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TECHNICAL SPECIFICATION

HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

PRESSURE TESTING

JUNE 2021

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Rev.	Date	Description
0	05/04/2011	First Issue (as Spec 181/2)
1	30/06/2021	Second Issue validated from TPI

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1. SCOPE AND OBJECTIVES

This specification covers pressure testing of natural gas transmission lines with design pressure up to / and 80 bar. The pressure testing described herein shall be witnessed and approved by the appointed Project TPI based on legislative requirements.

For pressure testing the requirements of the following, listed in order of precedence, shall be fulfilled:

- This specification
- "Technische Regeln, Arbeitsblatt G 469", published by DVGW (Deutscher Verein des Gas-und Wasserfaches e.v.), to the extent referred to in this specification (latest edition)
- ELOT EN 1594 and ELOT EN 12327

2. REFERENCES

2.1 Reference Documents

Job Spec. No. DSF-SPC-CIV-004

[Measuring-up and As Built Documentation]

2.2 Reference Codes and Standards

ELOT EN 1594

[Gas supply systems - Pipelines for maximum operating pressure over 16 bar - Functional requirements]

ELOT EN 12327

[Gas supply systems - Pressure testing, commissioning and decomissioning procedures - Functional requirements]

DVGW G469

[Druckprüfverfahren für Leitungen und Anlagen der Gasversorgung]

3. ACRONYMS

DP Design Pressure
Pt Tightness Test Pressure
Ps Strength Test Pressure
MIP Maximum Incidental Pressure
MOP Maximum Operating PressureSMYS Specified Minimum Yield Strength
NDT Nil-Ductility Temperature

4. TEST METHOD

The test method is described in DVGW G469. Water shall be used as test medium. The used method is designated as B2 and shall be performed with pressure and water volume recordings for the whole duration of the test.

Where a visual test can be made (e.g. preconstructed water crossings or prefabricated line stations), this shall be carried out according to the method designated as A2 in DVGW G469 .

When using method A2 a holding time of 4 hours is required, and a variation of the pressure of ± 2% is allowed.

The Owner Representatives will supervise the pressure test.

The test will be considered as completed when acceptance has been given by the Owner Representatives.

5. COMMENCEMENT OF THE PRESSURE TEST

The Contractor shall start the pressure test as soon as practicable after the construction of a pipeline section has been completed and the Owner has declared it is ready for testing.

The section shall be backfilled, with the exception of block valves and ends, and the affected drains reinstated before the pressure test is commenced.

The Contractor shall as soon as possible after start of construction submit a proposal for dividing the pipeline into pressure test sections for the approval by the Owner Representative. Special attention shall be given so that the ends of each test section not to fall within cultivated areas.

Not later than 6 weeks before start of pressure testing a detailed programme for the pressure tests shall be drawn up by the contractor. This programme is subject to the approval by the Owner Representative and the relevant authorities before the tests are initiated.

Pressure test with no special antifreeze precautions shall only take place with water and ambient temperature above 4°C. Metal temperature shall not be allowed to fall below 4°C, or its Nil Ductility Temperature (NDT), whichever is higher, while the metal is under stress.

6. SCOPE OF CONTRACTOR SERVICES

6.1 GENERAL

The Contractor shall supply and install all auxiliary facilities necessary for the pressure test, such as provisional scraper traps, scrapers, end caps, fittings, flanges, gaskets, pumps, compressors, measuring equipment, etc. He is also responsible for the supply and disposal of water.

Personnel, vehicles, communications, supervision of crossings and public places, etc. shall be supplied by the Contractor.

The Contractor shall in cooperation with the Owner give adequate notice to all involved authorities of his intention to begin the pressure test.

Costs arising from the location and repair of faults will be paid by the Contractor unless the faults are shown to be caused by defects in materials supplied by the Owner.

Prior to filling the pipeline with water, the test section shall be cleaned and gauged. This can be done by letting a pig with a gauging plate pass through the test section using water, in most of the cases. Pigging may be also done with air. This is subject to Site Supervisor’s decision.

During cleaning the pigs are moved by compressed air.

When running the cleaning pig does not require any back pressure from the receiver end. All pipeline cleaning activities shall take place prior to the installation of the main line valves in order to avoid damages in these components.

The gauging pig run will have an induced back pressure of 0.5 bar minimum and 2 bars maximum necessary to create a buffer at the receiving test section end.

Pigs are running at a speed of 0.5-0.8 m/sec or 1.8-3.0 km/h with back pressure to be monitored at the receiving testing trap. At sections with a great number of cold and with significant difference of topography the speed of pig travel can be reduced up to 0.14 m/sec or 0.5 km/h.

The aluminium gauging plate should be attached to the end of the gauging pig.

In connection with the water filling a gauging Pig- run shall be carried out. A gauging plate in aluminium shall be fixed to the rear end of the first filling pig.

The diameter of the plates shall be for each pressure test section as specified by the Owner, who will take into consideration and provide the necessary allowance for the safe passage through actual bores for components.

As a maximum diameter for the gauging plates (for pipes alone) 95% of the theoretical minimum internal pipe diameter minus 10 mm shall be used.

The pig with the mounted gauging plates shall be inspected by the Owner Representative before and after the pig-run. If the pig is damaged during passage through the pipeline, the Contractor is responsible for locating the defect, if necessary, by using an electronic pig, and repairing the cause of damage.

It is recommended to use a radio pig or some other pig with a device for its easy detection.

6.2 PRESSURE TEST PROGRAMME

A file containing all the details of the pressure test shall be submitted to the OWNER Representatives on site for review and approval prior to commencement of testing activities. This file shall include:

- Details of pressure test sections

-Welding and Non Destructive Testing logs

- Detailed calculations of test pressure and test volumes

- Approved plans for the supply and disposal of water

- List of materials for the pressure tests - plans for the information of landowners and authorities

- Water analysis certificate

- Safety written procedure

- Written procedure for performing the pressure tests - plans for the recording of test results

- Written procedure for emptying the pipeline after the pressure tests

- Special conditions

6.3 NOTICES TO LANDOWNERS AND AUTHORITIES

Landowners in the vicinity of the pipeline shall be notified about:

- The scope of and time schedule for the pressure tests

- The necessity of staying away from the test area during the pressure test.

Authorities shall be informed by means of a note stating:

- The scope of the pressure tests

- The time schedule for the pressure tests.

The following local authorities shall be informed:

- Salvage corps.

- Police.

- Utility companies.

- Highway authorities.

- Railway authorities.

- Watercourse authorities.

In special areas it may be necessary to inform other authorities, such as airports, the army, etc.

7. PRESSURE TEST PLANNING

7.1 PRESSURE TEST SECTIONS

The maximum length of the test section should not exceed 15 km, and the volume of the section should not exceed 3000 m^3 independently of the diameter of the pipes. (REF DVGW G469).

For the sloped portions of the pipeline, the test section shall be selected such as not to contain elastic bends in the lowest point of the slope.

In case that this is unavoidable, the selection of the test section shall be based on the judgment that the difference of level between the highest and the lowest point of the pipeline test section to be less than the maximum allowable difference of level established in the project, for the pipe wall thickness of the referred section, depending on the value of the hoop stress and the resultant (combined) stress.

However, if special measures are applied, ensuring a satisfactory determination of the water temperature and measurements of pressure and volume are included during the test for additional control of the air free filling of the section, the above-mentioned maximum length and volume can be increased, subject to approval by the Owner.

7.2 PRESSURE TEST VOLUME

The pressure test volume of each test section shall be calculated in a pipe log summary for pressure testing as described in Job Spec. No. DSF-SPC-CIV-004.

7.3 TEST PRESSURE

7.3.1 GENERAL

Test pressure calculations shall be included in the pressure test programme in a preliminary edition based on the project drawings.

Before the pressure tests are initiated a revised edition based on the pipe-log and as built measurements shall be available.

7.3.2 TEST PRESSURE IN PIPELINES

The tightness test pressure Pt shall be defined at the beginning of the project and shall not be less than the design pressure.

Unless otherwise specified in other paragraph of this specification or in other project document the duration of the tightness test shall not be less than 24 hours.

The strength test pressure Ps at the lowest elevation point of the tested pipeline section shall be at least 0,15 times the design pressure (DP) above the maximum incidental pressure (MIP) and at the highest elevation point of the tested pipeline section shall be at least 0,05 times the design pressure (DP) above the maximum incidental pressure (MIP).

The maximum incidental pressure (MIP) shall be defined at the beginning of the project and, unless otherwise specified, the maximum incidental pressure (MIP) shall be 1,10 times the maximum operating pressure (MOP).

The strength test pressure shall not exceed the pressure that causes a hoop stress of 95% SMYS or a resultant (combined) stress of 100% SMYS at any point of the tested pipeline section taking into account the water column differential head and any other existing load.

Unless otherwise specified in other paragraph of this specification or in other project document the duration of the strength test shall not be less than15 minutes.

Example:

For a design pressure (DP) equal to 80 barg and a maximum operating pressure (MOP) equal to 75barg the maximum incidental pressure (MIP), unless otherwise specified, will be 1,10x75 = 82,5barg. Therefore the strength test pressure at the highest elevation point of the tested pipeline section shall not be less than 82,5 + 0,05x80 = 86,5barg and at

the lowest elevation point of the tested pipeline section shall not be less than 82,5 + 0,15x80 = 94,5barg.

7.3.3 TEST PRESSURE IN GAS STATIONS

Unless otherwise specified crossings can be pressure tested together with the main line.

Scraper stations and line valve stations shall be pressure tested separately as for Class 1 - 4 locations.

8. SUPPLY OF EQUIPMENT AND INSTRUMENTATION FOR TESTING

A description of the different equipment and instruments is given in DVGW G469.

All instruments shall be calibrated. Calibration shall be against standards having a valid relationship to national standards. Certificate for calibration of the Deadweight - tester and documentation for the calibration of manometers and pressure recorders from the Deadweight-tester shall be available.

Gauges shall have full-scale range not exceeding twice the test pressure. The accuracy shall be ± 1%. The certificates for calibration of instrumentation shall not be older than 6 months.

9. SAFETY ASPECTS

All safety aspects specified in ELOT EN 12327 shall be adhered to. Additionally, the following shall apply:

- Testing equipment shall be placed in a safe distance from the pipeline under test.
- The test section shall normally be backfilled (REF DVGW G469).
- When pressurizing special short sections of pipeline and temporary equipment above ground or not backfilled, it shall either be located in a safe distance from public area, or secured by use of energy absorbing devices (such as sandbag barriers, piling and walls).

- A written test procedure, including actions to be taken in the event of faults during testing, shall be available, distributed and reviewed with all persons involved in conducting the test, prior to commencing the test.
- Communication between the pressure test-engineer and personnel responsible for various aspects of the test shall be adequate.
- Caution signs or barriers shall be erected and supplemented by security patrols and/or guards at road and major water crossings in residential and industrial areas, as well as in other areas with high risk for personal or environmental damage.
- Stand-by emergency crews shall be available to deal with washouts or other damage.

10. TEST CREW

The test crew shall be directed by an experienced person, the pressure test engineer with thorough theoretical knowledge and practical experience in performance and calculation of pressure tests. Contractor's personnel should be adequately trained and thoroughly familiar with the safety precautions and procedures.

Personnel for performance of the pressure test shall be well trained and skilled in these special works. Personnel should be instructed in the proper use of all equipment. A well-defined training program should be conducted before pressure testing.

Personnel for supervision of main crossings and other places with high risk of personal injury or damage to the environment shall be present to the extent necessary, i.e. normally one person at each point during the first raise of the pressure and 1st hold-time. During tightness-tests the section only needs to be supervised by mobile patrols.

Owner Representatives shall supervise the pressure test.

11. WATER

Water used for the pressure test shall be free of dirt and impurities.

The pH value shall be between 6 and 8 for test water, which is to be used for several pressure tests, or which is stored in the pipeline for more than 8 days. Storage of water for less than 8 days in the pipeline allows a pH value between 5 and 8.
The content of salt may not exceed 800 mg/l (i.e. sea-water shall not be used).
To fulfil these requirements, the addition of chemicals could be necessary.
Before filling with water a chemical analysis shall always be performed. This analysis shall be done by qualified laboratories.

12. PERFORMANCE OF THE PRESSURE TEST

12.1 FILLING WITH WATER

The water-filled pipeline shall be free of air.
In order to secure an effective driving out of air during water filling of long pipeline sections, the following instructions listed in order of precedence are to be followed:

- All line valves (if connected in the pipeline) shall be fully opened.
- The first 200-400 m (minimum) of the pipeline is filled with water depending on the length of the test section and the longitudinal profile.
- A pig of a type suitable for expulsion of air from the pipeline is placed in the line.
- A further 100-200 m (minimum) pipe length is filled with water. Depending on the length of the test section and the longitudinal profile
- A second pig is placed in the line. If necessary, more water and a third pig may be used in the leading water stream.
- Water is added until the pipeline is full.
- After filling with water, all valves, piping, etc. shall be vented, and positioned in the half- open position. Prior to venting a full opening and closing operation of valves shall be performed in order to fill cavities. All such valve operations may be performed by a nominated employee of the Contractor after the Contractor has obtained the written permission by the Owner to do so. If not, the Owner will

entrust these operations to a third party (e.g. the valve Supplier), at the Contractor's cost.

If a larger quantity of water than immediately available is required, the Contractor shall establish a temporary reservoir near the pipeline. Contact with the authorities, etc. and costs in connection with the provision of water are the responsibility of the Contractor.

The temperature of the water shall be as close as possible to the ground temperature during filling.

The pig shall be driven against a positive head of air of approximately 3 bars during filling.

The filling shall proceed uphill where possible to minimize the risk that the pig may run away on a downhill section, allowing air to enter the filled portion of the line.

The filling rate must not exceed a rate driving the pig ahead with a speed exceeding 1.3 m/s.

Measurements during filling:

- Time of departure and arrival of pigs.
- Water consumption in m^3 and temperature of the filled water in °C, at least four times, corresponding to 1/4, 1/2, 3/4, and 1/1 full.
- Filling and back-pressure shall be automatically and continuously.

12.2 EQUALIZATION PERIOD (Applicable to Method B2)

Depending on the temperature difference between the water in the pipe and the surroundings a shorter or longer equalization period could be necessary. The pressure shall during this time be kept under control, being between 1/8 and 1/4 of the test pressure. Admission and/or tapping of water may be necessary during this period.

Measurements during equalization:

- Pressure shall be automatically and continuously recorded.
- Pipe /ground temperature shall be measured at least every six hours.

Ground and pipe wall thermometers shall be located with a maximum distance of 2.5 km along the test section. One thermometer set shall be placed approximately 0.5 km from each end of the test section. At least 3 measuring points shall be used.

On sections with a length exceeding 15 km or a volume bigger than 3000 m^3, the number of thermometers shall be increased to a maximum distance of 2.0 km.

The stabilisation period shall be considered acceptable when the temperature difference recorder on any one of the probes does not exceed 0,5 °C over a 24 hour period.

12.3 STRENGTH AND TIGHTNESS TEST

During pressurizing of the test section the maximum rate of pressure increase shall not exceed 2bar/min. When the strength test pressure Ps is reached, drain tests shall be made so that the air content in the pipeline subsequently can be calculated.

The test and calculations shall be performed according to DVGW G469. If the outcome of the tests fulfils the requirements in DVGW G469, (i.e. for method B2 difference between the calculated amount and the real amount of drained water may not exceed 6%) the test may proceed. Otherwise, arrangement for driving out the air must be effected. 1st hold-time shall normally last for:

- 60-90 minutes with method B2.
- 90 minutes with method A2.

The following reduction of the pressure shall proceed at a rate not exceeding 2 bars/min. The pressure of 2nd hold-time shall be calculated to secure that the pressure will not be less than 2 bars at the highest point of the test section. 2nd hold-time shall last for approximately 30 minutes.

Hereafter the pressure shall be increased until the strength test pressure Ps is reached, kept at this level for 10 minutes, and then reduced to the tightness test pressure Pt. When the temperature is in equilibrium, pressure and temperature shall be kept under observation (3rd hold time) for at least 24 hours with method B2 and 4 hours with method A2.

The 3rd hold-time for method B2 may be reduced in accordance with DVGW G469 with the approval of the Owner however it shall never be less than 8 hours. With method A2 the hold time shall never be less than 4 hours.

If any leak is discovered during the test, it shall be located and repaired and the test shall be repeated.

Measurements during pressurizing cycles with method B2:

- Added/relieved quantity of water and corresponding values of time and pressure.

Measurements shall at least be recorded as follows:

• Until approx. 50% of test pressure: per 5.0 bar pressure rise

• Until approx. 85% of test pressure: per 1.0 bar pressure rise

• Until 100% of test pressure: per 0.2 bar pressure rise

- The pressure shall automatically and continuously be recorded
- Drain test (volumes and corresponding pressure drops).

Measurements during tightness test with method B2:

- Corresponding values of time, pressure and ambient temperature to be recorded at least every hour.

12.4 EMPTYING WATER FROM THE PIPELINE

On completion of the test the pipeline shall be emptied of water using swabbing pigs driven by compressed air. The disposal of water shall be done in areas approved by the relevant authorities.

This shall be repeated until only insignificant amounts of water are transported by the pigs.

The Contractor shall propose a detailed method of cleaning and emptying the line as part of his pressure testing procedure.

The acceptance criteria shall show that the maximum residual quantity of water in the line after the last pig run shall be 20 litres per 1000 m^2 of internal surface area. The lapse time between pressure testing and the final emptying of water shall be kept to a minimum for reasons of corrosion prevention.

13. DOCUMENTATION

13.1 PRESSURE TEST REPORT

This report shall contain a summary of the test with main results and reference to the forms and graphs containing test results.

Pressure Test Report forms are enclosed in APPENDIX A.

13.2 WATER FILLING REPORT

The water filling report shall contain measurements of:

- Quantity and temperature of the water filled into the section
- Time of the measurements and time for start and receiving of pigs

The form shall give a possibility of calculation of water filling rate (m^3/min.), and speed of waterfront - pigs (m/min). The report shall refer to the chart showing the back pressure.

Filling Record Form is enclosed in APPENDIX A.

13.3 STRENGTH TEST REPORT

This report shall contain measurements from the start of the first pressurizing period until the start of the 24-hours tightness test.

With method B2, the report shall refer to the chart showing the automatically measured pressure.

Strength Test Report Form is enclosed in APPENDIX A.

13.4 TIGHTNESS TEST REPORT

This report shall contain measurements from the start of the tightness test until the final acceptance or rejection of pressure test.

With method B2 the report shall refer to the chart showing the automatically measured pressure.

Tightness Test Form and Recording Chart are enclosed in APPENDIX A.

13.5 FAULT REPORT

Where deviations from the planned performance of the test occur, a fault report (e.g. leaks in temporary installations, instrument faults, leak in pipes, leak in valves, etc.) shall be prepared.

Fault reports shall at least contain statement about:

- When and how the fault was discovered.
- Location of the fault chainage as well as item number and position on the item.
- Damage as a result of the fault.
- Investigations, which have been performed.
- Repair arrangements, which have been performed.

Fault report shall be filled in by the Contractor's pressure test engineer. Fault Report Form is enclosed in APPENDIX A.

13.6 ACCEPTANCE OF THE TEST

The test is accepted when the forms are signed by the independent control authority / Owner Representative and Owner.

APPENDIX A

PRESSURE TEST REPORT FORMS

Water Filling	**(1 page)**
Equalization	**(1 page)**
Strength Test	**(1 page)**
Tightness Test	**(1 page)**
Fault Report	**(2 pages)**

PRESSURE TEST REPORT: WATER FILLING – Page 1 of 1

Project : **Date :**

Contract : **C. No :**

Contractor : **Sub-Contractor :**

Section : **Report No :**

TIME	COUNTER m^3	TOTAL m^3	FLOW RATE m^3/h	TEMPERATURE WATER ^oC	PH	REMARKS

Contractor	**TPI**	**Supervision**	**Owner**
Name :	**Name :**	**Name :**	**Name :**
Date :	**Date :**	**Date :**	**Date :**

Signature	**Signature**	**Signature**	**Signature**

PRESSURE TEST REPORT

EQUALIZATION – Page 1 of 1

Project : **Date :**

Contract : **C. No :**

Contractor : **Sub-Contractor :**

Section : **Report No :**

TIME	**COUNTER m^3**	**TEMPERATURE (^oC)**		**TEMPERATURE (^oC)**									
		Air	**Pipewall**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**t / m**

Contractor	**TPI**	**Supervision**	**Owner**
Name :	**Name :**	**Name :**	**Name :**
Date :	**Date :**	**Date :**	**Date :**
Signature	**Signature**	**Signature**	**Signature**

PRESSURE TEST REPORT: STRENGTH TEST – Page 1 of 1

Project : **Date :**

Contract : **C. No :**

Contractor : **Sub-Contractor :**

Section : **Report No :**

Pipe: **Length :**

TIME	ΔV TOTAL	ΔV	P	TIME	ΔV TOTAL	ΔV	P

Contractor	TPI	Supervision	Owner
Name :	**Name :**	**Name :**	**Name :**
Date :	**Date :**	**Date :**	**Date :**

Signature	Signature	Signature	Signature

PRESSURE TEST REPORT

TIGHTNESS TEST – Page 1 of 1

Project : **Date :**

Contract : **C. No :**

Contractor : **Sub-Contractor :**

Section : **Report No :**

TIME	DEADWEIGHT TEST (BAR)	TEMPERATURE (°C)		TEMPERATURE (°C)									
		Air	Pipewall	1	2	3	4	5	6	7	8	9	t / m

Contractor	TPI	Supervision	Owner
Name :	**Name :**	**Name :**	**Name :**
Date :	**Date :**	**Date :**	**Date :**

Signature	Signature	Signature	Signature

PRESSURE TEST REPORT

FAULT REPORT – Page 1 of 2

Project :	**Date :**
Contract :	**C. No :**
Contractor :	**Sub-Contractor :**
Section :	**Report No :**

Pipeline Description :

Section No : Chain No To Chain No

and :

Length of Section : m

Volume of Section : m^3

Fault Data :

Location : Chain No

Type : Leak --- Rate of Leak m^3/h

Break ---

Position : Field Weld ---

Pipe Seam ---

Body of Pipe ---

Valve ---

Temporary Installations ---

Others ---

Comments :

PRESSURE TEST REPORT

FAULT REPORT – Page 2 of 2

Project :		**Date :**	
Contract :		**C. No :**	
Contractor :		**Sub-Contractor :**	
Section :		**Report No :**	
Fault Log :			
Discovered during :	Water Filling : ---		
	Strength Test :		
	Tightness Test :		
Pressure at Leak / Break :	bar,	Pipe Temperature :	^{o}C
Fault Detected Time :		Date :	
Fault Located Time :		Date :	
Fault Repaired Time :		Date :	
Comments :	(Damages / Repair Arrangements, etc)		
Contractor	**TPI**	**Supervision**	**Owner**
Name :	**Name :**	**Name :**	**Name :**
Date :	**Date :**	**Date :**	**Date :**
Signature	**Signature**	**Signature**	**Signature**

PRESSURE TEST REPORT

SUMMARY – Page 1 of 3

Project :		**Date :**
Contract :		**C. No :**
Contractor :		**Sub-Contractor :**
Section :		**Report No** :
Pipeline Description		
Section No :	**Chain No**	**To Chain No**
	and :	
Length of Section :	**m**	
Volume of Section :	**m^3**	

PART LIST

Type	Manufacture	Material	Dimension	Length

Equipment and Instruments

Type	Manufacture	Chainage

PRESSURE TEST REPORT

SUMMARY – Page 2 of 3

Project :	**Date :**
Contract :	**C. No :**
Contractor :	**Sub-Contractor :**
Section :	**Report No :**

TEST PRESSURE	**Level (m)**	**Pressure (bar)**	**Stress Level in min wall (% YIELD STRENGTH)**
Down-Stream Point			
Highest Point			
Lowest Point			
Up-Stream Point			
FILLING WATER :	pH :		
	Temperature :		
Air content :	%		

TEST LOG :

	Time	**Date**	**Related Test Reports**
Began Filling			
Completed Filling			
Began Pressuring			
Completed Pressuring			
Began Depressuring			
Completed Depressuring			
Began Pressuring			
Completed Pressuring			
Completed Tightness Test			
Began Dewatering			
Completed Dewatering			

PRESSURE TEST REPORT

SUMMARY – Page 3 of 3

Project :		**Date :**	
Contract :		**C. No :**	
Contractor :		**Sub-Contractor :**	
Section :		**Report No :**	
TIGHTNESS TEST: Max. Allowed Volume Deviation :			1/h
Calculated Volume Deviation :			1/h
Duration of Tightness Test :			h

REMARKS :

Contractor	**TPI**	**Supervision**	**Owner**
Name :	**Name :**	**Name :**	**Name :**
Date :	**Date :**	**Date :**	**Date :**
Signature	**Signature**	**Signature**	**Signature**

PRESSURE TEST REPORT

EVALUATION OF TIGHTNESS TEST – Page 1 of 5

Nomenclature:

P_m : Mean Pressure in bar

t_m : Mean Temperature in ºC

A : Compressibility Factor in 10^{-6}/bar

L : Pipe sub-section Length in m

D_e : External Diameter in mm

S : Wall Thickness in mm

r_i : Inside Radius in mm

V r_i : Volume of Pipe Sub-section with inside radius r_i in m^3

ΔV_A : Calculated Discharge Water Volume in l

ΔV_{AB} : Measured Discharge Water Volume in l

B : Expansion Factor in 10^{-6}/K

ΔV : Volume differentiation in l

ΔV_h : Volume differentiation per hour in l/h

TECHNICAL DATA :

Sub-Section	**1**	**2**	**3**	**4**	**5**	**6**	**Σ**
Material							
L (m)							
D_e (mm)							
S (mm)							
r_i (mm)							
0.89 * r_i / s * L/ΣL							

Vr_i (m^3)								

AIR TEST :

P_m = ---------- bar t_m = ---------- ^oC => A = --------- 10^{-6}/bar

(A is plotted on the Compressibility Factor Chart on page 28)

ΔV_A / bar = [Σ (0.89 * r_i / s * L / ΣL) + A] * ΣVr_i / 1000 = ---------- l / bar

PRESSURE TEST REPORT

EVALUATION OF TIGHTNESS TEST – Page 2 of 5

TEST RESULTS:			
	1	**2**	**3**
P1 – P2			
ΔV_{AB}			
ΔV_{AB} / ΔV_A			

P1 = Pressure Immediately before Air Test

P2 = Pressure Immediately after Air Test

$\frac{\Delta V_{AB}}{\Delta V_A}$ = Air Factor. Acceptable value: Equal or less than 1.06

REMARKS :

TIGHTNESS TEST :

Maximum Allowed Deviation ΔV = + _____ l/h

TEST RESULTS :

	Time	**Date**	**Pressure (bar)**	**Average Temperature**		**°C**
				Ground °C	**Pipewall °C**	
Starting tightness test			p1	t1:	t1:	t_{1m}
Completion tightness test			p1	t2:	t2:	t_{2m}

ΔP ____ **Δt** ___

	Vri (m^3)
Earth covered segments	
Exposed segments	

$$\frac{t1 + t2}{2} = \left(\frac{t1.ground * Vri\ covered/\Sigma Vri + t1\ pipewall * Vri\ exposed/\Sigma Vri}{2}\right) +$$

$$+ \left(\frac{t2.ground * Vri\ covered/\Sigma Vri + t2\ pipewall * Vri\ exposed/\Sigma Vri}{2}\right) = \_\_\_\_\ ^{o}C$$

PRESSURE TEST REPORT

EVALUATION OF TIGHTNESS TEST – Page 3 of 5

$\frac{P1 + P2}{2}$ = _____ bar => B = _____ 10^{-6}/K

(B is plotted on the Expansion Factor Chart on page 29)

$\Delta V = \{ [(\Sigma (0.89*ri/s*L/\Sigma L)+A] * (V_{AB} / V_A) * (p1–p2) – B * (t_{1m} – t_{2m})\} * Vri/1000 =$ _____

Test time h = _____ hours, ΔV = _____ l $\Delta V/h$ = _____ l/h

REMARKS:

Contractor	**TPI**	**Supervision**	**Owner**
Name :	**Name :**	**Name :**	**Name :**
Date :	**Date :**	**Date :**	**Date :**

Signature	**Signature**	**Signature**	**Signature**

PRESSURE TEST REPORT

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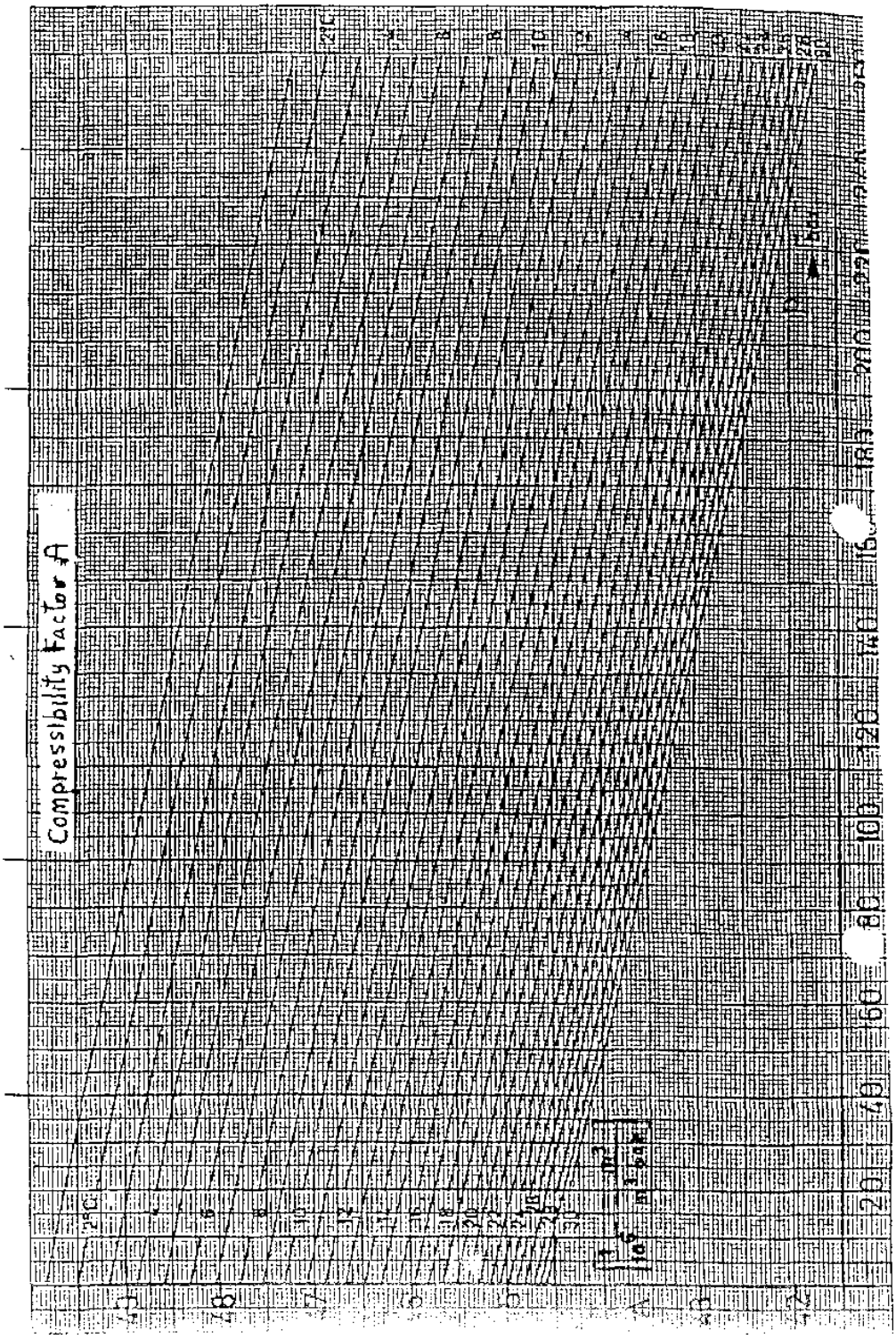
Compressibility Factor A

PRESSURE TEST REPORT

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