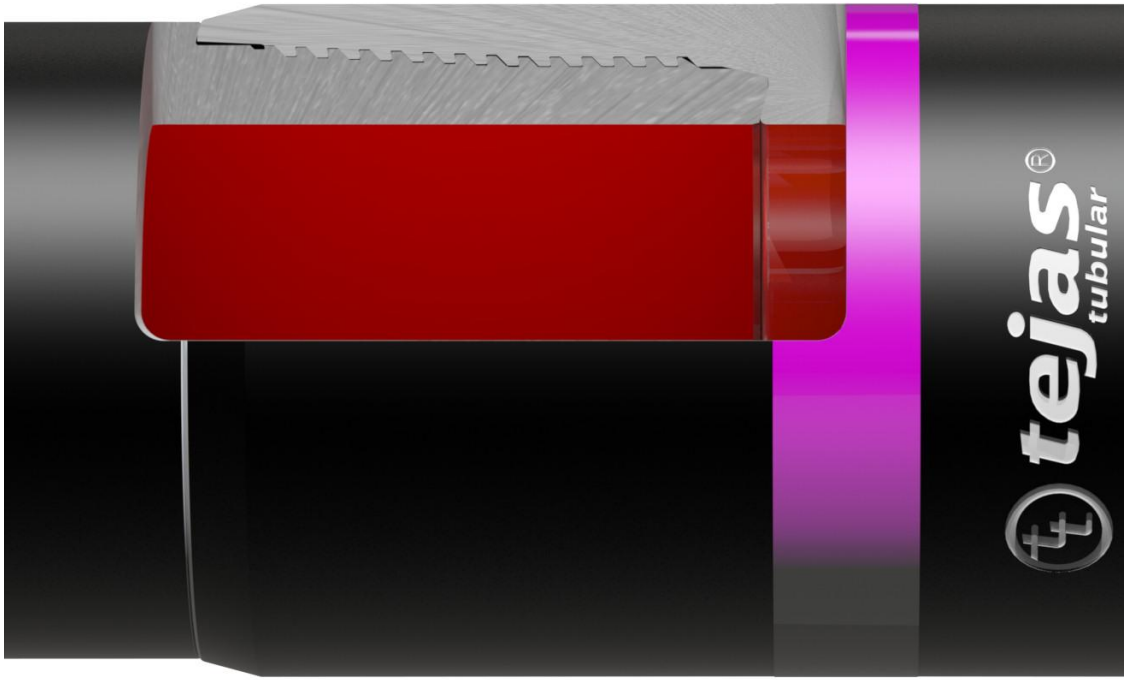
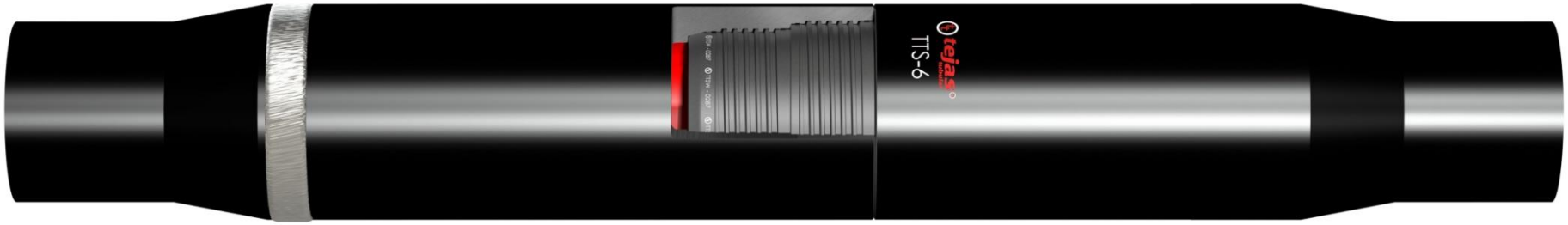
TEJAS WorkString Connections



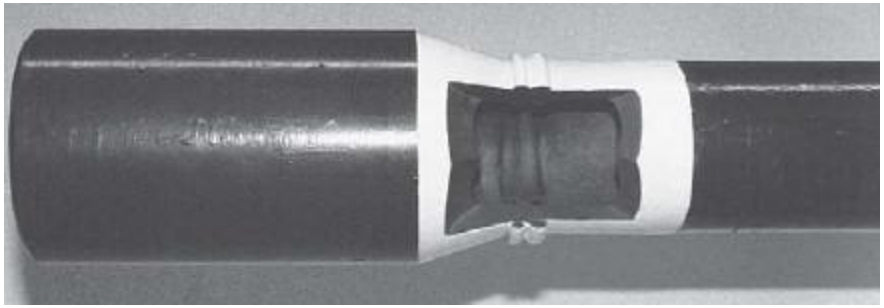
not just another PH6 lookalike

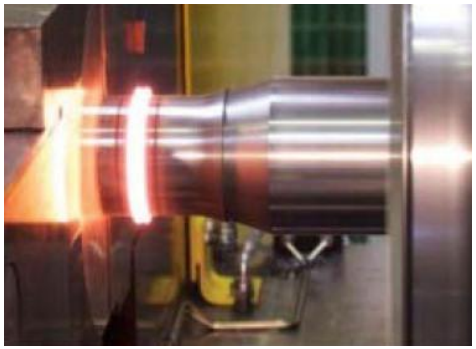


The TEJAS Two-Step 6-pitch (TTS-6 Black) workover connection, integrates two very well established technologies in the O&G industry, the PH6 premium workover connection and the drill pipe inertia welding/bonding method.

This merger introduces a series of benefits in the TTS-6 Black design, starting with customizability, regarding the tool joint dimensions and tool joint / tube body grade combos, moving to the differential advantage of increased number of re-cuts and ending with refurbishing and extending the life of decommissioned tubing, by replacing worn end-upsets, provided tube body is still functional.

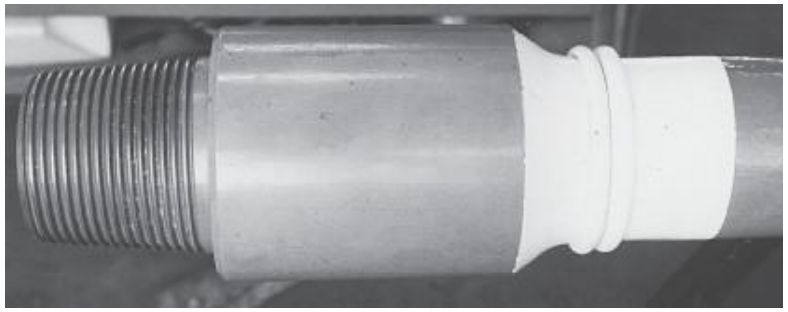
inertia welding is not welding

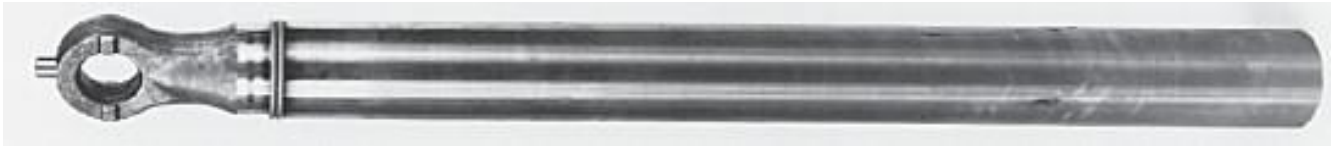




Welding processes can be classified into two main categories: 1) Liquid-phase welding (e.g. all fusion welding processes like arc, laser, electron beam welding) and 2) Solid-state welding (e.g. forge welding, friction stir welding, inertia welding, explosive welding, solid-state diffusion bonding).
In the former, bonds are established by the formation and solidification of a liquid phase at the interface, whereas in the later, applied pressure has a key role in bringing together the surfaces to be joined within interatomic distances.

Solid-state welding has been used for more than a thousand years. Japanese and Damascus swords were formed by heating, folding and hammering a strip of steel hundreds of times, until layers were bonded together …





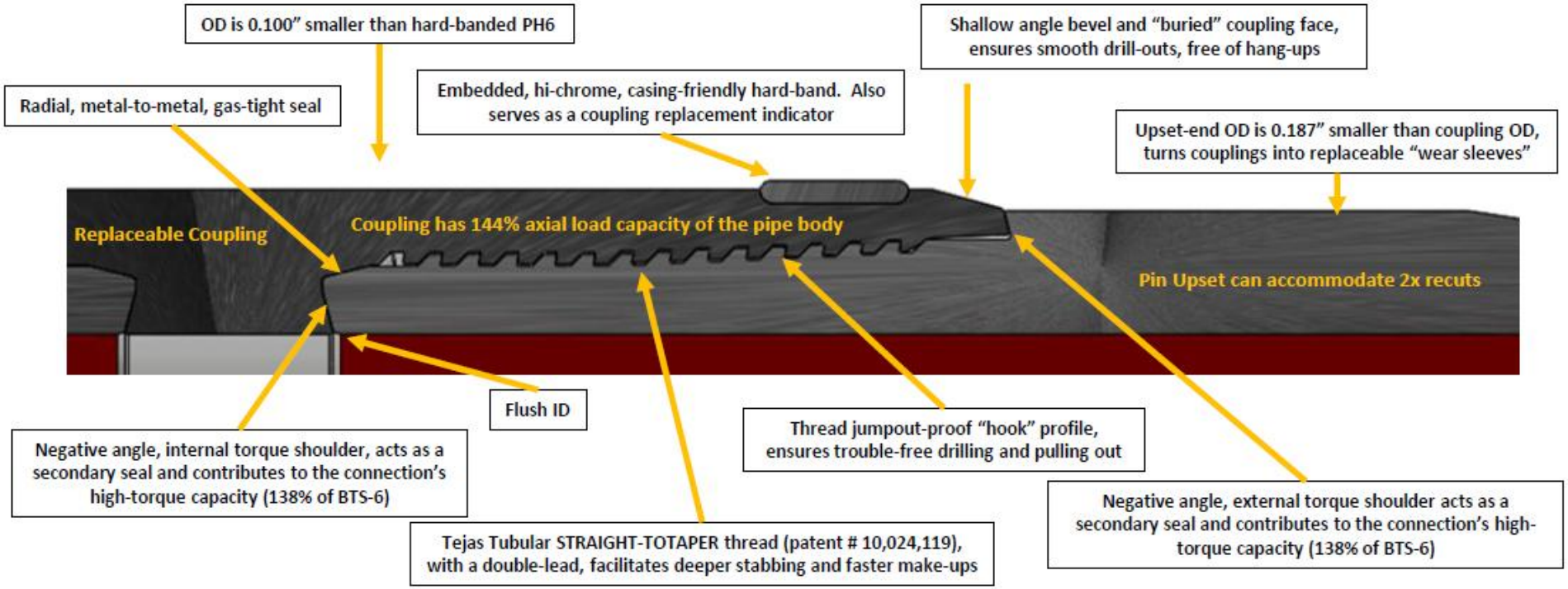
original WorkString T&C design

The TEJAS TUBULAR WORK STRING (TTWS) connection, was designed to address the need for an ultra hi-torque workover connection, that can reliably and economically tackle the present superlateral and future hyperlateral wells, that the O&G industry is moving towards.

The design combines a replaceable coupling concept, in order to extend tubing wear life, with a highly resilient, ruggedized thread incorporating locking/negative engagement angles and multiple torque shoulders …

but let's have a closer look to this connection's features and benefits …

features & benefits



- Rotating / Operating Torque exceeds the capacity of even the most powerful swivel
- High-speed rotating above 150 rpm w/o mudmotor, for fast drill-outs
- Long-reach frac-plug drill-out string, for the longest superlateral wells (32k ft TD drilled)
- Above 100% pull / push / torque efficiency, for demanding fishing operations
- Self-aligning long pilot and double-start thread, for fast and easy stabbing / makeup
- Negative-angle, self-locking torque shoulders and thread load flanks, that eliminate jump-outs
- In the absence of HB, replacing worn couplings way more economical than IJ designs

6 MM ft, 250 drillouts and counting

	WELL						STRING			INSPECTION									
START DATE	PLAY	NUMBER OF WELLS / RUNS	WORK-OVER	AVG TOTAL MEASURED DEPTH PER WELL / RUN (ft)	AVG PLUGS PER WELL	AVG TIME PER WELL / RUN (hours)	CPLG OD (in)	JOINTS ON LOCATION	STRING ID	TTWS RECUTS due to THREAD DAMAGE	TTWS RECUTS due to SHLDER DAMAGE	TTWS CPLGs Replaced due to DAMAGE only	TTWS CPLGs Replaced due to WEAR only	TTWS CPLGs Replaced due to DAMAGE and WEAR	TTWS SLIPCUT DBRs	TTWS BENT BEYOND REPAIR / NODRIFT	TTWS WORN UPSET OD DBRs	TTWS LOW BODY WALL DBRs	MILESTONES
8/18/2020	PERMIAN	3	PLUG DRILL w MUDMOT	22,000	60	81	3.438	660	A	2	0	14	0	0	11	2	0	0	First plug drill-out.
9/19/2020	MARCELLUS	1	PLUG DRILL w MUDMOT	26,778	66	102	3.500	929	B	66	20	1	115	0	21	9	0	3	First plug drill-out in a superlateral. First fishing job.
		15	FISHING PERFGUNS	18,336	N/A	31													
		1	PLUG DRILL w MUDMOT	25,500	26	72													
Oct. 2020	PERMIAN	4	PLUG DRILL w MUDMOT	19,285	64	81	3.438	671	A	4	0	0	319	0	16	5	0	0	First 7 wells with the same string.
11/12/2020	PERMIAN	4	PLUG DRILL no MUDMOT*	20,000	50	56	3.438 & 3.500	738	A	25	0	0	324	0	8	2	0	0	First plug drill-out without a mud motor.
12/5/2020	PERMIAN	3	PLUG DRILL no MUDMOT*	20,100	51	73	3.500	720	A										
12/16/2020	PERMIAN	4	PLUG DRILL no MUDMOT	24,000	75	90 (40)	3.525	739	C										First superlateral without a mud motor.
		3		23,650	80	79	3.525	774	A										Fastest drill-out (40 hours).
Jan. 2021	EAGLE-FORD	3					3.525		D										First high-pressure well.
1/22/2021	PERMIAN	3	PLUG DRILL no MUDMOT	17,461	53		3.525	660											SM adopts TTWS as its work-over work-horse
1/25/2021	MARCELLUS	2		19,500			3.525		B										
1/27/2021	PERMIAN	3		22,400	63		3.525		E										
1/30/2021	PERMIAN	6	PLUG DRILL no MUDMOT	20,619	65		3.525	662											
Feb. 2021	MARCELLUS	4	FISHING / PLUG DRILL	32,000			3.525	971	B	24	0	0	0	347	18	2	31	0	Logest TD (32000 ft).
3/1/2021	PERMIAN	1	PLUG DRILL no MUDMOT	20,405	62	105	3.525												
3/7/2021	PERMIAN	6	PLUG DRILL no MUDMOT	17,813	51	73	3.525 w HB	568											First use of hard-banded couplings.
3/20/2021	PERMIAN	3	PLUG DRILL no MUDMOT	18,252	50	80	3.525 w HB	591											
3/20/2021	PERMIAN	4	PLUG DRILL no MUDMOT	18,303	52	92	3.525 w & w/o HB	600											
3/20/2021	MARCELLUS	1	PLUG DRILL no MUDMOT	21,706	81	88	3.525 w HB												
3/20/2021	EAGLE-FORD	3					3.092 w HB & 3.525												First TTWS split string.
3/20/2021	PERMIAN	4	PLUG DRILL no MUDMOT	18,763	53	70	3.525 w & w/o HB	627											

Our connection was used to drill a kill plug and fish out a perforating gun; then proceeded to drill out plugs.

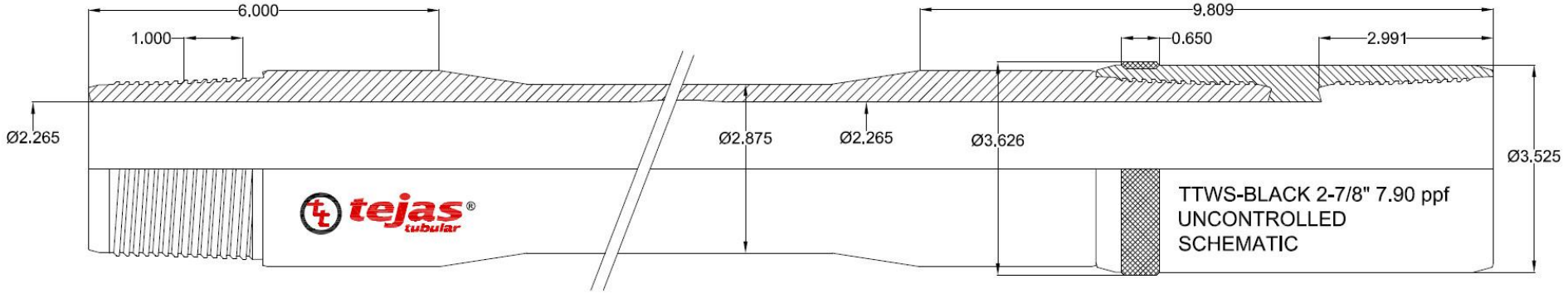
SPEARHEAD

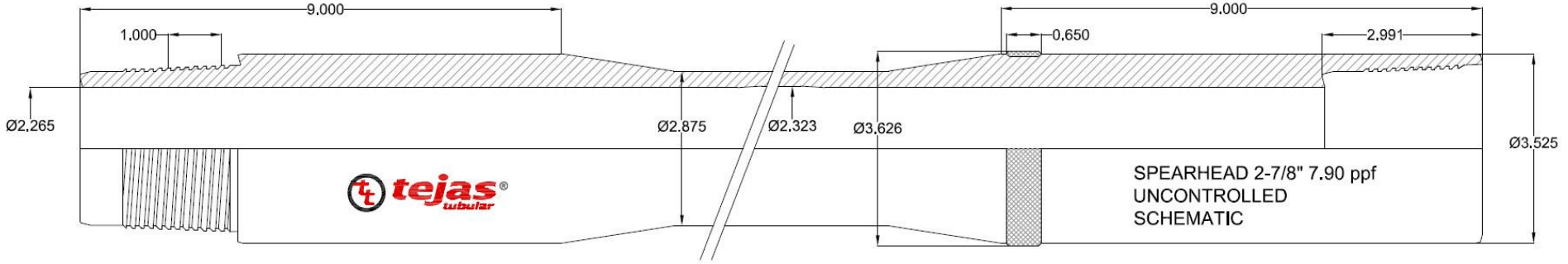
In the SPEARHEAD connection, which is the latest TEJAS workover string connection design, we have merged the proven TTWS hi-torque thread design with the inertia-welded integral-joint concept.

SPEARHEAD retains all the benefits of TTWS, with the added benefits of, (a) a customizable in regards of OD, length and material tool joint, (b) increased number of re-cuts and (c) reanimating scrapped tubing due to compromised upset ends (no more re-cuts or worn out OD) and turning it to a premium workover tool, by retrofitting it with SPEARHEAD tool joints.

SPEARHEAD runs as fast and easy as your standard PH6, but has a much longer reach, due to its extreme torque capacity. And in wells that are not as long, it will save you money, because you can run it fast and hard w/o the need for a mud motor. In all respects it is the ultimate workover rig tool.

TTWS T&C vs. SPEARHEAD IJ





Connection Data Sheets

tejas tubular

TTS6-black

Gas-tight Two-step Tubing Connection

SIZE: 2.875 inch [73.03 mm]

WEIGHT: 7.9 lbm/ft [11.76 kg/m]

GRADE: P-110

Interchangeable with PH6, BTS6, RTS6, NTS6, WTS6, etc. Can be equipped with 3/4 inch wide hardband on the box or both ends

Material Properties	Imperial	Metric
Yield Stress, Minimum (psi [kPa])	110,000	758,423
Yield Stress, Maximum (psi [kPa])	140,000	965,266
Tensile Stress, Minimum (psi [kPa])	125,000	861,845
Hardness, Maximum (HRC [HBW])	N/A	N/A
Pipe Dimensions & Weight		
Outside Diameter, Nominal (in [mm])	2.875	73.03
Weight, Nominal (lbm/ft [kg/m])	7.90	11.76
Wall Thickness, Nominal (in [mm])	0.276	7.01
Inside Diameter, Nominal (in [mm])	2.323	59.00
API Drift Diameter (in [mm])	2.229	56.62
Upset-End Diameter, Minimum (in [mm])	N/A	N/A
Upset-End Length, Maximum (in [mm])	N/A	N/A
Cross Sectional Area, Nominal (sq.in. [sq.mm])	2.254	1454.19
Pipe Load Capacities		
Tensile Yield (lbf [N])	247,900	1,102,714
Internal Yield Pressure (psi [kPa])	18,480	127,415
Collapse Pressure (psi [kPa])	19,090	131,621
Torsional Yield (lbf-ft [N.m])	14,160	19,200
Hydrostatic Test Pressure (psi [kPa])	10,000	68,948
Bending rate (°/100 ft [°/30 m])	175	173
Connection Dimensions		
Coupling OD (in [mm])	3.438	87.33
Special Clearance** OD (in [mm])	3.312	84.12
Connection ID (in [mm])	2.265	57.53
Tool-Joint Length (in [mm])	9.000	228.60
Make-up Loss (in [mm])	3.040	77.22
Threads per Inch (pitch [mm]	6.000	4.23
Connection Torque Capacities		
Low Shoulder Torque (lbf-ft[N.m])	650	880
High Shoulder Torque (lbf-ft[N.m])	3,250	4,410
Minimum Make-up Torque (lbf-ft[N.m])	3,500	4,750
Optimum Make-up Torque (lbf-ft [N.m])	4,000	5,420
Maximum Make-up Torque (lbf-ft [N.m])	4,400	5,970
Rotating Torque* (lbf-ft [N.m])	10,100	13,690
Yield Torque (lbf-ft [N.m])	12,600	17,080

Connection Load Capacities	
Tensile Efficiency (% of pipe body)	124
Internal Yield Pressure (% of pipe body)	100
External Yield pressure (psi)	31,130
Leak Resistance Pressure (psi)	radial m2m seal
Compression Efficiency (% of pipe body)	124
Torque Efficiency (% of pipe body)	89
Bending Strength Ratio (BSR)	1.71

* AS RESTRICTED BY WORKOVER RIG EQUIPMENT (POWER SWIVEL, TOP DRIVE OR ROTARY TABLE)

** Listed Rotating / Yield Torques and Connection Load Capacities have to be recalculated for Special Clearance OD.

Material is EMI/SEA inspected to 5% notch, over OD/ID, long/trans and wall thickness orientations, per API/ASTM requirements.

TTWS

Hi-Torque Fast-Running Xtended-Reach Workover Connection

SIZE: 2.875 inch [73.03 mm]
WEIGHT: 7.9 lbm/ft [11.76 kg/m]
GRADE: P-110

Double-Shoulder = Ultra High Torque, Deep-Stabbing = Self-Aligning, Double-Start = Fast-Makeup, Hook-Thread = No-Jumpouts, Replaceable Coupling = Xtra-Long Life

Material Properties	Imperial	Metric
Yield Stress, Minimum (psi [kPa])	110,000	758,423
Yield Stress, Maximum (psi [kPa])	140,000	965,266
Tensile Stress, Minimum (psi [kPa])	125,000	861,845
Hardness, Maximum (HRC [HBW])	N/A	N/A
Pipe Dimensions & Weight		
Outside Diameter, Nominal (in [mm])	2.875	73.03
Weight, Nominal (lbm/ft [kg/m])	7.90	11.76
Wall Thickness, Nominal (in [mm])	0.276	7.01
Inside Diameter, Nominal (in [mm])	2.323	59.00
API Drift Diameter (in [mm])	2.229	56.62
Upset-End Diameter, Nominal (in [mm])	N/A	N/A
Upset-End Length, Minimum (in [mm])	N/A	N/A
Cross Sectional Area, Nominal (sq.in. [sq.mm])	2.254	1454.19
Pipe Load Capacities		
Tensile Yield (lbf [N])	247,900	1,102,714
Internal Yield Pressure (psi [kPa])	18,480	127,415
Collapse Pressure (psi [kPa])	19,090	131,621
Torsional Yield (lbf-ft [N.m])	14,160	19,200
Hydrostatic Test Pressure (psi [kPa])	10,000	68,948
Bending rate (°/100 ft [°/30 m])	175	173
Connection Dimensions		
Coupling OD (in [mm])	3.525	89.54
Coupling Replacement Limit OD (in [mm])	3.400	86.36
Connection ID (in [mm])	2.265	57.53
Coupling Length, Minimum (in [mm])	6.800	172.72
Make-up Loss (in [mm])	2.991	75.97
Tool-Joint OD (in [mm])	3.338	84.79
Connection Torque Capacities		
Low Shoulder Torque (lbf-ft[N.m])	300	410
High Shoulder Torque (lbf-ft[N.m])	1,500	2,030
Minimum Make-up Torque (lbf-ft[N.m])	2,000	2,710
Optimum Make-up Torque (lbf-ft [N.m])	4,250	5,760
Maximum Make-up Torque (lbf-ft [N.m])	6,500	8,810
Rotating Torque* (lbf-ft [N.m])	13,800	18,710
Yield Torque (lbf-ft [N.m])	15,300	20,740

Connection Load Capacities	
Tensile Efficiency (% of pipe body)	122
Internal Yield Pressure (psi)	34,400
External Yield pressure (psi)	32,290
Leak Resistance Pressure (psi)	radial m2m seal
Compression Efficiency (% of pipe body)	122
Torque Efficiency (% of pipe body)	108
Bending Strength Ratio (BSR)	1.25

* AS RESTRICTED BY WORKOVER RIG EQUIPMENT (POWER SWIVEL, TOP DRIVE OR ROTARY TABLE)
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tejas tubular

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GRADE: P-110

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Material Properties	Imperial	Metric
Yield Stress, Minimum (psi [kPa])	110,000	758,423
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Hardness, Maximum (HRC [HBW])	N/A	N/A
Pipe Dimensions & Weight		
Outside Diameter, Nominal (in [mm])	2.875	73.03
Weight, Nominal (lbm/ft [kg/m])	7.90	11.76
Wall Thickness, Nominal (in [mm])	0.276	7.01
Inside Diameter, Nominal (in [mm])	2.323	59.00
API Drift Diameter (in [mm])	2.229	56.62
Upset-End Diameter, Minimum (in [mm])	N/A	N/A
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Minimum Make-up Torque (lbf-ft[N.m])	2,000	2,710
Optimum Make-up Torque (lbf-ft [N.m])	4,250	5,760
Maximum Make-up Torque (lbf-ft [N.m])	6,500	8,810
Rotating Torque* (lbf-ft [N.m])	13,900	18,850
Yield Torque (lbf-ft [N.m])	15,400	20,880

* AS RESTRICTED BY WORKOVER RIG EQUIPMENT (POWER SWIVEL, TOP DRIVE OR ROTARY TABLE)
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Connection Load Capacities	
Tensile Efficiency (% of pipe body)	122
Internal Yield Pressure (psi)	34,400
External Yield pressure (psi)	32,290
Leak Resistance Pressure (psi)	radial m2m seal
Compression Efficiency (% of pipe body)	122
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