



FOXTM
Premium Threaded Connections



FOX™ is an advanced premium threaded connection which has been jointly developed by JFE STEEL CORPORATION and HUNTING OILFIELD SERVICES. JFE STEEL CORPORATION has over seventy years experience in steel production, and provides proprietary JFE-series OCTG for sour service, low temperature service and hi-collapse service, in addition to API grades. HUNTING OILFIELD SERVICES has over twenty-five years experience in the design, manufacture and technical field service of connections for OCTG. Together, we have designed a connection which uses innovative design concepts to overcome problems found in conventional premium connections. Advanced thread geometry, a unique seal design and innovative gauging techniques combine to reduce thread galling and enhance sealing performance. **FOX™** has been field-proven around the world.



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INTRODUCTION

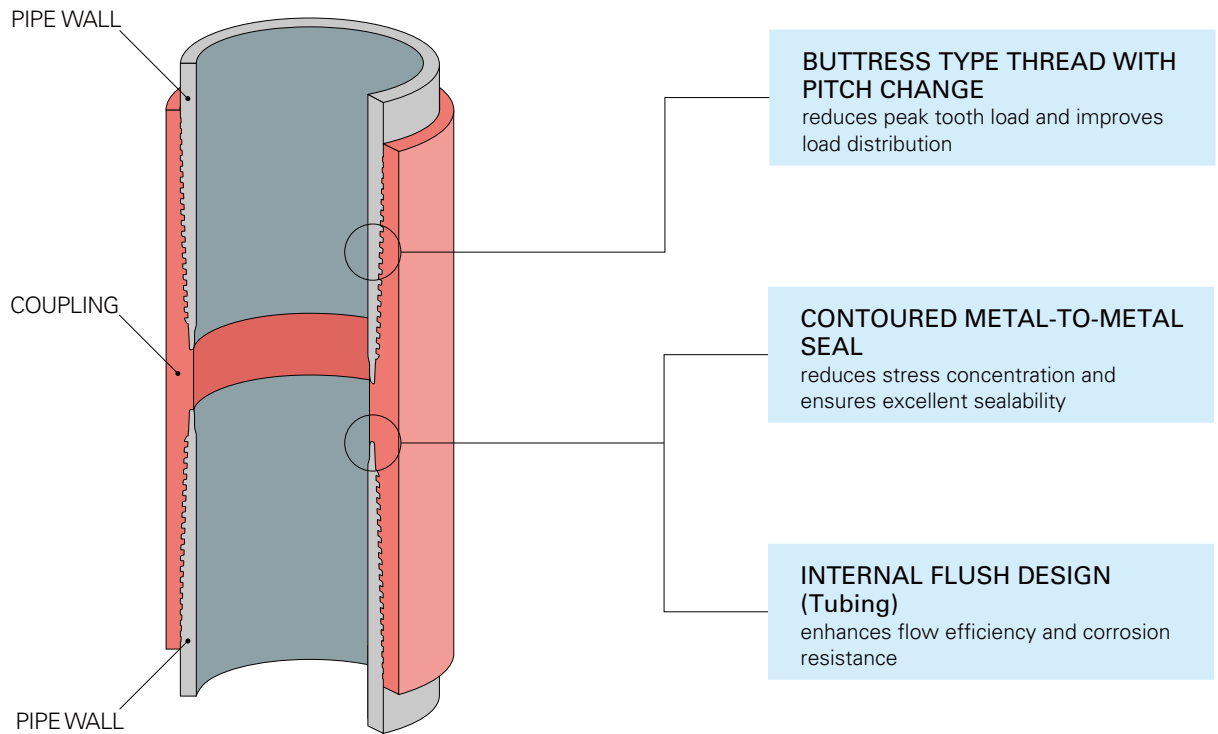
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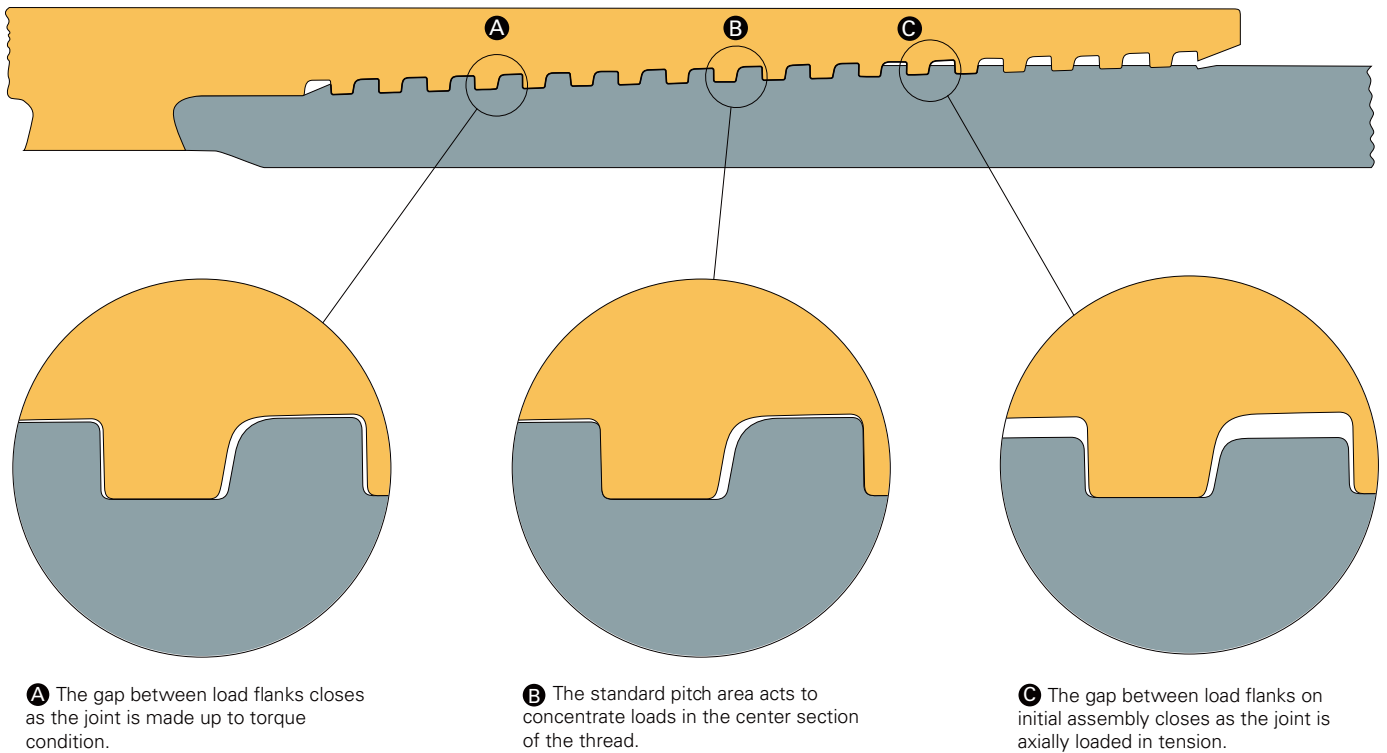
COVER: Graphic shows distribution of equivalent plastic strain around seal when made up with finite element analysis.

1. FOX™ CONNECTION: DESIGN FEATURES



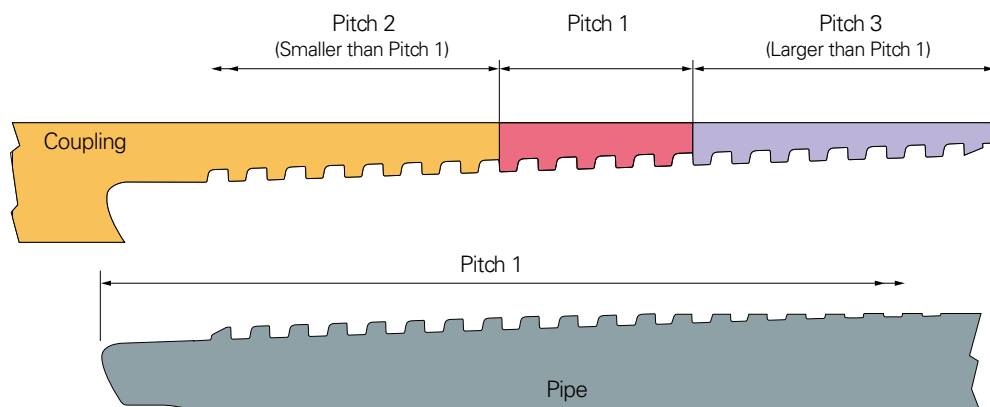
DESIGN FEATURE	EFFECT	IMPROVEMENT
THREAD PITCH CHANGE	<ol style="list-style-type: none"> 1. Reduction of maximum tooth load 2. More even tooth load distribution 	<ol style="list-style-type: none"> a. High resistance to thread galling b. Good control of make-up c. High resistance to back off d. High resistance to coupling bellling and unzipping e. increased fatigue life
METAL-TO-METAL TRIPLE RADIUS SEAL	<ol style="list-style-type: none"> 1. Localized high sealing pressure 2. Reduced stress concentration 	<ol style="list-style-type: none"> a. Ensure excellent sealability b. Reduce shoulder damage c. High resistance to over-torquing d. High resistance to seal galling
INTERNAL FLUSH	<ol style="list-style-type: none"> 1. Reduction of turbulence 	<ol style="list-style-type: none"> a. Enhanced resistance to corrosion b. High flow efficiency

2. THE FOX™ PITCH CHANGE CONCEPT

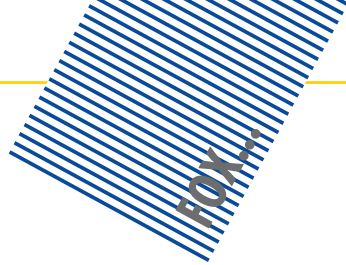


DOUBLE PITCH CHANGE

The pin member retains a standard pitch over its entire length. The box member features three sections, each having a different pitch: increased pitch (in relation to the pin) in the outer part of the box, standard pitch in the center section, and reduced pitch in the inner section. This produces gaps at the load-bearing flanks of the threads in the inner and outer regions of the thread prior to make-up and running.



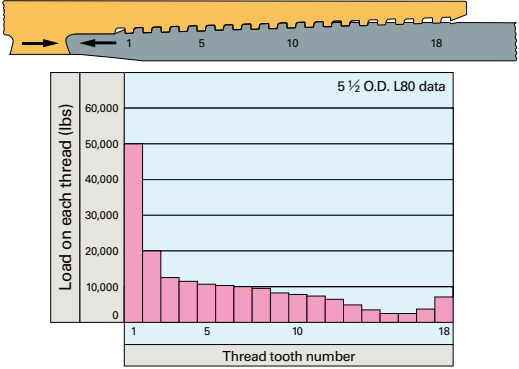
The gaps between the load-bearing flanks of the threads are closed by make-up torque and by the axial load imposed by pipe weight. Threads are preferentially loaded in the center of the connection, with reduced loads in the inner and outer sections. The risk of thread galling is reduced by the lower level of radial thread interference in the FOX™ connection in comparison to other designs.



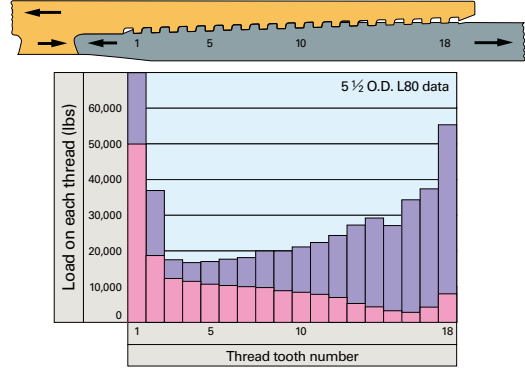
3. SUPERIOR LOAD DISTRIBUTION

TYPICAL PREMIUM CONNECTION

•Make-up only

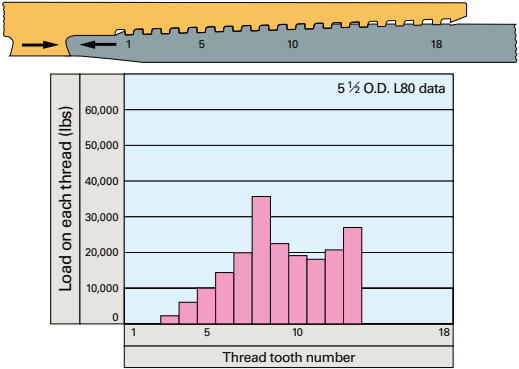


•Make-up plus axial tension

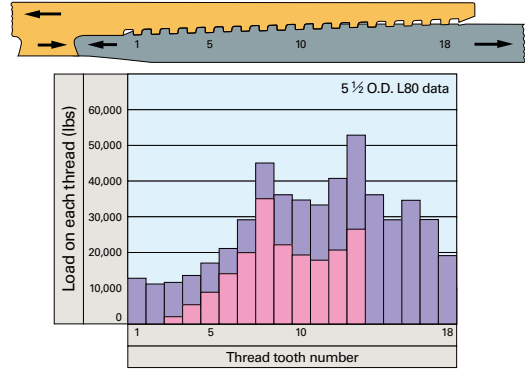


FOX™ PREMIUM CONNECTION

•Make-up only



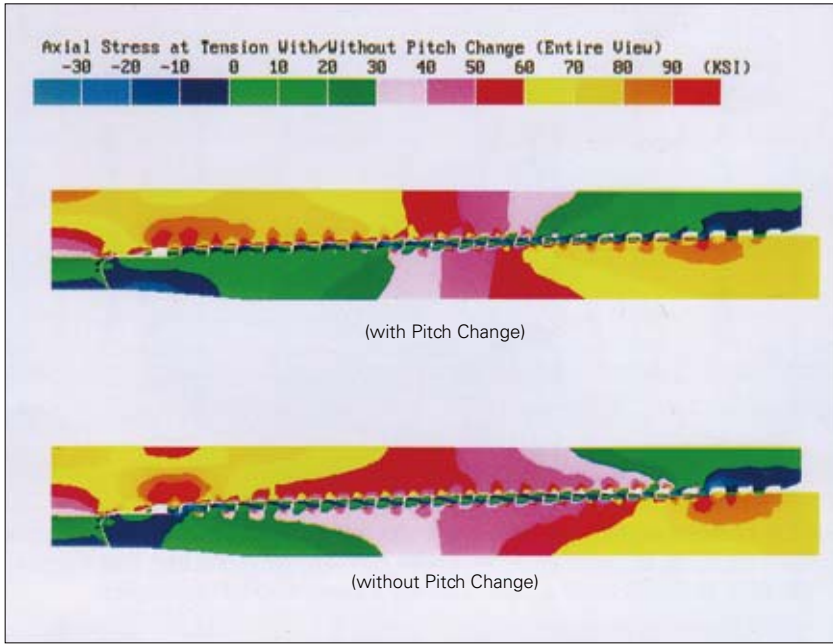
•Make-up plus axial tension



4. F.E.A. MODELS

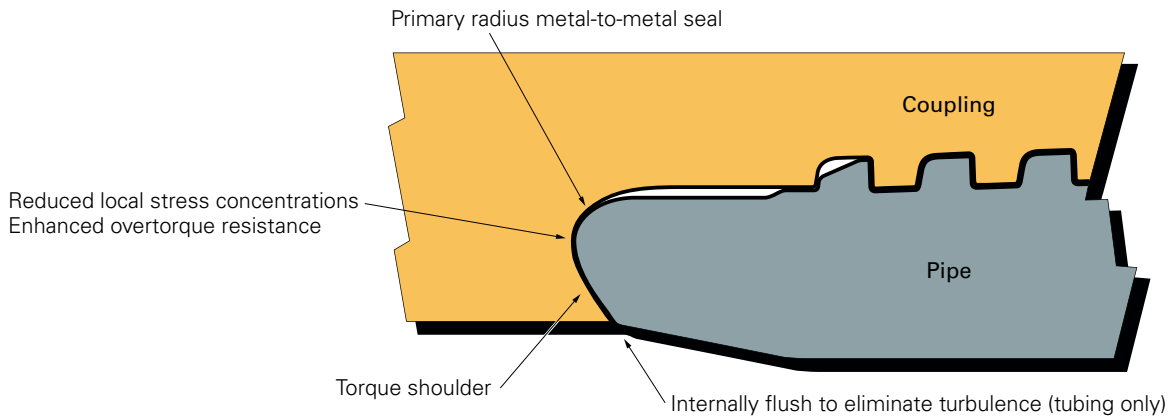
Two FEA graphics show the difference in axial stress distribution with and without pitch change.

The pitch change concept, which is one of the main features of the FOX™ design, works to give more even load distribution on each thread.



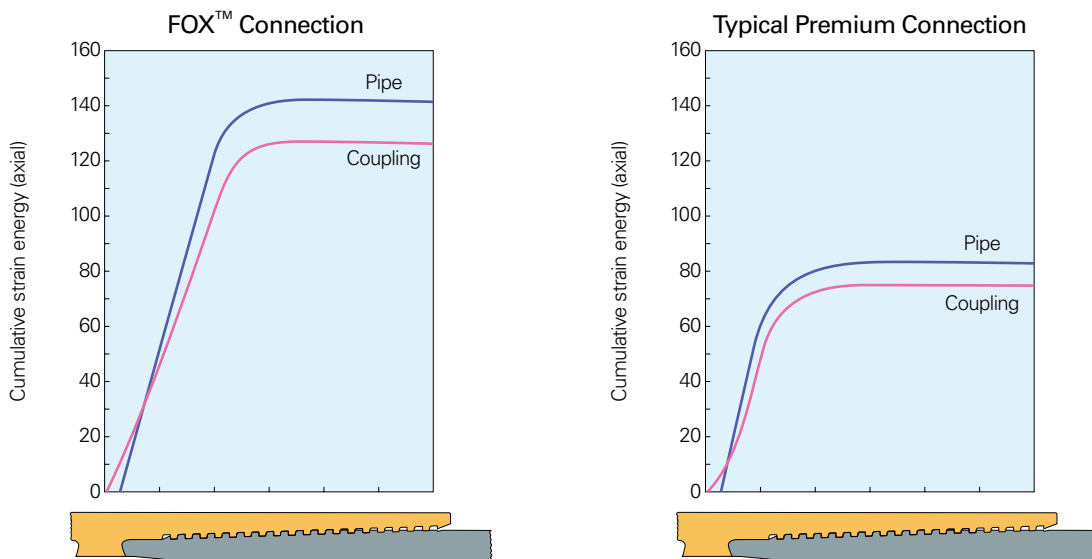
5. THE TRIPLE RADIUS SEAL CONCEPT

The triple radius seal used in the 'FOX™' connection comprises a pin seal feature having a profile of three interacting radii engaging with a corresponding sealing surface profile in the coupling. Because of the generous blending radius which this design allows, there is a reduced local stress concentration giving better resistance to over torquing and fatigue.



The smooth, continuous profile of the FOX™ triple-radius seal improves sealing performance, reduces stress concentrations and provides for increased overtorque resistance. A more gradual lead-in during make-up is achieved compared with the conventional double taper design, and the principle of tri-axial compression is included. Sealing is achieved as a result of combined radial and axial compression of the pin end. The smooth interior pin to coupling profile produces internally flush bores for tubing applications, maximizing bore diameter and reducing turbulence.

COMPARISON OF SEAL STORED ENERGY



Plots of strain energy induced in the pin and coupling for both a conventional and the FOX™ connections were obtained from the finite element analysis. These confirm the prediction that the strain energy stored across the metal-to-metal seal for the FOX™ is significantly greater than for a conventional connection.

6. GAUGING TECHNIQUES

Electronic Gauging

As part of the FOX™ development program, the FOX™ development team addressed problems of conventional thread gauging, and devised a new electronic gauging technique. The gauge measures stand-off, taper, seal diameter and lead of pin and box thread at a resolution of one micron. The measurements are analysed by a data processing unit, which is able to mathematically compensate for pipe ovality on the basis of measurement data. The electronic gauging process reduces the wear problem associated with hard gauging, and enables an individual data record to be retained for every FOX™ connection.



Pin Taper Seal Gauge

Data Processing Unit



Mechanical Gauging

Conventional taper, lead and thread height gauges may also be used in gauging of FOX™ connections, in such forms as go/no-go gauges.

MRP Gauge



To measure thread diameter.

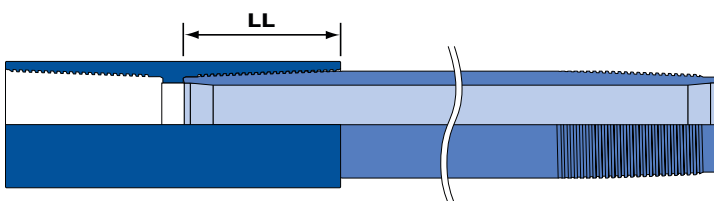
Thread Form Gauge



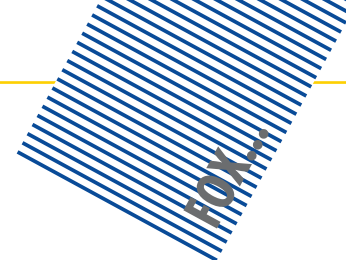
Go/No-Go Gauge to inspect thread form.

7. AVAILABLE SIZES

Outside Diameter	Nominal Weight	Wall Thickness		Nominal Inside Diameter	TPI	Drift Diameter (API)	Coupling Outside Diameter								Coupling Length	Make up Loss Length LL	
							FOX Regular Coupling		100% Efficiency		Special Clearance Coupling		Tensile Efficiency				
							Outside Diameter	Tensile Efficiency %	Outside Diameter	Tensile Efficiency %	Outside Diameter	Tensile Efficiency %	Outside Diameter	Tensile Efficiency %			
D		t	d			in.	mm	%	in.	mm	in.	mm	%	in.	in.		
2 3/8	60.32	4.60	0.190	4.83	1.995	8	1.901				2.723	69.16				5.125	2.313
		5.80	0.254	6.45	1.867	8	1.773				2.782	70.66				5.125	2.313
2 7/8	73.02	6.40	0.217	5.51	2.441	8	2.347				3.297	83.74				5.875	2.688
		7.80	0.276	7.01	2.323	8	2.229				3.297	83.74				5.875	2.688
		8.60	0.308	7.82	2.259	8	2.165				3.412	86.66				5.875	2.688
3 1/2	88.90	7.70	0.216	5.49	3.068	6	2.943				3.878	98.50				6.790	3.145
		9.20	0.254	6.45	2.992	6	2.867				3.878	98.50				6.790	3.145
		10.20	0.289	7.34	2.922	6	2.797				4.053	102.95				6.790	3.145
		12.70	0.375	9.52	2.750	6	2.625				4.053	102.95				6.790	3.145
		15.50	0.476	12.09	2.548	6	2.423				4.150	105.41				6.790	3.145
4	101.60	9.50	0.226	5.74	3.548	6	3.423				4.378	111.20				7.456	3.478
		10.70	0.262	6.65	3.476	6	3.351				4.378	111.20				7.456	3.478
		13.20	0.330	8.38	3.340	6	3.215				4.556	115.72				7.456	3.478
4 1/2	114.30	10.50	0.224	5.69	4.052	5	3.927	5.000	127.00	145	4.824	122.53	4.882	124.00	114	9.469	4.440
		11.60	0.250	6.35	4.000	5	3.875	5.000	127.00	131	4.867	123.62	4.882	124.00	103	9.469	4.440
		12.60	0.271	6.88	3.958	5	3.833	5.000	127.00	121	4.901	124.49	4.882	124.00	96	9.469	4.440
		13.50	0.290	7.37	3.920	5	3.795	5.000	127.00	114	4.932	125.27	4.882	124.00	90	9.469	4.440
		15.10/15.20	0.337	8.56	3.826	5	3.701	5.000	127.00	99	5.005	127.13	4.882	124.00	78	9.469	4.440
		18.90	0.430	10.92	3.640	5	3.515	5.000	127.00	79	5.142	130.61	4.882	124.00	62	9.469	4.440
		21.50	0.500	12.70	3.500	5	3.375	5.000	127.00	69	5.238	133.05	4.882	124.00	55	9.469	4.440
		23.70	0.560	14.22	3.380	5	3.255	5.000	127.00	63	5.316	135.03	4.882	124.00	49	9.469	4.440
		5	127.00	13.00	0.253	6.43	4.494	5	4.369	5.563	141.30	145	5.364	136.25	5.391	136.93	106
15.00	0.296			7.52	4.408	5	4.283	5.563	141.30	125	5.435	138.05	5.391	136.93	91	9.869	4.640
18.00	0.362			9.19	4.276	5	4.151	5.563	141.30	104	5.540	140.72	5.391	136.93	75	9.869	4.640
21.40	0.437			11.10	4.126	5	4.001	5.563	141.30	87	5.652	143.56	5.391	136.93	63	9.869	4.640
23.20	0.478			12.14	4.044	5	3.919	5.563	141.30	80	5.711	145.06	5.391	136.93	59	9.869	4.640
24.10	0.500			12.70	4.000	5	3.875	5.563	141.30	77	5.742	145.85	5.391	136.93	56	9.869	4.640
27.00	0.560			14.22	3.800	5	3.700	5.563	141.30	69	5.830	148.85	5.391	136.93	49	9.869	4.640
5 1/2	139.70	15.50	0.275	6.98	4.950	5	4.825	6.050	153.67	130	5.905	149.99	5.891	149.63	97	9.869	4.640
		17.00	0.304	7.72	4.892	5	4.767	6.050	153.67	118	5.953	151.21	5.891	149.63	88	9.869	4.640
		20.00	0.361	9.17	4.778	5	4.653	6.050	153.67	101	6.045	153.54	5.891	149.63	75	9.869	4.640
		23.00	0.415	10.54	4.670	5	4.545	6.050	153.67	88	6.128	155.65	5.891	149.63	66	9.869	4.640
		26.80	0.500	12.70	4.500	5	4.375	6.050	153.67	74	6.254	158.85	5.891	149.63	55	9.869	4.640
6 5/8	168.28	20.00	0.288	7.32	6.049	5	5.924	7.390	187.71	167	7.048	179.02	7.000	177.80	91	10.269	4.840
		24.00	0.352	8.94	5.921	5	5.796	7.390	187.71	138	7.155	181.74	7.000	177.80	75	10.269	4.840
		28.00	0.417	10.59	5.791	5	5.666	7.390	187.71	118	7.261	184.43	7.000	177.80	64	10.269	4.840
		32.00	0.475	12.06	5.675	5	5.550	7.390	187.71	104	7.352	186.74	7.000	177.80	56	10.269	4.840



The Make up loss for FOX™ is shown in the size table.



Outside Diameter		Nominal Weight	Wall Thickness		Nominal Inside Diameter	TPI	Drift Diameter (API)	Coupling Outside Diameter						Coupling Length	Make up Loss Length LL		
			t					FOX Regular Coupling		100% Efficiency		Special Clearance Coupling					
D		lb/ft	in.	mm	d		in.	in.	mm	Tensile Efficiency %	in.	mm	in.	mm	Tensile Efficiency %	in.	in.
7	177.80	20.00	0.272	6.91	6.456	5	6.331	7.656	194.46	155	7.384	187.55	7.380	187.45	99	10.669	5.040
		23.00	0.317	8.05	6.366	5	6.241	7.656	194.46	134	7.462	189.53	7.380	187.45	85	10.669	5.040
		26.00	0.362	9.19	6.276	5	6.151	7.656	194.46	118	7.538	191.47	7.380	187.45	75	10.669	5.040
		29.00	0.408	10.36	6.184	5	6.059	7.656	194.46	106	7.614	193.40	7.380	187.45	67	10.669	5.040
		32.00	0.453	11.51	6.094	5	5.969	7.656	194.46	96	7.686	195.22	7.380	187.45	61	10.669	5.040
		35.00	0.498	12.65	6.004	5	5.879	7.656	194.46	88	7.756	197.00	7.380	187.45	56	10.669	5.040
		38.00	0.540	13.72	5.920	5	5.795	7.656	194.46	81	7.821	198.65	7.380	187.45	52	10.669	5.040
7 5/8	193.68	26.40	0.328	8.33	6.969	5	6.844	8.500	215.90	169	8.098	205.69	8.000	203.20	83	11.069	5.240
		29.70	0.375	9.52	6.875	5	6.750	8.500	215.90	149	8.178	207.72	8.000	203.20	73	11.069	5.240
		33.70	0.430	10.92	6.765	5	6.640	8.500	215.90	131	8.270	210.06	8.000	203.20	64	11.069	5.240
		39.00	0.500	12.70	6.625	5	6.500	8.500	215.90	114	8.382	212.90	8.000	203.20	56	11.069	5.240
		42.80	0.562	14.27	6.501	5	6.376	8.500	215.90	102	8.479	215.37	8.000	203.20	50	11.069	5.240
8 5/8	219.08	45.30	0.595	15.11	6.435	5	6.310	8.500	215.90	97	8.529	216.64	8.000	203.20	47	11.069	5.240
		32.00	0.352	8.94	7.921	5	7.796	9.625	244.48	177	9.145	232.28	9.120	231.65	96	11.069	5.240
		36.00	0.400	10.16	7.825	5	7.700	9.625	244.48	157	9.227	234.37	9.120	231.65	85	11.069	5.240
		40.00	0.450	11.43	7.725	5	7.600	9.625	244.48	140	9.311	236.50	9.120	231.65	76	11.069	5.240
		44.00	0.500	12.70	7.625	5	7.500	9.625	244.48	127	9.393	238.58	9.120	231.65	69	11.069	5.240
9 5/8	244.48	49.00	0.557	14.15	7.511	5	7.386	9.625	244.48	115	9.484	240.89	9.120	231.65	62	11.069	5.240
		36.00	0.352	8.94	8.921	5	8.765	10.625	269.88	175	10.149	257.78	10.100	256.54	92	11.069	5.240
		40.00	0.395	10.03	8.835	5	8.679	10.625	269.88	157	10.244	260.20	10.100	256.54	82	11.069	5.240
		43.50	0.435	11.05	8.755	5	8.599	10.625	269.88	143	10.293	261.44	10.100	256.54	75	11.069	5.240
		47.00	0.472	11.99	8.681	5	8.525	10.625	269.88	132	10.355	263.02	10.100	256.54	69	11.069	5.240
10 3/4	273.05	53.50	0.545	13.84	8.535	5	8.379	10.625	269.88	116	10.476	266.09	10.100	256.54	61	11.069	5.240
		58.40	0.595	15.11	8.435	5	8.279	10.625	269.88	106	10.556	268.12	10.100	256.54	56	11.069	5.240
		40.50	0.350	8.89	10.050	5	9.894	11.750	298.45	175	11.274	286.36	11.266	286.16	98	11.069	5.240
		45.50	0.400	10.16	9.950	5	9.794	11.750	298.45	154	11.363	288.62	11.266	286.16	86	11.069	5.240
		51.00	0.450	11.43	9.850	5	9.694	11.750	298.45	137	11.449	290.80	11.266	286.16	77	11.069	5.240
		55.50	0.495	12.57	9.760	5	9.604	11.750	298.45	125	11.526	292.76	11.266	286.16	70	11.069	5.240
11 3/4	298.45	60.70	0.545	13.84	9.660	5	9.504	11.750	298.45	114	11.610	294.89	11.266	286.16	64	11.069	5.240
		65.70	0.595	15.11	9.560	5	9.404	11.750	298.45	105	11.693	297.00	11.266	286.16	59	11.069	5.240
		73.20	0.672	17.07	9.406	5	9.250	11.750	298.45	94	11.817	300.15	11.266	286.16	53	11.069	5.240
		47.00	0.375	9.52	11.000	5	10.844	12.750	323.85	162	12.322	312.98	12.268	311.61	92	11.069	5.240
		54.00	0.435	11.05	10.880	5	10.724	12.750	323.85	141	12.428	315.67	12.268	311.61	79	11.069	5.240
		60.00	0.489	12.42	10.772	5	10.616	12.750	323.85	126	12.522	318.06	12.268	311.61	71	11.069	5.240
11 3/4	298.45	65.00	0.534	13.56	10.682	5	10.526	12.750	323.85	116	12.599	320.01	12.268	311.61	65	11.069	5.240
		54.50	0.380	9.65	12.615	5	12.459	14.375	365.12	159	13.960	354.58	—	—	—	11.069	5.240
		61.00	0.430	10.92	12.515	5	12.359	14.375	365.12	141	14.050	356.87	—	—	—	11.069	5.240
		68.00	0.480	12.19	12.415	5	12.259	14.375	365.12	127	14.138	359.10	—	—	—	11.069	5.240
		72.00	0.514	13.06	12.347	5	12.191	14.375	365.12	119	14.198	360.63	—	—	—	11.069	5.240

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