



TAPI Pipeline Company Limited

**Project Management & FEED
Consultancy Services
SPECIFICATION FOR MAINLINE HOT
BENDS**

21/03/2018

ILF CONSULTING ENGINEERS



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1 INTRODUCTION

1.1 Project

The TAPI Project was originally conceived in the 1990s with a view to monetise Turkmenistan's vast natural gas reserves through gas exports to Afghanistan, Pakistan and India.

In 2013, the Governments of Turkmenistan, Afghanistan, Pakistan and India respectively nominated state-owned gas companies State Concern "Turkmengas", Afghan Gas Enterprise, Inter State Gas Systems (Private) Limited, and GAIL (India) Limited to promote and invest in the TAPI Project.

The TAPI Project aims to export up to 33 billion cubic meters of natural gas annually for 30 year period through a 1814 km pipeline from Turkmenistan to Afghanistan, Pakistan and India.

In November 2014, with the collaboration of the four abovementioned state-owned gas companies, TPCL was incorporated with the main objective of implementing the TAPI Project.

TPCL is a company limited by shares and incorporated in Isle of Man with a registered office at the following address: Fort Anne, Douglas, Isle of Man, IM1 5PD. The head office of TPCL is located in Dubai, United Arab Emirates.

In June 2015, State Concern "Turkmengas" was unanimously elected as a Consortium Leader for the TAPI Project.

The stone-laying ceremony for the TAPI Project was held in the Mary region of Turkmenistan, near the Galkynysh natural gas field, on 13 December 2015 and was attended by Gurbanguly Berdimuhamedov, the President of Turkmenistan, Nawaz Sharif, the Prime Minister of Pakistan, Ashraf Ghani Ahmadzai, the President of Afghanistan and Mohammad Hamid Ansari, the Vice-President of India.

The Shareholders' Agreement was signed concurrently with the TAPI Project stone-laying ceremony. In April 2016, the Shareholders of TPCL signed the Investment Agreement.

In January 2017, TPCL entered into a Project Management and FEED Development Contract in connection with the Afghanistan and Pakistan section of TAPI Project with ILF Beratende Ingenieure GmbH.

The implementation of the TAPI Project is divided into three main phases:

- a) Natural gas source development;

- b) Turkmenistan portion of the TAPI Project; and
- c) Afghanistan and Pakistan portion of the TAPI Project.

TPCL will act as the employer in relation to the construction works, as well as the owner of the Afghanistan and Pakistan portion of the TAPI Project.

The “Galkynysh” gas field, which is listed among the world’s largest natural gas fields and holds 26.2 trillion cubic meters of gas reserves, will be the source of natural gas for the TAPI Project.

Phase III of the development of the Galkynysh gas field has been initiated by State Concern “Turkmengas” so as to meet its obligations to supply natural gas to the TAPI Project.

The length of the Turkmenistan portion of the TAPI Project is 214 km. State Concern “Turkmengas” has already started the engineering and initial phase of the construction works on this portion of the TAPI Project.

The length of Afghanistan and Pakistan portion of the TAPI Project is 1600 km.

1.2 Purpose of the Document

Purpose of this document is to specify the minimum technical requirements for material, manufacture, inspection and testing of mainline hot bends as per ISO 15590 and the amendments and supplementary requirements as stated in this Specification.

This Specification is not all inclusive and the use of the guidelines set forth does not relieve the Manufacturer of his responsibility to provide a finished product capable of performing its intended service.

1.3 Definitions

Company	: TAPI Pipeline Company Limited
Consultant	: ILF Beratende Ingenieure GmbH
Contractor	: Companies under contract with the Company for the performance of works/services for the Overall Project
Manufacturer	: Company or corporation responsible for making, marking and delivering the product in accordance with the requirements of the Tender Documents. Where a Manufacturer is mentioned in this document, the Contractor is responsible for the full scope of work of, and performance by, that Manufacturer.
Overall Project	: Turkmenistan – Afghanistan – Pakistan – India (TAPI) Gas Pipeline Project
Project	: Project Management and FEED Consultancy Services for the Afghanistan and Pakistan portions of the TAPI Pipeline Project
Subconsultants	: Companies under contract with the Consultant for the execution of the Project
Subcontractor	: Companies under contract with the Contractor for the execution of works/services for the Overall Project

1.4 Abbreviations

API	: American Petroleum Institute
ASME	: American Society of Mechanical Engineers
EN	: European Standard
ISO	: International Organization for Standardization
ITP	: Inspection and Test Plan
MPQT	: Manufacturing Procedure Qualification Test
MUT	: Manual Ultrasonic Testing
NDT	: Non-Destructive Testing
OD	: Outside Diameter
PSL	: Product Specification Level

RT	: Radiographic Testing
SAWL	: Submerged Arc Longitudinal Welded
TAPI	: Turkmenistan – Afghanistan – Pakistan – India
UT	: Ultrasonic Testing

1.5 Referenced Documents

Document Number	Document Name
K358-ILF-OVA-PLG-GE-SPC-0002	: Specification 3 Layer PP Coating
K358-ILF-OVA-PLG-ME-DAT-0003	: Data Sheet for Line Pipes and Mother Pipe for Hot Induction Bends (LLI)
K358-ILF-OVA-PLG-ME-SPC-0002	: Specification for Internal Lining of Line Pipe
K358-ILF-OVA-PLG-ME-SPC-0003	: Specification for Line Pipes (LLI)
K358-ILF-OVA-PLG-ME-SPC-0004	: Specification for Transportation, Handling and Storage of Line Pipe

1.6 Codes and Standards

Document Number	Document Name
ASME B31.8	: Gas Transmission and Distribution Piping Systems
EN 10204	: Metallic products – Types of inspection documents
EN 10290	: Steel tubes and fittings for onshore pipelines - External liquid applied polyurethane and polyurethane-modified coatings
ISO 14001	: Environmental Management System - Requirements
ISO 15590-1	: Petroleum and natural gas industries - Induction bends, fittings and flanges for pipeline transportation systems - Part 1: Induction bends
ISO 3183	: Petroleum and natural gas industries - Steel pipe for pipeline transportation systems
ISO 8501-1	: Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO 9001:2008	: Quality management systems – Requirements

Document Number	: Document Name
OHSAS 18001	: Occupational Health and Safety Management System – Requirements

2 AMENDMENTS AND COMMENTS TO ISO 15590-1

This chapter shall be read in conjunction with ISO 15590-1:2009. The numbering in subsequent chapters corresponds with the numbering of chapters of ISO 15590-1, except where indicated as an additional clause. Paragraphs or parts of paragraphs contained in ISO 15590-1 and which are unaffected by this Specification, shall remain fully applicable. Amendments, supplements, choices and applicable paragraphs have been stated hereafter. All other paragraphs and clauses which have not been mentioned shall be considered unchanged and shall be applied as stated in ISO 15590-1 and references mentioned therein.

The terms of ISO 15590-1:2009 shall be deemed to be incorporated into this document. The Contractor shall perform its obligations under the Contract such that the Works comply with ISO 15590-1:2009, as amended and supplemented in accordance with the terms of this specification. Terms not otherwise defined in this document shall have the meaning given to them in ISO 15590-1:2009 unless specified otherwise.

1 SCOPE

This document specifies the technical delivery condition for bends made by induction bending process from longitudinal welded pipe (SAWL). The manufacture product specification level for the mother pipe is PSL2.

2 Conformance

2.1 Units of measurement (Amendment)

All measurements are expressed in the SI system. If Imperial sizes are used, these sizes are inserted between brackets.

2.2 Rounding

Applicable.

2.3 Compliance to this International Standard (Supplement)

ISO 9001 / ISO 29001 / API Q1(nomogram), OHSAS 18001, ISO 14001

3 Normative References

Applicable.

4 Terms and Definitions

Applicable

5 Symbols and Abbreviated Terms

Applicable.

6 Designation

Applicable.

7 Pressure rating and design

Manufacturer shall demonstrate compliance with requirements a) and b)

8 Information that shall be supplied by the purchaser

8.1 General Information

- a) ISO 15590-1:2009
- b) bend designation of each bend – see Chapter 6 of the specification. Mother pipe shall be PSL2, material grade is X70.
- c) The required quantity of bends shall be as specified in Purchase Order.
- d) Mother pipes shall be supplied by Manufacturer.
- e) Required bend dimensions, including

- The outside diameter is 1422 mm (56 inch).
 - Minimum bend wall thickness shall be equal to the matching line pipe nominal thickness: refer to K358-ILF-OVA-PLG-ME-DAT-0003 Data Sheet for Line Pipes and Mother Pipe for Hot Induction Bends (LLI)
 - Minimum bend radius shall be 5D (D = nominal outside diameter of the bend)
 - Bend angle shall be as specified in Purchase Order.
 - The hot bends shall be furnished with tangent ends. The minimum length shall be 1D.
- f) End preparation: see 9.8

8.2 Additional information

- a) minimum design temperature: -29°C
- b) maximum design temperature: 60°C
- d) special dimensional requirements:
- The dimensional tolerances on internal diameter, ovality, wall thickness and weld bevel at the ends of the bends shall comply with ISO 3183 and the K358-ILF-OVA-PLG-ME-SPC-0003 Specification for Line Pipes (LLI).
 - All mainline hot bends shall have a constant nominal outer diameter (nom. OD) regardless of any varying wall thickness.
 - The design wall thickness of the mainline hot bends shall be determined in accordance with the fundamental requirement that the final wall thickness of each bend, at any point on the bend circumference and length, will not be less than the nominal wall thickness of the connecting mainline pipe and that the hoop stress in the hot bend due to internal fluid pressure shall not exceed the hoop stress permitted for the adjoining mainline pipe.
- g) The pipeline design standard is ASME B31.8
- i) post bend heat treatment – see section 9.4
- j) For the required mechanical-property requirements at the maximum design temperature refer to K358-ILF-OVA-PLG-ME-SPC-0003 Specification for Line Pipes (LLI).
- k) Charpy impact test temperature shall be -29°C
- l) Hydrostatic testing shall be performed in acc. to section 10.8
- m) Hold points shall be specified and agreed in the inspection and test plan provided by the Manufacturer.

- n) Surface condition: Each bend shall be visually inspected regarding dimensions, materials and workmanship by an inspector approved by Company.

Prior to visual inspection, the entire outside surface of all bends shall be grit blasted to a cleanliness grade of Sa 2½ in accordance with EN ISO 8501-1.

Visual inspection for laminations, cracks, notches, gouges and other deleterious features shall be carried out on the complete outer and, if practical, the inner surface of the bend in accordance with the applicable clauses of K358-ILF-OVA-PLG-ME-SPC-0003 Specification for Line Pipes (LLI) in order to guarantee the same level of quality as for connecting mainline pipes.

- o) coating or painting requirements:

The bends shall be coated externally in accordance with the K358-ILF-OVA-PLG-GE-SPC-0002 Specification 3 Layer PP Coating. Alternatively, external coating with PUR acc. to EN 10290, type 3, Class B, is allowed.

The bends shall be lined internally in accordance with K358-ILF-OVA-PLG-ME-SPC-0002 Specification for Internal Lining of Line Pipe.

- p) Marking requirements shall be in acc. to section 12 of this Specification
- q) Packaging and Shipping preparation shall be in accordance with Manufacturer's detailed loading-, stacking- and shipping procedures, prepared in accordance to K358-ILF-OVA-PLG-ME-SPC-0004 Specification for Transportation, Handling and Storage of Line Pipe, which shall be submitted for approval by Company.

Manufacturer shall guarantee the integrity of the mainline bends during transportation and loading/offloading.

- r) Third-party inspection organization will be defined in contract
- u) Requirements for hardness testing see 10.4.4 and 10.4.5. Hardness will be checked on following locations for each bend:
- Bent Arc: neutral axis top, intrados, extrados. Location "neutral axis bottom" will be checked on 10% of hot bends.
 - Tangent Ends: once per tangent.

9 Manufacturing

9.1 Mother pipe (Supplement)

Applicable.

The mother pipe shall be supplied by the Manufacturer and shall comply with ISO 3183 PSL2 and K358-ILF-OVA-PLG-ME-SPC-0003 Specification for Line Pipes (LLI) and

K358-ILF-OVA-PLG-ME-DAT-0003 Data Sheet for Line Pipes and Mother Pipe for Hot Induction Bends (LLI).

Any deviations to the above documents shall be clearly stated at tender stage.

Manufacturer shall confirm the proposed mother pipe bend wall thickness as indicated in K358-ILF-OVA-PLG-ME-DAT-0003 Data Sheet for Line Pipes and Mother Pipe for Hot Induction Bends (LLI) to ensure maximum wall thinning tolerance. This shall either be verified or the required wall thickness stated by Manufacturer with its proposal during the bidding stage.

Before bending, the wall thickness on each length of pipe shall be measured to ensure the starting thickness will result in an acceptable final bend thickness. The maximum wall thickness shall not exceed 1.5 times the nominal wall thickness of the connecting pipe.

9.2 Qualification test bend

Applicable.

One MPQT bend is considered per dimension and material heat (approximately 200t) in line with Table 1.

9.3 Production bending (Amendment)

Applicable.

The longitudinal seam weld of the mother pipe due for bending shall be positioned at the neutral axis, with a maximum allowed offset of +/- 10°.

9.4 Post-bending heat treatment (Amendment)

Post bend heat treatment is applied to ensure that the mechanical properties of the hot bends will as a minimum equal the required strength properties of the mainline pipes.

The completed bends shall be heat treated.

The heat treatment procedure shall be agreed with the Company at tender stage.

9.5 Forming and sizing after bending (Amendment)

Any interruption to the bend forming operation shall not be permitted and shall result in the rejection of the bend.

Cold working or hot working operations carried out after bending and/or the final heat treatment, intended to meet the required dimensions, shall not be permitted. Local sizing up to maximum 1.5% plastic deformation is acceptable.

9.8 End preparation (Supplement)

The ends of the mainline hot bends shall be mechanically machined-beveled.

The transition in section thickness between the hot bend and the adjoining mainline pipe shall be overcome by chamfering the internal bend end with a maximum slope of 20° as is shown schematically in figure 1.

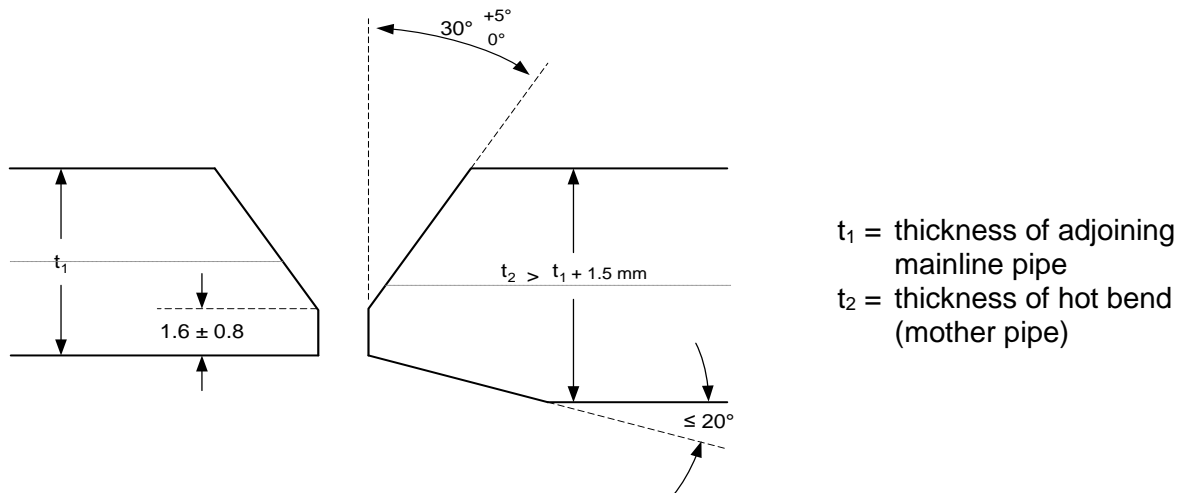


Figure 1. Welding End Transition

10 Testing and inspection (Supplement)

10.1 General requirements (Supplement)

Applicable.

The mainline bends shall be manufactured using a comprehensive quality system. Therefore, Manufacturer shall operate a quality management system in compliance with requirements of EN ISO 9001 which shall be approved and regularly supervised by competent authorities (i.e. Notified Bodies). Manufacturer shall present documentation to Company to demonstrate that an approved quality system is in use.

Manufacturer shall submit an Execution and Production Plan, a Quality Assurance and Quality Control Plan and a detailed Inspection and Test Plan (ITP) before start of production for approval by Company and/or third party.

Prior to fabrication of the bends, all procedures for testing shall also be subject to the approval of the Company and/or third party.

The bends shall be inspected and tested in accordance with this Specification and shall meet the requirements of this Specification and the referenced documentation. Testing and inspection shall be carried out on bends after final heat treatment.

During manufacturing all procedures for testing shall be available for review by the Company and/or third party.

Measuring and test equipment, as well as the qualification of inspection and test personnel, shall be in accordance with the requirements of the applicable Codes and Standards.

Manufacturer shall allow Company or its representative free access to the site for inspection at all stages during the manufacture of the hot induction bends.

10.3 Chemical composition (Amendment)

The chemical composition of each bend shall comply with the requirements for pipe of the same grade and type as specified in K358-ILF-OVA-PLG-ME-SPC-0003 Specification for Line Pipes (LLI).

10.4 Physical Testing (Supplement)

10.4.1 Charpy V-notch impact testing

The test temperature and test results shall meet the minimum requirements specified in ISO 3183 and K358-ILF-OVA-PLG-ME-SPC-0003 Specification for Line Pipes (LLI) and K358-ILF-OVA-PLG-ME-DAT-0003 Data Sheet for Line Pipes and Mother Pipe for Hot Induction Bends (LLI).

10.4.7 Drop-weight tear testing

Drop weight tear testing is not required.

10.4.8 Crack Tip Opening Displacement Tests

Crack tip opening displacement tests are not required.

10.5 Non-destructive testing (Supplement)

Applicable.

The acceptance criteria for NDT shall also comply with ISO 3183 and the K358-ILF-OVA-PLG-ME-SPC-0003 Specification for Line Pipes (LLI).

10.5.2 Weld Seam Testing

The complete length of the weld seam shall be subjected to radiographic testing (RT) in accordance with ISO 10893-6 or Ultrasonic Testing (UT) in accordance with ISO 10893-9 or agreed as equivalent.

Full length of any accessible weld seam shall also be examined using magnetic particle inspection.

10.5.3 Inspection of Bends Ends

Testing shall be by magnetic particle inspection.

Any internal longitudinal weld bead shall be ground flush for a distance of 100 mm from the end of bend.

A circumferential band 200 mm wide at the new bevelled end shall be manually ultrasonic examined for laminations.

10.5.4 Magnetic Particle Testing or Liquid Penetrant Testing on Bend Body

Bend body testing shall be by magnetic particle inspection.

Imperfection shall not be repaired by welding.

10.5.5 Ultrasonic Testing on Bend Body

MUT on bend body not required.

10.5.8 NDT Personnel

Personnel carrying out non-destructive inspection shall be experienced in using the equipment specified and shall be qualified to a minimum ASNT SNT TC 1A Level II (2) or an agreed equivalent for examination of base metal and welds.

The person responsible for the preparation of inspection procedure and supervision of inspection activities shall be qualified to ASNT SNT TC 1A Level III (3) or an agreed equivalent.

10.6 Dimensions (Amendment)

In addition to the requirements of Table 4 the dimensional tolerance on internal diameter, ovality, wall thickness and weld bevel at the ends shall comply with ISO 3183 PSL2 and the K358-ILF-OVA-PLG-ME-SPC-0003 Specification for Line Pipes (LLI) and K358-ILF-OVA-PLG-ME-DAT-0003 Data Sheet for Line Pipes and Mother Pipe for Hot Induction Bends (LLI).

Table 4: Permissible dimensional tolerances

Dimension	Permissible tolerance
Linear dimensions ^a	±30 mm (1.18 in)
Minimum wall thickness	Zero

Dimension	Permissible tolerance
Maximum wall thickness	+10%
Inside or outside diameter of bend ends	Acc. to K358-ILF-OVA-PLG-ME-SPC-0003 Specification for Line Pipes (LLI)
Inside diameter of bend arc and tangents	Acc. to section 10.7
Bend angle	$\pm 1^\circ$
Bend radius for bends with $r \geq 1\,000$ mm	$\pm 1\%$
End out-of-squareness	3 mm (0.118 in) max.
Out-of-planeness	1% OD
Out-of-roundness at ends	Acc. to K358-ILF-OVA-PLG-ME-SPC-0003 Specification for Line Pipes (LLI)
Out-of-roundness in bend body	2.5 % max.
^a Such as centre-to-end, offsets, chord lengths	

10.7 Gauging (Amendment)

The minimum permitted internal diameter of the bend shall be checked by a gauging plate consisting of two circular concentrically positioned, parallel plates. Gauging plate with 6 mm thickness (aluminium) separated by a length of one pipe diameter and 97% of nominal internal diameter of mother pipe shall be considered. The gauging plate shall be required to pass completely through the bend without obstruction.

10.8 Hydrostatic testing (Amendment)

Hydrostatic test shall be performed on one representative hot bend for each wall thickness at 100% of the minimum yield strength referred to the minimum specified wall thickness.

11 Inspection document (Amendment)

The finished mainline bends shall be furnished with inspection certificates according to EN 10204 Type 3.2, showing all chemical analysis required as well as the results of mechanical and dimensional tests, etc.

The certificate(s) shall be issued by Manufacturers' authorised inspection representative and shall be validated by Company's authorised inspection representative in accordance with the provisions of EN 10204.

12 Marking (Supplement)

Applicable.

Marking shall be paint stencilled on inside and outside surface of both ends.

The identification markings shall be as listed in Clause 12 of ISO 15590.

13 Documentation (Additional Clause)

One "Bend Book" shall be issued for each pipeline lot in which all information relating to the respective individual bends will be included. As a minimum the record shall contain the following information:

- Bend number
- Identification of steel charge
- Results of all production tests and inspections
- Identification and coordination of grinding operations and repairs

The format of the Bend Book and information of the Manufacturer bend and material tracking system have to be submitted for approval by Company before start of production.

The Bend Book is to be handed over by the Manufacturer to the Company after completion of the order.

Annex A

Applicable.

Annex B

Not Applicable.