



**NET4GAS, s.r.o**

**COMPRESSOR STATION JIRKOV  
73 BAR AND HSK  
NDT SPECIFICATION**

**22.12.2017**

**ILF CONSULTING ENGINEERS**

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**REVISION HISTORY**

000	22.12.17	Approved	Berger	Foltin	Schorling
B02	15.12.17	Re-Issue for Review	Foltin	Berger	Schorling
B01	31.10.17	Issue for Review	Fodor	Balatinec	Schorling
A01	20.10.17	Issue for IDC	Fodor	Foltin	Schorling
Rev.	Date	Issue, Purpose	Prepared	Checked	Approved

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## 1 GENERAL

### 1.1 Scope of the Document

This document specifies technical requirements, scope and acceptance criteria for nondestructive testing (NDT) during construction of the N4G facilities

This specification stipulates the requirements related to:

- Qualification requirements for NDT supplier
- Qualification requirements for testing staff for NDT
- Scope and conditions for NDT tests
- Requirements for individual testing methods
- Acceptance criteria for individual methods

In general, all works must be implemented in accordance to applicable standards, regulations and related standards, as amended by later regulations, which are effective at the moment of initiation of works.

### 1.2 Definitions

Term	Explanation
Project	Compressor Station Jirkov 73 bar and/or Capacity Extension of BTS Hora Sv. Kateřiny (HSK)
Employer	NET4GAS
Consultant	ILF Consulting Engineers
Supplier	Company having signed the contract with the Employer
Third party	Independent experienced and approved expert/authorized institute
Employer supervision	Performs activities appointed by the Employer or defined in the contract on behalf of the Employer

### 1.3 Abbreviations

Term	Explanation
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IQI	Image quality indicator
MT	Magnetic particle testing
MUT	Manual ultrasonic testing
NDT	Non-destructive testing
PA	Phased array
PT	Liquid penetrant testing
RT	Radiographic testing
RT-I	RT (isotope)
TIG	Tungsten inert gas welding
TOFD	Time-of-flight diffraction
UT	Ultrasonic testing
UT2	Ultrasonic testing level 2
VT	Visual testing
WPS	Welding Procedure Specification
WPR	Welder Performance Qualification
pWPS	Preliminary Welding Procedure Specification

#### 1.4 References

Refer to the Project documents listed in the tender package for the NDT testing.

#### 1.5 Codes and Standards

No.	Number	Title
1	ČSN EN ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel
2	ČSN EN ISO 17635	Non-destructive testing of welds - General rules for metallic materials

No.	Number	Title
3	ČSN EN 13480-5	Metallic industrial piping - Part 5: Inspection and testing
4	ČSN EN 13018	Non-destructive testing - Visual testing - General principles
5	ČSN EN 13927	Non-destructive testing - Visual testing - Equipment
6	ČSN EN ISO 17637	Non-destructive testing of welds - Visual testing of fusion-welded joints
7	ČSN EN ISO 5817	Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections
8	ČSN EN ISO 5579	Non-destructive testing - Radiographic testing of metallic materials using film and X- or gamma rays - Basic rules
9	ČSN EN ISO 17636-1	Non-destructive testing of welds - Radiographic testing - Part 1: X-and gamma-ray techniques with film
10	ČSN EN 13068-3	Non-destructive testing - Radioscopic testing - Part 3: General principles of radioscopic testing of metallic materials by X- and gamma rays
11	ČSN EN ISO 11699-1	Non-destructive testing - Industrial radiographic film - Part 1: Classification of film systems for industrial radiography
12	ČSN EN ISO 19232-1	Non-destructive testing - Image quality of radiographs - Part 1: Determination of the image quality value using wire-type image quality indicators
13	ČSN EN ISO 10675-1	Non-destructive testing of welds - Acceptance levels for radiographic testing - Part 1: Steel, nickel, titanium and their alloys
14	ČSN EN 25580	Non-destructive testing. Industrial radiographic illuminators. Minimum requirements (ISO 5580)

No.	Number	Title
15	ČSN EN ISO 16810	Non-destructive testing - Ultrasonic testing - General principles
16	ČSN EN ISO 16828	Non-destructive testing - Ultrasonic testing - Time-of-flight diffraction technique as a method for detection and sizing of discontinuities
17	ČSN EN ISO 17640	Non-destructive testing of welds - Ultrasonic testing - Techniques, testing levels and assessment
18	ČSN EN ISO 11666	Non-destructive testing of welds - Ultrasonic testing - Acceptance levels
19	ČSN EN 12668	Non-destructive testing - Characterization and verification of ultrasonic examination equipment
20	ČSN EN ISO 16811	Non-destructive testing - Ultrasonic testing - Sensitivity and range setting
21	ČSN EN ISO 2400	Non-destructive testing - Ultrasonic testing - Specification for calibration block No. 1
22	ČSN EN ISO 7963	Non-destructive testing - Ultrasonic testing - Specification for calibration block No. 2
25	ČSN EN ISO 23279	Non-destructive testing of welds - Ultrasonic testing - Characterization of indications in welds
26	ČSN EN ISO 10863	Non-destructive testing of welds - Ultrasonic testing - Use of time-of-flight diffraction technique (TOFD)
27	ČSN EN ISO 15626	Non-destructive testing of welds - Time-of-flight diffraction technique (TOFD) -Acceptance levels
28	ČSN EN ISO 9934-1,2,3	Non-destructive testing - Magnetic particle testing
29	ČSN EN ISO 17638	Non-destructive examination of welds - Magnetic particle testing
30	ČSN EN ISO 23278	Non-destructive examination of welds - Magnetic particle testing - Acceptance levels

No.	Number	Title
31	ČSN EN ISO 3059	Non-destructive testing - Penetrant testing and magnetic particle testing - Viewing conditions
32	ČSN EN ISO 3452-1	Non-destructive testing - Penetrant testing - Part 1: General principles
33	ČSN EN ISO 3452-3	Non-destructive testing - Penetrant testing - Part 3: Reference test blocks
34	ČSN EN ISO 3452-2	Non-destructive testing - Penetrant testing - Part 2: Testing of penetrant materials
35	ČSN EN ISO 23277	Non-destructive examination of welds - Penetrant testing - Acceptance levels
36	ČSN EN ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories
37	ČSN EN ISO 6520-1	Welding and allied processes - Classification of geometric imperfections in metallic materials - Part 1: Fusion welding
38	ČSN EN ISO 5817	Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections
39	ČSN EN 12732	Gas infrastructure - Welding steel pipework - Functional requirements
40	TPG 702 04	Gas mains and service pipelines of steel for maximum operating pressure up to 100 bar included
41	TP-T01-01-01-03	Principles for the design, construction, reconstruction and repair of HP pipelines and connections up to 100 bar

All the referenced related standards and technical rules, as amended by later regulations, applicable at the moment of initiation of activities.

## 1.6 Priority of regulations, exceptions

The Supplier must notify the Employer supervision/Third party, prior to initiation of activities, of any discrepancies between this specification, related documents, standards,

codes and technical rules listed above or any other specifications involved in the selection procedure. In such cases, the Employer supervision/Third party shall provide a written precedence decision and/or comment prior to initiation of construction/activity.

## 2 QUALIFICATION REQUIREMENTS FOR NDT SUPPLIER

The Supplier providing NDT must be accredited as per ČSN EN ISO / IEC 17025. at least 60 days before the initiation of works, the NDT Supplier shall prepare and submit for Employers/Third party's approval the technical conditions for implementation of individual NDT methods in the following minimum scope:

- Identification data
- Proprietary instrument equipment
- Calibration
- Testing procedures for each individual NDT method, (so-called written procedure)
- Method statements / Instruction sheets for individual NDT methods
- Test reports
- Qualification of internal staff with professional CVs

The Supplier shall be certified and authorized by the State Office for Nuclear Safety, which is necessary for permission to handle ionization radiation sources:

- Controlled zone at transition workplaces
- Internal emergency plan
- Quality Assurance for activities important in terms of radiation protection
- Monitoring program
- Permission for handling ionization radiation sources
- and other documents as per Act No. 18/1997 Coll.

The NDT Supplier must compile detailed testing procedures, so-called written procedures for individual NDT methods. These include documents containing detailed descriptions for the execution of individual NDT methods, which must be approved by a Level 3 employee.

The NDT Supplier and Employer (or Employer supervision ) are the only persons authorized to carry out all NDT inspections for Quality Control of welding works during construction (this does not apply to visual inspections).

The NDT Supplier must issue weekly (or monthly) reports on NDT results. Shall be agreed on the regular weekly coordination meeting on site.

The format of the reports shall be approved by the Employer or Employer supervision

Reports on the tests shall be issued by a technician with minimum Level 2 as per ČSN EN ISO 9712.

The Employer and Third party, with the minimum qualification of Level 2 as per ČSN EN ISO 9712, are authorized for supervision including interpretation of results and final approval.

The Employer and Third party are authorized for evaluation and the final decision in terms of interpretation of doubtful indications.

For the quality control of welded joints, the following methods shall be used:

- Visual testing (VT)
- Radiographic testing (RT) - RT-I (isotope), Manual ultrasonic testing (MUT) including tests using UT technology TOFD
- Magnetic particle testing (MT)
- Liquid penetrant testing (PT)

### **3 QUALIFICATION REQUIREMENTS FOR TESTING STAFF FOR NDT**

Non-destructive testing of welds shall be carried out by qualified staff in accordance with ČSN EN ISO 9712.

- Visual inspections of all welds must be ensured by a technician with Level 2 qualification as per ČSN EN ISO 9712.
- Radiographic tests must be carried out by operators with minimum Level 1 qualification as per ČSN EN ISO 9712. These tests must be carried out under supervision of a technician with minimum Level 2 qualification as per ČSN EN ISO 9712.
- Interpretation and evaluation of radiographic testing results must be carried out by technicians with Level 2 qualification as per ČSN EN ISO 9712.
- Ultrasonic tests, magnetic particle tests and liquid penetrant tests, including interpretation and evaluation of results, must be carried out by technicians with minimum Level 2 qualification as per ČSN EN ISO 9712 for given method.

The Supplier's staff carrying out interpretation of RT and UT results must have five-year experience with this work as the minimum.

The Supplier must employ or appoint at least one NDT operator with Level 3 qualification as per ČSN EN ISO 9712, who shall prepare and ensure the management of the

Supplier's NDT procedures, ensuring an employee(s) for interpretation of doubtful indications with Level 3 qualification as per ČSN EN ISO 9712 for given method.

The Employer and Third party are authorized to verify the qualification of the staff carrying out non-destructive tests and related activities complying with the testing procedures.

## **4 SCOPE AND CONDITIONS OF NDT TESTS FOR INDIVIDUAL TYPES OF WELDS OR MATERIALS**

### **4.1 Testing methods**

Depending on the specific Project conditions, NDT equipment and staff availability, welding method and the technology used, the testing method shall be carried out as specified in the Chapter 4.2 of this specification

The testing method selected for girth welds must be capable of producing permanent records from tests as well as permanent records of test results including appropriate reports. For other tests, the progress and results shall be recorded in test reports. The testing methods shall be selected prior to start of welding by the Employer and Third party.

The Employer and the Third party are always ultimately entitled to decide on the NDT method for individual welds and to make the final decision in case of interpretation of doubtful indications.

### **4.2 Scope of non-destructive testing**

The minimum scope of non-destructive testing for individual weld types and welding methods must meet the application design and welding standards and requirements listed in the table below.

#### **Scope of non-destructive testing**

Type of weld inspection	Inspected item	Scope of non-destructive testing			
		VT	RT-I	MUT/ TOFD (6)	MT/ PT
I	Linear girth butt welds executed using mechanical welding method <b>(a)</b>	100%	100%	-10%	(1)
II	Linear girth butt welds executed using manual welding method <b>(b)</b>	100%	100%	-10%	(1)
III	All other linear butt welds executed using manual welding method <b>(c)</b>	100%	100%	(1)	(1)
IV	Golden Welds <b>(d)</b>	100%	100%	100%	(1)
V	Repaired parts of any weld	100%	100%	100%	100% (2)
VI	Branch connections and fillet	100%	-	(3)	100%
VII	Welds on weld-on fittings of TDW type girth welds	100% 100%	-	100%	100% 100%
VIM	Selection of location for branch offsets, possibly for execution of pipe connection lines	100%	~	100%	100%
IX	Field bevels	100%	-	100%	100% (4)
X	Arc strikes and crater cracks	100%	-	100%(5)	100% (2)

Comments:

RT-I - isotope radiography using Ir 192 for material thickness  $\geq 10$  mm.

MUT manual ultrasonic method/TOFD can only be used for thickness  $t \geq 8$  mm.

For weld repairs, refer to the Chapter 7.

- a) Welding in protective atmospheres, which allows the root layer to be welded using manually covered electrode or TIG method.
- b) Manual welding using covered (basic) electrode + welds listed in (a) and welds designated by the Employer or a Third party.

- c) Transition welds between pipes of different thickness, connection line welds, T-piece welds, bends, reducers, fittings etc.
- d) Welds not subjected to water pressure test and welds in protective tubing/protective pipes. (Golden/Guarantee Welds)
- e) For interpretation of doubtful indications if required
- f) To ensure elimination of the defect (prior to weld repair)
- g) If practicable
- h) If flame cutting was used
- i) for verification of residual wall thickness after grinding
- j) Application is specified in the next chapters of this specification

#### **4.3 Allowed Moment of the NDT test**

Usually, NDT of welds follows after the final thermal treatment and cool down of the weld. The moment of test can be modified based on Employer's written approval. For Golden Welds, the NDT is carried out after the minimum delay of 12 hours.

#### **4.4 Weld identification**

Each weld shall be assigned a unique identification number. In each weld, a zero point shall be marked, corresponding to the pipe top, and testing direction (marked in the direction of gas flow). This also applies to welds to be cut out. Any faults and defects subject to rejection shall be clearly marked on the pipe weld in a suitable manner, e.g. by a permanent marker pencil (indelible ink), prior to the weld repair shall be done.

#### **4.5 Welding procedure qualification and testing**

Prior to start of production each preliminary welding procedure, pWPS, shall be qualified according to ČSN EN ISO 15614-1 including the additional requirements given in this specification.

The qualification test shall be carried out on steel with the highest specified minimum yield strength/maximum carbon equivalent, to be covered by the necessary WPS.

Welding of test joints covering all welding, including joints between structural elements and piping components and repair welding, shall be done under conditions similar to site conditions.

All results from the qualification test shall be reported and documented by the WPQR (including attachments) which shall be submitted to Employer / Third party for approval.

The test joints shall be 100% visually, radiographically as well as ultrasonically tested complying with this specification.

Based on the NDT results the Employer / Third party can decided to carry out the mechanical testing provided in the scope of welding qualification process. The mechanical testing shall included but is not limited to the Macro Examination, Hardness Test and Notch Toughness Test /Charpy V-impact test.

#### **4.6 Support and coordination of work on site**

NDT Supplier is required to provide necessary support to the station contractor during execution of construction work. The responsible manager / Work coordinator of NDT Supplier shall take part on the regular weekly site- coordination meetings and participant in the preparation of detailed time schedules and work organization between both parties.

### **5 NON-DESTRUCTIVE TESTING**

#### **5.1 Visual inspection (VT)**

All welds and weld repairs must be subjected to full-scope visual inspection, which shall be carried out as per ČSN EN ISO 17637.

The visual inspection shall be carried out by the contractor through a technician with Level 2 qualification as per ČSN EN ISO 9712, both in the course and after finalization of the weld. This will guarantee the weld quality for further NDT; the visual inspection will be permanently recorded next to the weld, specifying the date and result of the inspection.

The visual inspection shall include the weld head, both heat affected zones and - if possible in terms of safety - the internal surfaces (roots). The inspection must be carried out under acceptable conditions, namely with respect to illumination of the weld surface (minimum 350 lx, recommended 500 lx).

Acceptance or rejection of any weld must be recorded in the visual inspection report. The report format must be approved by the Employer in advance.

In case of cracks or other damage, the technician shall report this fact to the Employer supervision/Third party. If the weld execution is not acceptable, a thorough inquiry of the cause will take place. Further welding/repair work on the existing welds can only start after the cause of any defects is found and necessary corrective measures are taken. If necessary, the Employer representative or Third party shall decide on re-qualification of WPS. The new initial condition shall be reconfirmed by a new visual inspection.

### 5.1.1 Equipment

Product irregularities or defects are found either by visual assessment without any aids, or using simple aids (magnifying glasses, surface etalons, gauges, templates, weld scales, angle gauges, test plates etc.), or using complex technical devices/instruments (endoscopes, cameras/video-cameras etc.). In both cases, however, the inspected surfaces must be sufficiently illuminated by daylight or - mostly - artificial light. Testing devices and equipment shall be in accordance with ČSN EN 13927. The inspection must be carried out using aids with respected industrial quality level.

### 5.1.2 Required documentation of NDT

The test report must contain the following data as the minimum:

- Name of manufacturer of welded parts
- Name of test room, if different from a)
- Identification of inspected parts
- Material
- Weld type
- Material thickness
- Welding method
- Acceptance criteria
- Defects exceeding the acceptance limits incl. their locations
- Scope of inspection with references to appropriate drawings
- Equipment used for inspection
- Inspection results with references to acceptance criteria
- Inspection date/place
- Name, valid qualification and signature of the technician who carried out the test

### 5.1.3 Acceptance criteria

Any defects found must be marked as per ČSN EN ISO 6520-1. The weld itself as well as the adjacent surfaces must not show any cracks, craters, pits or other surface defects and shall be executed in accordance with ČSN EN ISO 5817, Quality Level B.

## 5.2 Radiographic testing (RT)

The radiographic test must be carried out as per ČSN EN ISO 17636-1 (Test Class B) and ČSN EN ISO 5579.

The tests shall be performed using gamma rays with iridium-192 or selenium-75 as the gamma source.

Supplier of NDT must have at least 3 isotope emitters Ir 192 with activity at least 50 Ci. The Employer can request the NDT Supplier of isotope emitters Ir 192 with activity at least 80 to 90 Ci, notably through two walls of Radioscopy of large diameters and wall thicknesses of the pipes.

The acceptable ranges of material thickness for gamma rays are provided in Table 2 of ČSN EN ISO 17636-1. The Employer permits reducing these values to 10 mm (for Ir 192) or 5 mm (Se 75). For thickness under 10 mm, Se 75 must be used as the radiation source. All deviations are subject to Employer approval.

Radiographic tests shall be carried under the pipe surface temperatures ranging from 0 to +50°C. The surface must be free of welding spray, varnishes, oxides or other substances that could impair the defect detection process. Radiographic testing can only be started after confirming of the sensitivity/quality of this method on specific welds (usually, on welds executed as part of qualification of the welding procedure).

If the radiographic test takes place in the vicinity of a steel structure or concrete floor or another concrete surfaces, the film must be shielded from the back-scattered radiation using a lead shield of sufficient thickness. The presence of back-scattered radiation must be confirmed for every other test by a lead character „B" as per ČSN EN ISO 17636-1.

Layout of the radiographic test must be set up so as to achieve the maximum detection rate of unacceptable defects. For all girth welds, the centric radiography layout is preferred, with the radiation source situated inside the pipeline. In case this radiography layout cannot be used for technical reasons (Golden Welds, inaccessible welds, certain welds in stations etc.), it is necessary to use the method of irradiation through two walls, capturing the image of a single wall. Radiographic test shall also include the repaired parts of welds and adjacent parts of welds over the minimum length of 100 mm. The selected radiography layout must allow full-scope inspection of the weld and minimum width of the evaluated area of 10 mm on both sides of the weld edge.

### 5.2.1 Equipment

For radiographic test, a lead tape measure shall be used around the pipe perimeter to exactly determine the position of weld defects.

The test start - so-called zero point - shall be identical to the top point of the pipe; the measurements shall proceed in the direction of gas flow. This direction shall be marked on the pipeline using an indelible paint, starting from the top. A record of the radiographic test shall be permanently marked next to the weld, specifying the date of inspection.

The films used for testing shall be of sufficient quality in accordance with ČSN EN ISO 11699-1. It is mandatory to use Class C4 films as per ČSN EN ISO 17636-1.

The minimum radiogram blackening for Class B is 2.3; the maximum value depends on the limits of the negatoscope used. The maximum permitted fogging is 0.3.

The radiographic sensitivity must be evaluated using wire indicators for image quality control as per ČSN EN ISO 19232-1. The image quality must achieve Class B as per ČSN EN ISO 7636-1.

When capturing pipeline with a diameter of 200 mm or larger in centric layout, it is mandatory to use at least 3 image quality indicators deployed along the pipe perimeter in regular intervals. The films where the image quality indicators are displayed are considered as typical images for the entire perimeter.

The films shall be developed under the conditions recommended by the film manufacturer, using chemicals needed for the required film system class.

The radiograms shall be displayed, evaluated and assessed using a negatoscope with infinitely adjustable illumination intensity, which allows reception of information under various (acceptable) blackening values as per ČSN EN 25580.

Each radiogram shall be clearly marked with designations (the designation must consist of numbers and letters included in the frame together with given weld). Each weld repair must be marked at the weld in the radiogram as well as in the report by the character "R".

The radiograms must be identifiable, as the minimum, by the reference number of the pipeline, weld number, date of radiographic test and repair reference number.

The weld position must be indicated for all welds in the pipe book with references to the numbering system described above. The conformity of the pipe book with weld positions shall be ensured by the Supplier.

After finishing the construction Project, all radiograms and related reports must be indexed, catalogued, packed in boxes and handed over to the Employer as part of the documentation package.

Acceptance or rejection of any weld must be recorded in the radiographic test report. The report format must be approved by the Employer in advance.

## 5.2.2 Required documentation of NDT

The test report must contain the following data as the minimum:

- Name of test room
- Object
- Material
- Thermal treatment

- Weld geometry
- Material thickness
- Welding procedure
- Test specification incl. acceptance requirements
- Radiography layout and class, required sensitivity of image quality indicators (IQI) as per ČSN EN ISO 17636-1
- Test layout as per Chapter 6.1 of ČSN EN ISO 17636-1
- Method of designation used
- Scheme of film layout
- Radiation source, type and size of radiation centre and identification of the equipment used
- Film, foil and filters
- Voltage/current of X-ray tube or source activity
- Exposure period and source/film distance
- Method of film development: manual/automatic
- Type and layout of image quality indicators (IQI)
- Test results with final assessment: acceptable/unacceptable
- Film blackening, information of image quality indicator (IQI)
- Deviations from regulatory requirements
- Name, certificate and signature of the person in charge
- Date of radiographic testing and test report

### 5.2.3 Acceptance criteria

Any defects found must be marked as per ČSN EN ISO 6520-1. Any defects found out during radiographic test shall be assessed as per ČSN EN ISO 10675-1, Acceptance Level 1.

## 5.3 Ultrasonic testing (UT)

Ultrasonic tests are namely used to detect planer defects such as cracks, cold joints and laminations, to measure wall thickness and to detect larger separated volume defects in the material. The test also allows detection and evaluation of defects in the basic material as well as the welded joints.

Ultrasonic testing can only be carried out under the pipe surface temperature ranging from 0 to +50 °C with respect to the coupling, which must ensure constant possibility of actual defect detection rate (reduced coupling means lower detection rate). The surface shall be free from welding spray, varnishes, oxides or other substances that may determine a different absorption from that obtainable from the sample calibration piece. Especially the application of time-of-flight diffraction (TOFD) requires relatively smooth, flat and clean surfaces.

Furthermore, the system must offer suitable tools for storage, analysis and visual presentation of data. Ultrasonic testing shall be carried out by manual ultrasonic testing (MUT) and manual ultrasonic TOFD testing. The probes shall be clearly marked with the manufacturer's name, sensor type, frequency and angle.

Acceptance or rejection of any weld must be recorded in the ultrasonic test report. The report format must be approved by the Employer in advance.

A record of the MUT/TOFD test shall be permanently marked next to the weld (indelible ink), specifying the date of inspection.

#### 5.3.1 Manual ultrasonic test (MUT)

The manual ultrasonic test must be carried out as per ČSN EN ISO 17640 (Test Class B) and ČSN EN ISO 16810.

Apart from using the conventional ultrasonic equipment, the NDT Supplier must be capable of providing weld testing using a manual TOFD ultrasonic instrument. The TOFD method shall be mainly used for testing of Golden Welds and selected welds of the pipeline DN900 constructed as part of scope of work Compressor Station Jirkov. TOFD tests must be carried out as per ČSN EN ISO 10863, Test Class C, and ČSN EN 12732, Annex C, with assessment as per ČSN EN ISO 15626, Acceptance Level 1. UT-TOFD technique - subject to approval by Employer.

The system of ultrasonic tests including the probes used must meet the minimum requirements specified in ČSN EN 12668-1, -2 and -3.

The sensitivity (size of defects) must be determined based on method No. 2 (AVG) as per ČSN EN ISO 17640 and ČSN EN ISO 16811.

MUT shall be used for selection of places for welding any branches, i.e. for fillet welds, to eliminate laminations in the material; the detailed test scope is specified in Chapter 4.2.

If flame cutting is used on pipe ends, the new bevel shall be prepared in accordance with the approved procedures. If the pipe is cut back more than 25 mm from the factory bevel, the pipe end shall be MUT tested, too, to ensure that no laminations are present.

After removal of arc burns by grinding the defective area shall be examined by MUT to guarantee the compliance with the minimum pipe thickness requirement.

### 5.3.1.1 Acceptance criteria

Any defects found by ultrasonic tests must meet the Acceptance Level 2 as per ČSN EN ISO 11666. Sizing defects using TOFD must be carried out in accordance with the provisions of ČSN EN ISO 15626 degree of acceptability 1 including mutual distances and grouping indications, summary length (frequency) and the number of point indications.

### 5.3.2 Required documentation of NDT

The test report must contain the following data as the minimum:

- Identification of tested object
- Product materials and shapes Dimensions
- Position of weld/tested welded joint
- Drawing of geometric layout (if needed)
- Reference to welding procedure, specification and thermal treatment
- Manufacturing condition
- Surface condition
- Object temperature
- Contractual requirements, e.g. specifications, directives, special agreements etc.
- Place and date of test
- Identification of testing body and identification and certification of operator
- Manufacturer and type of ultrasonic instrument with identification number
- Manufacturer, type, nominal frequency, converter dimensions and actual incidence angle of the probes used
- Identification of reference gauges used
- Couplant
- Test class(es) and reference to written procedure, if used
- Testing scope
- Positioning of testing surfaces
- Reference points and details for the coordinate system used
- Identification of probe positions
- Scope of time base
- Method and values used for sensitivity adjustment (adjustment of amplification for reference levels and values used for correction of transitional losses)

- Reference levels
- Results of tests of basic material
- Standards for Acceptance Levels and reference to the international standard ČSN EN ISO 17640
- Deviations from international standard ČSN EN ISO 17640 or from contractual requirements
- Coordinates of indications with detailed data on the probes used and corresponding probe positions
- Maximum echo amplitude and information on the type and size of indications
- Indication lengths and level of exceeding the registration level
- Assessment results in accordance with the specified Acceptance Levels

#### 5.4 Magnetic particle testing (MT)

Magnetic particle testing must be carried out as per ČSN EN ISO 17638 with respect to the requirements of ČSN EN ISO 3059.

Prior to test commencement, the tested surfaces shall be ground and free of welding spray, oxides, slag, oil or other residual substances and must not contain any notches or scratches that could have an adverse impact on the test results.

The tests shall be carried under the pipe surface temperatures ranging from 0 to +50°C.

Magnetic particle testing must ensure complete elimination of defects (namely cracks) prior to welding.

Magnetic particle testing can be used as a complement to radiographic testing as well as for the interpretation of doubtful indications in radiograms.

Magnetic particle testing shall be used for all fillet welds for selection of locations of welded-on pieces, inspection of welded-on joints and elimination of cracks on the pipe surface; see the nondestructive testing scope, Chapter 4.2.

Acceptance or rejection of any weld or bevel must be recorded in the magnetic particle test report. The report format must be approved by the Employer in advance. If an unsatisfactory indication is found, it must be photographed and the picture must be filed with the MT report. Prior to test commencement, the sensitivity/quality of this method shall be verified on specific welds. This verification can also be carried out on welds executed as part the welding procedure qualification. A record of the magnetic particle test shall be permanently marked next to the weld, specifying the date of inspection.

#### 5.4.1 Equipment

The test must be carried out using aids with respected industrial quality level. The dry powder can only be used with written consent of the ordering party. The testing equipment and instruments shall be in accordance with ČSN EN ISO 9934-3 and ČSN EN ISO 9934-2.

#### 5.4.2 Required documentation of NDT

The test report must contain the following data as the minimum:

- Name of company carrying out the test
- Tested object
- Date of test
- Basic material and weld material
- Possible thermal treatment after welding
- Joint type
- Material thickness
- Welding procedure
- Temperature of tested object, if different from normal ambient temperature
- Identification of testing procedure and description of used parameters including:
  - Magnetization type
  - Current type
  - Testing aid
  - Displaying conditions
- Details and results of verification of the testing procedure used
- Acceptance Levels
- Description, dimensions and position of all indications found + photographs of all indications found should be attached to the report
- Names, valid qualification and signatures of the persons who carried out the test

#### 5.4.3 Acceptance criteria

Indications found by magnetic particle testing must meet the requirements defined in ČSN EN ISO 23278, Acceptance Level 2X.

## 5.5 Liquid penetrant testing (PT)

Liquid penetrant testing must be carried out as per ČSN EN ISO 3452-1.

Prior to test commencement, the tested surfaces shall be ground and free of welding spray, oxides, slag, oil or other residual substances and must not contain any notches or scratches that could have an adverse impact on the test results.

Liquid penetrant testing shall be used for all fillet welds for selection of locations of welded-on pieces, inspection of welded-on joints and elimination of cracks on the pipe surface; see the nondestructive testing scope, Chapter 4.2.

The tests shall be carried under the pipe surface temperatures ranging from +5 to +50°C.

Acceptance or rejection of any weld must be recorded in the liquid penetrant test report. The report format must be approved by the Employer in advance. If an unsatisfactory indication is found, it must be photographed and the picture must be filed with the PT report. Prior to test commencement, the sensitivity/quality of this method shall be verified on specific welds. This verification can also be carried out on welds executed as part the welding procedure qualification. A record of the liquid penetrant test shall be permanently marked next to the weld, specifying the date of inspection.

### 5.5.1 Equipment

The test must be carried out using aids with respected industrial quality level. The pigment used must be neutral in terms of development of any form of corrosion. In case the corrosion characteristics and other properties of the pigment in combination with the pipe material are not known it is necessary to carry out corrosion and other tests complying with ČSN EN ISO 3452-2. Control indicators shall be used in accordance with ČSN EN ISO 3452-3.

### 5.5.2 Required documentation of NDT

The test report must contain the following data as the minimum:

- Data on tested part
  - Designation
  - Dimensions
  - Material
  - Surface condition
  - Production stage
- Purpose of test

- Designation of the penetration system used, name of manufacturer, designation and batch number of agent
- Testing regulations
- Deviations from testing regulations
- Test record (description, position, dimensions and evaluation of the indications found) + photographs of the indications found attached to the report
- Place/date of test
- Name, valid qualification and signature of the technician who carried out the test

### 5.5.3 Acceptance criteria

Indications found by liquid penetrant testing must meet the requirements defined in ČSN EN ISO 23277, Acceptance Level 2X.

## 6 GOLDEN WELDS

Golden Welds, i.e. welds not subjected to water pressure test, shall be subjected to the following NDT inspection:

- Visual inspection, which must be carried out as per ČSN EN ISO 17637, with evaluation in accordance with ČSN EN ISO 5817, Quality Level B.
- Radiographic test, which must be carried out as per ČSN EN ISO 17637-1 (Test Class B), with evaluation in accordance with ČSN EN ISO 10675-1, Acceptance Level B.
- Manual ultrasonic test using the TOFD method, which must be carried out as per ČSN EN ISO 10863, Test Class C, and ČSN EN 12732, Annex C, with assessment as per ČSN EN ISO 15626, Acceptance Level 1. TOFD method can only be used if the Golden Weld joins walls thickness difference is less than 3,5 mm.
- If the Golden Weld joins walls of thickness higher than 3,5 mm (weld joint by ball valves elbows or other fittings) the golden weld shall be manual ultrasonic tested from one site only with two or three angles of taper. Manual ultrasonic testing shall comply with ČSN EN ISO 17640 (class B), ČSN EN ISO 16810 with evaluation acc. to ČSN EN ISO 11666 acc. level 2. Manual ultrasonic testing relating to different wall thicknesses is subject to method statement approval by Employer / Third party.

## **7 WELD REPAIRS**

Weld repairs must be carried out using the same NDT method as during tests.

All repairs of butt girth welds must be subjected to radiographic test and manual ultrasonic test using TOFD method. If the weld was tested with both methods RT and UT-TOFD (most often Golden weld) the repair weld must also be tested with the same methods RT and UT-TOFD.

The requirements for these methods are identical to Chapter 5.

## **8 DESTRUCTIVE WELD TESTS**

Destructive weld testing shall be provided in the selected weld connections especially on the station piping DN900 and DN700 Quantity and weld joint selection is subject to Employer / Third party decision.

The weld cut-outs for destructive tests, preparation of samples from such welds and subsequent re-welding shall be ensured by the station contractor in the presence of the Third party. The subsequent destructive tests shall be ensured by the Third party through a company, which must be accredited and approved by the Employer in advance.

## **9 NDT IN STATIONS**

All butt girth welds executed in stations must be subjected to full-scope visual inspection and full-scope radiographic test. Golden Welds executed in stations must be subjected to full-scope visual inspection, full-scope radiographic test and full-scope TOFD ultrasonic test. . Prior to welding any fillet weld, the location of weld shall be selected using manual ultrasonic test to eliminate laminations in the material, and magnetic test to eliminate cracks on the pipe surface. All field fillet welds must be subjected to full-scope visual inspection and full-scope magnetic particle test or full-scope liquid penetrant test. The requirements for these methods are identical to Chapter5.

### **9.1 Selection of locations for branch welding**

Prior to welding any branch, i.e. fillet weld, the location must be tested using the magnetic particle method to eliminate surface cracks, and manual ultrasonic test to eliminate laminations in the material. Magnetic particle testing shall be carried out as per ČSN EN ISO 10893 evaluation level M2., Manual ultrasonic tests must be carried out and evaluated as per ČSN EN ISO 10893-9, Acceptance Level U1.

## 10 CLIMATIC CONDITIONS

In case of wind, rainfall, snowing, low temperatures etc., NDT must be suspended unless appropriate protective measures are taken. These measures can include suitable shelters for the testing staff and for locations under tests. For this purpose, the NDT Supplier must ensure that these shelters are enclosed on all sides; the shelters can be used at various places of testing. Possible solutions include tents. Under temperatures below freezing point, a heat source shall be used or it is necessary to select a suitable method allowing the tests and evaluation to be carried out. Under temperatures below freezing point, it is not acceptable to use testing methods, where there is a risk of freezing or impaired quality of evaluation. The NDT Supplier shall be equipped with sand and salt for frost protection during winter season. If the NDT inspector finds out that the measures taken are not sufficient, they can suspend the NDT until all faults are eliminated and new corrective measures are taken. If the ambient temperature drops below 5°C, special safety measures shall apply. If it is not possible to ensure that NDT is carried out at a sufficient quality level, the pipe welding works shall also be suspended.

## 11 NON-DESTRUCTIVE TEST REPORT

The NDT Supplier shall issue regular weekly and monthly reports, containing data on the progress, implementation and results of NDT. On finishing of the construction Project, a final report shall be prepared, informing on the quality level of the NDT works carried out during the entire Project.

The final reports shall be provided in four executions, which will be distributed as follows:

- 1 copy for the Employer supervision
- 1 copy for the Project contractor
- 1 copy for the Supplier (NDT Supplier)
- 1 copy for the Third party

Format of the reports must be approved by the Employer in advance.

### 11.1 Required documentation

#### Documentation available during the entire construction Project:

- Instruction sheets for all NDT methods
- Test reports for all NDT methods
- Calibration reports for the NDT equipment used

#### Documentation to be handed over on finishing of construction Project:

- List of all reports on the construction with hard copy as well as electronic version of all reports
- Software for viewing and control of measured data from AUT/TOFD tests incl. necessary license
- Radiographic films
- Digital records from TOFD manual ultrasonic tests
- Table indicating the numbers of welds tested using appropriate NDT methods
- Overall quality assessment of the construction Project
- Test reports for all NDT methods shall be distributed as follows:
  - 1 hard copy at the construction site office
  - 1 shared electronic version (sent by e-mail or stored on a shared server)

## 12 WORK SAFETY REQUIREMENTS DURING NDT

During the work activities, the Supplier shall ensure expert supervision over observance of work safety rules.

The NDT Supplier shall, in a demonstrable manner, inform the staff (NDT testing staff) of the work safety and risk prevention requirements during the work as per the applicable laws and standards.

In terms of monitoring the internal irradiation, it is necessary to focus on the key moments of such activity, which namely include:

- Ensuring sufficient quality of the measurement laboratories for direct as well as indirect measurements
- Inspections of observance of the prescribed procedures
- Definition of responsibilities of individual persons, organization structure
- Staff training and knowledge verification system
- Quality of registration/result notification system
- Observance and inspection of notification duties towards the State Office for Nuclear Safety
- Internal measurement control system, quality of measurement results archiving system
- Required documentation
- Participation in national and international benchmarking

Act No. 18/1997 Coll., on Peaceful Utilization of Nuclear Energy and Ionizing Radiation (the Atomic Act), as amended by later regulations

State Office for Nuclear Safety Decree No. 132/2008 Coll., on Quality Assurance System in Performing and Ensuring Activities Related to the Utilization of Nuclear Energy and Radiation Activities, and on Quality Assurance of Selected Equipment with Regard to their Ranking into Safety Classes.