

Standard Operating Procedure Carbon Steel Bending	SOP No. 5.047
--	------------------

DCR No.: 03038
Revision No.: 0

Effective: 8-12-03
Supersedes: 8-12-03
Revision Date: 8-12-03
Page No.: 1 of 4

- 1 Purpose
 - 1.1 To establish a standard procedure for performing cold rotary-draw internal mandrel carbon steel bending.
- 2 Scope
 - 2.1 This procedure applies to carbon steel pipe configurations fabricated by cold rotary-draw internal mandrel bending.
- 3 Responsibility
 - 3.1 Bending Department Manager shall check sample coupon that generated by bending operator. The acceptance criteria are described in formulas 5.1.3.1 and 5.2.4.1.
 - 3.2 The qualified bending operator shall perform the following bending procedures.
- 4 References
 - 4.1 American Society of Mechanical Engineers (ASME) B31.3, Section 332.4.2 (a), 1999 Edition.
 - 4.2 Wallace Coast Machinery Co. Cold Bending Manual.
- 5 Procedures
 - 5.1 Material
 - 5.1.1 Seamless carbon steel pipe shall be ordered as “minimum wall” to ensure outer apex wall thickness consistency after bending.
 - 5.1.2 All carbon steel pipe shall be ordered with material test report (MTR), which shall include the information, such as chemical composition, percentage elongation (%EL) and percentage reduction of area (%RA).

<p>THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION OF THERMA CORPORATION. ALL INFORMATION SHALL (A) BE RETAINED IN CONFIDENCE; (B) NOT BE REPRODUCED IN WHOLE OR IN PART; AND (C) NOT BE USED OR INCORPORATED IN ANY PRODUCT EXCEPT UNDER EXPRESSED WRITTEN AGREEMENT WITH THERMA CORPORATION.</p>

Revision No.	SOP No.	Page
0	5.047	2 of 4

- 5.1.3 After bending, the most severe stress point of the bend (outer apex) must yield at least 10% retained elongation (Reference to ASME B31.3 332.4.2a). The retained elongation is calculated by subtracting the bending elongation value from total elongation (%EL) as listed in the MTR.

Retained Elongation = Total %EL – Bending elongation (5.1.3.1)

$$BendingElongation = \frac{OutsideRadius - CenterLineRadius}{OutsideRadius} \quad (5.1.3.2)$$

Caution: If the retained elongation is less than 10%, the carbon steel pipe cannot be used for bending.

5.2 Bending Coupon

- 5.2.1 The bending operator shall generate a 90-degree bend as sample bend (i.e. coupon) when the following conditions occur.

5.2.1.1 At the beginning of production.

5.2.1.2 When material heat number is changed.

5.2.1.3 When pipe size is changed.

5.2.1.4 When pipe schedule is changed.

5.2.1.5 When power source is interrupted.

- 5.2.2 The bending operator shall measure wall thickness of the carbon steel pipe with ultrasound thickness gage before bending. Enter data in form FN 5.047.1 (Carbon Steel Bending Coupon).

- 5.2.3 After the bending is completed, the bending operator shall measure the wall thickness at the very outer apex point (marked with ink pen) and enter data in the form FN 5.047.1 (Carbon Steel Bending Coupon).

Revision No.	SOP No.	Page
0	5.047	3 of 4

- 5.2.4 The bending operator shall calculate the post-bend wall thinning. The post-bend wall thinning shall not exceed the bending elongation value as yielded by the elongation formula 5.1.3.2. The post-bend wall thinning is expressed as follows:

$$PostBendWallThinning = \frac{WT0 - WT1}{WT0} \quad (5.2.4.1)$$

Where: WT0 = Original wall thickness

WT1 = Post-bend wall thickness

- 5.2.5 The bending operator shall submit the sample bend (i.e. coupon) to the Bending Department Manager for final inspection.
- 5.2.6 The Bending Department Manager shall perform final inspections, which include the retained elongation and post bend wall thinning of the sample bend (i.e. coupon) as per formulas 5.1.3.1 and 5.2.4.1, respectively.

5.3 Bending

- 5.3.1 After the sample bend (i.e. coupon) is passed the final inspections by the Bending Department Manager, the bending operator shall proceed to fabricate production spools as per design drawings (e.g. isometric drawings).
- 5.3.2 After fabrication is done, the bending operator shall verify the dimensions of the spool piece as per the design drawings (e.g. isometric drawings).
- 5.3.3 The bending operator shall clean the bending spool pieces.
- 5.3.4 After the spool pieces are dry, the bending operator shall cap and tape the ends of each spool piece, mark design drawing (e.g. isometric drawing) number on the spool pieces.

6 Review and Approval

- 6.1 The bending operator shall send the spool pieces and design drawings (e.g. isometric drawings) to the welding shop or to job site.
- 6.2 The bending operator shall submit the form FN 5.047.1 (Carbon Steel Bending Coupon) and MTR to the Bending Department Manager.

Revision No.	SOP No.	Page
0	5.047	4 of 4

Document Approval

Bending Manager

Date

Quality Control Manager

Date

Vice President

Date

Quality Assurance Manager

Date

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION OF THERMA CORPORATION. ALL INFORMATION SHALL (A) BE RETAINED IN CONFIDENCE; (B) NOT BE REPRODUCED IN WHOLE OR IN PART; AND (C) NOT BE USED OR INCORPORATED IN ANY PRODUCT EXCEPT UNDER EXPRESSED WRITTEN AGREEMENT WITH THERMA CORPORATION.