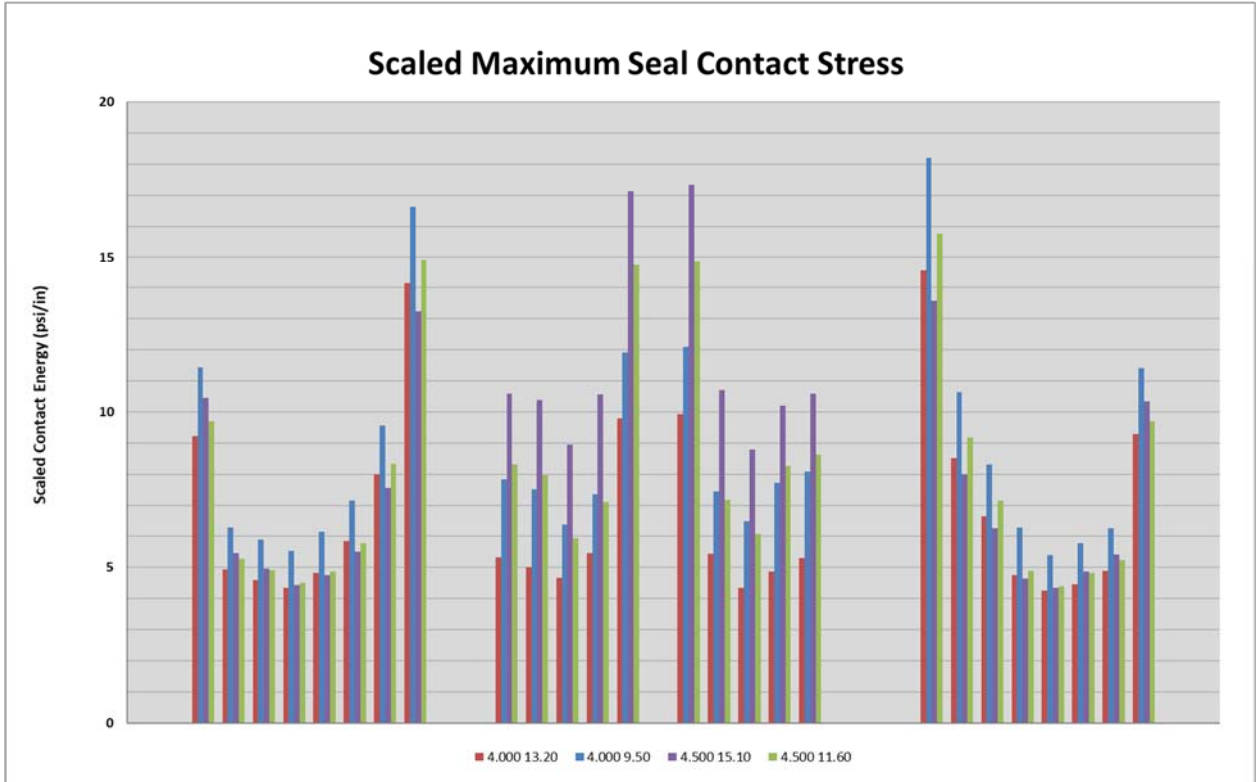


Table 3: Normalized Seal Contact Energy

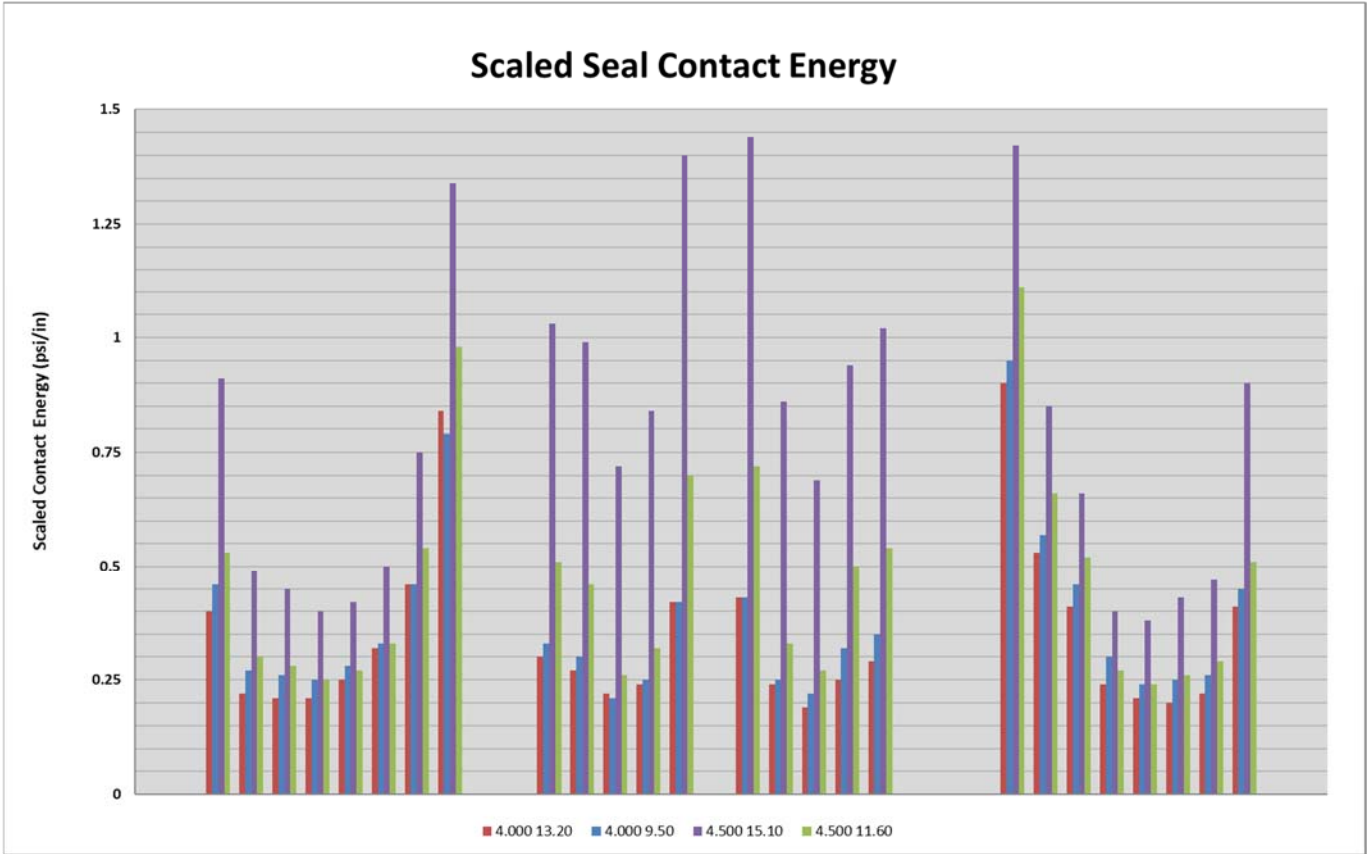


Table 4: Normalized Seal Contact Stress