

## SPECIFICATION FOR INDUCTION BEND

1. This specification covers the design, materials, manufacture and supply of pipeline induction bends (hot bends).

### 2. CODE AND STANDARD

The pipeline induction bends shall conform in design, materials, manufacture, supply and performance, except where otherwise specified, with the current issued amendments of the following prevailing on the effective date of the Contract:

ASME B31.8 Gas Transmission and Distribution Piping Systems

ASME B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids

ASME B16.49 Factory-Made, Wrought Steel, Buttwelding Induction Bends for Transportation and Distribution Systems

API 5L Specification for Line Pipe

ASTM Standard Test Methods and Definitions for Mechanical Testing of Steel Products

API 1104 Welding of Pipelines and Related Facilities

ISO 15590-1 Petroleum and Natural Gas Industries – Induction Bends, Fittings and Flanges for Pipeline Transportation Systems – Part 1: Induction Bends

ISO 6761 Steel tubes – Preparation of Ends of Tubes and Fittings for Welding.

Where conflicts exist between this specification and other Drawing, standards, codes or specification, the most stringent shall be applied.

### 3. QUALITY SYSTEM

The Subcontractor shall maintain effective quality assurance, and quality control programs in accordance with BS 5750, Part 2, covering all aspects of the work. Quality Control ensures that quality requirements are determined prior to commencement of manufacture and, subsequently satisfies the requirements of the Contract throughout all phases of production and delivery.

The Contractor shall submit for the Company's approval Quality Plan covering all aspects of manufacture, inspection and testing of the bends.

### 4. MATERIALS

The line pipe shall be supplied by the Contractor and manufactured in accordance with the Project Specification entitled "Material Specification for Pipelines"

The Contractor shall furnish hot induction formed bends from the above material in accordance with the requirements of this specification.

Generally, the bend shall be made from the mother pipe which same with pipes of piping class.

Contractor shall provide test rings to be used for weld procedure qualification test on site.

Test rings shall be 500mm long and shall be simulated to actual condition of the bend tangent part.

The number and size of test rings required will be defined on the Purchase Order.

### 5. MANUFACTURING PROCEDURE QUALIFICATION

5.1. The Contractor shall produce a procedure for the manufacture of the bends for approval by the Company prior to its usage in production.

5.2. The Contractor shall qualify the manufacturing procedure by producing a procedure qualification test bend for each pipe grade, size and thickness. The dimensions of each test bend

shall be the same as the dimensions of the corresponding production bends.

5.3. The manufacturing procedure and heat treatment shall be the same in all aspects as those corresponding production bends.

#### 5.4. Non-Destructive Testing (NDT) of Test Bends

If the bend manufacturing procedure includes a normalizing heat treatment, then the test bend shall be normalized prior to NDT.

NDT of the test bends shall consist of a magnetic particle inspection (MPI) of surface defects in accordance with BS 6072 and an ultrasonic examination of the weld in accordance with this specification.

#### 5.5. Mechanical Testing of Test Bends

##### 5.5.1. Tensile Testing

The following tensile tests shall be carried out on each test bend:

- a. High pressure pipelines operated under the pressure above 10 to 320 MPa; welding nozzles into the weld seams and also into the bent elements of the pipelines (in the bending points) is not allowed.
- b. For each of the external radius and the internal radius locations, one longitudinal specimen at the start of the bend, and one longitudinal specimen at the centre of the bend.
- c. For the weld, one transverse specimen at the start of the bend and one transverse specimen at the centre of the bend.
- d. The tensile strength, 0.2% proof stress and elongation shall be determined.
- e. Tensile testing shall be carried out in accordance with API 5L, and the results shall be minimum values of the appropriate grade of API 5L. Additionally, the ratio of yield stress to tensile strength shall not exceed 0.85.

##### 5.5.2. Impact Testing

The following impact tests shall be carried out on each test bend:

- a. For each of the external radius and the internal radius locations, one set of three Charpy specimens at the start of the bend, and one set of three Charpy specimens at the middle of the bend.
- b. For the weld, one set of three Charpy specimens for the weld and also for the fusion line plus 2 mm, at each of the external radius and the internal radius locations.
- c. Charpy specimens shall be tested and removed in accordance with API 1104.

##### 5.5.3. Hardness Testing

a. Hv10 hardness traverse shall be performed on specimens cut from each of the following locations:

Across the weld at the mid-bend location.

The external radius at the mid-bend location.

The internal radius at the mid-bend location.

- b. The hardness survey of the weld shall be conducted in accordance with the Project Specification entitled "Specification for Welding".
- c. The hardness surveys of parent material shall be conducted in accordance with BS 427. Two traverses shall be made on each specimen. One shall be parallel to and 1 mm below the external surface. The second shall be parallel to and 1 mm from the internal surface.
- d. The maximum hardness shall be 248 Hv10.

#### 5.6. Documentation

The bending procedure giving the temperature to which pipe is to be heated, monitoring pipe temperature, heating, cooling rate, together with the bending procedure qualification test results shall be submitted to the Company for approval prior to the manufacture of production bends, together with the schedule of bends.

## 6. PRODUCTION BENDING

All production bends shall be made in accordance with ASME B16.49 or ISO 15590-1 and qualified procedures and approved by the Company.

The seam weld of longitudinally welded pipe shall be located at the neutral axis of the finished bend. If seamless pipe is used, the thickest part of the pipe wall shall be orientated to the outside of the bend.

There shall be no circumferential welds in any section of the bends.

At the Contractor's option, a full-body normalizing heat treatment may be carried out in order to meet the requirements of API 5L.

The total bend length shall include the straight tangent parts at the bend ends, at the start and finish positions of the bend. The length of these parts shall not be less than 500 mm, for pipes up to 24" in diameter and 750 mm for diameter 26" and above. If the total developed length of the bend arc length plus two tangents exceed one pipe length, separate split bends shall be used to make up the total required bend.

## 7. BEVEL ENDS

The ends of each bend shall be beveled in accordance with API 5L. The inside diameter shall meet the tolerance of the appropriate line pipe specification.

## 8. INSPECTION

8.1. Bends shall be free of loose mill scale, foreign matter, oil and grease and shall be clean and dry for final inspection.

8.2. Each pipe bend shall be 100% visually inspected for injurious defects. Definition and allowable repair of injurious defects shall be in accordance with API 5L. All repaired areas shall be inspected using liquid penetrant or MPI repair procedure to be approved by the Company.

8.3. Bend shall be made in a manner to preserve cross-section shape and shall be free of cracks or other mechanical damage.

### 8.4. NDT

The Contractor shall submit the NDT procedures to the Company for approval as part of the manufacturing procedure.

All NDT shall be performed by operators qualified by a third party in accordance with Company approved.

The external surface of each production bend shall be 100% examined by MPI. MPI shall be conducted in accordance with BS 6072. The use of the current flow technique with "prods" is not permitted. MPI indications exceeding 3 mm in any direction shall be considered unacceptable defects.

All welds plus a band 25 mm wide either side of each weld line shall be 100% inspected after bending using an ultrasonic technique. Acceptance criteria shall be in accordance with API 5L.

### 8.5. Hardness Tests

Each production bend shall be hardness tested. Surface hardness readings shall be taken after final heat treatment at the beginning of the heat zone, at the end of the heat zone and in the centre of the sweep (hardness readings per bend).

The inside and outside radius areas of the pipe bend and any start-stop areas shall be visually examined to detect irregularities in the pipe bend curvature which may indicate hard spots. The hardness of the pipe body shall not exceed 250 Hv235.

#### 8.6. Dimensional Tolerances

Dimensional tolerance checks shall be made after final heat treatment.

The outside diameter (OD) of the pipe bend shall not be reduced in any circumferential plane by more than 2.5% of the nominal pipe diameter.

The maximum difference between any two OD measurements in any circumferential plane shall not exceed 5 % of the specified diameter and shall not exceed 1 % of the specified diameter within 4 in. of the pipe end.

Completed bends shall have a wall thickness that is not less than the minimum permitted for the wall thickness specified for the bend.

Wall thickness measurements shall be taken with a suitable approved ultrasonic procedure.

A plug gauge shall be manufactured for each diameter and wall thickness of bend as follows:

- a. The gauge shall consist of two parallel 6-mm-thick circular plates separated by a rigid bar of length of twice the nominal pipe ID.
- b. The diameter of each plug gauge shall be equal to 95% of the nominal inside diameter of the original pipe, where  $ID = (OD) - (2 \times \text{wall thickness})$ .
- c. The gauge shall be passed through the entire length of each bend. If gauging plates are damaged whilst passing through the bend, the test shall be considered failed and the bend rejected.

The radius of curvature of the bend shall be correct to within 10.5%.

Bend flatness shall be measured by placing each bend on a level surface. The centre lines of the bend shall not be more than 5 mm per 45° of arc out of place.

#### 9. POST BEND HEAT TREATMENT

Post-bend heat treatment shall be required if established by the bending procedure qualification testing. The post-bend heat treatment temperature shall be as established during procedure qualification but shall not exceed 1175 degrees F (635 degrees C). The pipe and bend heat numbering system shall allow bend traceability through the entire manufacturing process including post-bend heat lot identification.

#### 10. RESIDUAL MAGNETISM

Any detrimental magnetic fields which result from magnetic particle (wet or dry) inspection, electromagnetic inspection, or any other magnetic equipment shall be checked and removed.

#### 11. EXTERNAL COATING

All bends shall be externally coated according to Appendix 6 or 7 of "External Three Layer Polyethylene (3LPE) Coating for Pipelines". Bent Pipeline bends, with welding joints after joint welding will be heated up to temperature of 580 - 620 ° C (PWHT) and shall be delivered without the outside three layer coating. The coating can be applied / used on bent elbows in basic and field

conditions, after the joint welding and post welding heat treatment.

## 12. HYDROSTATIC TESTING

The Contractor shall test each qualification test bend to a pressure that will result in a circumferential stress equivalent to 90% of the specified minimum yield strength without leakage or impairment to serviceability of the pipe bend. The test pressure shall be maintained and recorded for a period of 4 hours.