

BENDING PROCEDURE 10

**P. O. Box 5811
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ABC PROJECT

PROJECT NUMBER XXXXXXXXXX

DOCUMENT TITLE: BENDCO MANUFACTURING PROCEDURE SPECIFICATION / INSPECTION TEST PLAN

INCLUDING

SECTION XI -SUPPORTING PROCEDURE SPECIFICATIONS

CLIENT DOCUMENT NUMBER:

VENDOR DOCUMENT NUMBER: MPS / IPT (REV C)

ISSUED FOR PREPRODUCTION MEETING

REV NO	DATE	REVISION DESCRIPTION	PREPARED BY	REVIEWED BY	APPROVED BY	APPROVED ENBRDGE
A	6/5/2017	ISSUED FOR REVIEW	MOLINA	PERRY	THARP	
B	6/13/2017	ISSUED FOR REVIEW	MOLINA	PERRY	THARP	
C	7/3/2017	ISSUED FOR REVIEW	AAKER	MEVIS	THARP	

XXXXXX / 7/09/2017 (REV C)	CUSTOMER/ DATE	CUSTOMER INFORMATION
Amanda Molina		CLIENTS NAME: ABC
James Perry		XXXXX P.O.:
John Tharp		CUSTOMER CONTACT:

Prepared By:
Reviewed By:
Approved By:

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MANUFACTURING PROCEDURE SPECIFICATION
AND INSPECTION TEST PLAN FOR INDUCTION BENDING

ASME CODE U, S & R STAMPS

PASADENA, TEXAS



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This MPS/ITP covers the manufacturing, testing, marking and inspection requirements for pipeline bends of carbon steel materials having controlled chemistry and mechanical properties, produced by the induction bending process, with or without tangents. This document covers induction bends for transportation and distribution piping (e.g. ASME B31.4, B31.8, and B31.11). This document does not cover process and power piping (Reference ASME B16.49, Paragraph 1.1). Standard units are U S Customer units, unless specified otherwise. Bendco assumes no responsibility for design or suitability of particular fluid service condition.

All induction pipe bending will be carried out according to this Qualified and Approved MPS as required by B16.49; except as modified by the Customer

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ABC PROJECT

JULY 9, 2017 REV C (ISSUED FOR PREPRODUCTION MEETING)

	XXXXXX / 7/09/2017 (REV C)	CUSTOMER/ DATE	CUSTOMER INFORMATION
Prepared By:	Amanda Molina		CLIENTS NAME: ABC
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SEC I INFORMATION SUPPLIED BY PURCHASER					
CUSTOMER REQUIREMENTS 1.0			BENDCO	CUST	TPIA
CUSTOMER REQUIREMENTS		BENDCO STANDARD PRACTICES			
Customer	ABC PIPELINE COMPANY		N/A	N/A	N/A
Customer Purchase Order			N/A	N/A	N/A
Project Name			N/A	N/A	N/A
Project Location			N/A	N/A	N/A
Shipping Address			N/A	N/A	N/A
Customer Contact			N/A	N/A	N/A

Customer Requirements are specified in left column in "Red". When Customer Requirements not specified by customer, Standard Bendco

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Customer Phone Number		Requirements shall be met. Customer is required to provide written	N/A	N/A	N/A
Customers Inspector		approval of all NDE prior to shipment of pipe bends.	N/A	N/A	N/A
Inspectors Phone Number			N/A	N/A	N/A
TECHNICAL DESCRIPTION					
Applicable Fabrication Code	ASME B16.49	All bends performed by Bendco will be performed in accordance with, ASME B16.49 and this MPS /ITP	N/A	N/A	N/A
Standards, Specs	ABC SPECIFICATION: INDUCTION BENDS FOR SUBSEA PIPELINES SPEC NO XXXXX REV 0	Unless otherwise specified by customer, Bendco's standard induction bending practice will be performed.	N/A	N/A	N/A
Material Description	API 5L X – 65 PSL2	Seamless, welded or Cylinders (ASME B16.49, para. 1.2)	N/A	N/A	N/A
Pipe Diameter	20 INCH OD (NOMINAL DIAMETER)	Bendco's capabilities includes induction pipe bending range up to 36 inch OD. X 1.00 INCHES	N/A	N/A	N/A
MAOP	3650 PSI	NA	N/A	N/A	N/A
Operating Temperature	NA	NA	N/A	N/A	N/A
Corrosion Allowance	NA	NA	N/A	N/A	N/A
Calculated Minimum Wall Thickness	8% OR LESS	WALL THICKENING NOT TO EXCEED 19%	M	W	M
Material Group	Group 3	Group 3 (Also, qualifies for Group 1 and 2 materials)	N/A	N/A	N/A
Special Requirements	NONE	NA	N/A	N/A	N/A

NON DESTRUCTIVE TESTING EXAMINATION		NOTES	BENDCO	CUST	TPIA
MT	NO		N/A	N/A	N/A
UT	NO	WALL THICKNESS USING UT FOR T _{min} ONLY	N/A	N/A	N/A
PT	YES	STANDARD IHTS PROCEDURE PT-ASME-100 REV.0	W	M	M
DRIFT	YES	STANDARD BENDCO PROCEDURE-13.0	W	M	M
RT	YES	STANDARD IHTS PROCEDURE RT-ASME-100 REV.0	W	M	M
MULTIPLY HEATS			BENDCO	CUST	TPIA
Multiply Heats	SINGLE HEAT WILL BE PROVIDED	A separate qualification for each heat is required unless specifically approved by the customer in writing.			
STD TOLERANCES (UNLESS OTHER WISE SPECIFIED, BENDCO STD TOLERANCE WILL BE PERFORMED, AS A MINIMUM)			BENDCO	CUST	TPIA
Radius of Bend	+ OR – 5%	BENDCO STD. + OR – 1%	W	M	M

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Degree of Bend	+ OR – 1%	BENDCO STD. + OR – 1/2 %	W	M	M
Plane of Bend	Not specified	BENDCO STD. + OR – 1 %	W	M	M
Flat Plane of Bend	+ OR – 1% of the C/L Radius	BENDCO STD. + OR – 1% of the C/L radius	W	M	M
Linear Dimensions	+ OR – 0.19	BENDCO STD. + OR - 1/8" for 12" NPS & Under	W	M	M
Linear Dimensions	Not Specified	BENDCO STD. + OR - 3/16" for Over 12" NPS	W	M	M
Ovality in Bent area	Less than or equal to 8%	BENDCO STD. IS NOT GREATER THAN 8%	W	M	M
Thickness Bent Area	Greater than 90% of min nom thickness	BENDCO STD IS 90% - REDUCTION IN NOMINAL WALL THICKNESS	W	M	M
Additional Customer’s Supplemental Bend Qualification Testing Requirements	SPECIFICATION: INDUCTION BENDS FOR SUBSEA PIPELINES	Qualification Bend Testing Requirements strictly according to Figure 2, (Written Procedure per ASME B16.49. para. 10.2.1, 11.1 & 11.2)			
REQUIRED DIMENSIONS			BENDCO	CUST	TPIA
“A” Tangent length		RANDOM TANGENT LENGTHS – CONFIRM DURING PPM (30 “ min /60” max)	W	M	M
“B” Tangent length		RANDOM TANGENT LENGTHS – CONFIRM DURING PPM (30 “ min /60” max)	W	M	M
“C” Centerline Radius		100 - inches	W	M	M
“D” Angle		90 degrees	W	M	M
“E” Dimension		100 - inches	W	M	M
“F” Dimension		160 - inches	W	M	M
“G” Dimension		160 - inches	W	M	M
Wall Thickness (3 READINGS ON EXTRADOS OF BEND)		0.955” min. / 0.955” min. / 0.955” min. (PER B16.49)	W	M	M
END PREPARATION					
End Prep “A”		SQUARE CUT - NO BEVELS - CONFIRM DURING PPM	W	M	M
End Prep “B”		SQUARE CUT - NO BEVELS - CONFIRM DURING PPM	W	M	M

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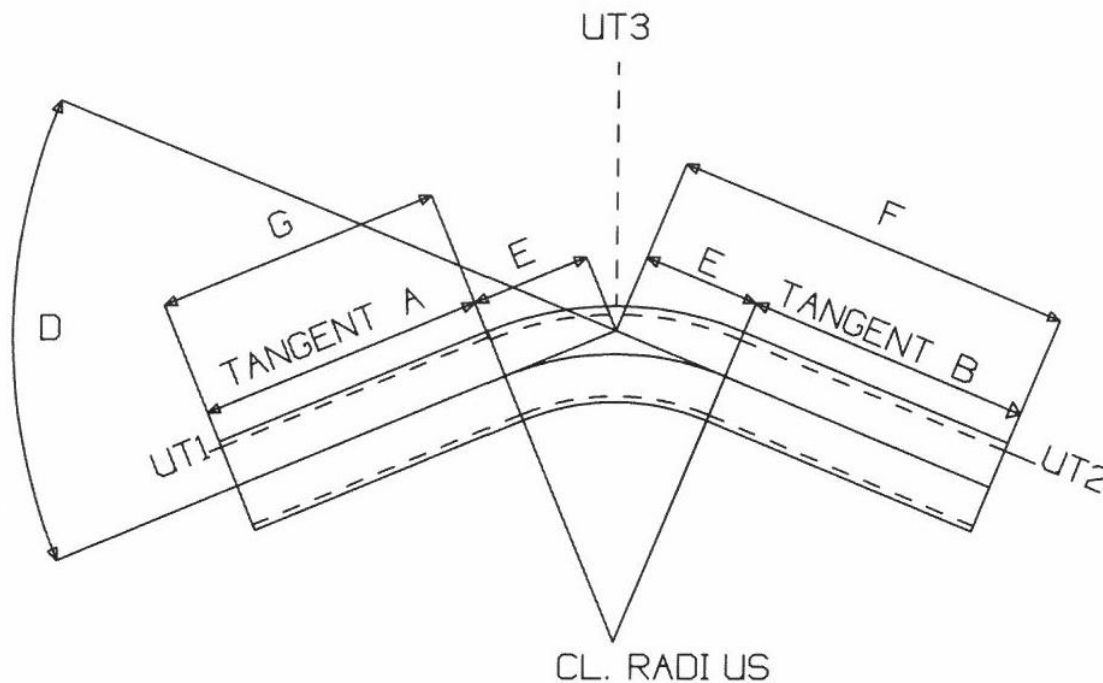
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SEC II INSPECTION KEY

H-Hold W-Witness M-Monitor R-Review RW-Random Witness TPIA-Third Party Inspection Agency WI-Work Instruction

Supplier has to prepare documents which are required by TPIA or COMPANY for review and approval Monitor (M) - Production can proceed without the presence of TPIA or COMPANY. However, TPIA or COMPANY reserves the right to attend the production stage at any time. Witness (W) / Random Witness (RW) TPIA and COMPANY will be informed of the time and location of production step. The production step may be preceded without the presence of TPIA and COMPANY.

SEC III TERMS

ARC - The curved portion of a bend.

BACKWALL OR PIPE HEEL - The outside arc of the bend.

BEND DIE OR BEND FORMER - A wheel shaped die with a groove in the outer circumference that conforms to half the pipe circumference. It will most often have a straight section used as half of the clamp set for holding the pipe against the die.

BEND RADIUS - See Centerline Radius

BENDER – 1. A mechanical device capable of forming a bend in a straight length of material.
2. A commercial or industrial company engaged in the business of making bends.

BENDING MOMENT - The amount of force (foot pounds) required to initiate a change of direction in a straight length of material about the center of curvature.

BENDING PROCEDURE - A written procedure containing the parameters and information necessary to guide the operator in producing bends which meet the requirements of this Standard.

BUCKLING - Definite folds, creases, or wrinkles formed on the surface of the pipe or tube during the bending operation.

CENTER TO CENTER - The distance between the theoretical or calculated centers of two adjoining bends. Also used for diametric measurements between the centerlines of two tangent points of a bend.

CENTER LINE DIAMETER - The distance from the centerline axis of the pipe across to the other centerline of a 180-degree return bend.

CENTER LINE RADIUS - 1. The distance from the center of curvature to the centerline (axis) of the pipe, expressed as a number multiplied by the pipe or tube size.

EXTRADOS - The outside arc of the bend.

FLAT PLANES - The deviation of the horizontal plane of a single bend between its tangent points, based on the theoretical centerline of the bend. (Out-of-Plane)

FLATTENING - The distortion of the cross section of pipe or tube from its normal (round) shape usually expressed as a percentage of the difference between the major and minor axes of the starting material compared to the O.D. before bending. (i.e. Ovality)

HOT BENDING - The bending of pipe or shapes through hot working methods.

HUMP - A rounded protrusion or bulge on the extrados.

I.D. - Inside diameter of the pipe or tube.

INDUCTION BENDING - A method or process of bending which employs an induction heating coil to create a narrow, circumferential, heated band around the material to be bent. When the appropriate temperature is reached, the material is pushed forward through the coil at a consistent speed and temperature while a bending moment is applied.

INNER RADIUS - The inside arc of the bend. (Intrados)

INTRADOS - The inside arc of the bend. (Inner Radius)

MINIMUM DESIGN WALL THICKNESS - The wall thickness specified on the fabrication drawing or computed in accordance with the applicable specification as the minimum acceptable for the design criteria.

NONDESTRUCTIVE TESTING (NDT) - Examination of materials or products in ways that do not impair future usefulness in order to detect, locate, measure, and evaluate defects and other indications.

NEUTRAL AXIS - That portion of the pipe or tube that is neither in compression nor in tension.

XXXXXX / 7/09/2017 (REV C)

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2. The distance on a bend forming tool from the center of curvature to a point corresponding to the centerline of the tubular shape when mounted in the bend-forming tool--nominal CLR. CHORD - The straight distance measured between the centerline points of any two points of a bend. COLD BEND - The bending of pipe or shapes by cold working at ambient temperatures. COMPRESSION - The forces which thicken the inside wall of the bend D OF BEND - Centerline radius (CLR) divided by the tube diameter or nominal pipe size (i.e., 1.5D, 3D, 5D, etc.) DEGREE OF BEND (DOB) - The angle, expressed in number of degrees, to which the bend is formed, (i.e., 45 degrees, 90 degrees, 180 degrees, etc.) DISTANCE BETWEEN BENDS (DBB) - The actual length of the straight section between the tangent points of two adjoining bends (i.e. common tangent) DUCTILITY - The ability of the material to deform plastically without fracture, as measured by elongation or reduction of area in a tensile test. ELONGATION - 1. The increase in length of a test specimen at failure in a tensile test, expressed as a percentage of the original length. TANGENT POINT - The theoretical point at which the bend is started or ended. TENSILE STRENGTH - The point at which the bend is started or ended. TENSION - The force which thins the outside wall of the bend. THROAT - The inner half of the pipe or the half undergoing compression during bending. TRANSITION ZONE - The area at the tangent points of a bend that covers the change from bent to unbent. WALL - The thickness of tubular material, usually expressed in "nominal" or "minimum". WALL FACTOR - The ratio of the pipe outside diameter (O.D.) to its wall thickness (t) (i.e. O.D./t) WALL THINNING - The amount of reduction from original wall thickness of pipe or tube to the amount of wall thickness remaining in the extrados of a bend after forming. WALL THICKNESS - The thickness of the material, usually stated as "Schedule" for pipe or "Gauge" for tube. YIELD POINT - The point at which material permanently deforms during bending. YIELD STRENGTH - The stress at which a material exhibits a specified deviation from proportionality as a result of stress and strain.	NOMINAL - Usually refers to pipe sizes up to and including 12-inch I.P.S. Also used in reference to wall thickness, generally as a "mean" or average measurement NOMINAL O.D. - Usually refers to referenced pipe sizes, not actual O.D. NOMINAL WALL - The mean or average measurement of the wall thickness. O.D. - Outside diameter of the pipe or tube. OUT OF PLANE - The deviation of the horizontal plane of a single bend between its tangent points, based on the theoretical centerline of the bend. (Flat Planes) OUT OF RADIUS - The outside arc of the bend. (Extrados) OVER BEND - The amount that a pipe has to be bent past the desired bend angle to compensate for residual stresses in the bend. This allows the pipe to return to the desired bend angle after all external support from clamping has been removed. PLANE OF BEND (POB) - The plane of a bend in relation to the axis of the straight section preceding it. Used specifically for changes of plane in successive bends. RADIAL GROWTH - The difference between the actual CLR and the bend die CLR of a tubular shape after all external forces that restrained it are removed. RADIUS - The distance from the center of curvature to the centerline (axis) of the pipe, expressed as a number multiplied by the pipe or tube size. SPRINGBACK - The movement of the bent pipe or tube toward the original straight configuration after release of the bending moment. TANGENT - A straight section of material on either end of the arc of a bend.
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SEC IV MATERIAL GROUPS

XXXXXX / 7/09/2017 (REV C)	CUSTOMER/ DATE	CUSTOMER INFORMATION
Prepared By: Reviewed By: Approved By:	Amanda Molina James Perry John Tharp	CLIENTS NAME: ABC XXXXX P.O.: CUSTOMER CONTACT:

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4.0			DETAILS			BENDCO	CUST	TPIA
4.1	Group 1-Carbon Steel					N/A	N/A	N/A
	Group 2-Carbon Steel (high yields without impacts)					N/A	N/A	N/A
	Group 3-Carbon Steel (high yield with impacts)					M	M	M
GROUPINGS						BENDCO	CUST	TPIA
4.2	Qualification of Group 2 will also qualify Group 1 only					N/A	N/A	N/A
	Qualification of Group 3 will also qualify Group 1 & 2 only					M	M	M
SEC V								
MATERIAL (RECEIVING INSPECTION/TRACEABILITY AGAINST CUSTOMER PO)								
5.0	DETAILS		NOTES			BENDCO	CUST	TPIA
5.1	Material for bending shall comply with the applicable specs and the customer’s PO	See Standard Receiving Inspection BENDCO PROCEDURE-1.0 and BENDCO PROCEDURE-4.0	ALL INCOMING CUSTOMER PIPE MUST BE INSPECTED AGAINST COMPANY PROVIDED MTRs AT TIME IT IS RECEIVED AND DOCUMENT IN ATTACHMENT A – NO EXCEPTION –			W	M	M
5.2	External surface shall be free from surface contamination or other defects that may inhibit successful completion of bend	See Standard Receiving Inspection BENDCO PROCEDURE-1.0 and BENDCO PROCEDURE-4.0				W	M	M
5.3	Inside & Outside surfaces shall be clean and free of foreign material that may be detrimental to bending	See Standard Receiving Inspection BENDCO PROCEDURE-1.0 and BENDCO PROCEDURE-4.0				W	M	M

SEC VI SUPPLEMENTAL REQUIREMENTS FOR WELDS IN BENDS				
6.0	DETAILS	BENDCO	CUST	TPIA
6.1	Supplemental requirements for longitudinal, spiral or circumferential pipe. Long seam weld in the bend area will be RT examined in accordance with IHTS Procedure RT-ASME-100 REV.1 (AFTER POST BENDING STRESS RELIEVING)	W	M	M
6.2	Longitudinal welded pipe seams shall be located not more than 15 degrees from neutral axis IF MULTIPLE BENDS ARE TO BE WELED TOGETHER THE WELD SEAM SHALL BE STAGERT ON ALTERNATE SIDES OF 15 DEGREES (IE. 10 DEGREES OR 20 DEGREES)	W	M	M

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6.3	Excessive weld buildup at circumferential welds located in the bend shall be removed prior to bending	N/A	N/A	N/A
6.4	All circumferential butt welds in the arc of the bend shall be examined according to applicable code, BENDCO PROCEDURE or customer requirements. CIRCUMFERNITAL WELDS MUST BE APPROVED BY CUSTOMER AND BE INCLUDED IN QUALIFICATION BEND WITH TESTING.	N/A	N/A	N/A

SEC VII HEAT TREATMENT					
7.0	DETAILS	NOTES	BENDCO	CUST	TPIA
7.1	CALIBRATED FURNACE HEAT TREATMENT POST BENDING	PER TEXAS STRESS PROCEDURE 051817BR DATED 5/18/17, IN STRICT ACCORDANCE TO ASME B16.49-2007	M	W	M

SEC VIII QUALIFICATION OF BENDS					
8.0	DETAILS	NOTES	BENDCO	CUST	TPIA
8.1	Qualification bends shall be done in accordance with B16.49 PER SECTION 10.1 GROUP 3	UNLESS SPECIFIED OTHERWISE BY CUSTOMER	W	W	M
8.2	Table 8-1 (BELOW) are essential variable. Any change outside the range of the essential variable will require requalification of the Qualification Bend and a separate qualification will be performed.	UNLESS SPECIFIED OTHERWISE BY CUSTOMER	W	W	M
8.3	Qualification Bend Mechanical Testing will be performed according to Table 8-2 and Table 8-3 (BELOW)	UNLESS SPECIFIED OTHERWISE BY CUSTOMER	M	W	M

TABLE 8-1 -BEND QUALIFICATION ESSENTIAL VARIABLE
Written Procedure per ASME B16.49, par. 10.2.1

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Material Group	Carbon Equivalent	Temperature in ° F		Bending Speed IPM		Pipe/Tube Diameter	Wall Thickness t = Nominal Wall Thickness
		Intrados	Extrados				
Group 1	N/A	± 150	± 100	N/A		N/A	N/A
Group 2	+ .05 - .10	± 150	± 100	± .5 IPM		2" – 12 " 14" – 28 " Over 30 "	± ¼"
Group 3	+ .02 - .04	± 50	± 50	± .3 IPM		± one pipe size	± 1/8"
Group 4	N/A	± 100	± 50	± .5 IPM		N/A	± 2t
Group 5	N/A	± 100	± 50	± .5 IPM		N/A	± 2t
Group 6	N/A	± 100	± 50	± .5 IPM		N/A	± 2t
Group 7	N/A	± 150	± 100	± .5 IPM		N/A	± 2t
Group 8	N/A	± 150	± 100	± .5 IPM		N/A	± 2t
NOTES	1. Any change in the following essential variables requires requalification: Cooling Type – air, water, or still air Heat Treatment ±50° 2. R/D Factor – Lower R/D qualifies higher R/D (i.e., qualifies 5D, 7D, etc.)						

TABLE 8-2 – LOCATION OF TEST PIECES					
Written Procedure per ASME B16.49, par. 10.2.1 & 11.1.1, 11.1.2, 11.1.3 & 11.1.4					
				BENDCO	CUST
					TPIA
8-2.1	FIGURE	TRANSVERSE TENSILE TESTS		M	R M
					M

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	11.1.1	1 EACH REQUIRED IN EACH OF THE FOLLOWING LOCATIONS (ACCORDING TO 11.1.1 & HML TTM3-01-16 REV 1 & HML-GP-05-06 REV 0) 11.1.1 Tensile Testing. Transverse tensile samples for NPS 8 (DN 200) or larger shall be taken from the tangent, the transition zone, and the bend segment at both the intrados and extrados for each lot of material as shown in Fig. 2. For sizes smaller than NPS 8 (DN 200), either transverse or longitudinal test specimens shall be used. If the tangents and/or transition zones are not left integral to the bend, no tensile tests are required except on the bend. See Fig. 2. A total of 8	1 - Start Transition Zone EXTRADOS (1 Tensile) 2 - Start Transition Zone INTRADOS (1 Tensile) 3 - Bend Zone Extrados (1 Tensile) 4 - Bend Zone Neutral Axis (1 Tensile) 5 - Bend Zone Intrados (1 Tensile) 6 - Finish Transition Zone EXTRADOS (1 Tensile) 7 - Start Transition Zone INTRADOS (1 Tensile) 8 - Tangent (1 Tensile)			
8-2.2	FIGURE 11.1.2	TRANSVERSE FRACTURE TOUGHNESS (ONE SET OF 3 REQUIRED FROM EACH OF THE FOLLOWING LOCATIONS (ACCORDING TO 11.1.2 AND HML CVN-05-06-REV 0) 11.1.2 Fracture Toughness Testing. A set of three transverse Charpy V-notch impact specimens shall be taken from the tangent, the transition zones, and the bend at both the intrados and extrados for each lot of material See Fig. 2 for locations. If the tangents and/ or transition zones are not left integral to the bend, no impact tests are required except on the bend. See Fig. 2. A total of 8 sets	1 - Start Transition Zone EXTRADOS (1 Set of 3) 2 - Start Transition Zone INTRADOS (1 Set of 3) 3 - Bend Zone Extrados (1 Set of 3) 4 - Bend Zone Neutral Axis (1 Set of 3) 5 - Bend Zone Intrados (1 Set of 3) 6 - Finish Transition Zone EXTRADOS (1 Set of 3) 7 - Start Transition Zone INTRADOS (1 Set of 3) 8 - Tangent (1 Set of 3)	M	R M	M

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8-2.3	FIGURE 11.1.3	WELD TESTING (THE TENSILE, IMPACT AND HARDNESS TESTS SHALL BE PERFORMED ON THE PIPE LONGITUDINAL SEAM WELD AT THE LOCATION SHOWN IN FIGURE 2 OF THE CODE.) (ACCORDING TO 11.1.3 1 & HML TTM3-01-16 REV 1 & HML-GP-05-06 REV 0, HML CVN-05-06-REV 0 AND (BRINELL PROCEDURE)) 11.1.3 Weld Testing (a) Longitudinal Seams. The tensile, impact, and hardness tests shall be performed on the pipe or cylinder longitudinal seam weld at the locations shown in Fig. 2. Acceptance criteria shall be as specified in paras. 8.1, 8.2, 8.3, and 11.1.4. (b) Helical Seam. The tensile, impact, and hardness tests shall be performed on the pipe or cylinder helical seam at the locations shown in Fig. 3. Acceptance criteria shall be as specified in paras. 8.1, 8.2, 8.3, and 11.1.4.	1 - Weld & HAZ (1 Tensile) 1 - Weld & HAZ (1 Set of 3 Impacts) 1 - Brinell Hardness (1) (Using same HARDNESS TESTING equipment that will be utilized in production testing)	M	R M	M
8-2.3	FIGURE 11.1.4	AVERAGE HARDNESS TESTING (READINGS SHALL BE TAKEN FROM ALL THE SAME LOCATIONS AS THE TENSILE TESTS) (ACCORDING TO 11.1.4 & (BRINELL PROCEDURE)) 11.1.4 Hardness Testing. The bend shall be tested for average hardness in all the same locations as the tensile tests are taken as well as each transition zone	1 - Start Transition Zone EXTRADOS (2 hardness Brinell) 2 - Start Transition Zone INTRADOS (2 hardness Brinell) 3 - Bend Zone Extrados (2 hardness Brinell) 4 - Bend Zone Neutral Axis (2 hardness Brinell) 5 - Bend Zone Intrados (2 hardness Brinell) 6 - Finish Transition Zone EXTRADOS (2 hardness Brinell) 7 - Start Transition Zone INTRADOS (2 hardness Brinell) 8 - Tangent (2 hardness Brinell)	M	R M	M

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8-2.4	FIGURE 11.1.4	AVERAGE HARDNESS TESTING		M	R M	M
		(IN ADDITION, AN AVERAGE HARDNESS READING SHALL BE TAKEN FROM A MINIMUM OF 2 LOCATIONS IN THE BEND AT THE EXTRADOS AND INTRADOS (ACCORDING TO 11.1.4 & (BRINELL PROCEDURE) 11.1.4 Hardness Testing. (continued) An average hardness reading shall be taken from a minimum of two locations in the bend at the extrados and intrados. The allowable difference between the minimum and maximum hardness <u>readings for a quadrant around the circumference</u> is 30 Brinell hardness number, or equivalent.				

TABLE 8-3 – BEND QUALIFICATION TESTING DETAILS Written Procedure per ASME B16.49, par. 10.2.1 & 11.1					
PHYSICAL TESTING			BENDCO	CUST	TPIA
8-3.2	Tensile Testing	Tensile Testing shall be performed according to ASME B16.49 para. 11.1.1 and HML-TTM3-01-16 Rev. 1	M	R	M
8-3.3	Impact Testing	Fracture Toughness (Impact) Testing shall be performed according to ASME B16.49 para. 11.1.2 and HML-CVN-05-06 Rev. 0	M	R	M
8-3.5	Surface Hardness Testing	Surface Testing shall be performed according to ASME B16.49 para. 11.1.4 and (BRINELL PROCEDURE)	M	R	M
NON DESTRUCTIVE TESTING			BENDCO	CUST	TPIA
8-4.1	Visual Inspection	In accordance with BENDCO PROCEDURE-4.0	M	M	M
DIMENSIONS			BENDCO	CUST	TPIA
8-5.1	Wall Thickness, Ovality & Bend Angle	In accordance with BENDCO PROCEDURE-27.0	M	M	M

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Table 8-6 – BEND QUALIFICATION ACTUAL ESSENTIAL VARIABLE							
Written Procedure per ASME B16.49, par. 10.2.1 AND BENDCO PROCEDURE BENDCO PROCEDURE 2.0							
	DETAILS	INTENDED VALUES BEFORE BENDING	ACTUAL RECORDED VALUES OF THE PRE-PRODUCTION BENDS	NOTES	BENDCO	CUST	TPIA
8-6.2	Temperature – Intrados	1800°F +/- 50°F		<i>To be recorded during bending process</i>	M	W	M
8-6.3	Temperature – Extrados	1800°F +/- 50°F		<i>To be recorded during bending process</i>	M	W	M
8-6.4	Bending Speed	1" PER MINUTE		<i>To be recorded during bending process</i>	M	W	M
8-6.5	Pipe / Tube Diameter	20" OD		<i>To be recorded during bending process</i>	M	W	M
8-4.6	Wall Thickness (nominal wall thickness) + or – 0.12 inches	1.062"		<i>To be recorded during bending process</i>	M	W	M
8-4.7	Bend radius to diameter	100" CLR		<i>To be recorded during bending process</i>	M	W	M
8-4.9	Forming temperature	1800°F +/- 50°F		<i>To be recorded during bending process</i>	M	W	M
8-4.11	Coolant type	Water			M	R	M
8-4.14	Weld Seam orientation	15% from neutral axis			M	R	M
8-4.15	Post Bend Heat Treatment	+/- 25°F		<i>To be recorded during stress relieving process</i>	M	R	M

BB – Before Bending

AB – After Bending

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SEC IX PRODUCTION TESTING						
9.0				BENDCO	CUST	TPIA
9.1	Production Bends		BENDING AND TESTING OF ALL BENDS (QUALIFICATION & PRODUCTION) SHALL BE WITNESSED BY CLIENT.	M,R	W	M
9.2	Frequency of Testing	All Bends shall receive inspection as outlined in this section.		M,R	R	M
9.3	Visual Inspection	Visual examine all bends for lamination, cracks, notches, gouges or other injurious defects. Remove surface defects by grinding and checked for T Min. Upsets that occur at each tangent point are cosmetic in nature and not detrimental to the bend shall be verified.	In accordance with BENDCO PROCEDURE-4.0	M,R	W	M
9.4	Roundness Measurements Range	All bends shall be measured for out of round width by calipers or C gauge in accordance with applicable code, standard or agreed by customer.	Per B16.49:12.1 Ovality not to exceed 3% in the bend body and 1% in the tangents And in accordance with BENDCO PROCEDURE – 27.0	M,R	W	M
9.5	Roundness Measurements at Ends-Range		Cold forming and sizing after bending provided the induced permanent strain does not exceed 1.5%	M,R	W	M
9.6	Bend Angle Measurement-Range		Per B16.49:12.6 (+/-) ½ degree And in accordance with BENDCO PROCEDURE – 27.0	M,R	W	M
9.7	Linear Measurements		Per B16.49:12.6 (+/-) 0.19 inches	M,R	W	M

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9.8	End "Square"-ness Measurements		Per B16.49:12.6 (+/-) 0.09 inches And in accordance with BENDCO PROCEDURE – 27.0	M,R	W	M
9.9	Wall Thickness Measurements	All bends shall be subject to measurements of post bend wall thickness by ultrasonic examination at not less than 3 separate locations on the extrados of the bend.	Per B16.49: 12.3 - WALL THICKNESS MEASUREMENTS WILL BE TAKEN AT THE APPROXIMATE 1/4, 1/2 AND 3/4 POINTS ALONG THE EXTRADOS WITH A DAKOTA ULTRASONICS PR8 THICKNESS GAUGE. WALL THINNING WILL BE 8% OR LESS OF ACTUAL WALL PRIOR TO BENDING. WALL THICKENING NOT TO EXCEED 19% and in accordance with BENDCO PROCEDURE – 27.0	M,R	W	M
9.10	Drift Test (Size & Shape)	Per B16.49: 12.4.2 - PIPE WILL BE DRIFTED WITH A DRIFT GAUGE FORMED FROM 2 PIPE PLATES THAT ARE 3/8" THICK AND SEPARATED BY A ROD LENGTH 1.5 TIMES THE ID.	DRIFT SIZE (17.16" OD - 96% OF ID OF PIPE)	M,R	W	M
9.11	Surface Hardness	Bends in final condition shall have 10% of each quantity randomly hardness tested at the location specified in Table XX	Per B16.49: 11.2 - HARDNESS READINGS SHALL BE TAKEN ON THE PRODUCTION BENDS AT THE FOLLOWING LOCATIONS (THE EXTRADOS, INTRADOS & NEUTRAL AXIS; WELD AND HAZ; AT THE APPROXIMATE MID POINT OF THE BEND ARC ON BOTH THE START AND STOP TRANSITION ZONES. THIS IS NOT EXACTLY THE SAME AS PARA 11. 2 MUST BE CLARIFIED IN PREPRODUCTION MEETING	M,R	W	M
9.12	Liquid Penetrant (of bevels)		In accordance with IHTS Procedure PT-ASME-100 Rev.0	W	W	M
9.13	(RT) of weld seam		In accordance with IHTS Procedure RT-ASME-100 Rev.0	W	W	M
9.14	Written Practice		In accordance with IHTS Procedure WP-IHTSI-100 Rev.0	W	M	M

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**SEC X – ATTACHMENT A
RECEIVING INSPECTION TALLY SHEET**

JOINT NO.	Heat #	MTR RECIEVED	LENGTH	WALL THICKNESS	NOTES	BENDCO APPROVED YES/NO/Initials
1	361779	YES – EISENBAU KRAMER	39' 8-1/2"	1.062"	MATERIAL HAS A FLAT MARK DOWN TOTAL LENGTH OF PIPE	YES
2	361779	YES – EISENBAU KRAMER	39'-6"	1.062"	MATERIAL HAS A FLAT MARK DOWN TOTAL LENGTH OF PIPE	YES
3	361779	YES – EISENBAU KRAMER	39'-6"	1.062"	MATERIAL HAS A FLAT MARK DOWN TOTAL LENGTH OF PIPE	YES
4	361779	YES – EISENBAU KRAMER	39'-7"	1.062"	MATERIAL HAS A FLAT MARK DOWN TOTAL LENGTH OF PIPE	YES

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SEC X – ATTACHMENT B SHIPPING TALLY SHEET PRODUCTION TESTING									
JOINT NO.	Heat #	Visual	BB/Wall Thickness	Bend Angle	AB/Wall Thickness	Bevel Angle	Marking	End Caps	Shipping
1	361779								
2	361779								
3	361779								
4	361779								
5	361779								
6	361779								

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MPS/ITP TAB NUMBER	SOURCE	PROCEDURE	DESCRIPTION	DATE ISSUED
1	BENDCO	BENDCO PROCEDURE - 1.0	MATERIAL RECEIVING	JUN 7, 2016
2	BENDCO	BENDCO PROCEDURE - 4.0	VISUAL INSPECTION	DEC 7, 2016
3	BENDCO	BENDCO PROCEDURE - 13.0	DRIFT / PIG TEST	DEC 7, 2016
4	BENDCO	BENDCO PROCEDURE - 18.0	LAYOUT	DEC 7, 2016
5	TEXAS STRESS	051817BR Rev. 1	HEAT TREATMENT (STRESS RELIEVING)	JUN 20, 2017
6	IHTS	WP-IHTSI-100 REV. 0	WRITTEN PRACTICES (NDE)	JAN 10, 2017
7	IHTS	RT-ASME-100 REV. 0	RADIOGRAPHY EXAMINATION	FEB 23, 2017
8	IHTS	PT-ASME-100 REV. 0	LIQUID PENETRANT EXAMINATION	JAN 10, 2017
9	HML	HML-HBW-05-06 Rev. 1	BRINELL TYPE HARDNESS TESTING PROCEDURE	JAN 01, 2016
10	HML	HML-TTM3-01-16 Rev. 1	TENSION TESTING OF METALLIC MATERIALS	APR 04, 2016
11	HML	HML-CVN-05-06 Rev. 0	CHARPY IMPACT TESTING PROCEDURE	JAN 01, 2008
12	BENDCO	BENDCO PROCEDURE - 12.0	INDUCTION BENDING	DEC 7, 2016
13	BENDCO	BENDCO PROCEDURE - 27.0	DIMENSIONAL INSPECTION	DEC 7, 2016
14	CLIENT	BENDCO PROCEDURE - 14.0	INDUCTION BENDS FOR SUBSEA PIPELINES	MAR 3, 2017 (REV 1)
15	HML	BENDCO PROCEDURE - 28.0	SHOP HARDNESS TESTING (TBD)	
16	HML	HML-GP-05-06 Rev. 0	PROCEDURE FOR CHECKING ELONGATION OF TENSION SPECIMENS	JAN 01, 2008

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