CENTRAL UP GAS LIMITED
(CITY GAS PROJECT IN KANPUR & BAREILLY)

TENDER FOR

Engaging Contractors for CS Pipeline Laying and Other associated works in Kanpur, Unnao, Bareilly and Jhansi

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TECHNICAL VOLUME
VOLUME II OF II – PART-3

OPEN DOMESTIC COMPETITIVE BIDDING

BIDDING (THROUGH E-TENDERING MODE)

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LAYING OF 3 LPE COATED CARBON STEEL PIPELINE IN BAREILLY, KANPUR & UNNAO AND JHANSI GA IN THE STATE OF UP

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PART 1

Site occupation

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1. SITE OCCUPATION

1.1. OCCUPATION OF THE SITE

The work site location will be specified in a separate PTS.

As soon as the Contract is signed, the Contractor will proceed with the setting-up of the site installation in accordance with the stipulations of his price bid and as agreed with the Owner according to relevant approved drawings.

The Contractor shall excavate all the topsoil if necessary from the site and provisionally store it. The topsoil shall be treated in such a way that it remains free of weeds until it is put back again. The site shall be levelled, sealed and hardened with a layer of stone chippings (size 0-40, thickness 25 cm) and a top layer 12-20 (thickness 10 cm). The surface to be occupied will depend on the category of site installation and shall constitute one single unit for the section of the Owner. The Contractor's installation shall be located no more than 200 metres away from the Owner premises.

The Contractor shall take all the necessary precautions to ensure that the site always remains dry and practicable. It must be possible to reach the site with trucks and cars from the public road. The site shall be arranged in accordance with the conditions set out in the building site regulations.

1.2. MARKING OUT AND PROVISIONAL FENCING

The entire terrain on which a site installation is to be located will be screened off by the Contractor with provisional fencing supply by the Contractor consisting of 2 metres high removable elements. The fencing shall be locked securely, display the necessary notices and be of such a design that it can only be dismantled with the use of tools. This enclosure shall be fitted with a lock and chain. The Contractor must hand over 2 keys to the Owner's representative.

1.3. EQUIPPING THE SITE INSTALLATION

The term site installation shall be taken to include the area set aside for the storage of equipment.

The Particular Technical Specification shall determine to which category the site installation belongs. Each installation shall comply fully with all the local rules of the building site regulations and the statutory provisions.

If necessary, the Contractor shall take all necessary steps to ensure the timely acquisition of the licences for connections to the utilities and drainage from the Authorities involved.

During the work the Contractor must procure and maintain the installation and equipment which are necessary for the functioning of the workshop and additional equipment.

The Contractor shall make all the necessary arrangements to cater for an uninterrupted supply of fuel, lubricant, electricity, water, telephone, etc. during the work.

1.3.1. Site installation

a) **Site installation Category 1** (installation for the laying, among other things, of pipelines)

b) **Site installation Category 2** (installation for special point)

c) **Site installation Category 3** (installation for, among other things, the construction of a new main station - e.g. mixing or compression station)

d) **Site installation Category 4** (installation, for example, for such things as the construction of a new regulating station or adaptations to an existing one, diversion works and reconstruction works)

Due to the diversity of the work site location and the local conditions the site installation required for the Owner's representatives as well as for the recognised inspection agency will be stated in a separate PTS.

1.3.2. Storage of material

When the Contractor takes over the materials, he shall immediately store the materials supplied by the Owner in accordance with the code of good practice and the conditions set out in the building site regulations and GTS part 4. The Contractor shall provide a covered and locked storage area to store the protected materials. Each covered and locked storage area is provided with lighting. The material shall be stored in the immediate vicinity of the site offices.

1.4. CLEARING OF THE SITE INSTALLATION

The installation shall remain at the disposal of the Owner until restoration of the site is completed. After the site installation has been dismantled and removed, the Contractor shall restore the terrain to its original condition to the satisfaction of all Parties Concerned.

PART 4

Delivery and handling of the material

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4. DELIVERY AND HANDLING OF THE MATERIAL

4.1. GENERAL

The description and quantities of the materials supplied by the Owner and/or to be supplied by the Contractor are described in the PTS and in the part lists.

The Contractor takes delivery of the items after a joint inspection with the Owner, after which the acceptance note drawn up by both parties is signed jointly.

When the materials are being handed over, the Contractor must take the required measures to:

- comply with the conditions of edited by the Owner in the purchase specification;
- avoid any form of damage and pollution;
- have sufficiently qualified personnel and equipment in relation to the quantity and type of deliveries available to handle and/or string them quickly;
- facilitate the acceptance inspections.

All equipment used for taking delivery of, handling and/or stringing the materials must be approved by the Owner and or the Engineer and accompanied by a certificate drawn up by a recognised inspection organisation.

The application period for the supply of material (Owner's supply) will be at least 10 working days. The delivery shall be requested to the representative of the Owner on the site.

All contacts between the Contractor and the Owner’s suppliers must always be made through the presentative of the Owner on the site.

All documents delivered together with the materials must immediately be handed over to the Owner.

For pipeline elements (pipes, fittings, bends, etc.), the thickness specified in the parts lists are minimum thickness.

4.2. METHOD OF DELIVERY

4.2.1. Pipes

The Owner will specify in the purchase order the location of his store site and depot.

The Contractor himself must take responsibility for the collection of the Owner’s material.

a) Except otherwise stated by the Owner if the pipes are stored in the Owner depot, transportation to the site and unloading shall be borne by the Contractor.

b) If certain materials are delivered directly to the site, this will be mentioned in the Particular Technical Specifications. In this case, the Contractor will only be responsible for unloading on the construction site. The Contractor chooses the unloading site and ensures that the access roads are sufficiently stable and accessible for the trucks of the supplier (min. length of trailer = 14.5 m). At least 5 working days prior to delivery, the Contractor sends an order form and a detailed plan indicating the unloading place and access roads to the representatives of the Owner/and or the Engineer on the worksite.

N.B.

The attention of the Contractor is drawn to the fact that uncoated pipes may be supplied with a plastic coating that has to be removed and evacuated to an approved waste disposal site.

4.2.2. Other materials (see part lists) and additional quantities

These can be collected by the Contractor from the Owner store or depot after prior written request sent to the Owner's representative on the worksite.

If the PTS states that the Owner is responsible for delivery to the site, the Contractor will order the materials to deliver per full load in places accessible to trucks. Unloading is borne by the Contractor. Transport costs for incomplete loads will be charged to the Contractor.

4.3. ACCEPTANCE PROCEDURES

4.3.1. Owner depot or store site

Delivery shall be taken over by the Contractor during loading of the trucks. Every material element must be inspected by the Contractor for visible defects. For pipe elements, this is when uplifted. Defects are noted and reported jointly in the take over report (delivery note). In the absence of the Contractor, they are noted by the Owner and are not refutable.

4.3.2. Direct deliveries on the site

The take over by the Contractor of the pipe elements or other material directly deliver on the worksite will be carried out during the uplifting of the elements.

4.3.3. Take over report

The take over report is drawn up jointly (Contractor and supplier or Owner) and must, among other things, include the following information :

- the length of each pipe and the individual number;
- the identification number of the equipment and pipeline element;

- any visible damage (scratches, dents, etc.);
- an estimation in dm^2 of the defects in the pipe external coating, visible or detected by means of a holiday detector (for test voltage see GTS part 9);
- any remarks regarding the deliveries.

4.4. MATERIAL TO BE SUPPLIED BY THE CONTRACTOR

4.4.1. Supplies

The materials indicated as "Contractor supply" on the part lists are supplied by the Contractor. For direct supplies to the worksite, the Contractor shall present the material supplied at least 2 working days prior to assembly to the Owner in order to control jointly the quantities supplied.

All costs resulting from late deliveries or from supply of damaged or defective material shall be borne by the Contractor. When some materials cannot be supplied, the contractor shall submit another option in writing to the Owner and/or the Engineer, taking into consideration the initially fixed term of delivery. The option is not accepted without the Owner's prior written consent. For the electrical equipment instruments and installation located in hazardous area classified as class 1 zone 0, 1 and 2 the Contractor will hand over to the Owner and/or the Engineer the required certificate of conformity.

4.4.2. Extra supplies

Materials not listed on the part lists and that are required for normal operation shall be listed by the Contractor and communicated in writing to the Owner prior to the start of the works. This material shall be purchased by the Contractor with the written consent of the Owner and or the Engineer.

4.5. DEFECTS NOTED IN PIPELINE ELEMENT AND/OR EQUIPMENT AND THEIR METHOD OF REPAIR

Damage and defects that are noticed at the time of delivery and expressly described in the take over report will be borne by the Owner. The repair and removal of damaged parts shall be carried out by the Contractor at the expense of the Owner for a price corresponding with the price list.

Damage and defects noticed after delivery must be repaired at the expense of the Contractor, as well as any extra costs due to the inspection work of the recognised inspection organisation. In the event of any non-conformity of the material at the time of delivery, the Contractor must immediately inform the Owner and or before accepting the delivery. If this condition is not observed, the Contractor will be the sole responsible for all the consequences resulting therefrom.

4.5.1. Defect noted in pipeline element

Any defects noted in the pipeline element may under certain conditions be repaired. Nonetheless, the final decision whether or not to use repaired pipeline element rests with the Owner and/or Engineer.

4.5.1.1. Surface defects in the metal

Surface defects noted in the pipe metal may be removed by grinding/polishing as long as the thickness of the wall, obtained after grinding, remains within the tolerances of the relevant standard and codes.

All repaired superficial defects shall be examined by the inspection organisation by means of ultrasonic, electromagnetic or penetrant testing. If these wall thickness tolerances cannot be respected, the damaged part must be cut away. The undamaged parts will be bevelled again and bear an identification number, etc.

4.5.1.2. Dents in the metal

The pipes must show no evidence of dents. The damaged part shall be cut out and the undamaged parts will be bevelled again and bear an identification number, etc.

4.5.1.3. Defects to the external coating

Defects to the external coating must be repaired by the Contractor as specified in GTS part 9.

4.5.2. Defects to equipment and accessories

All defects must be reported to the Owner and/or the Engineer. Defects noted in the equipment (shut-off valves, safety valves, relief valves, regulator, etc.) must be repaired by the equipment supplier in order to maintain the guarantee. Defects to accessories (fittings etc.) must be inspected by the recognised inspection organisation and repaired according to their instructions by the Contractor.

4.6. STORAGE AND HANDLING OF MATERIALS

The Contractor shall provide separate storage areas for all materials delivered by the Owner. Pipes, pipe parts and equipment must be handled with sufficient care so that all damage is avoided.

4.6.1. Storage and handling of equipment

The Contractor shall pay special attention to the handling and storage of control devices (regulator, filters, shut-off valves, operators, meter, etc.) so that this equipment is supported adequately and in a correct manner and completely protected against infiltration of dirt and humidity.

The Contractor should enquire with the Owner and/or the Engineer which method should be used for lifting special devices. The Contractor shall ensure that all openings in the equipment are sealed. The Contractor should provide all the means required to ensure that the external coating, paint and metallic paint are not damaged.

4.6.2. Storage and handling of pipes

The Tenderer shall enclose a stacking drawing with his bid. The pipeline elements may not come into direct contact with the ground or be placed on unsuitable supports. Encrustation's of gravel, stones, wood, etc. must be carefully avoided. Continuous contact of the pipeline parts with each other - in particular, pipes stacked cross-wise - is forbidden. To this end, cushions, wickerwork, bags of straw or other flexible materials must be provided over a sufficiently large surface area. The Contractor will assure the stacking of pipes in such a way that rules out any permanent deformation of the pipeline element taking account of their weight and resistance.

The maximum stacking height for PE-coated pipes, depending on the diameter of the pipe, is shown in the table below :

Nominal diameter	Number of layers, stack height
$\leq$ 150	12
200 - 250	10
300 - 350	8
400 - 450	6
500 - 650	5
$>$ 700	3

Between the ground surface and the first layer there shall be a free height of 20 cm. The pipes shall be placed on a suitable support so that damage to the coating and deformation of the pipes are avoided. The bottom layer of pipes will be sufficiently supported at the sides to ensure stable stacking. The lower pipes shall be supported from 0.75 m from their ends and crosswise at least every 4th meter.

During periods of high temperature, the Owner may require protection of the coating against the sun. Newly manufactured pipes that are delivered directly by the pipe supplier to the site may contain static electricity which must be discharged before handling the pipes. All supplementary material (supports, cushions, wickerwork, etc.) must be delivered in suitable quantities by the Contractor. The use of hooks without teflon protection is not permitted.

4.6.3. Storage areas

The Contractor shall provide the following storage areas on the site :

- A covered and locked storage room for the storage of all small material and all materials or packagings that are not weather-resistant.

- A marked-off stacking area for all large material that is weather-resistant.

4.6.4. Stringing of the pipes (pipeline construction)

The Contractor specifies the method of handling in the execution method file. The pipes shall be distributed by the Contractor along the pipeline alignment in the working area. He shall ensure that they do not hinder the traffic and shall prevent their lying too long in a situation that would be harmful to them (intactness, quality of coating). Transportation will be effected with suitable equipment to prevent damage to pipes and terrain. In rainy weather or on unstable subsoil, transportation will only take place with vehicles fitted with caterpillar tracks. The pipes must be laid on wooden blocks at least 0.15m x 0.15m x 1m or sand bags. The blocks or sand bags shall be provided by the Contractor.

4.7. PIPE OFF CUT

4.7.1. General

The Contractor shall keep a detailed inventory of the pipes received, per type of pipe, and a note of their location. On every 15th and 30th day of the month, the Contractor shall provide the Owner and or the Engineer with a detailed summary of:

- the pipes off-cut that can still be used in the lifetime of the Contract (minimum length, without defects and numbered, see Article 6);

- the rejected pipes, stating the reason for their rejection.

Before the end of the leak tests, the Contractor must provide the Owner with an inventory of the surplus pipes.

The term “surplus pipe” is defined as:

any pipe that can immediately be reused (undeformed, numbered, coating and chamfers in good condition), bearing the individual pipe number, stamp of the recognised inspection organisation, origin, type and length.

4.7.2. Pipeline construction

Only complete lengths of pipe element will be taken back by the Owner; all other pipe surpluses are the responsibility of the Contractor. Before termination of the strength and leak tests the Contractor will draw up a final account of the pipes and transmit it to the Owner and or the Engineer.

Settlement formula :

$X = T_r - (T_p + T_c + C_r + L_r)$

where :

T_r = length of the pipes delivered and accepted on the working sites.

T_p = length of the pipes effectively laid

T_c = 1.5 ‰ permitted loss

C_r = length of the remaining whole pipe elements

L_r = length of defective pipes element rejected for reasons which are not imputable to the Contractor

X = length invoiced to the Contractor (non re-usable pipe element or missing pipes).

4.8. RETURNING SURPLUS MATERIALS

The Contractor shall be responsible for collecting, transporting and unloading surplus material. This material must be sufficiently clean so that it cannot be distinguished from new. Returned material shall always be accompanied a document that shall be drawn up by the Contractor and countersigned by the Owner and or the Engineer. Material that is defective and/or unaccepted by the Owner will be charged to the Contractor.

4.8.1. Pipeline construction

Only whole and unbent pipes element in perfect condition shall be accepted. They must be transported to the Owner's storage site.

4.8.2. Station construction

- Only surplus pipes longer than 1m and bearing an individual number will be returned to the Owner's storage site. They shall bear the stamp of a recognised inspection organisation and shall again have chamfers along both sides;
- All unused equipment and small material must be returned to the Owner's warehouse.

4.9. USEFUL INFORMATION

4.9.1. Owner's storage site, warehouse and workshops addresses

To be specified in the PTS.

PART 6

Welding

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6. WELDING

Applicable documents :

- API 1104 Nineteenth Edition , Sept. 1999
- The present GTS.

General :

- API 1104 is applicable and all paragraphs of the present GTS as specified below.
- The line welds will be, to the extend possible, welded by an automatic or semi-automatic process. The requirements for automatic welding will be according to Section 12 of API 1104 as amended in this GTS under Section 6.5. "Automatic Welding".
- Manual welding will be used for all other welds where, in principal, automatic or semi-automatic welding is not possible or not justified for technical or economical reasons. This can apply, e.g., in the case of steep hills in the line, crossings, tie-ins, stations, special points, in city environment and other situations where access with the automatic or semi-automatic welding machines is limited.
- The Contractor must clearly state in his bid where automatic, semi-automatic or manual welding will be applied, and what type of welding process he intends to use.

6.1. QUALIFICATION OF WELDERS

Only qualified welders, according to the requirements of Section 6 of API 1104, will be used for the manual welding processes.

- The Contractor will take all the necessary measures to implement the welder qualification tests.
- The qualification tests will be made using a coupon of a line-pipe. Every welders will execute a test weld using a qualified procedure.
- A welder who has successfully completed the qualification test shall be qualified.
- Every welder shall execute for his qualification test a weld at least on half the circumference of the pipe starting from the top of the pipe until the bottom.
- If the W.P.S. specifies a procedure for a single welder.
- The welder will execute the weld test on the entire circumference of the pipe.
- A welder can only participate once to the qualification test. If he didn't completed successfully the qualification test session, he will be disqualified for the present contract.
- Before production welding is started, the Contractor will submit to the Owner and or the Engineer and/or appointed Third Party Inspection Agency :
  - the list of the qualified welders;
  - the procedures for which they are qualified;
  - the records of the welding performance test;
  - the validity dates of the qualifications.

- If during welding, question arise about his competence (e.g. too many repairs), the Owner, Engineer and/or Third Party Inspection Agency may require a re-qualification, eventually after an additional welder training.

6.2. WELDING PROCEDURE QUALIFICATIONS (WPQ)

6.2.1. General

The welding procedures qualifications must be performed according to the requirements of Section 5 of API 1104, the additional requirements specified on this GTS.

The characteristics of the pipeline elements are described in the PTS.

A welding procedure qualification must be performed for :

- each welding procedure used;
- each diameter and thickness (see PTS);
- for each type of steel, from a different origin (steel mill and/or pipe mill).

The use of the same welding procedure qualification for different thickness and/or different origin of steel is only acceptable after written approval of the Owner and/or Engineer.

6.2.2. Preliminary Welding Procedure Specifications (WPS)

- The Tenderer shall attach to his bid every preliminary Welding Procedure Specifications (WPS) he intends to use during the execution of the work. He will indicate where and under what circumstances these WPS are applicable i.e. line welding, repair welding, tie-ins, stations, etc...

- Once the Owner has approved and ordered the work, the Contractor shall submit a list of required final WPS he plans to qualify and use. The required material for the qualification tests should be added.

- After approval by the Owner and/or Engineer of these documents, the Contractor can start with the qualification welding.

- The Tenderer will quote a price per WPQ, since the total number of procedures depends on different factors, which are not known at the moment of the bidding.

6.2.3. Additional essential variables

Referring to API 1104 (Sections 5.3. and 5.4.), following additional essential variables are also applicable :

- 5.3.2.3. and 5.4.2.5. Diameters and wall thicknesses

  - Line pipes

    Each diameter and wall thicknesses shall be subject to a different WPQ.

- 5.3.2.5. and 5..4.2.6. Filler metal and number of beads

  - The type and size of electrodes, and the brand name used for the welding in an uphill or downhill direction must be submitted for approval by Owner and/or Engineer.

  - In addition, the change in filler metal from a different Supplier will require new qualification of the applicable WPS.

- A charge in the number of beads will also require a new WPQ.

- 5.3.2.13., 5.4.2.8. Pre- and post-heat treatment, tune between paces, cooling rate (i.e. heat management)

  - The preheat temperature must be specified in the WPS and checked during welding.
    The prescribed preheat temperature may not be exceeded by more than 100° C.
    If the ambient temperature is lower than 5° C and/or the weld joint is damp, the pipe must be preheated to a temperature of minimum 50° C.

  - The line between paces must be specified.

  - Post-weld heat treatment and/or controlled cooling of the welded joint must also be specified in the WPS and respected during welding.

- 5.4.2.2. Base material

  Any base material, even from the same type but from a different steel mill and/or pipe mill will result in a separate WPQ, except when written approval is given by the Owner and/or Engineer for a waiver.

- 5.4.2.3. Joint design

  Minor changes to a joint design, as specified in WPS, cannot be made without re-qualification, except when written approval is given by the Owner and/or Engineer.

- 5.4.2.9. Direction of welding and number of welders

  - For each WPS, the number of welders will be specified.

  - The welding position and direction of welding for each welder will be specified.

6.2.4. Qualification tests

6.2.4.1. Introduction

The qualification test will be executed as described in Section 5.6. of API 1104, as amended by the requirements of this GTS.

Qualification tests must be carried out with the material from same origin (steel mill and pipe mill) as the material that will be welded by the Contractor in the field.

The pipes for the qualification tests must be provided by the Owner.

The number of qualification welds to be executed depend on the scope of work and eventually the origin of the pipe material.

The number of qualification tests can therefore only be determined after procurement of the pipes, and will be notified in writing by the Owner and/or Engineer.

The Owner, Engineer and/or the Third Party Inspection Agency will attend the welding, mechanical testing, and non destructive testing of WPQ.

6.2.4.2. *Additional general requirements*

In addition to the test specified in Section 5.6. of API, the following testing will be done during the Welding Procedure Qualifications :

- Non-destructive testing

  - Visual examination
  - X-ray testing
  - Manual ultrasonic testing
  - Electromagnetic examination

- Additional destructive testing

  - Charpy impact testing in the weld metal and Heat Affected Zone (HAZ)
  - Macrographic examination
  - Hardness testing

  Further details are provided below.

6.2.4.3. Non-destructive testing

1. Visual examination

   The qualification test welds must be usually examined, on the inside and outside.

   The acceptance criteria for the visual examination are stipulated in Part 7, Article 7.2.1.1 of the GTS.

2. Radiographic Examination

   Each qualification test weld will be 100 % examined by radiography, according to the requirement of Section 11.1. of API 1104.

   The Radiographic Examination will be performed by filmy x-ray method (not gamma ray) and will be done according to a written procedure drafted and/or approved by a Level III according to American Society of None Destructive Testing (ASNT) (or equivalent).

   The x-ray operate must be Level II according ASNT (or equivalent).

   The acceptance criteria are specified in the Section 9.3. of API 1104.

3. Ultrasonic testing

   Each qualification test weld will also be 100 % examined by the ultrasonic method, according to the requirement of Section 11.4. of API 1104.

   The acceptance criteria are specified in Section 9.6. of API 1104.

   The ultrasonic testing will be executed, after the x-ray examination and interpretation of the films.

   The results of both examination methods will determine the acceptability of the qualification test welds.

4. Magnetic particle examination (MT)

   This examination will only be performed after acceptance by visual - radiographic and ultrasonic testing.

   The weld will be 100 % electromagnetically tested, after grinding out the reinforcement on the internal surface.

   The testing method must be in agreement with Section 11.2. of API 1104.

The classification of the indications and the acceptance standards are defined in Section 9.4. of API 1104.

The additional macrographic examination will be preferentially located in the areas where imperfections are observed with the MT method.

6.2.4.4. *Destructive tests*

- Before the tests are carried out, test welds using a cellulose electrode may be rendered hydrogen-free. This is carried out by heating the test weld to a temperature of 200 - 250° C for a minimum of six hours.
- The destructive tests must be in accordance with Section 5.6. of API 1104.
- The following destructive tests must be performed on the welding qualification test pieces :

1. Impact testing

   - 3 sets of 3 full size Charpy V - notch specimens must be taken in each process qualification weld in transverse direction to the weld :
     - 1 set of specimens will be located in the middle of the weld thickness, with the notch located in the HAZ;
     - the other 2 sets of Charpy V notch specimens will also be taken in the middle of the weld thickness with the notch located in the deposited weld material. These two sets must be taken at 180° C from each other, i.e. 1 set at the top of the weld and the other set at the bottom of the weld.
   - The test temperature of all Charpy V tests is -20° C.
   - The acceptance criteria are :

     The average value of a set of 3 specimens shall not be less than 35 J/cm².

     In addition, the lowest individual value of only one of the three specimens shall not be less than 28 J/cm².

2. Macrographic examination

   4 macrographic examination of the full cross-section of each qualification weld will be performed. The location of these macrographic examination will, by preference, be estimated in the area where imperfections were observed during the electromagnetic examination of the weld. These locations will be indicated by the Owner, Engineer and/or appointed Third Party Inspection Agency.

3. Hardness testing

   A serie of 10 hardness measurements will be taken at the level of the penetration bead in each cross section taken for macrography :

   - 2 measurements will be in the base metal
   - 2 in the HAZ
   - 6 in the weld metal (from HAZ to the middle of the weld).

   The average value of these measurements in the base metal, HAZ and weld will be max. 370 HV 10. An individual value may be max. 400 HV 10.

6.2.5. Qualification of the welding procedures for repairs

Welding procedures for repairs will be submitted by the Contractor for approval by the Owner, Engineer and/or Third Party Inspection Agency.

Each repair welding procedure must be qualified according to API 1104.

6.3. WELDING OF PIPELINE ELEMENTS

6.3.1. Welding conditions

The welding conditions as specified in Section 7 of API 1104 are applicable.

In addition, the following conditions are applicable :

- All welds and weld repairs shall be carried out in accordance with qualified welding procedures, by qualified welders.
- In the event of wind, rain or low temperatures which may affect the stability of the arc, welding tents or other suitable protection shall be used.

  One end of the pipe shall be sealed off during welding to avoid drafts which may influence the stability of the arc.

  The protective measures are subject to approval of the Owner, Engineer and/or Third Party Inspection Agency's representative on site.
- The welding procedures must specify the requirements concerning the interpass temperatures and the acceptable rest times between the different runs.

  In any case, the rest times between the different runs shall be kept to a maximum. The first three layers must always be performed without rest times. Only the necessary time for eventual brushing or grinding is allowed.
- Interruption in the welding for more than 30 minutes can only be allowed if the weld grove is filled up more than 40 % of the wall thickness.
- All welds must be completely filled at the end of a working day.
- The required pre-heat temperature (as stated on the qualified welding procedure) must be checked on each weld at the moment that the welding will be started. No welding should be performed if the minimum pre-heat temperature is not reached or exceeded by 100° C.
- If the welding is interrupted at the end of the welding pieces, isolating blankets should be put on the weld to avoid a quick cooling of the weld.
- The pipe elements to be welded shall be supported in a suitable manner without damaging the coating of the pipe. The height of the supports (wooden blocks or sands bags) must be such that each weld is at least 40 cm above the ground.
- After welding all weld spatter will be removed by grinding and/or brushing.
- Successive beads should not stop and/or end at the same place. The stops and starts of successive beads should be at least 10 cm shifted.

6.3.2. Preparation of the welding work

6.3.2.1. Verification of good condition of pipes and fittings

The Contractor shall check the condition of the pipes and fittings. Any defects (scratches, indentations, chips in the bevels, etc.,) shall be reported to the Owner and or the Engineer and the Third Party Inspection Agency.

6.3.2.2. Preparation of the pipe ends

The Contractor shall take account of the fact that the pipe ends may be protected with an anti-rust primer.

The ends of the pipes (bevel and root face) shall be cleaned with a metal brush, file or grinder. The bevels shall have an even surface free from laminations tears, scale, slag, grease, paint, etc...

If the pipes are delivered on site without prefabricated weld levels (i.e. plain ends), the bevelling will be performed on site by the Contractor, according to the requirements of the qualified welding procedures.

The levelling should be done as close as possible before the start of the welding pieces.

6.3.2.3. Joint preparation

The pipe ends are bevelled according to the pipeline technical delivery conditions.

If pipes of unequal thickness must be joined, the Contractor shall carry out the necessary additional joint preparation himself to bring the joint preparation into line with fig. 15 of standard ASME B 31.8.

Should a cut be made, the cutting material and the working method shall be subject to the approval of the Owner and or the Engineer and the Third Party Inspection Agency.

The unprocessed pipe ends shall be ground so that the bevels and root faces meet the requirements of the WPS.

The markings shall be transferred to the pipe element which does not contain this information. In the absence of these data, the pipe element in question shall be rejected and considered unfit for reuse.

6.3.2.4. Alignment

a) General

For both longitudinally seam and helical seam welded pipes, the pipes shall be positioned so that the ends of the longitudinal or helical welds of two successive pipes are offset from each other by at least 100 mm, measured on the circumference.

b) Pipeline fabrication

All longitudinal seam welds must be in a circular sector of 45° along either side of the lowest traced line of the pipe.

c) Station construction

For pipeline branches, a distance of 100 mm shall be maintained between the longitudinal seam or helical seam weld and the butt weld of the branch.

The zone cut out of the pipe shall be examined by ultrasound beforehand (zone of 100 mm along and around the complete weld).

If a distance of 100 mm cannot be maintained between the longitudinal or helical seam weld and the butt weld of the branch, the longitudinal seam or helical seam weld of the pipe shall be examined ultrasonically beforehand over a distance of at least one diameter along either side of the zone to be cut.

If these checks reveal any unacceptable imperfections, another zone shall be sought.

6.3.2.5. *Handling of pipes during welding and support of the pipeline*

The pipes shall not be manipulated during the welding of the first run (root bead). Thereafter they shall be supported on wooden blocks or sand bags without creating any additional stresses.

6.3.3. Arrangement of the pipe elements

6.3.3.1. *Pipeline fabrication*

working in line:

The length of the pipes to be welded shall be at least twice the pipe diameter, with a minimum of 1 m.

On either side of each circular joint, only one round joint shall be permitted within a distance of 8 m.

6.3.3.2. *Gas Stations (and valve stations)*

The number of welds shall be limited to a strict minimum. Should a bridging sleeve be used, it shall be at least 1 x ∅ in length.

The welds shall be carried out as pipe-to-pipe connections. Thus for a butt weld where moulded pieces are used, the pipe sections shall be welded to them first.

Tie-ins-butt welds which cannot be hydrostatically tested for strength shall be performed on pipes having the same wall thickness.

6.4. WELD NUMBERING AND WELD DATA RECORDS

6.4.1. Numbering

6.4.1.1. *Pipeline fabrication*

In accordance with the provisions of Part 2, the Contractor shall indicate the kilometre points along the working strip.

The welds between KP 0 and KP 1 are numbered 000/0001, 000/002, 000/003 etc. The welds between KP 1 and KP 2 are numbered 001/001, 001/002, 001/003 etc. All tie-in welds between KP 0 and KP 1 are numbered 000/101, 000/102, 000/103 etc.

These numbers are shown on the radiographic images preceded by the digit code number of the pipeline.

6.4.1.2. *Gas station construction and valve stations*

In the gas stations, the welds shall be numbered according to the Owner particular numbering system or numbering system approved by him and/or Engineer.

Example of a gas station numbering system (for information only) :

9.99.999 / *ST*XX / 9999 where;

9.99.999	= the code number of the installation of the Client
ST	= standard 'ST' to indicate 'STATION'
XX	= the first two letters of the name of the gas station
9999	= maximum of four figures for the individual weld number.

6.4.1.3. *Applying the weld numbers*

The Contractor will submit for approval to the Owner and or the Engineer the way he will indicate the weld number on the pipes.

The Contractor shall apply the weld number next to each weld in a correct and legible manner using an indelible product.

6.4.2. Welding data records

The Contractor shall provide the Owner and/or the Engineer on a daily basis with all the information for inspection and technical files, i.e. for every weld, root head, filler beads and finish beads :

- the ID of the welders who have carried out the welds;
- the weld number
- the date of the execution of the weld
- the individual numbers of the joined pipes and/or accessories, their grade, nominal thickness, origin and length
- the WPS used
- the number of repairs or cut out welds, the reason for repair and the date of repair.

All these data must be signed by both the Owner and or the Engineer and the recognised inspection organisation.

6.5. AUTOMATIC AND SEMI-AUTOMATIC WELDING

General

Line welds will be welded by an automatic or semi-automatic method : exceptions to this general requirement must be approved by the Owner, Engineer and/or Third Party Inspection Agency..

The requirements are those stipulated in Section 12 of API 1104 "Automatic welding", as amended below by this GTS.

The amendments are given in accordance with the respective articles of API 1104 - Section 12.

Art. 12.1. : Acceptable procedures

Add :

The welding process and the type of welding machine must be detailed in the bid documents, including the eventual name(s) of the subcontractor(s) and/or supplier of the welding machine(s).

Art. 1.2.2. : Procedure qualification

- The qualification procedure shall be done on the same pipes that must be welded on site for this project. The pipes will be provided by the Owner.

- One procedure qualification must be done per :

  - diameter
  - thickness
  - origin of the pipe (steel mill and/or pipe mill).

- The conditions for the procedure qualification must be as close as possible to the conditions that will be met on site.

- The mechanical testing will be the same as for the qualification testing of manual weld (see Section 6.2.4. of this GTS).

- The non-destructive testing will also be the same as specified in Section 6.24. of this GTS, except that the UItrasonic Testing (UT) will be performed by the automated UT method that will be used on the field welds and by the same non-destructive testing company.

  The requirements for the field testing are specified below.

Art. 12.4. : Procedure specification

12.4.1. General

- A preliminary WPS shall be added to the bid documents with all information as stated below.

- The origin and/or brand name of the major parts of the machine will be stated, i.e. welding machine, levelling machine, clamps, ...

12.4.2. Specification information

12.4.2.1. Process

A detailed description must be given.

12.4.2.2. Pipe and fitting material

Pipes will be provided by the Owner.

12.4.2.3. Diameters

As specified in the PTS.

12.4.2.4. Wall thickness

As specified in the PTS.

One qualification must be done per diameter and thickness, and combination (e.g. if different thicknesses must be welded together).

12.4.2.5. Joint design

- One sketch per diameter and thickness, or any combination of thicknesses.
- A detailed description must be given of the bevelling machine, including brand name and/or name of manufacturer.

12.4.2.6. Filler metal

In addition, the type, size and brand name of the filler metal shall be given.

12.4.2.10. Time between paces

- The qualification parameters must be the same as those that will be utilised on site. Under these conditions, a weld that has been started must be completed.

12.4.2.11. Type of lining clamp

A detailed description of the clamp and how it operates must be given. In addition, the brand name or a name of manufacturer must be given.

12.4.2.12. Cleaning

In addition, the cleaning after welding must be specified.

12.4.2.13. Preheat treatment

The method of measuring the preheat temperature shall also be specified.

12.4.2.14. Post-heat treatment

The use of isolation blankets during the cooling-off of the weld should be specified, and also applied during the qualification testing.

12.4.2.16. Shelding flux

The American Welding Society (AWS) classification number and brand name number shall be given.

12.4.2.18. Other factors

Some of these factors are :

- the use of a tent or any other means of weather protection
- the composition of the welding team, and their qualifications
- The time required for :
  - preparation of welding
  - welding cycle
  - cleaning
- number of welds that is foreseen on site per hour (for different diameters and thicknesses)

Art. 12.5. : Essential variables

In addition to API requirements, the following amendments are applicable :

12.5.2.2. Pipe material

Pipes from different steel mills and/or pipe mills will be qualified for each origin.

12.5.2.4. Wall thickness

- Each thickness/diameter combination will be qualified separately.
- The welding of different thicknesses shall also be qualified separately.

12.5.2.5. Pipe diameter

See 12.5.2.4.

12.5.2.6. Filler metal

A change in type, diameter and/or brand name of filler metal will require re-qualification.

12.5.2.11 Shielding flux

A change in AWS classification and/or brand name will require re-qualification.

12.5.2.12 Speed of travel

In addition, the total welding time, as stated in the welding procedure, should not change beyond ± 10 %.

Art. 12.6. : Qualification of welding equipment and operators

The destructive and non-destructive testing, as defined above, must be performed.

Art. 12.7. : Records of qualified operators

The company must keep detailed records of the welding operators on site, in a manner that an operator performing repeated bad welds may be identified. The Owner, Engineer and/or third party agency may request his renewal from the site. He may only be re-qualified after complementary training and approval by the Owner/engineer.

Art. 12.8. : Inspection and testing of production welds

- In addition, the amendments of this GTS will apply.
- All automatic welded joints will be inspected by automatic UT, as described in Section 7.9. of this GTS.

Art. 12.9. : Acceptance standards for NDT

See GTS Part 7 "Inspection and testing of production welds".

Art. 12.10. : Repair and removal of defects

The same criteria apply as for the manual welds (see 7.7. of this GTS).

Art. 12.11. : Radiographic testing

The testing of the automatic and semi-automatic welded joints shall be done by automatic UT (AVT) (See Section 7.9.).

PART 7

Inspection and testing of production welds.

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7. INSPECTION AND TESTING OF PRODUCTION WELDS

7.1. GENERALITIES

- The Inspection and testing of the field butt welds will be done according to the requirements of API 1104, and these of this GTS.
- The line welds will be to the extend possible welded by an automatic or semi-automatic paces. The inspection of these welds will be done by an Automated Ultrasonic System (AUT). The requirements for these inspections will be treated under Section 7.9. "Inspection and testing of automatic welded joints".
- The inspection and testing of the production welds will be supervised on site by the Owner, Engineer and/or third party inspection agency.

7.2. TESTING OF WELDED JOINTS AND ACCEPTANCE CRITERIA

The welded joints shall be tested prior to painting or coating.

7.2.1. Non-destructive testing

7.2.1.1. Visual inspection

The visual inspection shall be interpreted in accordance with API 1104 with the following additional requirements :

- Arc ignition points :
  - ≤ 0.5 mm : acceptable if ground out
  - > 0.5 mm : unacceptable and cut out
- Mass clamp craters :
  - ≤ 0.5 mm : acceptable if ground out
  - 0.5 mm - 1.5 mm : acceptable if ground out and welded according to repair procedure
  - > 1.5 mm : unacceptable and cut out

7.2.1.2. Radiographic testing

- Radiographic testing with x-rays shall be carried out in accordance with the provisions of API 1104.
- Gamma-rays shall only be used in case that the use of x-rays equipment is not possible and is agreed y the Owner, Engineer or third party inspection agency.

7.2.1.3. Ultrasonic testing

7.2.1.3.1. Test method and acceptance criteria

- Manual UT shall be carried out in accordance with ASMEV - Art. 5 and API 1104.

- The automatic or semi-automatic welded line pipe joints shall be tested by an automatic UT system (See 7.9.).

7.2.1.3.2. *Scope of the test*

a) Minimum test planned

- Manual welded joints will be 100 % tested by x-ray, and eventually also by manual UT, if deemed necessary by the Owner, Engineer and/or third party inspection agency, e.g. if there is doubt concerning the quality of the weld on basis of the interpretation of the x-ray films.

- For the stations and valve stations all welds will be inspected by x-ray, eventually complemented by UT if deemed necessary by the Owner, Engineer or third party inspection agency.

- Welded joints which are welded with the use of external clamps (e.g. tie-ins) shall be tested by 100 % x-ray and 100 % UT.

b) Supplementary tests

Further to a decision by the Owners and a Engineer and the third party inspection agency (for example in the event of cracks), all the welds carried out in the course of that day may be tested with ultrasound and if necessary this inspection may be extended to all welds. If these tests bring to light any defective welds, the Contractor shall carry out the repairs at his own expense.

7.2.2. Other test methods

As well as the non-destructive tests described above, the Owner and/or the Engineer and the third party inspection agency may decide to carry out additional destructive or non-destructive tests, such as :

- magnetic particle test
- liquid penetrant test
- weld sampling
- any other destructive or non-destructive test methods.

The acceptance criteria for the magnetic partial test and liquid penetrant test are defined on the basis of the following standards:

- Magnetic particle test :

  - Method : ASME V - Art 7
  - Acceptance criteria ASME VIII- Div 1 - App 6 and API 1104.

- Liquid penetrant test :

  - Method ASME V - Art 6
  - Acceptance criteria ASME VIII- Div 1 - App 8 and API 1104.

The acceptance criteria for the weld samples shall be the same as for the welding procedure qualification.

7.2.3. Destructive tests

In case of doubt of welding quality (i.e. too many repairs), the Contractor may be ask to cut out one production weld with a minimum of 50 cm of material on either side of the weld.

The production welds to be cut out shall be selected by the Owner's representative on site or the Engineer. The Contractor shall present this production weld for destructive testing to a recognised laboratory.

7.3. IDENTIFICATION OF INCOMPETENT WELDER(S)

The Contractor shall, within the limits of the welding procedure, form welding teams and keep track of there works in the field in such a way that incompetent welders can be identified at any time.

If the tests show that the majority of imperfections can be traced to the same welder(s), the third party inspection agency and the Owner and/or the Engineer can require the exclusion of this/these welder/s.

At the consent of the Owner, Engineer and/or third party inspection agency, excluded welders may eventually be proposed for additional training and re-qualification.

7.4. IMPLEMENTATION OF THE NON-DESTRUCTIVE TESTS

Radiographic examinations will be carried out daily after completion of the welding on the stretch of line and/or special point, station, ...

The necessary safety precautions, as specified in the Site Safety Procedure, to be drafted by the Contractor, will be taken before start of the inspection.

7.5. ANNOUNCEMENT OF TEST RESULTS

Only binding for work carried out during normal working hours.

7.5.1. General

The results of the non-destructive tests carried out during the course of the day shall be sent to the Contractor in writing by the Owner or the Engineer or by the third party inspection agency, subject to the agreement of the Owner, on the morning of the following working day before noon.

7.5.2. Welding of tie-ins, special points, and repairs

7.5.2.1. Radiographic testing

Subject to the approval of the Owner and/or the Engineer and the third party inspection agency, in urgent cases, the third party inspection agency shall inform the Contractor verbally of the provisional test results within the hour following the photograph by interpreting the wet film.

The results shall not be definitive until the dry film has been examined.

The deadline for verbal communication of the definitive results shall be twelve hours following the announcement of the results when they have been interpreted from the wet film. The definitive results shall be communicated as described in Article 7.5.1.

7.5.2.2. Visual and ultrasonic testing

The results of these tests shall be given verbally at the time of the test.

Written communication of the results shall be carried out in the same way as described in Article 7.5.1.

7.6. INSPECTION OF FILMS BY CONTRACTOR

Before carrying out any repairs, the Contractor may inspect the relevant film himself. The film remains the property of the Owner.

7.7. LOCAL REPAIRS AND CUT-OUT OF DEFECTIVE WELDS

7.7.1. General

The Contractor shall be obliged to repair welds or re-weld or cut out welds which are deemed defective by the third party inspection agency. This shall be carried out within normal working hours.

Each repair of a defective weld, whether local or total, shall be carried out within the two working days following the announcement of the results by the third party inspection agency. The performance of the repairs implies that the Contractor agrees with the interpretation of the non-destructive testing.

Section 10 of API 1104 is applicable, with the following requirements :

- all cracks other than shallow crater cracks or star cracks (see 9.3.10. of API 1104) shall not be repaired by welding. The cracks must be removed by cutting out the weld;
- all other defects (except superficial defects) detected by non-destructive testing can only be repaired by welding after approval by the third party representative on site;
- only superficial defects that can be removed by grinding do not need to be approved, provided the minimum thickness of the pipe is respected. After grinding, the ground area will be inspected by liquid penetrant (PT) or magnetic particle examination (MT);
- all areas to be repaired by welding must also be inspected by PT or MT after grinding, to make sure that all defects are removed;
- the weld repairs must be re-inspected by x-ray, UT and or MT as required by the third party representative on site;
- a second weld repair is not admitted, and the weld must be cut out in case defects are detected in the repairs;
- in case a weld must be cut out, a zone of a least 5 cm of the pipe material must be removed on both side of the weld. The new bevel should be checked by PT on the absence of defects;
- the cut out welds should be identified with the weld number and kept in stock for eventual further investigations.

7.7.2. Pipeline construction

Cut-out welds shall be repaired by welding in a connection sleeve. The repair shall be prepared and undertaken in accordance with the requirements of this specification.

If local circumstances permit, and subject to the agreement of the Owner and third party inspection agency, a cut-out weld may be remade without using a connection sleeve by displacing the adjacent pipe elements. The cut, as well as the new bevels, the positioning of the pipes and the performance of the new weld shall be carried out in accordance with the current specifications.

If there are separate procedures for tie-in welding and line welding, a cut-out weld shall be replaced according to the same welding procedure as for a tie-in weld.

7.8. SHARING OUT THE TEST COSTS

Costs relating to testing and supervision shall be charged to the Contractor insofar as they are incurred at his request outside normal working hours.

Testing during normal working hours.

	Visual inspection	Radiographic testing	Ultrasonic testing	Other test methods	Destructive testing
Minimum inspection prescribed in Articles 7.2.1., 7.2.2., 7.2.3.	Owner	Owner	Owner	Owner	Owner
Inspection above the minimum of Articles 7.2.1., 7.2.2	Contractor	Contractor	Contractor	Contractor	--
Inspection of repairs	Contractor	Contractor	Contractor	Contractor	--

The costs shall be divided between the Owner and the Contractor in proportion to the total test costs for the work in question, in other words :

costs charged to Contractor = total test costs x (% defective welds / 100 + % defective welds).

7.9. INSPECTION AND TESTING OF AUTOMATIC WELDED JOINTS

7.9.1. General

All requirements for inspection and testing, as described above, remain valid except that all automatic and semi-automatic welded joints will be inspected by Automatic Ultrasonic Testing (AUT) in stead of RX.

The AUT must be performed according to a detailed inspection procedure (see 7.9.2.) by an experienced Inspection Organisation accepted by the Owner, Engineer and/or third party inspection agency.

7.9.2. Details of the AUT procedure

A detailed AUT procedure must be drawn up by the Inspection Organisation. This inspection procedure must be approved by the welding Contractor and submitted to the Owner, Engineer and/or third party inspection agency for review and approval.

One AUT procedure must be made for each diameter, thickness and weld configuration.

The AUT procedures shall contain at least following information :

- number of UT probes (type, angle, frequency and focus) on both sides of the weld, including the TOFD probes;
- a sketch with the cross section of the weld, the different zones of the weld covered by the respective probes and placement of the probes;
- description of the scanner;

- description of cables coupling system and electronic equipment;
- detailed description of the UT instrument, computer and printing equipment;
- different type of mapping and data presentation used during inspection;
- calibration set-up;
- maximum temperature of the weld that can be inspected;
- inspection time for different diameters;
- number of welds than can be performed per hour (under normal field conditions);
- amount of water required.

In addition, the operational requirements and restrictions of AUT system should be given, e.g. accessibility to welds, steep kills in the field, conditions of welds and surrounding zones, ...

The required material for the fabrication of the calibration blocks should also be specified.

The procedure should also give a description (with sketch) of the calibration blocks for each diameter and thickness and the delay necessary for the fabrication of these blocks.

7.9.3. Implementation of AUT

The UAT should be performed as close as possible behind the welding team, in agreement with the welding contractor, and all completed joints should be tested the same day of welding.

Welding imperfections (especially systematic defects) should be reported directly to the welding contractor, to reduce the eventual repair rates.

The written reporting shall comply to Section 7.5.1. of the GTS.

7.9.4. Acceptance standards for AUT

The classification of indications and acceptance standards as defined in Section 9.6. of API 1104 are applicable.

The threshold settings of the AUT equipment should be agreed on before the start of the AUT inspections on site.

The Inspection Organisation, welding Contractor, Owner, Engineer and/or third party inspection agency, should during the AUT inspections of the qualification welds, define these threshold settings.

The different mappings that are required, should be defined during the qualification tests, and clear interpretation of these mappings for the different types of defects (cracks, linear defects, volumetric defects) should be given.

Special attention should be paid to geometric indications that are similar to those caused by weld imperfections but are not relevant to acceptability according to API 1104.

Once all parties are agreed with the threshold settings and form presentation (colour codes, amplitudes, range of transit distance, ...) no changes should be made in these settings and way of reporting them.

Different settings can only be used by the third party inspection agency during their interpretation of the results (E;G. other amplitude settings), but the mapping resulting from these settings will not be respected in order to avoid confusion by the different parties.

7.9.5. Calibration blocks

The Inspection Organisation will manufacture the calibration blocks with material provided by the Owner. The dimensions of the pipe sections to be provided by the Owner, should be specified by the third party inspection agency.

The Owner should provide the specified pipe sections, for each diameter, thickness and origin of the steel (steel mill and/or pipe mill).

Measurements of the ultrasonic wave propagation will be performed by the Inspection Organisation inspection agency, in order to determine if material from a different origin behave in a similar manner, and if 1 calibration block (for a given diameter and thickness) can be used for different type of steel or not.

The number of calibration blocks will therefore depend on the outcome of results the measurements.

The Inspection Organisation should draft a report of these measurements, and explain why the selected number of calibration blocks have been manufactured and the conditions where these calibration blocks can be used. The identification of the blocks should be clearly marked on the blocks, so that no confusion is possible during the inspection on site.

The applicable calibration block for the inspections on site should be given on the daily reports on site.

The Inspection Organisation must also include a sketch of each calibration block (per diameter and thickness) showing the different holes, notches, ... that have been put on the blocks.

These sketches must be added to the AUT procedures (see 7.9.2.)

PART 9

Coating

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9. COATING

9.1. GENERAL

9.1.1. Purpose of the coating

The purpose of the external coating is to insulate the steel pipe as much as possible from the ground and from every incidental structure located in the ground.

9.1.2. Material to be coated

Except otherwise stated in the PTS the Owner supplies :

- line pipes with a polyethylene external coating that meets the requirements of standard DIN 30 670 unless otherwise specified in the Special Specifications.
- uncoated fittings, uncoated moulded pieces, uncoated valves and uncoated hot bends.
- valves with protegol coating.
- at the following places, the Owner provides, for station construction, uncoated pipes that the Contractor shall coat:
  - For buried sections
    - all vertical pipes provided with a protection of reinforced polyester (ground passages).
    - all underground pipes $\varnothing \leq 600$ and a length < 1.5 m.
    - all underground pipes $\varnothing > 600$ and a length < 2.5 m.

9.1.3. Obligation of the bidder

The Tenderer shall specify in his bid the type of external coating that he will use and attach a certificate of conformity of the supplier specifying that the material to be used meets DIN 30 672 and/or DIN 30 673 and/or NEN 6909.

9.1.4. Obligation of the Contractor

The Contractor shall thus :

- submit a quality control certificate from the supplier stating that all products supplied comply with the requirements
- Apply the coating on the buried bare pipeline parts
- Apply the coating on the buried welded joints
- Make all the required repairs to defects in the external pipe coating that are either

- at the expense of the Owner (if there are defects that existed before the Contractor took delivery of the line pipes), or
- at the expense of the Contractor for defects that are discovered later; the acceptance note has conclusive force here (see Part 4).

- provide special protection at places indicated in the special execution conditions of the PTS or Particular drawings.

9.1.5. Overview of the coating systems to be accepted by the Owner/Engineer

The pipeline sections can be coated by means of :

- bitumen (asphalt)
- bituminous tapes reinforced with fiber glass
- PE wrapping tape
- Heat shrinkable sleeves
- plastic instant repair, tape
- polypropylene
- 2 components: coal tar epoxy

9.1.6. Definition of the type of coating according to application

- Bare pipes and hot bends are coated with plastic wrapping tape.
- Welds joints can be coated with plastic wrapping tapes or heat shrinkable sleeves.
- Moulded pieces can be coated with plastic wrapping tape, or bituminous tape.
- Bare valves will be coated with bitumen or bituminous tape.
- Valves with protegol coating will be repaired with 2 components: coal tar epoxy.
- For horizontal directional drilling, the Tenderer will submit a specific proposal.
- Reinforced heat shrinkable sleeves or equivalent will be used for pneumatic impact mole or thrust boring system.

9.1.7. Material used by the Contractor

The properties of the devices and machines used for the coating process (melting equipment) must be approved by the Owner and or the Engineer. This material must be properly maintained and checked.

9.1.8. Personnel

The personnel employed by the Contractor for on site coating of the welded joints must be in possession of a certificate of qualification issued by the supplier of the coating products certified by a Recognised Inspection Organisation.

9.1.9. Safety measures for installations in service

- The Contractor must take the required safety measures when removing and applying the coating to live installations in accordance with a procedure agreed with the Owner and or the Engineer. In each case, work may only be carried out on a live installation with a work procedure and fire licence and under the constant supervision of the Owner and or the Engineer.

- The formation of condensation in live installations can be removed by heating the section of pipe to a maximum of 50° C on small surfaces with an electric hot air blower.

N.B. :

Before buried valves are coated, the Contractor will check that the position of the body relief valves and the lubricant valves are in the "open" position. The valves may only be operated in the presence of the Owner and or the Engineer.

9.2. PREPARATION OF THE SURFACES TO BE COATED

The products must be applied to a surface that is completely dry and free of all impurities such as rust, scales, lamination tears, slags, grease, oil, paint, etc. Tar, grease, oil and all other greasy substances must first be removed by means of an approved solution (e.g. 1,1,1-trichloro-ethane) or an emulsifier. White spirit or turpentine may not be used. The pipe surfaces and the welded area should then be mechanically cleaned to a degree of cleanliness ST 2 in accordance with ISO 8501-1.

This mechanical cleaning must be carried out by means of mechanically driven rotating steel brushes. After this surface preparation has been carried out, the surfaces should be completely free of weld spatters slags, rust, lamination tears scales, paint or varnish stains and other foreign substances and impurities.

The mechanical cleaning must be continued to at least 10 cm beyond the existing intact coating, in such a way that all dirt is removed and the coating is roughened to ensure good adhesion. The intact coating will be chamfered at the extremities to an angle of 15 to 30° in order to form a perfect joint.

9.3. IDENTIFICATION OF ALL BURIED JOINTS

The Contractor will identify each buried joint by means of small aluminium plates that must always be positioned on the upper side of the welded joint. A first self-adhesive aluminium plate with the information in accordance with Part 6 will be stuck to the welded joint after applying the primer coat. A second self-adhesive aluminium plate will be placed above the joint after applying the coating. The uppermost plate must be kept visible and secured at the sides with PE tape.

9.4. WEATHER CONDITIONS WHEN CARRYING OUT THE WORK

In order to achieve optimum results during the coating work, it is essential that no condensation occurs on the blasted or cleaned surface or between the different layers. For this reason, the temperature of the surface to be coated should be at least 3°C higher than the dew point or condensation temperature of the surrounding air. The dew point of the air is given in the table below for a number of conditions of air temperature and relative atmospheric humidity.

Air temp.	Dew point in °C with a relative humidity of								
°C	50 %	55 %	60 %	65 %	70 %	75 %	80 %	85 %	90 %

5	- 4.1	- 2.9	-1.8	-0.9	0.0	0.9	1.8	2.7	3.6
6	- 3.2	- 2.1	-1.0	-0.1	0.9	1.8	2.8	3.7	4.5
7	- 2.4	- 1.3	-0.2	0.8	1.8	2.8	3.7	4.6	5.5
8	- 1.6	- 0.4	0.8	1.8	2.8	3.8	4.7	5.6	6.5
9	- 0.8	0.4	1.7	2.7	3.8	4.7	5.7	6.6	7.5
10	0.1	1.3	2.6	3.7	4.7	5.7	6.7	7.6	8.4
11	1.0	2.3	3.5	4.6	5.6	6.7	7.6	8.6	9.4
12	1.9	3.2	4.5	5.6	6.6	7.7	8.6	9.6	10.4
13	2.8	4.2	5.4	6.6	7.6	8.6	9.6	10.6	11.4
14	3.7	5.1	6.4	7.5	8.6	9.6	10.6	11.5	12.4
15	4.7	6.1	7.3	8.5	9.5	10.6	11.5	12.5	13.4
16	5.6	7.0	8.3	9.5	10.5	11.6	12.5	13.5	14.4
17	6.5	7.9	9.2	10.4	11.5	12.5	13.5	14.5	15.3
18	7.4	8.8	10.2	11.4	12.4	13.5	14.5	15.4	16.3
19	8.3	9.7	11.2	12.3	13.4	14.5	15.5	16.4	17.3
20	9.3	10.7	12.0	13.3	14.4	15.4	16.4	17.4	18.3
21	10.2	11.6	12.9	14.2	15.3	16.4	17.4	18.4	19.3
22	11.1	12.5	13.8	15.2	16.3	17.4	18.4	19.4	20.3
23	12.0	13.5	14.8	16.1	17.2	18.4	19.4	20.3	21.3
24	12.9	14.4	15.7	17.0	18.2	19.3	20.3	21.3	22.3
25	13.8	15.3	16.7	17.9	19.1	20.3	21.3	22.3	23.2
26	14.8	16.2	17.6	18.8	20.1	21.2	22.3	23.3	24.2
27	15.7	17.2	18.6	19.8	21.1	22.2	23.2	24.3	25.2
28	16.6	18.1	19.5	20.8	22.0	23.2	24.2	25.2	26.2
29	17.5	19.1	20.5	21.7	22.9	24.1	25.2	26.2	27.2
30	18.4	20.0	21.4	22.7	23.9	25.1	26.2	27.2	28.2

In certain exceptional cases where there is frost or dew, coating can be applied provided the Contractor properly dries the surfaces to be coated before applying it and for this purpose uses a method approved by the Owner and or the Engineer. The Contractor will provide a hygrometer, digital thermometer and dew-point meter accompanied by the required calibration certificates issued by a recognised inspection organisation for the representative of the Owner.

9.5. APPLICATION OF THE COATING

9.5.1. Coating with plastic wrapping tape

9.5.1.1. Composition of the coating

- The coating material proposed by the Contractor to the Owner and or the Engineer must comply with DIN 30 672 or EN 12068, class C for operating temperature up to 50°C and must be DIN DVGW certified.

The heat shrinkable sleeves must comply with DIN 30672 or EN 12068 class C for operating temperature up to 50°C.

- For moulded pieces, branching pieces and flanges, the plastic wrapping tape must meet :

  EN 12068 class C for operating temperature up 30°C or 50°C or DIN 30 672, class C for operating temperature up to 30°C or 50°C as stated in the PTS.

Nota :

For the compression station and within a area of 1 000 meters after the station the wrapping will comply with DIN 30672 or EN 12068 class C for operating temperature up to 50°C.

- The plastic wrapping tape and primer must be supplied by the same manufacturer.

9.5.1.2. *Applying the coating*

The Contractor shall draw up a working procedure accordingly to the supplier instructions and recommendations for the welded joints, bare pipes etc. as well as for the fittings, valves, relief pipes etc.

9.5.2. Coating with bituminous tapes

9.5.2.1. *Composition of the bitumen coating*

The coating material proposed by the Contractor to the Owner and or the Engineer must comply with the standard EN 12068 Class B for operating temperature up to 50°C.

The coating consists of:

- An oxidised bitumen-based priming or adhesive layer, solutions containing hydrocarbon and an adhesive to be applied to all blank metal parts. The product must comply with the provisions of the General Regulations for the Protection at Work.

- One or more petroleum bitumen-based plastic layers when the primer coat is sufficiently dry.

- A double reinforcement made of fibre glass (45 gr. per m2) set in the above-mentioned plastic layers.

The minimum thickness of the bitumen coating will be 4 mm and must at least be equal to the thickness of the existing pipe coating.

9.5.2.2. *Application of the bituminous coating*

The Contractor shall draw up a working procedure accordingly to the supplier instructions and recommendations for the welded joints, bare pipes etc. as well as for the fittings, valves, relief pipes etc.

9.5.3. Coating with heat shrinkable sleeves

9.5.3.1. *Composition of the coating*

The contraction sleeves must meet DIN 30 672 class C operating temperature up to 50°C.

9.5.3.2. *Application of the heat shrinkable sleeves*

The Contractor shall draw up a working procedure accordingly to the supplier instructions and recommendations for the welded joints, bare pipes etc. as well as for the fittings, valves, relief pipes etc.

9.6. REPAIRING OF THE COATING

Any defects detected will be repaired by the Contractor under the supervision of the Owner and or the Engineer. In places where the coating has been removed, reworked or repaired, the inspection will be conducted by the Contractor by means of a holiday detector under supervision of the Owner and or the Engineer.

The Contractor will only be paid for repairs that were accepted under the responsibility of the Owner at the time of the hand-over of the materials. In the case of adhesion defects, insufficient thickness of the coating, inaccurate positioning and/or bad impregnation of the reinforcement, the presence of traces of humidity, of air-pocket and solid particles, the coating will be removed and completely repaired.

9.6.1. Repairing PE Coating

9.6.1.1. *Repairing PE coating with plastic wrapping tape*

a) Repairing small defects in the PE coating that do not reach down to the metal by means of plastic wrapping tape.

- Preparation :

  Roughen the PE surface around the point faults with a brush disk. Dry the PE surface over the entire pipe circumference with the propane burner to a pre-heating temperature of 30°C. Apply adhesive plastic wrapping tape over the entire pipe circumference in accordance with the supplier instructions and recommendations.

b) Repairs to other defects in the PE coating with plastic wrapping tape.

- Preparation :

  Cut out the damaged PE surface around the defect to the point where the coating is adhering properly. Chamfer and roughen the edges of the existing coating. Clean the whole surface to be coated with a brush disk to a degree of cleanliness S.T.2.

  Dry the entire part to be coated with a propane burner to 30°C. Apply primer to the cleaned steel surface and the PE coating over the entire pipe circumference.

  Fill in the hole that has appeared with a mastic filler.

  Apply adhesive plastic wrapping tapes over the entire pipe circumference in accordance with the supplier instructions and recommendation.

9.6.1.2. *Repairing PE coating with plastic repair patch*

This method can be applied to all PE damage up to a maximum size of 350 mm x 350 mm. except for directional drillings The plastic repair patch must comply with DIN 30672 class C.

- Preparation :

Cut out the damaged PE surface around the defect to the point where the coating is adhering properly. Chamfer and roughen the edges of the existing coating. Clean the entire surface to be coated with a brush disk to a degree of cleanliness S.T.2.

Dry the entire part to be coated with a propane burner to 60°C. Fill in uneven spots and holes with mastic filler. Apply the correct size adhesive plastic repair patch and heat it until the pigment has disappeared. The repair patch must be smaller than the roughened PE surface area.

9.6.1.3. *Repairing PE coating for directional drilling*

The repair is carried out by means of a heat shrinkable sleeve reinforced with fibre glass or epoxy reinforced with fibre glass or of a specific proposal submitted by the Tenderer.

9.6.2. Repairing bituminous coating

9.6.2.1. *Repairing small damaged areas ≤ 1cm²*

Small damaged areas in bituminous coating must be repaired by heating the bitumen and sealing the defect using a spatula.

9.6.2.2. *Repairing large damaged areas > 1cm²*

- Preparation :

  The damage must be cut out in a rectangle. Clean the whole surface to be coated with a brush disk to a degree of cleanliness S.T.2. Dry the surface to be coated with a propane burner to 30°C and then apply a primer. Apply the bituminous coating in accordance with supplier instructions and recommendations.

9.6.3. Repairing protegol protection

Some valves are provided with a protective layer consisting of Protegol UT 32-10 R applied according to the supplier instructions and recommendations. The repairs must be carried out with Protegol UT 32-10 L applied with a brush and according to the instructions of the supplier.

9.7. REMOVAL OF COATING

The Contractor shall draw up the method for "removal of the pipe coating" and submit at to the Owner and or the Engineer for approval.

9.8. QUALITY CONTROL OF THE CORROSION PROTECTION

Independently of the inspection of the method of execution, the conditions of use of the products and the material for the realisation of the coating, the Owner and/or Engineer reserves the right to examine systematically the continuity of the insulation and to inspect the adhesion, the thickness, the position of the fibre glass fabric and his correct and complete impregnation, the presence of any trace of humidity, of any air pocket or of any solid particle by taking samples.

When pipelines are being constructed and laid, the Owner and or the Engineer will check, after backfilling, the electrical resistance of the coating by means of detection devices suitable for detecting any drops in potential through the coating (see Part 13). The Contractor will bear all costs resulting from the repair of the defects detected.

9.8.1. Systematic inspection

The Contractor will check the quality of the pipes insulation protections over their entire length at the appropriate time by means of a detector or a holiday detector.

This inspection will be carried out in the presence of the Owner and or the Engineer who reserves the right at any time to check the proper functioning of the device. The holiday detector will be clearly identifiable by means of an individual number engraved in an identification tag attached to the apparatus. A certificate, drawn up by the Supervisory Body, will attest that the apparatus complies with a recognised code. Verification is effected with a high-voltage voltmeter HV-40, calibrated by a calibrated testing bench (ball diameter 20 mm) according to the 50 % method.

For a preset scale value of 0.65, the maximum permitted deviation of the output voltage for 5 V can be 15 %. For a preset scale value of 8.3 the maximum permitted deviation of the output voltage for 25 V can be 10 %.

Besides the calibration, the HV-cable and handle, the sealing ring, the earthing cable and earthing as well as the carrying case must be accepted by the Supervisory Body. The maximum validity of the certificate is one year.

The test current of the device must be in accordance with the type of coating and must meet the standard according to which this coating was executed. During holiday detection, the pipeline and the holiday detector will be interconnected continuously by means of a copper wire, regardless of the length of the pipeline.

Specification of the test current for the inspection with the holiday detector :

- 5 kV/mm of coating thickness + 5 kV; maximum equal to 25 kV unless otherwise instructed by the supplier (protegol = max. 5 KV).

- The holiday detector may only be used when the coating is completely dry and after thorough removal of dirt from the surface.

- Inspection with the holiday detector is carried out before laying and after the repair of the defects.

All welded joints will be checked with an holiday detector after application of the welded joint coating in the trench.

9.8.2. Inspection by sampling

A test sample with a surface area of 15 cm^2 will be cut out as soon as the coating has reached ambient temperature. There is a defect in the adhesion when this operation makes the plastic layer come loose without tearing.

Moreover, the Owner and or the Engineer will check the thickness of the coating, the position of the reinforcement and his complete impregnation as well as the presence of any trace of humidity, air pocket or solid particles.

PART 10

Earthworks

Rev.	Date	Subject of revision	Author	Checked	Approved

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10. EARTHWORKS

10.1. EXCAVATIONS

10.1.1. General

10.1.1.1. Sequence of operations

As a general rule, the trench is excavated on the basis of the lengthwise profile. With specific soil types (rocks, solid blocks, etc.), it may nevertheless occur that the Owner and/or the Engineer require the excavation of the trench wholly or partially before the length profile has been drawn up and therefore before the changes of direction of the pipe have been carried out.

If this method is not prescribed, it may nevertheless be implemented at the suggestion of the Contractor who will then present to the Owner and/or the Engineer the necessary argumentation based on his surveys and soundings. In any case the permission of the Owner and/or the Engineer is required.

If the Owner and/or the Engineer requires or accepts this method, the Contractor shall draw up the lengthwise profile on the basis of the trench actually excavated. After the Owner and/or the Engineer has approved the lengthwise profile thus drawn up, the Contractor shall once more carry out the changes of direction of the pipe on the basis of this profile.

10.1.1.2. Method of execution

Before commencing excavations, the Contractor must in every case submit the work procedure and the material for the approval of the Owner and the Administrations concerned. For the work undertaken near existing buildings, the rules as described in part 16 art. 16.7.1 shall be applied.

If the Contractor wishes to use explosives, he automatically undertakes to keep and use them in accordance with the regulations currently in force and with the approval of the Authorities concerned and of the Owner or the Engineer. The supply of the explosives is the responsibility the Contractor as is the procurement of the required permits from the authorised official bodies.

If due to local circumstances the Owner and/or the Engineer deems it necessary, the Contractor shall carry out the excavation work manually without entitlement to any further payment.

In particular, the Contractor must detect all the cables, pipelines, services, etc. of the concessionary companies by means of a sufficient number of inspection holes before any pipes and cables etc. are exposed. Uncovering them will be carried out manually and according to the rules set out in the Building Site Regulations. The capacity of the excavator is specified on the basis of the following tables:

- Using an excavator bucket is not allowed

  Values can be obtained in these tables to limit the maximum force capacity of excavating machines working in the vicinity of the utility services to a certain maximum value in accordance with the practical possibilities. Two values are given in the tables, i.e. a force capacity (F_{cap}.) and a weight (W) derived from it based on average experimental values, and a force capacity (F_{safe}) and a weight (W_{safe}) derived from this based on a statistical lower limit for these experimental values. In the first instance, it is recommended to choose the values based on the lower limit and, if practically possible, lower still in order to incorporate a certain safety margin.

- Installations operated at a maximum working pressure of 66 bar

Diameter mm	s mm	F_{cap} kN	W ton	F_{safe} kN	W_{safe} ton
114.30	4.37	52.54	2.6	39.25	0.0
168.27	7.1	87.99	10.1	67.81	5.8
219.07	8.2	110.96	15.0	87.34	10.0
273.05	5.6	110.24	14.8	88.31	10.2
323.85	6.3	130.43	19.1	105.92	13.9
355.60	6.3	137.73	20.6	112.69	15.3
406.40	6.3	149.13	23.1	123.32	17.6
508.00	6.9	179.81	29.6	151.38	23.5
609.60	6.8	203.59	34.6	173.91	28.3
914.40	10.1	325.44	60.4	287.17	52.3
1016.00	13.6	409.90	78.1	364.04	68.6

- Installations operated at a maximum working pressure of 80 bar

Diameter mm	s mm	F_{cap} kN	W ton	F_{safe} kN	W_{safe} ton
114.30	4.37	53.78	2.9	40.18	0.0
168.27	7.1	89.92	10.5	57.11	3.6
219.07	8.2	113.64	15.5	78.39	8.1
273.05	5.6	113.73	15.6	81.61	8.8
323.85	6.3	134.71	20.0	100.45	12.7
355.60	6.3	142.55	21.7	111.30	15.0
406.40	6.3	154.80	24.3	119.75	16.8
508.00	6.9	187.23	31.1	140.98	21.3
609.60	6.8	212.52	36.5	165.73	26.6
914.40	10.1	339.81	63.5	244.82	43.3
1016.00	13.6	425.23	81.6	358.98	67.5

If it is deemed necessary for the laying of the pipe that cables, pipelines, poles or pylons have to be shifted or divert temporarily, this should take place in accordance with the directives of the Parties Concerned. If these activities cannot be carried out by the managers or owners concerned, they should be carried out by the Contractor or by a subcontractor in possession of the required professional qualifications or recognition.

If in spite of all safety measures a pipe or cable is nonetheless damaged, the works must immediately be halted and the Owner and/or Eengineer and the concessionary company concerned must be informed without delay. In addition, the Contractor shall provide all the assistance required for the repair work at his own expense.

If unforeseen obstacles appear during excavation work (old foundations, posts, bunkers, etc.), these must be removed in accordance with the indications of and in consultation with the Owner and/or the Engineer and possibly the Authorities concerned to at least 0.50 m below the underside of the pipe to be laid and evacuated from the site. "Good filling soil" should subsequently be used for backfilling.

If the subsoil appears to have several layers, each layer shall be stored separately from the other and later replaced in accordance with the original layering if these layers differ in density, elasticity or hydraulic permeability. If the excavated material is composed of layers of peat, the following rules shall be applied:

- peaty soil in layers with a thickness < 30 cm is not stored separately but mixed into the backfill soil;
- peaty soil in layers with a thickness > 30 cm is stored separately and mixed into the arable soil. The excavated volume, less the volume of the pipeline, shall be replaced by stone-free soil.

In the case of clay or rocky soil, the Contractor shall choose his working method in such a way that the excavated material is sufficiently crushed to ensure correct backfill of the trench.
If the Contractor wishes to use a mechanical trencher in areas with different subsoil's, he must submit a study that indicates that the new structure of the subsoil is at least equivalent. In the following areas, the use of a mechanical trencher is forbidden because this causes irreparable structural damage:

- Areas with the presence of thin layers of silt clay (from 20 to 100 µm) and sand or clay layers.
- Areas with sedimentary chalk and peat.
- Areas with peat and clay layers.
- Areas with large presence of basic and carbon-containing material, and layers with a very high iron content.

10.1.2. Underground obstacles

When the Contractor comes across buried cables, pipelines and drainage networks during excavation work, he must take the following measures:

- protect and support the cables, pipelines, drainage networks, etc. as the works progress;
- complete the inventory of fixture of the services encountered during excavation with the parties involved and the Owner and/or the Engineer;
- immediately after digging the trench, the Contractor shall survey the existing drainage systems in the presence of the Owner and/or the Engineer.

  The drains must be made visible by placing blue-painted posts at the edges of the trench. The drains must be closed off on both sides of the trench if they are not directly included in a drainage system laid out by the Contractor.

However, this does not diminish the Contractor's obligation to keep the existing drainage systems in operation and not to affect their functioning. After surveying the drains, the posts shall be positioned on the outside of the working area. These measurements shall immediately be set out by the Contractor in a 1/1000 layout drawing. This drawing shall mention for each Owner plot number:

- the position of each drain measured in relation to a fixed reference point;
- direction of slope;
- type and inner diameter of the drainpipe;
- condition of the drain;
- depth of the drain in relation to the surface.

and one copy of it shall be given to the Owner and/or the Engineer at the latest two working days after the excavation. The Owner and/or the Engineer will carry out the required inspection and if necessary the required corrections will be communicated to the Contractor. Three copies of the accepted drawing will be given to the Owner.

- The "Report of the Presence of Drainage Networks" (see Appendix 1) shall then be filled in together with the tenant/owner and the representative of the Owner;
- In the event of any damage, a proposal for repairs must be submitted for the approval of the Owner and/or the Engineer and the Parties Concerned;
- Observe a clearance of a least 0.20 m between the nearest parts of the cables, pipes and drains at points at which they cross and 0.40 m where they are parallel. These distances should be increased wherever possible especially where they approach large installation. So as to reduce, as far as possible, any risk to neighbouring installation inherent in the Contractor works.
- Adapt the profile design, if necessary.

10.1.3. Trench position

The trench shall be dug in such a way that is is symmetrical in relation to the axis of the channel actually market out.

Directrional changes on the trench floor should tally with the draft longitudinal profile perfectly – both horizontally and vertically – and with changes in pipe direction, so that welded pipe sections lie in a continuous and uniform manner along the trench floor.

To ensure that the above changes correspond, the Contractor shall conduct a topographical survey, in the presence of the Owner and/or the Engineer, after the trench has been dug and before laying the pipe in the trench.

10.1.4. Trenches depth

10.1.4.1. Minimum depth

Except other stated in the Particular Technical Specifications the minimum depth should be as follows:

The trench depth should allow a minimum covering of 1.10 m between the upper generatrix of the pipe and the general ground level even if the drawings require a smaller minimum covering. The covering is defined

as the vertical distance between the reference levels. The provisions of this article take precedence over the measurements shown on the drawings.

The Contractor is not entitled to increase his price if in local circumstances the pipe has a covering varying between 1.10 m and 1.40 m and/or if the increased depth (greater than 1.40 m) has already been stipulated in the Particular Technical Specifications or detail drawings.

An increase may only be granted if the additional depth is greater than 30 cm over a length exceeding 50 m. If the local additional depth could not be known beforehand and no supplementary storage space for piling up soil was provided on that basis (cf. Part 2), the Contractor should store the supplementary excavated soil on the access road. Such storage should be carried out in conformity with Part 2 of the GTS.

The Contractor shall ensure that when storing another type of soil on the access way it shall be kept separate from any other soil thus stored and that during the works no mixing shall occur due to works traffic. The Contractor shall himself be responsible for the inspection of the covering of the pipe after it has been laid in the trench, independently of the measurements that the Owner and/or the Engineer carries out for drawing up the technical archives.

10.1.4.2. Depths greater than the minimum

Except otherwise stated in the Particular Technical Specifications or the detail drawings and the Authorities concerned, the Contractor shall provide a greater trench depth :

- when the pipeline lies underneath a road or crosses a road;
- In such cases, a covering of 1.2 m is required between the upper generatrix of the pipe and the road surface;
- when the pipeline crosses a watercourse in an open cut. In this case, a covering of minimum 1.3 m is required between the upper generatrix of the pipe and the theoretical profile if this profile is lower than the existing natural profile. If the theoretical profile is higher than the natural profile, a covering of minimum 1.3 m is required between the upper generatrix of the pipe and the natural profile;
- when the pipeline crosses a waterway by means of a borehole. In this case, a covering of minimum 1.3 m is required between the upper generatrix of the casing and the theoretical profile if this profile is lower than the existing natural profile. If the theoretical profile is higher than the natural profile, a covering of minimum 1.3 m is required between the upper generatrix of the casing and the natural profile;
- when the pipeline crosses a ditch. In this case, a covering of 1.1 m is required between the upper generatrix of the pipe and the natural profile of the dredged and deepened ditch, with gauging down to compact ground;
- when the pipe crosses a railway, a minimum covering of 1.6 m is required between the upper generatrix coating of the casing and the bottom of the rail. Except otherwise requested by the railway Authority, the crossing should be perpendicular to the rails.
- when the pipe is located in a casing.
- In this case, a covering of minimum 1.2 m is required between the upper generatrix of the casing and the surface;
- when the pipe has additional equipment (half shells, ballast, anchoring, etc.).
- In such cases, there shall be a minimum covering of 1.1 m measured between the top side of the protection and the surface;

N.B.

Concrete slabs are considered as a mechanical protection and not as an additional equipment and are placed 30 cm above the upper generatrix of the pipe;

where under-ground obstacles are encountered, well-defined distances must be maintained.

10.1.4.3. Permitted reduction of the minimum trench depth

If, exceptionally, the minimum depth of the trench cannot be achieve due to local reasons, the Contractor will, provided he has received permission from the Owner and/or the Engineer, provide special protection (binders, half shells, concrete slabs, concrete tiles, etc.). The method of execution must be submitted beforehand for the approval of the Owner and/or the Engineer and the Parties Concerned.

10.1.5. Trench width

The foot of the trench must always have a minimum width equal to the outer diameter of the pipe with its coating and any mechanical protection plus at least 20 cm (10 cm on either side). If local circumstances dictate (ballast, anchoring, half shells, etc.), a wider trench shall be provided depending on the space required to ensure proper execution and complete filling up around the pipe.

When using a mechanical trencher, the foot of the trench shall have a width equal to the outer diameter of the pipe with its coating and any mechanical protection plus at least 40 cm (20 cm on either side). The Contractor must take the required precautionary measures to prevent the trench from caving in. In dry, non-cohesive ground, for example, the angle of the bank may at most be equal to the angle of the natural embankment.

In any case, the Contractor must take account of unfavourable factors such as water flowing into the trench, vibrations and excessive loads near the trench, heterogeneity of the ground, the trench remaining open for a long time, etc. Trench side shall under no circumstances be vertical.

10.1.6. Dimensions of the working pits

In places where welding must be carried out in the trench, the Contractor shall execute the working pits and/or connecting pits (“Under gas”) so as to facilitate welding as well as the inspection and coating thereof. The working pits must be kept dry. The minimum dimensions of these working pits are :

- length: distance between the welded joints + 2 x 1 m
- width: diameter of the pipe + 2 x 1 m
- the distance between a part fixed (e.g. valve) and the wall of the recess should be 0.60 m min;
- depth: 0.6 m under the pipe.

The minimum dimensions of connecting pits “Under gas” are :

- length: length of the pipe element to be put in place + 2 x 1.5 m.
- width : ∅ of the pipe + 2 x 1 m for a ø smaller than or equal to 300 mm

  ∅ of the pipe + 2 x 1.5 m for a ø of 300 to 600 mm

  ∅ of the pipe + 2 x 2 m for a ø larger than 600 mm

- depth : free space of at least 0.8 m under the pipe.

10.1.7. Shoring the trench and/or work pit

If the type of terrain makes it difficult to obtain a stable trench and in the vicinity of buildings, existing structures, cables and pipelines, the Contractor must, among other things, with a view to safety, use the required means for shoring up the trench walls. As a matter of principle, all temporary timbering sheathing and sharing shall not be left behind in the trenches and/or work pits.

Nevertheless, the Owner and/or the Engineer may, if he judges that the stability of the construction work requires it, oblige the Contractor to leave these struts in place. The Contractor will in this case be reimbursed in accordance with the unit prices of the pricelists. The Contractor shall keep the trench dry and stable until after the topographical measurements and until after the activities of the recognised Inspection Organisation have been completed.

Moreover, the Contractor is obliged to provide the assistance required and to ensure the safety of all personnel working in the trench and/or work pit, even if certain activities take place after normal working hours in the interest of the progress of the site.

10.1.8. Appearance of the trench bottom and trench walls

10.1.8.1. Trench bottom

The trench bottom should be evened out depending on the changes of pipeline direction. The bottom of the trench must be completely flat and free of all stones, debris, tree trunks, tree roots, remains of welding electrodes, sharp objects, etc. which would impede the proper execution of the work and damage the pipeline coating.

If the bottom of the trench is rocky or gravely or contains hard objects, the Contractor must apply a layer of sand or light soil to protect the pipeline coating so that any protruding points are covered by at least 20 cm.

The application of top soil instead of sand or light soil is forbidden as is the separation of the subsoil into light soil and stones when this would change the properties of the subsoil in the trench in relation to the surrounding situation. The Contractor may apply a special protection with the approval of the Owner (lathes, neoprene, geo-textile fabric, etc.).

10.1.8.2. Trench walls

The trench walls must be free of hard and protruding points to avoid damaging the pipeline coating when it is being lowered in.

10.1.9. Water run-off drainage of the trench and work pits

Before starting the drainage operation, the Contractor should apply for the required licences from the administrations concerned. If there is no suitable discharge point to hand in the vicinity (waterway, brook, drain, etc.), closed discharge pipes must be installed to a suitable discharge point. Laying these pipelines, procuring the required licences for this purpose and the right of way and any compensation to be paid are the responsibility of the Agreement. Water from the drainage operation shall only be discharged into a canal, ditch, waterway or drain. The dewatering pipes shall extend to these drainage points laid just outside the working area and buried and protected if they cross the access way. Under no circumstances shall the dewatering pipes discharge onto the adjoining terrain outside the working area.

The pumps may be placed on the outside of the working strip. Only pumps muffled for sound may be used. Only electrically driven pumps connected to the mains electricity network may be used in the vicinity of houses.

The discharge water may not under any circumstances run freely over the terrain. The removal of discharge water may cause neither damage nor nuisance to third parties. Any pollution, silts, etc. accumulated during the work must be evacuated by the Contractor after completion of the work at his own expense. The Tenderer shall attach to his bid a note in which the different types of dewatering methods are described in detail.

Prior to the start of the works, the Contractor should ascertain the correct height of the water table. He should also carry out some test bore-hole or soundings. The Contractor shall at regular intervals analyse the discharge water at his own expense. The quality thereof should always conform to the standards laid down (inter alia, the content of salt, iron, heavy metals, foreign matter, pH, etc.).

The dewatering operation or horizontal drainage should be carried out in good time so that when excavations start the trench will be sufficiently dry and the Owner and/or the Engineer can check the condition of the trench bottom before lowering in the pipeline.

The dewatering operation should, moreover, be kept in operation if this is necessary for the execution of the works, the topographical measurements, the activities of the Recognised Inspection Organisation, connecting up to the telemetry cable and backfilling.

The dewatering operation should be stopped in such a way that the water table rises slowly and regularly. When the dewatering wells are removed, the bore-holes must be filled in with sand.

In any case, care should be taken to prevent the pipeline from floating the dewatering operation fails or is stopped. The installation of the dewatering operation shall be carried out by an expert subcontractor or by the Contractor himself if he can prove that he is sufficiently competent and experienced in this field.

Any damage to third parties installations, buildings, plantations, crops, etc. as a consequence of drawing off ground water by the dewatering operation should be reported without delay to the Owner and/or Engineer and to the Authorities or private persons concerned. The Contractor, and only the Contractor, will be held responsible for this.

More particularly, the Contractor shall take the required measures if in consequence of the dewatering operation certain water wells run dry or if the course and/or the flow of natural springs are affected by the laying operations.

The Contractor shall bear the consequences of any disruptions to the water discharge system that he causes as a result of works of any kind whatsoever, both within the construction sites and in the vicinity thereof. He must ensure the protection of the construction site continuously against water to prevent any detrimental effect on the execution of the works.

10.1.10. Rocky soil

10.1.10.1. General

In rocky soil, the trench must be excavated with a mechanical trencher fitted with suitable teeth which assures maximum fragmentation of the excavated material.

The rocky soil is excavated with a mechanical trencher and backfilled with fine crushed stone. If the use of a mechanical trencher is unfeasible for technical reasons, such as:

- terrain's with a slope greater than 20%

- in bends with a bending radius smaller than 40D
- at special points

excavation is carried out with a excavator equipped with a toothed back-hoe which is permitted provided all stones with a diameter greater than 30 mm are crushed prior to backfilling or gathered, transported to a recognised waste disposal site and replaced by stone-free ground.

In such cases, the Contractor is only paid according to pricelist for the cotting, excavation, disposal and replacement by stone-free ground of class 3 rocks in the case of "works in line".

10.1.10.2. Classification of rocks

The classification of rocks on the basis of their natural cohesion comprises three classes:

- Class 1 Weathered rocks
- Class 2 Uneathered rocks
- Class 3 Compacted rocks

- Class 1 :

  All kinds of rocks can appear in this class provided the cohesion of their components are reduced by weathering or crumbling. In this way, small broken pieces occur which are referred to as weathering material. This material can be excavated with an ordinary excavator.

- Class 2 :

  These rocks show little or no sign of weathering or crumbling and can be excavated with a normal excavator equipped with a toothed back-hoe.

- Class 3 :

  The rocks show no sign of weathering or crumbling and can be considered as the mother rock. This rock can only be excavated with the use of a pneumatic rock breaking hammer mounted on an excavator. When encountering areas with a rocky soil structure, the Owner and/or the Engineer will determine to which class the rocks belong with the help of a geologist.

10.2. BACKFILLING THE TRENCH

10.2.1. General

Before backfilling the trench, the Contractor must make sure that all the required work has been completed before backfilling (cathodic protection, anchoring, ballast, etc.). In addition, he must take account of the work that has to be carried out during backfilling (teletransmission cable, mechanical protections such as half shells, concrete slabs, warning tape, warning net, etc.).

10.2.2. Survey to be carried out prior to backfilling

Before backfilling the trench, the Contractor will take measurements for drawing up the technical archives.

The measurements relate to :

- position of the pipe;
- covering of the pipeline;
- location of the welded joints, concrete slabs, anchorings, ballast, connections of the telemetry cable, cable and connection boxes of the potential measuring points, etc.;
- determination of the angles and the position of each change of direction.

Backfilling may in principle be started after the abovementioned measurements have been completed and the results communicated to the Owner and/or the Engineer.

10.2.3. Working method for backfilling

10.2.3.1. Lower part

The trench shall be backfilled to 10 cm above the pipe with light soil or sand. The light soil or sand must be free of all hard objects (stones, gravels, material that has been broken up, etc.) that might damage the coating. Filling in around the pipe must be carried out in such a way that all voids are filled so that later no subsidence of any kind will occur. As a matter of principle, all the different layers of earth shall be replaced as they were excavated.

If the excavated material contains no light soil or sand that could serve for this first backfill without changing the characteristics of the excavated material in relation to the surrounding subsoil, the Contractor shall provide for the importation of light soil or sand. The use of salty sand, gravel, coal slag, iron slag, etc. is forbidden.

In certain special cases, the Owner and/or the Engineer may stipulate methods of protection during the course of the works that are better suited to the local circumstances (see table). The supply and positioning of such protective items and/or backfilling systems will be paid in accordance with the unit prices of the pricelist as an addition to the price per linear metre of the existing unit price per linear metre for filling in the trench in the relevant pricelist. This price increase will also take account of the removal by transportation of surplus soil depending on the chosen backfilling system. Lump sum prices of the S.P. will always take account of these supplements. Consequently, no additional charge will be made for this.

In hot weather, backfilling may only be carried out if resistance to depressions on the pipeline coating permits it. If this resistance is insufficient, the Contractor shall carry out the backfilling only if the coating and the backfilling material have cooled off sufficiently. Filling in with frozen soil is also forbidden.

- Backfilling systems

TYPE OF FILLING SOIL	BACKFILLING SYSTEM
good filling earth	backfill with excavated soil
crushed rocky soil from the trencher	apply geo-textile fabric, min. thickness 8 mm. Fill in with excavated soil
medium rocky soil (1) particles < 30 mm	sand bed of 20 cm in trench bottom (2) apply geo-textile (3) or rock shield (5) fill in with excavated soil max. 0/30

rocky soil with (1) particles > 30 mm	sand bed to 30 cm above and 20 cm under the pipe (2) or non-rotting interlocking wooden lathes, thickness min. 15 mm (4) or geo-textile fabric or rock shield (5) with infill with particles smaller than 30 mm(3) to 30 cm above and 20 cm under the pipe

(1) Filling method to be approved by Owner and/or the Engineer.
Drop height of the filling soil must be limited to the absolute minimum.

(2) Filling with sand-bed only applicable on flat terrain.
On sloping terrain, an alternative protection method shall be used.

(3) Geo-textile fabric must be approved by the Owner - and/or the Engineer min. thickness 8 mm.

(4) Non-rotting interlocking wooden lathes, min. thickness 15 mm, must be approved by the Owner and/or the Engineer.

(5) Rock shield protection must be approved by the Owner and/or Engineer.

The Contractor is free to propose to the Owner and/or the Engineer another backfilling method which is taking into account the abovementioned remarks as far as the pipeline coating is well protected from any kind of damages.

Only an approved (by the Owner and/or the Engineer) alternative backfilling method is applicable.

10.2.3.2. Upper part

The thickness of the layers and the frequency of compacting depend on the type of backfilling material. If this backfilling material contains large stones or blocks of rock, these fragments shall be laid in the trench provided the stones are not heavier than 50 kg and the layer of light soil over the pipe must be at least 30 cm.

The upper part of the backfill shall be carried out in consecutive layers. Each layer must be tamped down to avoid hollow spaces which might later lead to subsidence. Each layer shall be put back in such a way that the original layering of the terrain is respected.

Backfilling is carried out with layers max. 30 cm thick. The Contractor must draw up a work procedure for compacting with a description of the compacting equipment that he wishes to use and their functioning. Compacting the filling soil must be carried out continuously by repeated processing of each layer with compacting equipment. The humidity shall be checked before compacting.

After compacting, the soil that has been put back must have the same penetration-resistance characteristics as the soil for the works, and this to a depth of 1m. This may be checked by the Owner and/or the Engineer using a penetrograph.

10.2.3.3. Top soil layer (arable soil)

In places where the arable soil has been taken away for storage, it shall be replaced and levelled in its original position. The top soil layer, which must be put back at its original height, shall be completely free of foreign objects.

If for one reason or another arable soil must be brought in from outside the working area, it must have the same physical and chemical characteristics as the original soil. The soil brought in should be free of debris or remains and of weed seeds.

Before placing the soil back on the working way, the subsoil should be raked up to restore the natural hydraulic permeability of the ground. The Contractor shall carry out an inspection in the presence of the Owner and/or the Engineer to determine the extent and depth of the compaction. The rake depth shall be determined by mutual consultation, depending on the results and taking account of the drainage presence.

10.2.4. Works during backfilling

10.2.4.1. Reinforced concrete slabs as mechanical protection for the pipe

The Contractor is responsible for the supply and placing of the reinforced concrete slabs in the places defined in the PTS or in the relevant drawings. The concrete slabs shall meet the specifications of the typical drawing.

The concrete slabs shall be laid in such a way that there is a 30 cm layer of soil or sand between the pipe and the concrete slabs. The slabs must be placed in a dry trench.

Partial backfilling of the trench to 30 cm above the pipe shall be carried out as described before. Prior to lay the concrete slabs, this partial backfilling shall be compacted in a adequate manner.

Before backfilling - necessary for the laying of the concrete slabs the Contractor shall take same measurements as described in para. 10.2.2.

The concrete slabs must be laid in such a way that they are centred on the centre-line of the pipe. The Contractor should take all the measures required to mark out the pipe's centre-line after partial backfilling to ensure that the concrete slabs are laid correctly. A warning tape (width 6") shall also be laid on the concrete slabs.

10.2.4.2. Warning signs

10.2.4.2.1. Netting

The Contractor is responsible for the supply and laying of the warning net over the entire length of the pipe.

- Characteristics: Plastified
  Minimum width: ∅ of the pipe + 2 x 0.2 m.

- The warning net shall be applied horizontally 30 cm above the upper generatrix of the pipeline.

No warning net is laid on the concrete protection slabs.

10.2.4.2.2. Warning tape

The Contractor is responsible for the laying of the warning tape over the entire length of the pipe. Except otherwise specified in the PTS, the Contractor will supply the warning tape.

- Characteristics: Width: 6"

- The warning tape shall be attached horizontally 30 cm above the upper generatrix of the pipeline.

10.2.5. Backfilling at below-ground obstacles

10.2.5.1. Presence of underground cables or pipelines

In places where the trench meets underground cables or pipelines, the Contractor shall place protective devices in accordance with the requirement of the Public Services and Authorities, owners, tenants and/or operators concerned. Protective items already existing shall be reinstalled by the Contractor and if damaged replaced at his own expense.

10.2.5.2. Presence of drainage systems

10.2.5.2.1. Repairing drainage systems

1. General :

For the repair work to the existing drainage system, it shall be assumed that the Contractor or his subcontractor is in possession of the necessary practical knowledge required for drainage work. He is therefore responsible for the repairs and should take all measures required and employ the working methods to supply a repaired drainage system that is free of deposits left behind after the repairs.

It must be emphasised that the repaired drains must be of the same type and have the same characteristics as the original drains (among other things, with regard to material, thickness, diameter, specific gravity, perforation pattern, resistance to compression, resistance to impact, tension, etc.).

It is in all cases forbidden to replace cut or damaged drainage pipes with drainage pipes of another type or with drainage pipes of a larger diameter slipped over the original pipe. The drainage pipes must be joined axially by means of fitted or threaded earth resist sleeves, so as to resist to axial forces. The sleeve must under no circumstances cover or hinder the perforations over a distance exceeding 300 mm.

2. Investigation before drain repair

Before commencing the drain repair, the Contractor shall investigate with suitable devices whether the drains have been moved, damaged or blocked by earth, mud, etc. If the Contractor proves that the drains on the working strip are not damaged, he may be discharged from responsibility for repair subject to the agreement of the Owner and/or the Engineer.

3. Draft for drain repairing

The materials used and the working procedure must be submitted for approval to the owners and/or the Engineer and the land owner/tenants. The Contractor shall submit a draft plan to the Owner and/or the Engineer at least five working days before repairing the drain. The draft plan shall be drawn up to a scale of 1/1 000 and shall mention the following:

- the position of the existing and new drains
- type and slope of the existing and new drains
- connections and closure points
- outlet point
- depth in relation to ditch bottom and gradient

The Owner and/or the Engineer will submit this draft via the Negotiator to the Parties Concerned for the purpose of obtaining prior agreement for the working procedure and for the restoration of the site. If the Party concerned refuses a proposal for repairs with diverted drains, the drainage network must be repaired in the conventional manner.

4. Conventional drain repair

The repair of conventional drains must as a matter of obligation be carried out before the restoration of the site. The drainage systems must be repaired over the complete width of the trench and if necessary over the width of the working strip. Prior to the repairs, the extremities of the drains shall be dug free so that a repair drain can be put in place in accordance with engineering design and the approved procedure.

5. Repair by means of longitudinal drains

If the Contractor decides to repair the drains by means of an open trench technique, this shall be carried out before the restoration of the site. Techniques without trenches can be applied after restoration of the site provided they do not constitute a danger to underground installations. In particular, any mixing of arable soil with subsoil must be avoided and if necessary rectified.

Drainage collectors or drainage pipes laid in parallel with the pipe must discharge into ditches or drains in such a way that their function cannot be reduced due to the block-off of the outlet caused by a build-up of deposits. In particular, the outlet must be located at least 20 cm above the ditch bottom. The Contractor shall hand over to the Owner and/or the Engineer an "as built" drawing (scale 1/1000) with the layout of the longitudinal drains, the connections and closure points, the outlet point with the depth in relation to the ditch bottom and slope, as the case may be.

6. Visiting the site after drain repair

After repairing the drainage, the Contractor will invite the party concerned to come and confirm whether the repair has in his opinion been carried out correctly. The Contractor will complete the "Report of Presence of Drainage Networks" and will submit it to the party concerned for signing. The rest of the backfilling of the trench may only be carried out after acceptance without reservation of the repaired drainage system by the Party concerned.

10.2.5.2.2. Backfilling at drains

The first 30 cm shall be backfilled manually. An endeavour should be made to ensure that the different back-filled layers will have hydraulic permeability equivalent to the original surrounding layers of soil. Outside the first layer of 30 cm, each layer shall then be compacted to prevent any subsidence and to prevent the water finding a course other than through the drainage network after the repair of the drainage system.

New drains and drains to be repaired must be laid according to the rules of the trade and in water-permeable soil (water flow at least 1 cm/hour); this should be sufficiently raked through according to the circumstances.

10.2.5.3. Presence of section junctions

At pipeline tie-in joints, backfilling may not be carried out over a distance that is a function of the diameter of the pipeline, on either side of the places in question, to facilitate the tie-in of the elements to be welded.

10.2.5.4. Presence of holes where dewatering filters have been installed

Their lower part shall be carefully filled with sand. The upper part should be filled with arable soil (top soil).

10.2.6. Sloping terrain

When the slope requires, the Contractor shall take the necessary measures under his own responsibility to prevent washout of the backfill, such as :

- the immediate re-sowing of sloping terrain (such as road embankments)
- non-removal of tree stumps in the working strip in wooded terrain (except in the trench) subject to the permission of the Owner and/or the Engineer and the Land Owner.
- the placement of a drain at the bottom, next to the pipe. Depending on the slope and the hydraulic permeability, setting of water pit trap, filled with gravel, into which the drain flows (buffer). Each water pit trap shall have minimum dimensions of 1 m x 1 m and a depth to 1 m under the level of the drain. 50 cm of the uppermost soil layers shall be replaced over these drainage pit trap.
- the placing of clay block-off wall.
- the placing of block-off wall composed of sand bags.
- other proposals (in particular situations) made by the Contractor and approved by the Owner/Engineer.

10.2.7. Inspection of the coating after backfilling

- After backfilling and before restoration of the site, the Contractor will carry out a supplementary inspection of the coating.
- In order for this inspection to be carried out in the best possible manner, the Contractor shall free the extremities of the sections to be checked and ensure the accessibility and the stability of the trenches (shoring) and ensure that the connection pits are kept dry.
- There must be absolutely no contact of bare metal with the surrounding ground. Bare metal shall be insulated from the ground by means of wooden blocks or equivalent. The sections of pipe to be inspected shall be a maximum of 5000 metres long.
- If the ground is too dry, the Contractor shall dampen the backfill by means of ± 1 000 litres of water per 250 metres of length.
- The Contractor shall immediately unearth all indicated defects and repair them in accordance with an approved procedure (see part 9).

APPENDIX 1

REPORT OF PRESENCE OF DRAINAGE NETWORKS
(SKETCH IN APPENDIX)

Pipeline : ..... CDF : .....

Owner : .....

Negotiator: ..... Contractor : .....

OWNER	LAND OWNER/TENANT
Name : ..... First name :	Name : ..... First name : .....
Address :	Address : .....
.....	.....

PLOTS LOCATED ON THE TERRITORY OF THE MUNICIPALITY :

PLOT no.	Land Register Sect.	No.	Quantity	Type (collector or secondary)	Type	Diam.	Depth	Present condition

Remarks : .....
.....
.....
.....

The undersigned declare(s) that the above description and appendices are correct and complete.

Drawn up in 5 copies on ..... 20.....

Signature of the Owner or operator For agreement	Signature of the member of staff of Owner responsible for negotiations	Read for agreement the representative of the Contractor	Read for agreement the expert

Report of restoration to original condition

I, the undersigned, ... resident in ...., Land Owner/Tenant of the plots concerned, hereby acknowledge that the drainage networks have been restored definitively and to my complete satisfaction following the placing of the natural gas pipeline.

Drawn up on ..... 20...
Signature

PART 11

Lowering-in and ballasting

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11. LOWERING-IN AND BALLASTING

11.1. LOWERING-IN

11.1.1. General

The working method that the Contractor will apply and the material that he will use for laying must :

- be adapted to the local circumstances (site configuration, geological and hydro-geological properties of the ground, diameter of the pipe, etc.);
- be approved by the Owner and/or the Engineer.

11.1.2. Conditions before laying

A pipe string section may only be laid if :

- the changes of direction were effected in accordance with the specifications of G.T.S. Part 5.,
- the requirements provided in G.T.S. Part 10 have been met,
- inspections of the welding seams have been carried out and accepted by the recognised inspection organisation,
- the external coating has been checked to see that it is in good condition with holiday detector immediately before laying (see G.T.S. Part 9). The inspection is carried out in the presence of the Owner and/or the Engineer,
- Prior to lowering-in work the recognised inspection organisation may (at the Owner and/or the Engineer request) check the pipeline coating by means of a holiday detector. This random inspection will be carried-out at the same time as the Contractor's inspection work and will not release the Contractor from his responsibility of his own inspection work.
- the temperature is such that the coating will not be damaged.

11.1.3. Precautions to be taken during lowering-in

11.1.3.1. Presence of the Owner

Lowering-in must be carried-out in the presence of the Owner representative and/or the Engineer. The Contractor must notify him in time.

11.1.3.2. Protection of the pipe and its coating

During lowering-in, the Contractor must ensure that :

- the pipe is not subjected to inadmissible stresses;
- **The Contractor will submit the required calculation notes in the work procedure;**

- the pipeline is supported over a sufficient surface area to prevent the supports from penetrating the coating;

- a sufficient number of machines with the required capacity will be used for lowering-in the pipeline strings (as per calculation note).

11.1.4. Inspection of the pipeline after lowering-in

11.1.4.1. Inspection of the stress in the metal

After lowering-in, the pipeline shall be completely stress free in the trench. Joining the different sections may not cause any inadmissible stresses in the pipeline. Tie-ins joints are only executed on consecutive sections at their definitive level.

11.1.4.2. Inspection of the profile of the pipe

In the absence of concordance between the changes of direction of the pipeline and the trench, both in the horizontal and in the vertical plane, the Owner and/or the Engineer may require the Contractor to make the necessary adjustments, it being understood that this does not entitle the Contractor to any price supplement.

These adjustments comprise :

- widening or deepening the trench,

- backfilling and compaction of the trench bottom,

- cutting out and replacing bends that are not adapted to the profile of the trench,

- if necessary, the complete adaptation of the section concerned.

All material supplied by the Owner and damaged as a result of such activities will be replaced by the Contractor at his own expense.

11.1.5. Tie-in pipe strings

11.1.5.1. General

The Contractor will carry out all the work required to tie-in the different welded and lowered-in sections together so that a continuous string is produced.

After digging out the working trenches, the Contractor will take all measures necessary to ensure their stability to guarantee the safety of his personnel, the personnel of the Owner and/or the Engineer and that of the recognised Inspection Organisation.

11.1.5.2. Moving sections after lowering-in

It is forbidden to shift or move the sections on the trench bottom with lifting gear or other means to bring the pipe ends to be joined closer together. The only method that shall be accepted in this case consists of welding in an additional piece.

11.1.6. Tie-in contract-boundary

The Contractor should take account of the fact that he may be asked to provide the necessary assistance in this tie-in work after his normal in-line activities have been completed.

These works comprise :

- signposting the construction site
- dewatering of the working pit
- excavations, manual and mechanical
- shoring up
- coating of the pipeline and welded joint
- filling up + compaction
- reinstatement

This work will be charged in the price list.

11.2. BALLASTING OF THE PIPE

11.2.1. General

In places where the type of ground is such that the pipe might rise as a result of the hydrostatic pressure, ballast should be placed on the pipeline.

The ballast will be applied in places that will be indicated in the P.T.S. and or the relevant drawings.

The Contractor is responsible for the supply and the placement unless otherwise stipulated in the P.T.S..

11.2.2. Nature of the ballast

The ballast consists of ballast blocks or blocks of prefabricated reinforced concrete, bags of cement, or a continuous coating of reinforced concrete on the most important section.

The reinforcement of the concrete may not come into contact with the pipe. The concrete in contact with the coated pipe should be sufficiently smooth. The cement must be resistant to the earth or the water with which it comes into contact.

11.2.3. Protection of the pipeline coating

Protection material must be placed between the pipeline coating and the ballast except for those applications where the ballast is applied by guniting. The costs for this should be included in the price for ballast.

The Contractor should indicate in his bid the method(s) of ballasting he intends to use as well as the sizes, the intermediate distances and the ballast materials. The depth of covering mentioned in the P.T.S. Part 10 is calculated between the upper generatrix of the anchoring or ballast fittings and the natural ground level.

PART 14

Testing, cleaning and drying

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14. TESTING, CLEANING AND DRYING

14.1. GENERAL

Except otherwise stated in the P.T.S., the following statutory acceptance tests shall be carried-out after construction of the pipeline in accordance with the provisions of the ASME code B31.8 latest edition and where applicable, with provisions that may be imposed by the authorities of the concerned country.

At latest 30 days prior to the start of the tests, the Contractor shall submit to the Owner and/or the Engineer a detailed work schedule and a work procedure file for the execution of the testing, cleaning and drying operations. The Contractor shall provide the labour, test medium, temporary supports, ladders and scaffolding, all material including test heads, the measuring apparatus and any spare parts that may be required for the tests and trials.

Such equipment shall be approved in its entirety by the Recognised Inspection Organisation and by the Owner and/or the Engineer. Measuring instruments, such as manometers, manometrographs, manometric scales, barometers, thermometers etc., shall be sufficiently sensitive to give the required degree of precision. Such instruments shall be accompanied by the required valid calibration certificates. The pumps, compressors, etc. should have sufficient capacity and output to permit rapid filling.

The tightness test shall be carried out following the resistance test.

Exception

The following equipment shall not undergo any mechanical test on the worksite:

- gas meters, gas regulator, shut-off valves, safety valves, instruments, thermowells, boilers, pressure vessels, etc., provided such parts have an acceptable pressure certificate;
- discharge lines to the atmosphere such as open vent pipes without noise mufflers and drains;
- (for the testing of instrumentation pipes, see Article 14.9. and Part 17 of the G.T.S.).

14.2. TEST PREPARATIONS

14.2.1. Required documents

- Plan of the section to be tested:

a) For pipeline construction:

For the purposes of the resistance test, the Contractor shall submit to the Owner and/or the Engineer and to the recognised inspection organisation a pipeline split up plan ten working days before the test. Due account should be taken in the split up plan of the minimum pressure at the highest point and the maximum pressure at the lowest point. This maximum pressure may under no circumstances exceed the test pressure of the pipes in the factory (i.e. 95 % of the Specified Minimum Yield Strength).

b) For station construction:

For each test section, an overall sketch or isometric drawing shall be submitted to the Owner and/or the Engineer and the recognised inspection organisation. Such documents shall include the following information:

- the location of the test inlet pipe, measuring instruments and bleeders;
- the adjustments that will be carried out for the test.

e.g. :

- removal of internal parts of check valves or bridging of the same by means of a bypass or instrumentation bosses;
- bridging carried out for non-tested "in-line" parts (see exceptions above);
- physical limits of the pipe by means of blind plates, blanks, hollow bases, etc.;
- as a general rule, it is not permissible to subject the shut-off valves in the closed position to one side test pressure;
- Copy of the valid calibration certificates of the devices and equipments used for the tests.
- Pressure data of the test apparatus used (manifold) such as valves, test heads, etc.
- Copy of all Non-Destructive Testing documents drawn up by the recognised inspection organisation.
- Copy of the weld log book.
- Form giving :
  - date of the test;
  - identification of the test equipment;
  - test medium and origin;
  - the maximum operating pressure;
  - test pressure and duration.
- Description of the working method and the material for filling up with water and purging of water from each section.

14.2.2. Inspections prior to the tests for station construction

- All welds, screw and flange joints must be clean (free of rust, paint, etc.);
- All welds must be accessible for visual inspection:
  - no temporary supports on the welds or flange connections;
  - provide all necessary ladders or scaffolding for the safe inspection of the welds.
- All heat treatments shall be carried out prior to the tests;
- All reinforcement plates shall already be tested;
- All welds for the preparation of the testing work shall be subjected to the same non-destructive tests as those which are required for the piping to be tested;

- Inspection of conformity with the isometric drawing;
- Inspection of the half-open position of the valves;
- All spring supports and expansion joints shall be anchored in good time according to the manufacturer's instructions;
- All precision instruments or regulators which may be damaged shall be temporarily removed by the Contractor;
- Orifice plates which may hinder correct filling up and drying shall only be mounted once the testing, cleaning and drying operations have been completed;
- Inspection of the connection of the filler pipe, manometer and pressure recording device;
- Cut-off valves which are used to close the testing system (e.g. test equipment) shall have a nominal pressure higher than or equal to the test pressure;
- The valves of drainage and bleeding points shall remain open during the tests and the ends must be fitted either with a flange with a blind flange or a screwed cover;
- For gas filters, check that the filter elements are removed;
- Inspection of marking-off of the test zone;
- When testing with nitrogen in a closed space, the Contractor shall assure constant ventilation. Furthermore, oxygen measurements shall be taken regularly;
- During the tests, the recording and testing devices shall be at least 10 m away from the tested pipe.

Exceptions

- If the trenches hinder the further construction of the station, at the request of the Owner and/or the Engineer and subject to the agreement of the recognised inspection organisation, the pipe shall be clad and the trench shall be backfilled before the mechanical resistance test and tightness test are carried out. The tightness test (with dry air or nitrogen only) must then be carried out with a manometric scale (see Article 14.4).
- If the scraper trap station is connected to a pipe, everything must be backfilled before the start of the resistance test (in conformity with the stress calculations).
- If exceptionally some parts of the pipeline sections under testing are not backfilled, those parts, will be covered by means of thermal insulation sheet.

14.3. MECHANICAL RESISTANCE TEST

14.3.1. General

- The test medium and the necessary accessory apparatus shall be supplied by the Contractor;
- For the pipeline, the pressure test shall be submitted to the recognised inspection organisation for approval on the basis of the split up plan. The maximum length per section is 30 km;

- The backfilling of the trench must be completed before starting the mechanical resistance test. During the resistance test, all traffic over the pipeline is forbidden;

- All reinforcement plates should preferably be tested in advance in the prefabrication workshop with nitrogen at 3.4 bar. The air bleed opening shall remain open until after the mechanical resistance test unless the trench is backfilled before the execution of the mechanical resistance test and tightness test (with dry air or nitrogen only) with a manometric scale;

- The choice of the test medium shall be made according to the following overview table.

Overview table - Resistance test for pipelines and mains to operate at less than 30% of the specified minimum yield strength of the pipe, but in excess of 100 PSI.

Situation	**Test medium**	**Test pressure**	**Test time**	**Safety measures ***
Backfill	Dry air, nitrogen or water	As specified in ASME CODE B31.8	6 hours	Around intersections and non-buried parts
Above-ground or under ground (but not backfilled) on supports				Everywhere

Overview table - Resistance test for pipelines and mains to operate at hoop stresses of 30 % or more of the specified minimum yield strength of the pipe.

Situation	**Test medium**	**Test pressure**	**Test time**	**Conditions**	**Safety measures ***
Backfill	Water	Min : 1.4 x MOP Max : testing pressure of factory	6 hours		Around intersections and non-buried parts
Above-ground or underground (but not backfilled) on supports and stations					everywhere
Gas supplied actuators and stations	Dry air or nitrogen	1.25 x MOP	6 hours	only for ND ≤ 3" pipe sections with max. volume ≤ 2m³ and if pipes have no low points where water can be drawn off (drains)	

Overview table - Resistance test for stainless steel control and instrumentation piping or tubing.

Situation	**Test medium**	**Test pressure**	**Test time**	**Conditions**	**Safety measures ***
Control and instrumentation piping	Dry air or nitrogen	1.1 x MOP	soaping time	see Article 14.9.	everywhere

* safety measures :

During the pressurisation of the installation and up to one hour after the test pressure has been reached, there is a general safety zone of 10 metres which all personnel and persons are forbidden to enter. Subsequently, until the installation is free of pressure, a safety zone of 5 metres must be observed. All valves and flange connections shall be marked with a sticker bearing the warning "Danger: under pressure". The zone in which the test is carried out must be marked out and indicated with pictograms and a rotating light.

14.3.2. Hydraulic resistance test

- General

When the outside temperature is below + 4 °C, no hydraulic tests shall be carried out with water unless the water is mixed with glycol.

a) Pipeline construction

A caliper plate or-pig shall be used to check that there are no unacceptable deformations in the pipeline before starting the resistance test. Sections with unacceptable deformations shall be cut out and replaced before any resistance test shall start.

For pipelines construction, a bi-di pig or scraper is used to fill the pipe. A quantity of clean water should be pumped in front of the scraper (i.e. approx. 150 m of pipeline volume depending with the pipeline routing).

The scraper and the test heads shall be supplied by the Contractor. The type of scraper must be approved by the Owner and/or the Engineer. The test heads must have the necessary approval certificates (non destructive testing and hydraulic tests. After filling up the pipeline, the valves must be in the half-open position.

Any pressure fluctuations noted during the passage of the scraper should not indicate the presence of obstacles which hinder the free passage of the section.

The pressure increase shall be effected under the supervision of the Owner and/or the Engineer and shall be monitored by the recognised inspection organisation.

Once these operations have started, it is strictly forbidden to cross the pipeline with heavy equipment.

b) Station construction

For station construction, all high points of the pipe section to be tested must be vented. The system must then be pressurised.

- Test water

The test water shall be supplied by the Contractor. It must be clean (eventually after filtering), not silty, with a pH between 6 and 8 and non-corrosive. For stainless steel pipes, the test water shall contain max. 5 ppm of chlorides.

The water shall be sand-free. A compulsory analysis shall be carried out by a recognised inspection organisation at the expense of the Contractor (with the exception of potable tape water). If, after analysis of the water, any doubt persists, a corrosion inhibitor - supplied by the Contractor and submitted to the Owner and/or the Engineer for approval - may be added to it, or another water supply source shall be sought.

If for any reason the test water has to remain in the pipeline for an unusually long period of time, it should have corrosion inhibitors added to it (supplied by the Contractor and submitted to the Owner and/or the Engineer for approval). In the case of longer storage periods, the Owner and/or the Engineer reserves the right to have a titration test carried out at the expense of the Contractor.

- De-watering

a) Pipeline construction

The Contractor shall under the supervision of the Owner and/or the Engineer inspect the complete open position of the valves before starting de-watering de pipeline.

The type of pigs and foam pigs shall be approved by the Owner and/or the Engineer.

The discharge of the test water shall be carried out in such a way that there is no damage to installations or adjacent plots of land. The Contractor shall request the necessary discharge permit from the competent authorities.

Conventional pigs and foam pigs shall be run through the pipeline as many times as necessary to de-water and clean satisfactorily the pipeline sections. This is subject to the judgement of the Owner and/or the Engineer who must be present at the installation when removing the pigs **from the pipeline**.

b) Station construction

If water is the test medium, the water may be drained through the bleeders and drains provided. During assembly, the Contractor shall check whether any additional drains and bleeders must be provided.

The valves shall be drained as much as possible in the half-open position under air pressure through the bleeder pipes under the supervision of and in consultation with the Owner and/or the Engineer. The discharge of the test water shall be carried out in such a way that there is no damage to installations or adjacent installations. The Contractor shall request the necessary discharge permit from the competent authorities.

14.3.3. Dry air or nitrogen resistance test

a) Pipe construction

(Only applicable if approved by the Owner and/or the Engineer.)

For pipe construction, the pipe shall be completely buried. Only applicable for pipelines and mains to operate at less than 30 % of the specified minimum yield strength of the pipe, but in excess of 6.9 bar (100 P.S.I.) and within the limits set in the ASME CODE B31.8.

b) Station construction

General safety regulations

- For the pneumatic test (air excluded) in enclosed spaces, the premises must be constantly ventilated if any personnel are present. Furthermore, oxygen measurements shall be taken regularly;
- Care must be taken to ensure that the pressure in the test system does not exceed the permissible limit (e.g. under the influence of heat from the sun);
- It is forbidden to hammer the piping;

- Weld, screw and flange connections found to be leak-free shall be marked with an indelible colour code on the piping;
- The paint or coloured markers used must not damage the material of the installation.

14.3.4. Measurements - measuring devices for the mechanical resistance test

- Pressure measurement

  The pressure measurement shall be carried out by at least three devices:

  - at least one manometer, which must be mounted on one of the piping of the test system;
  - a pressure recording device and at least one manometer, mounted near to the pressure recording device.

  Such measuring devices shall have an identification number and be accompanied by a calibration certificate. The two types of devices shall have a suitable scale position and range (preferably 1.5 x the pressure to be measured).

  When the difference between the readings of two of these devices is greater than 4 % of the arithmetic average of the readings on these 2 devices, the two measuring devices must be recalibrated. The recorded test pressure diagram shall be marked with the test system number and the identification number of the recording device and shall be appended to the test file.

- Pressure loss

  In the event of pressure loss, the cause must be investigated. If it is due to any defect in materials supplied by the Owner, any costs arising from any reworking and test re-runs shall be borne by the Owner. In all other cases, the Contractor undertakes to bear the consequences and the costs.

14.4. TIGHTNESS (LEAK) TEST

14.4.1. Pipelines and mains to operate at less than 6.9 bar (100 P.S.I.)

Overview table of tightness test for pipeline sections with maximum operating pressure (M.O.P) ≤ 6.9 bar.

Situation	Test medium	Test pressure	Test time	Safety measures*
Buried	Dry air or nitrogen	Min. 6 bar	6 hours	around intersections and non-buried parts
Above-ground or underground (not backfilled) on definitive supports			soaping time	everywhere

* Safety measures :

During the pressurisation of the installation and up to one hour after the test pressure has been reached, there is a general safety zone of 10 metres which all personnel and persons are forbidden to enter. Subsequently, until the installation is free of pressure, a safety zone of 5 metres must be observed. All valves and flange connections shall be marked with a sticker bearing the warning “Danger: under pressure”. The zone in which the test is carried out must be marked out and indicated with pictograms and a rotating light.

14.4.2. Pipelines > 6.9 bar (maximum operating pressure)

- Buried pipes

  Except if otherwise specified in the P.T.S., tightness test shall be performed with water.

  The tightness test may be combined with the strength test.

  The tightness test pressure shall not be higher than the Resistance test pressure. The test pressure shall not be less than D.P. (Design Pressure).

  The test duration shall be determined on the basis of the characteristics of the structure and the accuracy of the measuring instruments. It shall not be less than 24 hours. For volumes of less than 20 m^3 or for uncovered sections which can be fully inspected visually, this duration may be reduced for so far duly approved by the Owner and/or the Engineer.

  Before carrying out the tightness test, it shall be ascertained that the quantity of air in the pipe is sufficiently small not to affect the test results.

  The pipe is considered leak-tight if the temperature and pressure measurements show that the volume of test medium is maintained throughout the test.

  If the test reveals that the pipe is not perfectly leak-tight, the Contractor may only be indemnified for the cost of finding the fault if he can prove that the leak was the result of a defect in the Owner's supplies and that in any case this fault could not have been detected at the time when the pipe sections were received.

- For the installations which have been (resistance) tested with dry air or nitrogen as test medium

  The installation shall be brought to 6 bar air pressure and all welds and joints shall be soaped (bubble test) after 24 hours in the presence of the recognised inspection organisation.

14.5. CLEANING AND DRYING

14.5.1. Pipe construction

For pipeline construction once the tests (resistance and leak test) results have been declared satisfactory, the cleaning and drying operations shall be carried out. The pipeline section to be cleaned and dried is sealed at the ends by means of welded testing pig traps. These end stations are equipped with instruments for permanent measurement of the temperature, pressure and dew point. After de-watering, conventional pigs and foam pigs shall be run through the pipelines as many times as necessary until internal surface is free of dirt, such as welding slags, rust, oil and dust particles.

The compressors used to draw the pigs shall have an absorption drying units with adequate dew point outlet. After having measured a constant dew point of - 8°C during the last run, the pipeline is closed for at least 24 h.

Except otherwise specified in the P.T.S. the dew point is fixed at -8°C. During this time, the dew point is measured every 4 h. If the dew point has not increased after 24 h, the pipeline is considered dry. It is left at 0.2 bar overpressure dry air or under nitrogen. Dew point measurements are carried out under the supervision of and in consultation with the Owner and/or the Engineer or the recognised inspection organisation at the other end from the drying installation. The Contractor shall only use oil-free and soundproofed compressors for supply to the drying units. When venting the pipeline sections, there shall

always be a Contractor's staff present and the public authorities concerned shall be informed by the Contractor.

14.5.2. Station construction

14.5.2.1. Cleaning - General

During the works, the Contractor shall take the utmost care to keep the inside of the piping clean. He shall carry out the necessary inspections and fit protective covers where necessary.

During de-watering through the purges and drains, the necessary samples shall be taken in glass bottles to check the cleanliness of the pipelines. If it is discovered that these samples have an excess of dirt, the piping shall be cleaned again.

14.5.2.2. Methods of cleaning

- Compressed air

  After drying, the piping system shall be pressurised with pure, dry and oil-free air or nitrogen which shall subsequently be blown out with sufficient force through the specially designed valves. For the noise pollution caused by the venting, the Contractor shall as a general rule comply with the legislation on work and the environment of the Country concerned.

  If the cleanliness is insufficient, the blowing operation shall be continued. For low-pressure pipes, the pressure of blowing used shall under no circumstances be higher than ¾ of the max. operating pressure. For cryogenic pipelines, following cleaning and drying only the upper flanges of the valves shall be dismantled to check the cleanliness of the pipes.

- Flushing (only applicable for small diameters)

  The water speed (m/s), depending on the impurities in the case of construction in horizontal pipes (welding slags, rust and loose particles) can be calculated on the basis of the following experimental formula:

  $U = [0.225(R)^{0.12} \text{ X } (H)^{0.48}] \text{ x } 1.25$[1]

  where :

  - U = flushing water velocity (m/s)
  - R = inner radius of pipe (mm)
  - H = dimension of the impurity (mm)

  The flushing shall be continued until the desired cleanliness is achieved.

- High-pressure cleaning

[1] Bron : The institution of mechanical engineers proceedings, 1973, volume 18763/73. Pipework purging by water flushing, RR Cranfield, J. Lawrence

Can be applied when :

- the injected water can be removed;
- the pipe diameter ≥ 3";
- the pipe has no inner coating;
- there are no obstacles such as purges or valves with soft joints.

- Chemical cleaning (Pickling)

  Only applicable for certain piping processes (e.g. oil cooling circuit of compressors). If pickling is desired, it must be carried out by a specialised firm. When selecting, care must be taken to ensure that the proposed method will not damage the basic material and the welds.

  Immediately after this treatment, the pipes shall be thoroughly rinsed and dried. If possible, they should be passivated. As a protection, the pipe should be brought to a slight overpressure with dry air or nitrogen (0.2 bar).

14.5.2.3. Drying

Unless otherwise stipulated in the Particular Technical Specifications (P.T.S.), the piping shall be dried with compressed air. The compressors used for drying shall have an absorption drying units with adequate dew point outlet.

Valves shall be drained as much as possible in the half-open position under air pressure through the vent pipes under the supervision of and in consultation with the Owner and /or the Engineer. Manipulations of the valves without the supervision of the Owner and/or the Engineer is strictly forbidden. The blowing shall be continued until a constant dew point of -8°C (or other dew point as per PTS) is measured. Subsequently, the pipe shall be closed for 24 hours. If the dew point has not increased after 24 h, the installation is considered dry.

If lower dew points are required, they shall be stipulated in the Particular Technical Specifications (e.g. cryogenic pipes, pipes for piston compressors, etc.).

- The piping to be dried must have the necessary measuring devices to measure constantly the temperature, pressure and dew point;
- The piping is considered dry if following several measurements in 24 h and at several branches of the pipe the dew point measurements are constant and the desired value is not exceeded.

For faster drying, the Contractor may propose drying with heated nitrogen. The temperature shall be limited to +50 °C.

14.6. INSPECTION OF UNTESTED TIE-IN CONNECTION WELDS (GOLD WELDS)

The connection spool piece to be welded must already have successfully undergone a resistance test. The recognised inspection organisation must be informed at least 4 working days before the execution of the tie-in connection welds. Tie-in connection welds which do not undergo the resistance and tightness tests must :

- undergo all the necessary NDT inspections,

- be soaped (bubble test) when the pipe is brought into service at a pressure of 6 bar and at operating pressure.

These inspections shall be carried out in the presence of the recognised inspection organisation and the Owner and/or the Engineer. Certain gold welds determined by the Owner and/or the Engineer may only be **soaped** (bubble test) at a later stage. Consequently, these must be temporarily coated. The terrains shall be temporarily restored to their original condition.

Subsequently, the welds shall be uncovered once again in order to carry out the necessary inspections and to carry out definitive coating and backfill. If this work must be carried out outside the contractual period, they shall be paid for on the basis of pricelists.

14.7. BRINGING INTO SERVICE

- All above-ground flange and screw connections shall be soaped (bubble test) at operating pressure (including instrumentation);
- The Contractor shall provide the necessary material and labour for this purpose.

14.8. ACCEPTANCE

The Contractor shall hand over the final dossier to the Owner and/or the Engineer. The final dossier includes :

- a split-up plan or isometric drawing of each tested section;
- a copy of the calibration certificates for the tested devices;
- a duly completed test form mentioning :
  - the date of the test;
  - the identification of the test system;
  - the test medium;
  - the test pressure;
  - the test temperature (the ambient and pipe temperature);
  - the differences of any Nonconformity Reports and derogations with regard to the test, signed by the recognised inspection organisation and the Owner and/or the Engineer.
- the recording disks or pressure level diagrams of the resistance tests that have been interpreted and completed by the recognised inspection organisation;
- the QRN of the recognised inspection organisation;
- the NDT inspection reports.

14.9. INSTRUMENTATION AND REGULATION CIRCUITS < 2"

- Instrumentation and regulation circuits smaller than 2" (instruments, coupling, control line and accessories), insofar as these parts (e.g. thermowell) have not been included in a resistance test of a section of piping, shall be tested for their respective operating pressure during the precommissioning (carried out by the Owner and/or the Engineer). The instrumentation contractor shall include in his assembly price the necessary material and personnel, test medium and accessories (i.e. regulators flexible tubes, etc.);

- These tests need not be submitted to the recognised inspection organisation for approval;

- The instrumentation contractor shall submit the necessary proof that the materials supplied by him withstand the required operating pressure;

- The instrumentation connection pipes between the mini-cabins, the regulator, etc. and the gas pipe shall be tested with nitrogen at 1.1 x MOP.

PART 15

Site reinstatement and marking out

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15. SITE REINSTATEMENT AND MARKING OUT

15.1. SITE REINSTATEMENT - GENERAL

The Contractor will restore the Construction Site and any other places that have been damaged as a result of the Works to their original condition and this to the entire satisfaction of the Parties concerned.

These works must be carried out within the shortest possible time and at least within 8 weeks following the opening of the working area. In unfavourable weather conditions, the Owner may halt the schedule of the reinstatement work if no effective work can be carried out under these circumstances.

15.2. REINSTATEMENT WORK

The reinstatement of the terrain consists, among other things, of the works summarised in the following non-exhaustive list:

- The works arising out of the conditions, requirements and wishes of the public authorities and administrations;
- Removal of all remaining and surplus material and equipment;
- Reinstatement of drainage and outflow systems, canals, streams, waterways, dikes, road metal, roads, paths, etc;
- Removal of all debris of whatever type as well as stones or broken pieces that might hinder the farming of the land;
- Before replacing the topsoil, the Contractor will even out, level, and break down the subsoil in the working strip to the agreed depth (cf. Part 10, Article 10.2.3.3);
- The machines used for this purpose must be adapted to the different types of ground strata and the depth of the drains; these layers must each be break down without mixing them. The processing of the soil must finally result in a ground structure that shows properties in the areas of texture, permeability, fertility, etc. comparable with those that existed prior to the work operations;
- Replacing the topsoil in its original condition;
- After replacing the top soil, it will be evened out and levelled and thereafter made ready for sowing by raking and hoeing over the entire width of the working area;
- Placement of banks consolidation devices, concrete slabs or posts, wooden posts and sleepers, water fascines, blocks and/or sections of lawn. Wooden materials will be treated against rotting to guarantee a lifetime of 15 years;
- Repair of closures, access ways, walls, slopes, embankments, retainings walls and installations;
- Replacement of removed and/or damaged hedges, closures etc. to the entire satisfaction of the Parties concerned;
- Positioning and/or re-positioning of displaced or removed markers, beacons, property markers etc. with the aid of a surveyor;
- Dismantling and removal of provisional installations. See also part 2 art. 2.2.3.2a.;

- Clearing of the constructions sites;

- Any other special point mentioned in the inventory of fixtures.

15.3. SITE CONDITIONS AND SITE REINSTATEMENT REPORT

The reinstatement of site report will be drawn up by the Owner's representative. All remarks in connection with the reinstatement will be reported therein. The representatives of the Contractor and the Owner will together:

- measure and estimation of the off-working Strip area;

- state whether the terrain has been restored to its original condition (cf. Article 15.2). The Contractor will draw up a "List of plots of land for release" on the basis of this assessment. The Contractor undertakes to finish off the reinstatement of the terrain completely, including the markings and accessories, before the evaluation can be made.

On the basis of the "List of plots of land", a site visit will be organised within 15 days between the representative of the Owner (the Negotiator), the representative of the Contractor and the Parties concerned. They will together complete the "Declaration of release of plot", see Appendix 1.

If there are no reservations about the reinstatement of the site:

- the Contractor may no longer have access to the plot;

- the "Declaration of release of plot" will be signed by all parties;

- the Party concerned may have the use of his land;

- the Owner's Negotiator will make an arrangement with the Party concerned for the subsequent administrative settlement and payment joint assessment of the damage/satisfaction, see Appendix 2.

However, if there are any reservations:

- the reservations will be noted in the "Declaration of release of plot" together with a deadline for these to be made good. The Contractor undertakes to adhere to the agreed deadline;

- it will be mentioned whether the Party concerned may or may not have the use of his land;

- the "Declaration of release of plot" will be signed by all parties;

- a date will be specified for a new site visit.

If during the second visit to the site it is noticed that the works cannot be carried out or if the works yet to be carried out on the terrain are so inextensive, compensation can be awarded and the "Settlement" document will be completed (see appendix 3). These cases must be kept to a strict minimum by the Contractor and clearly justified before he requests permission from the Owner.

The Owner reserves the right to pay the Parties concerned directly for any damage caused by the Contractor during the course of the works and not repaired in the appropriate time by the latter, at the expense of the Contractor.

This will include the damage that might result from poorly executed reinstatement, in particular with regard to composition of the topsoil and the soil backfilled above the drainage pipes. This also includes abnormal damage, all damage arising or exacerbated by the non-observance of the contractual obligations including those relating to deadlines and working strip.

15.4. AERIAL BEACONS

The purpose of the definitive markings is :

- to indicate the correct location of the pipeline;
- to indicate the position of the pipeline for the purpose of survey with a helicopter.

The pipeline must be marked out during site reinstatement and before the terrain release. Positioning and placing the markers is carried out by the Contractor in accordance with the relevant drawings. Except otherwise specified the aerial beacons will be supplied by the Contractor. They will be in accordance with the relevant drawing and approved by the Owner and/or Engineer.

The Contractor will place the markers and attach the marker plates thereto in accordance with the instructions of the Owner and/or the Engineer. The Contractor will be paid in accordance with the quantities actually supplied and the work actually carried out and on the basis of the price given in the bid in pricelist.

15.5. MARKING OUT OF THE PIPELINE

15.5.1. Concrete Marker posts

The positioning of the marker posts is carried out by the Contractor in consultation with the Owner's Negotiator if the marker posts are located on private land and with the authorities concerned for the public domain in accordance with the relevant drawings and before the terrain release.

The concrete marker posts will be supplied by the Contractor. The Contractor will submit to the Owner and/or the Engineer (for approval) the type of marker he intends to use. The Contractor will place the marker posts, attach the Owner identification signs and fix the information on them. Immediately after the placing of the marker posts by the Contractor these will be checked by the Owner's surveyor for their correct positioning.

15.5.2. Cast iron marker tiles

The positioning of the marker tiles is carried out by the Contractor in consultation with the Owner's Negotiator if the marker tiles are to be located on private land and with the authorities concerned for the public domain according to the relevant drawing and before the terrain release.

The marker tiles will be supplied by the Contractor. The Contractor will submit to the Owner and/or the Engineer (for approval) the type of marker he intends to use. The Contractor will be responsible for the positioning and placing of the marker tiles in places indicated on the relevant drawing. Immediately after the placement of the marker tiles by the Contractor these will be checked by the Owner's surveyor for their correct positioning.

APPENDIX 1

DECLARATION OF RELEASE OF PLOT
CDF
OPSRA
Pipeline :
Owner :

Contractor :

Terrain manager :
Negotiator :

Minimum depth :

Width of the working strip :

PLOTS OF LAND LOCATED ON THE TERRITORY OF THE MUNICIPALITY:									**NIS :**
DS no.	**Land Register**			**Surface**			**Place name or street and no.**	**Nature and cultivation**	**Length of the working strip (m)**
	Div.	**Sect.**	**No.**	**ha**	**a**	**ca**			

OWNER	CRS :	OPERATOR	CRS :
Name :	First name :	Name :	First name :
Address :		Address :	
Account :		Account :	

A)

The undersigned hereby declares that the aforementioned plot(s) of land has/have been restored to their original condition following the works by the responsible contractor, in particular as regards:

1. cleaning of the terrain and discharge of waste, stones, material, etc.;
2. raking of the earth on the surface and depthwise;
3. evening of the terrain and REINSTATEMENT of the soil to its original condition;
4. REINSTATEMENT of canals, dikes, streams, gates, enclosures, drinking troughs, shelters;
5. REINSTATEMENT of drainage, irrigation and dewatering networks;
6. replacement of property posts;
7. REINSTATEMENT of roads and access roads used by the contractor;
8. any other particular point included in the site description.

The owner or operator **may** restore the plot(s) to use from ... / ... / 20...

From this onwards, the owner and/or operator can make no other claims vis-a-vis Owner and/or its Contractor as regards the REINSTATEMENT of the plot(s) within the framework of the works outlined above.

1/2

B)

The owner and/or the operator **may** restore the plot(s) to use from .. / .. / 20..

However, the following **"minor works"** will be carried out :

1.
2.
3.

B.1.) **by** ☐ the contractor ..... at the latest by ..... / ..... / ....
The owner and/or the operator, Owner and the Contractor will meet once again at the latest on ..... / ..... /..... to ascertain whether the aforementioned works have been carried out and to draw up the definitive description of the damage with a view to compensation.

B.2.) **by** ☐ the owner / operator (*) .....
The latter hereby declares that he agrees with the definitive description of the damage caused by the works carried out by Owner and/its contractor.

From this onwards, the owner and/or operator can make no other claims vis-a-vis Owner and/or its contractor as regards the REINSTATEMENT of the plot(s) within the framework of the works outlined above.

C)

The owner or the operator may **not** bring the plot(s) back into use.

Description of the works	Deadline	Contractor
1.		
2.		
3.		
4.		
5.		

The owner and/or the operator, the contractor and Owner will meet once again on ..... / ..... / 20..... to release the plot(s) concerned and to draw up the definitive description of the damage with a view to compensation.

Drawn up in ..... copies, in..... , on ..... / ..... / 20....

Signature of the owner or operator (*)	Signature of the representative of the contractor	Signature of the representative of
For agreement with point A/B.1./B.2./C(*)		

(*) delete where inappropriate 2/2

APPENDIX 2

JOINT ESTIMATE OF DAMAGE / DECLARATION OF SATISFACTORY EXECUTION
CDF
IMP
OPSRA
Pipeline :
Owner :
Width of the working strip : m. Contractor :
Negotiator : Date :

PLOTS OF LAND LOCATED ON THE TERRITORY OF THE MUNICIPALITY :									**NIS :**
DS no.	**Land Register**			**Surface**			**Place name or street and no.**	**Nature and cultivation**	**Length of the working strip (m)**
	Div.	**Sect.**	**No.**	**ha**	**a**	**ca**			

OWNER CRS : Name : First name : Address : Account no. :	OPERATOR CRS : Name : First name : Address : Account no. :

ESTIMATE OF THE DAMAGE

Damage for which OWNER is liable	**Damage for which contractor is liable**
TOTAL :	**TOTAL :**
	TOTAL :
	TO BE DEDUCTED: PREPAID AMOUNTS:
	BALANCE TO BE PAID :

Agreement with the above amounts and signing of the certificate of the declaration of Site release on ... / ... / 20... is valid as declaration of satisfactory execution.

The payment of the latter amount is valid as the definitive settlement for the damage, inconvenience and losses caused by the works.

Signature of the owner or operator For agreement	Signature of the representative in the negotiations of OWNER	Read for agreement by the representative of the contractor	Read for agreement by the expert

APPENDIX 3

SETTLEMENT
BETWEEN

OWNER N.V.,
represented by its mandatary....., hereinafter referred to as **OWNER**

AND
Mr, Mrs.(*) ....., hereinafter referred to as THE OWNER or OPERATOR (*)

The following agreement has been reached :

The OWNER or OPERATOR (*) exploits the following plot(s) in the municipality of .....

DS NO.	LAND REGISTER		
	DIV.	SECT.	NO.

As it has been jointly established that within the framework of the laying of (the works carried out on) the pipe .....the rectification of the following damage :

1.

2.

3.

cannot reasonably be technically effected by the contractor
or
has not been effected by the contractor by the agreed deadline (*) ;

With the understanding that the extent of the damage has been jointly estimated at ..... , taking account of possible future damage ;

OWNER will from now, by way of settlement, pay the above amount to the OWNER or the OPERATOR (*)
– by transfer to account no ..... or
– by postal order

This definitive lump-sum compensatory payment settles all existing or future damage caused by the works carried out in 20 on the aforementioned plot(s).

Consequently, the OWNER or else OPERATOR (*) definitively waives any claim, legal or otherwise, which he could lodge in future on account of the aforementioned works and undertakes to have any successor(s) comply with the provisions of the present agreement. If necessary, he will also inform the owner of the plot(s) of this.

Drawn up in ..... copies, in ....., on ...../ ...../ 20.... .

Signature of the owner or operator (*)	Signature of the representative of the contractor	Signature of the representative of Owner

(*) delete where inappropriate

PART 16

PARTICULAR CONSTRUCTION TECHNIQUES

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* * *

16. PARTICULAR CONSTRUCTION TECHNIQUES

16.1. GENERAL

The Particular Technical Specifications define the specific construction method to be used.

In his bid, the Contractor may suggest a different construction method. The Owner and/or the Engineer and the Recognised Inspection Organisation must approve of this method.

16.2. TRENCHLESS CROSSINGS

16.2.1. Boring

16.2.1.1. Geo technical survey report

If the Owner possesses a Geo technical report, he shall inform the Contractor of the results and mention them in the Particular Special Specifications for his interpretation. The Contractor must carry out the required supplementary tests himself if he deems that the information given to him is not sufficient.

The results will be brought to the attention of the Owner and/or the Engineer. The soil depths described in the drawings are estimated depths. Before starting the works, soundings must be carried out in order to ascertain the correct profile of the watercourse, or other obstacles to be crossed.

16.2.1.2. Working pits and shoring works

The supporting sheet piles of the working pits must always be higher than the highest possible level of the water course to be crossed so that if water breaks through there will be no danger of flooding the surrounding areas.

The calculation notes, including the design and construction method for supporting of the working pits, must be submitted by the Contractor to the Owner and/or the Engineer. However, the Contractor remains responsible for any damage or accident.

The Owner and/or the Engineer must be informed of any changes to the shorings during the works. No material may be left behind on the site. The works comprise, among other things, delivery, placing, maintenance, dismantling and removal of the provisional shorings, including driving unit parts, scaffoldings and all attendant obligations.

16.2.1.3. Casings

The casing elements to be used must be delivered by the Contractor. These pipes may be of the following types:

- approved reinforced concrete pipes;
- approved reinforced concrete pipes with steel plate core;
- approved concrete pipes reinforced with steel fibres.

Any other types are not approved by the Owner and/or Engineer.

If the Owner and/or Engineer prescribes a special type of casing, this shall be mentioned in the Particular Special Specifications. The section of the casing to be drive must be specified in the Particular Special Specifications or the relevant drawings. The casing elements used must comply with the following requirements :

a) They must comply with all the external loads during construction and after completion of the work. To this end, the Contractor will submit with his bid a detailed calculation note and detailed drawing for the casing mentioning all technical characteristics;

b) The casing elements (reinforced concrete or asbestos concrete pipes) must be fitted with a watertight joint able to resist at least the maximum prevailing water pressure;

c) Required tolerances of the casing elements :

- on the length of the segment : $\pm$ 30 mm;
- on the inner side ∅ : $\pm$ 1 cm;
- on the total thickness of the casing wall : +4 % and -2 % of the theoretical wall thickness;
- on the straightness of the casing : the straightness of the casing may deviate from the theoretical center-line at most 2.5 mm per metre.

d) Where necessary, the casing is provided with injection openings to enable lubrication of the casing during driving between the soil and the outside wall with thixotropic or equivalent fluids in order to reduce the friction between the outside wall and the soil as well as the driving force to be used. Following the driving, the lubricant must be pushed aside, stabilised or bound through injection of a mortar based on trass, lime or cement, after which the remaining cavities must be filled (blocking injection). Finally, the injection openings must be sealed with a durable air and watertight seal (e.g. a screw-cap);

e) Unless otherwise mentioned in the Particular Special Specifications, the following external pressures apply :

- soil pressure : volume weight = 2 t/m^3
- dry weight = 1.6 t/m^3;
- water pressure : water table level = ground level;
- traffic load : heavy convoy in accordance with relevant standard.

As far as soil covering and water levels are concerned, refer to the applicable drawings. Account must also be taken of the local soil characteristics in the soil analysis. The easing must be resistant to the various influences that may occur during transportation, handling and the driving operation itself.

16.2.1.4. *The driving*

If the Contractor deems that carrying out the driving is difficult or even impossible because of special circumstances (geographical situation, geology, special conditions imposed by the Particular Special Specifications, etc.), the Contractor must accordingly inform the Owner in his price bid. Otherwise, he is obliged to use all means to carry out the driving works to full completion.

The choice of the driving unit to be used for the driving of the casing as well as the method for excavation at the leading edge come under the responsibilities of the Contractor. However, he must take into account the construction requirements set by the Owner and/or the Engineer. The methodology suggested by the Contractor must guarantee reliable construction within the set timescale. The operating principle must be

specified by the Tenderer in his bid. In his work procedure file, the Contractor must submit to the Owner and/or Engineer a complete and detailed description of his operating method supported by calculations.

The proposed method must comply with the following conditions :

- The driving may start only after the working pits has been constructed and finished completely and the assembly between the wall and the driving unit has been carried out to the satisfaction of the Owner and/or the Engineer;

- An adapted device must guarantee sufficient pressure distribution over the walls of the working pit and the circumference of the casing;

- During construction of the bore holes for the entry and exit working pits, the Contractor must take into account all legal safety measures. He must submit for approval to the Owner a detailed description of the method of construction of these access ways;

- Approval of this method does not discharge the Contractor of any responsibility;

- During the driving process, a cutting head must be pushed gradually into the virgin soil. As the driving progresses, the soil excavated by the cutting head must be removed using a soil transportation device. The excavation face must under no circumstances go beyond the cutting head. Consequently, the excavation must always be fully lined along the sides;

- Where necessary, the works must be carried out by exercising a counter-pressure at the excavation face to prevent any water from bursting through;

- Depending on the nature of the soil, the groundwater level and the drilling shield used, this face support may consist of:

  - air pressure;
  - mechanical support;
  - drilling fluid or equivalent;
  - a combination of the above techniques.

- The front face must at all times be sealed tight against water and soil and separated from the area in which the labourers are operating the drilling shield. The cutting head must be manageable by itself and provided with the necessary guiding jacks which must be able to be driven independently;

- In case of driving with pressurised air as front support, the air pressure must be constantly maintained where there is a danger of water seepage and/or collapse. The Contractor must submit a calculation note illustrating that, under all circumstances, the front face support air pressure will preserve the equilibrium of the soil;

- The Contractor must provide all deliveries and works for the filling of any cavities that may arise at the front face;

- The casing must have a sufficient number of injection openings to enable lubrication of the casing, during driving, between the soil and the outside wall with thixotropic or equivalent fluids in order to reduce soil friction;

- After the driving operations, the injection openings must be sealed to air- and water-tightness;

- The maximum capacity of the entire driving unit must be specified by the Contractor. If this capacity is insufficient to drive the entire casing from the entry pit to the exit pit or if the driving pressure on the casing is too high, the Contractor must, where necessary, provide for intermediate driving stations;

- During the driving operation, the Contractor must take the following measurements:

  a) measurement of the number of metres drived in, including the cutting head in each work shift of 8 hours;

  b) measurement of the peak pressure of the main jacks and that of any intermediate driving stations required to start moving the casing at the commencement of the work of each work shift;

  c) measurement of the centre of the cutting head in x, y and z co-ordinates after driving each pipe with an accuracy of 5 mm and comparison with a fixed center-line system independent of the driving wall and casing train;

  d) the automatic recording of the front face support pressures (drilling fluid, air, soil, water).

- If the measurement reveals that the center-line of the cutting head deviates by more than 10 cm from the theoretical center-line, the Contractor must stop the work and determine with the Owner and/or the Engineer what measures must be taken to improve the manageability of the driving;

- The maximum permitted deviation throughout the entire duration of the driving process is 10 cm both vertically and horizontally measured in relation to the connection line of the centres of the boreholes in the entry and exit working pit walls. If, following the termination of the driving the deviations are greater at any point than permitted, the works will not be accepted by the Owner and/or the Engineer;

- The Contractor must submit the layout of his safety installation;

- A permanent guard must be present (on ground level) when work is carried out by workers in the casing;

- If work is being carried out with the front face supported by air pressure, the air pressure installation must be able to provide sufficient flow and pressure to turn back the groundwater; stand-by compressor unit must be provided;

- A backup electric generator must also be present to take over automatically the supply the power in case of electric power failure;

- The Contractor must take into account that the pipes used (for the casing) must be able to withstand all loads during driving without showing damages or cracks;

- Special attention must be given to the contact materials between two pipes element during the driving operation;

- The Contractor must provide for the finishing of the joints on the inside of the casing in such a way that they do not damage the pipeline and/or its accessories while being driving through.

16.2.1.5. *Spacer collars*

The spacer collars must be placed at 2.50 m from each other. At the extremities of the casing, two spacer collars must be placed whereby the outer spacer collars must be located at least 30 cm inside the casing.

The support points of the successive spacer collars may not be located in one line, but must be regularly staggered. The spacer collars must be supplied by the Contractor. They will be made completely of PEHD material with a minimum height of 10 cm and must be submitted to the Owner and/or the Engineer for approval.

16.2.1.6. *Driving the pipeline through the casing*

When the pipe is insert into the casing, the presence of the Owner and/or the Engineer is required. The insertion must be carried out with a sufficient number of suitable machines.

The pipeline must be kept completely in line with the casing. Damage to the coating must be excluded altogether. The progress of the pipeline in the casing must be gradual and under control. The front end of the pipe must be equipped with a slider-shoe and drawn by a cable through the casing.

16.2.1.7. *Description of the works*

The execution of an intersection by means of boring includes, in addition to the abovementioned works :

- The drafting of a length profile as described in Part 2, Article 2.2.4.3.;
- The preparation of the site, entry as well as exit working pit;
- The installation of appropriate road signs;
- The placement of work site warning signs in Part 2, Article 2.2.3.;
- The excavation and piling-up of the arable soil;
- The provision of thoroughfare for worksite traffic;
- The exact location and the accessibility of the complete drilling facilities;
- The excavation of the working pits up to a sufficient depth for the driving of the casing including the temporary piling-up of the soil, the necessary excavation supports, keeping the working pits and the installation dry, manipulation and removal of all necessary materials;
- The execution of all the works stipulated in the foregoing articles;
- The clearing of all excess excavation soil to a recognised waste disposal site;
- The temporary sealing of the casing ends after execution of the driving operation;
- The maintenance of the entry and exit working pits until after the tie-in with the line;
- The insertion of a PE encasement for the passage of a teletransmission cable and, where appropriate, the insertion of a HDPE encasement for the optic fibre cable if the pipe is equipped accordingly;
- The backfilling and compacting in layers of 30 cm of all excavations according to part 10.2;
- The restoration of the site according to part 15.

16.2.1.8. *Filling the casing with sand and sealing the extremities of the casing*

The working methods of filling and sealing the ends of the casing as proposed by the Contractor must guarantee sufficiently against subsequent subsidence at the extremities of the conduit. In any case, the method must guarantee that at least 95% of the casing will be filled with sand after filling.

16.2.1.9. *Information to be provided by the tenderer*

The Tenderer must include in his bid an outline and description of the excavation and working methods that he wishes to use as well as of the materials used both for the excavation and transportation of the excavated soil.

- Driving method: He will construct the required entry and exit working pits in accordance with his own working method. He must respect the minimum length measurements of the casing as indicated in the attached basic drawings;
- Level at the upper generatrix of the casing;
- Evaluation of the maximum driving force considered that must be taken into account;
- Number of possible intermediate driving unit;
- Planning and progress in metres per day of the casing. The Tenderer will also take the following into account while drafting his bid:

a) The drafting of:

- a driving report in which progress and any deviations must be noted daily;
- a diagram of the works showing:
  - the driving forces;
  - progress, delays, break down, etc.;
  - the measured deviations.

b) The supply of:

- a (continuous) calibrated recording manometer on the main driving unit and any intermediate driving unit(s).

c) The supply of :

- the required testing and manufacturing certificates of the casing as well as the date of manufacture;
- The concrete casing must have at least six weeks of drying before they can be used; if they must be used earlier, they must at least have the strength guaranteed by the manufacturer.

d) The tolerances relating to the results.

If the Tenderer cannot adhere to the required tolerances he must mention this in his bid and must indicate and guarantee the tolerances of his driving method - all of which taking into account his experience as well as the examination of any soil tests attached to the Particular Special Specifications.

e) Before starting the works, the Contractor must have his calculations and working methods approved by the Parties concerned and by the Owner and/or the Engineeer. Furthermore, all these documents must be accompanied by the required certificates that confirm the basic data used by the Contractor;

These documents must include :

- Technical notes that define the characteristics of the Contractor's supplies, for example: casing pipes, sheet piles, etc.;

- Calculations notes accompanied by sufficient justification, mainly referring to the following elements of the project:

  1) The distance between the upper generatrix of the casing and the bottom of the water course, the foundations of railways and roads;

  2) The sheet piles, coffer dams, supports, anchorings that form the entry and exit working pits;

  3) The calculations of the settings as a result of the driving;

  4) The provisions relating to injection, the use of lubricants, the construction details of the joints;

  5) The casing elements during the following stages:

     - during driving and over the largest possible driving length, i.e. before reaching the exit pit;
     - termination of the driving, empty casing;
     - during the insertion of the gas pipeline;
     - the completed installation, i.e. the remaining space filled with sand.

f) For the driving of casing underneath roads and railways, the working pits are located completely outside the area bordered by a line at an angle of 45° with the horizontal starting from the outermost edge of the road or rail construction (unless otherwise indicated in the drawings);

g) The driving of the sheet piles may not start until such time as the Contractor has obtained the approval referred to above;

h) The Contractor must consider the construction of the working pits in such a way that, following driving, all provisional sheet piles can be removed. If some sheet piles cannot be pulled out and as a consequence must remain in the ground, there must be explicit agreement on this between the Parties concerned. The working floor (gravel, concrete, steel plates, etc.) must also be removed completely.

This list is not exhaustive.

16.2.2. Ramming of product-carrier pipe

The intersection to be constructed must be limited to 2 complete pipe lengths (approx. 26 m) and the pipe must be clad with adequate PE.

16.2.2.1. Description

The construction of a crossing by means of ramming with the product-carrier pipe comprises :

- The setting-up of a length profile as described in part 2, Article 2.2.4.3;
- The preparation of the construction site, both entry and exit working pits;
- The placement of appropriate road signs;
- The placement of work site warning signs as described in Part 2, Article 2.2.3;
- Excavating and storage of the arable soil;
- Provision of an access way for worksite traffic;

- The exact location and the accessibility of the entire ramming installation;
- The excavation of the working pits to a sufficient depth for driving by ramming the pipeline, including provisional storage of the soil, the required support, keeping the working pits and the installation dry, manipulation and removal of all required equipment (compressors, driving unit installation, cleaning installation, etc.);
- The execution of the welding joint in accordance with approved welding procedure. The crossing may contain at most 1 welding joint. The welding joint must be milled flat prior to carrying out the welding checks;
- The preparation and coating of the welding joint with previously approved coating products for ramming. The approved products in Article 9.1. are not valid for ramming method;
- The ramming of the product-carrier pipe. The removal of the soil in the product-carrier pipe **may under no circumstances be carried out by compressed air.** The pipe must be absolutely clean inside;
- The transportation of the surplus excavated soil;
- The temporary sealing of the pipe ends after carrying out the ramming;
- The maintenance of the entry and exit working pits until after tie-in with the line;
- The insertion of a PE encasement for the passage of a teletransmission cable and the insertion - if any - of a HDPE-encasement for the optical fibre cable if the pipe is equipped accordingly;
- The backfilling and compacting in layers of 30 cm of all excavations according to part 10.2;
- The restoration of the site according to part 15.

16.2.2.2. *Working method*

The working method must be described in the bid. Before starting the works, the Contractor will submit a complete and detailed description of his working method to the Owner and/or the Engineer and the recognised Inspection Organisation.

The detailed description includes :

- The working method description and illustrations of the power transfer system on the product-carrier pipe;
- The description of the Working method for the insertion of the PE/HDPE encasements;
- The static calculation of entry and exit working pits;
- A sketch on which the entry and the exit working pits are indicated, among other things;
- The welding procedures to be used;
- The coating products for the welded joints;
- The dynamic force of the driving unit, percussion frequency and duration of the operation.

16.2.2.3. *Inspections*

The ramming of product-carrier pipes must be subjected to a number of technical tests:

- The preceding technical tests for the materials;
- Radiographic and US examination of the welded joints;
- Inspection of the coating of the welded joints and the pipe with a holiday detector prior to position the driving unit;
- Systematic checks, as the progress of the pipes demands, to verify whether the work is conform to the instructions in the drawings and to the specifications;

In this regard, the following must be checked in particular:

- The prescribed profile, direction lines and level markers;
- The condition of the pipes;
- The cutting of 30 cm of pipe at the pneumatic hammer side and US (ultrasonic test) or liquid penetrant test inspection of about 30 cm of the product-carrier pipe after removal of the 30 cm pipe section;
- Inspection of the coating by the cathodic protection company after the driving of the product-carrier pipes prior to tie-in with the line. For this purpose, the uncoated extremities of the pipe must be clean and lie completely free and dry. The cathodic protection current in the not yet coupled pipeline section must not exceed 1 µA per m².

16.2.3. Micro-tunnelling

16.2.3.1. *General*

This construction method is limited to a maximum of 2 entire pipe lengths (approx. 26 m) and the pipe must be coated with adequate PE.

16.2.3.2. *Description*

The construction of a crossing by means of dry-excavating and directly driving of the product-carrier pipe includes :

- The drafting of a length profile as described in Part 2, Article 2.2.4.3.;
- The preparation of the construction site, both entry and exit working pits;
- The placement of worksite signs as described in Part 2, Article 2.2.3;
- The placement of appropriate road signs;
- Excavation and storage of the arable soil;
- Provision of an access way for worksite traffic;
- Exact location and the accessibility of the entire micro-tunnelling installation;

- The excavation of the working pits, to a sufficient depth, necessary for driving the pipe through, including temporary storage of the excavated soil, the required support, keeping working pits and installation dry, manipulation and removal of all required equipment (including guiding and driving unit, jacks, drilling head, electrical generator, hydraulic sets, vacuum installation, soil transport system, drilling fluid, installation, etc.);

- Execution of the welding joint in accordance with an approved welding procedure with a maximum of one welded joint in the crossing;

- The preparation and coating of the welding joint with coating products that have been approved for micro-tunnelling. The approved products in Part 9 are not valid for micro-tunnelling;

- The driving of the pipes in loose or compact soil and the removal of the excavation soil to be carried away through the pipe which has been drived in;

- This may under no circumstances be carried out by means of compressed air;

- The transportation of surplus excavated soil;

- The works arising from and accompanying the foregoing works:

  - the injection of thixotropic or equivalent fluids to reduce friction;
  - the temporary sealing of the pipe ends after the driving;
  - the maintenance of the entry and exit working pits until after tie-in to the line;
  - the insertion of a PE encasement for the passage of the teletransmission cable and the insertion of an HDPE encasement to the optical fibre cable if the pipe is equipped accordingly.

16.2.3.3. *Construction method*

The construction method must be described in the bid. Before starting the works, the Contractor must submit a complete and detailed description of his working method to the Owner and/or the Engineer and Parties concerned. The detailed description comprises the following, among other things :

- A description and illustrations of the power transfer system on the product-carrier pipe;
- The description of the working method for the insertion of the PE/HDPE encasements;
- The static calculation of entry and exit working pits;
- The provisions relating to the injection and use of lubricant;
- A sketch in which the entry and exit working pits are indicated;
- The welding procedure to be used;
- The coating products for the welded joints.

16.2.3.4. *Inspections*

The drived pipes must be subjected to a number of technical tests:

- The previous technical tests of the materials;
- Radiographic and US examination of the welded joints;
- Inspection of the coating of the welded joints and the pipe with a holiday detector prior to driving;
- Systematic checks, according to the progress the pipes, in order to verify whether the works are conform to the instructions in the drawings and/or the specifications.

In this regard, the following will be checked in particular:

- The described profile, direction lines and level markers;
- The condition of the pipes;
- The coating by the cathodic protection company after driving of the pipe. For this purpose, the extremities of the pipe must lie completely free and dry. The cathodic protection current in the pipe not yet coupled pipeline section must not exceed 1 µA per m².

16.2.4. Horizontal directional drillings

Refer to GTS 740/001.

16.3. OPEN TRENCH CROSSING

16.3.1. Casing in open trench

16.3.1.1. Materials

The casing elements to be used for the works must be supplied by the Contractor. They may be of the following types :

- approved reinforced concrete pipes, open trench type
- approved fibre-cement conduits, sewage type
- any other types of conduits approved by the Owner

The inner diameter of the pipe must be at least 300 mm larger than the pipe diameter.

16.3.1.2. Description

The construction of a crossing by means of a casing includes :

- The drafting of a length profile as described in Part 2, Article 2.2.4.3.;
- The preparation of the construction site;
- The placement of worksite warning signs as described in Part 2, Article 2.2.3;
- The placement of appropriate road signs;
- Location of underground obstacles by means of sounding pits;
- Excavation of the trench including temporary storage (temporary transportation where necessary) of the soil, the required support, keeping the trench dry;
- The placing of casing element on a bed of 15 cm of stabilised sand;
- The backfilling and compaction of the trench;
- The transportation of the surplus soil to an approved waste disposal site;

- The temporary or final repair works of the roads;
- The insertion of the pipe into the casing;
- The placement of a HDPE encasement for the optical fibre cable if the pipe is equipped accordingly for the teletransmission cable if any;
- The placement of a 2" ø PE encasement with pulling cable;
- The placement of Mg anodes, supplied by the Owner, for casing longer than 40 m.;
- The filling of the casing with sand.

16.3.1.3. *Spacer collars*

See Article 16.2.2.5.

16.3.1.4. *Insertion of the pipe in the casing*

See Article 16.2.2.6.

16.3.1.5. *Filling the casing with sand*

See Article 16.2.2.8.

16.4. SINKERS/SYPHONS

16.4.1. Temporary assembly and construction sites

Moving already existing structures must be the subject of a special permit issued by the Parties concerned. The Contractor must carry out or have these works carried out in accordance with the instructions and requirements of the Owner and/or the Engineer and the Parties concerned. Permanent access must always be ensured along both banks of waterway.

The constructions of dikes and support dikes, provisional access roads, coffer dams, encasement sheet piles, excavation works, protections as well as reinstatement of existing installations, more particularly banks and dikes, construction of a slipway (where necessary), may only take place after having obtained the necessary permissions of the Parties concerned.

16.4.2. sheet piles and coffer dams

The Contractor must carry out the required supplementary tests or measurements if he deems that the information (relating to currents, tides, sediment movement, soil characteristics, etc.) provided for in the Particular Special Specifications is inadequate to guarantee professional work.

The Contractor must mention this in his bid. The results of any supplementary tests must be communicated to the Owner. The top level of the temporary sheet pile screens must always be higher than the highest possible water level of the waterway to be crossed to ensure that there is no danger of flooding of the surrounding areas if water should break through. For carrying out the excavation works, the Contractor must provide for coffer dams and/or sheet piles in accordance with the soil stability.

The sheet piles must be constructed over both dikes in such a way as to provide for maximum safety against water break-through. For instance, at no time when the works are being carried may free passage exist between the waterway and the surrounding land, even while the sinker is being put in place. The Contractor will be held fully responsible for any damage caused by the infiltration of water through the sheet piles or coffer dams.

Important note:

The coffer dams must be designed and constructed in the area specially provided for this purpose and indicated on the basic drawing in order not to obstruct any shipping activities. In his bid, the Contractor will provide a description of:

- measurements and installation of these coffer dams and/or sheet piles;
- type and characteristics of the sheet piles provided.

The installation as well as the measurements of coffer dams and sheet piles will be subject to an implementation drawing and a calculation to be submitted to the Owner and/or the Engineer as well as to the Parties concerned for approval. This approval does not in any way diminish the responsibility of the Contractor. The ramming of the sheet piles may not commence until the Contractor has obtained the approval mentioned above.

The specifications of Article 10.1. are also applicable to the realisation of the sinker trench. For this purpose tolerances of ±10 cm apply. The proposed working method must be selected in such a way that this method is in accordance with the planning, safety and stability of the entire works.

16.4.3. Anchoring, ballasting, mechanical protection of the sinker

Weight of the sinker per linear metre prior to application of a protection :

- $G_L = \frac{1}{4} \pi (\varnothing \text{ coated steel pipe})^2$ x weight of displaced water.

Weight of the coated pipe :

- G_B = Weight $_1$ (steel pipe + P.E. coating) + Weight $_2$ protection.
- G_1 = see manufacturer
- $G_2 = \frac{\pi}{4} (\varnothing_B^2 - \varnothing_L^2)$ x specific gravity of concrete.

  $\varnothing_B$= average outer diameter of the pipe after application of the protection (based on at least 5 measurements)

  $\varnothing_L$= $\varnothing$ coated steel pipe.

- $G_B/G_L > 1.3$ unless otherwise specified in the Particular Special Specifications

The form work used for the application of the concrete protection must be removed. The concrete protection must be at least 10 cm tick everywhere. The application there of may not damage the coating anywhere. The concrete must be reinforced. In the case of injected concrete, the Contractor must guarantee the specific gravity of the concrete.

16.4.3.1. *Specifications relating to shipping*

All floating material to be used (dredging vessels, floating derricks, pontoons, containers, tugs, etc.) must be provided with the required lighting, signalling devices, transmitter and transceiver equipment, in conformity with the requirements of the Parties concerned. In particular, during the sinking manoeuvre proper communications with the shore must be assured. The relevant instructions and requirements of the Parties concerned must be followed promptly and strictly.

The Contractor must submit the characteristics of his floating equipment for approval to the Owner and/or the Engineer and the Parties concerned in good time. In particular, all floating equipment or the accompanying support vessel must have sufficient motor capacity in order to ensure adequate manoeuvrability. Shipping may not be hindered during the dredging works; the shipping route must therefore always be freed in good time and provided with beacons according to the instructions of the Parties concerned. Non-operational floating equipment must always be moored alongside the shores according to regulations.

All work activities (profile narrowing, presence of floating equipment, etc.) must be announced through "Messages for Shipping" to the Parties concerned within the stipulated timescale. The date of the sinking works must also be announced in good time; this date may not be changed afterwards except in the case of unforeseen weather circumstances (ice-drift, fog, etc.).

16.4.3.2. *Dredging*

The characteristics of the soil to be dredged may be mentioned for information in the soil analysis attached to the Particular Special Specifications. If this information is not available, the Contractor himself must carry out the necessary investigations and present the results to the Owner and/or the Engineer and the Parties concerned before starting the works.

The minimum covering described on the drawings must be adhered to everywhere. The transversal banks of the temporary trench must be made in such a way as to avoid any danger of shearing and/or earth depletions that may affect the stability of constructions in the vicinity. Furthermore, the Contractor must adapt his working method to the speed of silting of the trench to be dredged.

If the Particular Special Specifications do not mention a waste disposal site, the Contractor himself must take the necessary steps. The waste disposal site must comply with the applicable legislation.

If during the dredging works it becomes clear that there are unforeseen and bulky obstacles at the bottom of the sinker trench, such obstacles must be removed to a minimum of 1 metre below the lowest generatrix line of the protected pipe. The resulting cavities must be filled with soil of which the characteristics are roughly equivalent to those of the soil from the dredging trench.

Before starting the works the Contractor must carry out a detailed sounding of the waterway to be crossed. This sounding must be repeated before the sinker is placed and after the backfilling has been carried out. In his bid, the Contractor must mention which method will be used for this sounding (determination of depth - positioning).

16.4.3.3. *Sinking*

The Contractor is free to suggest an alternative method of launching and sinking. He must submit this method, supported by the required calculations, for approval to the Owner and/or the Engineer and the Parties concerned. To his bid, the Contractor must attach a theoretical drawing and a detailed description that must provide clear insight into the various stages from prefabrication of the sinker on the land up to and including the process of laying it in the trench.

This work schedule must clearly show, among other things, which temporary measures are considered by the Contractor (including the application of temporary sheet pile constructions, coffer dams, dikes, bridge constructions, etc.) that will reduce the free profile of the waterway. If the Parties concerned do not agree with a certain working method, the Contractor must work out an acceptable working method at his own expense. The approval of a working method by the Owner and/or the Engineer and the Parties concerned, however, in no way discharges the Contractor of his responsibility in this matter.

In particular, special attention must be paid to the hoisting plan drawn up by the Contractor. It must be designed in such a way that during the entire operation no inadmissible stresses may occur in the pipeline and that there will be no danger of lateral kinking or folding. The hoisting belts may not damage either the pipe or the cladding around it.

During the sinking works, the Contractor must have sufficiently trained staff and equipment at his disposal. If necessary, the sinker must be ballasted evenly during launching, proportionate to the water displacement of the pipe during sinking. The filling of the trench may only start after measuring the correct position of the sinker and after explicit agreement by the Owner and/or the Engineer. This must be carried out with filling material that complies with the instructions of the Parties concerned and guarantees sufficient safety against floating. This must be submitted for approval to the Owner and/or the Engineer.

The filling must be carried out carefully to 1 metre above the pipe. In each case the filling soil must be free of stones, fragments or sharp objects that could damage the pipeline and its protection. The soil remaining after filling the trench and the rising banks becomes the property of the Contractor and must be transported away from the site or from the temporary waste disposal site to a recognised waste disposal site.

16.4.3.4. *Crossing of bank reinforcements, sheet pile supports coffer dams, embankments, etc.*

The demolition works at the crossing must be limited to a minimum area, compatible with the implementation of the work in accordance with the code of good practices. In order to render the sinker compatible in terms of stability and form with existing constructions, the Contractor must request the relevant drawings, calculations and working methods of the constructions to be crossed from the Parties concerned in good time.

If these are not available and/or provide insufficient information, the Contractor must carry out the necessary supplementary surveys (excavating test trenches, taking soundings, measuring, soil analysis, etc.). Based on the information thus obtained, the Contractor must draw up his design and construction drawings and submit them to the Owner and/or the Engineer and the Parties concerned for approval. The instructions of the latter must be strictly followed, and during reconstruction special attention must be given to the connection between old and new parts in order to avoid water seepage around and under the construction.

If certain demolition material are, in the opinion of the Parties concerned, fit to be reused after cleaning, they must be stored temporarily. Removed piles, asphalt concrete, rush mats, filter cloth, fascine mattresses, concrete, masonry, etc., however, become the property of the Contractor and must be carried away to a recognised waste disposal site.

16.4.4. Description of the works

The placement of a sinker also includes, in addition to the abovementioned works:

- The drafting of a length profile as described in Part 2, Article 2.2.4.3;
- The preparation of the worksite, for any working pits;
- The placement of appropriate road and waterway signs;
- The placement of worksite signs as described in Part 2, Article 2.2.3;

- The excavation and piling-up of arable soil;
- The provision of a access for worksite traffic;
- The excavation up to a sufficient depth for the placement of the sinker, including the temporary piling-up of the soil, the necessary support, keeping the work pit and the installation dry, manipulation and removal of all necessary materials;
- The execution of all works stipulated in the foregoing articles;
- The removal of all excess excavation soil to a recognised waste disposal site;
- The temporary sealing of the pipe ends after the placement of the sinker;
- The maintenance of the tie-in work pits until after the connection with the line;
- The insertion of a PE encasement for the passage of a teletransmission cable and, where appropriate, the insertion of an HDPE encasement for the optic fibre cable if the pipe is equipped accordingly;
- Backfilling according to Part 10, Article 10.2.;
- The restoration of the site according to the aforementioned articles and Part 15 of the General Technical Specifications.

16.5. ABOVEGROUND PIPELINE WORK

FOR INFORMATION ONLY.

16.5.1. General

To guarantee maximum security during Works near existing structures with underground access ways for persons, the following measures shall be taken:

- the demolition materials shall be removed immediately;
- the excavation shall be backfilled or removed the same day;
- the trenches may not remain open after 5 p.m.

16.5.2. Ground level transition protection

16.5.2.1. General note

The brand names of products used in this article are the result of a procedure approved by the Owner for treating the pipeline at above/underground transition point. It is not the intention to promote these products in one way or another. Consequently, the Contractor is free to suggest to the Owner equivalent products from other suppliers or with other brand names. The working method described here below are approved recommended method only. The Contractor must submit for approval his working method to the Owner and/or the Engineer.

16.5.2.2. Method 1 - In accordance relevant drawing

Application of Fibaroll; see part 18 article 18.5

16.5.2.3. *Method 2 - In accordance with relevant drawing*

Placing and filling of protection casing.

16.5.2.3.1. *Required materials:*

- Casings: these consist of concrete or fibre cement with an internal diameter that is 100 mm larger than the outer diameter of the pipe to be protected and a length of 1 metre + the nominal outer diameter. For the protection of existing pipelines two half-shells must be used. For new pipelines casings made out of one piece must be used;
- Centring collars must be placed in the middle of the part of the pipe to be protected;
- Closing device : to be placed on each end of the conduit. On new pipelines these rubber closing devices must be of the closed type;
- Other materials:

  1) PU paint Voss Chemie type K6 S.
  2) Liquid polyurethane, 2 components.
  3) Special glue for gluing the 2 half-shells: Mono-component polyurethane-based glue, PU type Glue 10.

16.5.2.3.2. *Working procedure*

1) Treating the pipe

a) Existing pipe (one part painted, the other part coated):

- Remove the pipe coating in accordance with a working method recognised by the Owner and/or the Engineer;
- Cleaning the unclad part by means of a solvent;
- The coating must not be removed further than point A of the below-ground section. Point A is located at 600 mm + nominal diameter of the casing below the surface;
- Sand-blasting SA 3 or mechanical brushing ST3;
- Application of a first layer of Voss Chemie PU paint type K6 S diluted with 20% trichloroethylene;
- Application of a sufficient number of undiluted layers of K6 S to obtain a dry layer 250 microns in depth. The surface to be treated with K6 S extends from point A, below-ground section, to 50 mm past the location where the closing device is to be fixed to the above ground section, to ensure a good connection with the paint.

b) New coated pipelines:

- Pipes coated with extruded polyurethane : the placement and filling of the casing may be carried out without removing the coating;
- Pipes coated with tapes or with a damaged coating: identical treatment as for existing pipelines.

2) Filling the casing

a) Existing pipe:

- The casing consists of 2 half-shells that are glued on site with PU glue 10;
- The closing device must be of the open type and glued on site (Special glue for vulcanising the rubber).

- 1. In vertical position:

- placing the centring collars in the middle of the part to be protected;
- placing and gluing the 2 half-shells, centring the casing;
- placing the bottom closing device;
- filling the conduit with polyurethane in order to ensure the adhesion of the coating at point A;
- repairing the painted part of the pipe above ground level;
- securing the upper closing device after polymerisation of the polyurethane;
- repairing the layers of paint according to code 01 of the Owner.

- 2 In horizontal position:

- placing the centring collars in the middle of the casing to be protected;
- fixing and securing the 2 half-shells, centring the glued casing to connect the coating point A with polyurethane;
- placing the rubber closing devices at the extremities of the casing (to be glued by means of vulcanistion);
- filling the casing with polyurethane;
- removing the closing devices after polymerisation and examining the surfaces injected;
- retouching the layers of paint on the side where the pipe is unclad.

b) New pipe:

The filling of the casing is performed in the workshop. The conduit is filled with polyurethane in accordance with the procedure under 1.b) or 1.a) according to whether they are pipes with PE coating or not. A casing made out of one piece will be used. Further steps are according to 2. (vertical position).

The products must be applied according to the specifications of the manufacturer.

16.5.3. Placing stainless steel clamping rings that serve as sliding sleeves on in service pipelines

In accordance with relevant drawing.

16.5.3.1. *General*

Clamping rings may only be applied to pipelines that are protected with paint against corrosion in accordance with code 01.

16.5.3.2. *Materials*

- 2 clamping ring halves made of stainless steel 304 or 304 L, 3 mm thick;
- neoprene mat 5 mm thick;
- silicone-based sealing product;
- stainless screws.

16.5.3.3. *Inspection and examination before applying the clamping rings*

a) Make sure that the pipe has already been treated with anti-corrosion paint (complete 01 system) at the location of the clamping rings. The paint must be dry and hard;

b) The indicated locations must be cleaned with cloths soaked well in trichloro-ethane, solvetane or chlorothene. There may be no grease or oil, humidity, scale, etc. on the contact surfaces between the neoprene sheet and the pipe. Where a new layer of paint must be applied at the locations of the clamping rings, this layer must be dry and hard before the clamping rings can be placed (24 to 48 hours);

c) Where necessary, dry the surface prior to application;

d) Check the length and width of the neoprene sheet; its width must be 5 to 10 mm less than the width of the clamping rings, and the circumference of the neoprene sheet must be ± 1 mm less than the circumference of the pipe;

16.5.3.4. *Placing the clamping rings*

a) Indicate with chalk the final position of the clamping ring on the pipe taking into account that the axis of the clamping ring must lie in the axis of the support;

b) Place the neoprene sheet close to the pipe, taking into account that the seam is located on the bottom line of the pipe at the same level as the seam of the stainless steel clamping rings. For fixing the seam, adhesive tape or glue paper may be used, to be applied crosswise to the pipeline;

c) Moisten the outside of the neoprene sheet slightly with soapy water in order to facilitate the sliding of the clamping ring halves when securing;

d) Place the uppermost half of the clamping ring;

e) Place the lower half of the clamping ring;

f) Connect the two clamping ring halves with stainless steel bolts without applying excessive force to prevent the neoprene creeping between the clamping rings. The bolts must be fixed with one of the following products:

  - PERMA BOND no. 118;

- LOCTITE Stud Loc. no. 270.

g) Filling of the space between the clamping rings and the pipe by means of silicone jointing compound that must be properly smoothed in such a way that no rainwater or condensation can infiltrate between the clamping rings and the pipe.

16.5.4. Placing of PVC half-shells as protection against discharge water at expansion joints of bridges and structures

In accordance with relevant drawing.

16.5.4.1. Materials

- Casing halves made of PVC with an inner diameter equal to the outer diameter of the pipe + 20 mm and a minimum length of 1.5 m;
- Rubber tape 20 mm thick;
- Special glue for rubber tapes;
- PVC fixing tape, "Colson" type or equivalent.

16.5.4.2. Inspection and examination prior to placing the half-shells

- The half-shells may only be placed around the pipe after being covered with a complete anti-corrosion paint treatment and after cleaning the surface to be treated;
- The rubber bands may not be glued to the pipeline.

16.5.4.3. Placing the half-shells

- Gluing the rubber bands on the PVC casing halves;
- Placing the casing halves on the pipe at the fixed locations;
- Placing the ring connection around the pipe.

N.B. : To secure the PVC casing halves only fixing clasps made of PVC may be used.

16.5.5. Replacing existing supports by new supports

16.5.5.1. Preparatory precautions

Prior to starting the works, the Contractor must:

a) Measure the position of the pipe - both vertically and horizontally - at the level of the existing support and the ground exits. The measurements must by carried out by the Contractor in the presence of the Owner's representative. The markers must be indicated on the installation and set out in the drawing by the Contractor. One or more copies of this drawing must be permanently present on the Construction site;

b) Take all required measures to prevent stresses in the pipe;

c) Start by dismantling the fire protection taking into account the approved procedure. The elements of the fire protection may only be reassembled at their definitive location when the new supports have been set in place;

d) The different parts of the supports must be delivered, finished and painted. Consequently, the Contractor must take all necessary precautions to avoid damage to the paintwork during unloading at the construction site and during assembly operations.

16.5.5.2. *Working method for dismantling a support*

a) Check that all preparatory measures have been taken;

b) Remove sliding supports or rollers below the pipe;

c) Grind away all metal parts that will no longer be used for the mounting of the new support;

d) Sand-blast all places where welding will be carried out.

16.5.5.3. *Procedure for mounting the new supports*

Except otherwise stated in the Particular Technical Specification the mounting and welding of the gliders or stainless steel shells shall be made by the Contractor under the express supervision of the Owner's representative.

16.5.5.3.1. *Preparatory works and precautionary measures*

a) Before placing the supports the Contractor must have the Teflon plates (gliders) already mounted on the supports;

b) All new supporting parts to be welded to the structure or the already existing support must be welded over the entire circumference in order to ensure complete tightness;

c) After welding new parts to the existing support, the support must be painted completely.

16.5.5.3.2. *Mounting*

a) Presenting, placing, adjusting and welding of the basic parts of the support to the existing structure;

b) Presenting, placing, adjusting and welding of the lateral guides;

c) Presenting, placing, adjusting and welding of the base plate or cross beam of the support. Painting of the entire assembly after welding;

d) Assembly and adjustment of the lowest sliding plate taking account of the time necessary for the paint previously applied to dry;

e) Assembly and adjustment of the base plate or uppermost transverse plate. A clearance of 0.2 mm must be provided between the pipe and the Teflon plate;

f) After the final adjustment, paint the entire support.

16.5.6. Removal, repair and replacing of the fire-resistant screens

16.5.6.1. Description of the fire-resistant screen

The fire-resistant screen consists of a [-shaped plate of galvanised metal painted prior to mounting and protected on the side of the pipe with a plate of asbestos cement with natural mineral fibres.

All fire-resistant elements must be mounted on the pipe support between the pipe and the structure of the bridge over the entire length of the construction. The elements of the fire-resistant screens will nearly always be used as support for the teletransmission cables.

16.5.6.2. Procedure

Before starting the works, the Contractor, in cooperation with the Owner, must make a site description to evaluate the scope of the works to be carried out and of the materials to be replaced. To this end, each fire-resistant part will be checked for distortion as well as the asbestos-cement plates, the connections, the paintwork, etc.

16.5.6.3. Scope of the works

a) Before dismantling the fire-resistant elements, the Contractor must determine the correct location of these elements because the distances between the supports may vary. The reinforcement steel plates (150 x 6 mm) will be prepared;

b) Dismantling the fire-resistant elements;

c) Remove the existing reinforcement steel plates from the supports by grinding;

d) Repair the damaged elements, where necessary replacing the plates of asbestos-cement, retouch the paintwork;

e) Mount the reinforcement steel plates on the elements of the fire-resistant equipment (steel bars 150 x 6 mm). The holes for fixing may be drilled in the steel plates beforehand (see detailed drawing). The last two elements on the upstream side of the bridge will be shortened to allow expansion (see detailed plan);

f) The new reinforcement steel plates on the support must be mounted and welded by means of continuous welding beads;

g) After the welding of the new reinforcement plates, retouch the paintwork;

h) Assembly and adjustment of the fire-resistant elements. The corner irons must be welded free of stress so that the axes can slide easily. Furthermore, they must be lubricated when they are mounted;

i) The new parts will be painted before delivery. Consequently, the Contractor must take all the necessary precautions to avoid any damage to the paintwork.

16.5.7. Welding of stainless steel shells to pipelines

The work must be carried out according to relevant drawing.

16.5.7.1. *Preparation*

a) The marking of locations of the shells, in accordance with the instructions in the drawing and specifications, taking into account the expansion of the pipe, in such a way that the welding of the shells remains at a distance of at least 300 mm from the welded joints of the pipes. If this distance is unfeasible, it may be reduced provided that supplementary checks are made of the round seam weld of the pipe;

b) Cleaning by sandblasting (Sa 3) or mechanical brushing (St 2.5) of the area(s) before placing and welding the stainless steel shells;

c) U.S. and E.M. inspection of the area concerned of the pipe before welding the shells;

d) Inspection of the outer diameter of the pipe at places where the stainless steel shells will be welded;

e) Apply the shells to the pipe and tighten them using a special tool intended for this purpose (clamping ring or chain) after, where necessary, grinding away the surplus thickness of the existing lengthwise weld on the pipe leaving a surplus thickness of 0.5 mm on the welding joint.

16.5.7.2. *Welding procedure for stainless steel shells, stainless steel 304L, on above ground pipes to be laid or on existing pipes which are not in service or under pressure*

The procedure is valid for welding on pipes made of steel API. Gr.B up to X60 with wall thicknesses of at least 4.5 mm and with a cooling rate limited to 75ºC/minute with min. temp. of 80ºC at the welding end.

16.5.7.2.1. *Electrodes to be used*

- Soudochrom L309 L.N.D. 2.5 mm;
- Soudochrom A.D. D.N. 2.5 mm exclusively for downward welding.

16.5.7.2.2. *Inspection of the pipe before welding*

U.S. inspection according to ASME V, art. 5 and API 1104 assessed according to ASME VIII, Div. 1, App. 12 and E.M. inspection according to ASME V, Art. 7 and acceptance criteria according to ASME VIII, Div. 1, App. 6 and API 1104.

If during inspection an error is discovered, another location must be chosen or if necessary a section of the pipe will be replace. Where necessary, however, the welding joint must be ground with a surplus thickness of approximately 0.5 mm, among other things for helical seam welded pipes or longitudinal seam welded pipes. The pipe must be perfectly cleaned, free of grease, scale, residue of metallisation and humidity.

16.5.7.2.3. *Welding sequence*

- Press the stainless steel shell solidly against the pipe by means of the appropriate tools;
- Pre-heat.

a) For the lengthwise welding of stainless steel shells:

The entire surface of the shells must be pre-heated with a burner to ± 100º C in order to remove all traces of humidity between the pipe and the shell. Weld in accordance with the indicated sequence 1-2-3-4 on fig. 1 and/or 2.

b) For round seam welding:

Pre-heat the pipe with a burner to 150 - 200 º C. Try to avoid heating the shell to such an extent that it might come loose from the pipe by expansion. Carry out the entire welding joint A following the sequence of the arrows of fig. 1 and/or 2, after which the same working method must be repeated for welding joint B. After welding, the shell must be neutralised, cleaned and polished with a product approved by the Owner (passivation - *Betspastor* type, AVESTA-JOHNSON & Co. N.V.).

16.5.7.2.4. Inspection after the welding

The welding seams must be thoroughly checked 100%.

16.5.7.2.5. Welding procedures approved by a recognised inspection organisation

The Contractor shall submit for approval the welding procedure he intends to use.

16.5.7.2.6. Special conditions for painting the round seam welds of the stainless steel shells welded on pipelines

The round seam welds between the stainless steel shells and the steel pipe must be protected against atmospheric influences by painting. To this end, a collar of approx. 20 mm at both ends of the stainless steel shell must be sand-blasted (Sa 3) or mechanically brushed (St 2.5) and painted in accordance with system code 01 approved by the Owner.

During these operations, the central parts of the stainless steel shells must be protected against sand-blasting or stripping. These parts must remain polished in order to facilitate the sliding of the shells on the Teflon sliding supports.

16.6. DISCONNECTING EXISTING PIPELINES

FOR INFORMATION ONLY.

16.6.1. General

The Particular Special Specifications determine which parts of the pipes must be disconnected. The interventions under gas will be carried out by the Contractor well trained team with a recognised experience and the Contractor will also carry out the following work :

- The required excavation works in accordance with the specifications of the G.T.S. Part 10;
- The removal of the existing coating as described in part 9 over the entire length of the working pit except for 0.5 metres along each extremity;
- The supply of all materials and the execution of all work as described in Art. 19.8.2. according to the specific status and service pressure of the pipe;
- The removal of the pipe parts indicated in the P.T.S. (valve station, sample pieces, etc.);
- The restoration of the site in accordance with G.T.S. Part 15;
- The transportation and unloading of the pipeline parts indicated in the P.T.S. to the worksites of the Owner.

The Contractor will supply all the materials that are not included in the parts lists.

16.6.2. Status of the pipe to be disconnected and special applications

16.6.2.1. Disconnection of pipelines to remain in service

a) Low-pressure pipes (≤ 14,7 bar):

The pipe must be disconnected with a conical terminal plug with a 1" vent. The Owner will supply the end cap and the materials for the 1" pressure release point. The Contractor will carry out all the necessary works in accordance with the relevant drawing.

The 1" pipe Sch.80 of the pressure release point must be bent cold by the Contractor. All welding seams must be tested non-destructively (Rγ for butt welding and liquid penetrant testing for the corner welded seams). The Contractor will deliver and place an approved 16 mm² cable in accordance with G.T.S. Part 13. The welding of the terminal part to the pipeline is carried out by the Contractor well trained team. The Contractor must carry out the required coating works in accordance with G.T.S. Part 9. The tie-in joint must be soaped at 6 bar and at operating pressure.

b) High-pressure pipelines > 14.71 bar:

The pipe must be disconnected with an end-piece in accordance with the relevant drawing. The Contractor will deliver all materials in accordance with the parts list. The Contractor must construct the end-piece in accordance with the drawing mentioned above. All welded joints must be radiographied. The Contractor will carry out a resistance test (1.4 x M.O.P.) and a leak test (soaping at 6 bar). The tie-in joint will be carried out by the Contractor well trained team, radiographied and soaped at 6 bar and operating pressure. The Contractor will supply and place an approved 16 mm² cable in accordance with G.T.S. Part 13 and carry out the coating work in accordance with G.T.S Part 9.

16.6.2.2. Disconnecting pipelines to be left behind permanently

The pipe must be disconnected with a terminal cap in accordance with the relevant drawing. The Contractor will supply all materials in accordance with the parts list. The Contractor will construct the end cap in accordance with the relevant drawing and weld it to the existing pipe after rinsing it with nitrogen and after the Owner and/or the Engineer's approval.

The Contractor will deliver the nitrogen required for rinsing the pipe. The Contractor will deliver and place an approved 50 mm² cable in accordance with G.T.S. Part 13 and will carry out all the coating works in accordance with G.T.S. Part 9. The Contractor will fill the pipe to be left with nitrogen with an over-pressure of 100 gr.

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PART 18

Paintwork

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18. PAINTWORK

18.1. General

18.1.1. Choice of paint products

The term system will be taken to mean the whole of two or more layers that will be applied consecutively to the base to be protected and which must finally constitute the homogeneous, continuous and sealed protective layer.

The Contractor will consult the paint manufacturer for the technical description of the paint systems stipulated in Article 18.8 of these specifications. The chosen paint systems will be included in the price quotation. The Contractor will indicate the methods of application for the different systems and the environmental conditions.

The Contractor will refer to the paint supplier of his choice to obtain all the guidelines for the addition of additives and solvents to obtain the required finish regardless of the environmental conditions of temperature and wind speed and the method of applying the coats (brush, roller or spray gun).

18.1.1.1. Products chosen by the Owner

FOR INFORMATION ONLY

The Owner has selected complete paint systems with a number of paint manufacturers for different applications. The selected systems along with the conditions for use and application are specified by the paint manufacturer in Article 18.8 of these Specifications.

Article 18.8 defines the systems to be used.

18.1.1.2. Environment - Aggressiveness

When a particular part of work is being carried out, the painting system should be chosen in accordance with the environment in which the material to be painted will be located. Indeed, the degree of aggressiveness of the atmosphere that will be encountered in the environment of the work can range from an environment which is not very aggressive to an extremely aggressive environment, depending on whether the location is in a rural area, a non-industrial built-up area, ventilated workshops, in the vicinity of the sea, at chemical plants, in humid rooms or in the vicinity of sources of cold or heat.

Taking account of these uncertainties, different painting systems can be recommended, and it is consequently important to mention at the time of the invitation to tender the degree of aggressiveness in which the material to be painted will be located so that the Contractor can mention this to the supplier of the paint products to determine the system to be applied.

18.1.2. Composition of the paint products used

18.1.2.1. Quality

The composition and quality of the products may not differ from batch to batch. A batch is all of the products of a specified manufacture. If the analyses of products bring to light that the composition does not conform to the specifications of the paint manufacturer, the Owner may refuse to use this batch of products. The paint products must comply with the following conditions:

- they must have the viscosity necessary for the described use and the established condition: use of the brush - paint roller (spray gun only for special cases and in the workshop).

Thinning on the building site of paint products with two components will be carried out in accordance with the specifications of the supplier.

18.1.2.2. Quality control - Sampling

While the works are in progress on the construction site, the Owner and/or the Engineer may carry out sampling on the paint being used for the purpose of checking conformity. The paint products must be made available free of charge to the laboratory or the approved supervisory body in sufficient quantities so that all the tests can be carried out on the same batch.

If the analyses reveal a non-conformity in the composition of the products used (tolerance of $\pm$ 3 % of the dosage of every component), the Owner and/or the Engineer may refuse application of the product under consideration, halt the work and have the nonconforming product already applied removed.

Before proceeding with the work, a product that does conform will be required. The only purpose of the analyses is to reveal any nonconformity of the composition of the products. Their purpose is therefore not to assess the quality of the different components. The analyses concerned are not acceptance tests of the products supplied and in no way affect the obligations of the Contractor specified in the contract towards the Owner.

18.1.3. Conditions of delivery

18.1.3.1. Packaging

Every recipient will be fitted with a hermetically-sealed lid with an opening that is sufficiently large to allow the contents to be stirred; the outside and inside are protected against oxidation, and, like the lid, are marked with a strip of colour identical to the contents.

18.1.3.2. Identification

Every recipient will bear the following information:

- name of the manufacturer;
- date and number of manufacture;
- name of the product type;
- net weight of the product or the contents of the recipient.

At the time of delivery, this packaging must be bear labels in conformity with the legal stipulations in force.

18.1.4. Leaving the site after work

After completion of a job, a general clean-up shall be carried out by the Contractor to remove all debris, materials or irregularities that his work has brought to the site so that it is left tidy.

The restoration work includes, among other things:

- the removal of abrasives;
- the removal of the different protective coverings;
- the Contractor will make the required repairs to any damage after refitting the supports;
- the removal of paint and cleaning of the stains on the floor.

18.2. Preparation of the Surfaces

18.2.1. General specifications

The cases that occur in practice on building sites, with regard to painted surfaces, can be broken down as follows :

- material of which the oxide content disappears by natural oxidation;
- material that has already been covered with a layer of paint in the workshop;
- material that is covered with old paint layers that show different degrees of weathering.

Good preparation of the surface is the best guarantee for good anti-corrosion protection.

Paintwork may never begin until the surface to be treated is dry and is independent of the base coat and cleared of dirt, dust, rust, scale, grease, salt attack, cement powder, cement mud-scale, sand, oil, etc.

The method of preparation of the surface will be implemented in accordance with the preparation methods described below:

- cleaning (bright blast-cleaning);
- mechanical cleaning;
- manual derusting.

The Contractor should have the required material at his disposal to clean the surfaces to be coated thoroughly in accordance with the preparation methods specified in Article 18.2, regardless of the form or the condition of such surfaces. Devices that might be damaged during the preparation will either be taken away by the Owner or screened off by the Contractor. The latter will inquire about this during his exploration of the site for the works.

18.2.2. Sandblasting

Before beginning cleaning by blasting, the person carrying out the work will take the following measures:

- clear the steel surface of oil and/or grease;
- ensure that each flange collar (section where the sealing is applied) is properly screened off against the blasting and the subsequent works;
- check that no blasting grains can get into the pipes during this process. Any openings not sealed off must be screened off;

- where there are valves, regulators and other devices, the manufacturer's identification plate will be dismantled so that all surfaces can be treated. The plate will then be put back again;

- screen off all non-metal structures such as rubber where there is a filter;

- with valves, operators and other devices, care should be taken to ensure that no metal filings or paint get into the apparatus;

- the Owner reserves the right to carry out or all of these works himself.

To prevent rust forming quickly as the result of humidity on the blasted surface, cleaning by blasting may only be carried out when the temperature of the steel surface is at least 3°C higher than the dew-point of the ambient air.

Blasting may not be carried out if the relative degree of humidity exceeds 80 %. The choice of the type of blasting medium used depends on local circumstances such as the possible presence of gas and the material to be blasted - e.g. INOX (stainless steel).

The abrasive to be used must conform to the local low i.e. it may contain no carbon and less than 1 % free silicone dioxide. The Sa 3 will always be requested and must at least reach Sa 2 1/2 during the initial stage of the paintwork. For blasting followed by metallisation, the surface preparation degree to be achieved is always Sa 3. The degree of cleanliness to be obtained will be inspected in accordance with the Swedish standard SVENSK STANDARD ISO 8501-1-1988 SS 05.5900.

- Sa 3 : surface blasted down to the bare metal; when the surface is inspected with a magnifying glass, scale, rust and foreign bodies must be completely removed and it should be possible to raise a metallic shine on the treated surface;

- Sa 2 1/2: blasted very carefully. Scale, rust and foreign bodies must be removed in such a way that anything left behind will only be visible as nuances (shading) or strips.

The blast-cleaning will be carried out by means of compressed air free of water and oil.

After the blasting and before painting, the surface should be completely cleaned of blasting material and so forth with a soft brush, a dry cloth or dry compressed air.

18.2.3. Mechanical cleaning

If sandblasting is not permitted or if the metal structures are not easily accessible for blasting or blasting for one reason or another is technically unfeasible, mechanical derusting can be used instead. With mechanical cleaning by means of chipping, rotating steel brushes and sanding discs, a degree of cleanliness St 3 should be reached.

- St 3 : removal of the old paint layers of which the adhesion leaves something to be desired and/or of which the paint layer no longer fulfils the requirements.

If parts are present that are so corroded that St 3 is difficult to achieve, this should be notified to the Owner's representative prior to the start of the works.

N.B. :

- St 3 : means removal of every old paint layer. Retouching means local polishing with St 3 or Sa 3 followed by application of the desired painting system.

After mechanical cleaning, the surface should be made dust-free with a cloth or a soft brush, washed with an organic solvent and thoroughly dried off with a dry cloth (e.g. with 1.1.1. Trichloroethane such as Solvethane, Chlorothene NU).

18.2.4. Manual derusting

Manual derusting with the aid of scrapers, steel brushes, sandpaper etc. shall only be permitted in exceptional cases for local repairs. Any deviation therefrom must be requested from the Owner and/or the Engineer.

With manual derusting, a surface preparation degree St 3 must be obtained. The length of the handles of the equipment used may not exceed 50 cm.

18.2.5. Preparation of a surface covered with a layer of paint in the workshop

This layer is in general applied by the manufacturer, for example, on valves, regulators, etc. Layers of this kind will be checked for their proper adhesion in accordance with ASTM D3359, method A. The adhesion should be at least 4A (see APPENDIX 1).

If the paint layer shows less adhesion or is incompatible with the rest of the system, it should be completely removed (see also Article 18.2.6.). If the paint layer is not removed, the Contractor accepts it in the state in which the coating is found and the guarantee remains in force. The adhesion does not have to be examined if system 63 has already been applied in the workshop on behalf of the Owner.

The Contractor, who must provide for the protection on the construction site, must therefore obtain the information regarding the treatment of the surface and the quality of the paint that was used and must, moreover, examine the adhesion of the layer on the construction site, the percentage of damage and weathering as well as the value of the preparation of the surface in the workshop together with the thickness thereof that must be supplemented if necessary.

18.2.5.1. Galvanised surfaces

Galvanised surfaces, both old and new, will be carefully roughened up. Every foreign body (concrete splatters, chalk marks, grease and oil stains, etc.) will be removed. Thereafter, rub the surfaces with abundant water and, if necessary, with cleaning products.

To this end, nylon brushes will be used for every kind of dirt as well as for removing zinc salt residue. Thereafter, the surfaces will be treated in accordance with system 21. Where the zinc layer is lacking, it will be derusted manually to a degree of cleanliness St 3, after which a primer coat will be applied in accordance with system 22.

18.2.5.2. Metallised surfaces treated with an impregnation layer

- degrease with the desired degreasing product;
- clean under high pressure or with a product prescribed by the paint supplier.

If the paint layer adheres well and is applied on a clean base, the painting system described may be continued (see Article 18.8). If the percentage of damage and weathering does not exceed 5 %/m, retouching may be considered. These partial repairs will be carried out in accordance with the stipulation in Article 18.8.

If, on the other hand, the percentage of damage does exceed 5 %/m or if the layer applied in the workshop comes loose, the Contractor must draw the attention of the Owner to this and carry out the complete application system in accordance with Article 18.8.

18.2.6. Preparation of surfaces covered with earlier paint layers that show different degrees of weathering

If the surfaces do not show deep weathering limited to the spread of rust by small pitted areas or non-penetrative rust in spots, it will very often be sufficient to clean the surfaces with abrasives or with an abrasive disc, then to rub them down with steel wool, remove the dust and wash off. If thick rust appears, in spots, scale rust and active rust canker, this should be removed with needle hammers or stripped away directly by blasting, removing the dust and washing off.

18.2.7. Preparation of concrete or cement plaster surfaces

Remove unsound paint layers and loose components with scrapers, blades or rotating steel brushes. Thoroughly clean the entire surface with water containing ammonia. Thoroughly remove moss, algae and fungal growths. Where these growths have been removed, treat the area with a fungicide in accordance with the instructions for use.

Once the entire area is completely dry, brush off the dead residue of moss, algae and fungus with a hard brush. In the case of reinforcement steel that has been laid bare, remove as much rust, dust and grease as possible and treat it with a primer coat. When painting concrete surfaces, they must first be checked for cracks. Cracks larger than 0.3 mm must be repaired with an appropriate system in accordance with the type and extent of the repairs (e.g. injection with epoxy mortar). Repair damage such as cracks and bursts to concrete parts with a two-component mortar or preferably with micro-mortars. Finally, check the alkalinity of the surface with the aid of litmus paper and neutralise it if necessary.

18.2.8. Use of solvents

It is sometimes necessary to use solvents when the surfaces to be painted are streaked with grease or oil. In this case a suitable organic solvent should be applied. The operation should be carried out with the aid of clean brushes or rags and clean solvent.

All the legal specifications in connection with solvents etc. must be adhered to. The Owner and/or the Engineer will be informed in advance of any toxicity or flammability. All measures must be taken to prevent any risk of fire and to rule out any possibility of poisoning (ventilation). The Contractor will provide drip collectors to keep the environment free of pollution.

18.2.9. Condition of the metal after stripping

The Contractor must call in a representative of the Owner and/or the Engineer or of the Approved Supervisory Body responsible for checking the condition of the metal during stripping and informing the Owner and/or the Engineer immediately of any damage that he might have noticed:

- deep corrosion of the plates - rivets – bolts;
- faulty welding;
- fittings that appear to be dangerous because of their age

18.2.10. Removing coating from surface pipelines

The Contractor must have the equipment necessary for the removal of asphalt from the pipe without damaging the latter (scratching, impact, etc.). The Contractor undertakes to carry out the work in accordance with an approved procedure.

18.3. METALLISATION

18.3.1. Applying the metallisation

- Metallisation must be carried out in accordance with ISO 2063;
- Metallisation is carried out as rapidly as possible after blasting in order to limit corrosion of the pipes (max. 3 hours later). With metallisation, a surface preparation degree Sa 3 is compulsory. The roughness of the blasted surfaces should be from 25 to 50 μ R_{max} ;
- The metallising is always carried out on dry parts in good weather conditions (maximum relative humidity 80 %);
- For metallisation, a wire composed of 85 % zinc and 15 % aluminium with a minimum guaranteed degree of purity of 99.5 % is used (subject to other specifications). The application thereof is always carried out in accordance with the conditions of the manufacturer and may at all times be submitted to the Owner's representative;
- The sealant should be applied maximum 3 hours after metallisation;
- The sealant must be thinned and applied in accordance with the tables in Article 18.8 of the present specifications. A visual inspection whereby the sealant completely covers the metallisation will suffice here;
- When evaluating the metallisation, a negative deviation from the minimum coating thickness, as prescribed in the tables in Article 18.8, to 80 μ for 20% of the measurements will be permitted.

N.B.:

For the metallisation of the surfaces that are exposed to high temperatures such as chimneys, ZINACOR 850 (85/ZN/15 AL) will be used of which the systems are defined in Article 18.8 of the present "Specifications for Paintwork" (syst. 51 - 51a).

18.4. CARRYING OUT THE PAINTWORK

18.4.1. Conditions for carrying out paintwork

Painting may not be carried out in unsuitable conditions.

All preparatory work and painting may only be carried out in dry weather and at a minimum temperature of 10°C, except for special cases requested by the Owner and/or the Engineer.

Unless otherwise stipulated in the specifications of the paint supplier, application of the paint is forbidden if it is forecast that the temperature will fall to below 0°C before the paint is dry. The temperature of the surface to be painted must be at least 3°C higher than the dew point of the ambient air. Application of the paint is also not permitted if there is a danger that the coat of paint will not be dry before dew or condensation sets in.

The work must be stopped:

- if the temperature of the surface to be painted is higher than that described by the supplier;
- in rain, snow, mist or fog or when the relative humidity is higher than 80 %.

Coats that have not yet dried and have been exposed to frost, mist, snow or rain and might thereby be damaged must be removed after drying and the surfaces must be repainted at the expense of the Contractor.

Working in direct sunlight or in hot weather must be avoided.

The first coat of paint must be applied maximum 3 hours after the preparation of the surface if the relative humidity of the air is between 50 % and 80 %. This time span may be increased to 6 hours if the relative humidity is less than 50 %. In all cases, the preparation of the surface must exhibit degree Sa 3 and at the very least the appearance of degree Sa 2 ½ at the time of painting.

The coats of paint may only be applied on carefully cleaned surfaces that must be dry and free of grease and dust.

18.4.2. Special conditions

Painting may be carried out when the Contractor can be sure that the instructions of the paint supplier have been scrupulously followed with regard to the parameters in the following (non-exhaustive) list:

- ambient temperature;
- surface temperature;
- relative humidity;
- dew point;
- drying times.

The Contractor must in this respect be able to produce the instructions for the paint on the site. The Owner will guarantee 100% supervision in this regard during the execution of the work.

In addition, the paintwork may only be carried out to a minimum ambient temperature of 5°C and/or to a maximum relative degree of humidity of 85 %. Application of the paint is also not permitted if there is a danger that the coat of paint will not be dry before dew or condensation sets in.

18.4.3. Precautions to be taken

Neither the environment of the site nor the marking labels of devices may be covered with paint, and they must be kept free of paint splashes. To this end, it is advisable to use removable masking tape.

Paint splashes, leaks, etc. on any adjacent installations such as measuring apparatus, valves, pipes, sources of light, insulation, heat insulators, walls, concrete, etc. must immediately be wiped up and the damage repaired before the paint is dry.

Otherwise, the Owner will be obliged to have the cleaning carried out at the expense of the Contractor. The paint recipient will only be opened at the time of use (unless otherwise specified by the manufacturer).

The product will be mixed in the recipient with the aid of suitable tools and thus homogenised.

18.4.4. Method of application

Normally, three methods of application will be used on the construction site for the paint products - i.e., with a brush, with a roller or with a spray gun.

- The brush method makes it possible to obtain good penetration of the paint over irregularities in the metal;
- Only this method will be used for application of the base coats, for retouching and for protrusions, welded areas, riveted joints or bolted joints;
- The roller method may be used on large flat surfaces for the intermediate and top coats;
- The spray gun method must be used in accordance with the instructions of the manufacturer and carried out by qualified personnel.

The Contractor must guarantee that all safety measures have been taken for such work. The spray gun method may only be used on the site for places that are difficult to reach with the brush. In this case, a request must be made to the Owner and/or the Engineer for a deviation.

All paintwork will be carried out with good brushes or rollers that are suitable for the type of paint being used and for the form of the material to be painted and fitted with short handles. The maximum length of the brush and roller handles will be 50 cm; longer handles may only be used for places that are absolutely inaccessible. The maximum width of a brush will be 13 cm.

18.4.5. Application of the coating

Application of the paint will be carried out in accordance with best practice in order to obtain a homogeneous and continuous layer. The Owner or the Approved Supervisory Body demands that painting of a layer will only be started after acceptance by them of the surface preparation or of the previous layer of paint.

The layers of paint must have a uniform thickness. They must be spread in such a way that all concave parts are dried out and that the surface is completely covered and has a glossy appearance without leaving brush marks and without exhibiting bubbles, foam, wrinkles, drips, craters, skins or gums that arise from weathered paint.

Each layer must have the colour stipulated in the tables in Article 18.8 of the present specifications, which clearly differs from the previous layer, taking account of the colour of the top layer, all of which for the purpose of being able to identify the number of coats and their order of sequence. If the colour of the coats is not mentioned in the tables in Article 18.8 the colour difference in consecutive coats must, if possible, be at least 100 RAL. The colour of the top layer is given in the table in APPENDIX 5.

The coating power should be such that the underlying layer is not visible. Only 1 layer per day may be applied, unless otherwise specified by the Owner or the Approved Supervisory Body.

The drying times prescribed by the paint manufacturer must be strictly observed in relation to the environmental conditions before proceeding with the application of the next layer.

The dry coating thicknesses indicated in the description of the paint systems are minimum thicknesses. In this connection, the Contractor is obliged to contact the paint manufacturer and conform to his guidelines. The Contractor must respect the thicknesses specified by the supplier.

18.4.6. Transporting treated items

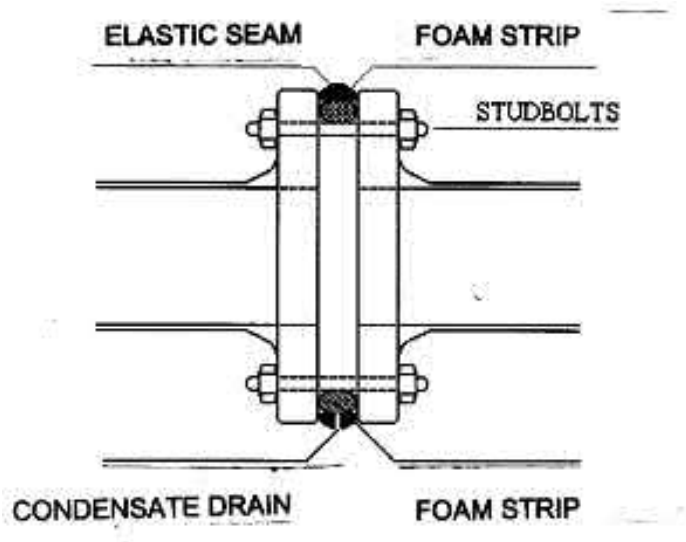
In the case of works being carried out in a workshop, the metal structures will be surrounded by ventilated contraction film that prevents damage during transportation. This film may only be applied after complete polymerisation of the paint.

18.4.7. Finishing the flanges, support surfaces, thread ends and stud bolts

Between flanges and around neoprene supports, polyurethane gaskets will be provided that will be covered with the last paint layer, except for the support of the above ground crossing. Some thread ends will be lightly sandblasted and protected with system 02 or 33. Stud bolts fitted in the workshop for metallised flanges may not be sandblasted but system St 3 - 01A will be applied.

After the paintwork, the flange will be finished off as follows:

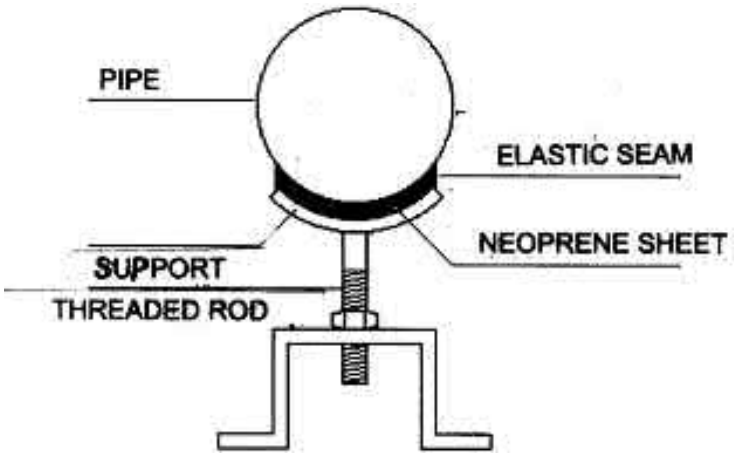
- a foam strip will be placed between the flange on the stud bolt;
- the space will then be filled with an elastic seam in accordance with the chosen paint system (see Article 18.1.2);
- an opening on the underside of at least 8 mm will be kept as a condensation outlet;
- the seam will finally be wiped smooth with white spirit so that a good appearance is obtained. Finally, the seam will be covered with the last coat of paint (see Article 18.4.7).



- Maintenance of the support surfaces

In order to maintain the support surface, the pipe or device support must be lifted up or lowered sufficiently. The existing supports shall be lowered, taken out and/or removed under the supervision of Owner's teams. They can then be moved by the Contractor in accordance with his needs for the painting operation. The local person in charge will indicate how this work will be carried out. The support surface will be treated in the same manner as the other parts. After the paintwork, the support will be refitted. Between the support and the pipe, there will be a NEOPRENE gasket supplied by the Owner.

Finally, the whole unit will be sealed with an elastic seam that will finally be covered with the last layer of paint between the support and the pipe. In the case of above-ground crossing , this grouting may not be covered with the last layer of paint (see Article 18.4.7).



18.5. GROUND-LEVEL TRANSITION POINT

18.5.1. Polyester protection system

The Contractor will provide system 02 over the entire length of the pipes above ground and below ground and up to a height of 20 cm and a depth of 40 cm, perpendicular to the ground level mark. In each case, he must ensure that the jointing below the asphalt is in good condition and assures faultless adhesion. He will apply the following products over the entire surface area, prepared in accordance with Sa 3:

1) The primer of system 01a

2) Reinforced polyester ± 20 cm above the ground level marker and ± 5 cm on the asphalt cleaned beforehand. (application of reinforced polyester is carried out in accordance with the work method prescribed by the manufacturer - see appendix 2). Moreover, in the case of PE, in contrast to asphalt, he will apply a polyken primer to the PE immediately before applying the reinforced polyester.

3) He will then apply the other coats of system 01a to the surface section and thus cover the reinforced polyester with about 5 cm (see article 18.8 paint systems)

4) For new constructions, the polyken primer will be applied to PE and then subsequently processed as described under point 2.

18.5.2. Transition protection system

The transition point will be treated in accordance with the products and methods described in the G.T.S. Part 16.

18.6. USE OF SCAFFOLDING

- Mounting, maintenance and dismantling of scaffolding for carrying out adaptation and/or paintwork to surface gas pipes or gas transport installations in use;
- The Contractor will specify the cost of scaffolding in the pricelist;
- The supplementary rental price for delays attributable to the Contractor will be charged to him;
- In his price quotation, the Contractor should present the Owner with diagrams of the scaffolding that he intends to install for carrying out the works of the Owner;
- For certain works, the Owner will provide scaffolding himself to carry out his own works. This scaffolding will be made available to the Contractor;
- A report will be drawn up when the scaffolding is handed over. The duration of the period when this scaffolding is made available free of charge is the number of working days necessary for the paintwork given in the pricelist, plus any delay resulting from bad weather conditions.

18.7. QUALITY CONTROLS AND GUARANTEE

18.7.1. Inspection of the works

The Contractor is responsible for checking the weather conditions to ascertain whether the paintwork can be carried out within the technical specifications mentioned in the present specifications (see Article 18.4.1 & 18.4.2.).

The Contractor should have the required calibrated monitoring apparatus for this purpose on site (with calibration certificates). The personnel who will have to use this apparatus should have the training required for this purpose.

The Owner or his representative and possibly the Approved Supervisory Body indicated by the Owner will maintain supervision during the works and inspect the works with random checks. A daily report (C45-N) (APPENDIX 3) will be drawn up in relation to the department that maintains supervision of these works.

The supplementary inspection and the supervision by the Owner or the Approved Supervisory Body does not diminish in any way the liability of the Contractor. The proper execution of the work and the materials used may be checked at any time.

18.7.2. Reference surfaces

At the start of the works, the Owner or the Approved Supervisory Body will indicate a few surfaces that the Contractor will prepare and cover in accordance with the recognised method of operation under the inspection and to the satisfaction of all parties: the Owner or his representative, the Approved Supervisory Body, the Contractor and possibly the paint manufacturer. These reference surfaces will serve as a point of comparison for the good adhesion of the paint on the installations as a whole. The parties will together work out a system for the identification of these surfaces in order to be able to monitor the condition of the coatings over time. If the paintwork on a section of the installations is in a worse condition than the reference surfaces, the Contractor may be obliged to treat these parts again.

18.7.3. Measures to be taken in the event of a dispute

If on delivery of the works no agreement can be reached between the Contractor and the Owner regarding the conformity of the works to the requirements of these specifications, an Approved Supervisory Body will be called in. The Approved Supervisory Body will then carry out inspections on site whereby the following assessment criteria will be used:

- The Swedish standards ISO 8501-1 1988 SS 05.5900 concerning the degree of cleanliness of the areas derusted by blasting, by machine or by hand;
- The wet film thickness of the paint will be measured in accordance with ISO 2808 or ASTM D1212;
- The dry layer thickness of the film will be measured electronically, with complete statistical information, in accordance with ISO 2808 or ASTM D 1186;
- The thickness of each layer will be measured in accordance with ISO 2808, ASTM 4138 or DIN 50986;
- Adhesion tests will be carried out in accordance with ISO 2409, ASTM 3359 or DIN 53151;
- Traction tests will be carried out in conformity with ISO 4624 or ASTM D 4541;
- The rugosity will be measured electronically in accordance with DIN 4768;
- The non-porosity will be measured with a test tension depending on the type of coating, the layer thickness and after consultation with the paint manufacturer;
- Any defects in the paint film may be inspected visually by means of a magnifying glass or microscope. If necessary, a photographic report may be drawn up in accordance with ASTM Standard D 4121-82.

The final judgement of the Approved Supervisory Body is irrevocable and binding for the Contractor and the Owner. In the event of non-conformity of the works with the criteria of these specifications, all costs arising from the inspection by the Approved Supervisory Body shall be borne by the Contractor.

18.7.4. Guarantee

18.7.4.1. General principles

The Contractor declares that he is aware of:

- the maximum operating temperature of the surfaces to be covered;
- the maximum permitted degree of humidity of the bearing surface;
- the properties of the environment to which the surfaces to be covered are subject.

18.7.4.2. Summary of the guarantee

The Contractor fully guarantees the following without reservation:

- the observance of all stipulations of the specifications for paintwork regarding, among other things :
  - the preparation of the surfaces;

- the thickness of each layer;
- the total thickness of the covering.

- the uniformity of the materials used;
- the repair of all defects before delivery of the works;

The Contractor will carry out the requested repair work as promptly as possible.

18.7.4.3. *Guarantee criterion*

Every protection system is considered to give satisfaction during the period of guarantee. The Owner requires the conditions as described in the General Terms and Conditions of Purchase.

18.8. PRODUCTS CHOSEN BY THE OWNER *(FOR INFORMATION ONLY)*

SUPPLIER : N.V. LAVENNE								
CODE	**APPLICATION**	**TYPE**	**NO. OF LAYERS**	**DESCRIPTION OF SYSTEM**	**COLOUR**	**DRY LAYER DEPTH IN MICRONS**		**TOTAL DRY LAYER DEPTH IN MICRONS**
						MIN	**MAX**	
LV01	Surfaces (to 90°C) Sa3	Epoxy + polyurethane (2 components)	1 1 1 1	RUSTOZINC EP 4024 RUSTOCOAT SEALANT 4230 RUSTOCOAT HB FINISH 4448 MURATHANE FINISH 5456	GREY RAL 9007 BEIGE ***SEE APPENDIX 5***	35 70 60 35	60 120 130 50	200
LVO1a	Surfaces (to 90°C) Sa3 or St3 Welding seams or repairs in system 01, 63 and stud bolts	Epoxy + polyurethane (2 components)	1 1 1	RUSTOCOAT HB PRIMER 4048 RUSTOCOAT HB MIOX 4248 MURATHANE FINISH 5456	RED-BROWN GREEN ***SEE APPENDIX 5***	75 100 35	100 150 50	210
LV02	Ground exit (see **Art. 18.5**) NETWORKS Sa3 INSTALLATIONS St3	Epoxy + polyurethane (2 components)	 1 1 1 (1	see system 01a RUSTOCOAT HB PRIMER 4048 RUSTOCOAT HB MIOX 4248 REINFORCED POLYESTER Polyken primer in case of PE) idem for nets but with St3 (remove all existing paint)	 RED- BROWN GREEN	 75 100	 100 150	75
LV03	Warm surfaces - with insulation (90° - 120° C) Sa 3 or St 3	EPOXY (2 components)	1 1	RUSTOCOAT HB MIOX 4248-102 RUSTOCOAT HB MIOX 4248-101	GREEN DARK GREY	75 75	150 150	150
	- without insulation (90° - 120° C) Sa 3 or St 3	EPOXY POLYURETHANE (2 components)	1 1 1	RUSTOCOAT HB PRIMER 4048 RUSTOCOAT HB MIOX 4248 MURATHANE FINISH 5456	RED- BROWN GREEN ***SEE APPENDIX 5***	75 100 35	100 150 50	210

LV15	Pipelines in cellars Sa 3	EPOXY (2 components)	1 2	RUSTOZINC EP 4024 RUSTOTAR HB 4428		35 100	60 150	235
	Pipelines in cellars St 3	EPOXY (2 components)	1 2	RUSTOCOAT HB PRIMER 4048 RUSTOTAR HB 4428		50 100	80 150	250

SUPPLIER : N.V. LAVENNE

CODE	APPLICATION	TYPE	NO. OF LAYERS	DESCRIPTION OF SYSTEM	COLOUR	DRY LAYER DEPTH IN MICRONS		TOTAL DRY LAYER DEPTH IN MICRONS
						MIN	MAX	
LV21	New galvanisation in the workplace	Synthetic resin dispersed in water		Preparation Degreasing with DEGREASER ZS 8014 Rinse off with clean water	CREAM	75	100	
			1	RUSTOCOAT HB PRIMER 4048	***SEE APPENDIX 5***	35	50	110
			1	MURATHANE FINISH 5456				
LV22	Galvanisation still in good condition (max. 10 % rust) St 3 or Sa 3	Synthetic resin dispersed in water		Preparation Rinse with clear water and dry. After removing rust, degrease with DEGREASER ZS 8014. Retouch with				
			1	RUSTOCOAT EP PRIMER 4054	GREEN BLUE	40	60	
			1	RUSTOCOAT HB PRIMER 4048	CREAM	75	100	
			1	MURATHANE FINISH 5456	***SEE APPENDIX 5***	35	50	110 / 150
LV33	Steel Sa3 or St 3	Vinyl Alkyd and Vinyl	1	RUSTOGALV VA PRIMER 1352		30	60	
			1	RUSTOGALV UNDERCOAT TC2350		50	70	
			1	RUSTOGALV MIOX 2351		50	70	
			1	RUSTOGALV FINISH 3350		30	50	160
LV41	Concrete plinths	EPOXY POLY-URETHANE (2 components)		Bare metal : remove rust				
			1	RUSTOCOAT HB PRIMER 4048		(50)	(60)	
				On concrete				
			1	RUSTOCOAT IMPREGNATION 4000				
				In small holes and cracks				
			1	RUSTOCOAT CONCRETE 4002 or RUSTOCOAT FILLER 4810				
				On surfaces				
			1	RUSTOCOAT HB FINISH 4448	BEIGE	60	130	
			1	MURATHANE FINISH 5456	***SEE APPENDIX 5***	30	50	90

SUPPLIER : N.V. LAVENNE

CODE	APPLICATION	TYPE	NO. OF LAYERS	DESCRIPTION OF THE SYSTEM	COLOUR	DRY LAYER DEPTH IN MICRONS		TOTAL DRY LAYER DEPTH IN MICRONS
						MIN	MAX	
LV51	Chimneys 450° C max. Sa3	Silicone resin and zinc		On the site				
			1	THERMOSIL PRIMER 5982		30	50	
			2	THERMOSIL MIOX 3181		25	40	80
				In the workshop				
				Metallisation ZN 100				
				ZINACOR 85/15		100		
			1	RUSTOZINC ST 4028		40	60	
				On the site				
			1	RUSTOZINC ST 4028		40		180
LV51a	Chimneys 600° C max. Sa 3 (rugosity : R max. 50 µ)	Silicone	1	METALLISATION ALU		120		
			1	THERMOSIL 600 3186		20	30	140
LV63	Metallisation Sa 3 (rugosity : R max. 50 µ)	EPOXY (2 components) Top coat POLYURETHANE (2 components)		In the workshop				
				Metallisation				
			1	ZINACOR 85/15		100		
			1	RUSTOCOAT SEALANT 4230 (20% thinned)	RAL 9007 BEIGE	40 80	120 130	220
			1	RUSTOCOAT HB FINISH 4448				
				On the site	***SEE APPENDIX 5***	35	50	255
				MURATHANE FINISH 5456				
LV70	Non-ferrous metals and special steel (Alu - Inox)	POLYURETHANE (2 components)		Preparation				
				Degreasing with DEGREASER ZS 8014				
				Rinse off with clean water and allow to dry				
			1	MURATHANE AZP 5032		30	50	
			1	MURATHANE FINISH 5456		30	50	60

SUPPLIER : N.V. LAVENNE							
CODE	**APPLICATION**	**TYPE**	**NO. OF LAYERS**	**DESCRIPTION OF THE SYSTEM**	**COLOUR**	**DRY LAYER DEPTH IN MICRONS**	**TOTAL DRY LAYER DEPTH IN MICRONS**
						MIN **MAX**	
LV81	Concrete floors Dry blast free of dust and oil	POLYURETHANE (2 components)	 1 1 or 2	After blasting and on a dry floor free of dust, dirt etc. MURATHANE FLOOR PAINT 5440 50 % thinned MURATHANE FLOOR PAINT 5440		 ± 10 m²/L	
LV85	Concrete floors Antislip idem LV81	POLYURETHANE (2 components)	 1	Idem LV81 + strew the still wet film liberally with silica of desired grain-size. After polymerisation, brush away excess silica and apply a new layer of MURATHANE FLOOR PAINT 5440		 ± 10 m²/L	
LV90	Indoor Masonry, concrete, stones	POLYVINYL ACETATE	 1 1 or 2 1 1 or 2	<u>On ceilings</u> MUR ECRAN 41 MURTEX 141 <u>On concrete and bricks</u> PREMUR 47 MURTEX 141		 ± 8 to 10m²/L ± 13 m²/L ± 8 m²/L ± 13 m²/L	
LV91	Outdoor concrete and bricks	ACRYL	1 2	ACROMUR 42 MURCRYL 145		± 10 m²/L ± 10 to 15 m²/L	
LV92	Outdoor Damaged concrete	Coating on basis of QUARTZ	1 1 1	ACROMUR 42 CREPIMUR 163 MURCRYL 145		± 10 m²/L ± 2à 4,5 kg/m² ± 10 to 15 m²/L	

SUPPLIER : LIBERT

CODE	APPLICATION	TYPE	NO. OF LAYERS	DESCRIPTION OF THE SYSTEM	COLOUR	DRY LAYER DEPTH IN MICRONS		TOTAL DRY LAYER DEPTH IN MICRONS
						MIN	MAX	
L01	Surfaces (up to 90°C) Sa3	Epoxy and polyurethane (2 components)	1 1 1 1	GALVOXY, zinc-rich primer coat OXYPAINT FF 1100, metallic finish CRYLTANE AC, middle coat gloss CRYLTANE AC, top coat gloss	GREY BLUE PINK ***SEE APPENDIX 5***	40 70 45	75 120 90	200
L01a	Surfaces (up to 90°C) Sa3 or St3 Welding seams or repairs of system 01, 63 and stud bolts	Epoxy and polyurethane (2 components)	1 1 1 1	OXYPAINT FA 503 Primer coat OXYPAINT FF 1100 Middle coat CRYLTANE AC, Middle coat CRYLTANE AC Top coat	RED BLUE PINK ***SEE APPENDIX 5***	40 70 45	75 120 90	200
L02	Ground exit (see **Art. 18.5**) NETS Sa3 INSTALLATIONS St3	Epoxy + polyurethane (2 components)	 1 1 1 (1	see system 01a OXYPAINT FA 503 Primer coat OXYPAINT FF 1100, metallic finish REINFORCED POLYESTER Polyken primer in case of PE) idem nets but with St 3 (removal of all existing paint)	 RED BLUE	 40 70	 75 120	40
L03	Warm surfaces - with insulation (90° - 120° C) Sa 3 or St 3	Polyurethane 1 component	1 1	CRYLTANE AC Primer coat CRYLTANE AC Top coat	PINK GREY	80 80		160
	- without insulation (90° - 120° C) Sa 3 or St 3	Polyurethane (2 components)	1 1 1	OXYPAINT FA 503 Primer coat OXYPAINT FF 1100 Middle coat CRYLTANE AC Top coat	RED BLUE ***SEE APPENDIX 5***	40 70 45	75 120 90	200

L15	Pipelines in cellars Sa 3	EPOXY (2 components)	1 2	GALVOXY, zinc-rich Primer coat OXYTAR Epoxy tar	GREY ***SEE APPENDIX 5***	40 150	75 200	340
	Pipelines in cellars St 3	EPOXY (2 components)	1 2	OXYPAINT FA 503 Primer coat OXYTAR Epoxy tar	RED ***SEE APPENDIX 5***	60 150	75 200	360

SUPPLIER : LIBERT								
CODE	**APPLICATION**	**TYPE**	**NO. OF LAYERS**	**DESCRIPTION OF THE SYSTEM**	**COLOUR**	**DRY LAYER DEPTH IN MICRONS**		**TOTAL DRY LAYER DEPTH IN MICRONS**
						MIN	**MAX**	
L21	New galvanisation in the workplace	Water-thinned paint		Preparation a or b a) Degreasing with trichloro-ethane 1.1.1. and clean with Lithoform 2. Wash off with clean water + dry b) variant : With steam degreasing (high pressure) Steam Devil Type				
			1	CRYLTANE AC Primer coat	PINK	60	100	
			1	CRYLTANE AC Top coat	***SEE APPENDIX 5***	60	90	120
L22	Galvanisation still in good condition (max. 10 % rust) St 3 or Sa 3	Water-thinned paint		Preparation a or b a) degreasing with trichloro-ethane 1.1.1. and clean with Lithoform 2. Wash off with clean water + dry b) Variant : Steam degreasing (high pressure)				
				Rub down rust spots, retouch with		60	100	
			1	CRYLTANE AC Primer coat	BROWN RED	60	100	
			1	CRYLTANE AC Primer coat	PINK	60	90	180 / 120
				CRYLTANE AC Top coat	***SEE APPENDIX 5***			
L33	Steel Sa3 or St 3	Vinyl Copolymer	1	DUROZINC SA 507 Primer coat	RED	50		
			1	DUROZINC SA 820 Primer coat	GREY	50		
			1	SM MIDDLE COAT	PINK	40		180
			1	SM TOP COAT	***SEE APPENDIX 5***			

SUPPLIER : LIBERT

CODE	APPLICATION	TYPE	NO. OF LAYERS	DESCRIPTION OF THE SYSTEM	COLOUR	DRY LAYER DEPTH IN MICRONS		TOTAL DRY LAYER DEPTH IN MICRONS
						MIN	MAX	
L41	Concrete plinths	Epoxy (2 components)		Blast - remove dust Protect uncovered and derusted steel				
			1	with OXYPAINT FA 503	RED	40-80		
				Impregnate cracks with				
			1	AQUAPOX DW/FM 1000	WHITE			
				Repair the cracks with epoxy FX/SL product				
			1	AQUAPOX DW/FM 1000, soak	WHITE			
			1	CRYLTANE AC, primer coat	PINK	45	90	
			1	CRYLTANE AC, top coat	***SEE APPENDIX 5***	45	90	90
L51	Chimneys Blast Sa 3 450° C maximum	Silicic acid salt ethyl of zinc (2 components)		On the site				
			2	SILIKA GALVEX (brush)		25	50	50
				In the workshop				
			1	Metallisation Zinacor 85/15		100		
			1	SILIKA GALVEX (Airless)		60	90	160
L51a	Chimneys up to 600° C	Silicone Aluminium	1	Aluminisation (rugosity R.max 50 µ)		120		
			2	WP 1110		30		180
L63	Metallisation Sa 3 (rugosity : R max. 50 µ)	Polyurethane (2 components)		In the workplace				
				Metallisation ZINACOR 85/15				
			1	CRYLTANE AC PRIMER 30 % thinned	RED	100		
			1	CRYLTANE AC PRIMER	PINK	80	100	
				On the site				
			1	CRYLTANE AC, top coat, gloss	***SEE APPENDIX 5***	60	80	240

SUPPLIER : LIBERT								
CODE	**APPLICATION**	**TYPE**	**NO. OF LAYERS**	**DESCRIPTION OF THE SYSTEM**	**COLOUR**	**DRY LAYER DEPTH IN MICRONS**		**TOTAL DRY LAYER DEPTH IN MICRONS**
						MIN	**MAX**	
L70	Non-ferrous metals and special steel (Alu., Inox...)	Polyurethane (2 components)	 1 1 1	Degreasing with trichloro-ethane 1.1.1. and clean Lithoform 2 Rinse off thoroughly and dry <u>Variant:</u> Degreasing with high-pressure steam CRYLTANE AC primer CRYLTANE AC primer CRYLTANE AC, top coat gloss	 RED PINK ***SEE APPENDIX 5***	 60 60 60	 80 80 80	 180
L81	Concrete floors Dry blast free of dust and oil	Polyurethane 1 component	 1 2	Light sandblasting - remove dust, wash off with warm soda (oil). Rinse and dry POLYFLOOR primer POLYFLOOR finish		 0,14-0,15L/m² 2 x 0,15 L/m²		
L85	Concrete floors Antislip idem L81	Polyurethane 1 component	 1 1 1	Light sandblasting - remove dust, wash off with warm soda (oil). Rinse and dry POLYFLOOR primer POLYFLOOR anti-slip POLYFLOOR finish		 0,14-0,15L/m² 2 x 0,15 L/m² 2 x 0,15 L/m²		
L90	Indoor Masonry, indoor concrete, bricks	Acrylate	1 1	RESACRYL A.F. thinned 10 % to 20 % RESACRYL A.F. not thinned		±0,15 L/m² ±0,2 L/m²		
L91	Outdoor Concrete and bricks	Acrylate	1 1	RESACRYL A.F. thinned 10 % to 20 % RESACRYL A.F. not thinned		±0,15 L/m² ±0,2 L/m²		
L92	Outdoor Damaged concrete and bricks	Acrylate	1 1 1	RESACRYL A.F. thinned 10 % to 20 % water LIBOQUARTZ RESACRYL A.F. not thinned		± 0,15 L/m² ± 0,8 L/m² ± 0,2 L/m²		

SUPPLIER : RIPOLIN BENELUX								
CODE	**APPLICATION**	**TYPE**	**NO. OF LAYERS**	**DESCRIPTION OF THE SYSTEM**	**COLOUR**	**DRY LAYER DEPTH IN MICRONS**		**TOTAL DRY LAYER DEPTH IN MICRONS**
						MIN	**MAX**	
RB01	Surfaces (up to 90°C) Sa3	Epoxy Polyurethane (2 components)	1 1 1	VIGOR ZN 302 VIGOR EP 235 VIGOR PU 801 ST	GREY-GREEN RED- BROWN ***SEE APPENDIX 5***	50 80 80	100 150 150	210
RB01a	Surfaces (up to 90°C) Sa3 or St3 Welding seams or repairs of system 01, 63 and stud bolts	Epoxy Polyurethane (2 components)	1 1 1	VIGOR EP 235 VIGOR EP 235 VIGOR PU 801 ST	RED- BROWN OCHRE BEIGE ***SEE APPENDIX 5***	80 80 80	150 150 150	240
RB02	Ground exit (see **Art. 18.5**) NETS Sa3 INSTALLATIONS St3	Epoxy + polyurethane (2 components)	 1 1 1 (1	see system 01a VIGOR EP 235 VIGOR EP 235 REINFORCED POLYESTER Polyken primer in case of PE) idem nets but with St 3 (removal of all existing paint)	 OCHRE BEIGE RED- BROWN	 80 80	 150 150	 80
RB03	Warm surfaces - with insulation (90° - 120° C) Sa 3 or St 3	Epoxy	1 1	VIGOR EP 235 VIGOR EP 235	RED- BROWN OCHRE BEIGE	80 80	150 150	160
	- without insulation (90° - 120° C) Sa 3 or St 3	Epoxy	1 1 1	VIGOR EP 235 VIGOR EP 235 VIGOR PU 801 ST	RED- BROWN OCHRE BEIGE ***SEE APPENDIX 5***	80 80 80	150 150 150	240
RB15	Pipelines in cellars	Epoxy	1	VIGOR ZN 302	GREY-GREEN	50	100	

	Sa 3		1 1	VIGOR EP 235 VIGOR EP 235	OCHRE BEIGE GREY	80 80	100 100	 210
	Pipelines in cellars St 3	Epoxy Epoxy - Tar	1 1 1	VIGOR EP 235 VIGOR EP 235 VIGOR EP 235	RED- BROWN OCHRE BEIGE GREY	80 80 80	100 100 100	 240

SUPPLIER : RIPOLIN BENELUX								
CODE	APPLICATION	TYPE	NO. OF LAYERS	DESCRIPTION OF THE SYSTEM	COLOUR	DRY LAYER DEPTH IN MICRONS		TOTAL DRY LAYER DEPTH IN MICRONS
						MIN	MAX	
RB21	New galvanisation in the workplace	Epoxy		(see art.2.5.2.) degreasing, clean and rinse with clean				
			1	water	WHITE-GREY	40	60	
			1	CENTREPOX PZ	*SEE APPENDIX 5*	80	150	120
				VIGOR PU 801 ST				
RB22	Galvanisation still in good condition (max. 10 % rust) St 3 or Sa 3	Epoxy		After degreasing with trichloro-ethane, clean with P2-Henkel and rinse with clean				
			1	water	WHITE-GREY	40	60	
			1	CENTREPOX PZ	OCHRE BEIGE	80	150	
			1	VIGOR EP 235	*SEE APPENDIX 5*	80	150	200
				VIGOR PU 801 ST				
RB33	Steel Sa3 or St 3	Vinyl Alkyd	1	FREITANYL HB PRIMER		60	100	
			1	FREITANYL HB MIO		60	100	
			1	FREITANYL HB Top coat		60	100	180
RB33 a	Repair of system RB33 Sa3 or St 3	Vinyl Alkyd	2	FREITANYL HB Top coat	*SEE APPENDIX 5*	50	70	100
RB41	Concrete plinths	Epoxy + Polyurethane		On metal after careful brushing				
			1	VIGOR EP 235	OCHRE BEIGE	80	150	
				On concrete after the correct preparation				
			1	ENDOKOTE 426.20		40	50	
				fill with epoxy mortar				
			1	FREITAGSOL EP250	*SEE APPENDIX 5*	5 mm		
			1	VIGOR PU 801 ST		80	150	
RB51	Chimney up to 400° C Sa 3	Zinc ethyl silicate		Metallisation ZINACOR 85/15		100		
			1	VIGOR ZN 304, 30% thinned		35	60	135
			1	damage: layer of ECOLZINC no. 2 after removal of the zinc salts on the site				

SUPPLIER : RIPOLIN BENELUX								
CODE	APPLICATION	TYPE	NO. OF LAYERS	DESCRIPTION OF THE SYSTEM	COLOUR	DRY LAYER DEPTH IN MICRONS		TOTAL DRY LAYER DEPTH IN MICRONS
						MIN	MAX	
RB51a	Chimney up to 600° C Sa 3 - rugosity: Rmax 50 µ	Silicone resin aluminium	2 1	Metallisation ALUMINIUM SUPERTHERMOVIT 600	SILVER GREY ALUMINIUM	120 25	 35	
			1	SUPERTHERMOVIT 600		20	30	190
RB63	Metallisation Sa 3 (rugosity : R max. 50 µ)	Epoxy + Polyurethane (2 components)		In the workshop. Metallisation ZINACOR 85/15		100		
			1	CENTREPOX PZ	WHITE-GREY	40	60	
			1	VIGOR EP 235	RED-BROWN	80	100	
				On the site				
			1	VIGOR PU 801 ST	***SEE APPENDIX 5***	40	60	260
RB70	Non-ferrous metals and special steel (Alu., Inox...)	Epoxy + Polyurethane		After degreasing with trichloro-ethane and rinse with clean water				
			1	CENTREPOX PZ	WHITE-GREY	40	50	
			1	VIGOR EP 235	RED-BROWN	80	150	
			1	VIGOR PU 801 ST	***SEE APPENDIX 5***	40	60	160
RB81	Concrete floors Dry blast free of dust and oil	Epoxy-phenol		For new floors: remove the surface milk-skin of the cement by a mechanical procedure For old floors : degrease and remove dust				
			1	SOLENDOKOTE 442.40 15% thinned		± 250 gr./m²		
			1	SOLENDOKOTE 442.40		± 250 gr./m²		

SUPPLIER : RIPOLIN BENELUX							
CODE	APPLICATION	TYPE	NO. OF LAYERS	DESCRIPTION OF THE SYSTEM	COLOUR	DRY LAYER DEPTH IN MICRONS	TOTAL DRY LAYER DEPTH IN MICRONS
						MIN / MAX	
RB85	Concrete floors Antislip idem RB81	Epoxy-phenol	 1 1	<u>For new floors:</u> remove the surface milk-skin of the cement by a mechanical procedure <u>For old floors :</u> degrease and remove dust For the use of anti-slip powder SOLENDOKOTE 442.40 15% thinned SOLENDOKOTE 442.40 The anti slip is obtained by anti slip powder min. 5% in the last layer		 ± 250 gr./m² ± 250 gr./m²	
RB90	Indoor masonry, concrete, stones inside buildings	Acrylate	 1 1 to 2	Before starting work take humidity measurements Thoroughly clean surface and remove dust Check all joints GUIPRIM adhesive coat, thinned RIPALO Facade		 ± 8 m²/kg ± 5 m²/kg	
RB91	Outdoor concrete and bricks outside	Acrylate	 1 1 to 2	Before starting work take humidity measurements Thoroughly clean surface and remove dust Check all joints GUIPRIM adhesive coat, thinned EUCRYL Facade		 ± 8 m²/kg 11-14 m²/kg	
RB92	Outdoor damaged concrete and bricks	Acrylate	 1 1 to 2	Before starting work take humidity measurements Thoroughly clean surface and remove dust. Check all joints RIPONOV adhesive coat, thinned RIPONOV		 ± 3 m²/kg ± 3 m²/kg	

SUPPLIER : SIGMA COATINGS N.V.

CODE	APPLICATION	TYPE	NO. OF LAYERS	DESCRIPTION OF THE SYSTEM	COLOUR	DRY LAYER DEPTH IN MICRONS		TOTAL DRY LAYER DEPTH IN MICRONS
						MIN	MAX	
S01	Surfaces (up to 90°C) Sa3	Epoxy and polyurethane (2 components)	1 1 1	SIGMACOVER ZN PRIMER SIGMACOVER CM MIOCOAT SIGMADUR HS SEMIGLOSS	CREAM BEIGE ***SEE APPENDIX 5***	60 70 70	80 150 100	200
S01a	Surfaces (up to 90°C) Sa3 or St3 Welding seams or repairs of system 01, 63 and stud bolts	Epoxy and polyurethane (2 components)	1 1 1	SIGMACOVER ALU PRIMER SIGMACOVER CM MIOCOAT SIGMADUR HS SEMIGLOSS	GREY BEIGE ***SEE APPENDIX 5***	70 70 70	200 150 100	210
S02	Ground exit (see **Art. 18.5**) NETWORKS Sa3 INSTALLATIONS St3	Epoxy + polyurethane (2 components)	 1 1 1 (1	see system 01a SIGMACOVER ALU PRIMER SIGMACOVER CM MIOCOAT REINFORCED POLYESTER Polyken primer in case of PE) idem Networks but with St3 (removal of all existing paint)	 GREY BEIGE	 70 70	 200 150	70
S03	Warm surfaces 90° C - 120°C Insulated Sa 3 - St 3	Epoxy	1 1	SIGMACOVER CM MIOCOAT SIGMACOVER CM MIOCOAT 9553	GREEN BEIGE	70 70	100 100	140
	Warm surfaces 90° C - 120°C Not insulated Sa 3 - St 3	Epoxy	1 1 1	SIGMACOVER ALU PRIMER SIGMACOVER CM MIOCOAT SIGMADUR HS SEMIGLOSS	GREY BEIGE ***SEE APPENDIX 5***	70 70 70	200 150 100	210
S15	Pipelines in cellars Sa 3	Epoxy (2 components)	1 1 1	SIGMACOVER ZN PRIMER CHEMIKOTE T BROWN CHEMIKOTE T BLACK	CREAM ***SEE APPENDIX 5***	40 100 100	100 180 180	240

	Pipelines in cellars St 3	Epoxy (2 components)	1 1 1	SIGMACOVER PRIMER CHEMIKOTE T BROWN CHEMIKOTE T BLACK	KHAKI ***SEE APPENDIX 5***	50 100 100	100 180 180	 250
S21	New galvanisation	Epoxy	 1 1	Degreasing and clean. Rinse with clean water and dry. SIGMACOVER PRIMER SIGMADUR HS SEMIGLOSS	 KHAKI ***SEE APPENDIX 5***	 50 70	 100 100	 120
S22	Galvanisation still in good condition (max. 10 % rust) St 3 or Sa 3	Epoxy	 1 1 1	Degreasing and clean. Rinse with clean water and dry. Remove rust from the rusted parts St 3 Retouch the derusted parts SIGMACOVER PRIMER SIGMACOVER PRIMER SIGMADUR HS SEMIGLOSS	 KHAKI KHAKI ***SEE APPENDIX 5***	 50 50 70	 100 100 100	 170
S33	Steel Sa3 or St 3	Vinyl Alkyd	1 1 2	VINYL ALKYD PRIMER 7023-2051 SIGMA VINYL MIO 7025-5051 SIGMA VINYL top coat 7027		40 40 40	70 70 70	 160
S41	Concrete plinths	Two components solvent-free	 1 1 1 1	Any repairs : abrade down to clean concrete and remove rust from steel to St 3 apply COLTURA PRIMER MAC to steel and concrete to be repaired after application of the still wet primer fill with COLTURA PRIMER EPU SIGMARITE WL PRIMER 30 % thinned with 91-92 SIGMACOVER CM MIOCOAT SIGMADUR HS SEMIGLOSS	 WHITE BEIGE ***SEE APPENDIX 5***	 70 70	 100 100	 grouting layer 140

S51	Chimneys 450° C Sa3			In the workshop Metallisation ZN 100 ZINACOR 85/15		100		
			1	SIGMASILGUARD MC, thinned 50% with 90-53		35	55	
				On the site Remove chloride by washing off with water to which a detergent has been added, with a hard brush				
			1	SIGMASILGUARD MC, 50 % thinned with 90-53		35	55	± 170
S51a	Chimneys up to 600° C Sa 3 - rugosity: Rmax 50 µ	Alu silicate	1	Metallisation Alu.		120		
			1	SIGMATERM SILICAAT ALUMINIUM		30		150
S63	Metallisation Sa 3	Epoxy (2 components)		In the workshop Metallisation ZN 100 ZINACOR 85/15		100		
	(rugosity : R max. 50 µ)		1	SIGMARITE SEALANT 20% thinned	GREEN	40	60	
			1	SIGMACOVER CM MIOCOAT	BEIGE	70	150	
		Polyurethane		On the site				
			1	SIGMADUR HS SEMIGLOSS	***SEE APPENDIX 5***	70	100	280
S70	Non-ferrous metals (Alu, Inox ...)	Epoxy (2 components)		Preparation Remove the oxidation layer with Deoxidiser 670 solution and. hard nylon brush. Rinse off to remove every trace of Deoxidiser. On the still wet surface, apply Alodine 1200* (ready for use) * Instructions Henkel				
			1	SIGMACOVER PRIMER	KHAKI	50	100	
		Polyurethane	1	SIGMACOVER CM MIOCOAT	BEIGE	70	150	
			1	SIGMADUR HS SEMIGLOSS	***SEE APPENDIX 5***	70	100	190

SUPPLIER : SIGMA COATINGS N.V.							
CODE	APPLICATION	TYPE	NO. OF LAYERS	DESCRIPTION OF THE SYSTEM		DRY LAYER DEPTH IN MICRONS	TOTAL DRY LAYER DEPTH IN MICRONS
						MIN MAX	
S81	Concrete floors Dry blast, free of dust and oil		 1 1	Below-ground free of dirt, dust, cement slag and other impurities SIGMARITE GP Finish, 20 % thinned with 91-92 SIGMARITE GP Finish		 yield 5 m²/L yield 5 m²/L	
S85	Concrete floors Antislip idem S81	Anti-slip paint	 1 1	Below-ground free of dirty, dust, cement slag and other impurities SIGMARITE GP Finish, 20 % thinned with 91-92 SIGMARITE GP Finish + 5 % anti-slip powder		 yield 5 m²/L yield 5 m²/L	
S90	Indoor masonry, concrete, bricks	PV acetate	2 to 3	SIGMATEX SUPERLATEX 1st layer 10 % thinned with water 1 or 2 layers unthinned		yield 10m²/L	
S91	Outdoor concrete and brick	Acrylate	1 2	SIGMAFIX UNIVERSAL 1/4 parts water SIGMACRYL FACADE		 yield 10m²/L	
S92	Outdoor damaged concrete and brick	Quartz finishing	1 2	SIGMAFIX UNIVERSAL 1/4 parts water KWARTSTONE		 400 gr/m²/low	

18.9. SURFACE AREA CALCULATIONS

The measurement statement must allow an estimate to be made of the quantities and/or surface area of the work carried out or yet to be carried out.

18.9.1. Pipes and fittings

The surface area per linear metre of the pipes is given in table 1. The equivalent length that must be taken into consideration for the calculation of the surface area of the fittings is given in table 2. Any fittings not mentioned in table 2 will not be considered for the supplementary equivalent length.

Cut-off valves and operators are mentioned in table 2. For a T-piece and a reducer, the largest nominal diameter will be considered. For smaller diameters not mentioned in the tables, the larger diameter will be considered.

18.9.2. Construction elements

I, L, T, U profiles

- the surface area of the profiles is given in table 3;
- profiles not mentioned will be calculated ;
- openings or off-cuts will be deducted if they exceed 50 % of the part considered.

18.9.3. Screw thread, nuts & bolts

The surface is the length of the screw thread and nut multiplied by a coefficient (see table 4).

TABLE 1

Nominal diameter INCH	Nominal diameter MM	Outside diameter MM	Surface area per linear M-M2
1	25	33.7	0.11
2	50	60.3	0.19
3	80	88.9	0.28
4	100	114.3	0.36
6	150	168.3	0.53
8	200	219.1	0.69
10	250	273	0.86
12	300	323.9	1.02
14	350	353.6	1.12
16	400	406.4	1.28
18	450	457	1.48
20	500	508	1.60
24	600	609.6	1.92
28	700	711.2	2.24
32	800	812.8	2.35

36	900	914.4	2.87
40	1000	1016	3.19
42	1050	1066	3.35
48	1200	1220	3.83
56	1400	1420	4.46
64	1600	1620	5.09
72	1800	1820	5.72
80	2000	2020	6.35

TABLE 2

Outside diameter MM from - up to	T- Piece	Flange Blind flange
6 - 50	0.30	0.3
65 - 200	0.75	0.5
250 - 2000	1.50	0.7

VALVES :

Outside diameter	DS-Surface area (m^2)
2"	0.38
3"	0.64
4"	0.83
6"	1.22
8"	1.58
10"	2.24
12"	2.65
14"	2.91
16"	3.33
20"	4.16
24"	4.99
28”	5.84
36"	7.46
40”	8.34

OPERATORS

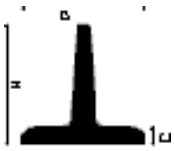
Outside diameter	DS-Surface area (m^2)
8"	2.64
10"	3.20
12"	3.31
14"	3.38
16"	3.72
20"	4.18
24"	4.65
28”	5.11
36"	6.05
40”	6.51

TABLE 3

U-PROFILES

Name	H x W (mm)	m² / m	m²/ton
	30 x 15	**0.103**	59.19
	30 x 33	**0.174**	40.74
	40 x 20	**0.142**	49.47
	40 x 35	**0.199**	40.86
	50 x 25	**0.181**	46.89
	50 x 38	**0.232**	41.50
	60 x 30	**0.215**	42.41
	70 x 40	**0.276**	41.02
UPN 8	80 x 45	**0.312**	36.10
UPN 10	100 x 50	**0.372**	35.10
UPN 12	120 x 55	**0.434**	32.40
UPN 14	140 x 60	**0.489**	30.60
UPN 16	160 x 65	**0.546**	29.--
UPN 18	180 x 70	**0.611**	27.80
UPN 20	200 x 75	**0.661**	26.10
UPN 22	220 x 80	**0.718**	24.40
UPN 24	240 x 85	**0.775**	23.30
UPN 26	260 x 90	**0.834**	22.--
UPN 28	280 x 95	**0.890**	21.30
UPN 30	300 x 100	**0.950**	20.60
	320 x 100	**0.982**	16.50
	350 x 100	**1.047**	17.30
	380 x 102	**1.110**	17.70
	400 x 110	**1.182**	16.50

SYMMETRICAL T-PROFILES

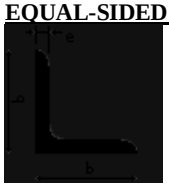


H x W	D	m² / m	m²/ton
15 x 15	3	**0.055**	84.60
20 x 20	3	**0.075**	85.20
25 x 25	3.2	**0.094**	72.90
30 x 30	4	**0.114**	64.40
35 x 35	4.5	**0.133**	57.10
40 x 40	5	**0.153**	51.70
45 x 45	5.5	**0.171**	46.60
50 x 50	6	**0.191**	43.--
60 x 60	7	**0.229**	36.80
70 x 70	8	**0.268**	32.20
80 x 80	9	**0.307**	28.70
90 x 90	10	**0.345**	25.70
100 x 100	11	**0.383**	23.40
120 x 120	13	**0.459**	19.80
140 x 140	15	**0.537**	17.20
160 x 160	15	**0.617**	17.20
180 x 180	18	**0.693**	14.30

ASYMMETRICAL T-PROFILES

H x W mm	D	m² / m	m²/ton
30 x 60	5.5	**0.171**	47.--
35 x 70	6	**0.201**	43.10
40 x 80	7	**0.233**	37.50
45 x 90	8	**0.258**	32.20
50 x 100	8.5	**0.287**	30.50
60 x 120	10	**0.345**	25.70
70 x 140	11.5	**0.402**	22.50
80 x 160	13	**0.460**	19.80
90 x 180	14.5	**0.518**	17.80
100 x 200	16	**0.576**	16.20

EQUAL-SIDED ANGLE IRONS



b x b (x e)	P Kg/m	Surface m²/m
20 x 20 x 3	0.88	**0.077**
x 4	1.14	
25 x 25 x 3	1.11	**0.097**
x 4	1.45	
x 5	1.78	
30 x 30 x 3	1.36	**0.116**
x 4	1.78	
x 5	2.18	
35 x 35 x 3	1.60	**0.136**
x 4	2.10	
x 5	2.57	
40 x 40 x 3	1.84	**0.155**
x 4	2.42	
x 5	2.97	
x 6	3.52	
45 x 45 x 3	2.09	**0.174**
x 4	2.74	
x 5	3.38	
x 6	4.00	
50 x 50 x 3	2.33	**0.194**
x 4	3.06	
x 5	3.77	
x 6	4.47	
x 7	5.15	
x 8	5.82	
60 x 60 x 4	3.70	**0.233**
x 5	4.57	
x 6	5.42	
x 8	7.09	
x 10	8.69	
70 x 70 x 5	5.37	**0.272**
x 6	6.38	
x 7	7.38	
x 8	8.36	
x 10	10.30	

EUROPEAN SERIES

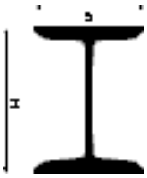
b x b (x e)	P Kg/m	Surface m²/m
80 x 80 x 6	7.34	**0.311**
x 7	8.49	
x 8	9.63	
x 10	11.90	
x 12	14.10	
90 x 90 x 6	8.31	**0.351**
x 8	10.90	
x 9	12.20	
x 11	14.70	
x 13	17.10	
100 x 100 x 6.5	9.98	**0.390**
x 8	12.20	
x 10	15.00	
x 12	17.80	
x 15	21.90	
120 x 120 x 8	14.70	**0.469**
x 10	18.20	
x 12	21.60	
x 15	26.60	
150 x 150 x 10	23.00	**0.586**
x 12	27.30	
x 15	33.80	
x 18	40.10	
180 x 180 x 15	40.90	**0.705**
x 18	48.60	
x 20	53.70	
200 x 200 x 16	48.50	**0.785**
x 18	54.20	
x 20	59.90	
x 24	71.10	

UNEQUAL-SIDED ANGLE IRONS **EUROPEAN SERIES**

b x a (x e)	P Kg/m	Surface m²/m
30 x 20 x 3	1.11	**0.097**
x 4	1.45	
x 5	1.78	
40 x 20 x 3	1.36	**0.117**
x 4	1.77	
x 5	2.17	
40 x 25 x 4	1.93	**0.130**
x 5	2.37	
45 x 30 x 4	2.25	**0.146**
x 5	2.77	
50 x 30 x 4	2.41	**0.156**
x 5	2.96	
x 6	3.51	
60 x 30 x 5	3.37	**0.175**
x 6	3.99	
60 x 40 x 5	3.76	**0.195**
x 6	4.46	
x 7	5.14	
65 x 50 x 5	4.35	**0.224**
x 6	5.16	
x 7	5.97	
x 8	6.75	
70 x 50 x 5	4.56	**0.233**
x 6	5.41	
x 7	6.25	
x 8	7.07	
75 x 50 x 5	4.74	**0.244**
x 6	5.63	
x 7	6.51	
x 8	7.39	
80 x 40 x 5	4.55	**0.234**
x 6	5.41	
x 7	6.25	
x 8	7.07	

b x a (x e)	P Kg/m	Surface m²/m
90 x 65 x 6	7.07	**0.300**
x 7	8.19	
x 8	9.28	
x 10	11.44	
100 x 50 x 6	6.85	**0.292**
x 7	7.93	
x 8	8.99	
x 10	11.1	
100 x 65 x 7	8.77	**0.350**
x 8	9.94	
x 9	11.1	
x 10	12.25	
100 x 75 x 8	10.6	**0.342**
x 10	13.0	
x 12	15.4	
120 x 80 x 8	12.2	**0.391**
x 10	15.0	
x 12	17.8	
130 x 65 x 8	11.9	**0.381**
x 10	14.6	
x 12	17.3	
150 x 75 x 9	15.36	**0.471**
x 10	17.0	
x 12	20.17	
150 x 90 x 10	18.2	**0.469**
x 12	21.6	
x 15	26.6	
200 x 100 x 10	23.0	**0.587**
x 12	27.3	
x 14	31.6	
x 16	35.9	

NORMAL I-PROFILES OF 80 MM AND MORE
EUROPEAN SERIES



Usual name	P Kg/m	H mm	B mm	Surface m²/m
IPN 8	5.95	80	42	**0.30**
IPN 10	8.32	100	50	**0.37**
IPN 12	11.2	120	58	**0.44**
IPN 14	14.4	140	66	**0.50**
IPN 16	17.9	160	74	**0.58**
IPN 18	21.9	180	82	**0.64**
IPN 20	26.3	200	90	**0.71**
IPN 22	31.1	220	98	**0.78**
IPN 24	36.2	240	106	**0.84**
IPN 26	41.9	260	113	**0.91**
IPN 28	48.0	280	119	**0.97**
IPN 30	54.2	300	125	**1.03**
IPN 32	61.1	320	131	**1.09**
IPN 34	68.1	340	137	**1.15**
IPN 36	76.2	360	143	**1.21**
IPN 38	84.0	380	149	**1.27**
IPN 40	92.6	400	155	**1.33**
IPN 42.5	104	425	163	**1.41**
IPN 45	115	450	170	**1.48**
IPN 47.5	128	475	178	**1.55**
IPN 50	141	500	185	**1.63**
IPN 55	167	550	200	**1.80**

SYMMETRICAL IPE PROFILES

Usual name	P Kg/m	H mm	B mm	Surface m²/m
IPE 80	6.00	80	46	**0.33**
IPE 100	8.10	100	55	**0.40**
IPE 120	10.4	120	64	**0.48**
IPE 140	12.9	140	73	**0.55**
IPE 160	15.8	160	82	**0.62**
IPE 180	18.8	180	91	**0.70**
IPE 200	22.4	200	100	**0.77**
IPE 220	26.2	220	110	**0.85**
IPE 240	30.7	240	120	**0.92**
IPE 270	36.1	270	135	**1.04**
IPE 300	42.2	300	150	**1.16**
IPE 330	49.1	330	160	**1.25**
IPE 360	57.1	360	170	**1.35**
IPE 400	66.3	400	180	**1.47**
IPE 450	77.6	450	190	**1.61**
IPE 500	90.7	500	200	**1.74**
IPE 550	106	550	210	**1.88**
IPE 600	122	600	220	**2.01**

PROFILES WITH WIDE PARALLEL FLANGES

EUROPEAN PROFILES: EURONORM 53-62

No. of profile profile	Name	P Kg/m	H mm	B mm	Surface m^2/m
10	HE 100 A	16.7	96	100	**0.561**
	HE 100 B	20.4	100	100	**0.567**
	HE 100 M	41.8	120	106	**0.619**
12	HE 120 A	19.9	114	120	**0.677**
	HE 120 B	26.7	120	120	**0.686**
	HE 120 M	52.1	140	126	**0.738**
14	HE 140 A	24.7	133	140	**0.794**
	HE 140 B	33.7	140	140	**0.805**
	HE 140 M	63.2	160	146	**0.857**
16	HE 160 A	30.4	152	160	**0.906**
	HE 160 B	42.6	160	160	**0.918**
	HE 160 M	76.2	180	166	**0.970**
18	HE 180 A	35.5	171	180	**1.024**
	HE 180 B	51.2	180	180	**1.037**
	HE 180 M	88.9	200	186	**1.089**
20	HE 200 A	42.3	190	200	**1.136**
	HE 200 B	61.3	200	200	**1.151**
	HE 200 M	103.0	220	206	**1.203**
22	HE 220 A	50.5	210	220	**1.255**
	HE 220 B	71.5	220	220	**1.270**
	HE 220 M	117.0	240	226	**1.322**
24	HE 240 A	60.3	230	240	**1.369**
	HE 240 B	83.2	240	240	**1.384**
	HE 240 M	157.0	270	248	**1.460**

PROFILES WITH WIDE PARALLEL FLANGES **SPECIAL PROFILES: COLUMNS**

Name	P Kg/m	H mm	B mm	Surface m²/m
HD 100 x 15	14.9	96.5	100.0	**0.564**
x 20	19.6	101.6	100.0	**0.573**
x 24	23.8	103.0	102.0	**0.579**
HD 130 x 20	20.3	124.0	128.0	**0.729**
x 24	23.8	127.0	127.0	**0.737**
x 28	27.5	130.0	127.6	**0.744**
x 33	33.2	125.0	123.0	**0.705**
HD 160 x 30	29.96	157.0	155.0	**0.896**
x 35	34.87	160.0	156.0	**0.904**
x 40	39.82	163.0	157.0	**0.912**
x 46	46.06	167.0	158.0	**0.922**
HD 210 x 43	43.45	201.0	204.0	**1.174**
x 50	49.85	204.0	205.0	**1.182**
x 56	56.31	207.0	206.0	**1.190**
x 63	62.81	210.0	207.0	**1.198**
x 71	70.99	214.0	208.0	**1.208**
x 83	82.39	219.0	210.0	**1.222**
x 94	94.25	225.0	211.0	**1.236**
x 117	116.59	235.0	213.0	**1.256**
x 139	139.12	245.0	216.0	**1.283**
x 162	162.02	255.0	219.0	**1.308**
x 200	200.22	271.0	225.0	**1.356**
x 252	251.53	291.0	232.0	**1.410**
HD 260 x 60	59.99	248.0	253.0	**1.452**
x 68	67.92	251.0	254.0	**1.460**
x 78	77.89	255.0	255.0	**1.470**
x 90	89.94	260.0	256.0	**1.482**
x 104	104.15	265.0	258.0	**1.496**
x 121	120.56	271.0	260.0	**1.512**
x 141	141.15	278.0	262.0	**1.530**
x 160	160.15	286.0	264.0	**1.550**

Name	P Kg/m	H m	B mm	Surface m²/m
HD 260 x 240	240.37	314	273	**1.625**
274	273.76	326	276	**1.654**
333	333.39	346	282	**1.707**
HD 310 x 94	93.91	306	305	**1.767**
106	105.92	310	306	**1.777**
118	117.99	314	307	**1.787**
135	135.05	319	309	**1.801**
155	154.71	325	311	**1.817**
177	177.00	332	313	**1.835**
207	207.15	341	316	**1.859**
240	240.23	351	319	**1.885**
274	273.77	361	322	**1.912**
308	307.79	371	325	**1.938**
350	350.43	383	329	**1.970**
435	434.78	407	336	**2.032**
HD 360 x 135	135.18	355	369	**2.117**
152	152.49	360	370	**2.129**
176	175.67	366	372	**2.145**
199	199.03	372	374	**2.161**
HD 400 x 190	190.04	369	391	**2.226**
214	214.34	375	393	**2.242**
237	237.10	381	394	**2.255**
262	261.74	387	396	**2.271**
287	286.56	393	398	**2.287**
312	311.57	399	400	**2.303**
337	336.77	405	402	**2.319**
370	370.48	413	405	**2.342**
404	403.78	421	407	**2.361**
446	445.88	431	410	**2.387**
488	488.45	441	413	**2.413**
531	531.49	451	416	**2.439**
577	577.37	461	420	**2.468**

x 184	183.66	294.0	267.0	**1.573**
x 209	209.47	302.0	270.0	**1.595**

621	621.43	471	423	**2.494**
679	678.56	481	426	**2.510**

TABLE 4

Diameter of screw thread INCHES up to	Diameter of screw thread MM up to	Coefficient
1	25	20
1 1/4	32	25
1 1/2	40	30
2	50	40

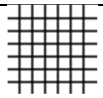
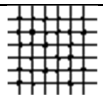
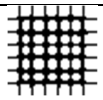
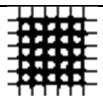
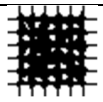
* * *

APPENDIX 1 - adhesion tests

ADHESION TEST ON COATINGS BY MEANS OF THE GRID TEST

DIN 53 151
ISO 2409

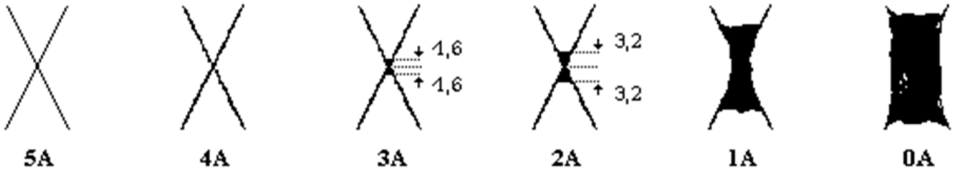
ASTM D3359-B
BS 3900-E6

Description	Surface of the gridded area that is peeling. (Example for 6 grooves)	Classification DIN	Classification ASTM
The sides of the cuts are completely smooth. Not one square in the grid pattern has come loose.		**0**	**5B**
Small coating particles have come loose at the cutting points. Less than 5% of the surface is affected.		**1**	**4B**
Small coating particles have come loose along the sides and at the corners of the cuts. 5 to 15% of the surface is affected.		**2**	**3B**
The coating crumbles away along the sides of the cuts and on parts of the little squares. 15 to 35% of the surface is affected.		**3**	**2B**
Much of the coating crumbles away along the sides of the cuts and complete squares have peeled loose. 35 to 65% of the surface is affected.		**4**	**1B**
Crumbling and peeling to a greater extent than that of DIN4	More than 65% has peeled.	**5**	**0B**

Carrying out the GRID test

- For dry coating layer less than 50 μm, a Cross-Cut blade is used with a distance between blades of 1 mm. For coating layer larger than 50 μ, a Cross-Cut blade should be used with an interspacing of 2 mm.
- The application of incisions is carried out in two stages, each in one continuous movement. First a cut of ± 20 mm is made, followed by a second cut of about the same length but at 90 degrees to the direction of the first incision.
- The grid pattern is then rubbed away with a soft brush or cloth. The result is subsequently compared with the table above.
- If this work is carried out in accordance with ASTM D3359-87, a piece of adhesive tape specified in accordance with that standard will then be applied to the grid pattern and peeled off.

TABLE Cross Cut Adhesion Test (acc. to ASTM)



APPENDIX 2 WORK METHOD FOR REINFORCED POLYESTER

- Information about the product
  - is a polyester coating in rolls;
  - is a plastic easy to work with, reinforced with glass fibre (G.R.P.);
  - is made in sheets and delivered as standard in 10 m x 2 mm rolls;
  - in its untreated form is extremely flexible; it can be cut to any shape or in accordance with the required format; it can then be fashioned, adapted, rolled up, rolled out and/or fitted to practically any object or surface;
  - when exposed to UV light, it begins to harden after a few minutes and will become hard over a period of a few hours;
  - once hardened is:
    - an extremely strong and inalterable material with an exceptional lifetime and good resistance to heat;
    - waterproof;
    - resistant to a large number of acids, chemical products and solvents;
  - offers numerous possibilities:
    - clean, safe and extremely easy to use;
    - quality always guaranteed;
    - maintains its strength, weight and lifetime;
    - has a resistance stronger than UV;
    - minimum waste.
- Painting firms

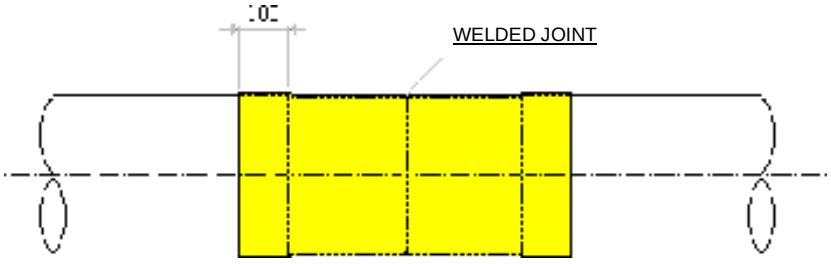
  Paint appliers :
  - must be officially recognised and registered;
  - must be known and given a permit by DuPol Benelux;
  - once registered and given a permit, they will undergo training by the instructors of DuPol;
  - after the training and practical experience, they will be taken on as “recognised appliers of reinforced polyester”;
  - every year an assessment will take place regarding the working method used and the knowledge developed with reinforced polyester.

  Application
  - requires the use of suitable tools and accessories of good quality, such as:

- cutting table;
- ruler;
- universal knife and scissors;
- cutting machine safety bar;
- pressing roll;
- wide transparent adhesive tape;
- thick black polyethylene film.

- he application of reinforced polyester may only be carried out in dry weather with a minimum temperature of ± 5ºc;
- the site must always be protected from direct sunlight;
- it is highly advisable to cut reinforced polyester beforehand to the required sizes (protected from sunlight);
- unused reinforced polyester must immediately be protected from sunlight by means of the thick black polyethylene film.

- On new steel pipes
  - clean the steel surface to be treated by sandblasting Sa3;
  - protect the site from direct sunlight;
  - apply a layer of reinforced polyester having the width of the surface to be treated with a longitudinal and transversal overlap of 100 mm; press hard and/or roll all over these overlaps (see drawing: the dotted section represents the reinforced polyester);



  - fix the applied reinforced polyester with wide transparent adhesive tape;
  - exposed to sunlight, reinforced polyester will harden in ± 20 min.;
  - in the absence of sunlight, UV lamps may be used (min 300 W); the hardening time will then be a little longer;
  - after hardening, remove the transparent adhesive tape;

- for increased protection, it is recommended to use UV resin (UVH-100) on the transversal and longitudinal overlaps;
- use UV resin (UVH-100) beforehand for jointing with already hardened reinforced polyester.

- On existing steel pipes (after sandblasting)
  - remove the old coating;
  - sandblast Sa3 to check the condition of the surface;
  - repair or replace the metal, if necessary;
  - derust manually to St3;
  - apply a layer of ALUTEC and/or PRIMER (D400);
  - protect the site against sunlight;
  - after drying, apply reinforced polyester over the width of the surface to be treated with an overlap of 100 mm; press hard and/or roll all over these overlaps;
  - spread the extremities with UV resin (UVH-100);
  - fix the applied reinforced polyester with wide transparent adhesive tape;
  - exposed to sunlight, reinforced polyester will harden in ± 20 min.;
  - in the absence of sunlight, UV lamps may be used (min 300 W); the hardening time will then be a little longer;
  - use UV resin (UVH-100) beforehand for jointing with already hardened reinforced polyester.
- Existing steel pipes (without sandblasting)
  - do not remove the old coating, but do remove dust;
  - apply 1 layer of PRIMER (D400);
  - protect the site from direct sunlight;
  - after drying (± 1 to 1 ½ hours), apply reinforced polyester over the width of the surface to be treated with an overlap of 100 mm; press hard and/or roll all over these overlaps;
  - spread the extremities with UV resin (UVH-100);
  - fix the applied reinforced polyester with wide transparent adhesive tape;
  - exposed to sunlight, reinforced polyester will harden in ± 20 min.;
  - in the absence of sunlight, UV lamps may be used (min 300 W); the hardening time will then be a little longer;
  - use UV resin (UVH-100) beforehand for jointing with already hardened reinforced polyester.
- Concrete

- clean the surface to be treated and, if necessary, smooth it;
- apply 1 layer of PRIMER (D400);
- protect the site from direct sunlight;
- after drying (± 1 to 1 ½ hours), apply reinforced polyester over the width of the surface to be treated with an overlap of 50 mm;
- press hard and/or roll over the reinforced polyester;
- it is recommended to use UV resin (UVH-100) and vulcanising on the overlaps for a better seal before applying the next layer of reinforced polyester;
- exposed to sunlight, reinforced polyester will harden in ± 20 min.;
- in the absence of sunlight, UV lamps may be used (min 300 W); the hardening time will then be a little longer;
- use UV resin (UVH-100) beforehand for jointing with already hardened reinforced polyester.

APPENDIX 3 PAINTWORK - DAILY REPORT

Supervisor _____ Hours worked: by supervisor _____
Activity: _____ Hours worked on site : _____

General weather conditions: Dry □ Humid □ Rain □

Site personnel	Number	Hours

Site equipment	Number	Hours

WEATHER CONDITIONS								
TIME	Td	Th	RH	DP	Tobj	ΔT	OK	NOK

Ts : Temperature dry - Th : Temperature humid - RH :Relative humidity - DP :Dew point - Tobj : Temperature of object - ΔT : Tobj - DP

COMMENTS: The paintwork was only started when the weather conditions were acceptable.

Humidity and temperature were continuously measured during and after execution of the work

R102 C45-N Blad 1/2

OWNER / Material - Paintwork - Daily report

Object		Preparation of surface**		Layers & Depths		Paint used	Paint system
Pipe	☐	Sa 3	☐	❶	μm		
Shut-off valve	☐	St 2	☐	❷	μm		
Filter	☐	Dgr	☐	❸	μm		
....	☐	None	☐	❹	μm		
Pipe	☐	Sa 3	☐	❶	μm		
Shut-off valve	☐	St 2	☐	❷	μm		
Filter	☐	Dgr	☐	❸	μm		
....	☐	None	☐	❹	μm		
Pipe	☐	Sa 3	☐	❶	μm		
Shut-off valve	☐	St 2	☐	❷	μm		
Filter	☐	Dgr	☐	❸	μm		
....	☐	None	☐	❹	μm		
Pipe	☐	Sa 3	☐	❶	μm		
Shut-off valve	☐	St 2	☐	❷	μm		
Filter	☐	Dgr	☐	❸	μm		
....	☐	None	☐	❹	μm		
Pipe	☐	Sa 3	☐	❶	μm		
Shut-off valve	☐	St 2	☐	❷	μm		
Filter	☐	Dgr	☐	❸	μm		
....	☐	None	☐	❹	μm		

** SA3 = Sand-blasted - St2 = Rust removed manually - Dgr = Degreased

Supplementary notes in appendix (Second page of Daily Report - Form C42N) *Yes* ☐ *No* ☐

SUPERVISOR - DS	**OPERATOR**
Name & Signature	Name & Signature

Copies:

WHITE : Operator
YELLOW : Supervisor
PINK: Person in charge of Works

C45-N BLAD 2/2

APPENDIX 4. ATMOSPHERIC CONDITIONS

- No paintwork may be carried out if the atmospheric conditions are not suitable.

- To obtain the best results when carrying out paintwork, it is of essential importance that no condensation appears on the cleaned or blasted surface or between the different layers.

For this reason, the temperature of the surface to be painted should be at least 3º higher than the dew point or condensation temperature of the ambient air. In the table below, the dew point of the air is given for a number of conditions of air temperature and relative humidity. Correlation between relative humidity, air temperature and dew point

Air temp. °C	Dew point in ºC with a relative humidity of :								
	50%	55%	60%	65%	70%	75%	80%	85%	90%
5	-4.1	-2.9	-1.8	-0.9	0.0	0.9	1.8	2.7	3.6
6	-3.2	-2.1	-1.0	-0.1	0.9	1.8	2.8	3.7	4.5
7	-2.4	-1.3	-0.2	0.8	1.8	2.8	3.7	4.6	5.5
8	-1.6	-0.4	0.8	1.8	2.8	3.8	4.7	5.6	6.5
9	-0.8	0.4	1.7	2.7	3.8	4.7	5.7	6.6	7.5
10	0.1	1.3	2.6	3.7	4.7	5.7	6.7	7.6	8.4
11	1.0	2.3	3.5	4.6	5.6	6.7	7.6	8.6	9.4
12	1.9	3.2	4.5	5.6	6.6	7.7	8.6	9.6	10.4
13	2.8	4.2	5.4	6.6	7.6	8.6	9.6	10.6	11.4
14	3.7	5.1	6.4	7.5	8.6	9.6	10.6	11.5	12.4
15	4.7	6.1	7.3	8.5	9.5	10.6	11.5	12.5	13.4
16	5.6	7.0	8.3	9.5	10.5	11.6	12.5	13.5	14.4
17	6.5	7.9	9.2	10.4	11.5	12.5	13.5	14.5	15.3
18	7.4	8.8	10.2	11.4	12.4	13.5	14.5	15.4	16.3
19	8.3	9.7	11.2	12.3	13.4	14.5	15.5	16.4	17.3
20	9.3	10.7	12.0	13.3	14.4	15.4	16.4	17.4	18.4
21	10.2	11.6	12.9	14.2	15.3	16.4	17.4	18.4	19.3
22	11.1	12.5	13.8	15.2	16.3	17.4	18.4	19.4	20.3
23	12.0	13.5	14.8	16.1	17.2	18.4	19.4	20.3	21.3
24	12.9	14.4	15.7	17.0	18.2	19.3	20.3	21.3	22.3
25	13.8	15.3	16.7	17.9	19.1	20.3	21.3	22.3	23.2
26	14.8	16.2	17.6	18.8	20.1	21.2	22.3	23.3	24.2
27	15.7	17.2	18.6	19.8	21.1	22.2	23.2	24.3	25.2
28	16.6	18.1	19.5	20.8	22.0	23.2	24.2	25.2	26.2
29	17.5	19.1	20.5	21.7	22.9	24.1	25.2	26.2	27.2
30	18.4	20.0	21.4	22.7	23.9	25.1	26.2	27.2	28.2

From this table we can deduce that paintwork may not be carried out when the relative humidity of the air is higher than 80% (in theory 82%). With an air humidity of 82% and higher, the temperature of the steel surface should be higher than the air temperature.

Application of the paint is also not permitted if there is a danger that the film of paint will not be dry before dew, condensation or frost sets in.

APPENDIX 5 colour code

COLOUR CODE				
COMPRESSION STATIONS				
DESCRIPTION	COLOUR	RAL CODE		
High-pressure gas	White	RAL 9010		
Low-pressure gas	Orange	RAL 2003		
Surplus gas burners	Yellow	RAL 1004		
Fire extinguishers	Red	RAL 3000		
Air	Blue	RAL 5009		
Water	Green	RAL 6010		
Oil	Brown	RAL 8003		
Valves – devices	Grey	RAL 7038		
Supports	Black	RAL 9005		
Doors	Dark blue	RAL 5010		

PRESSURE REGULATING				
Pipes - valves Supports etc.	Grey	RAL 7038		
Fences, doors	Green	RAL 6020		
High-pressure arrow	Red	RAL 3000		
Low- or medium-pressure arrow	Orange	RAL 2003		

HORIZONTAL DIRECTIONAL DRILLING

GENERAL TECHNICAL SPECIFICATION

Rev.	Date	Subject of revision	Author	Checked	Approved
4	14/09/09	Logo Changed	SS	DNS	NC
3	24/03/08	Logo Changed	SS	DNS	NC
2	16/04/04	Logo Changed	MRT	DKB	MRY
1	15/06/00	First Issue	MRT	DKB	LEP

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✳ ✳ ✳

1. GLOSSARY

Consultant	the Engineering Company appointed by the Owner for the design of the Project.
Contractor	The specialised construction company that will be granted the contract by the Owner to implement the HDD.
DP	The Design Pressure as specified in the PTS.
GTS	General Technical Specification.
HDD	Horizontal Directional Drilling.
MOP	The Maximum Operating Pressure as specified in the PTS.
ND	The Nominal Diameter of the pipeline as specified in the PTS.
Owner	Shall have the meaning as defined in the PTS.
Project	Is specified in the PTS
PTS	Particular Technical Specifications.
SITE	Means the location where the Contractor has to perform the work.
Third Party Inspection	Agency specially appointed by the Owner to perform Quality Controls and Certification.

2. GENERALITIES

2.1. SCOPE OF THE GTS

The present GTS intends to define the nature of the works to be performed by a Contractor for the design and the construction of a gas pipeline at particular major obstacle crossing point using the HDD method (Horizontal Directional Drilling).

2.2. SCOPE OF THE CONTRACTOR

Otherwise specified under the PTS the mission of the Contractor shall include all the required tasks necessary to built a gas pipeline string across a major obstacle using the HDD method.

These tasks can be summarised as follow (non-limited)

- The Contractor shall provide and pay for all labour, materials, tools, equipment machinery, water, electricity, utilities, transportation, installation of other facilities and services necessary for the proper execution and completion of the works. The Contractor shall be fully in charge with the dismantling and eventually the repatriation of the equipment etc…

- The Contractor shall pay any duty tax, load and unload port duties, temporary import taxes etc… for all the equipment mentioned above.

- The Contractor shall be fully responsible for all means, methods, techniques, sequences and procedures and for the co-ordination of all operations of the work under contract.

- Contractor shall verify accurately the data provided and proceed to all additional tests or surveys (Topographic - Hydrological - Geological - etc.) he feels necessary to implement its works.

- The Contractor shall perform all engineering activities that are needed to complete the basic documentation provided by the Owner; in particular, it shall not neglect to proceed to all engineering - detailed engineering - stress calculations - etc. as necessary.

- The Contractor is deemed to have considered and accepted all the risks involved in his task.

- The Contractor shall make all necessary arrangements for the hiring of the labour (local or not) and care for their payment. He will take care of all the expenses relating to accommodation, transportation and subsistence for the staff.

- The work will be supervised by competent staff who speaks at least the official language (specify in the PTS) of the concerned country.

- The Contractor will execute all the required tasks including the welding of the pipeline by qualified welders specified in the contract and the PTS in conformity with the relevant code and standard.

- Traceability
  Due attention of the Contractor is drawn to the absolute necessity to keep detailed trace of all equipment subjected to pressurised gas.

2.3. <u>SUPPLIES</u>

- Except otherwise stated in the PTS the line pipe elements and fittings will be directly supplied at the work-site by other.

- The Contractor will provide all the necessary consumable to built the pipeline.

- During the works, the Contractor must procure and maintain the installation and equipment which are necessary for the functioning of the workshop and additional equipment.

- The Contractor shall make all the necessary arrangements to cater for an uninterrupted supply of fuel, lubricant, electricity, water, telephone, etc… during the work.

2.4. SITE LOCATION

The exact location of the work site as well as the access road will be specified in the PTS

2.5. Geographical Co-ordinates

The local official system of co-ordinates that is in force in the concerned country will be used for all activities related to survey, drawings, alignment sheet, geographical information, measurements, etc…

3. LAWS - CODES - RULES & STANDARDS

3.1. GENERAL

Basically, the following is applicable :

- asic Laws - Codes - Rules & Standards, mandatory by law in the country concerned.
- The present GTS as amended from time to time by attached PTS;
- Peculiar Codes & Standards as per Section 3.2.
- The "Rules of good Practice" commonly used by the world-wide gas industry;
- The "Rules of Art" and "Sound Practices" of the Engineer.
- in general the HDD has to be built in accordance with the best states of Engineering practice.

In case of contradiction, the above shall prevail in descending order of precedence.

3.2. PECULIAR CODES & STANDARDS

The Codes - Rules and Standards applicable in specific cases are listed under a separate PTS.

Except if otherwise specified in the PTS, the following shall serve as basis :

- ASME B.31.8 "Gas Transmission and Distribution Piping Systems" - Last edition and all Codes it refers to.
- Codes - Rules and Standards that are already mandatory at European level.

- European standards that are still in project but under final clean-up before final approved (referenced "pr EN number") shall be assimilated.

Except if otherwise specified in the PTS, in case of contradiction, the most stringent of the present GTS and the above shall be applied.

4. GEOLOGICAL DATA

The owner has performed hydrological and geological surveys.
The final report is appended to the PTS.

These data are given for indicative purpose.

It is the responsibility of Contractor to proceed, at its costs, to any additional surveys that it deems necessary.

5. RIGHTS OF WAY AND WORK SPACE

5.1. WORK SPACE

The minimum temporary working space allocated to Contractor by the Owner is :

- 75 m x 75 m at the drilling site
- 50 m x 50 m at the opposite site.

A working space of 15 m wide will be granted to built and test the pipeline string.

Prior to any HDD activity or pipeline construction work the top soil will be removed and keep in stock apart from the subsoil for reinstatement purpose.

If the drilling points (entry/exit) are located below the highest river water level, the Contractor shall protect the drilling points by creating a dyke 50 cm minimum above the highest recorded water level.

The temporary access road to the work sites will be determine jointly by the Owner and the Contractor and granted by the Owner.

The cost of improvement or execution of temporary accesses will be born by the Contractor.

5.2. RIGHTS OF WAY

The working space and the site location is specified in the PTS.

The right to use the specified working space will be granted by the Owner.

Should Contractor require more space, it will be Contractor's responsibility to negotiate such additional space in close co-ordination with the Owner. Contractor shall support all relevant costs.

6. DRILLING PROFILE

The Owner will provide (annexed to the PTS) a basic profile drawing and the constraints and particularities of the obstacle to be crossed.

The Contractor shall specify and submit to the Owner for approval his final profile and the different parameters or their limited value which define the location and configuration of the drilled path.

These parameters are:

- entry point
- exit point
- entry angle
- exit angle
- PI elevation
- radius of curvature.

It is acceptable that the entry and exit will vary from the design proposed location. They have to be located inside an area (5 x 10 m) centred around the proposed location, 10 m shall be measured parallel to the HDD alignment.

Except if otherwise specified in the PTS, the minimum radius shall be not less than 1 000 times the Nominal Diameter(**ND**).

The predetermined theoretical profile shall be closely adhered to when drilling the pilot hole. The permitted deviation shall not exceed 2 m laterally and 1 m vertically from the approved theoretical profile.

7. DOCUMENTS TO BE SUPPLIED BY THE CONTRACTOR

the Contractor will supply with his tender the different documents listed here below.

- Key staff organisation chart.
- curriculum vitae of his key staff
- Project reference list regarding similar HDD works he carried out in the past 5 years.
- A complete description of the anti-corrosion pipe wraps he intends to use for pipeline field joints and repairs.

- A description of the major drilling equipment as
  - Drill rig specification
  - Maximum dynamic torque
  - Pull back capacity
  - Drilling fluid trailer tank specification
  - Control cab
  - Pipe racks
  - Workshop
  - Generators
  - Positioning system
  - Drilling head
  - Ancillary equipment.
- A complete description of the directional drilling working method as:
  - The positioning record system and procedure
  - Drilling of the pilot hole and wash over pipe.
  - Hearing operation (type and size of the reamer)
  - Mix compound of the bentonite mud.
  - Soil cuttings/Bentonite mud separation and treatment process and reuse of the Bentonite.
  - Pipeline pull back operation.
  - Alignment and positioning of the pipe string.
  - Rollers support used. The support will be designed so as not to damage the pipe coating.
  - Detail drawing showing the theoretical profile, the final design profile, the position of the pipe string (with support arrangement) before pull back operation and the location of the bends if any.
  - Detailed Time-schedule.
  - On site working-time.

- The method he intends to use for controlling the integrity of the pipeline coating as well as "anti-corrosion" pipe-wraps.

- The method he intends to use for verification of the pipeline final profile after the pull-back operations.

8. PIPELINE CALCULATION

The Contractor will submit for approval to the Owner and Third Party Inspection agency the stress calculation as described in the Deutsche standard NEN 3650 and NEN 3651 or equivalent.

The following phases should be analysed in the pipeline design process :

- predisposition of the launching catenary :

  Before the pulling operation, the pipeline is outside the bore-hole and has a onfiguration which allows it to enter the hole. During this phase, the only bending moment is due to the curvature of the catenary and the weight. The pipeline should be designed so that it behaves elastically.

- pull-back operation :

  In this phase the pipeline will be pulled back through the bore-hole. The following forces should be considered :

  - bending moment due to curvature of the hole;

  - friction force between the pipe and drilling mud including the friction due to extra cables/sleeves attached to the string;

  - friction force inside the hole, at the location where the soil reaction occurs;

  - stress due to soil reaction;

  - the Contractor will specify the means he intends to use in order to reduce the friction during the pull-back operation.

  The resultant stress should be calculated and the pipeline designed to behave elastically.

- operating conditions :

  In this phase the loads acting on the pipeline are :

  - bending moment due to curvature of the hole;

  - internal pressure of the gas;

  - temperature difference of the line between the pipe-laying and operating conditions;

- dead loads

  Vertical soil load at the top of the pipe can be calculated for different pipe laying conditions.

- for pipeline with ND > 500 mm the Contractor shall specify the ballasting method he intends to use to limit the friction during pull-back.

The following effects should be combined for the purposes of calculating the resultant stress :

- calculated longitudinal effects on the entire pipeline system;
- calculated effects on the cross-section of the pipeline.

The stress/strain shall not exceed the relevant allowable stress.

The effects of soil load on the cross-section of the pipe may be analysed. This analysis should be carried out at the deepest point reached in drilling.

9. DOCUMENTS TO BE SUPPLIED BY THE CONTACTOR BEFORE AND DURING THE EXECUTION OF THE HDD AND AFTER HIS COMPLETION

9.1. BEFORE AND DURING THE HDD EXECUTION

- Before the pull-back operation the Contractor will submit for approval to the Owner the final profile of the HDD including any deflexion of the drilling head. The Contractor can start the pull-back operation only after the Owner approval.

  This document needs to demonstrate that after completion (operating condition) and under internal pressure (MOP and test pressure), soil load and hydrostatic load the section of the pipeline will not have a radius of curvature smaller than those permitted by the design.

  The document shall also indicate the pulling force on the pipe at the beginning, during and at the end of the process and the rate of progress of the pipe.

- During the different execution phases of the HDD the Contractor will record all the information regarding the different operations which includes, among others :

  - the measurements of mud pressure, mud flow rate, pulling force, X-Y-Z of the drill head recorded during drilling and any other relevant statistics.

  - stand-off during operations and the reasons thereof

9.2. AFTER THE HDD EXECUTION

After completions of the HDD the Contractor will transmit to the Owner the horizontal drilling operation record of the relevant activities which includes.

- Concerning the drilling mud
  - quantity of mud used;
  - mud pressure (at the drilling)
  - the density of the drilling fluid and soil cuttings;
  - the localisation of storage site for the waste from the drilling operation and the measures taken to comply with environmental constraints.
- During drilling operation (per drill pipe element)
  - the maximum force applied (push/pull/torque);
  - time duration for assembling 2 elements;
  - the drilling head position in X-Y-Z- co-ordinates;
  - deviation compared to the required position;
  - the proposed corrective measures.
- During drill pipe pull-back (per drill pipe element)
  - pull-back duration per element;
  - maximum pulling force per element.
- An alignment sheet with length profile of the pipeline (scale 1/500) showing the location of each weld joint and their X-Y-Z co-ordinates.
- An official certificate concerning the discharge of the drilling operations tailings approved by the relevant Authorities.

10. CONTROLS

10.1. GENERAL

Prior to any control on site, the overall procedure for weld examination, cleaning, pre-testing, testing, de-watering, etc… shall be submitted to the Owner and the Third Party Agency for approval.

The approved control procedure shall be carried out under the supervision of the Third Party Agency.

10.2. WELD EXAMINATION

All welds shall be inspected non-destructively (Radiographic and ultrasonic testing) in accordance with the requirements of the selected and approved standard for welding.

10.3. COATING

Immediately after the pull-back operation an expert in cathodic protection from the Contractor or his sub-contractor (accepted by the Owner) will control the pipeline external coating. The impressed current needs for the unconnected pipeline string will not exceed 1μA/m².

10.4. CLEANING

Before testing and commissioning, the pipeline section shall be checked for cleanliness and ovalization.

The pipeline section shall be cleaned with a pig or foam sphere.

To clean the pipe and check for ovalization , a pig or a sphere shall be run several times through each underground section.

The pig travel speed shall be controlled and monitored.

To prevent ingress of foreign matter, the sections shall be capped before and after the test.

10.5. TESTING

10.5.1. General

The pressure tests shall prove the resistance and tightness of the pipeline. Testing shall be performed in accordance with applicable standard.

The Contractor will transmit all the records of the tests to the Owner and the third party agency.

10.5.2. Pre-testing

Pipe and fittings shall be pre-tested prior to the pull back operation and weld joint coating a compulsory strength and leak test shall be performed. The minimum duration for strength testing shall be 6 hours (see Resistance test for the test pressure).

The leak test will be carried out using dry air or inert gas of a minimum pressure of 6 bar (see weld points shall be distempered with soapy water and visually examined (soap bubble test).

10.5.3. Final Test preparation

Except if otherwise specified in the PTS, resistance test shall be performed with water.

The water shall be clean, with a corrosion inhibitor added if necessary.

The pipe shall be filled using pigs to prevent the formation of air pockets.

The tests should normally be carried out with trenches adequately back-filled, if any, to avoid the influence of temperature changes. If the ground temperature in the immediate vicinity of the pipes is less than 2°C, antifreeze shall be added.

On completion of filling operations, time should be allowed for the water in the sections to stabilise. The water pressures to be maintained and the location and characteristics of the measuring apparatus (thermometers, dead-weight pressure gauges etc.) shall be defined before testing commences.

The measuring instruments shall have undergone certified periodic calibration. Pressure-recording instruments shall be installed in a sheltered place.

10.5.4. Resistance test

The minimum duration for Resistance testing shall be 6 hours.

Except if otherwise specified in the PTS, Resistance testing shall be carried out at a pressure of at least 1.4 times the DP at the highest point but, at the lowest point, below the pressure at which the line pipes have been tested in factory

The pressure shall be continuously monitored and recorded and shall not show any significant drop during the test.

The test may be performed during the stabilisation period prior to the tightness test.

10.5.5. Tightness test

Except if otherwise specified in the PTS, Tightness test shall be performed with water.

The tightness test may be combined with the strength test.

The tightness test pressure shall not be higher than the Resistance test pressure. The test pressure shall not be less than DP.

The test duration shall be determined on the basis of the characteristics of the structure and the accuracy of the measuring instruments. It shall not be less than 24 hours. For volumes of less than 20 m^3 or for uncovered sections which can be fully inspected visually, this duration may be reduced for so far duly approved by the Owner.

Before carrying out the tightness test, it shall be ascertained that the quantity of air in the pipe is sufficiently small not to affect the test results.

The pipe is considered leak-tight if the temperature and pressure measurements show that the volume of test medium is maintained throughout the test.

10.5.6. De-watering - Cleaning - Drying

Once the test results have been declared satisfactory, the pipeline shall be de-watered and properly cleaned and dried.

Conventional pigs and foam pigs shall be run through the pipeline as many times as necessary to de-water and clean it satisfactorily.

Cleaning and drying shall be performed after all tests are finished and certified.

The pigging system shall be equipped with necessary devices to measure temperature - pressure and Dew Point on a continuous way.

After completion of the test, the pipeline is scraped as much as needed by using bi-directional pigs followed by additional runs of foam- en polypigs as needed up to when the pigs do not show any more humidity and all dirt is removed like calamine or other residues from welding, rust, oil, dust, etc..

The compressors used for running the pigs shall be of "oil-free" type and equipped with absorption drying units with adequate Dew Point outlet.

When, during the last run, a constant Dew Point of -8°C is measured, the pipeline is then closed and left quiet for minimum 24 hours.

If, after 24 hours, the Dew Point does not increase any more, the pipeline is then considered dry.

EINSTATEMENT

10.6. REINSTATEMENT OF THE WORKING SITE AND ACCESS ROAD

The ground occupied during the work shall be reinstated to its original condition as quickly as possible after completion of the works.

Accesses to property, fences, ditches, retaining walls, irrigation systems and other structures shall be reinstated in compliance with the agreements drawn up at the time of initial survey.

Land register marks moved for the work shall be replaced by a surveyor. Where necessary, devices to prevent erosion of the backfill materials shall be installed when reinstating embankments and slopes.

Reinstatement of footpaths, road surfaces, banks, shoulders etc. shall be performed with the agreement of authorities concerned.

10.7. MARKINGS

The location of the pipe shall be clearly marked by suitable means : conventional yellow markers, overhead markers, sign, etc..

The Marker systems shall be firmly anchored to ensure permanency throughout the time.

10.8. FINAL SITE INSPECTION WITH OWNERS AND USERS

When reinstatement and marking is completed, the site affected by the work shall be subjected to a final inspection by the parties concerned.

11. ACCEPTANCE

11.1. AS-BUILT RECORDS

As work advances, the position of the pipe shall be surveyed and plotted on the drawings.

"As-Built" Documentation containing all documents (drawings, design calculations, welding log etc) which enable location and description of the pipe shall be compiled on completion of the work.

"As-Built" documents shall maximise the use of CAD, computer database (Access 97) and digital records in such a way to allow later integration in a "Geographical Information System" (**GIS**).

All equipment shall be duly traced with reference to initial supplier Identification Reference (**ID**) - weld log-book - Certificates - etc..

The exact position "As-build" of these elements shall be accurately located with reference to ID and geographical co-ordinates.

11.2. PRE-COMMISSIONING & COMMISSIONING

Except if otherwise stated in the PTS, Pre-commissioning and Commissioning shall be performed by the Owner after being declared "Ready for Start-up".

Pre-commissioning shall take place prior to the introduction of the gas.

The system may only be commissioned when it is completely installed, tested and cleaned and where applicable, connected to a main network.

If necessary, drying may be completed by vacuum drying, blasting with dry air or any other suitable method in addition to drying by pigging.

If pre-commissioning of the pipeline is not to commence soon after "Ready for Star-up", it shall be filled with a fluid to protect against internal corrosion.

11.3. READY FOR "START-UP"

After "Final Testing" - de-watering - cleaning and drying duly certified by the Third Party Inspection - adequate back-filling of sections adjacent to the HDD itself and completion of all works except those mentioned in a "Punch List" as accepted for later completion, the system may be handed over to Owner as "Ready to Start-up".

11.4. PROVISIONAL ACCEPTANCE

The pipeline system may be proposed for "Provisional Acceptance" after pre-commissioning on final and countersigned inspection of the site and on submission of the construction completion report, including archives, construction drawings, specifications and all documents related to the design and construction.

11.5. FINAL ACCEPTANCE

General criteria for "Final Acceptance" are described in the "Administrative & Commercial Conditions".

In addition to these, "Final Acceptance" shall not be declared before all works are satisfactorily achieved including all points in the "Punch-list" agreed at "Provisional Acceptance" and for so far all certificates are obtained from Authorities - Owners of obstacles - Owner & Tenants of lands - etc. that the reinstatement is achieved properly and to their satisfaction.

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PIPELINE VALVES

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1. SCOPE

This General Technical Specification covers the supply of pipeline valves used in high pressure natural gas transport and distribution systems. It describes the general requirements, controls, tests, QA/QC, examination and final acceptance criteria which needs to be fulfilled.

This specification is general and is updated / amended by the Particular Technical Specification dedicated to the project.

2. DEFINITIONS

Engineer : The Entity of the Purchaser or the Company nominated by the Purchaser to design the natural gas transport or distribution system and to specify the equipment.

Purchaser : The Company which makes the purchase order.

Control Authority or **CA** : The Organisation put in place/requested by the Purchaser/Engineer to proceed to Quality Controls and Certification.

Manufacturer : Manufacturer who receive the purchase order

3. PRELIMINARY STATEMENT

The name of Control Organisation shall be mentioned in the purchase order.

Eventual interpretations and deviations to this specification by the Manufacturer shall be requested by writing in his offer with detailed justification and approved by the Purchaser/Engineer and the Control Authority before the eventual order to the Manufacturer. The latter is responsible and shall indemnify the Purchaser/Engineer for any damage resulting from the non-respect of this obligation.

The specifications of the steel used, the material Manufacturer and all potential subcontractors (such as forging plant, heat treatment, weld fabrication, ...) will be described in the offer. After order, no change will be accepted except for justified "force majeure". In that case, the asked changes shall be supported by a technical file submitted to the Purchaser/Engineer for approval.

The Manufacturer shall provide a technical description of the manufacturing method that might influence the quality of the material.

When the order is placed, the Manufacturer shall promptly inform the Purchaser/Engineer about his subcontractor's names, addresses, phone numbers as well as sub-order numbers, extent and delivery terms. On this basis, the Manufacturer shall send a general planning including at least the raw material supply, the manufacturing stages (machining, welding, part assembly, ...), testing , painting and packing/dispatching. This planning shall be updated by the Manufacturer at least every month unless otherwise provided in the purchase order. A Dispatcher/Inspector

delegated by the Purchaser is entitled to follow, examine and verify the planning's' relevance and effectiveness.

The Purchaser keeps the right to audit the Manufacturers and subcontractor's manufacturing process and control methods. All costs form such an audit shall be borne by the Manufacturer except the wages and travel expenditures of the auditor(s) supported by the Purchaser.

The manufacturing processes and the laboratories, in which welding tests, destructive and non destructive tests are carried out, shall be approved by the Control Authority.

The Purchaser/Engineer and the Control Authority shall have, at any time, free access to all parts of the Manufacturer's facilities and to those of all his subcontractors involved in the order manufacturing. All reasonable means shall be placed at the inspector(s)'s disposal to enable him to check that the product is being manufactured in accordance with this specification. All tests and inspections required in this specification shall be carried out, prior to shipment, in the Manufacturer's plant (or subcontractor's plant) and at the Manufacturer's expenses, unless otherwise provided in the order. The Purchaser/Engineer and the Control Authority shall try not to interfere unnecessarily with other Manufacturer's works when running these tests and inspection.

A valid copy of the ISO 9001 certificate shall be included in the offer.

For any control, test or examination required under the supervision of the Control Authority (LOFC intervention points included), the latter shall be informed in writing FIFTEEN (15) working days in advance by the Manufacturer about place and time with a copy to the Purchaser/Engineer.

If manufacturing is to be carried out under LOFC concept, the Manufacturer shall send for approval a List of Operation in Manufacturing and Control to the Control Authority and Purchaser/Engineer, TEN (10) working days before manufacturing. This list shall be in conformity with the annex 1 to this document. Before starting any manufacturing, the Manufacturer shall be in possession of this approved document, filled in with all intervention points.

Material, even released by the Control Authority and in which injurious defects are found after delivery, shall be rejected. The Manufacturer shall be notified and the material replaced : all costs involved, including wages and travel expenditure of the Control Authority's representative, Purchaser and Engineer shall be borne by the Manufacturer.

An approval of documents can never be considered as an acceptance of deviations on relaxations to requirements. A deviation is only possible after specific request to the purchaser.

4. GENERAL

- Valves are intended to be used in aboveground or underground, with cathodic protection services.

  All particular conditions for each valve are described in attached data sheet and valve list.

  All valves shall conform to API 6D spec. Whenever this specification and API 6D spec. conflict, this specification shall prevail.

  Unless otherwise specified, pipeline valves covered by this specification are suitable for use in gas transmission and distribution systems, and in accordance with ASME B31.8.

5. CODES, NORMS AND STANDARDS

Latest edition of following standards are applicable.

- ASME STANDARDS

ASME B16.5	Pipe flanges and flanged fittings
ASME B16.34	Valves- flanged and butt welding end
ASME B31.8	Gas transmission and distribution piping systems

- ASTM STANDARDS

ASTM A 53	Pipe, steel, black and hot-dipped zinc coated welded and seamless
ASTM A 105/A 105 M	Forgings, carbon steel, for piping components
ASTM A 106	Seamless carbon steel pipe for high temperature service
ASTM A 193/A 193 M	Alloy steel and stainless steel bolting materials for high temperature service
ASTM A 194/A 194 M	Carbon and alloy steel nuts for bolts for high temperature service
ASTM A 234/A 234 M	Piping, fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures
ASTM A 320/A 320 M	Alloy steel bolting materials for low temperature service

ASTM A 333	Seamless & Steel Pipes for low temperature service
ASTM A 350/A 350 M	Forgings, carbon and low alloy steel, requiring notch toughness testing for piping components
ASTM A 370	Mechanical testing of steel products
ASTM A 381	Metal-arc-welded steel pipe for use with high-pressure transmission systems
ASTM A 420/A 420 M	Piping fittings of wrought carbon steel and alloy steel for low temperature service
ASTM A 694/A 694 M	Forgings, carbon and alloy steel, for pipe flanges, fittings, valves, and parts for high-pressure transmission service
ASTM A 707/A 707 M	Flanges, forged, carbon and alloy steel for low temperature service

- API STANDARDS

API 5L	Specification for line pipe
API 6D	Specification for pipeline valves, end closures, connectors and swivels
API 6FA	Fire test for valves
API 605	Large diameter carbon steel flanges

- MSS STANDARDS

MSS SP 6	Standard Finishes for Contact Faces of Pipe Flanges & Connecting – End Flanges of Valves and Fittings
MSS SP 25	Standard marking system for valves, fittings, flanges and unions
MSS SP 44	Steel pipeline flanges
MSS SP 54	Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components Radiographic Examination Method
MSS SP 55	Quality standard for steel castings for valves, flanges and fittings and other piping components (visual method)

MSS SP 72	Ball valves with flanged or butt welding ends for general service
MSS SP 75	Specification for high test wrought butt welding fittings

- ASME STANDARDS

ASME	Boiler and Pressure Vessel code

- EN STANDARDS

EN 10204	Metallic products : types of inspection documents
EN 10045/1	Metallic products : Charpy impact test – test methods (V and U notches)

- ISO STANDARDS

ISO 148	Acier – Essai de résilience Charpy (entaille V)
ISO 9001 :	Quality management standard

- BRITISH STANDARDS

BS 5146	Inspection and test of valves
BS 5351	Steel ball valves for the petroleum, petrochemical and allied industries

- NACE STANDARDS

MR0175	Sulphide Stress Cracking Resistant Metallic Materials for Oilfield Equipment.

6. DESIGN AND CONSTRUCTION

6.1. RATINGS

1) The pressure temperature ratings of flanged and butt welding end valves shall be in accordance with ASME B16.34.

2) The temperature and pressure ranges of valves shall be in accordance with the indicated values on the appropriated piping specification and valve data sheet.

3) Wall thickness for parts used for the welding connection with the line pipes shall meet the following requirements :

- The maximum allowable stress in the material of the butt weld connection for butt welding end valves shall be equal to fifty per cent of the minimum yield strength guaranteed by the specification of the steel used.

- The minimum wall thickness for butt welding connection must be greater than or equal to the largest value of either the calculated minimum thickness of butt welding connection or the nominal thickness of the pipe as indicated on data sheet.

- If the butt welding connection has a yield strength lower than the yield strength of the pipe to which it is intended to be welded, the wall thickness in each zone of the butt welding connection is at least equal to the specified pipe wall thickness times the ratio of the minimum yield strength guaranteed by the specification of the steel of the pipe and the minimum yield strength guaranteed by the specification of the steel of the butt welding connection.

- The specified pipe wall thickness and grade (with reference to the equivalent grade in API 5L spec. or ASTM spec.) with which the valve is intended to be used is specified in the data sheet/piping class.

4) The Manufacturer shall submit for approval to the Control Authority and to the Purchaser/Engineer the dimensional drawings, the calculation of the parts used for the welding connection to the pipeline and the material part list for all the types of valves. All these documents must be identified with the individual valve number according to attached valve list and shall be attached to the CMTR.

5) The design shall take into consideration performance requirements prescribed in the next paragraph.

   All valves under this specification shall be designed to withstand a field hydrostatic test pressure with non corrosive water, after installation, during 24 hours when the gate, plug, ball or piston is partially or fully open at a pressure of 1.5 times the 38^{O}C pressure rating gauged by ASME B16.34

   During this test the closure element shall not be moved.

6.2. DESIGN

6.2.1. Face-to-face and end-to-end dimensions

Face-to-face and end-to-end dimensions for ball valves shall be in accordance with API spec. 6D.

Valves may be made to special dimension by agreement between the Manufacturer and the Purchaser.

6.2.2. Welding ends

The connecting pipe outside diameter, wall thickness, specified minimum yield strength and material grade are mentioned in the relevant piping specification and valve data sheet.

Butt-welding ends shall be in accordance with figure 1 for wall thickness up to 20.0 mm; for thicker walls, refer to figure 2. The inside diameter at the welding end shall be equal to that of the pipe on which the valve shall be welded. If a welding end of a valve has a thickness not equal to the pipe with which it is intended to be used, the welding end preparation at the joint has to be in conformity with fig. 3.

The tolerance of the inside diameter at the bevel end shall be following :

NPS	Tolerance of inside diameter at bevel end (1) (mm)	
2" - 10"	+ 1.6	-0.4
12" - 48"	+ 2.4	-0.8

(1) Tolerance refers to variation from specified ID calculation by (OD spec. - 2t spec).
OD = outside diameter
t = wall thickness

The out-of roundness at a welding end, defined as the difference between the maximum and the minimum inside diameter at the welding pipe end shall not exceed 1% of the specified inside diameter.

The length of the butt end shall be sufficient to allow welding and heat treatment without damage of the internal parts of the valve. If Purchaser/Engineer accepts design which do not meet this requirement, than Manufacturer shall inform the Purchaser/Engineer about the precautions which needs to be fulfilled in order to guarantee that during welding of the butt welding ends no damage shall occur to the seat. These precautions shall be highlighted by the Manufacturer in the erection and installation instruction book.

6.2.3. End flanges

End flanges shall be furnished in the same class as the valve body with raised face or ring-joint face, as specified by the valve data sheet. Dimensions and tolerances (including drilling templates, flange facing, spot facing and back facing) shall conform to :

- ASME B16.5 standard for NPS 24" and smaller
- MSS SP-44 for NPS 26" to 60"
- MSS SP-6 for flange facing.

6.2.4. Design features

All ball valves shall be full bore - to allow pigging - unless stipulated otherwise on the valve data sheet.

All trunnion mounted ball valves shall be fitted with following devices :

- Double block and bleed : design of a valve with two seating surfaces between which the cavity can be vented through a bleed connection and thus confirm the tightness of the valve, at least in closed position, when pressure is applied to any side or both sides of the valve.

- Double piston effect : when the pressure is applied to one side, let us say "upstream" side, and when upstream ball seat is leaking, transfer pressure shall have a positive shut-off effect on the downstream seat (acting, for instance, on the back face of this seat) and thus reinforcing the global tightness of the valve.

- Anti-static design : all ball valves shall be fitted with anti-static device conforming to BS 5351.

- Stem retention (anti blow-out) : In conformity with BS 5351 valve shall be designed with an anti blow-out stem so that the stem cannot be fully ejected by pressure inside the valve with the stem packing, gland retainer bolting removed.

- Secondary seat and stem sealing : all ball valves NPS 6" shall be fitted with a secondary stem sealing and all ball valves greater or equal to NPS 8" shall be fitted with a secondary seat and stem sealing. This system permits an injection of sealant and shall be fitted with an integral check valve. The number and the location of sealing points shall be on the Manufacturer's responsibility.

  Purchaser is allowed to request the check of this system design and its operation, specially for modified or new valve model.

- A drain connection shall be located at the lowest part of the body cavity.

6.2.5. Auxiliary connections

The Manufacturer shall complete the valve data sheet with the size and allowable pressure for the following auxiliary piping connections.

a) Aboveground valves

   - The drain shall be plugged.

   - The vent/bleed connection for valves NPS 6" and above shall be equipped with one block valve plus one needle valve, each with anti blow-out stem. The block valve shall be of ball type. The needle valve shall have screwed connections, shall be preferably of angular pattern and shall be fitted with a special plug at the outlet : this plug shall be designed to relieve slowly the pressure without being ejected.

- For valve size < NPS 6", the vent/bleed connection shall be equipped with this anti blow-out, depressurising plug only.

- Each secondary stem - and each secondary seat sealing device, when required (see § 6.2.4.), shall be fitted with a check valve integrated in the body plus a sealant fitting with built-in, spring loaded ball check valve, as mentioned in the valve data sheet.

b) Underground valves

- Vent/bleed connection shall be plugged and this functionality is by passed through the drain.

- Drain shall be fitted with a normally open block valve (ball type with anti blow-out stem) at the drain tap, piped to the upper part of the extension and ended by one ball valve plus one needle valve, each with anti blow-out stem.

- The needle valve shall have screwed connections, shall be preferably of angular pattern and shall be fixed with an anti blow-out, depressurising plug, at the outlet.

- Each stem and seat sealing connection, when required (see § 6.2.4) shall have a check valve integrated in the main valve body, a block valve (ball type with anti blow-out stem) closed to the body tap, shall be piped up to the upper part of the extension and equipped with a block valve (same type) plus a sealant fitting with built-in, spring loaded check valve, as mentioned in the valve data sheet.

- Valves and tubing shall be carefully fastened to the valve body and/or extension.

Valve bodies shall have tapped holes with a minimum effective threaded engagement at least equal to the nominal thread diameter. If body wall thickness is too thin, then unthreaded side of OEP/OET (One End Plain/One End Threaded) piece of pipe of a material compatible with the body, shall be welded to the valve body with full penetration or via a boss. Anyway, weld on threads is prohibited.

Material of auxiliary connections (pipe, tube, fittings, valve, …) shall be, at the least of the same material quality as the main valve and can be in stainless steel series AISI 300.

6.2.6. Stem extension for underground valve

When a stem extension is required (see valve data sheet), the configuration and the length H shall be in accordance with this valve data sheet.

In this case and except otherwise specified in the purchase order, valves shall be fitted with drain and sealant extensions well fixed to the stem extension and clearly indicated in the as built design. The stem extension shall be fully watertight, but shall be provided with a means to prevent overpressure built up in the mechanism resulting from stem or bonnet seal leakage.

Valves, equipped with stem extension and/or actuator, shall be delivered completely equipped and mounted (in one piece).

Underground actuated valves shall be provided with one identification plate on the valve body and one on the upper part of the extension.

6.2.7. Miscellaneous

Lifting lugs are required on all valves NPS 6" and larger. The lifting lugs shall be stamped with the safe working load. Number of lugs shall be sufficient for safe handling on site. Valve support : All valves greater than NPS 24" shall be equipped with supports to permit the installation of the valve in horizontal position directly on the floor. These supports shall be directly welded or fitted on the body of the valve.

6.2.8. Design review

The Manufacturer shall submit for approval to the Engineer/Purchaser and Control Authority the calculation for all bonnet, cover and body bolting for pressure retaining parts conforming to ASME B16.34.

6.3. OPERATION

6.3.1. Valve shall be operated by a hand-wheel, wrench, manual key or actuator.

Manual override devices shall be provided on all valves. Hand-wheels of electric actuators, shall be normally disengaged and shall automatically disengage when the actuator is operated.

6.3.2. The length of the wrench or diameter of the hand-wheel for direct or gear operated valves shall (after opening and closing a new valve at last three times) be such that a force not exceeding 350 N shall be required to operate the ball from either the open or closed position under the maximum differential pressure recommended by the Manufacturer.

For valves without stem extension equipped with a hand-wheel in vertical position, the maximum radius of the hand-wheel is equal to the distance between the centre line of the pipe and the centre of the hand-wheel minus 120 mm. In this case no extruding lugs on hand-wheel are permitted, and provision for by-pass valve shall be kept.

6.3.3. Hand-wheel shall be marked to indicate the direction of closing.

6.3.4. Hand-wheels and wrenches shall be fitted in such a way that whilst held securely they can be removed and replaced where necessary.

6.3.5. All ball valves shall be provided with a mark on the stem to show the position of the ball in order to enable a good regulation of the actuator without seeing the ball. Exception can be made for valves with gear boxes for underground service.

6.3.6. Ball manual direct operated valves shall be fitted out with fully open and fully closed stops. These stops shall be well fixed to the body of the valve in order to withstand many extreme opening and closing actions. These stops shall be easily removable. Ball gear operated valves shall be fitted out with fully open and fully closed stops shall be adjusted and fixed on the gear box.

6.3.7. The Manufacturer shall advise the maximum operating torque or force which can be sustained without causing permanent damage anywhere in the drive train from the actuator to the obturator. The Manufacturer shall also provide the torque graph : torque value in function of opening angle of the ball and pressure.

Deflection in the extended drive train must be limited so that the closing position contact reflects exactly the real position of the obturator.

6.3.8. Maximum rated differential pressure (MRDP)

The MRDP is the maximum difference between the valve upstream and downstream pressure at which the obturator (closure member) may be operated (opening). The Manufacturer shall specify this value and shall mark it on the valve name plate.

For the specification of different types of actuator refer to the concerned GTS/740/403.

7. MATERIALS

7.1. STEEL USED

The steel used in the valve Manufacturing shall be selected by the Manufacturer and filled in data sheet form

This list shall be submitted for approval to the purchaser/Engineer at the time of the offer. This list shall be added to the CMTR.

7.2. PRESSURE RETAINING PARTS

For pressure retaining parts the following requirements must be fulfilled

7.2.1. Bodies, including end flanges and welding ends (other than for field welding), bonnet and covers of valves shall be made in material conforming to API 6D spec. (or another material specification accepted by the Purchaser/Engineer) and be furnished with certificates EN 10204-3.1. B stating the quality, the mechanical properties (yield strength, tensile strength, percent elongation, impact test value at the temperature specified under per Section 8.4.2), the chemical analysis, the manufacturing process and the marking (e.g. the heat number) of the steel. These certificates shall be added to the CMTR.

For the valves with butt welding end, for the part on which the line pipe shall be welded, see paragraph 7.2.4. and 8.4.

7.2.2. Notch toughness properties

The impact test temperature conditions and temperature are defined under Section 8.4.2.

7.2.3. The carbon content of parts involved in welding operation (except for those parts which shall be used for the welding connection with the line pipes) shall be restricted as follows :

- maximum percentage of carbon : 0.230
- $C + \frac{Mn}{6} \leq 0.41$

7.2.4. For parts used for the welding connection with the line pipes the following supplementary requirements must be fulfilled :

- The chemical composition of the steel meets the requirements of table 1. The choice and use of alloying elements made from high strength low alloy steels to give the tensile properties prescribed in table 2 shall be made by the Manufacturer and included and reported to identify the type of steel.
- For each heat, the Manufacturer shall analyse the following elements : C, Mn, Si, P, S, Nb, V, Cr, Mo, Ni and Cu.
- The carbon equivalent shall be computed by the following equation :

$$C.E. = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

and shall not exceed 0.45.

- The steel used shall be fully killed, fine grain practice.
- The steel used shall be suitable for field welding to pipes, flanges or fittings manufactured under ASTM A53, A105, A106, A234, A333, A350, A381, A420, A694, A707 or API 5L, 605 or MSS SP-44, SP-72, SP-75, EN10208-2.
- The steel used has tensile properties conforming to requirements prescribed in table 2 and capable of meeting the valve design.
- The ratio of yield strength to tensile strength shall not exceed 0.85.
- Mechanical tests as prescribed in section 8.4. shall be performed after final heat treatment.

7.3. BONNET, COVER AND BODY BOLTING

Bonnet flange cover, and body bolting shall be conform to ASTM A320 Gr L7 or L7M or ASTM A193 grade B7 or B7M. Nuts shall be conform to ASTM A194 Gr 7 or 7M or 2H. For NPS greater than 4", they must be supplied with certificates EN 10204-3.1.C. and for NPS 4" and smaller with certificates EN 10204.3.1.B. These certificates shall be added to CMTR.

Bolt design shall be done to withstand safety all stresses occurring under operating conditions, calculations shall be submitted for approval.

Materials shall be compatible in order to avoid galvanic corrosion and shall not be susceptible to hydrogen embrittlement or stress corrosion cracking. Manufacturer must take into account that the materials shall be eventually cathodic protected.

7.4. NON-METALLIC PARTS

Non-metallic parts and elements, which usually include such items as packing, injectable material and lubricants, shall be suitable for the service and must be defined in the offer.

7.5. OTHER PARTS

Metal parts, which usually include such items as yokes, yoke nuts, stems, glands, gland bushing, gates, balls, plugs, discs, pistons, hand-wheel, gearing and motor drive attachments, shall be of material suitable for the service and must be defined in the offer.

7.6. SOUR GAS SERVICE

When sour gas service or NACE is specified, all process wetted, pressure containing parts and bolting shall meet the requirements of NACE MR0175.

8. FABRICATION AND TEST

Prior to manufacturing a meeting shall be organised between Manufacturer, Purchasing agent, Engineer and Control Authority.

8.1. WELDING FABRICATION

1) Welds and repair welds shall be performed according to written procedures. The welding procedure must be submitted for approval to the Control Authority before any fabrication and/or repair.

2) Only welders and welder operators who are qualified shall be used in production.

3) The joints shall be furnished in accordance with the requirements of Section VIII of ASME Boiler and Pressure Vessel Code - Division 1.

4) The machine welding shall be done by an electric process, preferably by submerged arc.

5) Repair by welding is prohibited on forged material.

8.2. WELDING PROCEDURES

8.2.1. All welds, repair welds and repair by welding shall be performed according to written procedures. These welding procedures shall be qualified according to the requirements of the ASME Boiler and Pressure Vessel Code, Section IX.

The welding procedure tests are required on material which is on the high side of the chemistry specification.

The Manufacturer shall maintain a weld record of the procedure and performance test results.

For the tensile test, the rupture of the specimen must take place in the unaffected parent material.

The welding procedure qualification must include an impact test set in the weld and in the HAZ with requirements of paragraph 8.4.2. and a macrographic examination described in paragraph 8.2.2. These tests shall be performed after eventual final heat treatment. If weld thickness is higher than 25 mm, even covered by the PQR, additional impact test shall be performed on the test specimens taken in weld thickness layers.

8.2.2. Macrographic examination : the etched surface of the macro test specimen viewed macroscopically must display the image of a well performed welded joint with sufficient penetration, free from linear defects and important inclusions. In case of doubt, the etched surface must be examined microscopically and additional macroscopic examinations of other areas may be required.

The macrographic examination will include hardness measurements in the weld and the HAZ. The hardness will not exceed the values measured on the parent metal by more than 80 points for the welds and 100 point for HAZ, with an absolute maximum of 350HV10.

The acceptance of inclusions can be decided upon with the NDE of the welded plates (see paragraph 8.5.).

8.2.3. Additional requirements for "Sour Gas". Qualified welding procedure shall guarantee a good geometry without stress concentration and shall be realised according to NACE MR 0175 (max. 1% Ni in welding consumables).

On the macro, series of hardness tests shall be performed in the base metal, weld and Heat affected zone; results shall be maximum 248HV10.

8.3. HEAT TREATMENT

8.3.1. After hot working and before re-heating for normalising heat treatment, forging or casting shall be allowed to cool substantially below the transformation range. All forging or casting shall be heat treated by normalising. Normalising shall be carried out in such a way that the base material acquires a fine grained perlitic structure.

8.3.2. Heat treatment of welds : the rules of ASME VIII Div. 1 are applicable. If a required treatment is not feasible (seat damage, etc, …), special agreement must be obtained from Purchaser/Engineer and Control Authority ACA, after the Manufacturer has proved good quality of welds.

8.3.3. The Manufacturer shall include in the CMTR data of this heat treatment.

8.4. MECHANICAL TESTS ON THE PARTS USED FOR WELDING CONNECTION WITH THE LINE PIPES

The following mechanical tests shall be performed on these parts after final heat treatment under the supervision of the Control Authority's delegate and the certificates shall be added to the CMTR.

Test specimens may only be cut after a marking transfer by the Control Authority.

8.4.1. Tensile testing

Requirements :

The material shall be in conformity with table 2. The ratio of yield strength to tensile strength shall not exceed 0.85.

Test specimen :

The test specimen represents any part of the same shape, the same heat of steel and the same heat treatment lot.

Number of test : one

Test location and orientation :

The test specimen shall be orientated transversally to direction of lamination and if this orientation is not feasible, it shall be orientated longitudinally. For castings only one orientation is applicable.

Test method :

Testing shall be performed in accordance with ASTM A370 standard rectangular plate type 1 1/2" wide (fig. 4 - A370) or standard round (fig. 5 or fig. 6 - A370).

Yield strength shall be determined either by the 0.2 % offset or the 0.5 % extension under load (EUL) method. If another material are accepted by the Purchaser, the test method will be as specified in the material specification.

8.4.2. Impact test

Requirements :

The standard impact test temperature is -20°C, except if otherwise stated in the "Material Requisition" or particular Technical Specification. The average value of a set of 3 test specimens shall be equal to 35 J/cm². The minimum value per test specimen shall be equal to 35 J/cm² but this value may drop to 28 J/cm² for only one test specimen per series.

- Test specimen :

  The test specimen represents any part of the same shape, the same heat of steel and the same heat treatment lot.

- Number of tests :

  2 test sets (3 test specimens constitute one test set). For castings only 1 test set.

- Test location and orientation :

  1 set shall be orientated longitudinally and another one transversally. For castings only one orientation is applicable.

- Test method :

  The notched bar impact test shall be performed in accordance with ISO 148 or A370-Charpy V - Notch.

  If the wall thickness of these parts or the coupon does not enable machining of full size specimens, the largest possible size must be used but not less than (10 x 5) mm. The axis of the notch shall be orientated through the wall thickness of these parts. If the weld thickness is > 25 mm, several specimen sets shall be taken in the weld thickness with min one (1) set per 12.5 mm of thickness, the specimen sets shall be selected in agreement with the Purchaser/Engineer and Authorised Control Authority.

8.5. <u>NON DESTRUCTIVE EXAMINATION (NDE)</u>

The following NDE will be performed after the final heat treatment and before coating.

8.5.1. List of NDE

- All butt welds shall be examined by a radiographic examination. If the thickness exceeds 15 mm or if the radiographic examination is not feasible than welds are only examined by ultrasonic examination to the largest extent possible.

The radiographic examination shall be executed in accordance with ASME Boiler and Pressure Vessel Code, section V, art. 2 - using fine grain film and lead screens.

- Butt welding ends on cast bodies shall be examined before fabrication welding end, by radiography in accordance to MSS-SP-54 and over a width of 70 mm.

- 25 mm of base material at each side of each weld and each weld shall be 100 % ultrasonically examined.

  The ultrasonic examination shall be executed in accordance with ASME Boiler and Pressure Vessel Code, section 5, art. 5.

- Body for all valves NPS 6" and greater shall be tested by magnetic particle examination in conformity with ASME Boiler and Pressure Vessel Code, section V, art. 7.

  - All valves shall be visually examined.

  - All valves shall be dimensionally examined.

  - For butt welding end valves after machining, the finished bevel end pipe used for field welding shall be submitted to the following tests :

    - Magnetic (ASME V Art. 7) or liquid penetrant (ASME V Art. 6).

    - Ultrasonic inspection (ASME V Art. 5) or radiographic examination (ASME V Art. 2)on 25 mm of base material.

    - Visual and dimensional examination.

  - If any repair by welding is performed, the concerned parts shall be completely re-examined.

8.5.2. Additional NDE requirement for "SOUR Gas"

A series of hardness test on surfaces in contact with the fluid shall be performed to NACE MR 0175. Results shall be 22 HRC or 248 HV 10 max.

8.5.3. Acceptance criteria of the different NDE

- Radiographic examination :

  ASME Boiler and Pressure Vessel Code, section VIII, division 1, UW 51 for forged steel

  ASME Boiler and Pressure Vessel Code, section VIII, division 1, appendix 7 for casted steel. The control will done on width of 70mm with.

  On the first 40mm A1,B1,C1 acceptable, D, E, F and G are rejected.

Between 40mm and 70mm, A2, B3, C3 acceptables; D, E, F, G are rejected.

- Ultrasonic inspection of weldings and HAZ:

  ASME Boiler and Pressure Vessel Code, section VIII, division 1, Appendix 12.

- Magnetic particle inspection of the body:

  ASME Boiler and Pressure Vessel Code, section VIII, division 1, Appendix 6.

  For casted pieces refer to Appendix 7.

- Visual examination

  MSS-SP-55.

- Magnetic particle or liquid penetrant of the finished bevel:

  The following defects are unacceptable :

  - Defects extending into the bevel provided the lamination is parallel to the surface and has a transverse dimension exceeding 6.35 mm.
  - All defects not parallel to the surface extending into the bevel.

All the NDE (except radiographic examination) shall be performed under the supervision of the control authority's delegate and the certificates shall be added to the CMTR.

8.6. PRESSURE TESTING

8.6.1. General requirements

- Each valve shall be tested by the Manufacturer under the supervision of the Control Authority after final completion of all welding and all heat treatment operations.
- Hydrostatic and air seat test shall be performed after an acceptable shell test.
- Fluid for shell and hydrostatic seat tests shall be liquid as water (which may contain a corrosion inhibitor), kerosene, or other fluid with a viscosity not greater than that of water. Temperature of the test fluid shall not exceed 50°C.
- Valves shall be substantially relieved of air when tested with liquid.
- Valves shall be shell tested prior to painting.
- Valve test fixture loads applied to valve ends shall be limited to those required to effectively seal the valve ends.
- Pressure testing certificates shall be included in the CMTR.

- Drain, the sealant and the bleed valve shall be included in all pressure tests.

- If any supplementary welding, repair by welding or treatment are performed, valve shall be completely re-tested.

8.6.2. Shell test

- Each valve shall be given a shell test at the gauge pressure not less than 1.5 times the 38°C rating gauged by ASME B16.34, rounded off to the next higher 1 bar increment.

- Shell test shall be conducted with the valve in a partially open position and with the valve ends closed.

- *Drain lines and valves*

  Shall be either included in the hydrostatic shell test, or tested separately.

- Duration of the shell test

  NPS up to 18" shall not be less than 15 minutes.

  NPS 20" and larger shall not be less than 30 minutes.

- Visual leakage or harmful inelastic deformation are not accepted.

8.6.3. Hydrostatic seat test

- Each valve shall be given a hydrostatic seat test at the gauge pressure not less than 1.1 times the 38°C rating gauged by ASME B16.34, rounded off to the next higher 1 bar increment.

- Seat closure testing shall be performed with seat surfaces free of sealant, grease or other foreign material that aids in sealing except as provided hereafter :

  - When necessary to prevent damage during valve actuation, a light oil of viscosity not greater than that of kerosene may be applied to sealing surface.

  - When valve primary design is based on the presence of a sealant material (lubricated plug valve), the sealant material may be in place.

- For valve of the double seating type such as gate, plug and ball valve, the test pressure shall be applied successively to each end of the closed valve and leakage to opposite end checked. Provision shall be taken before, for de energising the self relieving pressure system.

  - For soft seated valves there shall be no visible leakage - for metal seated valves the leakage rate shall not exceed 0.006 ml per minute and per mm of nominal pipe size (ND).

- For double block and bleed valve the following tests shall be performed :

  Close valve, open body vent, apply seat test pressure to both ends of the valve.

  Close valve, open body vent, apply seat test pressure to one end of the valve, release pressure and repeat test for the other end of the valve.

- For double piston effect valve the following test shall be performed :

  Release pressure, close valve, open body vent, apply seat test pressure through the body vent.

- For other valve type, the test pressure shall be applied across the closure member in the direction producing the most adverse seating conditions. For example, a globe valve shall be tested with pressure under the disc. A check valve, globe valve or other valve type designed, sold and marked as a one-way valve, requires a closure test only in the appropriate direction.

- The duration of the hydrostatic seat test shall not be less than 5 minutes for each end.

- Visual leakage or harmful inelastic deformation are not accepted.

8.6.4. External leak testing

Under the supervision of the Control Authority's delegate, the Manufacturer shall check the external leak tightness of body, stem and all external taps. This shall be done with soap suds at an inner pressure of 6 bar. For underground valves, this test shall include piping, fittings and valves of the auxiliary lines for drain, vent/bleed and sealant connections.

8.6.5. Air seat test

- Each valve shall be given an air seat test at 6 bar.

- This test shall be performed in the same manner as hydrostatic seat test.

- The duration of this test shall not be less than 5 minutes for each end.

- No signs of leakage are accepted.

8.6.6. Procedure

Procedure of all pressure tests shall be included in the offer.

8.6.7. After tests

After test, any auxiliary connections shall not be removed, and auxiliary piping shall be cleaned and dried, especially the sealant piping.

8.7. OPERATIONAL TORQUE TEST

For valves operated with an actuator the Manufacturer shall perform an operational torque test at full rated differential pressure and at ambient temperature. The procedure must be included in the offer. The certificates shall be included in the CMTR.

8.8. FIRE TEST

The Manufacturer shall supply valves qualified by fire testing as specified in API 6FA and this certificate shall be added to the CMTR.

8.9. ANTI-STATIC DEVICE TESTING

If requested in the purchase order, all ball valves shall be submitted of to an anti-static electricity testing in accordance with BS 5146 and this certificate shall be added to the CMTR.

8.10. VISUAL AND DIMENSIONAL EXAMINATION

All valves shall be visually and dimensionally examined, according to API 1104 and MSS-SP-55.

9. MARKING

9.1.1. All valves supplied under this specification shall be clearly identified on the body, on the identification plate and on the valve flange edge.

9.1.2. Body markings

The following markings shall be cast, stamped, forged or engraved on the body of the valve :

c) Manufacturer's name or trademark.

Individual tag number according to attached valves list.

The monogram of the Control Authority. This marking shall only be applied after complete approval of the CMTR.

Flow direction on unidirectional valve.

9.1.3. Permanently attached identification plate markings

On minimum the following markings shall be shown on permanently attached identification plates :

a) Manufacturer's name or trademark.

b) Individual valve fabrication number (serial number).

c) Individual tag number.

d) The maximum operating pressure;

e) The min and maximum operating temperatures

f) Body material designation (conforming MSS SP-25).

g) Rating designation (conforming ASME B16.34).

h) Valve trim identification (conforming MSS SP-25).

i) Nominal valve size.

j) Monogram of the Control Authority.

10. INSPECTION

10.1. INFORMATION

The Manufacturer shall inform the Control Authority min. five (5) working days in advance of any intervention required by this specification and shall send a copy of it to the Purchaser/Engineer (by fax).

10.2. DOCUMENTS

Before starting any fabrication, the Manufacturer shall submit for approval to the Control Authority and the Purchaser/Engineer the following documents :

- Detailed fabrication drawing and calculations.
- Fabrication and control procedure.
- Qualified welding procedures;
- Welders performances qualifications;
- NDT procedures;
- List of Operations in Fabrication and Control (LOFC) in accordance with annex 1.

Each company dealing in the order by fabrication and/or control shall implement a LOFC for all operations and interventions performed in its organisation. They shall also be responsible for the implementation of the same by their subcontractors.

10.3. CERTIFIED MATERIAL TEST REPORT

A Certified Material Test Report (CMTR) shall be furnished listing as built drawings and calculations, the LOFC (see paragraph 10.2.), the base material certificate, the chemical check analysis of the welding ends. The certificate of the heat treatment, the mechanical test, the non-destructive examination, the pressure testing, the operational torque test, the quality release note (see paragraph 10.4.) and any special test required by the purchase order. The valve individual number (see paragraph 9.1.2.) must be indicated in the CMTR to permit the correct traceability of each valve. The Manufacturer shall furnish one copy of the CMTR to the Control Authority's delegate and one original and one copy to the Purchaser/Engineer.

10.4. QRN

After final approval of valves and the acceptance of the CMTR, the control authority's delegate shall furnish to the Purchaser/Engineer and to the Manufacturer a Quality Release Note (QRN). The Manufacturer shall deliver one copy of the QRN with the valves and one copy shall be included in the CMTR (see paragraph 10.3.).

10.5. REPAIR

Defects in material may only be repaired provided written acceptance by the contracting parties and the Control Authority has first been obtained.

This written acceptance must be given case per case. Defective material, that cannot be satisfactory repaired or repaired without written approval shall be definitively rejected.

10.6. REJECTION

Each valve in which injurious defects are found after delivery shall be rejected. The Manufacturer shall be notified. In this case, the valve shall be replaced immediately. All the costs involved, including wages and travel expenses of the Control Authority's delegate shall be borne by the Manufacturer.

11. PAINTING AND COATING

The surface of the valve will be shot-blasted SA 2 1/2 (Swedish standard SIS 055900). Before painting, the valve shall be cleaned from grease and dirt. The painting shall consist of a primer coating (30 - 40 µm) and a finish coating (30 - 40 µm).

The nature of the products shall be specified in the offer and shall guarantee a corrosion protection for a storage period in a shop for at least one year.

Painting in accordance with Purchaser/Engineer's specifications.

Painting and coating procedures shall be submitted for approval before manufacturing to the authorized Control authority and to the purchaser / engineer.

For underground valves the Manufacturer shall propose an adequate protection at the time of offer. This adequate protection shall be in accordance with the Purchaser/Engineer's specification.

TABLE 1

CHEMICAL COMPOSITION FOR WELDING END OF VALVES

Maximum limit of chemical elements which may be used in material under this standard.

	% Maximum
C	0.230
Mn	1.60
Si	0.50
P	0.030
S	0.025
Nb	0.080
V	0.120
Mo	0.250
N_t	0.0150

Alternate alloy elements may be used but they shall be discussed with the user prior to delivery of the material. This table is not intended to represent the composition of any heat of steel, but merely to record the maximum permissible amounts of one element. The combination of elements of any heat must conform to the carbon equivalent, subsection 3.2.4.3.

For each heat the Manufacturer shall analyse the following elements :

C, Mn, Si, P, S, Nb, V, Cr, Mo, Ni and Cu.

The intentional addition of elements other than those specified is not permitted unless agreed upon by the Purchaser.

In any case, for unintentional additions, the following limitations shall be respected :

$Cr \leq 0.15$ % $Mo \leq 0.05$ % $Cu \leq 0.20$ %

Ni ≤ 0.30 % Co ≤ 0.01 % Al ≤ 0.07 %

The content of N total (N_t) may be up to 0.0150 % and Must be guaranteed by the Manufacturer. If the Manufacturer cannot give any guaranty of N content, he shall analyse this element.

The total content for Nb + V will be limited to 0.150 %.

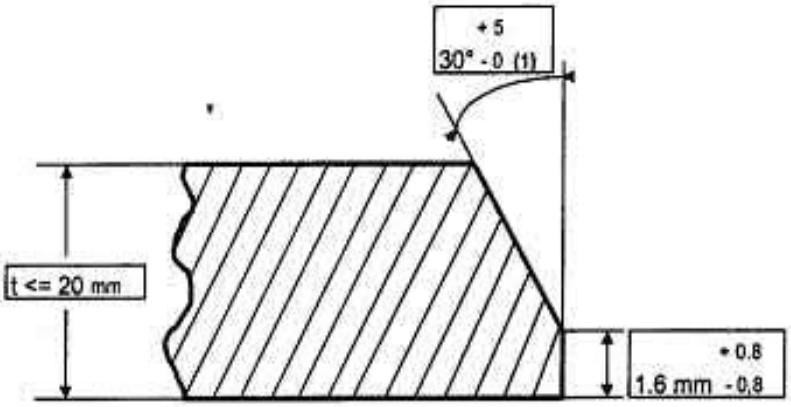
In grades X42 through X60 for each reduction of 0.01 % below the maximum carbon content, an increase of 0.05 % manganese above the specified maximum is permissible, up to a maximum of 1.70 %.

TABLE 2

TENSILE REQUIREMENTS OF THE WELDING END OF VALVES

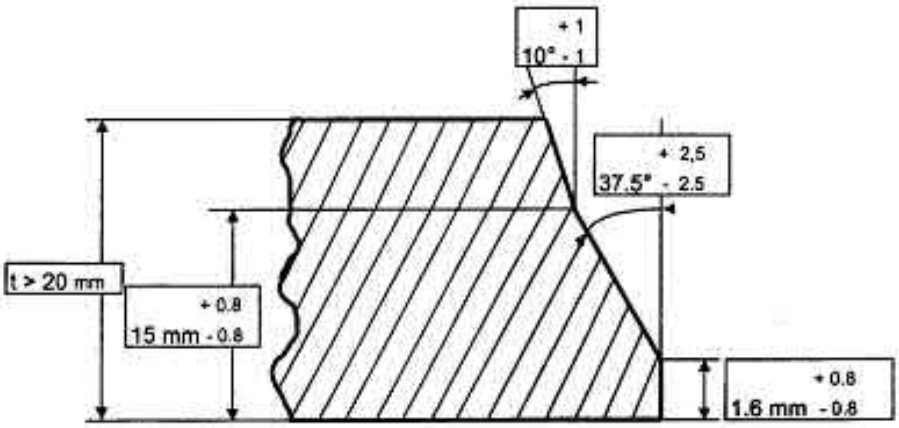
CLASS SYMBOL	FIELD STRENGTH (min)		TENSILE STRENGTH (min)		ELONGATION in 2" min. %
	KSI	MPa	KSI	MPa	
B	35	241	60	413	25
X42	42	289	60	413	25
X46	46	317	63	434	25
X52	52	358	66	455	25
X60	60	413	75	517	20

The ratio of effective yield strength to effective tensile strength of the steel shall not exceed 0.85.

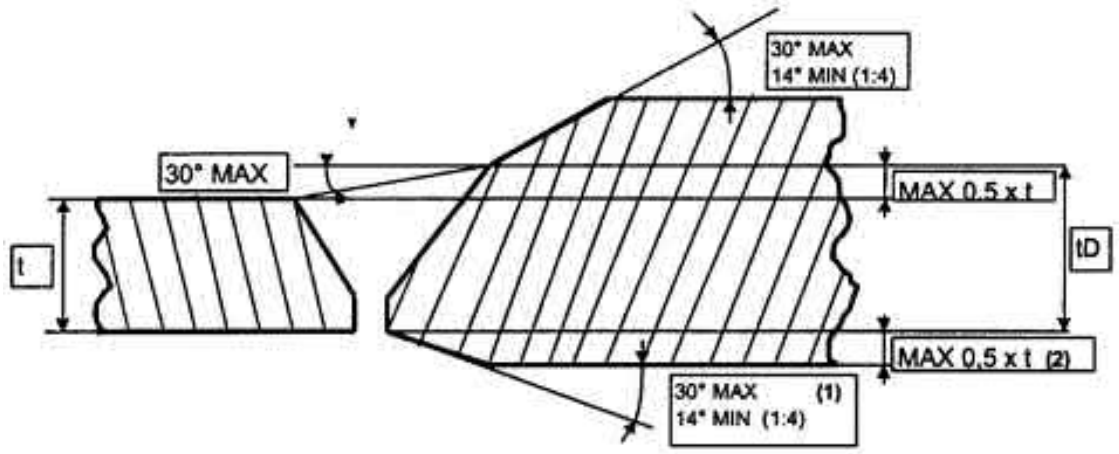


(1) : welding end, size 24" and smaller may be furnished with 37.5° +- 2.5 bevel at manufacturer option.

Figure 2



ACCEPTABLE DESIGN FOR UNEQUAL WALL THICKNESS AT WELDING END OF VALVE



Notes

(1) No minimum when materials joined have equal yield strength.

(2) Dimension to be limited to a minimum.

When the minimum specified yield strengths of the sections to be joined are unequal :

- the deposited weld metal shall have mechanical properties at least equal to those of the section of the higher strength.
- tD shall be equal to at least t times the ratio of min. specified yield strength of pipe by those of welding end of valve.
- $tD \geq tx \dfrac{\text{Min. Yield strength guaranteed by the standard of the steel of the pipe}}{\text{Min. yield strength guaranteed by the standard of the steel of the welding end of the valve}}$

ANNEX 1

LOFC (LIST OF OPERATIONS OF FABRICATIONS AND CONTROLS)

Each LOFC must contain the following information as a minimum (all clearly marked and separated) :

k) Company name and references relating to the order.

l) All technical and other information required in order to define the items covered.

The area of application will be limited to that item or those considered as in fabrication and control.

m) A numerical sequence of operations with description will be built-up in a logical way of work progress.

- The first operation will be the control of the incoming material(s) and documents.
- The last operation will be the control of the CMTR.

The following operations have to be included (not limited to) :

- Each fabrication step.
- Each step which calls for own quality control (eventually QA).
- Each applicable examination as part of this specification.
- Document controls - stamping and final documentation.

n) Each operation will be followed by the applicable specification or procedure number (with the latest revision).

o) Columns to be provided for possible interventions of :

- the Manufacturer's fabrication control,
- the Manufacturer's quality control (eventually QA),
- Control Authority,
- the Purchaser/Engineer,

and place of intervention if not by the Manufacturer.

The interventions will be indicated per operation with H or W and/or R.

H = hold point
No further steps may be undertaken before the intervention of the appointed responsible takes place.

W = witness point
The appointed responsible has to be notified of the operation in advance, but production will continue whether the intervention took place or not.

R = point for which a control report or a recording has to be made.

The Manufacturer will fill in his own H, W and R points. The Control Authority and the Purchaser/Engineer will do the same in their designated columns, but this will not implicate a relaxation or wearing of the requirements of the Manufacturer's controls.

Each intervention has to be signed and dated by the person acting as controller. Only the original documents will be presented for this purpose.

p) One column to be provided for report or record numbers (points marked R) and one for the review of these documents by the Control Authority.

q) Two extra columns may give reference to a non-conformity report if any and to the resolution given to it.

Completion of the LOFC does not automatically give rise to a release of the material or it must be stipulated otherwise in the contract.

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PE ACCESSORIES
for underground networks for natural gas distribution

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Σ Σ Σ

1. SUBJECT AND AREA OF APPLICATION

This specification has been established to define the requirements that must be met by injected moulded polyethylene accessories (PE) destined for the construction or the maintenance of underground networks for natural gas distribution where the maximum operating pressure (MOP) is equal to 5 bars.

It also defines some of the more general characteristics of materials used for accessory manufacturing and includes the appropriate classification model.

The specification also includes testing method parameters for the material in question.

All accessories included in these specifications are listed as follows :

- Electrofusion welded accessories
- Electrofusion welded saddles
- Accessories equipped with insertion connection for end to end welding and assembly using electrofusion-welded sleeve coupling.

This specification is limited to accessories with a nominal diameter of 225 mm and a working temperature between -20°C and +40°C.

PE and steel accessories with a tapered section and front section connections are not included in these specifications.

2. REFERENCE STANDARDS AND SPECIFICATIONS

EN 682	Air-tight rubber seals - specification for air-tight seal materials for gas and hydrocarbon fluid transfer piping
EN 1555-1	Plastic piping systems for combustible gas distribution. Polyethylene (PE). Part 1. General information
EN 1555-3	Plastic piping systems for combustible gas distribution. Polyethylene (PE). Part 3 . Accessories
EN 1555-7	Plastic piping systems for combustible gas distribution. Polyethylene (PE). Part 7. Conformity evaluation.
ISO DIS 11413	Preparation of test assemblies between a polyethylene (PE) pipe and an electrofusion fitting.

ISO DIS 11414	Preparation of test assemblies between a pipe/pipe or pipe/fitting polyethylene (PE) by butt fusion
ISO DIS 12093	Format for a technical brochure for electrofusion joint characteristics
ISO TR 13950	Electrofusion identification methods
CEI 60335-1	Safety standards for household appliances and similar equipment.
CEI 364	Electrical installations on buildings (including building sites and other temporary installations)
CEI 449	Voltage domains for building electrical installations.
70000/740/GTS/0008 to 70000/740/GTS/0010	Tractebel technical specification: polyethylene piping for underground networks for natural gas distribution
70000/740/GTS/0012	Tractebel technical specification: raw materials for manufacturing piping and accessories for underground networks for natural gas distribution.
70000/740/GTS/0013	Tractebel specification sheets: program execution. Polyethylene pipe laying.

3. DEFINITIONS

3.1. ELECTROFUSION ACCESSORY

This term covers all injected moulded polyethylene accessories equipped with a heated element designed to transform electrical energy into heat to create self-welding.

In certain exceptional cases, an accessory can present one or more smooth ends. In this case the accessory will provide for the requirements of each connection end as regards shape, measurement, and technical characteristics.

3.2. ELECTROFUSION SADDLE

This term covers a saddle shaped injection moulded PE accessory that is equipped with one or several heating elements that convert electrical energy into heat. The released heat provides a fusion surface sufficiently large to ensure correct saddle-pipe assembly.

Electrofusion saddles can be subdivided into two categories:

Wrap around Electrofusion saddle whose upper shell is brought against the pipe during welding using a fastening stirrup located on the lower part of the accessory to guarantee that the welding pressure is sufficient. Generally the stirrup is left in place after welding.

Top load Electrofusion saddle where the welding pressure is obtained by pressing down on the saddle head using a fixing system (clamp) that is removed after welding is completed.

There are four different saddle types:

Support This is an accessory designed for joining branch pipes and is equipped with a drill bit made to pierce the wall of the pipe; this bit remains in the saddle body after installation.

Branch piping saddle This accessory is designed for joining branch piping where an additional bit is necessary to pierce the wall of the main pipe next to the branch.

Ballooning saddle This accessory provides the positioning of a sealing (or blocking) balloon and that can be filled again after work completion.

Repair saddle This accessory will seal/block any leaks on the pipe or will reinforce piping in the case of localised deterioration.

According to their leakage flow, the supports are divided into two model categories:

Model 1	Supports whose maximum immediate external leak flow is practically equal to zero at 5 bar pressure in the piping.
Model 2	Supports whose maximum immediate external leak flow never exceed 200 litres an hour at 5 bar pressure in the piping.

3.3. END TO END WELDING ACCESSORIES

This term describes injection moulded polyethylene accessories with smooth ends but not equipped with integrated heating elements. These are connected to the network by end-to-end welding using electrofusion sleeves.

In certain exceptional cases, an accessory can also present one or more electrofusion ends. In this case the accessory will provide for the requirements of each connection end in shape, measurement, and technical characteristics.

4. GENERAL SPECIFICATIONS

This specification is based on the series of EN 1555 standards, which standardise all the gas distribution network plastic piping systems.

The accessories described in this document comply with all prescriptions included in EN standard 1555-3, as well as all complementary requirements and/or options described in these Tractebel specifications.

The accessories are destined for use in gas distribution networks in piping in compliance with Tractebel specification 70000/740/GTS/0008 to 70000/740/GTS/0010

The pipes are laid and welded as described in our specification sheet for pipe laying 70000/740/GTS/0013.

5. MATERIALS

5.1. GENERAL INFORMATION

The materials used for the manufacturing of the accessories must conform to the requirements demanded for components used in gas fuel distribution networks.

The accessory material that is in contact with the PE piping must not be composed of any material that will provoke a reduction in pipe performance, nor must it provoke cracking under stress.

All equipment will marked with inscription/description and specification in English language.

5.2. RAW MATERIAL SPECIFICATIONS

The raw material PE, used for accessory production, is in compliance with all prescriptions in EN 1555-1 standards. It must be approved according to the prescriptions in Tractebel specification 70000/740/GTS/0012.

The raw material belongs to class PE100.

The following are strictly forbidden:

- use of recycled raw materials
- mixing of different raw materials
- The addition of supplementary additives to the raw material.

5.3. SPECIFICATIONS FOR COMPONENTS MADE OF MATERIALS OTHER THAN POLYETHYLENE

5.3.1. Metal parts

All metal parts subject to corrosion must be protected in an adequate manner

Metal parts must conform to prescribed standards of that particular material for gas distribution, for quality levels, size/gauge and measurements.

Cast iron, aluminium and its alloys are not authorised for use.

5.3.2. Elastomers

Elastomer air and watertight seals, like all other elements manufactured in this material, must comply with the prescriptions of EN 682 standards.

5.3.3. Other materials

All other materials used are in compliance with the prescriptions described in paragraph 5.1. The accessories included in the paragraph comply with the requirements of this specification and are adapted for all general use for natural gas distribution.

6. GENERAL ACCESSORY CHARACTERISTICS

6.1. TECHNICAL INFORMATION

The manufacturer must supply a technical information dossier composed and including the same material and presented in the same manner, in compliance with the prescriptions of the ISO DIS standard12093.

This dossier must mention all of the following information for each accessory:

- PE raw material used
- Measurements and tolerances
- Domain of application (temperature and pressure limits, SDR and ovalisation)
- Assembly instructions
- Welding instructions (welding parameters and limits)
- Test results attesting to the accessory conformity standard: c.f. EN standard 1555-3 for test descriptions.

For electrofusion accessories, the manufacturer must also supply the SDR series for the pipes, which will be used together with their accessory, according to their thickness.

In addition, for the saddles:

- The attaching method (tools necessary and/or lower shell)
- saddle category (refer to 3.2)
- Maximum saddle height (H in figure 2)
- the height of the branch pipe for supports (h in figure 2)

For all smooth ended accessories, the manufacturer must also supply the SDR series of connections; the accessory must be guaranteed for use on piping of the same class.

In the case of welding parameter modification, size or raw material changes, the manufacturer must include a new technical dossier providing proof that the accessory in question is still compliant with the specification prescriptions.

Testing assemblies will take into consideration manufacturing tolerance, assembly tolerance and the variations in environmental temperature corresponding with the conditions where the accessories will be in use. The manufacturer must observe all methods recommended for polyethylene accessory installation as shown in the Tractebel specifications.

The accessories will be tested exclusively using piping in compliance with Tractebel specifications concerning PE piping (70000/740/GTS/0008 to 70000/740/GTS/0010).

The assembly of piping and accessories manufactured and used in the tests must be in compliance with the manufacturer's technical instructions and the limits of use conditions. When the test assemblies are carried out, the manufacturing and assembly tolerances must be taken into consideration. Samples destined for assembly testing with electrofusion accessories must be prepared according to standard ISO DIS 11413. End-to-end welded samples must be prepared according to standard ISO DIS 11414.

6.2. APPEARANCE AND FINISH

The internal and external surfaces of the accessories must be smooth, clean and free of all scratching, pitting and other surface faults that can possibly reduce accessory and assembly performance.

No element of any accessory must show any signs of damage: scratching, scraping, piercing, blisters, bloating, denting, holes, cracks or other faults that can reduce required performance.

It must be possible to place the accessory on the pipe or on another accessory without moving the electric winding or the air/water tight seals etc. and this must respect the tolerance permitted for piping and accessories.

6.3. COLOUR

All accessories will be black. If agreed previously, they can also be coloured yellow or orange.

6.4. JOIN APPEARANCE

After welding, when examined visually without a magnifying glass, the internal and external surfaces of the pipes and accessories must appear free of welding exudation outside the accessory limits (unless identified by the accessory manufacturer as normal, or carried out deliberately as a welding test, but on condition that there is no wiring position change inside the electrofusion accessories that could provoke a short-circuit). Internal surfaces of all adjacent piping must remain identical to the previous condition before welding.

6.5. ELECTROFUSION ACCESSORY ELECTRICAL CHARACTERISTICS

6.5.1. General information

The accessories include an electrical system as described in the standards CENELEC 60335-1, CEI 364 and CEI 449.

This system is equipped with an appropriate electrical protection for the voltage and intensity of the current in use, and adapted to the characteristics of the electrical supply line.

For voltage over 24 V protection is essential against direct contact with the active parts (conductors on line). The type of protection in question depends on the local site conditions.

6.5.2. Classification

Electrofusion accessories are divided into three classes according to the voltage and/or current characteristics.

Class A Electrical supply based on voltage set between 8V and 42 V

Class B Electrical supply based on voltage set between 42 V and 220 V

Class C Electrical supply based on power supply settings.

All supplies, unless otherwise stipulated in the order, concern Class A accessories.

The power required for electrofusion accessory welding must not exceed 3kW during welding operations.

Unless stipulated otherwise in the order, only “wrap-around” saddles can be supplied (refer to par. 3.2.)

Unless otherwise agreed between Tractebel and the supplier, all electrofusion accessories must be “single wire“ type.

6.5.3. Connectors

Electrical connectors installed on electrofusion accessories must comply with the diagram included in Annex 1 with these specifications, also including constant current supply where this is the case. The state of the connector terminal surface must offer the minimum possible contact resistance during voltage cable joining.

6.5.4. Protection against overheating

Electrofusion accessories that can only be welded once are equipped with a lock system which prevents re-welding.

Electrofusion accessories that cannot be re-welded immediately after initial welding are equipped with an incorporated security system in their welding program: that is they cannot weld while the wire is still hot.

If the welding program does not possess this lock system, the electrofusion accessory must absolutely be protected against a second or several welding cycles whatever the temperature of the winding wire.

6.6. SUPPORT DRILLING EQUIPMENT

The support drilling equipment has been designed so that during drilling the maximum immediate leak flow will never exceed 200 litres per hour at 5 bar pressure, in the main pipe. According to this flow rate, the supports are divided into two categories:- models 1 and 2 (refer to par. 3.2.) The required model will be specified when ordered.

The bell drill is equipped with a manoeuvring opening for the insertion of a 17 mm hexagonal spanner.

The bell drill path is limited at the top and bottom by a limit block.

The drill mechanism is designed so that no additional tools (except the hexagonal spanner described above) are necessary for carrying out drilling operations.

6.7. BRANCHING SUPPORT AND SADDLE LOAD LOSS UNDER LOW PRESSURE

The maximum load loss measured with natural gas at an inlet pressure of 20 mbar must not exceed the values listed below.

Flow m^3 /hr	**Saddle Type**	**Maximum load loss Mbar**
10	63 x 32	1.0
10	110 x 32	1.0
10	160 x 32	1.0
10	200 x 32	1.0
40	63 x 63	2.0
40	110 x 63	1.0
40	160 x 63	1.0
40	200 x 63	1.0

6.8. ELECTROFUSION SLEEVE B LOCK

All electrofusion sleeves are equipped with an immovable block in the centre of the sleeve.

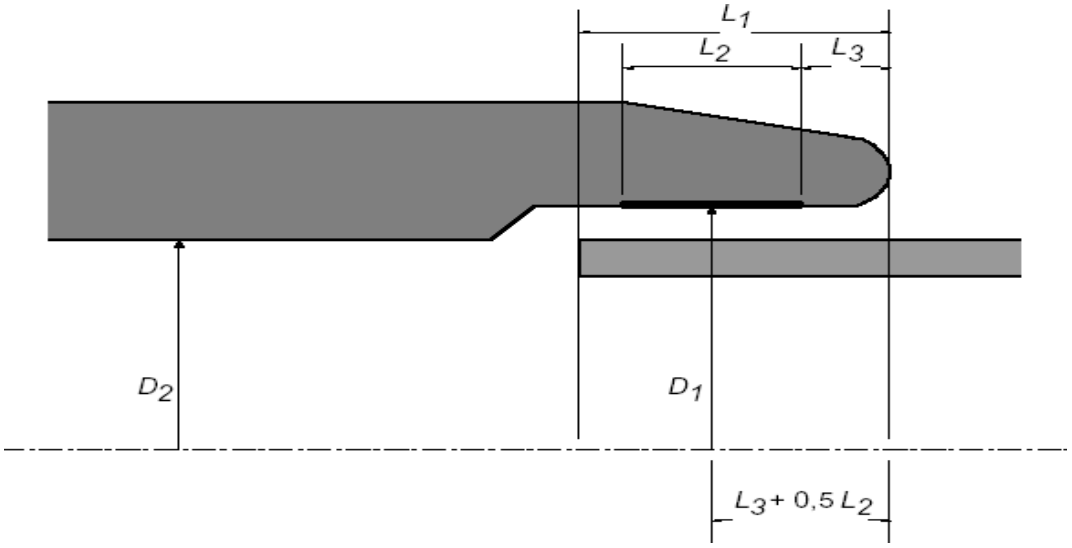
7. GEOMETRICAL CHARACTERISTICS

7.1. SIZE OF ELECTROFUSION SLEEVES

The sizes of the electrofusion accessory sleeves and their tolerance limits are described in chapter “Geometrical characteristics” of EN standard 1555-3.

They are controlled according to the method described in the specification standard. Any possible sealing plugs are removed from the sleeve 4 hours before the size control check. Measurements are controlled without the plugs inserted.

The main symbols are shown in the figure 1 below:



D_1 The “average internal diameter in the welding zone” – that is: the average internal diameter measured in a parallel plane to the opening plane, at a distance of $L_3 + L_2/2$ of the latter.

D_2 “Minimum drilling/boring” – that is the minimum diameter of the draining canal through the body of the accessory.

L_1 “penetration depth” of the pipe or the inserted (male) end of the accessory

L_2 “Nominal length of the welding zone” that corresponds with the length subject to heating.

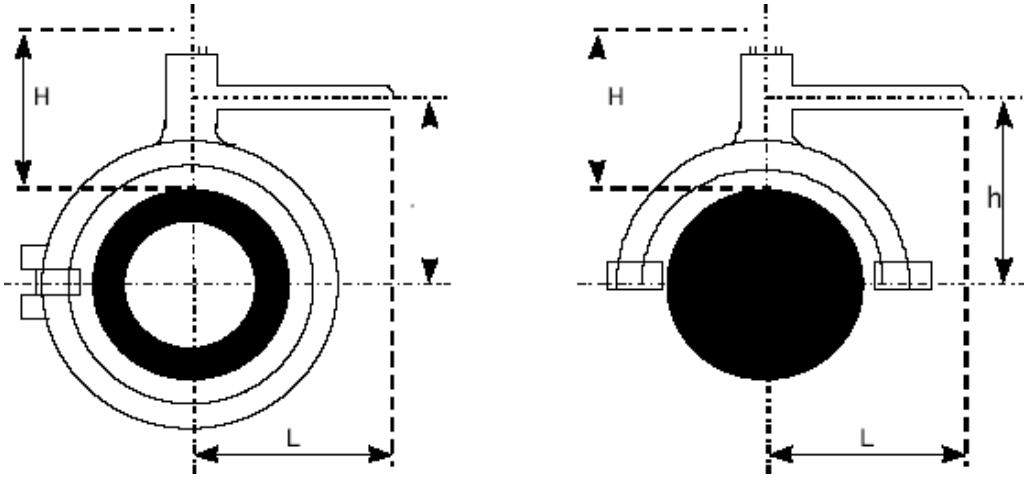
L_3 “Nominal non-heated entry/inlet length of the sleeve”. This refers to the distance between the tip of the accessory and the beginning of the welding zone.

7.2. ELECTROFUSION SADDLE MEASUREMENTS

The measurements of the electrofusion saddles and their tolerance limits are described in EN standard 1555-3

They are controlled according to the method described in the specification standard. Any possible sealing plugs are removed from the sleeve 4 hours before the size control check. Measurements are controlled without the plugs inserted.

The main symbols are shown in the figure 2 below:



H The “height of the saddle” – that is the distance between the upper generator of the main pipe and the top of the branch pipe saddle

h The “height of the branch pipe” - that is the distance between the axis of the main pipe and the axis of the branch pipe

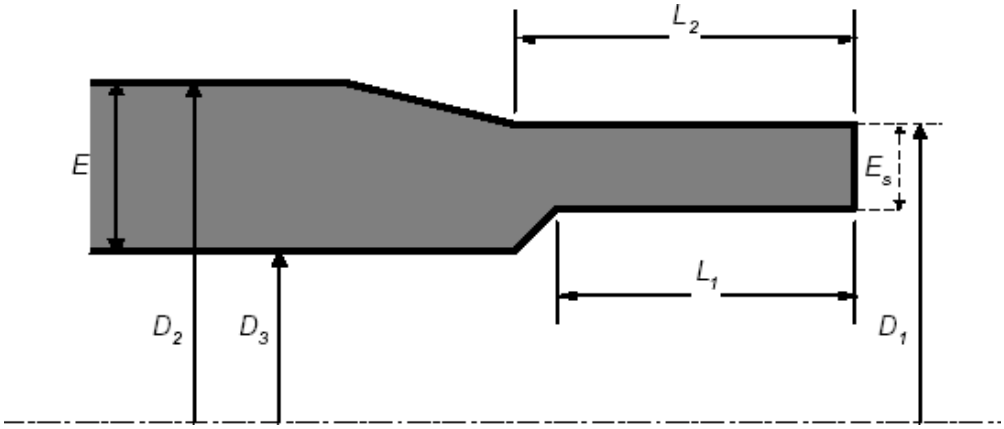
L The “width of the branch pipe saddle” - that is the distance between the axis of the pipe and the surface plane of the branch pipe opening

7.3. MEASUREMENTS OF ACCESSORY ENDS TO BE WELDED

The measurements of the ends and their tolerance limits are described in EN standard 1555-3.

They are controlled according to the method described in these specification standards. Any possible sealing plugs are removed from the sleeve 4 hours before the size control check. Measurements are controlled without the plugs inserted.

The measurements and main symbols used in this specification are shown in the figure 3 below:



D1 The "average external diameter of the end to be welded measured on any plane parallel to the inlet/entry plane at a distance where this plane does not exceed L_2 (tubular section).

D2 The "average external diameter of the body" of the tip of the accessory.

D3 "Minimum drilling/boring" – that is the minimum diameter of the passage through the body of the accessory. Measuring of the diameter must not include any ribbing due to welding.

E "Thickness of the accessory body wall" – that is: the thickness measured at any point of the accessory wall.

Es "Thickness of the end to be welded" measured at any point but where the distance does not exceed L_1 (length that can be cut) compared to the inlet/ entry plane, must be equal to the thickness of the nominal pipe wall.

L1 The "cuttable section" of the end to be welded – that is the initial depth of the tip of the insertion section, necessary for end-to-end welding or for starting an end-to end weld again.

L_2 The “tubular section” of the end to be welded – that is the initial length of this section. This tubular section permits the following in all types of combination :

- Use of the clamp stirrups, as is essential for end-to-end welding, or for electrofusion.
- Assembly using electrofusion sleeves.

8. ACCESSORY MECHANICAL CHARACTERISTICS

All accessories must obey the requirements and tests described in the chapter concerning the mechanical characteristics of EN standard 1555-3. They must also comply with the hydrostatic test conditions described in the same standard.

They must be controlled as described in the same standard.

9. PHYSICAL CHARACTERISTICS

All accessories must obey the requirements and tests described in the chapter concerning the mechanical characteristics of EN standard 1555-3

They must be controlled as described in the same standard

10. PRODUCT APPROVAL

The product will be approved by the Owner if all results of the tests, controls and checking prescribed by this specification are satisfying.

The manufacturer will provide a complete approval dossier including all the product characteristics specified in 6.1. (technical dossier) and the results of tests prescribed in these specifications. The number of tests run on the product must comply with EN standard 1555-7. The results of these tests described in the approval dossier must be confirmed by the Owner authorised laboratory. Hydraulic testing must be continued until the rupture of at least two test samples for each set of tests. (max. 2000 hours).

All changes made to the approved product must be communicated to the Owner, and this entails further control checks for approval.

Any requirement not observed or test missing from this specification will result in the withdrawal of the product approval and can even result on annulment of contract.

11. MARKING

11.1. ACCESSORY MARKING

11.1.1. Identification marking will be made directly on the accessory. The system used to make the product must not provoke cracking or other faults. All marking must be permanently legible for the product life under standard stocking conditions, exposure to external weather conditions, treatment, installation, and use.

11.1.2. Where the products are printed, the colour of the printed identification mark must be different from that of the basic product colour.

11.1.3. Marking quality and size must be of a standard that can be read with the naked eye without magnification.

No marking must be printed on the minimum length of the insertion section of accessories.

11.1.4. 11.1.4. Each accessory must be marked with at least the obligatory details required by EN standard 1555-3. The marking must be printed on the accessory itself or on a label as shown in the standard described above

The SDR pipe range that are to be fitted with these accessories must be clearly marked on the fitting. Details must include: each SDR value, or the upper and lower value of the permitted SDR range.

11.2. COMPLEMENTARY INFORMATION

All complementary information on welding conditions (welding time and cooling time) can also be described on a label affixed to the accessory or delivered with the accessory.

12. PACKAGING AND DELIVERY

Normally all accessories are packed separately in plastic sheeting and/or cardboard boxes.

Sometimes they can be loosely packed together where there is no danger of damage or deterioration or loss of loose parts.

All boxes and plastic sheeting must be marked with at least one label showing the manufacturer's name, the product type, part measurements, and number of single parts contained in the box or bag, plus all details necessary for stocking and stock expiry dates.

All electrofusion accessories must be printed with a bar code and an individual magnetic card. The magnetic card contains the welding parameters that have been encoded in the magnetic track, as well as the bar code printed on the card. Coding must be carried out according to prescriptions included in ISO TR 13950 standards.

With regard to stocking guarantee, accessories must correspond with the prescriptions of the local laws & regulations if any. If the guarantee period decided by the manufacturer is shorter that that in these document, the Owner must be informed in writing at the time of the offer.

13. QUALITY CONTROL

13.1. GENERAL RULINGS

13.1.1. Manufacturer's responsibility

The manufacturer is entirely responsible for the quality of the PE accessories manufactured by his firm.

All control checks prescribed above do not relieve him of this responsibility.

To ensure that all PE accessories are in compliance with the specification in all aspects, they must be controlled by the plant control service, which must be independent from the manufacturing department.

All PE accessories supplied are guaranteed for a one-year period after application for use, that is a maximum of three years after the date of production.

13.1.2. Quality assurance

The manufacturer must have some form of quality control to ensure that products comply with EN standards 29001 or 29002. The quality assurance manual must be madeavailable to the Owner Control Service or an external Control laboratory appointed byhim.

The system of quality assurance must be certified by an authorised body.

13.2. CONTROLS

13.2.1. Control testing b y the manufacturer

13.2.1.1. By material batch.

The manufacturer demands a certificate from the raw material manufacturer including the following :

- Fluid index
- Water content
- Volume mass
- Carbon black or yellow stabilising agent content
- Carbon black or yellow stabilising agent quality
- OIT value (thermal stability)

13.2.1.2. By accessory batch

The manufacturer must run control checks as follows :

- Appearance / colour
- Measurements
- Hydraulic testing
- Electrical resistance
- Printing/marking.

Control checks and the number of tests must be carried out according to the prescriptions of the EN standard 1555-3

Also refer to table N° 8, paragraph 4.2.3. “Lot release tests” of EN standard 1555-7.

The results must be written out in documents that contain the complete identification of the accessory batch.

These documents must be made immediately available for the Owner representative.

13.2.2. Plant Reception by the Owner Control Service representative

13.2.2.1. General information

All quality controls must be run in the presence of the Owner Control Service representative.

All tests and control checks must comply with appropriate standard prescriptions and with the specific specifications established with the order.

At each visit by the Owner representative, the manufacturer must provide, free of charge, all means and personnel necessary for running the established control checks.

While the order is under production, the Owner representative must have access to stocking installations of all raw materials before manufacturing, manufacturing and control installations, as well as the accessory stocking areas for any control checks he is responsible for.

During his visits, the Owner representative will receive a certificate as soon as he reaches the plant for each batch of accessories presented for reception.

Each time this is requested by the Owner representative, the manufacturer must provide recent reports of all control checks and measuring instrument results and testing results.

13.2.2.2. Convocation for reception

Convocation instructions for reception are to be defined with the order.

13.2.2.3. Reception control checks

For each accessory batch or any fractions of the batch, minimal batch sampling is established in annexed enclosure 3. These control checks and tests are to be run according to the prescriptions of EN standard 1555-3

13.3. ACCEPTANCE OR REFUSAL

13.3.1. Appearance, measurements and marking

Any requirements not supplied will lead to the refusal of the complete batch. However in the case where a batch is refused, it can be presented for approval again after a control check, on agreement with the Owner Control Service.

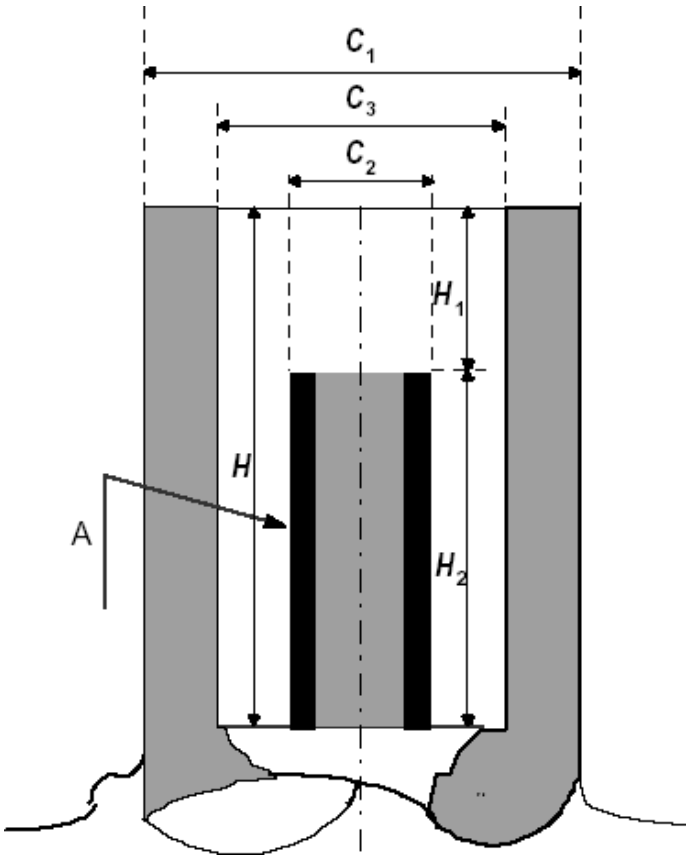
13.3.2. Control check on characteristics

All results that do not comply with the specification prescriptions and the particular specifications requested with the order, demand counter-testing on at least double the number of the samples previously tested. If the undesirable result is confirmed, then the batch is refused permanently. If the result is positive, then the batch will be accepted.

As a complementary control check, other analyses and/or tests can be run after common agreement, and at the manufacturer's cost.

ANNEX 1

CONNECTOR FOR ELECTROFUSION ACCESSORIES



Symbols

C_1	External diameter of connector	C1≥ 11,8 mm
C_2	Diameter of active part of connector	C2 = 4.0 ±0.03 mm
C_3	Internal diameter of connector	C3 = 9,5 ±.1,0 mm
C_4	Max. Diameter of active part foot	C4 ≥ 6,0
H	Connector internal depth	H ≥ 12,0 H ≥ H1 + H2
H_1	Distance between upper part of connector and active part	H1 = 3,2 ± .0,5
H_2	Height of active part	H2 ≥.7,0 mm
A	Active zone.	

RECEPTION AT MANUFACTURER'S PLANT.

Characteristics	Reference EN 1555-3	Minimum drill tests / frequency	N° of samples	N° of measure/ samples
Appearance /colour	5.2 /5.3	1 x /size / product type / internal space	10	1
Measurements	6	1 x /size / product type / internal space	10	1
Thermal stability (OIT)	8.2	1 x batch	1	1
Meltmass/flow rate (MFR)	8.2	1 x batch	1	1
Electrical resistance	5.6	1 x /size / product type / internal Space	5	1
Cohesion resistance	7.2	1 x /size / product type	2	1
End-to-end seam resistance to traction (cohesion resistance)	7.2	1 x /size / product type	2	1
Shock resistance	7.2	1 x /size / product type	1	1
Load loss	7.2	1 x /size / product type	1	1
Marking	10.2	1 x /size / product type	1	1

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Polyethylene compounds for manufacture of pipes and fittings for underground networks for natural gas distribution

Acceptance procedure

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1. SUBJECT

This specification describes the procedure to be followed for acceptance of a polyethylene (PE) compound for manufacture of natural gas underground distribution systems.

This specification also gives the minimum requirements which have to be met by PE compounds for manufacture of pipes, fittings and valves and for the construction of underground distribution systems for natural gas.

The compounds that meet this specification must at the minimum be PE 100.

The colour shall be black or orange in accordance with the local requirements.

2. REFERENCES: STANDARDS AND SPECIFICATIONS

This section contains the list of standards and specifications referred to in this specification.

EN 728: 1997	Plastics piping and ducting systems – Polyolefin pipes and fittings - Determination of oxidation induction time.
prEN 1555-1	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 1: General
EN 1555-3 prEN 1555-7	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 7: Assessment of conformity.
prEN 12099	Plastics piping systems - Polyethylene piping materials and components - Determination of volatile content.
prEN 12118	Plastics piping systems - Determination of moisture content in plastics by coulometry.
EN ISO 12162: 1995	Thermoplastics materials for pipes and fittings for pressure applications - Classification and designation - Overall service (design) coefficient.
EN ISO 13478: 1997	Thermoplastics pipes for the conveyance of fluids - Determination of resistance to rapid crack

	propagation (RCP) - Full-scale test (FST).
EN ISO 13479: 1997	Thermoplastics pipes for the conveyance of fluids - Determination of resistance to crack propagation (RCP) - Test method for slow crack growth on notched pipes (notch test).
EN 45001: 1990	General criteria for the operation of testing laboratories.
ISO 1133: 1997	Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics.
ISO 6964: 1996	Polyolefin pipes and fittings - Determination of carbon black content by calcination and pyrolysis - Test method and basic specification.
ISO/DIS 9080	Plastics piping and ducting systems - Determination of the long-term hydrostatic strength of thermoplastics materials in pipe from by extrapolation.
ISO 11420: 1996	Method for the assessment of the degree of carbon black dispersion in polyolefin pipes, fittings and compounds.
ISO 13477: 1997	Thermoplastics pipes for the conveyance of fluids - Determination of resistance to rapid crack propagation (RCP) - Small-scale-steady-state test (S4 test).
TBL 70000/740/GTS/0008 to 70000/740/GTS/0010	Polyethylene pipes for underground networks for natural gas distribution
TBL 70000/740/GTS/0011	PE Accessories for underground networks for natural gas distribution

3. DEFINITIONS AND SYMBOLS

3.1. LOWER CONFIDENCE LIMIT (LCL)

A quantity with the dimensions of stress, in megapascal, which can be considered as a property of the material under consideration and represents the 97.5% lower confidence limit of the predicted long-term hydrostatic strength at a temperature of 20°C for 50 years with internal water pressure.

3.2. MINIMUM REQUIRED STRENGTH (MRS 10)

Standardised class of compounds for which the LCL is equal to 10.

3.3. PE 100

Standard designation for PE compounds in class MRS 10.

For such PE compounds, the long-term hydrostatic strength - calculated and classified according to the standardised method (ISO 9080 and ISO 12162) for a temperature of 20°C, a period of 50 years and a reliability of 97.5 % – must be at least 10 MPa.

3.4. BATCH OF COMPOUND

By batch of compound is meant a homogeneous quantity of PE compound of the same origin and of a particular brand.

The batch must be registered under a single identification number (batch number) which leaves no doubt as to the origin, identity and date of manufacture of the compound.

3.5. BATCH OF PIPES

By batch of pipes is meant a homogenous lot of pipes with identical dimensions, made in a continuous process by the same extrusion machine and from the same batch of compound.

4. GENERAL SPECIFICATIONS

The PE compounds that are acceptable according to the requirements of this specification must conform to the requirements for PE 100 described in prEN1555-1.

If the proposed compound is destined for manufacture of pipes, then the acceptance procedure is carried out as described in this specification.

If the proposed compound is destined for manufacture of fittings, then the first stage (section 6) of this acceptance procedure is carried out, after which type tests are carried out on the fittings manufactured from the material concerned. An independent laboratory appointed by Owner will then evaluate whether conformity with the characteristics mentioned in the technical file has been proved, on the basis of the provisions of prEN 1555-7 and Tractebel specification TBL 70000/740/GTS/0011.

5. SUMMARY OF THE PROCEDURE

5.1. GENERAL

The acceptance procedure for PE compounds comprises two stages, namely the evaluation of the technical file and the confirmation tests. The different steps are carried out in the order described below.

The tests which form part of the technical file are carried out on pipes or samples supplied by the compounds manufacturer. In principle, all tests mentioned in the technical file are carried out on pipes from the same batch.

The tests mentioned in chapter 7 are carried out on pipes manufactured by a pipe manufacturer chosen by Owner.

The tests mentioned in chapter 6.1 (table 1), 6.2 and 7 are carried out in a laboratory appointed by Owner.

5.2. APPLICATION FOR APPROVAL

A manufacturer that wishes to have a certain PE compound classified for the manufacture of PE gas components must submit a written application to Owner.

This application must be accompanied by a clear description of the compound concerned, including the technical characteristics.

All correspondence must be in English.

6. TECHNICAL FILE

6.1. EVALUATION

If the application is taken into consideration by Owner, the compound manufacturer must submit a technical file to a laboratory appointed by Owner.

This technical file must include the following information:

- name and class of the PE compound;
- technical characteristics of the compound, with reference to the standard;
- a dossier with test results, from an independent laboratory, showing that the proposed compound meets the requirements of prEN 1555-1 for a PE 100 compound. The dossier must also state which tests have been carried out on the same batch of pipes or test samples, including the identification of their origin.

The laboratory chosen by Owner will also evaluate the conformity of this dossier, taking the following rules into account:

a) If the tests mentioned in the technical file have been carried out by a laboratory accredited according to EN 45001, and if the tests have been carried out on the same batch of pipes for the required diameter and wall thickness, then the evaluation will be limited to an examination of the dossier in accordance with the provisions of prEN 1555-1 and the quantity of test samples laid down in 1555-7;

b) If the tests mentioned in the technical file have been carried out by a laboratory that is not accredited according to EN 45001 and/or on different batches of pipes for the same diameters/wall thickness, then the evaluation will be done on the basis of further tests in order to confirm the characteristics mentioned in the technical file.

c) The characteristics for rapid crack propagation (RCP) and slow crack propagation (SCG), as mentioned in the technical file, must comply with the requirements of the standard. Furthermore, the requirements of table 1 must be met:

Table 1

Characteristic	Requirement	Standard
Pc S4	DN 250 - SDR 11 0^{O}c - > 3,5 BAR	ISO 13477
Pc FS	DN 250 - SDR 11 0^{O}c - > 15 BAR	EN ISO 13478
SCG	DN 250 - SDR 11 80^{O}c - σ4,6 - > 500 h	EN ISO 13479

The tests mentioned in table 1 must be carried out by an independent laboratory appointed by Owner. The three series of tests must be carried out on the same batch of pipes.

If it emerges from the evaluation of the technical file that conformity with prEN 1555-1 is guaranteed, then the next stage of the procedure can commence, as described in section 7.

6.2. ADDITIONAL TESTS

6.2.1. General

If from the evaluation it emerges that the dossier submitted is incomplete or does not offer the necessary guarantees of conformity with the standard, then additional tests will be carried out by the laboratory appointed by Owner, at the cost of the compound manufacturer.

The same procedure will be followed if the technical file has been drawn up by a laboratory that is not accredited and/or if several batches of pipes have been used for each diameter/wall thickness in carrying out the tests.

6.2.2. Delivery of the pipes

The required batch of pipes must be delivered by the compound manufacturer, the pipes having been produced by a pipe manufacturer who at that moment is a Owner supplier.

The number of pipes must be based on the numbers and frequencies mentioned in prEN 1555-7.

If the technical file is based on tests carried out by a non-accredited laboratory and/or carried out on several batches of pipes per diameter/wall thickness, then the tests will repeated on at least half of the required test samples; if the number thus calculated is not a whole number, the number of test samples taken will be equal to the next whole number.

6.2.3. Test results

If from the additional tests it appears that conformity with prEN 1555-1 is guaranteed, then the next phase of the procedure can commence, as described in section 7.

If despite the additional tests no unambiguous decision can be taken regarding the conformity of the compound, then further additional tests will be carried out, until the number of test samples is at maximum equal to the number specified in the standard concerned. For this purpose, the manufacturer must keep sufficient pipes of the same batch in reserve.

If the evaluation is still not positive after the maximum number of samples has been tested, then the compound will be considered as not accepted.

7. CONFIRMATION TESTS

The second stage of the acceptance covers the industrial production of pipes, the verification of the characteristics, the laying of the pipes and the fusion to existing PE systems.

This second stage of the acceptance is carried out by Owner.

Before this stage can commence, the manufacturer must provide Owner with a technical data sheet (see appendix 1) showing the limit values for the characteristics of the compound concerned.

For the purpose of carrying out this part of the procedure, Owner will order a batch of pipes from one of its pipe manufacturers. After verification of the characteristics in the factory and confirmation by an independent laboratory, the pipes will be installed in the Owner gas distribution network, taking into account the following aspects:

- Any problems with delivery and with extrusion of the compound will be noted.
- The limits of the characteristics mentioned in the technical data sheet.
- For characteristics not included in the technical data sheet, the measured value may
- deviate by max. 30% from the average values mentioned in the technical file, to the extent that these are relevant and not in conflict with the requirements of the standard.
- Any problems with laying or welding or connecting the pipes; these will be noted.

If from the test results it appears that the characteristics of the compound and/or pipes do not comply with the requirements, or if anomalies are found in laying and/or welding of the pipes, then the acceptance procedure will be provisionally suspended. The problems found will be analysed in consultation with the compound manufacturer, and an attempt will be made to find solutions which are acceptable to both parties. If this turns out to be impossible, then the compound will be considered as not accepted.

In such a case, the costs of the second stage could be charged to the compound manufacturer.

If the second stage of the procedure is successfully completed, then the compound is accepted and will be included in the list of “Approved PE Compounds”. This list is published in the Tractebel specifications for PE pipes (TBL 70000/740/GTS/0008 to 0010) and PE fittings (TBL 70000/740/GTS/0011). The materials will be included when the list is next published (around once every two year).

8. FOLLOW-UP

8.1. TECHNICAL DATA SHEET

The manufacturer must supply Owner with a technical data sheet, as described in Appendix 1, with permission for Owner to publish this technical data sheet in the specifications for PE pipes and fittings, for as long as the compound is included in the list of approved compounds.

The data entered on this data sheet apply as limit values for the compound concerned. Whenever one or more characteristics of a batch of compounds falls outside these limits, then the batch will be automatically refused for production of components destined for our gas network.

8.2. CONTINUITY OF THE COMPOUND

No alterations may be made to the compound without prior permission from Owner.

As mentioned in 8.1, the limits mentioned in the technical data sheet must be respected. Furthermore, in the case of characteristics not included in the technical data sheet, the measured values may not deviate by more than 30% from the average value mentioned

in the technical file, to the extent that these are relevant and not in conflict with the requirements of the standard.

Each change that affects the final characteristics of the compound can result in additional tests being carried out by the compound manufacturer in accordance with the provisions of prEN 1555-7 appendix A. The procedures for the test shall correspond to those described in section 6.1 of this specification.

APPENDIX 1

Technical Data Sheet

Characteristics of (*name of PE compound*)
as per prEN 1555-1

Characteristics	Standard	Specification
MRS	EN ISO 12162	> …. MPa
Density	Method D of ISO 1183	
min.		…. kg/m3
max.		…. kg/m3
MFR 190/5	ISO 1133	
min.		…. g/ 10 min
max.		…. g/ 10 min
Volatile content	prEN 12099	
max.		…. mg/kg
Water content	prEN 12118	
max.		…. mg/kg
Carbon black content	ISO 6964	
min.		…. %
max.		…. %
Carbon black dispersion	ISO 11420	
max.		≤ grade …
OIT at 210°C	EN 728	
min.		… min

Company .....

Person responsible .....

Position .....

Signature .....

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POLYETHYLENE VALVES FOR NATURAL GAS DISTRIBUTION UNDERGROUND NETWORK

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1. SCOPE AND FIELD OF APPLICATION

This General Technical Specification specifies the requirements for valves and its component made from extruded or injected moulded polyethylene (PE) and which are intended to be used for the Natural gas distribution systems where the maximum operating pressure (MOP) is equal to 5 bar.

In addition, it specifies some general properties of the materials from which these valves are made.

It applies to bi-directional valves with spigot ends or electrofusion sockets intended to be fused with polyethylene pipes in accordance with the TBL 70000/740/GTS/0008-0009-0010 and 0012 PE pipe specification and with spigot fittings in accordance with the TBL 70000/740/GTS/0011.

This specification is limited to valves with a nominal diameter (d_n) up to and including 225 mm.

2. NORMATIVE REFERENCES

prEN 1555-1	Plastics piping systems for the supply of gaseous fuels- Polyethylene (PE) - part 1 : General
prEN 1555-4	Plastics piping systems for the supply of gaseous fuels- Polyethylene (PE) - part 4 : Valves
prEN 1555-7	Plastics piping systems for the supply of gaseous fuels- Polyethylene (PE) - part 7 : Guidance for assessment of conformity
ISO CD 12176-4	Plastics pipes and fittings - Equipment for fusion jointingpolyethylene system - part 4 : raceability coding
ISO TR 13950	Plastics pipes and fittings - Automatic recognition systems for electrofusions
TBL 7000/740/GTS/0008	Polyethylene pipes for underground networks for Natural gas distribution - General requirements
TBL 70000/740/GTS/0009	Polyethylene pipes for underground networks for Natural gas distribution - Technical data sheet
TBL 70000/740/GTS/0010	Polyethylene pipes for underground networks for Natural gas distribution - Quality control of pipes
TBL 70000/740/GTS/0011	PE accessories for underground network for natural gas distribution
TBL 70000/740/GTS/0012	Polyethylene components for manufacture of pipes and fittings for underground networks for natural gas distribution - Acceptance procedure
TBL 70000/740/GTS/0013	Execution of works. Installation of polyethylene pipes

3. DEFINITIONS

3.1. NOMINAL SIZE DN/OD

Nominal size, related to the outside diameter.

3.2. NOMINAL OUTSIDE DIAMETER (d_n)

Specified outside diameter, in millimetre, assigned to a nominal size DN/OD.

3.3. NOMINAL WALL THICKNESS (e_n)

Numerical designation of the wall thickness of a component, which is a convenient round number, approximately equal to the manufacturing dimension in millimetre (mm).

Note : For thermoplastics components conforming to prEN 1555, the value of the nominal wall thickness en is identical to the specified minimum wall thickness at any point, e_{min}.

3.4. COMPOUND

Homogenous mixture of base polymer (PE) and additives, i.e. anti-oxidants, pigments, UV-stabilisers and others, at a dosage level necessary for the processing and use of components conforming to the requirements of this standard.

3.5. MAXIMUM OPERATING PRESSURE (MOP)

Maximum effective pressure of the fluid in the piping system, expressed in bar, which is allowed in continuous use. It takes into account the physical and the mechanical characteristics of the components of a piping system.

Note : It is calculated using the following equation : MOP = $\frac{(20xMRS)}{Cx(SDR-1)}$

3.6. VALVES

An obturating device designed to stop or restore the gas flow by operating the opening and closing mechanisms.

3.7. BASE PLATE

The valves are split into two models.

MODEL 1	Valve supply without base plate
MODEL 2	Valve supply with a base plate fixed or integrated

3.8. SPINDLE PROTECTION SLEEVE

A sleeve tube that protect the valve spindle. The protection sleeve exists in two models

VENTILATED	The sleeve is provided with opening and wrapped with textile fabric in order to let the gas escape and prevent the soil to go in.
NON VENTILATED	A normal sleeve tube without textile fabric.

3.9. EXTERNAL LEAK-TIGHTNESS

The tightness of the body enveloping the space containing the gas, with respect to the atmosphere.

3.10. INTERNAL LEAK-TIGHTNESS

The tightness between the inlet and the outlet of the valve, obtained by closing the operating mechanism.

3.11. LEAK-TIGHTNESS TEST

Test to determine

- the internal leak-tightness of the valve's closing seat when closed and pressurised from either side;
- the external leak-tightness of the valve when half open.

3.12. INITIATING TORQUE

Torque required to initiate movement of the obturator.

3.13. RUNNING TORQUE

Torque required to achieve full opening or closing of the valve at maximum allowable operating pressure.

3.14. LEAKAGE

Emission of gas through the body, sealing membrane or any other component of the valve.

4. GENERAL SPECIFICATION

The present specification is based on the European Standards EN 1555 series prepared by technical committee CEN/TC 155 plastic technical and ducting system.

The requirements of this General technical specification are chosen in order to guarantee a high quality gas system which will respond to the European Standards for gas supply systems.

- the valves described in this General technical specification comply with the standard prEN1555-4 and the complementary particular requirements or options of the present GTS.
- the valves are intended to be use in gas distribution networks made of PE pipes and accessories complying with TBL 70000/740/GTS/0008-0009-0010-0011-0012.
- the valves are laid and welded as specified in the TBL 70000/740/GTS/0013

5. MATERIAL PARTICULARITIES

5.1. GENERAL

All parts of the valve in contact with the gas stream shall be resistant to the gas, its condensates and other occurring substances such as dust.

All metallic parts of the PE valve shall resist to both internal and external corrosion.

5.2. PE COMPOUND FOR POLYETHYLENE VALVES BODIES

- The PE compound from which the valve body, with spigot end or electrofusion socket is made out, shall conform to prEN1555-1 and comply with the TBL 70000/740/GTS/0012 "acceptance procedure".
- The PE valves bodies are PE 100 class made from approved material as specified in the TBL 70000/740/GTS/0008 General requirements - appendix 1.

Are forbidden :

- use of recycled materials,
- mixture of different materials,
- addition of complementary materials.

5.3. SEALS

- The seals shall be homogeneous, without any inner crack, inclusion or impurities and cannot contain any component that can alter the properties of the materials they are in contact with, and prevent the non-conformity of those materials with the present specification.
- additives shall be distributed evenly.
- The rubber seal rings shall comply with standard EN 682.
- Other seals shall comply with the relevant standard and be suitable for gas service.

5.4. LUBRICANTS

Lubricants cannot have any adverse effects on the long-term performance of the valve parts.

5.5. OPERATING CAP

Operating cap are in plastic material or in metal, protected against corrosion.

6. VALVES GENERAL PARTICULARITIES

6.1. TECHNICAL FILE

The manufactures of the valves shall deliver for each type of valve a technical file which includes:

- Raw materiel used,
- drawings, dimensions and tolerances, including for the accessories,
- application range (temperature and pressure limits),
- running torque and initiating torque,
- pressure drop and flow diagram,
- test results and data proving the conformity of the valve in accordance with prEN1555-4 and prEN1555-7,
- the pipe elements used during valves testing have to be conform to the TBL 70000/740/GTS/0008,
- the assembly pipes/valves realised during testing shall be in conformity with the manufactures instructions and the extreme installation conditions.

- For the test assembly due consideration should be taken regarding the fabrication tolerances and the variation of the outside ambient temperature.

- The welding of the assembly will comply with TBL 70000/740/GTS/0013.

6.2. DESIGN

- The valves will be designed for a maximum operating pressure (MOP) equal to 10 bar.

- The wall thickness of the PE valve body shall be equal or greater than the minimum wall thickness of the corresponding SDR 11 series pipes.

- Valves body and valves ends form an indivisible whole.

- Except otherwise stated in the Owner purchase order, all valves will be "ball valve" type.

- The operating cap shall be designed in a way that it cannot be ejected "non blow out" type.

- The design of the extension spindle and the spindle protection sleeve will be such that they will never, in any case, even due to soil settlement, lay on the non reinforced part of the valve body or the valve ends. The spindle protection sleeve cannot turn during valve turning operation.

- The owner will specify if the spindle protection sleeve is a ventilated or non-ventilated type.

- The spindle protection sleeve ventilated type will have holes (min. diameter 10 mm) or slot type holes (min. width 1 mm) all around the sleeve in sufficient number in order to assure a maximum permeability for the gas.

- The sleeve will be covered by a non-waved geo-textile fabric (90 µm). The geo-textile fabric with a 50 mm overlap will be well secured on the sleeve;

- The valves should be equipped with a base plate. In order to achieve this, the valve body will be design with a flat base (model 1) or with an attached base plate or an integrated one (model 2). The Owner or his representative will specify the model.

- The operating mechanism and the stop wedges will be protected against water intrusion.

- The valve body is completely sealed except a passage for the spindle mechanism.

6.3. APPEARANCE AND COLOUR

- The internal and external surfaces of valves shall be smooth clean and shall have no scoring, cavities or other defects to an extend that would prevent non-conformity to the present GTS or to the standard prEN 1555-4.

- The colour of the PE valves shall be either yellow, black or orange.
- The colour of the valve shall be specify by the Owner or his representative in the purchase order;

6.4. DIMENSIONS

- The dimensions will be in conformity with the standard prEN1555-3 and prEN1555-4.
- The dimensions of the extensions spindle are detailed in appendix A.
- The operating cap will be design as per appendix B, C or D.
- The type of the operating cap will be specified by the Owner or his representative in the purchase order.
- The design of the extension spindle is such that the extension can be turn easily at
- any time to suit the site conditions.

7. MECHANICAL CHARACTERISTICS FOR ASSEMBLED VALVES

7.1. GENERAL

The valve shall have mechanical characteristics and be tested as specified in the standard prEN 1555-4.

7.2. RUNNING TORQUE

The running torque and the concept of the valve shall prevent the valve from being easily operated (by hand) without an operating key. To operate the valve designed with running torque as specified I the standard prEN 1555-4, the use of an operating key is requested.

Neither the operating cap nor the spindle shall be damaged when operating at maximum operating torque as specified in the standard prEN 1555-4;

7.3. INDIVIDUAL TEST (BATCH RELEASE TEST)

Before delivery each valves will be individually tested for mechanical strength and leaktightness as per standard prEN1555-4.

A combined mechanic resistance and leak-tightness test shall be performed in conformity with the prEN1555-4.

By batch of valves a supplementary leak-tightness test (25 mbar) shall be performed in conformity with the prEN 1555-4 on 3 valves taken at random.

7.4. PRESSURE DROP AT LOW PRESSURE

The drop of pressure is measured with natural gas as a medium and according to the diagram specified in the standard EN 12117 (fig.1).

The maximum drop of pressure measured with natural gas (inlet pressure 25 mbar) will be limited to 0,2 mbar for a nominal gas flow as per table below.

d_n	**Flow m^3/h**
32	10
40	15
63	60
90	180
110	250
160	600
200	1000

8. MARKING

At least the information given below shall be printed or formed directly on the valve :

a) Manufacturer's name and/or trademark;

b) Material and designation (e.g. PE 100);

c) Design application series (e.g. SDR 11);

d) Nominal diameter;

e) Internal fluid "gas";

f) Traceability code (valve and component) as per standard ISO/FDIS 12176-4;

g) Number of the system standard (e.g. prEN 1555-4) this information can be printed/formed directly on the valve or on a label associated with the valve or on an individual bag.

h) Production period, year and month;

The marking shall stay legible during normal manipulation, storage and installation.

The marking shall not adversely influence the performance of the valve and prevent the non-conformity of the valve.

No marking will be accepted at the valve spigot ends.

9. PACKAGING AND DELIVERY

The valve and its accessories shall be packaged individually in plastic bags in order to prevent them from deterioration. The valves ends shall be protected with external caps.

The cartons and/or individual bags shall bear at least one label with the manufacturer's name, type and dimensions of the part number, number of units in the box and, any special storage conditions and storage time limits.

10. GUARANTEE

The manufacturer will extend his guarantee for each part for 10 years after production. This guarantee period is valid if the parts are kept in proper conditions and in the original packaging.

The valves equipped with electrofusion sockets will be supply with a magnetic card and a code bar tag containing the welding parameters. The coding of the parameters shall be in conformity with the standard ISO TR 13950.

The operating manual (in English) will be inserted in the individual part package.

11. QUALITY CONTROL

11.1. GENERAL RULINGS

11.1.1. Manufacturer’s responsibility

The manufacturer is entirely responsible for the quality of the PE valves manufactured by his firm.

All control checks prescribed above do not relieve him of this responsibility.

To ensure that all PE valves are in compliance with the specification in all aspects, they must be controlled by the plant control service, which must be independent from the manufacturing department.

All PE valves supplied are guaranteed for 10 years after the date of production.

11.1.2. Quality assurance

The manufacturer must have some form of quality control to ensure that products comply with EN standards 29001 or 29002. The quality assurance manual must be made available to the Owner Control Service or an external Control laboratory appointed by him.

The system of quality assurance must be certified by an authorised body.

11.2. CONTROLS

11.2.1. Control testing by the manufacturer

11.2.1.1. By material batch.

The manufacturer demands a certificate from the raw material manufacturer including the following :

- Fluid index
- Water content
- Volume mass
- Carbon black or yellow stabilising agent content
- Carbon black or yellow stabilising agent quality
- OIT value (thermal stability)

11.2.1.2. By accessory batch

The manufacturer must run control checks as specified in the standard prEN 1555-4 and prEN 1555-7:

Control checks and the number of tests must be carried out according to the prescriptions of the EN standard 1555-4.

Also refer to table N° 8, paragraph 4.2.3. “Lot release tests” of standard prEN 1555-7.

The results must be written out in documents that contain the complete identification of the accessory batch.

These documents must be made immediately available for the Owner representative.

11.2.2. Plant Reception by the Owner Control Service representative

11.2.2.1. General information

All quality controls must be run in the presence of the Owner Control Service representative.

All tests and control checks must comply with appropriate standard prescriptions and with the specific specifications established with the order.

At each visit by the Owner representative, the manufacturer must provide, free of charge, all means and personnel necessary for running the established control checks.

While the order is under production, the Owner representative must have access to stocking installations of all raw materials before manufacturing, manufacturing and

control installations, as well as the accessory stocking areas for any control checks he is responsible for.

During his visits, the Owner representative will receive a certificate as soon as he reaches the plant for each batch of accessories presented for reception.

Each time this is requested by the Owner representative, the manufacturer must provide recent reports of all control checks and measuring instrument results and testing results.

11.2.2.2. Convocation for reception

Convocation instructions for reception are to be defined with the order.

11.2.2.3. Reception control checks

For each accessory batch or any fractions of the batch, minimal batch sampling is established in annexed enclosure 3. These control checks and tests are to be run according to the prescriptions of standard prEN 1555-4.

11.3. ACCEPTANCE OR REFUSAL

11.3.1. Appearance, measurements and marking

Any requirements not supplied will lead to the refusal of the complete batch. However in the case where a batch is refused, it can be presented for approval again after a control check, on agreement with the Owner Control Service.

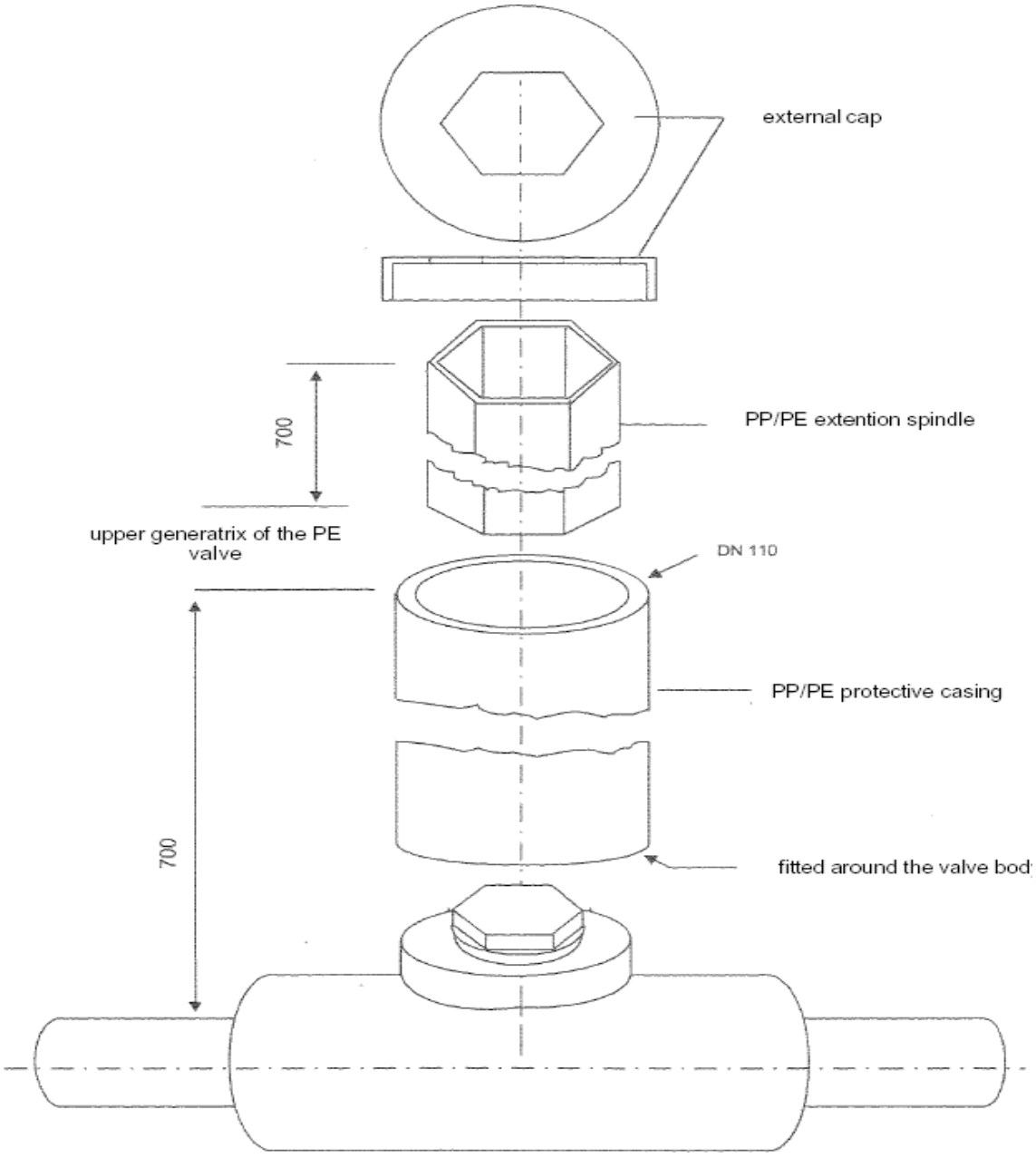
11.3.2. Control check on characteristics

All results that do not comply with the specification prescriptions and the particular specifications requested with the order, demand counter-testing on at least double the number of the samples previously tested. If the undesirable result is confirmed, then the batch is refused permanently. If the result is positive, then the batch will be accepted.

As a complementary control check, other analyses and/or tests can be run after common agreement, and at the manufacturer's cost.

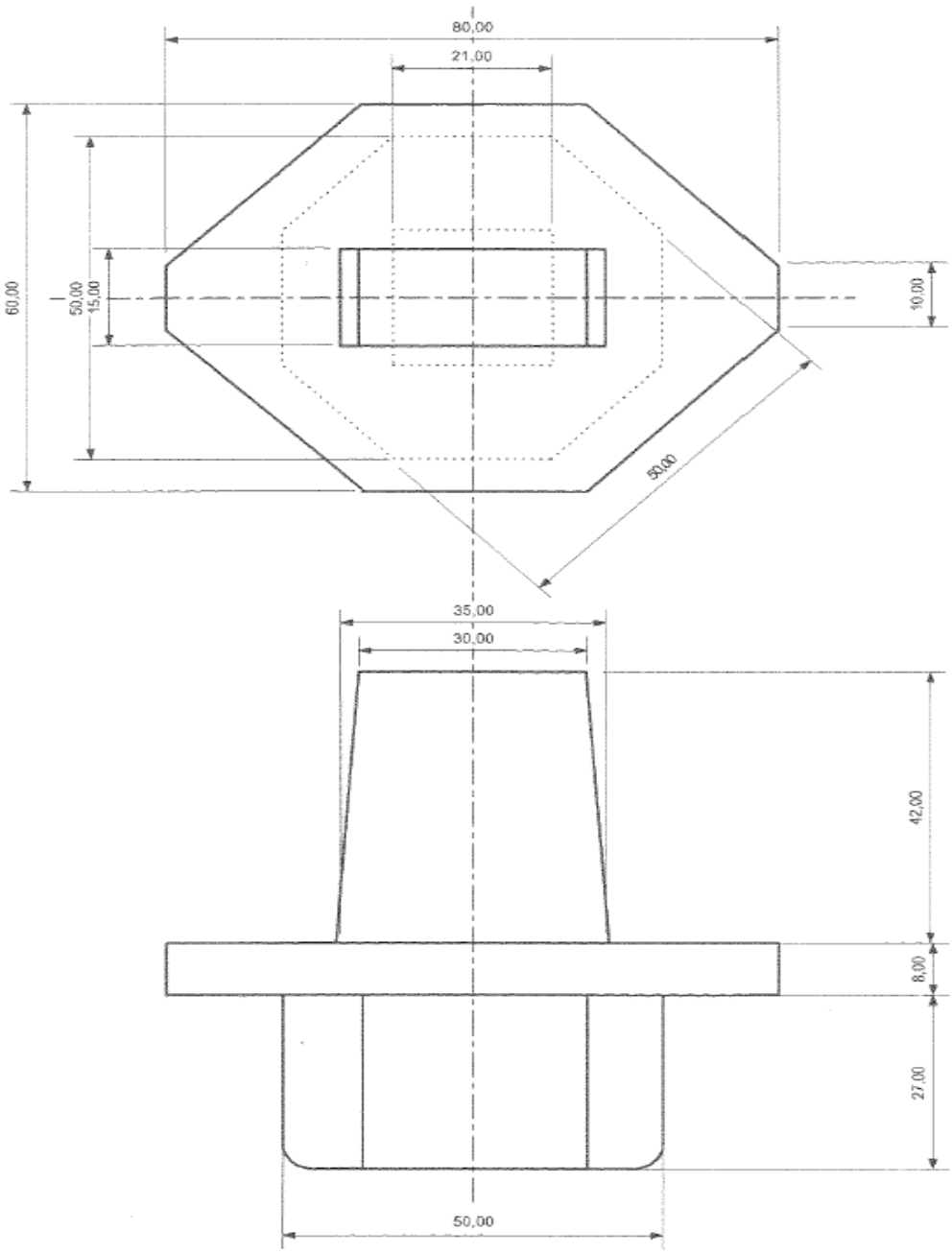
ANNEXE A

Dimensions of the extension spindle

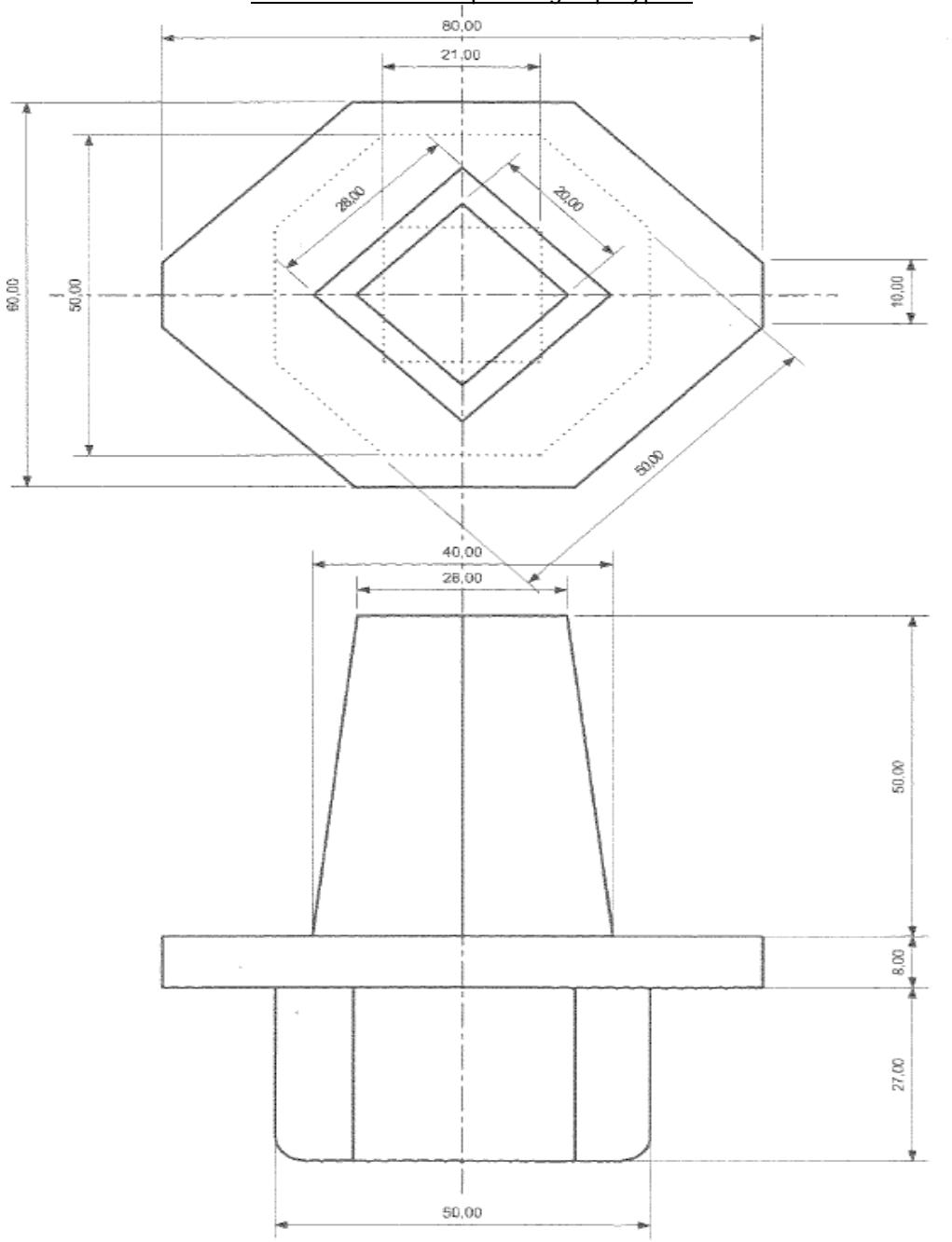


ANNEX B

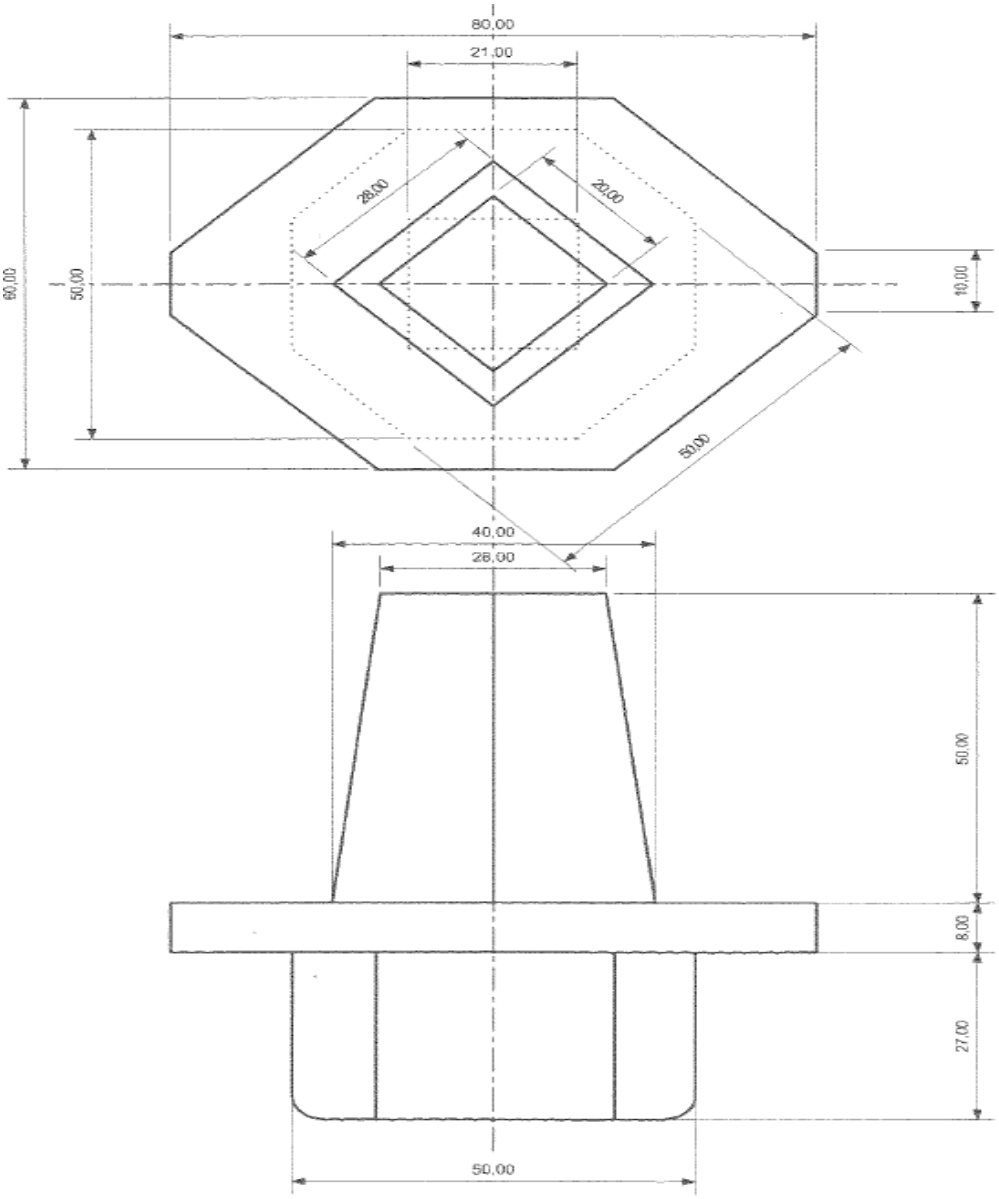
Dimensions of the operating cap Type A



Dimensions of the operating cap Type B



Dimensions of the operating cap Type C



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SOIL INVESTIGATION

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1. INTRODUCTION

The specification covers the procedure for soil investigation for foundation work involves carrying out boreholes upto minimum 15 m depth or upto refusal (when N values reaches 100), collecting (disturbed/undisturbed) soil samples, and carrying out different In-Situ and lab tests as per specifications.

2. IN- SITU GEOTECHNICAL WORK EXECUTION TECHNIQUE

2.1. Work Schedule

The program of the works must comply with the site availability.

2.2. Setting Up of The In-Situ Tests

2.2.1. The contractor shall be provided with the location of the in-situ tests. He must set up the tests at site, after locating the position of the boreholes accurately.

2.2.2. If the location, azimuth or inclination of any drill holes or in- situ tests does not conform to the given indication, such holes shall be executed anew at the contractor's expenses.

2.2.3. After completion of the work, the Contractor shall provide a map with the location of in -situ tests "as built".

2.2.4. Contractor should check for the presence of underground services prior to commencing of drilling or trial excavations and will validate and confirm that no underground services are at risk of being damaged or disturbed in any way.

2.2.5. In case specifications given under are insufficient, the test and works shall comply with relevant Indian Standard Specifications, wherever applicable.

2.2.6. Contractor is responsible for supplying the work site in due time with all material required for smooth and timely execution of work.

2.3. Execution of The Bore-Holes

2.3.1. General marks

a) Boreholes of 100 mm to 150 mm internal diameter shall be sunk to the required depth with Shell and auger equipment through sand, silt and clay, but excluding rocks, pebbles or grabbers.
b) The methods and machinery must, in all cases, tend to mark the levels and confirm the nature of the crossed layers.
c) If one of the crossed layers causes landslide or soil instability, the drilling hole is to be protected by any efficient means, provided the subjacent soil is not contaminated. Bentonite slurry can be used in case of cohesionless soils.
d) The drilling machine is to be steered by a chief drilling operator with the help of at least one experienced workman.
e) The method of drilling is the responsibility of the Contractor. This method must permit to collect samples for identification and description of the crossed layers. The Contractor shall propose his method before starting the works.
f) The drilling is to be vertical.
g) During the drilling operation, all incidents are to be recorded, and in particular the losses of water, with estimates of flow and volume, possible caverns, rising of water level, alteration in type and colors of mud, etc.
h) The boreholes shall be cased throughout the depth of boring.

i) Boreholes shall be cleaned properly before conducting any in-situ test or taking out undisturbed samples.
j) After the tests are conducted, the boreholes shall be filled with sand.

2.3.2. Description of the bore log

a) Levels survey

During the drilling, the levels of separation of the different layers and the upper and lower levels of the possible caverns are to be recorded in relation to the level of topsoil.

The location of the water table is to be determined. The dates and hours corresponding, to the end of the perforation and to the recording of levels as well as the losses of water observed during the drilling are to be noted.

b) Soil Identification

As drilling progresses, the extracted soil shall be carefully preserved to enable its identification.

However the following information must be noted immediately:

- Sampling level,
- Temporary name given to the soil by the driller,
- Colour and odour,
- Soil consistency,
- Recuperation.

2.3.3. Undisturbed Soil Samples from Boreholes

The samples shall be minimum 100 mm dia and 450 mm long. Both the area ratio of the cutting edge as well as all recovery ratio of the cutting edge and the recovery ratio of the sample shall be measured and reported.

In order to reduce wall friction, suitable precautions such as oiling inside and outside the sampling tubes shall be observed. The sampling tube shall have smooth finish.

For highly sensitive soils, piston samples shall be employed. The undisturbed samples shall be tested within a period of two weeks of taking them from the boreholes or trial pit.

After recovery of sample, all exposed faces shall be sealed with wax to prevent moisture loss and the sample shall be properly labeled and transferred to the laboratory immediately.

The undisturbed samples shall be taken at an interval of 2 m or change of stratum whichever occurs earlier.

2.3.4. Disturbed Soil Samples from Boreholes

Disturbed soil samples shall be collected at ever4y half a metre and at every change of strata. Identification labels indicating depth, borehole number and visual soil classification shall be affixed on the container.

2.3.5. Documents to be supplied by the Contractor

At each time, the contractor shall fill in a report giving details on the work executed, describing difficulties and methods used, the description of machinery, the precise depth of each operation, etc.

In addition, two weeks after the completion of boring which is covered by the contract, the Contractor hands over a provisional report in two copies including a drilling log, and in particular:

- The reference number of the bore-hole
- The location marked on a map to a convenient scale together with the X, Y and Z co-ordinates of the bore-hole
- The point level from which depths are measured
- The diameter of the bore-holes
- The recuperation
- All observations and incidence noted by the operator concerning the boring operation
- The equipment in use and the process for drawing samples
- The levels of water at the start and at the end of each shift
- The date at which the boring starts and ends, together with a graph showing progress and effective preparation speeds
- The depths at each operation
- The reports on special tests or sampling with the numbers of the samples extracted and their position
- The sectional drawing of the bore-hole with references and symbolic representations of the nature of the crossed soils

A global report shall collect all the results and data from the various daily reports, from the drilling logs, etc.

Five copies of this global report shall be submitted two weeks after completion of the in-situ works.

The Contractor shall also submit over a reproducible original of all the maps, drilling maps, etc., which are part of his daily report and of the global report.

3. STANDARD PENETRATION TESTS IN THE BOREHOLES

3.1. Mode of Operation

Standard Penetration Tests shall be carried out during the boring in accordance with IS 2131 (latest). The depth of each test shall be correctly determined. In the event that the penetration resistance "N", determined in a test, is less than 5, the Engineer may require to clean out the borehole and to carry out another test immediately afterwards. Small-disturbed samples removed from the Standard Penetration Test split spoon sampler shall be taken in accordance with IS 2132 (latest). The Standard equipment with split spoon sampler in soil or solid cone in hard soil with 65 kgs hammer shall be used.

Unless otherwise instructed a Standard Penetration Test shall be carried out every 0.5m in the upper soft layers upto 2.0 m depth and at 1.0 m interval in the bottom layers.

3.2. Documents to be Supplied By The Contractor

The information on the Standard Penetration Test to be submitted by the Contractor consists of the following:

- Penetration resistance (Nblows/300 mm) or the Penetration (mm) for 50 blows. The procedure of testing and determination of N value shall be as per IS:2131 (latest).
- Depths (m) between which penetrations resistance is measured.
- Depth of casing and size at time of test.
- Before start of test depth SPT tools sunk under own weight from base of borehole.
- Number of blows for each 75 mm of Penetration including seating blows.
- Type of equipment
- Weight of hammer.
- Height of drop.
- Method of release.
- Use of drilling mud or casing.

Disturbed samples resulting from SPT shall be taken for classification purposes.

3.3. Document And Report

At the end of the investigation and on completion of all the tests, the contractor shall submit a report consisting of the following documents and recommendations.

3.3.1 All computations leading to the logical conclusion of bearing capacities of soil, safe capacity of piles etc. shall be included in report. If references are drawn from standard test books, such references shall be clearly indicated.

3.3.2 The report shall contain recommendation about: -

a) The safe net bearing capacity of soil for isolated / strip footings and proposed depth of footings, starting from bottom level.
b) Estimated lengths, and capacities of piles of various diameters, if recommended.
c) For design of retaining walls, recommendations shall be made as to the layer of excavated Design parameters like coefficient of earth pressure at rest shall be recommended.

4. STATIC CONE PENETRATION TEST

The equipment used for this test shall conform to the requirement of IS : 4968 (Part III). The capacity of equipment to be used for test shall not be less than 10.0 tonnes capacity. The test shall not be carried out on gravely soil and soil with standard penetration value 'N' greater than 50. Location of tests shall be indicated on the drawing.

4.1. Carrying Out The Test

The procedure shall meet the requirement of IS 968 (Part III). Some of the important points of the procedure given below.

a) CPT machine, equipped with suitable core shall carry out test down to a depth of 15 m or upto refusal whichever is earlier. Test shall be performed according to codal provision IS 968 (part III) / ASTM D 3441-98 (M2 type cone)/ ASTM D 5778-95 (E1 type cone)
b) Each CPT shall be carried out with an anti-friction device, placed above the friction sleeve, in order to penetrate as deep as possible.
c) Use of mechanical cone, with electrical measurement and recording of parameters, is prohibited.
d) If a M2 type cone is used, the cone resistance and lateral skin friction shall be measured at least at each 20 cm depth.
e) If an E1 type cone is implemented, a continuous recording of cone resistance, of the lateral skin friction and of the pore pressure versus depth is required for each test.
f) The level of water table encountered is to be noted for each test.
g) Results of test shall give cone resistance q_c, the total latest friction and the f_c "Friction Ratio" versus depth.
h) The CPT refusal is characterised by a cone-resistance (q_c) value of 60 Mpa, a local skin friction (fc) one of 1 Mpa/ or a total resistance one of 20 tons. The E1 type cone may be equipped with an inclinometer device. The refusal criterion on minimum allowed inclination shall be done or equal to 10^0. CPT cones with refusal valves lower than those quoted above will not be accepted.
i) The cone is pushed through a distance in accordance with the design of the equipment and the need for the sub-strata and the cone resistance noted. The cone and the friction jacket are pushed together subsequently for a distance depending upon, the design of the cone and friction jacket assembly and the combined value of cone and friction resistance noted. This procedure is repeated at predetermined intervals.
j) Equipment shall be securely anchored to the Ground at the test point for obtaining the required reaction.
k) The rod of the Driving mechanism shall be brought to the top most position. The cone –friction jacket assembly shall be connected to the first sounding rod and the mantle tube. The assembly shall be positioned over the test point through the mantle tube guide and held vertically. The plunger of the driving mechanism shall be brought down so as to rest against the protruding sounding rod.

l) To obtain the cone resistance this sounding rod only shall be pushed. Switching the gear clutch to the slow position, the drive handle shall be operated at a steady rate of 1 cm per sec approximately, so as to advance the cone only to a depth, witch is possible with the cone assembly available. During the pushing, the mean value of resistance as indicated by pressure gauges shall be need ignoring erratic changes.

m) For finding combined cone and friction resistance of the soil, the sounding rod shall pushed to the extent. The cone has been pushed at the rate of 1 cm per sec noting mean resistance on the gauges.

n) Above procedure shall be repeated after pushing the combined cone-friction jacket and mantle tube assembly to the next depth at the next depth at which the test is to be performed.

4.2. Reports

The CONTRACTOR fills in a daily report giving details of the tests carried out, difficulties encountered, depths achieved, resistance values measured etc.

The ENGINEER must have access to these documents at any time.

At the latest one week after the execution of each test, the CONTRACTOR submits to the ENGINEER two copies of a test report including :

- the test number,
- the execution date of the test,
- the location of tests on a map supplied by the engineer or on a sketch in comparison with known and fixed points,
- the ETM co-ordinates X, Y and Z of the test,
- the level of the point from which depths are measured,
- the level of water encountered,
- the characteristics of the equipment in use (type of cone, etc.)
- the test diagram showing the variations of the cone resistance, the local lateral friction and the "friction ratio" versus depth. The results are also supplied in the form of a table detailing the level, the depth, qc, fc and F_R. In addition, the contractor supplies a 3.5" compatible diskette (1.44 Mbytes or more). On this diskette, the results must be presented in three columns : depth, qc, fc and F_R.
- the remarks noted in the daily report;
- the calibration certificate(s) of the cone(s) used.

A global report including all the preliminary test reports shall be provided to the Engineer one week after completion of the work on site. This report must be reproducible and supplied in 5 copies.

5. DYNAMIC CONE PENETRATION TEST

The test shall be conducted by driving a standard size cone attached loosely or screwed to a string of drill rods. The driving system shall comprise of 65 Kg. weight having a free fall of 75 Cm.

5.1. Test Procedure

The method of conducting the test and details of the equipment shall conform to one of the two alternatives given below. The particular method to be followed is indicated under specific requirements.

a) The test shall be conducted in accordance with IS : 4968 (Part I). The cone size shall be 50 mm.

b) The test be conducted in accordance with IS : 4968 (Part II). A continuous flow of bentonite slurry shall be maintained through the rods and the cone so as to avoid friction between the rods and the soil. The cone size shall be 65 mm and provide with vents for flow of bentonite slurry.

The test shall be reported in a suitable tabular form giving blow counts for every 30 cm. Penetration, supplemented by a graphical plot of blow counts versus depth. The test shall be terminated when blow counts (Nc) exceeds 150 for two successive penetration of 30 cms each.

6. PLATE LOAD TEST

6.1. Plate Size And Thickness

a) For clayey and silty soils and for loose to medium compact sandy soils (N < 15) normally met with, checkered plate of 60 cm x 60 cm shall be used. Alternatively, circular plate of equipment area also may be used.
b) For dense sandy or gravelly soils (15< 30) the smallest size shall be 30 cm square and largest 75cm square. Circular plates of equipment area may also be used.
c) The minimum thickness of the chequered plate shall be 25mm.

6.2. Test Pit

a) Test pit shall be atleast five times as wide as the test plate and the depth of the pit shall be the same as the depth of actual foundations.
b) If the test is to be done on strata water table, the water level shall be maintained at the plate level, if necessary, throughout the test by dewatering, especially in sandy soils.
c) The test shall be conducted immediately after examination of soil.

6.3. Placing Of Test Plate

Plate shall be added to the soil by spreading fine sand in a layer not exceeding 5mm carefully levelled and set horizontally at the bottom of the pit. The ground shall be protected from rain and a minimum sealing pressure of 70g/cm2 shall be applied and removed before starting the load test.

6.4. Method Of Loading

The reaction method of loading shall be employed. In this method loading is done by a jack against suitable reaction, such as, a well designed truss anchored to the ground at the two ends by soil anchors, loaded platform or any other suitable device.

6.5. Application Of Load

a) Loading shall be carried out in increments of 1/5 design load or about 0.3 kg/cm2 whoever is lower.
b) Loading shall be carried out till one of the following conditions occur:

    1) Soil under the plate fails.
    2) Total settlement of the plate exceeds 40mm.
    3) A load intensity equal to thrice the design load is reached.
    4) Load intensity 6.5 kg/cm2 is reached.

6.6. Settlement And Observation

a) Settlement shall be recorded with four dial gauges.
b) Settlement shall be observed for each increment of load after an interval of 1, 4, 9, 16, 25, 36 and 64 minutes and thereafter every one hour.
c) The next load increment shall be applied when the rate of settlement is less than 0.05 mm/hour with a minimum period of two hours. For computing the rate of settlement its extrapolation for periods less than one hour shall not be permitted.

6.7. Unloading

a) Unloading shall be done in stages in the same manner as was done during the application of load. Rebound observations during the unloading also shall be noted.
b) Rebound shall be noted during unloading stages till the readings become reasonably constant.

6.8. Record

a) Record shall consist of the following:
   1) Load-settlement reading in tabular form.
   2) Time-Settlement curve for each load stage.
   3) Load- Settlement curve for each load stage.
   4) Load- settlement curve in natural and log-log scale.
   5) Modules of sub-grade reaction evaluated from test.

b) In addition to above the record shall also contain the following:
   1) Date
   2) List of personnel
   3) Weather conditions
   4) Irregularity in routine procedure, if any.

6.9. Post Test Requirements

a) Back filling of the pit be carried out in an approved manner and as per the directions of Engineer-in-charge on completion of test.
b) An auger bore shall be made from the depth of test extending to depth of 6.0m below test depth so as to ascertain the nature of sub-soil test depth. If required, undisturbed samples shall be obtained at suitable depths from bore hole.

7. DYNAMIC SOIL TESTS

7.1. General

The following tests shall be conducted for the determination of Elastic Modulus and Dynamic Shear modulus of the soil and their variation with confining pressure for use in the design of foundation subject to vibratory loads.

7.1.1. Wave velocity measurements

7.1.2. Resonance tests

7.1.3. Cyclic plate load test

7.1.4. Repeated triaxial shear test.

7.2. Wave Velocity Measurements

The test set up and method of conducting the tests shall conform to IS: 5249 (latest edition). Concrete block shall be cast at a minimum depth of 0.5 m in a virgin soil. Back filling of the pit shall be carried out in an approved manner and as per the directions of the Engineer-in-Charge after removing the concrete block on completion of the test.

7.3. Resonance Test

The block size and test depth be the same as laid out in 3.4.2 above. The equipment set up and method of conducting the tests shall conform to IS : 5249 (latest edition).

7.4. Cyclic Plate Load Test

The test set up and plate size small conform to that for plate load tests. After stabilization of settlements for each load increment, load shall be removed and elastic rebound & residual settlements recorded. Where necessary, more than one cycle of loading and unloading shall be applied until a steady state of settlements is reached.

7.5. Repeated Triaxial Shear Test

The test shall be carried out for confining pressure ranging from 0.5 kg/cm^2 to 4.0 kg/cm^2.

The traixial sample shall first be subjected to an initial load equal to the anticipated static working load, which shall be indicated at the time of testing. Positive and negative values of a small increment of load shall then be applied to the sample in cycles and a graph plotted of stress against strain. E-value shall be obtained from this plot after obtaining a stable state.

8. LABORATORY TEST ON SELECTED SOIL SAMPLES

8.1. Storing Of Soil Samples In Laboratory

8.1.1. Soil samples shall be inspected and tested shortly after their arrival at the laboratory.

8.1.2. Bags of canvas and bins can be used for storing large quantities of soil. The container should have a label or tag, which gives such data as soil type, project location, boring number, depth, etc.

8.1.3. If disturbed clay samples are taken from pit, they should be covered with a protective coating. The coating shall preferably be with wax having melting point between 120ºC to 160ºF. Wax coating can be applied by either dipping the soil samples in the melted wax or using a soft brush to spread the melted wax. Wax should not be heated to more than a few degrees above its melting temperature, since heating to higher temperature tend to drive off more volatile hydrocarbons, thus making the wax more permeable and more brittle upon coating.

8.1.4. If soil samples are to be stored for more than 15 days, then a protective coating of wax, in more than one layer, is recommended with a total thickness of 12 mm to 18 mm.

8.1.5. Few selected samples shall be stored in laboratory till the soil investigation report is finalized and approved by the Engineer-In-Charge.

8.2. Handling Of Undisturbed Samples In Laboratory

8.2.1. Undisturbed samples shall be handled in laboratory with due precautions to avoid distu8rbance and loss of moisture content which may adversely affect the test results.

8.2.2. Unprotected samples shall never be handled with bare hands because hands foster disturbance and loss of moisture. Sample shall be protected by using Aluminum cellophone or wax paper.

8.2.3. When transporting a specimen it should be supported over its entire length by using a mould, plate or paper sling(s).

8.3. Procedure Of Testing

8.3.1. All apparatus used for laboratory testing shall conform to the specifications laid down in relevant Indian Standards.

8.3.2. All testing procedures shall conform to relevant Indian Standards.

8.4. Tests To Be Performed

The following tests shall be performed on the selected soil samples (according to IS 2720) and water samples collected.

- Atterberg Limits: - Liquid limit + plastic limit shall be required for U.D. samples
- Natural Moisture: - shall be required for U.D. samples as per IS:2720, Part II.
- Particle size analysis: Sieve & hydrometer analysis as per IS:1498 on at least one sample from each stratum shall be required. Porosity of soil as well as uniformity coefficient shall be determined.
- Wet & Dry Density: for U.D. samples.
- SP Gravity: For one sample from each stratum.
- Unconfined compression Test: To be conducted at site on about 25% of U.D. Samples as per IS:2720, Part I.
- Triaxial Tests: unconsolidated undrained tests and consolidated drained tests shall be done on UD samples available at Laboratory.
- Consolidation Tests: on U.D. samples taken at least one from each stratum shall be conducted for a range of pressure from 2.7 t/sq.m to 8.6 t/sq.m as per IS:2720, Part XV.
- Chemical Tests: Sulphate & chloride contents of water samples.
- Sulphate, carbonate, chloride and organic matter, content of soil samples.
- Permeability Test :: Coefficient of permeability shall be determined as per IS:2720, Part XVII.
- Soil Resistivity :: Soil resistivity shall be carried out as per IS:3043.
- California Bearing Ratio Test :: This test shall be carried out as per IS:2720, Part XVI. Curve of load-penetration in arithmetic shall be plotted.

8.5. Report

8.5.1. The report shall state in brief the description of test procedure employed.

8.5.2. The report shall also include wherever required a sample calculation with reference to formula used to evaluate various parameters.

8.5.3. Report shall also contain the summary of various soil parameters evaluated.

8.5.4. Report shall indicate character and genesis of soil.

8.5.5. Report shall contain details of borelogs, subsoil sections, lab and field test results in tabular and graphical form and a plot plan showing locations and reduced levels of boreholes and other tests.

8.5.6. Results obtained and their interpretation shall be indicated in the report.

8.5.7. Report shall indicate type, depth, ultimate and safe bearing pressure and settlement of foundation for following structures:

8.5.7.1. Power Plant Equipments, which carry heavy unit load.

8.5.7.2. Admonish building etc. which are lightly loaded.

8.5.7.3. Storage tanks and other structures found at or near ground surface.

8.5.8. Recommendations shall also be given for allowable bearing pressure and settlements for foundations of various sizes and at different depths ranging from surface to 5 m depth.

8.5.9. Report shall indicate aggressiveness of soil and soil water to reinforced concrete and steel and other building materials.

8.5.10. Report shall indicate suitability of soil and degree of compactness of fill for the pavement and recommendation for thickness of pavement for Class AA and Class A loadings.

8.5.11. Modules of subgrade reaction for pressure ranging upto 3 kg/cm^2 shall be indicated in the report. The recommended values shall include the effect of size, shape and depth of foundation.

8.5.12. In case of poor soil conditions recommendations are to be made for ::

a) Grand treatment method,
b) Pile foundations if considered necessary. If so, type of pile, depth of pile, safe load capacity of pile etc.

8.5.13. Upon completion of tests, the Contractor shall submit two (2) interim and five (5) final copies of the report.

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BRICK MASONRY

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1. GENERAL

This specification establishes the materials, dressing, laying, joining, curing, workmanship etc. for brick masonry works. Brick masonry shall also comply with all the requirements of IS specification.

2. REFERENCE

2.1. BIS Codes

IS:2212, 2250.

2.1.1. Sequence

Commencement, scheduling and sequence of works shall be planed in detail and must be specifically approved by the Owner's Representative. However, the contractor shall remain fully responsible for all normal precaution and vigilance to prevent any damage to works whatsoever till handing over.

3. MATERIALS

Cement shall be ordinary Portland Cement (Grade 43) conforming to IS 8112.

Bricks of Class I shall be table moulded / machine made of uniform size, shape and sharp edges and shall have minimum compressive strength of 75 Kg/cm^2.

4. GENERAL REQUIREMENTS

4.1. Mixing Mortar

IS 2250 shall be followed as general guidance for preparation and use of mortar. Only cement – sand mortar shall be used.

Unless otherwise specified mortar for brick work having one or more brick thickness shall be 1 part cement & 6 part sand by volume and for half brick work shall be 1 part cement and 4 part sand by volume.

Mortar shall meet the compressive strength requirement as per IS 2250 and IS 1905. sand shall conform to IS 2116 and grading shall be tested as per IS 2386.

4.1.1. Proportioning

The unit of measurement for cement shall be a bag of cement weighing 50 kgs and this shall be taken as 0.035 cubic metre. Sand shall be measured in boxes of suitable size on the basis of its dry volume. In case of damp sand, its quantity shall be increased suitably to allow for bulkage.

4.2. Mixing

The mixing of mortar shall be done in a mechanical mixer operated manually or by power. The Owner's Representative may, however, permit hand-mixing as a special case, taking into account the magnitude,

nature and location of work. The Contractor shall take the prior permission of Owner's Representative, in writing, for using hand-mixing before the commencement of work.

4.2.1.1. Mixing in Mechanical Mixer

Cement and sand in specified proportions, by volume, shall be thoroughly mixed dry in a mixer. Water shall then be added gradually and wet mixing continued for atleast one minute. Care shall be taken not to add more water than that which shall bring the mortar to the consistency of stiff paste. Wet mix from the mixer shall be unloaded on water-tight masonry platform, made adjacent to the mixer. Platform shall be atleast 150 mm above the levelled ground to avoid contact of surrounding earth with the mix. Size of the platform shall be such that it shall extend atleast 300 mm all-round the loaded wet mix area. Wet mix, so prepared, shall be utilised within initial setting time [thirty (30) minutes either for ordinary Portland cement conforming to IS:269 after addition of water. Mixer shall be cleaned with water each time before suspending the work.

4.2.1.2. Hand Mixing

The measured quantity of sand shall be levelled on a clean water-tight masonry platform and cement bags emptied on top. The cement and sand shall be thoroughly mixed dry by being turned over and over, backward and forward, several times till the mixture is of uniform colour. The quantity of dry mix which can be consumed within initial setting time of cement shall then be mixed with just sufficient quantity of water to bring the mortar to the consistency of stiff paste.

5. CONSTRUCTION PROCEDURE

5.1. Soaking of Bricks

Bricks shall be soaked in water before use for a period that is sufficient for the water to just penetrate the whole depth of bricks as well as to remove dirt, dust and sand. Proper soaking of bricks shall prevent the suction of water from the wet mortar as otherwise mortar will dry out soon and crumble before attaining any strength. The bricks shall not be too wet at the time of use as they are likely to slip on mortar bed and there will be difficulty in achieving the plumbness of wall as well as proper adhesion of bricks to mortar. The period of soaking shall be determined at site by a field test by immersing the bricks in water for different periods and then breaking the bricks to find the extent of water penetration. The least period that corresponds to complete soaking, will be the one, to be allowed for in the construction work.

The soaked bricks shall be removed from the tank, well in advance, so that at the time of laying, they are only skin dry. The soaked bricks shall be stacked over a clean place, wooden planks or masonry platforms to avoid earth, dirt being smeared on them.

5.2. Laying

5.2.1. Brick Work (one or more brick thickness)

IS:2212 shall be followed as general guidance for construction of brick masonry.

Brick work (one or more brick thickness) shall be laid in English Bond unless otherwise specified. Half or cut bricks shall not be used except when needed to complete the bond. In no case the defective bricks shall be used.

A layer of average thickness of 10 mm of cement mortar shall be spread on full width over a suitable length of lower course of the concrete surface and shall be so laid that all joints are full of mortar. In order to

check and achieve uniformity in masonry, the thickness of bed joints shall be such that four courses and three joints taken consecutively shall measure equal to four times the actual thickness of the brick plus 30 mm. Each brick with frog upward, shall be properly bedded and set in position by gently tapping with handle of trowel or wooden mallet. Its inside faces shall be buttered with mortar before the next brick is laid and pressed against it. After completion of the course, all vertical joints shall be fully filled from top with mortar.

All brick courses shall be taken up truly plumb; if battered, the batter is to be truly maintained. All courses shall be laid truly horizontal and vertical joints shall be truly vertical. The level and verticality of work in walls shall be checked up at every one metre interval.

The masonry walls of structures shall be carried up progressively, leaving no part one metre lower than the other. If this cannot be adhered to, the brick work shall be raked back according to bond (and not left toothed) as an angle not more than 45 degrees but raking back shall not start within 60 cm of a corner. In all cases, returns, buttresses, counter forts, pillars etc. shall be built up carefully course by course, and properly bonded with the main walls. The brick work shall not be raised more than fourteen (14) courses per day.

At the junction of any two walls, the bricks shall at each alternate course, be carried into each of the respective walls so as to thoroughly unite the work.

The courses at the top of plinth and sills, at the top of the wall just below the soffit of the roof slab or roof beam and at the top of the parapet, shall be laid with bricks on edge unless specified otherwise. Brick on edge course shall be so arranged as to tightly fit under the soffit of the roof beam or roof slab, restricting the mortar layer thickness upto 12 mm, however, any gap between the finished brick work and soffit of roof slab/beam shall be suitably sealed with the mortar. Care shall be taken that the brick forming the top courses aid ends of wells are properly radiated aid keyed into position.

5.2.2. Brick Work (half brick thickness)

For brick walls of half brick thickness, all courses shall be laid in stretcher bond. Wall shall be reinforced with 2 nos. – 6 mm diameter mild steel reinforcement bars, embedded at every third course. These bars shall be securely anchored into the masonry at the ends or shall be keyed into the main brick work as the case may be. Half the mortar thickness for the bedding joint shall be laid first and mild steel reinforcement, one on each face of the wall, shall be embedded, keeping a side cover of 12 mm mortar. Subsequently, the other half of the mortar thickness shall be laid over the reinforcement covering it fully.

The reinforcement bars shall be carried at least 150 mm into the adjoining walls or RCC columns. In case the adjoining wall being of half brick thickness, the length of bars shall be achieved by bending the bars in plan. During casting of reinforced concrete columns, 6 mm dia. M.S. reinforcing bar shall be placed at every fourth course of brick masonry. At the junction of two walls, the brick shall, at each alternate course, be carried into each of the respective walls so as to thoroughly unite the work. The brick masonry work shall not be raised more than 14 courses per day.

Brick course under the soffit of beam or slab, shall be laid by restricting the mortar thickness to 12 mm. However, any gap between the finished brickwork and soffit of slab/beam, shall be suitably sealed with the mortar.

5.2.3. Cavity Walls

Brick work in cavity walls shall be included with general brickwork. It shall consist of one wall of one or more brick thickness while the other wall shall be of half brick thickness at a clear gap of 50 mm. The brick work on with side of cavity shall conform to the specifications already stated under 5.2.1 and 5.2.2. At the base of the cavity wall, the walls shall be solidly constructed upto 300 mm above the ground level. The

cavity wall shall be terminated 300 mm below the soffit of roof slab/beam and the courses over this shall be continued in solid brickwork.

Cavity should be continuous and free from obstructions. Mortar droppings shall be prevented from falling down the cavity by the use of laths or by hayhands which shall be drawn up the cavity as the work proceeds. Any mortar which may unavoidably fall on the wall-ties, shall be removed daily and temporary openings shall be provided to permit the daily removal of mortar droppings from the bottom of the cavity.

The outer and inner levels shall be tied by means of wall ties. Ties shall be of mild steel round bars of 8 mm dia 200 mm long with hooks at both the ends. These shall be placed not more than 750 mm c/c horizontally and not more than 300 mm vertically, and staggered. Additional ties shall be provided near the openings. There shall at least, be 5 ties per square metre of surface area of the wall. Ties shall be given a bituminous coat before placement, to protect them from corrosion.

In order to keep the cavity dry, air slots shall be provided in the cavity walls at bottom as well as top to the extent of 50 sq. cm area of vents to every 2.0 sq. metre area of the wall.

5.2.4. Circular Brick Work

The specification for brick work covered under 5.2.1 and 5.2.2 shall apply, in so far as these are applicable. Bricks forming skew backs, shall be dressed or cut so as to give proper radial bearing. Defects in dressing of bricks shall not be covered up by extravagant use of mortar, nor shall the use of chips etc. be permitted.

The circular brick work shall be carried up from both ends simultaneously and keyed in the centre. The bricks shall be flushed with mortar and well pressed into their positions so as to squeeze out a part of their mortar and leave the joints thin and compact. All joints shall be full of mortar and thickness of joints shall be between 5 mm and 15 mm.

5.3. Jointing

Joints shall be restricted to a width of 10 mm with brickwork of any classification. All bed joints shall be normal to the pressure upon them i.e. horizontal in vertical walls, radial in circular brick masonry and at right angles to the face in the battered retaining walls. The vertical joints in alternate courses shall come directly one over the other and shall be truly vertical. Care shall be taken that all the joints are full of mortar, well flushed up. In case no pointing is to be done, cement mortar shall be neatly struck as the work proceeds. The joints in faces which are to be plastered or pointed shall be squarely raked out to a depth of 12 mm while the mortar is still green. The rake joints shall be brushed to remove loose particles. After the day's work, the faces of the brick work shall be cleaned on the same day with wire brush and all mortar droppings removed.

5.4. Curing

Green work shall be protected from rain or any other running water or accumulated water from any source, by suitable means. Masonry work, as it progresses, shall be kept thoroughly wet by sprinking water at regular intervals, on all faces. Curing shall be done after 24 hours of completion of day's work and shall be done for atleast 10 days after completion. Proper watering cans with spray nozzles, rubber or PVC pipes shall be used for this purpose. Brick work done during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

5.5. Staging/Scaffolding

5.5.1. Staging/scaffolding shall be properly planned and designed by the Contractor. Use of only steel tubes is permitted for staging/scaffolding. Design of staging/scaffolding shall be submitted for approval of the Owner's Representative, before commencement of work.

Single scaffolding having one set of vertical support, shall be used and other end of the horizontal scaffolding member shall rest in a hole provided in the header course. The support shall be sound and strongly clamped with the horizontal pieces over which the scaffolding planks shall be fixed. The holes left in the masonry work for supporting the scaffolding shall be filled and made good with plain cement concrete of grade 1:2:4 and shall be made good before plastering. Suitable access shall be provided to the working platform area. The scaffolding shall be strong enough to withstand all loads likely to come upon it and shall also meet the requirements specified in IS:2750.

Double scaffolding shall be provided for pillars less than one metre in width or for the first class masonry or for a building having more than two storeys.

The following measures shall also be considered during erection of the scaffolding/staging.

a. Sufficient sills or underpinnings, in addition to base plates, shall be provided, particularly, where scaffoldings are erected on soft grounds.

b. Adjustable bases to compensate for uneven ground shall be used.

c. Proper anchoring of the scaffolding/staging at reasonable intervals shall be provided in each direction with the main structure wherever available.

d. Horizontal braces shall be provided to prevent the scaffolding from rocking.

e. Diagonal braces shall be provided continuously from bottom to top between two adjacent rows of uprights.

f. The scaffolding/staging shall be checked at every stage for plumb line.

g. Wherever the scaffolding/staging is found to be out of plumb line, it shall be dismantled and re-erected afresh. Efforts shall not be made to bring it in line with a physical force.

h. All nuts and bolts shall be properly tightened and care shall be taken that all the clamps/couplings are firmly tightened to avoid slippage.

i. Erection work of a scaffolding/staging, under no circumstance shall be left totally to semiskilled or skilled workmen and shall be carried out under the supervision of Contractor's technically qualified civil engineer.

5.5.2. For smaller work or work in remote areas wooden ballies may be permitted for scaffolding/staging by the Owner's Representative at his sole discretion. The Contractor must ensure the safety and suitability of such works as described under Clause 5.5.1 above.

5.6. Embedment of Fixtures

All fixtures, pipes, conduits, holdfasts of doors and windows etc. required to be built in walls, shall be embedded in plain cement concrete block of grade 1:3:6, at the required positions, as the work proceeds.

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EXCAVATION, BACKFILLING, COMPACTION

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1. GENERAL

1.1. Scope

This SPECIFICATION covers the excavation and backfilling of pits and trenches for the foundations of structures and the compacting of the backfill material.

It also covers the excavating and backfilling of trenches for drainage pipes, utilities pipes, ducts and cables and the excavating and backfilling of pits for manholes and alike.
The following definitions shall apply :

AGREEMENT	Designates the agreement concluded between the OWNER and the CONTRACTOR, under which the latter undertakes to the former the GOODS and/or SERVICES according to the stipulations which are agreed and specified in the form of an order.
OWNER	Designates the purchaser of the GOODS and/or SERVICES which are the subject of the AGREEMENT.
CODE	Designates a set of systems and Indian rules or international standardization documents for design, materials, tests, etc.
CONTRACTOR	Designates the individual or legal entity with whom the order has been concluded by the OWNER. The term "CONTRACTOR" may be used indifferently for a supplier, a manufacturer, an erection CONTRACTOR, etc.
DAYS - WEEKS - MONTHS	Specify the number of calendar days, weeks or months and not of working days, weeks or months.
OWNER'S REPRESENTATIVE	Designates the individual or legal entity to which the OWNER has entrusted various tasks in relation with the carrying out of his PROJECT.
GOODS and/or SERVICES	Designate, depending on the case, all or part of the drawings or documents, substances, materials, materiel, equipment, structures, plant, tools, machinery,... to be studied, designed, manufactured, supplied, erected, built, assembled, adapted, arranged or put into service by the CONTRACTOR under the AGREEMENT, including all the studies, tasks, works and services specified by the order. The terms GOODS or SERVICES may be indifferently used one for the other as required by the context.
PROJECT	Designates the aggregate of GOODS and/or SERVICES to be provided by one or more CONTRACTORS.
STANDARD	Designates a set of models or references, corresponding to common practice and generally used by the OWNER'S REPRESENTATIVE. This can be : typical standard drawings or documents.
SPECIFICATION	Designates a document describing in some details general or particular requirements for specific type of works.

1.2. References

The standards referred to in this section are as follows :

[As per Indian Labour Laws]

1.3. Submittals

1.3.1. Construction and method drawings

The CONTRACTOR shall submit the following drawings and details :

a) the results of the survey specified in paragraph 3.1.

b) construction drawings, method diagrams and plant details for each major excavation in close proximity to an existing structure showing in full detail, with appropriate supporting calculations, the CONTRACTOR'S proposals for carrying out the excavation, for shoring the sides of the excavation, for shoring and underpinning the existing structure if necessary, for controlling and recording all movements which could affect the structure, for compacting the backfill material and, if necessary, for dewatering the excavation or lowering the level of the groundwater in the vicinity of the excavation to enable the whole of the work to be executed in the dry and the stability and condition of the adjoining structure to be preserved.

1.4. Site Conditions

1.4.1. Existing conditions

The attention of the CONTRACTOR is drawn to the fact that, at certain locations, excavation for the foundations of structures will have to be carried out in close proximity to existing structures and to the requirements of this SPECIFICATION in this respect.

2. MATERIALS

2.1. Backfill Material

Only suitable material as defined below and approved by the OWNER'S REPRESENTATIVE shall be used for backfilling.

Suitable material shall comprise all materials which are acceptable in accordance with the Contract for use in the Works and which are capable of being compacted in the manner and to the specified density.

Unsuitable material shall mean other than suitable material and, unless instructed otherwise by the OWNER'S REPRESENTATIVE, it shall include :

i. material from swamps, marshes or bogs and soil containing more than 10% organic matter;

ii. peat, logs, stumps and perishable material;

iii. clay of liquid limit exceeding 70 and/or plasticity index exceeding 45;

iv. soils containing soluble salts other than calcium sulphate in quantities exceeding the relevant percentages by weight given in the following table :

pH value of soil	Total soluble salts excluding $CaSO_4$	Sulphates $NaSO_4$ + $MgSO_4$	Chlorides
over 6	as e)	-	-
5 - 6	0,5 %	-	-
under 5	0,5 %	0,05 %	0,45 %

v. salty of gypsiferous soils containing more than 10 % soluble salts.

3. EXECUTION

3.1. Preparation

Before any major excavation work is undertaken, the CONTRACTOR shall carry out an adequate survey of all existing structures in close proximity which could be affected by the intended work. The survey shall include the establishment of the following data regarding each structure:

a) type of construction, structural condition and any defects;

b) limits and levels of foundations;

c) type and quality of foundation;

d) extent of vaults, tunnels and similar underground structures;

e) locations of utilities in the vicinity.

The CONTRACTOR shall provide all shoring and underpinning of existing structures, required to ensure their stability and safety during the excavation work. Shoring and underpinning shall comply with the requirements of :

[As per Indian Labour Laws]

Before starting the excavation of trenches etc. and if the presence of existing underground utilities is known or suspected, the CONTRACTOR shall establish the exact location of these by means of carefully excavated trial pits, using hand methods in the immediate vicinity of the pipe, duct or cable, and shall carry out such diversion or protection of these as is shown on the drawings or directed by the OWNER'S REPRESENTATIVE.

3.2. Excavation, Backfilling And Compacting Of Foundation Pits And Trenches

3.2.1. Excavation of foundation Pits and Trenches

Depth and dimensions of footings

Pits and trenches for foundations of structures and buildings shall be excavated to the levels and dimensions shown on the drawings or to such other levels and dimensions as directed by the OWNER'S REPRESENTATIVE. The OWNER'S REPRESENTATIVE may require from the CONTRACTOR to excavate below the foundation levels shown on the drawings or he may order him to stop when suitable foundation material is encountered.

Bottom of the excavation

The bottom of all excavation shall be carefully graded and if required by the OWNER'S REPRESENTATIVE stepped or benched horizontally.

All excavations shall be taken out as nearly as possible to the exact dimensions of the foundations to minimise backfilling.

In excavations for foundations of structures and buildings a bottom layer of soil shall be left in place temporarily and subsequently removed only when the concrete is about to be placed, in order to avoid, as far as possible, softening or deterioration of the surface of the bottom of the excavations by exposure.

The thickness of the layer will depend on the type of soil and will be determined by the OWNER'S REPRESENTATIVE. Any pockets of soft material in the bottom of pits and trenches shall be removed as directed and the cavities so formed filled with concrete Grade M15. Where, after grading of the bottom, any volumes of material become puddled, softened or loosened, the disturbed or damaged material shall be removed as directed and the cavities so formed filled with concrete Grade M15, at the CONTRACTOR'S expense.

After the completion of placing of any blinding concrete required by the Contract, no trimming of the side faces shall be carried out for 24 hours.

When any excavation has been taken out and trimmed to the levels and dimensions shown on the drawings or directed by the OWNER'S REPRESENTATIVE, the OWNER'S REPRESENTATIVE shall be informed accordingly so that he may inspect the completed pit or trench.

Excavated materials

Excavated materials from excavations which are suitable and required for backfilling shall be stockpiled clear of the excavation works. The stockpiles shall be shaped and graded to permit proper drainage.

Excavated materials from excavations which are suitable but superfluous to the needs for backfilling shall be utilised by the CONTRACTOR where suitable filling material is required elsewhere in the Works or, if superfluous to all the requirements for backfilling or filling, it shall be removed from the site by the CONTRACTOR.

If the CONTRACTOR allows material which, on excavation is suitable for re-use, to become unsuitable and it is in this condition when required for backfilling or filling, he shall make good by running in to spoil and replacing with other suitable material, or when directed by the OWNER'S REPRESENTATIVE, the moisture content of the material shall be adjusted before deposition, to facilitate the compaction in a way as specified by this SPECIFICATION.

Excavated materials from excavations which are unsuitable for use as backfilling shall be run to spoil off the Project Site, selected by and at the CONTRACTOR expense or to a dumping place as directed by the OWNER (as defined by the agreement constituent documents).

Excavation greater than necessary

Excavation to a depth greater than specified shall be corrected by the CONTRACTOR at his own expense by concrete Grade M15.

Excavation to a width greater than specified shall be corrected by the CONTRACTOR at his own expense and to the satisfaction of the OWNER'S REPRESENTATIVE by completely filling the excess volume of excavation against the completed foundation either with concrete Grade M12/15 or if agreed by the OWNER'S REPRESENTATIVE with approved material compacted in a way as specified in paragraph 3.2.5 of this SPECIFICATION.

Shoring to excavations

The sides of all excavations shall be shored adequately at all times to the satisfaction of the OWNER'S REPRESENTATIVE.

The submission by the CONTRACTOR of the details of his proposals for such work and the OWNER'S REPRESENTATIVE'S agreement thereto, shall not relieve the CONTRACTOR of any responsibility for the safety of the work.

Timber or other shoring materials shall be removed as the work proceeds unless otherwise directed or permitted by the OWNER'S REPRESENTATIVE. The OWNER'S REPRESENTATIVE may direct shoring materials other than timber to be left behind in trenches or other excavations.

In placing, altering or removing shoring to the sides of excavations, care shall be taken to avoid pressure being brought to bear on the permanent work before it is capable of withstanding such pressure.

3.2.2. Excavation of Trenches

Excavation of trenches

Excavation for pipes, ducts and cables shall be carried out in trenches and shall be conform to the lines and levels shown on the drawings or to any specified gentle curve in plan. Except where any greater width is shown on the drawings all trenches shall be excavated to such a width as will give adequate room in the trench for the proper support of the trench, and shall be excavated to a sufficient depth and width to enable the pipe, duct or cable and any specified or agreed joint, bedding, haunching and surround to be accommodated.

Trenches for sub-soil drains and land drains shall be of the minimum width capable of accommodating the pipes in order to ensure good alignment of the pipes as laid and shall be excavated to uniform gradients in straight lines or specified gentle curves.

Trenches for French drains having pipes up to 150 mm in diameter shall be excavated to a width of at least four times the nominal diameter of the pipes; for pipes over 150 mm in diameter the width shall be the diameter plus 450 mm.

The excavation of trenches at or near the toes of cutting or embankment slopes shall be carried out in such a manner that there is no excavation into the slope for working space.

Where a trench is adjacent to an existing or a new structure or building, and the bottom of the trench is lower than the foundation of the structure or building, the pipe or duct shall be bedded and surrounded in

concrete Grade C12/15 and the trench shall be filled in with concrete up to the level of the top of the foundation.

When constructing new structures and buildings and laying adjacent pipes or ducts the item, requiring the deepest excavation, shall be executed first.

Bottom of the trench

Before any pipes, ducts or cables are laid or concrete or other bed placed in the trench, the base of the excavation shall be trimmed true in cross-section and gradient and rammed by hand solid to afford a firm and uniform bearing throughout the entire length of the trench. Where, after trimming of the base of the excavation, any volumes of material become puddled, softened or loosened, the disturbed or damaged material shall be excavated to such additional depth as may be required by the OWNER'S REPRESENTATIVE, to the full width of the trench, and be replaced up to the proper level with sand, gravel or pipe bedding material properly compacted or with concrete of the same grade as the bed, as the OWNER'S REPRESENTATIVE may direct, at the CONTRACTOR'S expense.

Where a firm foundation is not encountered, due to soft, spongy or other unsuitable material, all such unsuitable material under the pipe, duct or cable shall be removed over the full width of the trench and the space shall be backfilled with sand, gravel or pipe bedding material properly compacted or with concrete of the same grade as the bed, to provide adequate support for the pipe, duct or cable.

Excavated materials

Excavated materials from trench excavations which are suitable for the purpose shall be set aside for use as backfill.

Excavated materials from excavations which are unsuitable for use as backfilling shall be run to spoil off the Project Site, selected by and at the CONTRACTOR expense or to a dumping place as directed by the OWNER (as defined by the agreement constituent documents).

Excavation greater than specified

Excavations taken out to a greater depth than specified shall be filled in to the required level with compacted suitable material or with the specified pipe bedding material properly compacted.

Where pipes or ducts are to be bedded on a concrete bed, any such additional excavation shall be filled in to the required level with concrete of the same grade.

Where pipes or ducts are to be bedded on, haunched or surrounded with concrete, any additional lateral excavation beyond the specified overall dimensions of the concrete bed, haunch or surround shall, except where such additional lateral excavation is shown on the drawings, be filled in to the level of the top of the specified concrete with concrete of the same grade. No payment will be allowed for any of the filling in of additional excavation specified in this paragraph.

Supporting of sides of trenches

The sides of the trenches shall be supported adequately at all times by means of walling, struts and runners or sheet piling of sufficient numbers and dimensions to prevent the falling in, movement or slipping of the ground, injury to workmen and damage to the Works or adjacent property.

3.2.3. Excavation around existing structures

Should the results of the survey specified above, indicate that an existing structure would be affected by the intended excavation work, the CONTRACTOR shall design and employ a temporary support system for

the excavation, of sufficient strength to preserve the stability of the structure, and of sufficient rigidity to prevent any movement of the soil which could cause significant damage to the structure. The CONTRACTOR shall include in his design calculations for temporary support systems a reliable estimate of the expected settlement of each existing structure affected.

In all cases where for any reason (e.g. due to the close proximity of the excavation to an existing structure, the conditions of the soil, changes in ground water level due to de-watering, etc.) the displacement of any part of a temporary support system of an excavation could cause movement or settlement of an existing structure, the CONTRACTOR shall provide and monitor adequate reference marks and instrumentation for controlling and recording all movements which could affect the structure.

Should the movement of any part of a temporary support system of an excavation or of any existing structure exceed the amount of movement or settlement estimated for that particular stage of the excavation work, the work shall be discontinued and the OWNER'S REPRESENTATIVE shall be notified immediately. In such cases the CONTRACTOR shall carry out to the approval of the OWNER'S REPRESENTATIVE all measures necessary to prevent further movement or settlement.

The methods used for constructing temporary support systems and for excavating in close proximity of an existing structure shall be compatible with the condition and use of the concerned structure. No equipment shall be used which could cause damage to the structure, for example due to static loading, vibration or shock waves.

Equipment used close to occupied building shall be of a type which causes the least disturbance to the occupants in respect of noise, vibration, shock waves, dust and mud.

Where necessary, walkways, building entrances and façades shall be protected adequately from damage or soiling from debris, dust or alike.

3.2.4. Excavations to be kept free from water

The CONTRACTOR shall keep all excavations quite free from water, whether affected by floods, storms or otherwise, so that the works may be constructed in dry conditions. He shall construct, as may be required by the OWNER'S REPRESENTATIVE, grips or channels or sub-drains at levels lower than the bottom of the permanent works to convey the water to sumps which he shall construct in positions convenient for the disposal of the liquid drained thereto. The grips, channels, sub-drains and sumps shall, where possible, be constructed clear of the permanent works and shall be filled as the permanent work proceeds to the satisfaction of, and as may be ordered by, the OWNER'S REPRESENTATIVE.

The sub-drains shall be formed with pipes of adequate diameter. Trenches shall be excavated to the minimum width capable of accommodating the pipes, their inverts shall be graded to outfall and approval clay tile pipes shall be laid open-jointed in the trenches which shall then be backfilled carefully with granular filter material. The grading of the filter material used in the sub-drain shall, where necessary, be such that the ground below foundation level is in no way weakened by the washing out of any of its finer particles. Where sub-drains are located directly below any part of the permanent concrete works, the trenches shall, immediately before the construction of the permanent work is started, be covered with approved waterproof sheets which shall lap both sides of such trenches by at least 150 mm.

The CONTRACTOR shall also provide, fix, maintain and work such engines, pumps, hoses, chutes and other appliances as are necessary to keep the sub-soil or accumulated water at a level 300 mm lower than the bottom of the permanent works (or at a lower level as the OWNER'S REPRESENTATIVE may direct) for such periods as the OWNER'S REPRESENTATIVE shall direct. After raising the water herein referred to, the CONTRACTOR shall immediately convey it away from the Works. When practical the water shall be discharged into the permanent outfall for the pipe drainage system.

Foundation pits and trenches shall be kept free from water during the time that excavation is being carried out and until, according to the OWNER'S REPRESENTATIVE, any concrete therein is sufficiently set and all constructional works therein can suffer no damage from flooding, hydrostatic pressure, flotation or other cause. They shall be kept free from water during the period that backfilling is being carried out.

Precautions shall be taken to prevent piping uplift of the bottom of excavations either by the use of cut-off walling or sheeting by lowering the water table or by other means and all such precautions shall, prior to adoption, be subject to the approval of the OWNER'S REPRESENTATIVE.

The CONTRACTOR shall take care to avoid undermining any part of the Works or other properties by pumping, but should the undermining or other damage occur due to prolonged or excessive pumping he shall immediately make good this at his own expense, to the satisfaction of the OWNER'S REPRESENTATIVE.

3.2.5. Backfilling and compacting of foundation pits and trenches

Backfilling of Foundation Pits and Trenches

Backfilling of foundation pits and trenches shall be carried out as soon as the foundations and structural works therein have acquired adequate strength as specified by the OWNER'S REPRESENTATIVE.

The timing and rate of placing backfill material around or upon any completed or partially completed structure shall be arranged in such a way that no part of the work is over-stressed, weakened, damaged or endangered. In particular the placing of backfill material against walls designed to be restrained by structural elements, located above or below finished ground level, shall not be started until such structural elements have been installed and, if made of concrete, have attained their full specified strength and have had their temporary supports removed.

Backfill material shall be placed in layers of uniform thickness and shall be brought up uniformly on all sides of the foundation or structure being backfilled. Each layer shall be so placed as to maintain adequate drainage and to prevent accumulation of water.

Timber sheeting and other excavation supports shall be removed carefully as the filling proceeds except as otherwise specified or ordered, but the removal of such supports will not relieve the CONTRACTOR of his responsibility for the stability of the works. No timber supporting member shall be left behind in pits or trenches. Care shall be taken to maintain the integrity of the sides of the excavation and to fill all spaces left by the withdrawn supporting members.

Compacting of Backfill Material

The backfill material shall be compacted in layers not exceeding 150 mm in depth when compacted, to a dry density not less than that obtaining in the adjacent undisturbed soil and not less than 95 % of the maximum dry density. Cohesive materials shall be compacted at a moisture content within 2 % of the optimum moisture content on the wet side.

Full compaction shall be achieved throughout every layer, up to the edges of the pits or trenches and up to the faces of the foundations or structural works therein.

- Unless other compacting equipment is required or agreed on, compaction shall be carried out by power rammers, vibrating plate compactors or lightweight vibratory rollers.
    - Power rammers are machines which are actuated by explosions in an internal combustion cylinder, each explosion being controlled manually by the operator.

- Vibrating plate compactors are machines having a base plate to which is attached a source of vibration consisting of one or two eccentrically-weighted shafts. Vibrating-plate compactors shall be operated at the frequency of vibration recommended by the manufacturer and shall normally be operated at travelling speeds of less than 15 m per minute.

- Vibratory rollers are self propelled or towed rollers having means of applying mechanical vibration to one or more rolls. Vibratory rollers shall be operated with their vibration mechanism operating only at the frequency of vibration recommended by the manufacturer.

- All such rollers shall be equipped with a device which indicates automatically the frequency at which the mechanism is operating.

- Compacting equipment or methods which transmit excessive pressure to foundations or structural works in the pits or trenches shall not be used.

3.2.6. Backfilling and compacting of trenches

Backfilling of Trenches

Backfill material shall be approved by the OWNER'S REPRESENTATIVE and shall be free from stones or lumps exceeding 40 mm in largest dimension, vegetable matter and other unsatisfactory material.

If the CONTRACTOR allows material which, on excavation is suitable for re-use, to become unsuitable and it is in this condition when required for backfilling, he shall make good by running it to spoil and replacing with other suitable material, or when directed by the OWNER'S REPRESENTATIVE, the moisture content of the material shall be adjusted before deposition in the trench, to facilitate compaction in the manner specified in this paragraph.

Backfilling shall wherever practical be undertaken immediately after the preceding specified operations have been completed, and the works have been inspected and approved by the OWNER'S REPRESENTATIVE, so as to reduce the lengths of trenches open at any one time.

When concrete beds, haunches or surrounds have been placed, compaction by mechanical means shall not be started until at least four days have elapsed from the time of placing of the last concrete.

Where no haunch or surround of concrete or surround of pipe bedding material is specified, backfill material shall be brought up equally on both sides of the pipe or duct, first to the level of the centre of the pipeline and then to a height of 300 mm above the top of the pipe barrel or duct. The backfill material shall be placed in layers, each of them not exceeding 150 mm in loose depth and each of them compacted carefully and thoroughly for the full width of the trench with hand tools not driven by an engine. During the placing of backfill material below the level of the top of the pipe barrel or duct, the backfill material shall be placed in layers on alternate sides of the pipe or duct so that at no time the difference in level between the top surfaces of the compacted material on either side of the pipe or duct shall be greater than 150 mm.

Where a surround of concrete or surround of pipe bedding material is specified, backfill material placed above the surround up to a height of 300 mm (or a greater height as may be shown on the drawings) above the top of the pipe barrel or duct shall be placed in layers, each of them not exceeding 150 mm in loose depth and each of them compacted carefully and thoroughly for the full width of the trench with hand tools not driven by an engine.

Where, in wide trenches, backfilling is necessary at the sides of a haunch or surround of concrete or a surround of pipe bedding material as well as above them, the backfill material placed at the sides of, and above, the haunch or surround up to a height of 300 mm (or a greater height as may be shown on the drawings) above the top of the pipe barrel or duct shall be placed in layers each of them not exceeding 150

mm in loose depth and each of them compacted carefully and thoroughly for the full width of the trench with hand tools not driven by an engine. During the placing of backfill material below the level of the top of the pipe barrel or duct (where the pipe or duct is haunched) or below the level of the top of the surround the backfill material shall be placed in layers on alternate sides of the pipe, duct or surround so that at no time the difference in level between the top surfaces of the compacted material on either side of the pipe, duct or surround shall be greater than 150 mm.

In no case, the backfill material shall be thrown directly on to exposed pipes or ducts.

Care shall be taken not to disturb the pipes, ducts, haunch or surround during the placing and compacting of the backfill material.

The backfill material placed above the upper level of material compacted by hand specified in the preceding paragraphs shall be deposited in layers each of them not exceeding 150 mm in depth when compacted and each of them compacted in a way as specified in this paragraph.

Timber sheeting and other excavation supports shall be removed carefully as the filling proceeds except as otherwise specified or ordered, but the removal of such supports will not relieve the CONTRACTOR of his responsibility for the stability of the works. No timber supporting members shall be left behind in trenches. Care shall be taken to keep the sides of the trench solid and to fill all spaces left by the withdrawn supporting members.

Regardless of the method of compaction, no traffic or heavy loads shall be allowed over the backfilled surface until the four days for setting of the last concrete have elapsed.

Compacting of Backfill Material

The backfill material shall be compacted in accordance with the requirements of paragraph 3.2.5 of this SPECIFICATION.

3.3. Field Quality Control

Tests of compacted backfill material will be made as often as the OWNER'S REPRESENTATIVE shall deem necessary to ensure compliance with the requirements of this SPECIFICATION.

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ROUTE SURVEY

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CHAPTER I : GENERAL ROUTE SURVEY

1. OBJECTIVE

1.1. Route Survey

The objective of route survey work is to obtain topographic features, soil stratification, geo-technical and soil resistivity data, carry out cadastral survey, collect information and data about the existing facilities located along and in the vicinity of the pipeline route, collect revenue maps,determinine population density index, locating centreline of pipeline alignment on the ground etc.

2. SCOPE OF WORK

The scope of work of Contractor specified in this document shall include, but not limited to the following.

2.1. Detailed Route Survey

2.1.1. Carrying out detailed route survey work along the entire route of the proposed pipeline in accordance with specification. The proposed route will generally follow the recommended route except for changes made at places due to site conditions. The detailed route survey will also include identification of most optimum location/position for the Tee–offs which are foreseen along the pipeline route.

2.1.2. Carryout Topographical survey of the route

Survey should extend up to a maximum of 50 m width of pipeline in cross country and 15 m where route is parallel to a wall or fenced property.

2.1.3. To parepare cross section drawings at each crossing of pipeline with other features like pipes/cables/roads/railway track and other obstructions etc and at every 200 m along the pipeline showing details of 50 m on either side of pipeline.

2.1.4. Observe clockwise horizontal angles in direction of survey to indicate change in direction.

2.1.5. Azimuth observation to the sun are to be made at regular interval to obtain true bearing of the line.

2.1.6. Establish Bench Marks (BM's) along the route and fix apex points.

2.1.7. Levelling is to be carried out using automatic levels between the BM.'s.

2.1.8. Carrying out soil investigation along the proposed pipeline route including water body crossing in accordance with specification.

2.1.9. Carrying out Hydrographic survey (if any) of water bodies.

2.1.10. Supply and installation of the survey markers as per requirements of the specification and instructions of the CONSULTANT.

2.1.11. Locating all buried/ above ground pipelines, their diameter, type of material transported through them, their design pressure, cables and other utilites within a distance of 50 metres on either side of the pipeline alignment with the help of pipelines/ cable locators or other suitable instruments. Underground scans will be taken with appropriate scanning technique to positively identify position of possible pipelines at pinch point . These scans are also to be used to locate other problem front areas. At specific areas trial excavations will be needed to confirm location/details of pipelines, cables etc.

2.1.12. Carrying out population density survey and location class along the pipeline route as per enclosed specifications. A zone of 400 M width is to be considered along the pipeline route with proposed pipeline in the centre of the zone.

2.1.13. Carrying out cadastral survey covering areas 50 metres on either side of center-line of the proposed pipeline. All revenues and other maps as well as forms required for carrying out this survey shall be arranged by the Contractor at his own cost and responsibility. The contractor shall mark the pipeline route on maps with the following details.

- Land schedules giving the survey numbers, area and details of owners as per the latest official revenue records for last 10 years.
- Major features/land marks including:
- All built-up areas such as
- Religious place, school, hospital etc.
- District/village and panchayat roads.
- Water bodies
- Forest land
- Overhead and underground utility crossings
- Marshy land/ waste land
- Existing pipelines, their diameter, their design pressure etc.
- Name/ type of Industries.
- Present and future railway lines.

These information shall be adequate in all respects for ROU acquisition.

Width of ROU proposed to be acquired will be for 50 m.

2.1.14. Pipeline Alignment must be selected in a manner that the entire width of ROU corridor proposed to be acquired lies in firm ground.

2.1.15. Carrying out corrosion survey including measurement of soil resistivity, chemical analysis of soil/water and collection of Cathodic Protection related data including powerlines along ROU of the proposed pipeline as per Specifications .

2.1.16. Collection of all information and proposed development plans etc. of the area through which the pipeline passes from the concerned departments of Government of India/State Governments, private/public institutions/ companies, etc. within 500 metres on either side of the proposed pipelines alignment.

- 25 years historical data for Hydrographic, Flood, Soil erosion, Crop patterns Rainfall data, seismic data etc.Detailed information about high and low tide etc
- Information regarding future plans (0-10 years), irrigation project, infrastructure project, Railway project, Forestation, Defence, Industrial growth, Private/Public constructions, unless otherwise specified.

2.1.17. The scope of work shall also include any other item/work required to complete the work in all respects as per specifications, drawings and instructions of CONSULTANT whether specifically mentioned herein or not, but is required to fulfil the intended purpose of this tender document.

2.1.18. Carry out Soil Investigation upto refusal using SPT at End Point Stations and intermediate stations and at location of Tee-Offs.

3. CONTRACTOR'S RESPONSIBILITIES

3.1. Contractor shall provide all qualifed skilled/ unskilled personnel to carry out the entire job, all surveying and other equipment, tools, tackles and other necessary materials and facilites required to complete the job to the entire satisfaction of the CONSULTANT in accordance with the requirements of the tender document.

3.2. CONTRACTOR shall also be responsible for arranging, acquiring all data, access, permissions and other activities/ services required for and/ or incidental to performing the work tendered.

3.3. Location of Survey of India Bench marks and determination of their values including tieing-in of proposed pipelines profile to the same shall also be Contractor's responsibility.

3.4. Contractor shall be responsible for settling all compensation and disputes arising out of any damages caused by him or his workmen during the execution of work.

3.5. The detailed survey to ensure:

- Connectivity with adjoining surveys.
- Geocoding be done and closing of surveys at both the ends.
- Data and inputs to be organised in a prescribed manner and output so as to be easily transformed to GIS & LIS platform

3.6. Resurvey can be ordered in case of doubt; descripancy; change in route; problem in cadastral and better option. Different alternative routes may have to be survey if required.

3.7. Contractor should check for the presence of underground services prior to commencing of any drilling or trial excavations and will validate and confirm that no underground services are at risk to be damaged or disturbed in any way.

3.8. At least one supervisor is required at work site when work is ongoing for Route Survey and Soil Investigation.

4. CONTRACTOR'S SCOPE OF SUPPLY

4.1. The mobilization / supply in sequence and at appropriate time of all equipment, data, skills, accessories, materials, softwares, hardwares and consumables etc. required for completion of all work covered under this contract shall be entirely the responsibility of the Contractor.

4.2. The pillars used for TBMS (Tremporary Bench Marks) at TP's/IP's, crossing etc. shall be pre-cast R.C.C, with reinforcement of 4 nos. 6 mm dia bars with 4 equally spaced rings of 6 mm dia. All pre-cast R.C.C. pillars should also be engraved with letters "HLPL" on the shorter vertical face. Casting/ supply of these pillars is in scope of supply of contractor.

5. LIST OF ENCLOSURES

5.1. SPECIFICATIONS

Specification required for Detailed Pipeline Route Survey is enclosed at Chapter-1-7.

6. DOCUMENT/ DATA SUBMISSION

6.1. Documents to be submitted for detailed route survey shall be as per requirement of applicable specifications and other documents enclosed with tender documents.

6.2. Contents and presentation of survey data/ records shall be reviewed / approved by CONSULTANT in the initial stage on sample drawings/documents to be prepared by the Surveyor. The CONTRACTOR shall incorporate all comments/ suggestions given by CONSULTANT and prepare all documents accordingly.

6.3. Two sets of paper copy of completed drawings/ data/ documents shall be submitted by the Contractor for review in the form of draft report. Comments, if any, shall be incorporated by the CONTRACTOR. This report can be demanded in parts and in different phases at the discretion of CONSULTANT.

6.4. All drawings, reports, formats, etc. forming the part of submission shall be prepared on approved computer package. All drawings, including, but not limited to alignment sheets, crossing drawings, soil profiles etc. shall be prepared using AutoCAD R 2000 / GIS based suitable package as per decision of CONSULTANT. All reports, formats, write-ups, charts shall be prepared on computer using software package compatible with MS Office.

6.5. The data and drawings submitted shall be in approved GIS package.

6.6. Final drawings/data/documents, after incorporation of comments by Surveyor, shall be submitted to CONSULTANT in the following number of copies.

a)	Drawings	-	six copies, one transperancy and one copy on CD & floppy diskettes.
b)	Soil Resistivity Report	-	six copies and one copy on CD & floppy diskettes.
c)	Geo- technical investigation	-	six copies and one Report copy on CD & floppy diskettes.
d)	Other Reports and Records	-	six copies and one copy on CD & floppy diskettes.

CHAPTER II : DETAILED ROUTE SURVEY

1. SCOPE

This chapter covers the minimum requirements of topographical survey along the pipeline route including locating the centre-line of pipeline alignment on the ground, constructing survey monuments, field measurements, profiles and preparation of drawings and documents.

2. REQUIREMENTS

2.1. All survey works shall be performed under the supervision of a experienced persons deputed by the CONTRACTOR.

2.2. All measurements shall be in metric units.

2.3. The reading and noting shall be neat, legible and scorings and over-writing shall be duly initialled by the Contractor.

2.4. All surveys shall be carried out using approved methodology and equipment e.g. GPS, DGPS, Total Stations, Auto levels,High Precision Theodolite, EDM.

2.5. Survey should take into account not only existing obstructions /infrastructures / facilities but should also consider other facilities in the master plan of the area that may come up in future. This needs to be accomplished by collection of development plans (Approvaed Master Plans for the area along the foreseen route).

2.6. The contractor should also identify most optimum way in which a fresh water pipeline (Max 6" diameter) can be laid alongside HP pipeline in the same corridor.

2.7. Contractor should check for the presence of underground services prior to commencing of any drilling or trial excavation and will validate and confirm that no underground services are at risk to be damaged or disturbed in any way.

3. PRELIMINARY AND LOCATION SURVEYS

The Contractor is expected to make himself aware of the general conditions of the terrain before starting detailed survey

3.1. Alignment and location surveys

A preliminary survey for locating the centre-line of pipeline alignment on the ground shall be carried out as follows:

3.1.1. Contractor shall make a preliminary survey along the route of the Proposed Pipe line to establish flag control point. Based on the preliminary survey drawings, a geocoded mapping be developed as preliminary

plan, particularly the start and end point and other major TP's/IP's. Contractor shall study and suggest better alignment based on site visit and shall make suitable alteration in the proposed route after consultaton with CONSULTANT.

3.1.2. Where it becomes apparent that a better route could be followed, the Contractor shall consult the CONSULTANT for authorisation to make a change. In selecting the pipeline route, the contractor shall take into account the requirement for safe construction, operation and maintenance of pipeline.

3.1.3. Alternate routes (partly)at different places has to be surveyed considering the requirement for safe construction, operation and maintenance etc. Routing should take into account any planned facilities / utilities not only at the time of survey but also facilities which may come up in future. This needs to be accomplished by collection of approved Master Plans of the area along the route.

3.1.4. Turning Points (TPs) shall be located by Contractor considering the following:

- Detailed survey would be carried out using Differential Geographical Positoning system and/or Geographical Positioning system and Total Stations. Use of high precision Theodolite and/ or Total Station shall be made in suitable conjunction with GPS to establish the markers.
- To avoid obstruction along the line, by ranging on ground and shifting the Turning Points, wherever needed.
- Check for terrain gradient by using hand Clinometer/ Total Stations.
- Ensure proper angle of crossing by keeping as nearly right angle (to road/rail/rivers etc.) as possible. Unless mentioned otherwise all minor/ major crossings shall be surveyd by total stations.
- To check the route for ease of construction and avoid objects like, trees, dwellings, poles (power, telephone and telegraph), walls, tubewells or such other structures falling in the strip of land, 25M on either side of pipeline alignment unless directed otherwise.

3.1.5. While finalising the pipeline route, the contractor should also identify most optimum way in which a fresh water pipeline (Max 6" diameter) can be laid alongside HP pipeline in the same corridor.

3.1.6. Alignment to be studied on SOI maps as well as on village maps.

3.2. Staking of pipeline route

3.2.1. The pipeline defining trench centre line shall be staked by placing suitably painted marker stakes at Turning Points (TPs) and at Intermediate Points (IPs) between consecutive TPs. All Turning Points (TPs) and intermediate points are referred as Intersection Points.

The pipeline centre line shall be staked on the ground as follows:

First, the Turning Points (TPs) shall be staked on the ground. After locating and marking the TPs, the intermediate points shall be staked while measuring stack distance. The staking shall normally be done at intervals of 500 M along the centre line of the pipeline.

3.2.2. The Intersection Points shall be serially numbered from the starting point. The serial number of each Intersection Point shall be boldly inscribed on the marker stake. In addition, the Turning Point (TP) marker stake shall identify the Turning Point reference number from the starting point.

3.2.3. For Intermediate Points (IPs) letter "P" shall precede the serial number of the instersection point marker. For Turning Points, the "TP" shall precede the Turning Point reference number.

Example : P52; TP16

3.2.4. The marker stakes at Turning Points (TPs) shall be referred with three reference stakes around the TP. The reference stakes shall carry the Turning Point reference number and their respective distance from the TP marker stake.

Example : TP32 – 3.5L; TP6 – 4.8R, TP18-3.6W etc.

3.2.5. Change in direction of line shall be marked on the TP marker stakes. In addition, direction markers near TPs and other locations shall be placed wherever necessary.

3.3. Stakes and Markers

3.3.1. All marker stakes shall be pre-cast reinforced concrete blocks having dimension 150x200x1000 mm deep, and shall be buried to a depth of 500 mm.

The exposed surface of the blocks shall have a smooth finish and shall be painted with 'Post Office' red paint. All letters and figures shall be paint marked on the surface of the blocks in white.

3.3.2. On the top surface of the reinforced concrete blocks, a cross inside a circle shall be engraved at the centre or a nail shall be put centrally inside an engraved circle, to indicate the exact position of the Intersection Point. The circle shall be of approximately 50mm diameter.

3.3.3. Contractor can, however, propose CONSULTANT other types stakes/markers which are better suited to site conditions.

3.3.4. Where it is apprehanded that the marker may get lost, damaged, flooded or Vandalised some adjoining markers and landmark locations may also be included.

4. BENCH MARKS

4.1. Permanent Bench Marks (BM) approx. at every 1 KM or permanent structures on or off the Right-of-Use (ROU) shall be established and described.

4.2. Additional permanent bench marks shall be established near the major pipeline crossing sites. All these bench marks shall be geocoded and an index be submitted soon after the completion of detailed survey.

4.3. Location of Bench Marks shall be established in the field by using reinforced concrete blocks similar to pipeline marker stakes described earlier. Exact position of BM shall be marked by a cross inside a circle or a nail put centrally inside an engraved circle on the top surface of the concrete block. The reduced level of

the BM shall be paint marked on the concrete block. Letters "BM" shall precede the reduced level of bench mark recorded to the second place of decimal.

4.4. Accuracy of the reduced levels of the Bench Marks shall be verified wherever possible by checking levels with the nearest permanent Bench Mark established by Survey of India, which shall be connected through geocoding system.

5. CROSSINGS

5.1. General

As far as possible, crossing shall be made at right angles. The Contractor shall record the angles of crossing for all fences, property lines, utilities, roads, railways, canals, streams, etc. that are crossed. In addition, the true bearings of the centreline of the road, railway, canal, as well as that of the pipe centre-line shall be recorded. Turning Points (TPs) provided near crossings shall be located, atleast 50m from the crossing's boundaries, in stable and firm ground.

5.2. Railway Crossings

The angles for all railway crossings shall be as close to 90 degrees as possible, but in no case less than 85 degrees to the centre line of the railway, unless approved otherwise.

5.3. Primary Road Crossings

Primary roads are the National & State Highways, all-weather roads (paved/unpaved) and roads providing access to major installations. The angle of crossings shall be as close to 90 degree as possible, but in no case less than 80 degrees to the centre line of the road, unless approved otherwise.

5.4. Secondary Road Crossings

The angles of crossing for secondary roads shall be as close to 90 degrees as possible, but in no case less than 45 degress to the centre-line of the roads. All seasonal roads, unpaved village roads, cart/tracks, etc. come under this category.

5.5. Stream/Drain/ Drainage Ditch crossings

These crossings shall be established as close as possible to the locations shown on the route map. Crossings shall be located in a comparatively straight reach of the Drain where the banks are stable and there is sufficient area for construction. Angle of crossing shall be as close to 90 degrees as possible, unless approved otherwise. Crossings shall be proposed on firm ground, banks and where there is no presence of authorised/ unauthorised borrow area for gravel/sand etc.

5.6. River/ Canals Crossings

The angle of crossing shall be as close to 90 degrees as possible but in no case less than 60 degrees to the centerline of the canal/River unless approved otherwise. Crossings shall be located where there is no evidence of slumping or erosion of banks or bed.

5.7. Utility Crossings

Utilities crossings shall be located at their centerlines with stakes containing station numbers in the survey. The angle of crossings shall be measured and locations established relative to their aboveground facilities. The names and sizes of all utility lines shall be included in the survey notes. In the cases of overhead power and telephone lines, the distance to the poles and towers on each side of the survey line shall be measured, and the numbers of poles or towers noted. Line voltage shall also be recorded. Where possible, the survey shall be established so that there is a minimum distance of 50 metres from the survey line to the nearest High Tension pole or tower except at crossings.

Underground utilities shall be located as far as possible and staked for a minimum distance of 25 metres on either side of the Survey Line.

6. ACCURACIES IN MEASUREMENT

6.1. Contractor shall incorporate corrections to the linear ground measurement due to differential corrections, standard errors, variations from standard temperature and free from selective availability causing inaccuracies in position and velocity imposed by regulatory authorities and needed corrections be applied.

6.2. For Linear detail survey, sub-meter accuracy (less than 1m in 1km) is required while using GPS/DGPS technique.

The error for angular closure for the work shall not exceed one minute per station and for linear measurements it shall be read to the nearest 0.005 M in case of crossings, surveys for which use of Total Stations/ high precision Theodolite is mandatory.

6.3. The error on closure for measurements on vertical distance to establish benchmarks shall not be more than $24 (K)^{\frac{1}{2}}$ millimeters (where 'K' is the linear distance in KM). The observations for measurement of vertical distances on benchmarks shall be read to pipeline route and at crossings to the nearest 5 mm. The error of mis-closure in vertical distance shall be distributed linearly.

6.4. Azimuth checks shall be made by observations of the sun or Polaris at intervals of 1-2 Km. These observations of bearings together with deflection angles shall be recorded in survey notes.

Azimuth mis-closure based on bearings with observed angles at Turning Points shall be equally distributed over the number of stations observed in between. Accuracy of azimuth observations shall be acceptable if the three deductions agree within one minute.

7. CHAINAGE

Generally the chain age system shall not be adopted for surveying except in special circumstances and locations e.g. thickly habited / paved area, thickly wooded area and prohibited area where use of GDS/DGPS/ Total Stations may not be permitted. In such cases: -

7.1. Slack distance measurement will be made using 50M steel tapes or 30M chains. However, in case of abrupt slope change the tape/chain is straightened parallel to the probable grading.

7.2. Distance between Intersection Points staked along the pipeline route should be measured and recorded. In addition, distance between level points shall also be measured and recorded.

7.3. Chaining will be continuous in the direction of survey

7.4. The true bearing of all straights shall be observed and recorded.

7.5. Data on nature of terrain, viz. sandy, rocky, vegetation, etc. and type of ground will also be recorded along with chainage of change points.

7.6. Check on distance measurements will be stadia method and also GPS based measurements at the time of leveling.

7.7. Standard chain survey format will be used for record keeping.

8. MEASUREMENT OF HORIZONTAL ANGLES

Horizontal angles are measured to indicate the change in direction of alignment and specify the horizonrtal bend at the Turning Points.

8.1. Theodolite reading direct to 10 seconds or better, shall preferably be used. Angles shall be measured clockwise from back station to fore-station. Mean of two readings-one on face left and other on face right shall be taken as the horizontal angle.

8.2. The line at both ends shall be tied to the grid control system being used for end facilites. True bearing at the beginning, end and every 1-2 KM shall be observed to keep a check on errors in angular measurements.

9. PROFILES

9.1. The continuous profile of the proposed pipeline route shall be established from the reduced levels taken.

a) at the starting point,

b) at all Turning Points (TPs)

c) at all Intermediate Points staked on the ground

d) at all points on the pipeline route where there is a change in slope.

9.2. When the terrain is flat, reduced levels shall be additionally recorded along the pipeline route at 25m interval.

9.3. When the terrain is undulating observation of reduced level shall be made at a sufficient number of points so as to give an accurate plotting of the ground profile along the route.

9.4. For road and railway crossings, the reduced levels shall be recorded at all points along the pipeline alignment wherever there is a change in slope with the entire width of the Right-of-Use of the road/railway. CONTRACTOR shall prepare a detailed drawing for the crossing in scale 1:100 (in both horizontal and vertical directions) which shall be truly representative of the crossing profile.

9.5. For river/stream/nala/canal crossings, levels shall be taken at intervals of 5M to 30M beyond the highest banks of both sides. Levels shall be taken at closer intervals, if there is a change in slope. CONTRACTOR shall prepare a detailed drawing for the crossing in scale 1:100 (in both Horizontal and Vertical directions) which shall be truly representative of the crossing profile.

9.6. For major water crossing sites, cross section as above shall be observed at both banks.

9.7. Method of RISE and FALL shall be used to compute reduced levels of various poins. Check on computation shall be made by using the following formula:

Back site – Fore site = Rise- Fall = First R.L. – Last R.L.

9.8. Maximum misclosure shall not exceed 24 $K^{½}$ MM where 'K' is the distance in KMs. Maximum length of the sight shall not exceed 100 M.

9.9. All levels shall be with respect of Mean Sea Level (MSL).

9.10. Levels need to be taken on both sides of all crossings.

10. BUILT-UP AREAS

10.1. Monuments and Properties

The pipeline alignment shall run clear of the existing monuments, properties and structures etc.

For congested areas, closer distance may be adopted, however, location shall be approved by CONSULTANT.

10.2. Parallel Alignment

The pipeline alignment wherever runs parallel to an existing or planned under/over ground facility will be treated as parallel alignment. For underground facilites, surveyor shall identify and locate them with suitable special ground laths. The following clearances shall be observed in case of parallel alignment defined above.

1) Between existing/planned electrical power cables/lines and the proposed line – 50.0 metres

2) Between existing/planned communication cables/lines and the proposed line – 25.0 metres.

3) Between existing / planned pipelines and the proposed pipeline- 1m.

10.3. Parallel encroachment

Unless otherwise stated, when the pipeline alignment runs generally parallel to a road or railway it shall be kept sufficiently clear of the Right of Way limits of the facility.

11. AZIMUTH OBSERVATIONS

Azimuth control shall be maintained by observation of azimuth at every 1 to 2 kilometres by closing the traverse on existing control points. Azimuth may be obtained by making observations to sun or star depending upon the location of the area and direction control. In case of azimuth from sun, the computed values must be with one minute. In case of stars the computed values should agree within 10 to 15 sec.

Horizontal misclearances between two azimuth stations shall be equally distributed away TP's in between.

12. SURVEY NOTES, OBSERVATIONS AND COMPUTATIONS

12.1. The procedures followed both for field and office calculations shall be such that the results obtained shall be readily understood and retraceable.

12.2. All up-to-date notes and observations related to the basis for determination of boundary lines and corners shall be maintained by surveyor.

12.3. Survey records must contain schematic diagrams of all horizontal controls pertinent to the project showing all existing and established control points, bench marks, any triangulation station and boundary lines.

12.4. Geo-graphical and UTM co-ordinates of all Turning Points and starting/end points of the pipeline shall be computed and furnished to the CONSULTANT.

13. MAPS AND DRAWINGS

13.1. All maps and drawings shall be made on standard format furnished by the CONSULTANT. Contractor shall peform mapping and drawing work so as to contain all relevant data consistent with the survey notes and observations. The drawings shall also contain details of roads, streets, highways, structures, all types of crossings, terrain, surface vegetation and all other details which will be required for the purpose of enginnering design.

13.2. Following types of detailed survey drawings will be made:

a) -	Right of Use Planimetry in UTM grid	:	1:5000 along the line
			1:1000 across the line
b) -	Ground Profile	:	1:5000 Horizantal
			1:500 Vertical
c) -	Crossing Details	:	1:100 Horizontal
			1: 100 Vertical
d) -	Detailed Route Map	:	1:50000
e) -	Cross-Section Details	:	1:100 Horizontal

1:100 Vertical

* (Key route map to be indicated in all drawings)

14. PRESENTATION OF FIELD SURVEY DATA

Survey drawings shall contain the following data as a minium requirement.

14.1. Pipeline Route Map

Pipeline route map shall be prepared on approved GIS package. Pipeline route map shall show all features including, but not limited to roads and railroads, canals, streams, lakes, rivers, villages, towns that are located within a distance of 1 Km from the pipeline centre-line on either side of it. For the entire region, contours shall be plotted on the route map at 1 M contour interval. Additional information like cultivated areas, barren land, areas prone to flooding, rocky areas and forests including access path/roads to Right-of-Use shall also be shown on the route maps.

Pipeline route map should also indicate facilities/ obstructions/ infrastructures etc. that are planned for future. This needs to be accomplished by collection development plans (Approvaed Masterplans for the Area along the route).

14.2. Pipeline Route map should also show location and details of 3rd party pipelines, cables (overhead and buried) utilities etc within the foreseen pipeline corridor and ROW. At specific problem areas trial excavations will be needed to confirm location/details of pipelines, cables etc.

14.3. Right-of-Use Planimetry shall show all objects within 50 metres on either side of the Pipeline in Plan.

14.4. In case of all rail, road, river, stream, canal, existing pipelines and utility crossings, the angle of crossing shall be mentioned.

14.5. In case of rail, road, river, stream and canal crossing wider than 10M, the distances at the start and at the end of the crossing from the nearest IP shall also be mentioned. For crossing less than 10M, the distance of the centre line of crossing from the nearest IP shall be given.

14.6. For all river, stream and nala crossings, the level of water at the time of survey and the approximate surface velocity of the flowing stream shall be observed and recorded and reported in the survey drawings. Also, the general nature of the surface soil (soft/hard, normal soild or rock/boulders) at the banks of the river/stream/nala shall be observed and mentioned in the drawings.

15. ADDITIONAL DATA REQUIREMENT

Detail description of route all alongwith the route chainage wise is required.

The following data is also to be submitted in tabular form with respect to the chainage along the route.

Crossing	Railways	Distance of center of rail from center of pipeline
Roads	Type	Distance of center of road from center of pipeline
Pipelines:		location
		Type of product transported

	Burried/ above ground backfill depth
	Protection
	History of leaks
Rivers, canals	location
	depth
Electrical lines	location
Telephone lines	location
Vegetation	type
	Location
	History of wood fire in dry season
	Ground types at and above backfil depth
	Topography

16. DOCUMENTS/DATA SUBMISSION

All drawings shall be prepared on approved AutoCAD/GIS based package including but not limited to the Pipeline Route map, alignment sheets and Crossing details. All other document shall also be prepared on computer package approved by CONSULTANT. The documents shall generally be prepared on MS Office.

In addition, hard copies of documents shall also be submitted.

CHAPTER III : SOIL INVESTIGATION ALONG ROUTE

1. GENERAL

The purpose of soil investigation is to obtain visual engineering classificationof soil along the pipeline route.

2. SCOPE

The scope of soil investigation includes boring, collection of disturbed samples from boreholes and visual engineering classifcation of soil along the pipeline route, and submission of detailed report. Visual classification of soil shall be in accordance with IS-1498, "IS Classification and Identification of Soils for General Engineering Purposes." Data for high / low tide is to be prepared. Tide timings and water table details during high/low tide is also to be prepared.

3. BORING

3.1. Boreholes shall be made at intervals of 500M (maximum distance) along the pipeline route, Boreholes are also to be made at all intermediate points where there is apparently a change in the type of soil and at any other place as directed by CONSULTANT. The objective will be to determine different types of terrain and the transition points between different types of terrain.

3.2. For canal, stream and river crossings, boreholes shall be made one on either bank and one on the bed.

3.3. Minimum diameter of boreholes shall be 150 MM. Auger boring shall be resorted to above the water table, whereas below water table the boreholes shall be advanced by shell and auger.

3.4. Along the pipeline , the boring shall be either terminated at a depth of 3 M below NGL or on top of bed rock if rock is encountered at a dept of less than 3 M.

3.5. The boring shall be upto 6.0 m on either side at all crossing locations.

3.6. Contractor should check for presence of underground services prior to commencement of drilling.

4. SAMPLING

Disturbed representative samples shall be collected from boreholes to classify the subsoils visually at site.

5. DETAILED REPORT

5.1. The report shall include proper visual engineering classification of soils encountered along the pipeline route in borelog form. Depth of Ground Water Table (GWT) below NGL shall also be mentioned ,if encountered.

5.2. Soil profiles along the pipeline route shall also be prepared and attached with the report.

5.3. Regions along the pipelines route where special excavation techniques like blasting, etc. needs to be adopted for excavation of pipeline trenches shall be clearly indicated in the report.

5.4. Data for high/low tide is to be noted. Tide timings and water table details during High/Low tide is also to be collected.

CHAPTER IV : POPULATION DENSITY INDEX & CLASS LOCATION SURVEY

1. GENERAL

When survey is performed for gas pipelines, the class locations based on population density index as per code ANSI B31.8 "Gas Transmission and Distribution Piping Systems" shall be recorded along with chainages at change points of each class location.

2. SCOPE

Population density index along the pipeline route shall be determined as follows:

A zone, 400 M (one quarter mile) wide (200 m either side) shall be considered along the pipeline route with the pipeline in the centre-line of this zone. Then the entire route of the pipeline shall be divided into lengths of 1600 M (one mile) such that the individual lengths will include the maximum number of dwellings intended for human occupancy. The number of such dwellings which are intended of human occupancy within each 1600 M (one mile) zone shall be counted and reported along with other survey data.

3. CLASSIFICATION GUIDELINES

Areas shall be classified based on guidelines as given below:

3.1. A. Class 1 Location (Including its subparts)

Class 1 location is any 1600 M (one mile) section that has 10 or fewer dwellings intended for human occupancy.

B. Class 2 Location

Class 2 location is any 1600 M (one mile) section that has More than10 but less than 46 dwellings intended for human occupancy.

C. Class 3 Location

Class 3 location is any 1600 M (one mile) section that has 46 or more dwellings intended for human occupancy except when a Class 4 Location prevails.

D. Class 4 Location

Class 4 location include areas where multi-storey buildings are prevalent, and where traffic is heavy or dense and where there may be numerous other utilities underground.

3.2. In addition to the criteria contained in Clause 3.1 above, while classifying areas, additional consideration must be given to possibilities of increase in concentration of population along the pipeline route such as may be caused by the presence of schools, hospitals, recreational areas of an organized character, places of assembly, places of worship, etc. If one or more of these facilities are present, the area shall be classified as a Class 3 Location.

3.3. Notwithstanding the provisions of Clause 3.1 and 3.2 above, while determining class location of an area due consideration shall be given to the possibility of future development of the area during the design life of the pipeline. If it appears likely that future development may cause a change in the location class, this shall be taken into consideration while determining its class location.

CHAPTER V : CADASTRAL SURVEY

1. SCOPE

This document covers various requirements for Cadastral survey to be carried out along pipeline route.

2. OBJECTIVE

The objective of the Cadastral survey is to identify the Ownership and land use details, collect data/ all other details sufficient for acquisition of ROU.

3. REQUIREMENTS

The contractor shall carry out detailed plane table cadastral survey along the pipeline route covering areas 50 metres on either side of centre line of the pipeline. All revenue and other maps as well as the forms required for carrying out this Survey shall be arranged by the Contractor at his own cost and responsibility. However, authorisations, if any required, shall be provided by CONSULTANT. Contractor's scope of work shall be as follows:

3.1. Prepare the following maps in six copies:

- Maps to scale 1:5000 as per format to be provided by CONSULTANT, showing the pipeline route and the villages block No. survey numbers encountered enroute.
- Maps to scale 1:1000 as per format to be provided by CONSULTANT showing the pipeline route and areas 50 metres on either side of the centre line of the pipeline complete with the following details:
  - Property Identification / Survey number , parts 'Hissas" on survey numbers as well as details of owners(Name, Address , Village etc.) as per the latest official revenue records along with an appropriate listing of the land owners.
  - Major features/land marks inlcuding
  - All built-up areas.
  - Creeks, river, canals and nallahs
  - Forest land
  - Industrial land
  - Quarry/mining and other prohibited areas
- Map of individual survey number is to be prepared indicating name of Owner , area, type of crops etc.
- Route alignment is to be provided on village map for ROW and ROU activities.

3.2. Ownership of all crossings, road, pipelines, canals etc. is to be collected.

3.3. Details of illegal structures like shops, hutments, canteen etc. are to be indicated along with their name , type of business etc.

3.4. Search report for Ownership of land along the route for last 10 years is to be collected from revenue records.

3.5. Type and cost of crop along route in the local market is to be collected.

3.6. Arrange and furnish extracts in duplicate of all land areas to be shown in map area as per para 3.1 above. These extracts are required to be duly certified by the "Talatis" concerned. Expenses in obtaining these extracts shall be borne by the Contractor.

3.7. In respect of the map at 3.1 above, Contractor's work of marking part "Hissas" as per the latest official revenue records shall be checked/verified by the Competent Authority. The Contractor shall ensure that the land records are submitted to Competent Authority for checking and verification as work proceeds.

3.8. Prepare a schedule, as per format to be approved by CONSULTANT showing information on part "Hissas" and details of owner (to be extracted from map at para 3.1 above for obtaining pipeline Right of Use (ROU). This ROU shall generally be a 50 metre wide strip.

3.9. The cadastral maps to be prepared in computer package approved by CONSULTANT with suitable compatibility with GIS / LIS based package.

CHAPTER VI : CORROSION SURVEY

1. SCOPE

The chapter covers the corrosion survey including measurement of soil resistivity, chemical analysis of soil/ water and other cathodic protection related data collection along right of way of the pipeline.

2. CODES AND STANDARDS

Equipment and measurement techniques shall unless otherwise specified, conform to the requirement of following latest applicable standards:

BIS Specifications

BS specifications and codes of practice

NACE publications

The work shall be carried out in compliance with all applicable local laws and regulations.

3. GENERAL

This specification defines the basic guidelines for carrying out the corrosion survey. Contractor shall be responsible for providing necessary data interpretation based on corrosion survey measurements which is intended to form a basis for design of cathodic protection system for the pipeline to be buried along ROW.

4. SOIL RESISTIVITY SURVEY

4.1. Unless otherwise specified, the soil resistivity measurements shall be carried out at intervals of maximum 500 mtr along the ROW. Where soil resistivity is less than 100 ohm mtr and two successive readings differ by more than 2:1 then additional soil resistivity readings in between two locations shall be taken. Measurements of soil resistivity can be at intermediate points also where there is apparent change in type of soil and at other places as directed by CONSULTANT.

4.2. To carryout the soil resistivity measurement Wenner's 4-pin method or approved equal shall be used. The depth of resistivity measurement shall be around the burial depth of the pipeline or 1.5 mtr Approximately. At locations where multi layer soil with large variation in resistivity/ corrosiveness is expected, measurements at additional depth of up to 2.5 mtr (Approx.) or more shall be taken. In general the resistivity of soil, which shall be surrounding the pipe, shall be measured. Hence the depth of measurement/ electrode spacing may vary depending on topography and strata at the area. In general, electrode spacing shall be approximately equal to 1.5 times the depth of the pipeline.

4.3. At places where Right of Way has not yet been cleared measurements shall be made right over the center line of pipeline route surveyed accounting for the cuttings/ fittings also.

4.4. Observations shall be made enclosing the soils adjoining the trench wherever pipeline trenching has already been done.

4.5. The observations shall be made enclosing the soil immediately surrounding the pipeline route where right of way has been cleared but trenching has not been done.

4.6. All measurements shall be taken at right angles to the right of way, unless otherwise asked by CONSULTANT or his representative at site.

4.7. At places in right of way where other pipelines already exist, care shall be taken to precisely locate such pipelines and take such precautions that observations are not adversely affected by presence of such pipelines.

4.8. Care shall also be taken that the observations are not influenced by presence of other earth currents in the area especially in the vicinity of HT lines and plants using earth return in their source of power etc.

4.9. Wherever possible/ advised by CONSULTANT, depth of water table shall be determined by resistivity observations.

4.10. All measurements shall be made and recorded in metric units. While recording the data, reference to the nearest intersecting point shall be made. To provide visual representation of variations in the resistivities along right of way, values shall be plotted on semilog graph sheets. The resistivity graph shall also indicate the resistivities at additional depths measured at various locations and depth of water table.

5. TESTS OF SOIL SAMPLES

Soil/ water samples shall be collected along the Right of way for analysis. Samples shall be collected on an average at one location per every 500 M (maximum distance) along Right of way. Exact locations shall be decided at site depending on the type of soil, soil resistivity and in consultation with CONSULTANT. The soil samples shall be collected at 1 mtr and 2-mtr depths at each location.

The collected soil/ water samples shall be analysed to determine presence and percentage of corrosive compounds including moisture content, oxygen activity and pH value.

6. ADDITIONAL DATA COLLECTION

The following data shall be collected with a view to generate design for evaluation of cathodic protection interaction possibilities due to presence of other services in Right of Way and its vicinity.

6.1. The following data shall be collected with a view to generate design for evaluation of cathodic protection interaction possibilities due to presence of other services in Right of Way and its vicinity.

6.2. Coating details, Diameter, wall thickness, pressure, soil cover etc. of the foreign pipeline.

6.3. Voltage rating, phase and sheathing details of parallel running or crossing cables with ROW.

6.4. Details of existing cathodic protection systems protecting the services including rating and location of grounds bed test station locations and connection schemes etc. Where pipeline is likely to pass close to any existing ground bed, necessary anode-bed potential gradient survey shall be carried out.

6.5. Interference remedial measures existing on nearby pipelines/ services/ shall be collected from the owner of the foreign pipeline/ services.

6.6. Graphical representation of existing structure/ pipe to soil potential record. T/R unit / CP power source voltage/ current readings.

6.7. Possibilities of integration/ isolation of the pipeline CP System with foreign pipeline/ structure CP System, which may involve negotiations with owner's of foreign services.

6.8. Information on existing and proposed DC/AC power sources and system in the vicinity of the entire Right of way.

6.9. Details of Crossing and parallel running of electrified and non-electrified railway tracks along with details of operating voltage and type (AC/DC).

6.10. Details of Crossing or parallel running of any H.T. AC/DC overhead line with in approximately 25 mtr from ROW along with details of voltage rating, fault level etc.

6.11. Any other relevant information that may be needed in designing and implementing of proper cathodic protection scheme for the proposed pipeline.

6.12. Type of CP provided by other pipeline is also to be collected.

6.13. Description of soil all along the route.

7. REPORT

On completion of all the field and laboratory work an interim report incorporating results generated from surveys, additional data collected, results of tests carried out, etc. shall be submitted for comments/ approval. The final report incorporating comments/ missing data shall be furnished for records. The report along with various drawings, graphs etc. prepared in connection with the work shall be submitted along with six prints by the contractor.

8. INFORMATION REQUIRED WITH BID

Bidder shall provide following information along with the bid without which the bids are liable for rejection.

8.1. Instruments that will be used for carrying out soil resistivity survey.

8.2. Measures that will be taken to avoid foreign pipeline / HT lines etc. affecting the soil resistivity observations.

8.3. Measurement location identification procedure.

8.4. Procedure for collection of soil samples.

8.5. Description of soil test procedure.

8.6. Specification of soil testing instruments.

8.7. Formats for presentation of results.

CHAPTER VII : SOIL INVESTIGATION AT STATIONS

1. INTRODUCTION

Soil investigation is to be carried out at end point station , at intermediate block valves station and at locations of Tee-Offs using SPT. Number of tests to be performed are 4 for main end point station and 1 for intermediate block valve station and at locations of Tee-Offs. Thereafter laboratory tests are to be done on selected soil samples.

2. IN- SITU GEOTECHNICAL WORK EXECUTION TECHNIQUE

2.1. Equipment and measurement techniques shall unless otherwise specified, conform to the requirement of following latest applicable standards:

The program of the works must comply with the site availability.

2.2. Setting up of the in- situ tests

2.2.1. The CONSULTANT shall provide location of the in-situ tests on maps. The Contractor must set up the tests on the site, after locating the position of the boreholes accurately, which will be checked by the CONSULTANT.

2.2.2. If the location, azimuth or inclination of any drill holes or in situ tests do not conform to the given indication, such holes shall be executed anew at the contractor's expenses.

2.2.3. After completion of the work, the Contractor shall provide a map with the location of in situ tests " as built".

2.2.4. Contractor should check for presence of underground services prior to commencing drilling or excavation.

2.2.5. Contractor should check for the presence of underground services prior to commencing of drilling or trial excavations and will validate and confirm that no underground services are at risk of being damaged or disturbed in any way.

2.3. Execution of the bore-holes with SPT

2.3.1. General marks

a) Boreholes of 110 mm to 200 mm internal diameter shall be sunk to the required depth with Shell and auger equipment through sand, silt and clay, but excluding rocks, pebbles or grabbers.

b) The methods and machinery must, in all cases, tend to mark the levels and confirm the nature of the crossed layers.

c) If one of the crossed layers causes landslide or soil instability, the drilling hole is to be protected by any efficient means, provided the subjacent soil is not contaminated . Bentonite slurry can be used in case of cohensionless soils.

d) The drilling machine is to be steered by a chief drilling operator with the help of at least one experienced workman.

e) The method of drilling is the responsibility of the Contractor. This method must permit to collect samples for identification and description of the crossed layers and to perform SPT. The Contractor shall propose his method before starting the works.

f) The drilling is to be vertical.

g) In the boreholes SPT will be performed. Mode of operation is explained before.

h) During the drilling operation, all incidents are to be recorded, and in particular the losses of water, with estimates of flow and volume, possible caverns, rising of water level, alteration in type and colors of mud, etc.

i) The boreholes shall be cased throughout the depth of boring.

j) Boreholes shall be cleaned properly before conducting any in-situ test or taking out undisturbed samples.

k) After the tests are conducted, the boreholes shall be filled with sand.

2.3.2. Description of the bore log

a) Levels survey

During the drilling, the levels of separation of the different layers and the upper and lower levels of the possible caverns are to be recorded in relation to the level of topsoil.

The location of the water table is to be determined. The dates and hours corresponding, to the end of the perforation and to the recording of levels as well as the losses of water observed during the drilling are to be noted.

b) Soil identification

As drilling progresses, the extracted soil shall be carefully preserved to enable its identification.

However the following information must be noted immediately:

- Sampling level,
- Temporary name given to the soil by the driller,
- Colour and odour,
- Soil consistency,
- Recuperation.

2.3.3. Documents to be supplied by the Contractor

At each time, the contractor shall fill in a report giving details on the work executed, describing difficulties and methods used, the description of machinery, the precise depth of each operation, etc.

The CONSULTANT must have access to these documents at all times.

In addition, two weeks after the completion of boring which is covered by the contract, the Contractor hands over a provisional report in two copies including a drilling log, and in particular:

- The reference number of the bore-hole
- The location marked on a map to a convenient scale together with the X, Y and Z co-ordinates of the bore-hole
- The point level from which depths are measured
- The diameter of the bore-holes
- The recuperation
- All observations and incidence noted by the operator concerning the boring operation
- The equipment in use and the process for drawing samples
- The levels of water at the start and at the end of each shift
- The date at which the boring starts and ends, together with a graph showing progress and effective preparation speeds
- The depths at each operation
- The reports on special tests or sampling with the numbers of the samples extracted and their position
- The sectional drawing of the bore-hole with references and symbolic representations of the nature of the crossed soils

A global report shall collect all the results and data from the various daily reports, from the drilling logs, etc.

Five copies of this global report shall be handed over to the CONSULTANT two weeks after completion of the in-situ works.

The Contractor shall also hand over to the CONSULTANT a reproducible original of all the maps, drilling maps, etc., which are part of his daily report and of the global report.

2.3.4. Standard Penetration tests in the boreholes

a) Mode of operation

Standard Penetration Tests shall be carried out during the boring in accordance with IS 2131 (latest). The depth of each test shall be correctly determined. In the event that the penetration resistance "N", determined in a test, is less than 5, the Engineer may require to clean out the borehole and to carry out another test immediately afterwards. Small-disturbed samples removed from the Standard Penetration

Test split spoon sampler shall be taken in accordance with IS 2132 (latest). The Standard equipment with split spoon sampler in soil or solid cone in hard soil with 65 kgs hammer shall be used.

Unless otherwise instructed by the CONSULTANT a Standard Penetration Test shall be carried out every 0.5m in the upper soft layers and at 1.0 m interval in the bottom layers.

b) Documents to be supplied by the Contractor

The information on the Standard Penetration Test to be submitted by the Contractor consists in of the following:

- Penetration resistance (Nblows/300 mm) or the Penetration (mm) for 50 blows. The procedure of testing and determination of N value shall be as per IS:2131 (latest).
- Depths (m) between which penetration resistance is measured.
- Depth of casing and size at time of test.
- Before start of test depth SPT tools sunk under own weight from base of borehole.
- Number of blows for each 75 mm of Penetration including seating blows.
- Type of equipment
- Weight of hammer.
- Height of drop.
- Method of release.
- Use of drilling mud or casing.

Disturbed samples resulting from SPT shall be taken for classification purposes. They shall be placed immediately in an airtight, non-corrodible and durable container, which the sample will fill with a minimum of air space. The undisturbed samples shall be taken at intervals of 2 m or at change of stratum whichever occurs earlier. The samples shall be minimum 100 mm dia and 450 mm long.

2.4. Document and Report

At the end of the investigation and on completion of all the tests, the contractor shall submit a report consisting of the following documents and recommendations.

2.4.1. Plan showing the location of the boreholes with co-ordinates as executed.

2.4.2. All field records namely the bore-log, details of samples taken, records of all in-situ and laboratory test profiles, classification of soil stratum, and any other significant details which might be found out during investigation.

2.4.3. All computations leading to the logical conclusion of bearing capacities of soil, safe capacity of piles etc. shall be included in report. If references are drawn from standard test books, such references shall be clearly indicated.

2.4.4. The report shall contain recommendation about: -

a) The safe net bearing capacity of soil for isolated / strip footings and proposed depth of footings, starting from bottom level.

b) The safe net bearing capacity of soil for mat/ raft foundations at basement level.

c) Estimated lengths, and capacities of piles of various diameters, if recommended.

d) For design of retaining walls, recommendations shall be made as to the layer of excavated Design parameters like coefficient of earth pressure at rest shall be recommended.

e) Safe bearing capacity of soil for temporary structures and structures of secondary importance shall be included.

f) Water table in each bore hole.

g) Max. Water table to be adopted for design of foundations.

3. LABORATORY TEST ON SELECTED SOIL SAMPLES

The following tests shall be performed on the selected soil samples (according to IS 2720) and water samples collected.

- Atterberg Limits: - Liquid limit + plastic limit shall be required for U.D. samples
- Natural Moisture: - shall be required for U.D. samples.
- Particle size analysis: Sieve & hydrometer analysis on at least one sample from each stratum shall be required.
- Wet & Dry Density: for U.D. samples.
- SP Gravity: For one sample from each stratum.
- Unconfined compression Test: To be conducted at site on about 25% of U.D. Samples.
- Triaxial Tests: Un-drained quick tests shall be done on UD samples available at Laboratory.
- Consolidation Tests: on U.D. samples taken at least one from each stratum shall be conducted for a range of pressure from 2.7 t/sq.m to 8.6 t/sq.m
- Chemical Tests: Sulphate- & chloride contents of water samples.
- Sulphate, carbonate, chloride and organic matter, content of soil samples.

CHAPTER VIII : HEALTH, SAFETY & ENVIRONMENT MANAGEMENT

1. SCOPE

This specification establishes the Health, Safety and Environment Management (HSEM) requirement to be complied with by the Contractor during execution of work.

Requirement stipulated in this specification shall supplement the requirements of HSEM Management given in relevant Act (s)/legislations. Where different documents stipulate different requirements, the most stringent shall be adopted.

2. REFERENCE

This document should be read in conjunction with the following:

- Relevant IS Codes
- Reporting Format

3. REQUIREMENT OF HEALTH, SAFETY AND ENVIRONMENT MANAGEMENT (HSEM) SYSTEM TO BE COMPLIED BY BIDDERS

3.1. Management Responsibility

3.1.1. The Contractor should have a documented HSEM policy to cover commitment of their organization to ensure Health, Safety and Environment Management aspects in their line of operations.

3.1.2. The HSEM system of the Contractor shall cover the HSEM requirement including but not limited to what is specified above.

3.1.3. Contractor shall be fully responsible for planning and implementing HSEM requirements. Contractor as a minimum requirement shall designate/deploy the following to co-ordinate the above:

No. of workers deployed

Up to 5 - At least one safety supervisor

5 –10 - At least two safety supervisors

Contractor shall indemnify and hold harmless CONSULTANT and their representatives from any and all liabilities arising out of non-fulfillment of HSEM requirements.

3.1.4. The Contractor shall ensure that the Health, Safety and Environment (HSEM) requirements are clearly understood and faithfully implemented at all levels, at site.

3.1.5. The Contractor shall promote and develop consciousness for Health, Safety and Environment Management among all personnel working for the Contractor Regular awareness programmes and fabrication shop/work site meetings shall be arranged on HSEM activities to cover hazards involved in various operations.

3.1.6. Arrange suitable first aid measures such as First Aid Box, Trained Personnel to give first Aid to the satisfaction of CONSULTANT.

3.1.7. The Contractor shall evolve a comprehensive planned and documented system for implementation and monitoring of the HSEM requirements. This shall be submitted to CONSULTANT for approval. The monitoring for implementation shall be done by regular inspections and compliance to the observations thereof. Any review/approval by CONSULTANT shall not absolve contractor for his responsibility/liability in relation to all HSEM requirements.

3.1.8. Non-Conformance on HSEM by Contractor (including his Sub-contractors) as brought out during review/audit by CONSULTANT shall be resolved forthwith by Contractor. Compliance report shall be provided to CONSULTANT.

3.1.9. The Contractor shall ensure participation of his Resident Engineer/ Site-In-Charge in the Safety Committee/HSEM Committees meetings arranged by CONSULTANT. The compliance of any observations shall be arranged urgently. He shall assist CONSULTANT to achieve the targets set by them on HSEM during the project implementation.

3.1.10. The Contractor shall adhere consistently to all provisions of HSEM requirements. In case of non-compliance or continuous failure in implementation of any HSEM provisions; CONSULTANT may impose stoppage to work without any Cost and Time implication to CONSULTANT and/or impose a suitable penalty for non-compliance with a notice of suitable period, up to a cumulative limit of 1.0% (one per cent) of Contractor Value. The penalty shall be in addition to all other penalties specified else where in the contract. The decision of imposing stoppage of work, its existent and monetary penalty shall rest with CONSULTANT and shall be binding on the Contractor.

3.2. House Keeping

3.2.1. Contractor shall ensure that a high degree of house keeping is maintained and shall ensure interalia the following.

A. All surplus earth and debris are removed/disposed off from the working areas to identified location(s).

B. All wooden scrap, drums and other combustible packing materials shall be removed from work place to identified location(s).

C. Water logging on roads shall not be allowed.

D. No parking for trucks/trolleys, etc. shall be allowed on roads, which may obstruct the traffic movement.

E. Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas.

3.3. Health, Safety And Environment Management

3.3.1. The contractor shall provide safe means of access to any working place including provisions of suitable and sufficient scaffolding at various stages during all operations of the work for the safety of his workmen, and, members of CONSULTANT. Contractor shall ensure deployment of appropriate equipment and appliances for adequate safety and health of the workmen and protection of surrounding areas.

3.3.2. The Contractor shall ensure that all their staff and workers including their sub-contractor(s) shall wear Safety Helmet and Safety shoes. Contractors shall also ensure use of safety belts, protective goggles, gloves, etc. by the personnel as per job requirements. All these gadgets shall conform to relevant IS specifications or equivalent.

3.3.3. The contractor shall assign to his workmen, tasks commensurate with their qualification, experience and state of health of driving of vehicles, handling and erection of materials and equipment. All lifting equipment shall be tested certified for its capacity before use. Adequate and suitable lighting at every work place and approach there to, shall be provided by the Contractor before starting the actual operations at night.

3.3.4. Hazardous and/or toxic materials such as solvent coating, or thinners shall be stored in appropriate containers.

3.3.5. All hazardous materials shall be labeled with name of the materials, the hazards associated with its use and necessary precautions to be taken.

3.3.6. Contractors shall ensure that during the performance of the work, all hazards to the health of personnel have been identified assessed and eliminated.

3.3.7. Chemical spills shall be contained and cleaned up immediately to prevent further contamination.

3.3.8. All personnel exposed to physical agents such as ionizing or non-ionizing radiation, ultraviolet rays and similar other physical agents shall be provided with adequate shielding or protection commensurate with the type of exposure involved.

3.3.9. Where contact or exposure of hazardous materials could exceed limits or could otherwise have harmful effects, appropriate personal protective equipment such as gloves, goggles, aprons, chemical resistant clothing and respirator shall be used.

3.3.10. Suitable facilities for toilet, drinking water, proper lighting shall be provided at site and labour camps, commensurate with applicable Laws/Legislation.

3.3.11. Contractor shall ensure storage and utilization methodology of materials that are not detrimental to the environment. Where required Contractor shall ensure that only the environment friendly materials are selected.

3.3.12. All persons deployed at site shall be knowledgeable of and comply with the environmental laws, rules and regulations relating to the hazardous materials substances and wastes. Contractor shall not dump, release or otherwise discharge or dispose off any such materials without the express authorization of CONSULTANT.

4. DETAILS OF HSEM SYSTEM BY CONTRACTOR

4.1. On Award of Contract

The Contractor shall prior to start of work submit his Health, Safety and Environment Management Manual or procedure and HSEM Plans for approval by CONSULTANT. The Contractor shall participate in the pre-start meeting with CONSULTANT to finalize HSEM Plans including the following:

- Job procedure to be allowed by Contractor for activities covering handling of equipment, scaffolding, electric installation, describing the risks involved, actions to be taken and methodology for monitoring each activity.
- CONSULTANT review/audit requirement.
- Organization structure along with responsibility and authority, records/reports etc. on HSEM activities.

4.2. During Job Execution

4.2.1. Implement approved Health, Safety and Environment Management procedure including but not limited to as brought out under Para 3.0. Contractor shall also ensure to:

- Arrange workmen compensation insurance, registration under ESI Act, third party liability insurance etc. as applicable.
- Submit timely the completed checklist on HSEM activities. HSEM report, accident reports, investigation reports etc. as per CONSULTANT requirements. Compliance of instruction on HSEM shall be done by Contractor and informed urgently to CONSULTANT.
- Ensure that Resident Engineer/Site-In-Charge of the Contractor shall attend all the Safety Committee/HSEM meetings arranged by CONSULTANT. Only in case of his absence from site that a second senior most person shall be nominated by him in advance and communicated to CONSULTANT.
- Display at site office and work locations, caution boards, and list of hospitals, emergency services available.
- Carryout audits/inspection at sub contractor works as per approved HSEM document and submit the reports for CONSULTANT review.
- Assist in HSEM audits by CONSULTANT and submit compliance report.
- Generate and submit HSEM records/report as per HSEM Plan.
- Appraise CONSULTANT on HSEM activities at site.

CHAPTER IX : APPENDIX-I

1. **RELEVALENT IS CODES**

IS: 2925-1984	Industrial Safety Helmets
IS: 4770-1968	Rubber gloves for electrical purposes
IS: 6994-1973 (Part-I)	Industrial Safety Gloves (Leather and Cotton Gloves)
IS: 1989-1986 (Part-I & III)	Leather safety boots and shoes
IS: 3738-1975	Rubber knee shoes
IS: 5557-1969	Industrial and Safety rubber knee Boots
IS: 6519-1971	Code of practice for selections, care and repair of Safety footwear
IS: 11226-1985	Leather Safety footwear having direct molding sole
IS: 5983-1978	Eye protectors
IS: 9167-1979	Ear protectors
IS: 3521-1983	Industrial Safety belts and harness

CHAPTER X : APPENDIX-II

1. HEALTH, SAFETY & ENVIRONMENT MANAGEMENT (HSEM) PLAN

PROJECT : _____ CONTRACTOR : _____

DATE : _____ CONSULTANT :

ACTIVITY DESCRIPTION	PROCEDURE/W.I. / GUIDELINES	CODE OF CONFORMANCE	PERFORMING FUNCTIONS			AUDIT FUNCTION
			PERFORMER	CHECKER	APPROVER	CUSTOMER REVIEW/AUDIT REQUIREMENTS

PREPARED BY REVIEWED BY APPROVED BY

2. WEEKLY HSEM CHECKLIST CUM COMPLIANCE REPORT

PROJECT : _____ **CONTRACTOR :** _____

DATE : _____ **CONSULTANT :** _____

INSPECTION BY: _____

Note: Write 'NA' wherever the item is not applicable

ITEMS	YES	NO	REMARKS	ACTION
HOUSEKEEPING				
General neatness of working areas				
Others				
Personnel protective equipment				
Face protection				
safety belts				
others				
Excavations/openings				
Openings properly covered or barricaded				
Excavations shored				
Excavations barricaded				
Overnight lighting provided				
Others				

3. WEEKLY HSEM CHECKLIST CUM-COMPLIANCE REPORT

ITEMS	YES	NO	REMARKS	ACTION
VEHICLE AND TRAFFIC				
Rules and regulations observed				
Inspection and maintenance				
Licensed drivers				
Others				
TEMPORARY FACILITIES				
Emergency instructions posted				
Fire extinguishers provided				
Fire-aid equipment available				
Secured against storm damage				
Others				
HANDLING AND STORAGE OF MATERIALS				
Properly stored or stacked				
Passageways clear				
Others				
WORKING AT HEIGHT				
Erection plan				
Safety nets				
ENVIRONMENT				
Chemical and Other Effluents properly disposed				
Lubricant Waste/Engine oils properly disposed				
ITEMS	**YES**	**NO**	**REMARKS**	**ACTION**
Disposal surplus earth, stripping materials, Oily rags and combustible materials done properly				
Green belt protection				

HEALTH CHECKS				
Hygienic conditions at labour camps O.K?				
Availability of First Aid facilities				
Proper sanitation at site, office and labour camps				
Arrangement of medical facilities				
Measures for dealing with illness				
Availability of Potable drinking water for workmen and staff.				

Signatures of CONSULTANT

4. ACCIDENT CUM FIRE REPORT

(To be submitted by contractor after every accident within hours of accident)

Report_____

Date : _____

Name of the Site

Contractor_____

NAME OF THE INJURED_____

FATHER'S NAME_____

SUB-CONTRACTOR M/S_____

DATE AND TIME OF ACCIDENT_____

LOCATION

BRIEF DESCRIPTION OF ACCIDENT

CAUSE OF ACCIDENT

NATURE OF INJURY/DAMAGE

MEDICAL AID PROVIDED/ACTIONS TAKEN

INTIMATION TO LOCAL AUTHORITIES

DATE: **SIGNATURE OF CONTRACTOR**

WITH SEAL

TO CONSULTANT **1 COPY**

5. SUPPLEMENTARY ACCIDENT & INVESTIGATION REPORT

Project :_____ Supplementary to Report No.:_____
(Copy enclosed)

Site : _____Date : _____

Contractor :_____

NAME OF THE INJURED_____
FATHER'S NAME_____
SUB-CONTRACTOR M/S_____
DATE AND TIME OF ACCIDENT_____
LOCATION

BRIEF DESCRIPTION & CAUSE OF ACCIDENT

NATURE OF INJURY/DAMAGE

COMMENTS FROM MEDICAL PRACTITIONER WHO ATTENDED THE VICTIM/INJURED

SUGGESTED IMPROVEMENT IN THE WORKING CONDITION, IF ANY

LOSS OF MANHOURS AND IMPACT ON SITE WORKS

ANY OTHER COMMENT BY SAFETY OFFICER

DATE: **SIGNATURE OF CONTRACTOR**
WITH SEAL

TO: **CONSULTANT** **1 COPY**

6. WEEKLY HEALTH, SAFETY, AND ENVIRONMENT (HSEM) REPORT

Actual work start Date : _____ For the Month of: _____

Project : _____ Report NO : _____

Name of the Contractor : _____Status as on : _____

Name of the Work_____ Name of the safety officer_____

ITEMS	**THIS WEEK**	**CUMULATIVE**
Total Strength (Staff + Workmen)		
Number of HSEM meetings organized at site		
Number of HSEM awareness programmes conducted at site.		
Whether workmen compensation policy taken	Y/N	--
Whether workmen compensation policy is valid	Y/N	--
Whether workmen registered under ESI Act	Y/N	--
Number of Fatal Accidents		
Number of Loss Time Accidents (Other than Fatal)		
Other accidents (Non Loss Time)		
Total No of Accidents		
Total man-hours worked		
Man-hours loss due to fire and accidents.		
Compensation; cases raised with Insurance		
Compensation cases resolved and paid to workmen		
Remarks		

Date : Safety Officer/Resident Engineer
(Signature and Name)

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STRUCTURAL CONCRETE

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1. GENERAL

This general technical SPECIFICATION is based on Indian CODES.

1.1. Definitions

Subject to the requirements of the context, the terms (hereafter listed in alphabetical order) used in this document are given the following meaning :

AGREEMENT	Designates the agreement concluded between the OWNER and the CONTRACTOR, under which the latter undertakes to the former the GOODS and/or SERVICES according to the stipulations which are agreed and specified in the form of an order.
OWNER	Designates the purchaser of the GOODS and/or SERVICES which are the subject of the AGREEMENT.
CODE	Designates a set of systems and rules or international standardization documents for materials, tests, etc.
CONTRACTOR	Designates the individual or legal entity with whom the order has been concluded by the OWNER. The term "CONTRACTOR" may be used indifferently for a supplier, a manufacturer, an erection contractor, etc.
DAYS - WEEKS - MONTHS	Specify the number of calendar days, weeks or months and not of working days, weeks or months.
OWNER'S REPRESENTATIVE	Designates the individual or legal entity to which the OWNER has entrusted various tasks in relation with the carrying out of his PROJECT.
GOODS and/or SERVICES	Designate, depending on the case, all or part of the drawings or documents, substances, materials, equipment, structures, plant, tools, machinery,... to be studied, designed, manufactured, supplied, erected, built, assembled, adapted, arranged, commissioned and put into service by the CONTRACTOR under the AGREEMENT, including all the studies, tasks, works and services specified by the order. The terms GOODS or SERVICES may be indifferently used one for the other as required by the context.
PROJECT	Designates the aggregate of GOODS and/or SERVICES to be provided by one or more CONTRACTORS.
STANDARD	Designates a set of models or references, corresponding to common practice and generally used by the OWNER'S REPRESENTATIVE. This can be : typical standard drawings or documents.
SPECIFICATION	Designates a document describing in some details general or particular requirements for specific type of works.

1.2. Codes, Standards And Legal Requirements

The design, construction, materials, testing shall be in accordance with the CODES and STANDARDS mentioned in the present SPECIFICATION and with the CODES, STANDARDS and legal requirements listed in the Particular Technical SPECIFICATION (if any) for the PROJECT.

1.3. Scope

This SPECIFICATION covers :

a) materials for, and the batching, mixing, transporting, placing, compacting, curing and protecting of, all concrete for use in the Civil Works;

b) materials for, and the construction of, all formwork for cast in situ concrete:

c) materials for, and the bending and fixing of, steel reinforcement for concrete;

d) the finishing of formed and unformed surfaces of concrete;

e) the casting, handling and placing of precast concrete units;

f) materials for, and the use or application of, mortars, grout and rendering.

1.4. Review And /OR Approval

Whenever a OWNER'S and/or an OWNER'S REPRESENTATIVE'S review and/or approval of a document, to be submitted by the CONTRACTOR, is requested or before an action is implemented by the CONTRACTOR, the review and/or the approval shall always be requested in writing by the CONTRACTOR to the OWNER and/or to the OWNER'S REPRESENTATIVE before any action subject to this review and/or approval has been taken.

A OWNER'S and/or an OWNER'S REPRESENTATIVE'S approval shall always be given in writing.

1.5. References

The CODES referred to in this section are :

Subject	Indian CODES
Sand	IS 2116 : 1980
Testing aggregates	[IS 2386 : 1963]
Cement & methods for testing cement	[IS 8112 : 1989] [IS 269 : 1989]
Concrete & methods for testing concrete	[IS 516 : 1959]
Reinforcement	[IS 1786 : 1985 IS 432 : 1982]
Aggregates for concrete - determination chloride content	[IS 383 : 1999 & IS 2386 : 1963]
CODE for Labour Protection	[Indian labour Laws]

and all derived CODES.

1.6. Submittals

1.6.1. Product Data

1.6.1.1. General

In accordance with the requirements of this SPECIFICATION, the CONTRACTOR shall submit the details specified in the following paragraphs regarding the materials covered by this SPECIFICATION.

1.6.1.2. Cements

Before orders are placed, the CONTRACTOR shall submit details of the proposed cement manufacturers with, at the same time, sufficient information on the proposed methods of transport, storage and certification of the cement to enable the OWNER'S REPRESENTATIVE to convince himself that the required quantity and quality can be supplied and maintained throughout the period of construction.

Having obtained the OWNER'S REPRESENTATIVE'S approval of the source(s) of supply, and the methods of transport, storage and certification of the cement, the CONTRACTOR shall not modify or change the approved arrangements without first having obtained the permission of the OWNER'S REPRESENTATIVE.

1.6.1.3. Aggregates

The CONTRACTOR shall submit the following details regarding the aggregates which are proposed to be used in the concrete :

source(s)

petrological type(s).

1.6.1.4. Admixtures

The CONTRACTOR shall submit the following details regarding the admixtures which are proposed to be used in the concrete :

source(s)

types(s)

manufacturer's technical details.

1.6.1.5. Water

The CONTRACTOR shall submit the following details regarding the water, proposed to be used, for the mixing and/or curing of concrete, mortar, grout and rendering :

source(s)

chemical analysis

physical analysis.

1.6.1.6. Reinforcement

The CONTRACTOR shall submit the following details regarding the reinforcement which is proposed to be used :

source(s).

1.6.1.7. Curing compounds

The CONTRACTOR shall submit the following details regarding the curing compounds, proposed to be used :

source(s)

types(s)

manufacturer's technical details.

1.6.1.8. Sealing compounds

The CONTRACTOR shall submit the following details regarding the sealing compounds proposed to be used :

source(s)

type(s)

manufacturer's technical details.

1.6.1.9. Reinforcement Couplers

The CONTRACTOR shall submit the following details regarding the reinforcement couplers, for connecting bars in tension and compression, proposed to be used :

source(s)

type(s)

manufacturer's technical details.

1.6.2. Test reports

In accordance with the requirements of paragraph 1.2. of this SPECIFICATION the CONTRACTOR shall submit, as soon as possible after their completion, reports on the tests specified in paragraphs 1.6 and 3.2 of this SPECIFICATION.

1.6.3. Certificates

The following requirements shall be applicable only if specifically requested by the AGREEMENT constituent documents.

1.6.3.1. General

In accordance with the requirements of this SPECIFICATION the CONTRACTOR shall submit certificates of compliance with the specified CODES regarding the materials mentioned in the following paragraphs.

1.6.3.2. Cement

All cement shall be certified by the manufacturer as complying with the requirements of the appropriate CODES.

1.6.3.3. Reinforcement

The CONTRACTOR shall submit to the OWNER'S REPRESENTATIVE copies of the manufacturer's certificates of tests for all supplied reinforcement.

1.6.4. Samples

The following requirements shall be applicable only if specifically requested by the AGREEMENT constituent documents.

1.6.4.1. General

In accordance with the requirements of this SPECIFICATION, the CONTRACTOR shall supply the samples specified in the following paragraphs.

1.6.4.2. Cements

If requested by the OWNER'S REPRESENTATIVE, the CONTRACTOR shall deliver samples of cement(s) to an approved laboratory for the further analysis and testing envisaged in paragraphs 1.6 and 3.2 of this SPECIFICATION.

1.6.4.3. Reinforcement

If requested by the OWNER'S REPRESENTATIVE, the CONTRACTOR shall deliver samples of steel reinforcement to an approved testing agency for the independent tests envisaged in paragraphs 1.6 and 3.2 of this SPECIFICATION.

1.6.4.4. Aggregates

The CONTRACTOR shall deliver, to the OWNER'S REPRESENTATIVE'S site laboratory or to an approved testing agency, as directed by the OWNER'S REPRESENTATIVE, samples of all aggregates in such quantities sufficient for carrying out the tests as described in paragraphs 1.6 and 3.2 of this SPECIFICATION.

1.6.5. Drawings and other details

1.6.5.1. General

In accordance with the requirements of this SPECIFICATION, the CONTRACTOR shall submit the drawings and other details specified in the following paragraphs.

For the paragraphs, marked with (*), the requirements shall be applicable only if specifically requested by the AGREEMENT constituent documents.

1.6.5.2. Formwork (*)

The CONTRACTOR shall submit details of the methods and materials proposed for the formwork for each element of the works.
Details of formwork for producing special finishes shall be submitted for approval to the OWNER'S REPRESENTATIVE before any materials are brought on site.

The CONTRACTOR shall submit for approval complete construction drawings, including method diagrams and full supporting calculations (when required by the OWNER'S REPRESENTATIVE) of the formwork for each major structural element of the works.

1.6.5.3. Concrete placing and curing

The CONTRACTOR shall submit details of his proposed construction sequence and method including :

a) Positions of construction joints additional to those shown on the drawings

b) Pour size and sequences

c) Methods for controlling concrete temperature

d) Methods for concrete compaction

e) Curing procedures.

1.6.5.4. Bar schedules (*)

Bar schedules shall be submitted to the OWNER'S REPRESENTATIVE. The layout and typical content of bar bending schedules shall be submitted to the OWNER'S REPRESENTATIVE prior to issue them with the drawings.

1.6.5.5. Plant details

The CONTRACTOR shall submit details of the types and sizes of items of equipment proposed to be used for the transport, placing and compacting of concrete and of the proposed manner of their use. For concrete mixes to be used in the works which may have a relatively low workability and a large maximum size of aggregate, all plant and operating procedures shall be adapted to be made suitable.

1.6.5.6. Mix proposals

Before any concrete is poured, the CONTRACTOR shall submit to the OWNER'S REPRESENTATIVE for approval full details of the mixes he proposes to be used for each grade of concrete together with their anticipated average target strengths.

1.6.5.7. Precast concrete

The CONTRACTOR shall submit to the OWNER'S REPRESENTATIVE for approval full details of all his proposed arrangements for casting, handling and placing precast concrete units.

1.6.5.8. Concrete documentation

The CONTRACTOR shall send daily to the OWNER'S REPRESENTATIVE a return showing the quantities of cement, per grade of concrete, used in the permanent works and in temporary works, of the previous day.

1.6.5.9. Temperature records

The CONTRACTOR shall record the daily maximum and minimum ambient shade and unshaded air temperatures adjacent to those parts of the works where concrete is being placed or cured. The CONTRACTOR shall send a copy of these records to the OWNER'S REPRESENTATIVE every week.

1.6.5.10. Calibration of weighing equipment

The CONTRACTOR shall submit to the OWNER'S REPRESENTATIVE, as soon as possible after their completion, the results of the calibration checks specified in paragraph 2.2.6 of this SPECIFICATION.

1.7. Delivery, Storage and Handling

1.7.1. Cement

See also :

[IS 8112 : 1989]

The cement shall be delivered to the site in bulk or in sound, properly-sealed and marked bags. While being loaded or unloaded and during transit to the concrete mixers, whether conveyed in vehicles or by mechanical means, cement shall be protected effectively from the weather. Mechanical transfer systems shall be fully enclosed and bagged cement shall be protected by tarpaulins or other effective coverings.

If the cement is delivered in bulk, the CONTRACTOR shall provide approved silos of adequate sizes to store a sufficient amount of cement to ensure the continuity of the works and the cement shall be placed in those silos immediately after it has been delivered to the site. Approved precautions shall be taken during unloading to ensure that the resulting dust does not constitute a nuisance or health hazard.

If the cement is delivered in bags, the CONTRACTOR shall provide perfectly waterproof and well ventilated sheds having a floor of wood or concrete raised clear of the ground.

The sheds shall be large enough to store a sufficient amount of cement to ensure the continuity of the work and to enable the OWNER'S REPRESENTATIVE to determine the suitability of the cement before being used.

Each consignment shall be stacked separately therein to permit easy access for inspection, testing and approval. When delivered at the site the cement shall immediately being placed in the above mentioned sheds and it shall be used in the order in which it has been delivered.

The CONTRACTOR shall ensure that the arrangements for the storage of the cement at the site are sufficient for the separation and identification of each consignment until the results of the sampling and testing referred to in paragraph 1.6.4 and 2.2.1 of this SPECIFICATION are available.

1.7.2. Aggregates

See also :

[IS 383 : 1999]

All aggregates for concrete shall be stored in concrete-based bins or on stages designed to prevent intermixing of different aggregates and to avoid the inclusion of dirt and other foreign materials in the concrete. Each size of aggregate shall be stored separately.

The storage bins shall be emptied and cleaned and the grading of the aggregates checked at intervals, subject to the approval of the OWNER'S REPRESENTATIVE.

1.7.3. Reinforcement

All reinforcement shall be stored above ground, racked systematically as necessary and protected from all aggressive elements to the approval of the OWNER'S REPRESENTATIVE.

1.8. Quality Assurance

1.8.1. General

The materials mentioned below shall be tested at the place of manufacturing (or elsewhere if convenient and appropriate) by an approved testing agency to ensure that they comply with the requirements of this SPECIFICATION.

The OWNER'S REPRESENTATIVE may agree on the fact that the routine tests, carried out by the manufacturers, fulfil all or part of the requirements of this paragraph, provided that he is satisfied with the manufacturer's testing procedures.

1.8.2. Cements

Cements from all proposed sources shall be tested for compliance with all the requirements and by the methods, set out in paragraph 2.1.1 of this SPECIFICATION.

Where necessary the OWNER'S REPRESENTATIVE may require further representative samples of the proposed cement(s) to be taken and forwarded to an approved laboratory for analysis and testing before the source(s) is/are approved.

All cement(s) delivered to the site shall be tested on a routine basis to enable the CONTRACTOR to submit the certificates required by paragraph 1.6.3 of this SPECIFICATION. The CONTRACTOR'S testing program shall ensure that any cement delivered on site from bulk storage elsewhere, satisfies the requirements of paragraph 2.1.1 of this SPECIFICATION.

1.8.3. Reinforcement

All reinforcement delivered to the site shall be tested on a routine basis to enable the CONTRACTOR to submit the certificates required by paragraph 1.6.3 of this SPECIFICATION.

The OWNER'S REPRESENTATIVE may, however, order independent tests to be performed and any steel which does not comply in all respects with the appropriate CODES will be rejected.

1.8.4. Reinforcement couplers

The CONTRACTOR shall prepare and test three connections for each diameter and type of the reinforcement bar to be coupled in such a way as to demonstrate compliance with paragraph 2.1.13 of this SPECIFICATION.

Test specimens shall be prepared using the materials, equipment and personnel to be applied during the works, and they shall be prepared, as far as possible, under the conditions similar to the ones likely to be encountered during the works.

1.8.5. Aggregates

Tests to assess the suitability of the aggregates proposed to be used in concrete for the permanent works shall be carried out as follows :

a) Grading

b) Magnesium Sulphate Soundness

c) Specify Gravity and Water Absorption

d) Clay, Silt and Dust Content

e) Organic Impurities

f) Sulphate and Chloride Content

g) Aggregate Crushing Value

h) Elongation and Flakiness Determination

i) Potential Alkali Reactivity, chemical and petrographic examination

These tests shall be carried out in accordance with the appropriate Belgian CODES or foreign CODES and the results shall comply with the limits given therein or as otherwise stated in this SPECIFICATION.

1.8.6. Water

Water proposed to be used for the production and/or curing of concrete, mortar, grout and rendering, shall be in accordance with :

[IS 456 : 2000 / IS : 3025]

1.9. Site Conditions

The attention of the CONTRACTOR is drawn to the paragraphs 3.1.4, 3.1.5 and 3.1.6 of this SPECIFICATION regarding the requirements for concreting in specific environmental conditions.

2. PRODUCTS

2.1. Materials

2.1.1. Cement

In principle, the cement to be used throughout the works shall be (Ordinary) Portland cement and it shall comply with the requirements of :

[IS 8112 : 1989 IS 269 : 1989]

For applying special types of cements, refer to relevant Indian Codes i.e. :

[IS 12330 : 1988]

for Sulphate-resisting Portland cement

The particular technical SPECIFICATIONS might refer to other specific types of cement.

In order to ensure that all visible exposed faces of concrete have a uniform colour, the CONTRACTOR shall take all necessary steps to ensure the supply of cement of uniform colour.

2.1.2. Aggregate sources

Aggregates for concrete shall be obtained from sources to be approved for this purpose by the OWNER'S REPRESENTATIVE. The CONTRACTOR shall be responsible for selecting suitable aggregates and samples of sand and stone for the specified tests to be carried out, before any arrangements of obtaining aggregates from new or alternative sources are approved by the OWNER'S REPRESENTATIVE. Laboratory check tests of the aggregates will be performed at regular intervals to confirm their suitability for concrete and the consistency of the grading.

Aggregates shall be produced to the sizes and grading specified for the various concrete mixes. If instructed by the OWNER'S REPRESENTATIVE the CONTRACTOR shall carry out investigations to convince the OWNER'S REPRESENTATIVE that there are sufficient quantities of suitable aggregates available to complete the works.

The CONTRACTOR shall be responsible for all arrangements and costs involved in the exploitation of quarries and borrow pits and he shall carry out any boring and investigations he deems necessary to determine the precise location of the working and the manner in which the quarries and borrow pits may be exploited efficiently and economically.

Quarries shall be run in a safe manner and on completion of the works they shall be left in a tidy state. No rocks shall be left overhanging except with the approval of the OWNER'S REPRESENTATIVE. The aggregate winning and processing operations shall be such that they do not constitute a danger to health either during their operation or after completion of the works.

The CONTRACTOR shall ensure that his activities in no way interfere with existing operations being carried out by others, and he shall be responsible for providing his own local accesses and all plant's facilities.

2.1.3. Aggregates - General

Aggregates for concrete, mortar or for any other purposes shall always be free from earth, clay, loam, soft, clayey, shaley or decomposed stone, organic matter and other impurities and shall be hard and dense. The percentage of hollow shells shall be limited to an approved level compatible with the production of dense concrete to the satisfaction of the OWNER'S REPRESENTATIVE.

Aggregates for use in concrete shall be, in all respects, in accordance with :

[IS 2386 : 1963, IS 383 : 1999]

except where specifically indicated otherwise (below).

Sand for use in mortar shall be, in all respects, in accordance with :

[IS 2116 : 1980]

Aggregates shall not contain any materials that are deleteriously reactive with the alkalis in the cement, or any alkalis which may be additionally present in the aggregates or in the mixing water, or in water in contact with the concrete or mortar, in amounts sufficiently to cause an excessive local or general expansion of the concrete or mortar.

In order to ensure that all visible exposed faces of concrete have a uniform colour, the CONTRACTOR shall take all necessary steps to ensure a supply of aggregates of uniform colour.

Aggregates for concrete in the permanent works shall, wherever practical, have characteristics best suited to the minimisation of drying shrinkage and thermal shrinkage of the concrete. Such aggregates would have :

a) Low drying shrinkage

b) Low modules of elasticity

c) High tensile strength

d) Low thermal expansion.

2.1.4. Fine Aggregate

The fine aggregate for concrete shall be conform to :

[IS 383 : 1999]

The appropriate grading zone shall be selected by the CONTRACTOR and approved by the OWNER'S REPRESENTATIVE after carrying out tests of trial concrete mixes, to determine workability and density. The grading of fine aggregate shall be such as to produce the maximum concrete density compatible with the desired workability.

Crushed sand may be added to natural sand in proportions approved by the OWNER'S REPRESENTATIVE in order to achieve the required grading. Crushed sand alone may only be used with the approval of the OWNER'S REPRESENTATIVE.

The amount of material passing a 75 micron fine test sieve, when tested in accordance with :

[IS 2386 : 1963]

shall not exceed 2 % by weight for river sand and 3% for quarry sand.

Fine aggregate shall not contain appreciable amounts of flaky and/or elongated particles.

2.1.5. Coarse Aggregate

The term "coarse aggregate" means an aggregate retained on a 5,00 mm test sieve. The grading of the coarse aggregate shall be within the limits prescribed in :

[IS 383 : 1999]

and shall be such that when the coarse aggregate is combined with the approved fine aggregate and cement it shall produce a concrete of maximum density consistent with the required workability. Minimum values of densities of the various grades of concrete will be fixed by the OWNER'S REPRESENTATIVE after tests have been carried out on the site.

The amount of material passing a 75 micron fine test sieve, when tested in accordance with :

[IS 2386 : 1963]

shall not exceed 1 % by weight for coarse aggregate for all concrete (including granolithic concrete).

The flakiness index and elongation index of the predominant-size fractions in each single-sized coarse aggregate, determined in accordance with :

[IS 2386 : 1963]

shall not exceed 35 % by weight.

Aggregate for use in concrete which is subject to abrasion and impact shall be tested in accordance with :

[IS 2386 : 1963]

2.1.6. Grading of Combined Aggregate

The CONTRACTOR shall be responsible for ensuring that the combined grading of the aggregates is constant.

The required percentage to pass any sieve size as determined by approved trial mixes shall be the target grading for all concrete of that type. The combined grading of the used concrete shall not vary by more than $\pm$ 4 % from the one from the trial mixes. If the estimated or measured combined grading of the permanent concrete does not meet this requirement then a new trial mix shall be prepared for the approval of the OWNER'S REPRESENTATIVE.

If at any time samples are proven to be unsatisfactory, the CONTRACTOR shall be required, at his own expenses, either to change to a new supply or to make arrangements acceptable to the OWNER'S REPRESENTATIVE to cure the situation.

2.1.7. Admixtures

Admixtures shall only be used in the concrete or mortar with the explicit permission of the OWNER'S REPRESENTATIVE or when specified and in no circumstances will the admixtures, containing chlorides or other corrosive agents, be allowed.

Air-entraining agents shall consist of neutralised vinsol resin or other approved products.

2.1.8. Water

The CONTRACTOR shall make his own arrangements for providing fresh water for the mixing and curing of concrete and mortar and it shall be subject to the OWNER'S REPRESENTATIVE for approval.

In general, water to be used for the mixing and/or curing of the concrete, mortar and grout shall be fresh and free from all sediment and dissolved or suspended matter which may be harmful to the manufacturing of concrete, mortar and grout.

The OWNER'S REPRESENTATIVE may request analysis of water samples to be taken from the intended source of supply before any concrete work is started and he may request this at intervals throughout the duration of the AGREEMENT. If, at any time, the samples are proved to be unsatisfactory, the CONTRACTOR will be requested, at his own expenses, either to change to a new supply or to make arrangements, acceptable to the OWNER'S REPRESENTATIVE, to remove the offending matter.

2.1.9. Steel Reinforcement

Steel reinforcement, other than steel for pre-stressing, used in reinforced concrete shall comply with :

[IS 1786 : 1985]

and with the following CODES as appropriate :

a) Hot rolled steel bars for the reinforcement of concrete shall comply with the requirements of :

[IS 1139 : 1966]

b) Cold worked steel bars for the reinforcement of concrete shall comply with the requirements of :

[IS 1786 : 1985]

2.1.10. Control of Chlorides in Hardened Concrete and its Constituents

Ordinary Portland cement concrete

For concrete manufactured with ordinary Portland cement the levels of equivalent acid-soluble chlorides as NaCl shall generally not exceed the values specified below. The levels are indicative for the individual constituents of the mix and are subject to the overriding maxima specified for the total mix, which shall not be exceeded.

i. Coarse aggregate

   a. reinforced concrete 0,03 % by weight

   b. mass concrete 0,10 % by weight

ii. Fine aggregate

   a. all concrete 0,10 % by weight

Testing of chlorides content of aggregates shall comply with :

[IS 2386 : 1963]

The total estimated chloride content of any mix, including the one, present in the cement, shall not exceed the following : (expressed as a percent by weight of cement).

1) Prestressed concrete 0.4 %

2) Conventionally reinforced concrete 0.6 %

   in a moist environment and exposed to chloride.

Acceptable levels of chlorides in concrete and its constituent materials shall be reduced to two-thirds of the values specified in paragraphs 1 and 2 above, where sulphates are present in concentrations greater than 50 % of those allowable.

Sulphate-resisting Portland cement concrete

For concrete manufactured with sulphate-resisting Portland cement the NaCl max. content by weight of cement in the hardened concrete shall not exceed 0,10 %.

Testing by the OWNER'S REPRESENTATIVE

Independently from the CONTRACTOR'S QC (Quality Control) testing the OWNER'S REPRESENTATIVE will carry out selective tests at intervals during the production of concrete to check that these criteria are being achieved consistently.

2.1.11. Control of sulphates in hardened concrete and its constituents

The levels of acid-soluble sulphates (as SO_3) shall generally not exceed the values specified below. The levels are indicative for the individual constituents of the mix and are subject to the overriding maxima specified for the total mix, which shall not be exceeded :

a) Coarse aggregate 0,4 % by weight

b) Fine aggregate 0,4 % by weight

The total estimated sulphate content (as SO_3) of any mix, including the one, present in the cement, shall not exceed 4 % by weight of cement in the mix.

Independently from the CONTRACTOR'S QC (Quality Control) testing (the) OWNER'S REPRESENTATIVE will carry out selective tests at intervals during the production of concrete to check that these criteria are being achieved consistently.

2.1.12. Acceptable level of chlorides and sulphates in any concrete

The acceptable level of chlorides and sulphates quoted in the above paragraphs shall not be considered as mean values for the whole of the Works, but shall be deemed to apply to any concrete.

2.1.13. Mechanical coupling of reinforcement

Where specified, directed, or approved by the OWNER'S REPRESENTATIVE, mechanical coupling of reinforcement may be used. Proprietary mechanical coupling systems shall meet the requirements of this paragraph and shall be subject to the approval of the OWNER'S REPRESENTATIVE.

The couplers for tension connections shall have a yield strength and ultimate tensile strength at least 1.2 times the characteristics strength yield strength and ultimate tensile strength respectively of the bars being coupled.

In case the loadings are not predominantly static, the CONTRACTOR shall demonstrate that the couplings can resist loading of a cyclic and dynamic nature.

Couplers designed for use with bars in compression only, may be used at locations where the OWNER'S REPRESENTATIVE agrees that in no case, the bar will be required to resist a tensile load.

All fixing of mechanical couplers shall be carried out either by the manufacturer's personnel or by CONTRACTOR'S staff trained by the manufacturer. Fixing of couplers shall be carried out in accordance with the manufacturers instructions and recommendations.

2.2. Mixes and Mixing

2.2.1. Concrete Mixes

Concrete for construction shall be as detailed in the Table of Concrete Mixes and as shown by test cube results as specified. This list may be extended by the addition of other mixes as required and to the approval of the OWNER'S REPRESENTATIVE.

The criteria stated in the Table of Concrete Mixes are designed to produce concrete of the required strength and durability.

The specified characteristic strength is for concrete which has been cured at a temperature of 20° C $\pm$ 1° C. The term "characteristic strength" represents the value of the strength of concrete corresponding to the probability that, for a normal statistic distribution of the test results for determining the strengths by compression tests, only 5 % of the test results have a value lower than the one determined in this way.

The mixes shall be designed to have mean strengths that are greater than the specified characteristic cube strengths by a margin of 1.64 times the standard deviation expected from the concrete batching plant, except that no standard deviation of less than 3.5 N/mm^2 shall be used as a basis for designing a mix.

Mixes shall be designed with due regard for minimum workability necessary to allow the CONTRACTOR to place and compact the concrete as specified with the equipment he proposes to use in any particular situation.

TABLE OF CONCRETE MIXES

Concrete grade	Minimum quantity of cement kg/m³	Maximum free water-cement ratio	Character. strength (cube) 150 mm Cube
			28 days N/mm²
M20	300	0.55	20
M25	300	0.50	25
M30	320	0.45	30
M35	340	0.45	35
M40	360	0.40	40

Where air-entrainment is specified the average air content as measured in accordance with relevant Indian Codes:

shall be as follows :

a) Concrete containing

40 mm max. size aggregate 4.0 % $\pm$ 1.0 %

Concrete containing

20 mm max. size aggregate 5.0 % $\pm$ 1.0 %

These air contents are applicable at the time of concrete placing.

Concrete for paving or non structural precast units shall have a minimum flexural beam strength of 3.5 N/mm^2 at 28 days.

2.2.2. Water-cement ratio

The water-cement ratio for the various mixes of concrete shall be determined by the preliminary trial mixes and shall not exceed the values given in the Table of Concrete Mixes.

Effective means shall be provided for determining the moisture content and water absorption value of the fine and coarse aggregates at all times. The CONTRACTOR will be required to have an accurate knowledge of the moisture content and water absorption values of all fine and coarse aggregates as they reach the mixer and if necessary, he shall make adjustments to the mix by changing the moisture content and water absorption values of all aggregates.

2.2.3. Use of admixtures

In the event of the OWNER'S REPRESENTATIVE'S permission being obtained for the use of a proposed admixture, the concrete tests described in this section shall be carried out with the correct proportion of admixture incorporated in the concrete to ensure that the specified strengths are achieved. Comparison shall be made with concrete manufactured without the admixture to prove that the density has not been reduced. If air-entraining agents are used the density shall not be reduced by more than 5 %.

When admixtures are used in the concrete very strict control shall be maintained to ensure that the correct quantity of admixture is used at all times. The equipment to be used for dispensing and the method of incorporating the admixture in the concrete shall be submitted to the OWNER'S REPRESENTATIVE for approval. The dispensing unit shall be translucent such that the operator can see the discharge of the admixture.

2.2.4. Laboratory concrete trial mixes

The below described procedure is not applicable when the concrete is supplied by a ready mix plant which has been approved by the OWNER'S REPRESENTATIVE or when evidence exists about a previous testing campaign of the same nature.

Preliminary laboratory tests shall be carried out by the CONTRACTOR in the presence of the OWNER'S REPRESENTATIVE to determine the mixes which will satisfy the SPECIFICATION, with the available materials.

Laboratory trial mixes of concretes for use in the permanent works shall, wherever practical, be designed in such a manner as to minimise drying shrinkage and thermal shrinkage of the concrete. Such mixes would have :

a) the largest practical maximum size of aggregate,

b) the lowest practical sand content,

c) the lowest practical slump,

d) the lowest practical temperature,

e) the lowest practical cement content,

f) the lowest practical water content.

To facilitate the above and to minimise the temperature rise within large concrete pours, water reducing and/or air entraining admixtures may be included in the mix design subject to the approval of the OWNER'S REPRESENTATIVE.

2.2.5. Initial concrete field tests

Following the results of laboratory trial mixes, trial mixes shall be prepared under full scale site conditions and tested in accordance with relevant Indian Codes :

During the course of these tests, panels of concrete containing representative samples of reinforcing details shall be cast and investigated, before hardening by the use of hand tools and after hardening by means of coring, as outlined in paragraph 3.2.5 of this SPECIFICATION, to assess the suitability of the mixes.

Representative samples of the materials to be used shall be taken and three trial mixes using the proposed proportions shall be made on different days. The workability of each of these three trial mixes shall be the designed target value and a batch of six cubes from each mix shall be made, three for test at 28 days and three for test at 7 days. The OWNER'S REPRESENTATIVE will normally approve the proposed mix proportions provided the average 28-day strength of the three trials mixes is not less than the designed mean strength and subject to the conditions noted below.

Further trial mixes shall be made if the range, that is the maximum minus the minimum of the three cube results in any batch, exceeds 15 % of the average of that batch, or if the range of the three batch averages exceeds 20 % of the overall average of the batches.

In addition to tests for properties specified in this SPECIFICATION, tests shall be carried out jointly by the CONTRACTOR and the OWNER'S REPRESENTATIVE on field trial mixes to determine the following properties :

a) Air content (where air entrained concrete is specified) ;

b) Free water-cement ratio ;

c) Workability ;

d) Wet and dry densities.

Should any of the values obtained in the above tests be unacceptable, according to the OWNER'S REPRESENTATIVE, the mixes shall be re-designed.

2.2.6. Batching and mixing

Batching

The aggregates and cement shall be batched by means of efficient weigh-batching machines except as otherwise approved by the OWNER'S REPRESENTATIVE. The machines shall be carefully maintained and cleaned. They shall be provided with simple and convenient means of checking the accuracy of weighing mechanism, and they shall be checked and adjusted when required by the OWNER'S REPRESENTATIVE.

When volumetric batching is permitted, the constituents shall be measured by volume in a suitable gauge box and the volumes used shall be based on a whole bag mix.

The temperature of the cement shall be kept as low as possible by adequate shading, good air circulation and reflective protection to the storage silos, but all never exceed 40°C at the time of incorporation into the mix.

A simple and convenient system of accurately varying the water supply to the concrete mixers shall be installed, with a suitable metering system to ensure that the amount fed into the machine can be easily controlled, ascertained and recorded.

Accuracy of scales

The divisions on direct reading scales for cement, aggregate and water (if the latter is measured by weight) shall be readily discernible and not less than 2.5 mm in width. They shall represent a weight not greater than 0.5 per cent of the nominal capacity of the appropriate weighing hopper or compartment. Digital readouts should display to 0.1 per cent of the nominal capacity of the appropriate weighing hopper or compartment.

At the time of installation or reconditioning, the indicated weight, shall not vary from the correct weight by more than 0.5 per cent of the actual scale reading in the range quarter-scale to full scale capacity. For indicated weights of less than quarter-scale capacity, the variation shall be not greater than 0.5 per cent of quarter-scale reading. At any time of operation, the indicated weight at any point of the scale shall not vary from the correct weight by more than 1.0 per cent of the actual scale reading in the range quarter-scale to full scale capacity. For indicated weights of less than quarter-scale capacity, the variation shall be not greater than 1.0 per cent of the quarter-scale reading.

Accuracy of batching

See also :

[IS 4925 : 1968, IS 456 : 2000]

Batched materials shall be measured out within the following tolerances and shall be discharged into the mixer without loss :

Cement ± 2 % of the weight of the cement in the batch;

Aggregate ± 2 % of the weight of each aggregate in the batch;

Water ± 2 % of the weight of water added to the batch;

Calibration of weighing equipment

Sufficient test weights shall be kept available at the site for checking the accuracy of all scales. The scales shall be checked at the commencement of preliminary concrete tests and checks shall be carried out at intervals as directed by the OWNER'S REPRESENTATIVE but in any case not greater than 2 weeks.

The results of these checks shall be recorded and submitted to the OWNER'S REPRESENTATIVE.

All scales shall be inspected and checked over their complete range by a specialist at least every three months, the results being recorded and submitted to the OWNER'S REPRESENTATIVE.

With admixture dispensers, the accuracy of measurement shall be checked at least once each month with a calibrated container, the results being recorded and submitted to the OWNER'S REPRESENTATIVE.

Mixing concrete by machine

Concrete shall be mixed in batches in machines of approved type. All the concreting materials including the water shall be mixed together thoroughly between the time of their deposition in the mixer and before any portion of the mixture is discharged.

The machines shall be capable of discharging their contents while running.

Transfer of concrete

The concrete shall be discharged from the mixers and transported to the Works by means which shall be approved by the OWNER'S REPRESENTATIVE and which shall prevent contamination (by dust, rain or other causes), segregation or loss of ingredients. The means of transport shall ensure that the concrete is of the required workability at the point and time of placing and is transported and placed with the minimum of delay.

2.2.7. Ready-mixed concrete

Ready-mixed concrete shall not be used unless previously approved by the OWNER'S REPRESENTATIVE and, where used, shall comply with all the requirements specified herein and any additional requirements of :

[IS 4926 : 1976]

Ready-mixed concrete plants and mixer trucks shall be subject to the approval of the OWNER'S REPRESENTATIVE which approval may be withdrawn in the event of non-compliance with the requirements of this SPECIFICATION.

3. EXECUTION

3.1. Execution of Concrete Works

3.1.1. General

Except where otherwise specified herein, or directed by the OWNER'S REPRESENTATIVE, concrete workmanship shall conform to the recommendations of :

[IS 2386 : 1963]
current at the time of execution of the work.

3.1.2. Placing of concrete

The concrete shall be placed in the positions and, where shown, in sequences as indicated on the drawings, in the SPECIFICATION or as directed by the OWNER'S REPRESENTATIVE. Except where otherwise directed, the pouring shall not start until the OWNER'S REPRESENTATIVE has examined and approved the positioning, fixing and condition of reinforcement and any other items to be embedded, and the cleanliness, alignment and suitability of the containing surfaces or formwork. A period of not less than 24 hours notice shall be given to the OWNER'S REPRESENTATIVE to allow for his examination and, if satisfactory, approval of the reinforcement and formwork prior to the placing of the concrete.

The CONTRACTOR shall make due allowance in his concreting program for the period of the OWNER'S REPRESENTATIVE'S examination.

The limit of individual pours and the height of lifts shall be subject to the approval of the OWNER'S REPRESENTATIVE.

The length of element that may be poured in one operation and the elapsed time between adjacent pours in the horizontal direction shall be subject to the prior approval of the OWNER'S REPRESENTATIVE. The sequence of pours shall be arranged to minimise thermal and shrinkage strains.

Slabs and roof pours shall be made in an approved sequential fashion. Concrete shall not be placed in adjacent bays until 7 days, or another period of time to be approved by the OWNER'S REPRESENTATIVE, has elapsed.

The CONTRACTOR shall take all necessary measures to ensure that newly placed concrete, and particularly the one in large pours, is protected against the effects of thermal shrinkage. The aim shall be to achieve a maximum temperature differential of 20°C within the concrete and between the concrete and the surrounding air. The CONTRACTOR shall propose suitable insulation for the formwork and exposed surfaces of the pour.

The concrete shall be deposited as nearly as possible in its final position without rehandling or segregation and in such a manner as to avoid displacement of the reinforcement, or other embedded items or the formwork.

Wherever possible concrete shall be placed by pumping or bottom-opening skips. Where chutes are used to convey the concrete, their slopes shall not be such as to cause segregation, and suitable spouts or baffles shall be provided where necessary. Concrete shall not be dropped through a free height greater than 2.0 m except with the approval of the OWNER'S REPRESENTATIVE. Where the work requires the concrete to be deposited from a height exceeding 2.0 m, chutes to the OWNER'S REPRESENTATIVE'S approval shall be used to prevent segregation of materials. Concrete shall not be placed in standing water or running water unless specified or approved by the OWNER'S REPRESENTATIVE. If this is the case, the concrete shall be placed in accordance with the requirements of paragraph 3.1.7 below.

All concrete and mortar shall be placed and compacted within 30 minutes of water being added to the mix or otherwise included through damps aggregates, unless admixtures are in use. If an admixture is used, tests shall be carried out jointly by the CONTRACTOR and the OWNER'S REPRESENTATIVE to determine the initial set time. No partially set material shall be used in the works.

Placing of concrete in each section of the work shall be carried out as a continuous operation between construction joints. The CONTRACTOR shall make adequate arrangements for standby equipment. If the placing of concrete is unavoidably delayed due to mechanical or other breakdown then the CONTRACTOR shall as directed by the OWNER'S REPRESENTATIVE either :

a) erect stop ends and form a construction joint,

b) or

c) remove the concrete already placed and restart the operation after the breakdown has been rectified.

3.1.3. Compacting of concrete

Except where otherwise permitted by the OWNER'S REPRESENTATIVE, concrete shall be compacted during placing by approved pattern internal vibrators. The vibrators shall operate at a frequency of not less than 100 Hz and shall be designed for continuous operation. The performance of vibrators shall be such as to suit the working conditions and they shall be selected accordingly. For normal use, they shall be not less than 75 mm diameter and shall be subject to the OWNER'S REPRESENTATIVE for approval. The radius of influence shall be at least 300 mm.

The vibrators shall be disposed in such a manner that the whole of the mass of concrete under treatment shall be compacted adequately at a speed commensurate with the supply of concrete from the mixers and to the satisfaction of the OWNER'S REPRESENTATIVE.

Internal vibrators shall penetrate the full depth of the layer of concrete placed and just into the layer below and shall be withdrawn slowly so as to avoid the formation of voids.

Vibration shall not be applied directly or indirectly to masses of concrete after the initial set has taken place but, subject to the approval of the OWNER'S REPRESENTATIVE, revibration of the upper lift of a concrete pour may be employed as late as the concrete will respond to the vibration in order to close settlement cracks.

Vibration shall not be used to make the concrete flow in the formwork.

3.1.4. Concreting in adverse weather

No concreting will be allowed to take place in the open during storms or heavy rains. In places where such conditions are likely to occur the CONTRACTOR shall arrange for adequate protection of the materials, plant and formwork so that the work may proceed under proper cover.

Where strong winds are likely to appear, additional precautions shall also be taken to ensure protection from driving rain and dust.

The OWNER'S REPRESENTATIVE may withhold approval of the starting of concreting until he is satisfied with the full and adequate arrangements being made.

3.1.5. Concreting at night or in the dark

Where approval has been given to the carrying out of concreting operations at night or in places where daylight is excluded, the CONTRACTOR shall provide adequate lighting at all points where mixing, transporting, placing and compacting of concrete shall take place.

3.1.6. Concrete placing temperatures

Concrete is to be manufactured, transported and placed at all times in accordance within the limitations set out in the following paragraphs.

The temperature of the concrete shall not exceed 30°C at the time of placing.

The CONTRACTOR shall take the following measures in order to control the temperature of concrete at time of hot weather :

a) effectively shade aggregate stockpiles, cement silos, water tanks and concrete handling plant;

b) run all concrete handling plant with flake ice to reduce the temperature of the machinery before mixing/transporting concrete;

c) add flake ice to the mixing water;

d) concrete at night, if approved by the OWNER'S REPRESENTATIVE.

The following measures shall be taken :

e) all forms, moulds, reinforcement and other embedded parts, mixed and placed concrete shall be shaded from sunlight and protected from any drying wind;

f) transit time shall be restricted to a minimum to be agreed in advance between the OWNER'S REPRESENTATIVE and the CONTRACTOR taking into account the use of admixtures etc.

The size of concrete pours may be restricted if the OWNER'S REPRESENTATIVE decides that shrinkage and other factors are a consideration for particular elements of the construction.

The CONTRACTOR shall follow the requirements of :

[IS 7861 : 1981]
for concreting during cold weather.

3.1.7. Deposition concrete under water

The arrangement for depositing concrete under water shall be such that there shall be, at all times, a minimum of disturbance of the water. Running water crossing or entering areas where concrete is to be deposited shall be brought under control before concreting starts. The concrete to be deposited under water shall be of the grade shown on the drawings and specified in the Table of Concrete Mixes.

The concrete mix design shall be such that the concrete shall be sufficiently fluid to flow freely. Concrete shall be deposited under water by means of hopper pipes or bottom dump skips, or other method approved by the OWNER'S REPRESENTATIVE. The method and rate of deposition shall ensure that no segregation shall occur. Concreting shall be carried out in sections previously ordered or approved by the OWNER'S REPRESENTATIVE and shall proceed continuously in each section until completed and no interval shall be allowed to elapse while the work is in hand.

If concreting under water is done by hopper pipe, the bottom of the hopper pipe shall always be buried in the concrete and care shall be taken not to allow the pipe to empty as it is moved over the area. If concreting under water is carried out by bottom dump skip, canvas or other approved covering shall be used to cover the surface of the concrete in the skip before it is lowered into the water. The doors of the skip shall be opened only when the skip is resting on the bottom with no tension in the support cable. After opening, the skip shall be lifted gradually so that the concrete flows out steadily.

3.1.8. Formwork

General

Forms shall be constructed from sound materials of sufficient strength, and shall be properly braced, strutted and shored, to ensure rigidity throughout the placing and compacting of the concrete. Forms shall be constructed in such a way that they can be removed without shock or vibration to the concrete. Internal ties shall be made of metal and shall either be capable of complete removal without damage to the concrete or, if remaining permanently embedded in the concrete, be no nearer to any finished surface than the largest value of 50 mm or the specified cover to reinforcement. The resulting cavity shall be so formed as to permit satisfactory filling as specified hereafter.

All joints shall be close fitting to prevent leakage of grout and at construction joints the formwork shall be secured tightly against previously-cast or hardened concrete to prevent stepping or the formation or ridges on exposed surfaces.

Formwork shall be constructed to provide the correct shape, lines and dimensions of the concrete shown on the Drawings. Due allowance shall be made for any deflection which will occur during the placing of concrete within the forms.

Panels shall have true edges to permit accurate alignment and to provide a neat line with adjacent panels and at all construction joints. All panels shall be fixed with their joints either vertical or horizontal, unless otherwise specified or approved. When chamfers are to be formed the fillets shall be cut accurately to the correct sizes to provide a smooth and continuous chamfer.

The CONTRACTOR shall make due allowance for the renewal and/or repair of formwork in case it has to be re-used.

Rough formwork

Where rough formwork is specified, the form may be constructed of plain, butt-jointed properly-seasoned sawn timber unless otherwise instructed by the OWNER'S REPRESENTATIVE.

The tolerances are stated here below. The minimum specified cover to the reinforcement shall be maintained at all points. Abrupt irregularities or surface discontinuities shall not exceed 5 mm in height.

Wrought formwork

Where wrought formwork is specified, the forms shall be of steel or properly-seasoned plywood and shall be such as to produce a smooth and even surface free from irregularities, with joints flush with the surface. The minimum specified cover to the reinforcement shall be maintained at all points.

Lined formwork

Where lined formwork is specified the forms shall be lined with clear lacquered extra-hard hardboard, or other similar lining which will produce a finish acceptable to the OWNER'S REPRESENTATIVE. The panels of the lining material, and the forms, shall be fixed with close flush joints.

Formwork tolerances

- Wall thickness

  The tolerance, expressed in cm, on each linear dimension e (in cm) is equal to $\pm 1/3\sqrt[3]{e}$ and anyhow limited to 4 cm.

Exposed surfaces of concrete

The finished faces of all concrete work shall be sound, solid and free from defects. All exposed arises shall have a 25 mm x 25 mm chamfer unless otherwise specified.

No rendering of imperfect concrete faces will be allowed and any concrete that is defective in any way, including colour, shall be cut out and replaced to such depths, or be improved in such a way as directed by the OWNER'S REPRESENTATIVE.

Preparation of formwork for concreting

The formwork shall be coated with an approved mould oil and all excess shall be removed carefully. Mould oil shall not be allowed to come into contact with concrete already placed or with reinforcement.

Before concrete is placed, all formwork and supports shall be cleaned thoroughly. Temporary openings shall be provided to assist in the removal of the rubbish.

Concrete shall not be placed until the relevant formwork has been inspected and approved by the OWNER'S REPRESENTATIVE although the giving of this approval does not relieve the CONTRACTOR from his responsibilities concerning the requirements of soundness, finish and accuracy, specified elsewhere.

A period of not less than 24 hours notice shall be given to the OWNER'S REPRESENTATIVE to allow for his examination and, if satisfactory, approval of the reinforcement and formwork prior to the placing of the concrete.

Removal of formwork

Forms shall be removed in such a way that they do not damage the concrete. No forms shall be removed until the concrete has gained sufficient strength to support itself. Centres and props may be removed when the member being supported has gained sufficient strength to carry itself and the load to be supported on it with a reasonable safety factor.

The following table is a guide to the minimum periods which must elapse between the completion of the concreting operations and the removal of formwork. Notwithstanding this table, no prop nor formwork shall be removed without the permission of the OWNER'S REPRESENTATIVE and this permission shall not relieve the CONTRACTOR from his responsibilities for the safety of the structure.

- Vertical sides of beams, walls, columns - lift not exceeding 1.2 mm — 12 hours

- Vertical sides of beams, walls, columns - lift exceeding 1.2 mm — 36 hours

- Soffits of beams and main slabs (props left under) — 5 days

- Beams and main slabs - removal of props — 18 days

After removal of formwork no remedial works shall be attempted until the work has been inspected by the OWNER'S REPRESENTATIVE. If, according to the OWNER'S REPRESENTATIVE, any defect cannot be cured to his satisfaction, he may direct the CONTRACTOR to replace such work at the CONTRACTOR'S expense.

3.1.9. Reinforcement

Preparation and fixing of steel reinforcement

Steel rod reinforcement shall be cut, bent and fixed in accordance with :

[IS 2502 : 1963]

Generally it shall be bent cold in a manner which will not damage the material. Bending hot at a cherry red heat (i.e. not exceeding 840°C) may be allowed except for bars which depend for their strength on cold working. Bars bent hot shall not be cooled by quenching.

Bends, cranks or other labours on reinforcing bars shall be formed carefully in accordance with :

[IS 2502 : 1963]
and with the working drawings.

The length of laps shall be calculated in accordance with :

[IS 456 : 2000]

The number, size, form and position of all steel reinforcing bars, ties, links, stirrups and other parts of the reinforcement shall be in accordance with the Drawings.

All parts of the reinforcement shall be maintained in the correct position in the forms without displacement during the process of vibrating, tamping and ramming the concrete in place. The CONTRACTOR shall provide all necessary distance pieces and spacer bars to maintain the reinforcement in the correct position. Any ties, links or stirrups connecting the bars shall be tied so that the bars are properly braced and the inside of bends shall be in contact with the bars around which they are intended to fit. Bars shall be bound together with best black annealed mild steel wire approximately 1.5 mm diameter or other approved binders. Wire binding shall be twisted tight with proper pliers. The free ends of the binding wire shall be bent inwards.

Before any steel reinforcement is embedded in the concrete any loose rust and any oil, grease, salt contamination, products and causes of pitting, or other deleterious matter shall be removed from it, by grit blasting, mechanical wirebrushing and/or washing. The method of removal to be adopted will depend on the degree of contamination and/or corrosion and shall be to the approval of the OWNER'S REPRESENTATIVE. Partially-set concrete which may have adhered to exposed bars during previous concreting operations shall likewise be removed.

Reinforcement left projecting temporarily from the concrete at construction or other joints shall not be bent out of position during the period in which concreting is suspended, except with the approval of the OWNER'S REPRESENTATIVE. When such approval is given the reinforcement shall be bent out over a suitably-sized former to prevent any damage to, or over-stressing of, the reinforcement.

Electric arc welding may be permitted in some locations for joining bars, subject to the approval of the OWNER'S REPRESENTATIVE.

Cover to reinforcement

The concrete cover to reinforcement shall be in accordance with the drawings. If no cover is specified on the drawings, the CONTRACTOR shall refer this matter to the OWNER'S REPRESENTATIVE.

No pieces of steel, timber blocks or materials other than approved concrete or plastic spacers shall be permitted for use as cover blocks or spacers.

Where concrete spacing blocks are used, they shall be of similar quality to the concrete specified for the particular element of the structure. For concrete having a characteristic strength of 30 N/mm^2 or greater, the spacing blocks shall comply with the requirements of this SPECIFICATION for water absorption and the ties shall be made from non-metallic material.

The cover to mechanical couplers shall be in accordance with this paragraph.

3.1.10. Construction joints

Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be as indicated on the drawings or as approved previously by the OWNER'S REPRESENTATIVE. The CONTRACTOR shall allow for working beyond the ordinary working hours where necessary in order that each section of concrete may be completed without any lapse while the work is in hand.

All construction joints shall be formed square to the work. Keyways shall be formed in all horizontal and vertical construction joints except where ordered to be omitted by the OWNER'S REPRESENTATIVE.

Construction joints shall be located, and the sequence of concreting arranged, to minimise the effect of shrinkage and thermal strains in the setting and hardened concrete and in subsequent pours.

When work is resumed on a surface of concrete which has set, the whole surface shall be roughened or scabbed thoroughly with suitable tools so that no smooth skin of concrete which may be left from previous work is visible and that all aggregates and solid matrix around them are exposed.

If according to the OWNER'S REPRESENTATIVE any deleterious materials have come into contact with the concrete of the construction joint the concrete shall be cut back to such depth as the OWNER'S REPRESENTATIVE shall direct and the roughened surfaces shall be brushed and watered immediately before depositing concrete.

If according to the OWNER'S REPRESENTATIVE doubt exists about the soundness of the joint, then the CONTRACTOR shall take all steps considered necessary to investigate and cure any defects, to the approval of the OWNER'S REPRESENTATIVE.

In water-retaining structures all construction joints shall require the use of an approved type of waterbar and the joint shall be sealed at the liquid face(s) where no special seal coating of that face by a waterproof sealant is specified.

3.1.11. Design Joints

Contraction, expansion and other movement joints shall be positioned as shown on the drawings.

Contraction joints in non-water-retaining structures, where specified, shall be formed as deliberate planes of discontinuity in the concrete structure.

To form such a joint the face of the concrete slab or block first formed shall be painted with two coats of approved rubber bitumen paint before the adjoining slab or block is concreted.

The adjoining slab or block shall be cast with a suitable groove against the joint to accept sealant. The exposed edges of the joints shall be chamfered and sealed with an approved polysulphide rubber sealing compound applied over bond breaking tape at the black of the joint rebate.

When according to the OWNER'S REPRESENTATIVE a contraction joint is likely to be contaminated with deleterious materials, the joint shall be sealed off immediately with an approved sealing compound as soon as striking of the formwork has been completed.

Expansion and other movement joints in non-water-retaining structures, where specified, shall be formed in the same way as contraction joints but in addition an approved compressible filler shall be placed in the joint to provide freedom for the adjacent concrete slabs to move.

The adjoining slab shall be cast with a suitable groove against the joint to accept sealant. The exposed edges of the joints shall be chamfered and sealed with an approved polysulphide rubber sealing compound.

Where a design joint occurs in a water-retaining structure, or where otherwise ordered, the joint shall be made water-tight by the provision of a continuous waterstop strip as specified by the OWNER'S REPRESENTATIVE, fixed across the joint where shown on the drawings. Special care shall be taken to ensure that the concrete is well worked against the embedded parts of the strips and is free from honeycombing.

Precautions shall be taken to protect any projecting portions of the strips from damage during the progress of the works and, in the case of rubber and plastic, from light and heat.

In the case of copper waterstop where directed bituminous painting shall be applied to the lips of the loop and the loop shall be filled with a bituminous compound, these applications being made before the strip is buried in the concrete.

The method of jointing waterstops shall be in accordance with the manufacturer's instructions and to the approval of the OWNER'S REPRESENTATIVE.

3.1.12. Reinforced concrete and mass concrete - general

Concrete shall be of the grades specified on the drawings and detailed in the Table of Concrete Mixes.

Concrete shall be placed generally as specified in the relevant clauses. It shall be placed in small quantities and shall be compacted thoroughly. The concreting of individual members shall be continuous without stoppage up to a pre-arranged construction joint or until the member is completed. Concreting shall be finished off in such manner that each member shall be monolithic with the adjoining members and with any concrete to which it is connected.

The concrete shall be well protected against the action of the weather.

Where new concrete is to be deposited on concrete already set, the surface of the latter shall be prepared as specified in paragraphs 3.1.10 and 3.1.13 of this SPECIFICATION.

All reinforced concrete work shall be matured for such a period as the OWNER'S REPRESENTATIVE may direct before it is charged with loads of any kind.

3.1.13. Preparation of surfaces to receive concrete

Before concrete for reinforced concrete work is deposited on a natural formation, a screed of blinding concrete (lean concrete), as specified on the Drawings and detailed in the Table of Concrete Mixes, shall be placed over the ground below the underside level of the reinforced concrete to form a hard even surface on which to construct the latter.

Immediately before depositing concrete on or against a surface of masonry, brickwork, old concrete or the like, the following preparation shall be done. All loose material shall be removed and the surface washed down; all seepages of water emerging at the surface shall be stopped as far as possible or suitably channelled or piped away from the work. On upward facing horizontal or near horizontal surfaces a layer of 2:1 sand-cement mortar shall be spread over the surface of the section to be concreted if so directed by the OWNER'S REPRESENTATIVE.

3.1.14. Mass concrete backing to masonry or brickwork

The water-cement ratio of mass concrete backing to masonry or brick facing shall be increased compared with that of concrete mixed for placing against timber forms by such an amount as necessary according to the OWNER'S REPRESENTATIVE to compensate for the absorption of moisture by the masonry or brickwork. Before any concrete is placed, the mortar joints in the facework shall have thoroughly hardened, and the back of the facing shall be thoroughly wetted. The concrete shall be tamped carefully round any ties or bond stones, and mortar from the concrete shall be worked carefully into the open joints in the back of the facework.

3.1.15. Curing and protection

Immediately after compaction and for at least 7 days thereafter all concrete shall be protected against harmful effects of sunshine, drying winds, cold, rain or running water to the satisfaction of the OWNER'S REPRESENTATIVE. During this period the measures given in this clause shall be taken to prevent the loss of moisture from the concrete and to minimise thermal stresses caused by the difference in temperature between the surface of the concrete and the core of the concrete mass. No other methods shall be employed except with the OWNER'S REPRESENTATIVE'S approval.

Unless otherwise agreed by the OWNER'S REPRESENTATIVE, curing of horizontal surfaces shall be carried out as follows :

a) Polythene sheeting shall be placed immediately after finishing.

b) After final set has taken place, the polythene shall be replaced by wet hessian which shall then be immediately covered with polythene.

c) Measures shall be taken to ensure that the hessian is always damp.

d) After 7 days the hessian and polythene may be removed and an approved aluminised or white pigmented resin based curing compound sprayed on the surface, as an alternative to retaining the hessian and polythene in place for at least another 7 days.

e) Concrete shall be shaded as approved by the OWNER'S REPRESENTATIVE.

f) Where specific surface textures are required (e.g. brush finishing on road slabs) then alternative methods of curing may only be employed with the approval of the OWNER'S REPRESENTATIVE.

Unless otherwise agreed by the OWNER'S REPRESENTATIVE curing of vertical surfaces shall be carried out as follows :

g) Immediately after the stripping of formwork, the member shall be wrapped with wet hessian and then covered with polythene which shall be held, firmly in place.
The hessian shall not be allowed to dry out.

h) After an initial curing period of 7 days the hessian and polythene may be removed. Without undue delay the concrete surface shall be sprayed with an approved aluminised or white pigmented resin-based curing compound as an alternative to retaining the hessian and polythene in place for at least another 7 days.

Where water is to be used for curing concrete it shall be fresh water in accordance with the requirements of this SPECIFICATION.

Where the use of a curing compound is proposed, the particular compound and method of application shall be subject to the approval of the OWNER'S REPRESENTATIVE. The rate of application of an approved compound shall be strictly in accordance with the manufacturer's recommendations.

Where timber or other insulating formwork is used it shall either be struck in accordance with the SPECIFICATION or be left in place until such time after the temperature peak is reached as the OWNER'S REPRESENTATIVE may direct.

Air circulation shall be prevented as far as possible along the exposed faces of concrete during the curing period.

All joints which are to be filled with sealing compound, or surfaces formed as construction joints, shall be protected in a manner which will ensure that no curing compound is placed on the bonding surface, e.g. by placing wet hessian.

The protection shall be such as will ensure proper curing of the joint surface and adjacent concrete.

All concrete shall be protected from anything likely to interfere with the process of setting. No load of any kind shall be imposed upon any concrete member until the concrete has hardened sufficiently to resist the imposed load.

The surfaces of the concrete shall be protected from contamination of any sort.

When curing membranes are used they shall be compatible with waterproofing or other materials that may be applied subsequently to the surface of the concrete.

3.1.16. Concrete surface finishes

Absence of defects

All concrete shall be dense, sound, even textured and free from defects both internally and externally.

Fine face finish to formed surfaces

Where a formed surface of concrete is required to have a "fine face finish", the formwork used shall be lined formwork. On removal of the formwork the face of the concrete shall be rubbed smooth with Carborundum blocks whilst the concrete is green and all small holes shall be stopped with cement mortar of such a mix as to dry out with the same colour as the adjacent concrete.

Finishes to concrete surfaces without formwork

Where, on an upward facing horizontal or near horizontal surface which does not require formwork and which will neither be exposed to view nor receive any subsequent surface treatment, no particular finish is called for. The surface shall be that produced by the proper placing and compacting operations without further labours, provided a reasonably plane surface is produced.

Screeded finish

Where a screeded finish is specified, it shall obtained by screeding. This shall be done, immediately after the compacting of the concrete, by the slicing and tamping action of a screed board running on the top edges of the formwork, or on accurately-set screeding guides, to give a dense concrete skin, true to line and level. The finished surface shall be plain or with an even texture of parallel ribs as may be directed by the OWNER'S REPRESENTATIVE.

Floated finish

Where a floated finish is specified, it shall be obtained by first screeding the concrete as described in the preceding paragraph then leaving it until the concrete has stiffened and the moisture film has disappeared. Floating shall then be carried out with a steel or wooden float to produce either a "glossy" surface or a "sand paper" surface as required. Working shall be kept to a minimum compatible with a good finish. The surface shall be true to the required profile to fine tolerance. Whenever necessary a properly-constructed overhead cover shall be erected before the work is commenced to prevent the finished surface from being marred by raindrops or dripping water.

A floated finish shall be provided to all concrete surfaces which may be exposed to view in the finished works except where otherwise shown on the drawings.

Exposed aggregate finish

Where an exposed aggregate finish is specified, then immediately after removal of the forms the surface of the concrete shall be well scrubbed down by means of stiff wire brushes and water or other approved methods to remove the cement slurry from the surface and expose the aggregate.

Bush hammered finish

Not less than 3 weeks (for ordinary Portland or sulphate-resisting Portland cement concrete) after pouring has been completed, the exposed surface shall be bush hammered to remove the cement from the surface and expose the aggregate. Bush hammers shall be of an approved type, and they shall be worked to within 12 mm of all corners and arises, the treatment of the remaining 12 mm borders being by means of suitable hand chisels to produce an effect similar to that of the adjoining bush-hammering.

Bush hammers shall be kept perpendicular to the surface being worked and care shall be taken to ensure that only the surface mortar and the irregular projections of the aggregate are removed without any fracturing or loosening of the portions left embedded. As the bush-hammering is completed, the surface so treated shall be washed with water and scrubbed down with a stiff brush. All finished surfaces shall be of an even and uniform appearance with the exposed aggregate clean and free from film.

Use of chemical surface retarders

The use of a chemical surface retarder will only be permitted as an alternative means of producing a decorative exposed aggregate finish subject to the OWNER'S REPRESENTATIVE'S approval of the type and rate of application of the retarder and to demonstration by the CONTRACTOR that a finish can be achieved which is deemed acceptable by the OWNER'S REPRESENTATIVE, without detriment to the durability of the concrete which remains at the exposed surface.

Specimen panels of concrete

Where required by the OWNER'S REPRESENTATIVE, the CONTRACTOR shall construct and treat specimen panels of concrete to the finish required, in order to satisfy the OWNER'S REPRESENTATIVE as to the suitability and effectiveness of the proposed method of treatment.

3.1.17. Special Concretes

Where so directed by the OWNER'S REPRESENTATIVE, the CONTRACTOR shall add approved compounds to the concrete materials before mixing, or apply them to the surface after completion, to give a concrete with improved dust-proof and oil-proof qualities. Such compounds shall be used in accordance with the instructions of the manufacturer.

Where placed on set concrete, granolithic type concrete paving shall be placed in panels not exceeding square 3 metres. Contraction joints of an approved type shall be provided around the perimeter of each panel.

Carborundum finish concrete

Concrete described as having a Carborundum finish shall be finished by sprinkling and working in Carborundum grit to form a non-slip surface. The Carborundum grit shall vary in size between 1.18 mm mesh and 0.600 mm mesh. It shall be distributed from a 1.18 mm mesh hand screen at the rate of 2.15 kg/m¨ and shall be worked into the concrete by means of a wooden float.

3.1.18. Precast Concrete

All precast concrete units shall be cast on a properly-constructed bed which shall not be liable to settlement and which shall have a smooth, hard and truly-levelled top surface.

No precast units shall be removed from the casting beds until the flexure test beams representing them reach a strength such that the OWNER'S REPRESENTATIVE is satisfied that the units can be handled and stacked without detriment to the units.

Similarly, no units shall be set in place until the cubes representing them reach a strength not less than that specified as the minimum works cube strength at twenty-eight days for the grade of concrete concerned. All units shall be marked clearly with a serial number and date of casting.

The CONTRACTOR shall submit to the OWNER'S REPRESENTATIVE for approval his proposed method of lifting precast units and the proposed positioning of lifting points.

Precast concrete units which are of symmetrical section but in which the reinforcement is not symmetrical shall be marked clearly to show the face which will be uppermost when the unit is in its correct position in the Works.

Wherever possible the marks shall be so located that they are not exposed to view when the unit is in its permanent position.

3.1.19. Mortars and rendering

Cement mortar shall, unless otherwise specified or ordered, consist of one part of cement to three parts of fine sand by volume mixed and thoroughly incorporated together with just enough water to render it workable.

Rendering shall consist of three parts of fine sharp sand to one part of cement and be applied in two 10 mm coats and one 5 mm finishing coat giving an overall thickness of not less than 25 mm, the finishing coat being of a colour to be approved by the OWNER'S REPRESENTATIVE.

All cement mortar and rendering shall be used whilst freshly mixed and no softening or re-tempering will be allowed.

Acid resistant epoxy mortar shall be obtained from an approved manufacturer and shall be used strictly in accordance with the manufacturer's instructions.

3.1.20. Grouting

3.1.20.1. General

This paragraph covers the mandatory requirements for the supply and installation of all grouting work related to :

- structural steel or supports baseplates
- equipment bed plates or skids
- base rings for towers

The type, thickness and areas of grout shall be in accordance with the OWNER'S REPRESENTATIVE'S construction drawings.

Proprietary products considered by the CONTRACTOR to meet this section shall be submitted for approval to the OWNER'S REPRESENTATIVE with the CONTRACTOR'S report and recommendation, and shall be approved before use.

3.1.20.2. Types of grout

The compressive strengths of the grout types listed below are based on 40 mm x 40 mm x 160 mm test prism, tested in accordance with relevant Indian Codes.

3.1.20.3. Type G1

This is a proprietary, non-shrink, non-metallic, fluid grout. 'Master Flow 713' by Master Builders or an approved equal shall be used.

3.1.20.4. Type G2

This is a cement/sand grout. The ratio of cement to sand in the mix shall be :

- 1:1 for bedding thickness not greater than 25 mm
- 1:2 for bedding thickness not greater than 50 mm

- 1:3 for screeding and dry packing.

When Type G2 grout is to be used over a large area, a suitable plasticiser approved by the OWNER'S REPRESENTATIVE may be added in accordance with the manufacturer's instructions.

The ratio of water to cement shall not be greater than 0.5 and seven day compressive strengths shall not be less than :

- 1:1 mix - 25 N/mm^2
- 1:2 mix - 20 N/mm^2
- 1:3 mix - 15 N/mm^2

Three Test cubes are to be tested for each 1 m^3 of Type G2 grout that is used.

3.1.20.5. Type G3

This is a proprietary epoxy grout and selected aggregate, "Escoweld 7505" by Esso Chemicals or an approved equal, used and mixed strictly in accordance with manufacturer's instructions.

3.1.20.6. Materials

3.1.20.6.1. Cement & sand

Cement shall conform to paragraph 2.1.1 of this SPECIFICATION.

Sand shall conform to paragraph 2.1.3 of this SPECIFICATION.

Admixtures

A water reducing plasticiser may be used, only where approved by the OWNER'S REPRESENTATIVE. Admixture containing calcium chloride shall not be used. Where approved admixtures shall be used strictly in accordance with the manufacturer's instructions and shall comply with :

[IS 9103 : 1999]

3.1.20.6.2. Handling and storage of Materials

a/ <u>Cement</u>

Bagged cement shall be stored in waterproof, ventilated sheds, and the floors of the sheds shall be kept clear of the ground or otherwise protected from dampness. The cement shall be stored in such a way that the oldest deliveries are used first. Re-bagged cement may not be used unless permitted by the OWNER'S REPRESENTATIVE. If bulk cement is used it shall be stored in a steel bulk cement storage silo of approved design and manufacture. The CONTRACTOR shall provide the OWNER'S REPRESENTATIVE with a test certificate to the effect that the weighing mechanism is working correctly and he shall continue test checks at least once per week throughout the period of concreting in the presence of the OWNER'S REPRESENTATIVE.

Cement bags containing lumps that cannot be broken by a light touch of the fingers shall not be used.

Quantities of cement shall be stored on site as are considered sufficient by the OWNER'S REPRESENTATIVE to ensure continuity of work, taking in account the transport and climatic conditions, etc. No cement shall be kept on the site longer than 3 months.

b/ Sand

The CONTRACTOR shall ensure that adequate supplies of the approved sand is available prior to commencing work and shall at all times maintain on site quantities sufficient to ensure continuity of work.

Sand shall be separately transported and stored, and shall not be contaminated with any other types of aggregate or other material. The floor of storage areas shall be of concrete or other approved material having sufficient slope to ensure drainage of surplus water. Regular cleaning of sand bins shall be carried out to remove accumulated dust. Wet sand shall be kept on site for at least 24 hours to ensure adequate drainage before being used for grouting.

c/ Proprietary Materials

All other materials shall be stored in a similar manner to cement to protect them from deterioration and contamination from whatever source, to the approval of the OWNER'S REPRESENTATIVE.

3.1.20.7. Preparation

- Concrete surfaces which are to receive grout shall be finished level and reasonably smooth by tamping. When the concrete has become firm but is still green, it shall be hosed and lightly brushed to remove laitance and expose the aggregate without disturbing it.
- The surface shall be cleared of all defective concrete and laitance, oil, grease and other chemicals and dirt, and shall be approved by the OWNER'S REPRESENTATIVE.
- Bolt sleeves shall be freed of all static water, polystyrene formers and foreign matter.
- All grout shall be placed within shuttering. Shuttering shall be of adequate strength and securely fixed to withstand the pressure of the grout and be sealed to prevent leakage.
- Grout shall be placed as soon as possible after the erection of the equipment or steelworks as directed by the OWNER'S REPRESENTATIVE.
- Proprietary grouts shall be mixed and prepared strictly in accordance with the manufacturer's instructions.
- Foundations to receive water-mix grout shall be kept wet for 24 hours before the grout is placed.

3.1.20.8. Mixing and placing

- Grout shall be mixed in equipment capable of continuous mechanical mixing and agitation that will produce uniform distribution of material.
- Surfaces to receive or be in contact with any grout shall not exceed 32 °C or be less than 10 °C. Care shall be taken to ensure that the grout completely fills the void to be grouted and is thoroughly compacted and free from air pockets. Any areas or pockets which are not to receive grout shall be sealed with an approved material.
- Grout may be placed either by pouring or pumping. The grout shall be applied under a suitable head and worked until the space is completely filled. Exposed surfaces shall receive a steel trowel finish and be sloped to allow drainage.

- All bolt holes and sleeves shall be filled adequately and pressure grouting used where directed by the OWNER'S REPRESENTATIVE. Steel shims shall be encased by grout with at least a 20 mm cover.

- All proprietary grouts shall be placed strictly in accordance with the manufacturer's installation procedure.

- All exposed cement based grouts must be correctly cured. Twenty-four hours after placing the grout the shuttering shall be removed and the grout cured with an approved agent or wet hessian and polythene sheet. Grouts shall be cured for a minimum of 3 days.

3.1.20.9. Finishing

- After a period to be determined by the OWNER'S REPRESENTATIVE, the work shall be neatly pointed and trowelled off and left in a workmanlike manner.

- Exposed edges shall be protected adequately against damage and the effects of the elements during the curing period.

3.1.21. Protection to concrete

Where detailed, concrete structures shall be protected internally or externally with an approved proprietary waterproofing membrane or coating, and fixed to the concrete surfaces required to be protected. The protection shall be placed in accordance with the drawings and the manufacturer's instruction.

Membranes and coatings which are to have concrete, backfill or other material placed against them shall be protected as soon as practicable after application.

Horizontal surfaces shall be protected with mortar or concrete as shown on the drawings.

Vertical surfaces shall be protected with hardboard or other approved material, which shall be left as permanent protection.

3.1.22. Tolerances of concrete surfaces

The acceptable tolerances of concrete surfaces shall be in accordance with the requirements of paragraph 3.1.8.

Notwithstanding the above specified tolerances no concrete surface shall intrude within the structure gauge and easement.

3.2. Field Quality Control

3.2.1. Testing of cement

Notwithstanding the submission by the CONTRACTOR of the certificates required by paragraph 1.6.3 of this SPECIFICATION, the OWNER'S REPRESENTATIVE may, at his discretion, decide that any consignment of cement, on arrival at the site and also after it has been stored at the site prior to use, be subjected to the whole of the tests and analyses required by this SPECIFICATION and no cement of that consignment shall be used in the works until it has been tested by the OWNER'S REPRESENTATIVE and accepted by him as satisfactory.

3.2.2. Testing of Reinforcement

Notwithstanding the submission by the CONTRACTOR of the certificates required by paragraph 1.6.3 of this SPECIFICATION, the OWNER'S REPRESENTATIVE may, at his discretion, decide that any consignment of reinforcement be subjected to independent tests and no reinforcement of that consignment shall be used in the works until it has been tested by the OWNER'S REPRESENTATIVE and accepted by him as satisfactory.

3.2.3. Testing of Aggregates

The grading of aggregates shall be tested at least at weekly or at 100 m^3 intervals whichever is the sooner when concrete is being produced on a regular basis or before the start of production when the production of concrete is irregular.

The moisture content and water absorption value of all fine and coarse aggregates shall be tested by the CONTRACTOR at such frequent intervals as will enable him to comply with the requirements of paragraph 2.2.2 of this SPECIFICATION.

3.2.4. Testing of Concrete - General

Sampling of concrete for test purposes shall be carried out in accordance with the requirements of :

[IS 1199 : 1959]

Concrete specimens shall be manufactured and cured in accordance with the requirements of :

[IS 9013:1978, IS10086 : 1982]

Compression tests of concrete which has a maximum size aggregate of more than 40 mm shall be carried out as required in paragraphs 2.2.5 and 3.2.5 however by first sieving and discarding prior to moulding all aggregate that is larger than 50 mm.

3.2.5. Permanent works concrete quality control

Test cubes shall be made, cured, stored, transported and tested in compression in accordance with :

[IS 10086 : 1982]

Cubes shall be manufactured on the site at the location where the concrete is being placed.

A sample of concrete shall be taken at random on eight separate occasions during each of the first five days of using a mix. The standard deviation shall be calculated from at least 40 individual test results each representing separate batches of similar concrete produced by the same plant and under the same supervision. Thereafter samples will be taken at random at the frequencies given below :

Type of Structural Element	Sampling frequency (m^3 per sample)
• Precast concrete elements	10
• Normal structural elements such as columns, walls, slabs	25
• Heavy base and roof slabs, thick walls	50

The samples shall be taken for the concrete produced by each batch plant, for each grade of concrete and at least one sample shall be taken on each day on which any concrete of a particular grade is made.

From each sample two cubes shall be made for testing at 28 days and one for testing at 7 days for control purposes.

Each 28-day test result shall be the mean of the cube strengths of the two cubes made from the same sample.

If three or more results in 40 consecutive tests are below the characteristic strength or if one result in 40 consecutive tests is less than 85 % of the characteristic strength the OWNER'S REPRESENTATIVE may order any or all of the following actions to be taken:

a) the adjustment of the mix and/or improvement to the standard of quality control;

b) the cutting of test cores from the concrete for examination and testing of specimens prepared therefore;

c) the carrying out of load tests on areas or structural members containing the suspect concrete;

d) the cutting out and replacement of such volumes of concrete as, at his discretion, he considers to be defective;

e) the carrying out of non-destructive tests to assess the in-situ quality of the suspect concrete.

The procedure outlined above shall be repeated whenever a change in materials to be used or mix design is intended.

If the range of individual cube strengths made from the same sample exceeds 15 % of the mean then the method of making, curing and testing cubes shall be examined thoroughly.

In the event of a result having a range exceeding 20 % the result shall be unacceptable and the OWNER'S REPRESENTATIVE may order any of the actions outlined above to be taken.

Where the OWNER'S REPRESENTATIVE orders the cutting of test cores from the concrete, the CONTRACTOR shall cut cores from locations selected by the OWNER'S REPRESENTATIVE. If the strength of these cores, when corrected by the reduction for each week of age in excess of 28 days is less than 75 % of the specified characteristic cube strength then the concrete shall be cut out and replaced to the extent directed by the OWNER'S REPRESENTATIVE unless the OWNER'S REPRESENTATIVE orders otherwise.

In addition to the works test cubes described above, the OWNER'S REPRESENTATIVE may order additional cubes and tests :

f) to determine stripping times for formwork;

g) to determine the duration of curing;

h) to check testing and sampling errors.

When air entrained concrete is being produced the air content shall be determined for each load of concrete produced.

This frequency may be reduced once consistency of production has been achieved.

In the early stages of permanent works concreting and, if instructed by the OWNER'S REPRESENTATIVE, when the CONTRACTOR starts to use new materials or mix design or to employ new materials or procedures of curing, the CONTRACTOR shall take measurements with resistance thermocouples or other appropriate and approved devices, and shall thereby provide the OWNER'S REPRESENTATIVE with records of the temperature variations in the centre of and at the surface of the concrete in such pours as the OWNER'S REPRESENTATIVE may direct. Such records may be used by the OWNER'S REPRESENTATIVE in order.

i) to assess the suitability of the concrete mix design;

j) to assess the suitability of and stripping times for timber or other insulating formwork;

k) to assess the suitability of the curing materials and procedures.

3.2.6. Workability of concrete

The CONTRACTOR shall carry out compaction factor or slump tests in accordance with :

[IS 7320 : 1974]

or other workability tests as required during concreting.

The purpose of these tests is to ensure the adequate control of workability at the batching plant and the site of the pour. The degree of workability obtained when concreting the permanent works shall be in accordance with the trial mixes.

3.2.7. Chlorides in hardened concrete

Tests in accordance with relevant Indian Codes:

will be made on hardened concrete at regular intervals to determine the acid soluble chloride content.

Reinforced concrete will be judged acceptable provided that no result is greater than 0.50 % NaCl by weight of cement in the mix.

3.2.8. Sulphates in hardened concrete

Tests in accordance with relevant Indian Codes:

shall be made by the CONTRACTOR on hardened concrete at regular intervals to determine the total sulphate content as SO_3 of any mix. Notwithstanding the requirements given in paragraph 2.1.11 of this SPECIFICATION, the concrete will be judged acceptable if this does not exceed 3.7 % by weight of cement in the mix.

3.2.9. Testing of reinforcement couplers

For each 200 splices executed in the field the CONTRACTOR shall execute, under field conditions, five splices for quality control tests using representative samples of such reinforcement diameters as the OWNER'S REPRESENTATIVE may nominate.

The OWNER'S REPRESENTATIVE may increase the frequency of testing if the results are not satisfactory.

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STRUCTURAL STEEL WORKS

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1. SCOPE

This specification covers the requirements for material, storage, preparation of fabrication drawings, fabrication, assembly, tests/examinations, transportation, erection and painting of all types of bolted welded structural steel works for general construction work. Fabrication of structures shall also include fabricating:

a. Built up sections/plate girders made out of rolled section and/or plates.

b. Compound sections made out of rolled sections.

2. REFERENCE

2.1. BIS Codes

IS:800, 816, 819, 822, 919, 1024, 1261, 1323, 1477,1852, 2074, 7205,7215, 7307, 7310, 7318, 9595 and other relevant BIS Codes.

SP: 6(1)

3. MATERIALS

3.1. General

All materials shall conform to their respective specifications given in Specification. The use of equivalent or alternative materials shall be permitted only in very special cases and for all such cases prior written approval of the Owner's Representative will be obtained.

3.2. Receipt & Storing of Materials

3.2.1. Each section shall be marked for identification and each lot shall be accompanied by Manufacturer's quality certificate, chemical analysis and mechanical characteristics.

3.2.2. All sections shall be checked, sorted out and arranged by grade and quality in the store. Any instruction given by the Owner's Representative in this respect shall be strictly followed.

3.2.3. All material shall be free from surface defects such as pitting, cracks, laminations, twists etc. Defective material shall not be used and all such rejected material shall be immediately removed from the store/site. The decision of Owner's Representative in this regard shall be final and binding.

3.2.4. Welding wires and electrodes (packed in their original cartons) shall be stored separately by quality and lots inside a dry and enclosed room in compliance with IS:9595 and as per the instructions given by the Owner's Representative. Electrodes shall be kept perfectly dry to ensure satisfactory operation and weld metal soundness.

3.2.5. Each lot of electrodes, bolts, nuts etc. shall be accompanied by manufacturer's quality/test certificates.

3.2.6. All bolts (including nuts & washers) shall be checked, sorted out and arranged diameter-wise by grade and quality in the store.

3.3. Material Tests

3.3.1. The Contractor shall submit manufacturer's quality certificates for all the materials supplied by him. In case, quality certificates are not available or are incomplete or when material quality differs from standard specifications, such materials shall not be used in the construction. However, the Contractor shall get all appropriate tests conducted in approved test houses for such materials as directed by the Owner's Representative, at no extra cost, and submit the same to Owner's Representative for his approval. The Owner's Representative may approve the use of such materials entirely at his discretion.

3.3.2. The Contractor shall ensure that all materials brought to site are duly approved by the Owner's Representative. Rejected materials shall not be used and shall be removed from site forthwith. Any material of doubtful quality for which specific tests are to be carried out as per the instruction of the Owner's Representative shall be separately stacked and properly identified and shall not be used. These shall be removed from site forthwith.

4. FABRICATION DRAWINGS

4.1. Fabrication and erection drawings shall be prepared by the Contractor on the basis of "Approved for Construction (AFC)" design drawings. These drawings shall be prepared by the Contractor or by an agency appointed by the Contractor and approved by the Owner's Representative.

4.2. Fabrication and erection drawings shall be thoroughly checked, stamped "Approved for Construction" and signed by the Contractor's own responsible Engineer irrespective of the fact that such drawings are prepared by the Contractor or his approved agency, to ensure accuracy and correctness of the drawings. Unchecked and unsigned drawings shall not be used for the purpose of proceeding with the work. The Contractor shall proceed with the fabrication and erection work only after thoroughly satisfying himself in this regard.

4.3. All fabrication and erection drawings shall be issued for construction by the Contractor directly to his work site. Six copies of such drawings shall simultaneously be submitted to the Owner's Representative who may check / review some or all such drawings at his sole discretion and offer his comments for incorporation in these drawings by the Contractor.

However, the Contractor shall not proceed with the fabrication of such structures whose fabrication drawings are required to be reviewed before taking up the fabrication work as noted on "Approved for Construction (AFC)" design drawings issued to the Contractor or as conveyed by the Owner's Representative. The fabrication of such structures shall be done only as per the reviewed fabrication drawings.

The review of such drawings by Client shall be restricted to the checking of the following only:

i. Structural layout, orientation and elevation of structures/members.

ii. Sizes of members.

iii. Critical joint details.

4.4. Fabrication drawings shall be drawn to scale and shall convey the information clearly and adequately. Following information shall be furnished on such drawings:

- Reference to design drawing number (along with revision number) based on which fabrication drawing has been prepared.
- Structural layout, elevations and sections (with distinct erection marking of all members).
- Framing plans, member sizes, orientation and elevations.
- Layout and detailing of rain water pipes and gutters showing all necessary levels, connections and provisions wherever required.
- Detailing of shop/field joints, connections, splices, for required strength and erection.
- Location, type, size and dimensions of welds and bolts.
- Shapes and sizes of edge preparation for welding.
- Details of shop and field joihnts/welds.
- Bill of materials / D.O.D. lists.
- Quality of structural steel, plates etc., welding electrodes, bolts, nut and washers to be used.
- Erection assemblies identifying all transportable parts and sub-assemblies with special erection instructions, if required.
- Method of erection and special precautions to be taken during erection as required.

4.5. The Contractor shall additionally ensure accuracy of the following and shall be solely responsible for the same:

i. Provision for erection and erection clearances.

ii. Marking of members.

iii. Cut length of members.

iv. Matching of joints and holes.

v. Provision kept in the members for other interconnected members.

vi. Bill of materials/D.O.D. lists.

4.6. Connections, splices and other details where not shown on the design drawings shall be suitably designed and shown on the fabrication drawings based on good engineering practice developing full member strength. Design calculations for such connections/ splices shall be submitted to the Owner's Representative along with the fabrication drawings.

4.7. Any substitution or change in section shall be allowed only when prior written approval of the Owner's Representative has been obtained. Fabrication drawings shall be updated incorporating all such substitutions/changes by the Contractor at no extra cost to the Owner.

4.8. In case during execution of the work, the Owner's Representative on review of drawings considers any modifications/substitutions necessary to meet the design parameters/good engineering practice, these shall be brought to the notice of the Contractor who shall incorporate the same in the drawings and works without any extra cost to the Owner. The Contractor will be totally responsible for the correctness of the detailed fabrication drawings and execution of the work.

4.9. Contractor shall incorporate all the revisions made in the design drawings during the course of execution of work in his fabrication drawings, and resubmit the drawings at no extra cost to the Owner. All fabrication shall be carried out only as per the latest AFC design drawings and corresponding fabrication drawings.

4.10. The Contractor shall supply two prints each of the final/As-built drawings along with their transparencies to Owner's Representative for reference and record. The rates quoted shall include for the same.

5. FABRICATION

5.1. General

5.1.1. Fabrication of structures shall be done strictly as per "Approved for Construction" fabrication drawings (prepared by the Contractor based on the latest design drawings) and in accordance with IS:800, 9595 and other relevant BIS Codes and BIS Hand Book SP:6(1).

5.1.2. Prior to commencement of structural fabrication undulations in the fabrication yard, if any, shall be removed and area levelled and paved by the Contractor.

5.1.3. Any defective material used in the work shall be replaced by the Contractor at his own expense. Necessary care and precautions shall be taken so as not to cause any damage to the structure during any such removal and replacement.

5.1.4. Any faulty fabrication pointed out at any stage of work by the Owner's Representative, shall be made good or replaced by the Contractor at his own cost.

5.1.5. Tolerances for fabrication of steel structures shall be as per IS:7215.

5.2. Fabrication Procedure

5.2.1. Straightening & Bending

5.2.1.1. All materials shall be straight and, if necessary, before being worked shall be straightened and/or flattened (unless required to be of curvilinear form) and shall be free from twists.

5.2.1.2. Bending of rolled sections and plates shall be done by cold process to shape/s as shown on drawings.

5.2.2. Clearances

The erection clearance for cleated ends of members shall be not greater than 2mm at each end. The erection clearance at ends of beams without web cleats and end plates shall be not more than 3mm at each end but where for practical reasons, greater clearance is necessary, suitably designed seatings approved by the Owner's Representative shall be provided.

5.2.3. Cutting

5.2.3.1. Prior to cutting, all members shall be properly marked showing the requisite cut length/width, connection provisions e.g. location and dimensions of holes, welds, cleats etc. marking for cutting shall be done judiciously so as to avoid wastages or unnecessary joints as far as practibcable. Marking shall be done by placing the members on horizontal supports/pads in order to ensure accuracy. Marking accuracy shall be limited to + 1mm.

5.2.3.2. Cutting may be affected by shearing, cropping or sawing. Gas cutting by mechanically controlled torch shall be permitted for mild steel. Hand flame cutting may be permitted subject to the approval of the Owner's Representative.

5.2.3.3. Except where the material is subsequently joined by welding, no loads shall be transmitted into metal through a gas cut surface.

5.2.3.4. Shearing, cropping and gas cutting shall be clean, square, free from any distortion and burrs, and should the Owner's Representative find it necessary, the edges shall be ground afterwards, to make the same straight and uniform at no extra cost to the Owner.

5.2.4. Holing

5.2.4.1. Holes for bolts shall not be formed by gas cutting process.

5.2.4.2. Holes through more than one thickness of material of members such as compound stanchions and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped/bolted together. Punching may be permitted before assembly, provided the thickness of metal is less than 16 mm and the holes are punched 3mm less in diameter than the required size and reamed, after assembly, to the full diameter. Punching shall not be adopted for dynamically loaded structures.

5.2.4.3. Holes may be drilled in one operation through two or more separable parts and burrs removed from each part after drilling.

5.2.4.4. Holes in connecting angles and plates, other than splices, also in roof members and light framing, may be punched full size through material not over 12mm thick, except where required for close tolerance bolts or barrel bolts.

5.2.4.5. All matching holes for black bolts shall register with each other so that a gauge of 2mm less in diameter than the diameter of hole shall pass freely through the assembled members in the direction at right angle to such members. Finished holes shall be not more than 2mm in diameter larger than the diameter of the black bolt passing through them, unless otherwise specified by the Owner's Representative.

5.2.4.6. Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to H8 tolerance specified in IS:919. Parts to be connected with close tolerance or barrel bolts shall be firmly held together by tacking bolts or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all the thicknesses in one operation shall be drilled to a smaller size and reamed out after assembly. Where this is not possible, the parts shall be drilled and reamed separately.

5.2.4.7. To facilitate grouting, holes shall be provided in column bases or seating plates exceeding 300mm in width for the escape of air.

5.2.4.8. To avoid accumulation of water in gusseted column bases of laced, battened or box type stanchions, suitable reverse U-type holes shall be provided at the junction of base plate and column section in the vertical gussets for draining out of any water.

5.2.5. Assembly

The component parts shall be assembled and aligned in such a manner that they are neither twisted nor otherwise damaged, and shall be so prepared that the required camber, if any, is provided. Proper clamps, clips, jigs and other fasteners (bolts and welds) shall be placed in a balanced pattern to avoid any distortion in the members and to ensure their correct positioning (i.e. angles, axes, nodes etc.). Any force fitting, pulling/stretching of members to join them shall be avoided. Proper care shall be taken for welding shrinkage and distortion so as to attain the finished dimensions of the structure shown on the drawings.

5.2.6. Welding

5.2.6.1. General

a) All joints shall be welded unless noted otherwise on the design drawings.

b) Welding shall be in accordance with IS:816, IS:819, IS:1024, IS:1261, IS:1323 and IS:9595 as appropriate.

c) The Contractor shall make necessary arrangement for providing sufficient number of welding sets of the required capacity, all consumables, cutting and grinding equipment with requisite accessories/auxiliaries, equipment and materials required for carrying out various tests such as dye penetration, magnetic particle, ultrasonic etc.

d) Adequate protection against rain, dust, snow and strong winds shall be provided to the welding personnel and the structural members during welding operation. In the absence of such a protection no welding shall be carried out.

e) It shall be the responsibility of the Contractor to ensure that all welding is carried out in accordance with the terms of this specification and relevant BIS codes. The Contractor shall provide all the supervision to fulfil this requirement.

5.2.6.2. Preparation of Member for Welding

a) Edge Preparation

Edge preparation/bevelling of fusion faces for welding shall be done strictly as per the dimensions shown in the drawings. In case, the same are not indicated, edges shall be prepared (depending on the type of weld indicated in the drawing) as per the details given in IS:9595. Bevelling of fusion faces shall be got checked and approved by the Owner's Representative. The tolerances on limits of gap, root face and included angle shall be as stipulated in IS: 9595.

b) Cleaning

Welding edges and the adjacent areas of the members (extending upto 20mm) shall be thoroughly cleaned of all oil, grease, scale and rust and made completely dry. Gaps between the members to be welded shall be kept free from all foreign matter.

c) Preheating

Preheating of members, shall be carried out as per IS:9595 when the base metal temperature is below the requisite temperature for the welding process being used. Preheating shall be done in such a manner that the parts on which the weld metal is being deposited, are above the specified minimum temperature for a distance of not less than 75mm on each side of the weld line. The temperature shall be measured on the face opposite to that being heated. However, when there is access to only one face, the heat source shall be removed to allow for temperature equalization (1 minute for each 25mm plate thickness) before measuring the temperature.

d) Grinding

i. Column splices and butt joints of struts and compression members (depending on contact for load transmission) shall be accurately ground and close-butted over the whole section with a tolerance not exceeding 0.2mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., shall be accurately ground so that the parts connected butt over minimum 90% surface of contact. In case of connecting angles or channels, care shall be taken so that these are fixed with such accuracy that they are not reduced in thickness by grinding by more than 2mm.

ii. Ends of all bearing stiffeners shall be ground to fit tightly at both top and bottom. Similarly, bottom of the knife edge supports along with the top surface of column brackets shall be accurately ground to provide effective bearing with a tolerance not exceeding 0.2mm locally at any place.

iii. Slab bases and caps shall be accurately ground over the bearing surfaces and shall have effective contact with the ends of stanchions. Bearing faces which are to be grouted direct to foundations need not be ground if such faces are true and parallel to the upper faces.

5.2.6.3. Welding Processes

Welding of various materials under this specification shall be carried out using one or more of the following processes.

- Manual Metal Arc Welding Process (MMAW)
- Submerge Arc Welding Process (SAW)
- Gas Metal Arc Welding Process (GMAW)
- Flux Cored Arc Welding Process (FCAW)

The welding procedure adopted and consumables used shall be specifically approved by the Owner's Representative. A combination of different welding processes or a combination of electrodes of different classes/makes may be employed for a particular joint only after qualifying the welding procedures to be adopted and obtaining the written approval of the Owner's Representative.

5.2.6.4. Approval & Testing of Welders

The Contractor shall satisfy the Owner's Representative that the welders are suitable for the work upon which they will be employed. For this purpose the welders shall have satisfied the relevant requirements of IS:7318. If the welders will be working to approved welding procedures, they shall have satisfied the relevant requirements of IS:7310.

Adequate means of identification shall be provided to enable each weld to be traced to the welder by whom it was made. The Contractor shall intimate the Owner's Representative sufficiently in advance, the commencement of tests, to enable him to be present to witness the same.

5.2.6.5. Approval & Testing of Welding Procedures

The Contractor shall carry out procedure tests in accordance with IS:7307 to demonstrate by means of a specimen weld of adequate length on steel representative of that to be used, that he can make welds with the welding procedure to be used for the work to the complete satisfaction of the Owner's Representative. The test weld shall include weld details from the actual construction and it shall be welded in a manner simulating the most unfavourable instances of fit-up, electrode condition etc., which are anticipated to occur on the particular fabrication. Where material analysis are available, the welding procedure shall be carried out on material with the highest carbon equivalent value.

After welding, but before the relevant tests given in IS:7307 are carried out, the test weld shall be held as long as possible at room temperature, but in any case not less than 72 hours, and shall then be examined for cracking. The examination procedure shall be sufficiently rigorous to be capable of revealing significant defects in both parent metal and weld metal.

After establishing the welding method, the Contractor shall finally submit to the Owner's Representative for his approval the welding procedure specification in standard format given in IS:9595 before starting the fabrication.

5.2.6.6. Sequences of Welding

a. As far as practicable, all welds shall be made in a sequence that will balance the applied heat of welding while the welding progresses.

b. The direction of the general progression in welding on a member shall be from points where the parts are relatively fixed in position with respect to each other towards points where they have a greater relative freedom of movement.

c. All splices in each component part of a cover-plated beam or built up member shall be made before the component part is welded to other component parts of the member.

d. Joints expected to have significant shrinkage shall be welded before joints expected to have lesser shrinkage.

e. Welding shall be carried continuously to completion with correct number of runs.

f. The Contractor shall choose the welding sequence after carefully studying each case such as to minimize distortion and shrinkage and submit the same to the Owner's Representative for comments and approval.

5.2.6.7. Welding Technique

a. After the fusion faces are carefully aligned and set with proper gaps, the root pass of butt joints shall be executed properly so as to achieve full penetration with complete fusion of the root edges.

b. On completion of each run, all slag and spatters shall be removed and the weld and the adjacent base metal shall be cleaned by wire brushing and light chipping. Visible defects such are cracks, cavities and other deposition faults, if any, shall be removed to sound metal before depositing subsequent run of weld.

c. All full penetration butt welds shall be completed by chipping/gouging to sound metal and then depositing a sealing run of weld metal on the back of the joints. Where butt welding is practicable from one side only, suitable backing steel strip shall be used and joint shall be arranged in such a way as to ensure that complete fusion of all the parts is readily obtained.

d. While welding is in progress care shall be taken to avoid any kind of movement of the components, shocks, vibrations to prevent occurrence of weld cracks.

e. Any deviation desired from the recommended welding technique and electrodes shall be adopted only after obtaining written approval of the Owner's Representative.

5.2.6.8. Inspection & Testing of Welds

The method of inspection shall be according to IS:822 and extent of inspection and testing shall be in accordance with the relevant applicable standard or, in the absence of such a standard, as specified by the Owner's Representative. Welds shall not be painted or otherwise obscured until they have been inspected, approved and accepted.

The Owner's Representative shall have access to the Contractor's work at all reasonable times and the Contractor shall provide him with all facilities necessary for inspection during all stages of fabrication and erection with, but not limited to, the following objectives.

i. To check the conformity with the relevant standards and suitability of various welding equipments and their performance.

ii. To witness/approve the welding procedure qualification.

iii. To witness/approve the welders performance qualification.

iv. To check whether shop/field welding being executed is in conformity with the relevant specifications and codes of practice.

Inspection and testing of all fabricated structures shall be carried out by the Contractor by any, or, a combination of all the following methods as directed by the Owner's representative and no separate payment shall be made, unless otherwise mentioned, for inspection and testing of welds/fabricated structures:

A. Visual Inspection

All finished welds (i.e. 100 percent) shall be visually inspected for identification of the following types of weld defects and faults.

a. Weld defects occurring at the surface such as blow holes, exposed porosity, unfused welds, etc.

b. Surface cracks in the weld metal or in the parent metal adjacent to it.

c. Damages to the parent metal such as undercuts, burning, overheating, etc.

d. Profile defects such as excessive convexity or concavity, overlapping, unequal leg lengths, excessive reinforcement, incompletely filled groves, excessive penetration beads, root grooves etc.

e. Distortion due to welding i.e., local shrinkage, camber, bowing, twisting, rotation, wariness etc.

f. Linear eccentric, angular and rotational misalignment of parts.

g. Dimensional errors.

B. Mechanical Tests

The mechanical testing (such as tensile load tests, bend tests, impact tests etc.) shall be done in accordance with the relevant standards and as per the instructions of the Owner's Representative.

C. Magnetic Particle/Dye Penetration/Ultrasonic Examination

The examination shall be done at random as directed by the Owner's Representative. Whenever such tests are directed, the tests shall be carried out on joints chosen by him. The tests shall be carried out by employing approved testing procedure in accordance with IS:822.

D. Radiographic Examination

Radiographic examination shall be carried out only in special cases for random joints as directed by the Owner's Representative. The Contractor shall be paid extra for such examination except for penalty radiographic tests for which the cost shall be borne by him. The Contractor shall make necessary arrangement at his own expense for providing the radiographic equipment, films and all other necessary materials required for carrying out the examination. The tests shall be carried in the presence of the Owner's Representative by employing approved testing procedure in accordance with IS:822. The Contractor shall fulfil all the statutory safety requirements while handling X-ray and Gamma-ray equipment and provide the Owner's Representative all the necessary facilities at site such as dark room, film viewer etc., to enable him to examine the radiographs.

5.2.6.9. Repair of Faulty Welds

No repair of defective welds shall be carried out without proper permission of the Owner's Representative and his approval for the corrective procedure.

Welds not complying with the acceptance requirements (as specified by BIS Codes and the Owner's Representative), as revealed during inspection and testing of welds or erection or in-situ condition, shall be corrected either by removing and replacing or as follows:

a.	Excessive convexity	-	Reduced to size by removal of excess weld metal.
b.	Shrinkage cracks, cracks in parent plates and craters	-	Defective portions removed down to sound metal and rewelded.
c.	Under cutting	-	Additional weld metal deposited.
d.	Improperly fitted / misaligned parts.	-	Welding cut & edges suitably prepared and parts
e.	members distorted the by heat of welding	-	Member straightened by mechanical means or careful application of limited amount of heat, temperature of such area not to exceed 650 degree Centigrade dull red heat).

In removing defective parts of a weld, gouging, chipping, oxygen cutting or grinding shall not extend into the parent metal to any substantial amount beyond the depth of weld penetration, unless cracks or other defects exist in the parent metal. The weld or parent metal shall not be undercut in chipping, grinding, gouging or oxygen cutting.

Any fabricated structure or its component which, in the opinion of Owner's Representative, is defective and/or beyond any corrective action shall be removed forth with from the site as instructed by the Owner's Representative without any extra claim. The Owner reserves the right to recover any compensation due to any loss arising out of such rejections.

5.2.7. Bolting

5.2.7.1. All bolts shall be provided such that no part of the threaded portion of the bolts is within the thickness of the parts bolted together. Washers of suitable thickness shall be used under the nuts to avoid any threaded portion of the bolt being within the thickness of parts bolted together.

5.2.7.2. The threaded portion of each bolt shall project through the nut at least one thread.

5.2.7.3. Flat washers shall be circular and of suitable thickness. However, where bolt heads/nuts bear upon the bevelled surfaces, they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

5.2.8. Splicing

5.2.8.1. Splicing of built up/compound/latticed sections shall be done in such a fashion that each component of the section is joined in a staggered manner.

5.2.8.2. Where no butt weld is used for splicing, the meeting ends of two pieces of joist/channel/ built up section shall be ground flush for bearing on each other and suitable flange and web splice plates shall be designed and provided for the full strength of the flange/web of the section and welds designed accordingly.

5.2.8.3. Where full strength butt weld is used for splicing (after proper edge preparation of the web and flange plates) of members fabricated out of joist/channel/angles/built up section, additional flange and web plates shall be provided, over and above the full strength butt welds, to have 40% strength of the flange and web.

5.2.8.4. Where a cover plate is used over a joist/channel section the splicing of the cover plate and channel/joist sections shall be staggered by minimum 500mm. Extra splice plate shall be used for the cover plate and joint/channel section as per clause 5.2.8.2 or 5.2.8.3.

5.2.8.5. Prior approval shall be obtained by the Contractor for locations of splices where not shown on design drawings. Only a single splice at approved location shall be allowed for members upto a length of 6 to 7m. Maximum two numbers of splices shall be allowed for members exceeding this length.

5.2.9. Machining and Grinding

5.2.9.1. All slab bases and slab caps shall be accurately machined over the bearing surfaces and shall be in effective contact with the ends of column sections (shafts).

5.2.9.2. For slab bases and slab caps, ends of column shafts shall be accurately machined. However, for gusseted bases and caps, the column shafts shall be ground flush for effective contact with parts connected together.

5.2.9.3. Gussetted bases and caps shall be ground flush for effective contact with ends of column sections.

5.2.9.4. End of all bearing stiffeners shall be machined or ground to fit tightly at top and bottom without any air gap.

5.2.9.5. While machining or grinding care shall be taken so that the length or thickness of any part does not get reduced by more than 2.0mm.

5.2.9.6. For all machining or grinding works for gassetted base and cap plates, the clearance between the parts joined shall not exceed 0.2mm at any location.

6. MARKING FOR IDENTIFICATION

6.1. Each component shall be distinctly marked (with paint) before delivery in accordance with the marking diagrams and shall bear such other marks as will facilitate erection.

6.2. For small members which are delivered in bundles or crates, the required marking shall be done on small metal tags securely tied to the bundle.

7. SHOP ERECTION

The steel work shall be temporarily shop erected complete or as directed by the Owner's Representative, so that the accuracy of fit may be checked before despatch.

8. INSPECTION AND TESTING OF STRUCTURES

8.1. The Owner's Representative shall have free access at all times to those parts of the Contractor's works which are concerned with the fabrication of the steel work and shall be provided with all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with the provisions of these specifications and other relevant BIS Codes.

8.2. Should any structure or part of a structure be found not to comply with any of the provisions of this specification (or relevant BIS Codes as referred to), it shall be liable to rejection. No structure or part of the structure, once rejected shall be resubmitted for inspection, exception cases where the Owner's Representative considers the defect as rectifiable.

8.3. Defects which may appear during/after fabrication/ erection shall be made good only with the consent of the Owner's Representative and procedure laid down by him.

8.4. All necessary gauges and templates shall be supplied free to the Owner's representative by the Contractor whenever asked for during inspection. The Owner's Representative, may at his discretion, check the test results obtained at the Contractor's works by independent tests at a test house, and the cost of such tests shall be borne by the Contractor.

9. SHOP PAINTING

9.1. All components and members of steel work shall be given one shop coat of red oxide zinc chromate primer (conforming to IS:2074) or any other primer as specified, in the tender, immediately after the surfaces have been properly prepared (i.e. degreased, derusted, descaled and cleaned) in accordance with IS:1477. The primer coat shall be applied over completely dry surfaces (using brushes of good quality) in a manner so as to ensure a continuous and uniform film without "holidaying". Special care shall be taken to cover all the crevices, corners, edges etc. However, in areas which are difficult to reach by brushing, daubers/mops shall be used by dipping the same in paint and then pulling/pushing them through the narrow spaces. The primer coat shall be air dried and shall have minimum film thickness of 25 microns.

9.2. Surfaces which are inaccessible after shop assembly, shall receive the full specified protective treatment before assembly (this shall not apply to the interior of sealed hollow sections).

9.3. Steel surfaces shall not be painted within a suitable distance of any edges to be welded if the paint specified would be harmful to welders or impair the quality of the welds.

9.4. Welds and adjacent parent metal shall not be painted prior to deslagging, inspection and approval by the Owner's Representative.

9.5. Parts to be encased in concrete shall have only one coat of primer and shall not be painted after erection.

10. PACKING

10.1. All items shall be suitably packed in case these are to be despatched from the fabrication shop to the actual site of erection so as to protect them from any damage/distortion or falling during transit. Where necessary, slender projecting parts shall be temporarily braced to avoid warping during transportation.

10.2. Small parts such as gussets, cleats etc., shall be securely wired onto their respective main members.

10.3. Bolts, nuts washers etc. shall be packed in crates.

11. TRANSPORTATION

Loading and transportation shall be done in compliance with transportation rules. In case, certain parts can not be transported in the lengths stipulated on the drawings, the position details of such additional splice joints shall be got approved by the Owner's Representative.

12. SITE (FIELD) ERECTION

12.1. Plant & Equipment

The suitability and capacity of all plant and equipment used shall be to the complete satisfaction of the Owner's Representative.

12.2. Storing & Handling

All steel work shall be so stored and handled at site so that the members are not subjected to excessive stresses and any damage.

12.3. Setting Out

Prior to setting out of the steel work, the Contractor shall get himself satisfied about the correctness of levels, alignment, location of existing concrete pedestals/columns/brackets and holding down bolts/pockets provided therein. Any minor modification in the same including chipping, cutting and making good, adjusting the anchor bolts etc., if necessary, shall be carried out by the Contractor at his own expense. The positioning and levelling of all steel work including plumbing of columns and placing of every part of the structure with accuracy shall be in accordance with the drawings and to the complete satisfaction of the Owner's Representative.

12.4. Tolerances

Tolerances for erection of steel structures shall be as per Appendix – 'A'.

13. SAFETY AND SECURITY DURING ERECTION

13.1. The Contractor shall comply with IS:7205 for necessary safety and adhere to safe erection practices and guard against hazardous as well as unsafe working conditions during al stages of erection.

13.2. During erection, the steel work shall be securely bolted or otherwise fastened and when necessary, temporarily braced/guyed to provide for all loads to be carried by the structure during erection till the completion, including those due to the wind, erection equipment and its operation etc. at no extra cost to the Owner. For the purpose of guying, the Contractor shall not use other structure in the vicinity without prior written permission of the Owner's Representative.

13.3. No permanent bolting or welding shall be done until proper alignment has been achieved.

13.4. Proper access, platform and safety arrangement shall be provided for working and inspection, (at no extra cost to the Owner) whenever required.

14. FIELD CONNECTIONS

14.1. Field Bolting

Field bolting shall be carried out with the same care as required for shop bolting.

14.2. Field Welding

All field assembly and welding shall be executed in accordance with the requirements for shop assembly and welding. Holes for all erection bolts where removed after final erection shall be plugged by welding. Alternatively erection bolts may be left and secured.

15. GROUTING

15.1. Prior to positioning of structural columns/girders/trusses over the concrete pedestals/ columns/brackets, all laitance and loose material shall be removed by wire brushing and chipping. The bearing concrete surfaces shall be sufficiently levelled, hacked with flat chisels to make them rough, cleaned (using compressed air) and made thoroughly wet. All pockets for anchor bolts shall also be similarly cleaned any any excess water removed. Thereafter, the structural member shall be erected, aligned and plumbed maintaining the base plates/shoe plates at the levels shown in the drawings, with necessary shims/pack plates/wedges.

15.2. After final alignment and plumbing of the structure, the forms shall be constructed all round and joints made tight to prevent leakage. Grouting (under the base plates/shoe plates including grouting of sleeves and pockets) shall be done with non-shrink grout having compressive strength (28 days) not less than 40N/sq.mm non shrink grout shall be of free flow premix type and of approved quality and make. It shall be mixed with water in proportion as specified by the manufacturer. Ordinary 1:2 cement/sand mortar grout shall be used only for small, isolated structures e.g. operating platforms not supporting any equipment, pipe supports, crossovers, stairs and ladders. The thickness of grout shall be as shown on the drawings but not less than 25 mm nor more than 40 mm in any case.

15.3. The grout mixture shall be poured continuously (without any interruption till completion) by grouting pumps from one side of the base plate and spread uniformly with flexible steel strips and rammed with rods, till the space is filled solidly and the grout mixture carried to the other side of the base plate.

15.4. The grout mixture shall be allowed to harden for a period as decided by the Owner's representative. At the end of this period, the shims/wedges/pack plates may be removed and anchor bolts tightened uniformly. The alignment of the structure shall now be rechecked and if found correct, the voids left by the removal of shims/wedges/pack plates (if removed) must be filled upto with a similar mixture of grout. In case after checking, serious misalignment is indicated, the grout shall be removed completely and fresh grouting done after making appropriate correction of alignment.

16. SCHEME AND SEQUENCE OF ERECTION

The Contractor shall furnish the detailed scheme and sequence of erection to match with the project schedule and get the same approved by the Owner's Representative. All necessary co-ordination and synchornization shall be done with the Civil contractor where Civil works are not included in the scope of structural contractor at no extra cost so as to match with the project schedule.

17. PAYMENT

This clause shall apply to Item Rate tender only.

17.1. Payment for structural steel works shall be made on the basis of admissible weight in metric tons (determined as described in clauses 17.2 and 17.3 below) of the structure accepted by the Owner's Representative. The rate shall include supplying (as per supplying conditions given in the tender) fabricating, erecting in positions (at all levels & locations), testing/examining (excluding radiography only) of bolted and/or welded structural steel works of all types (including all built up/compound sections made out of rolled sections and/or plates) including all handling, transporting, storing, straightening if required, cutting, edge preparation, preheating, bolting and welding of joints (including sealing the joints of box sections with continuous welding), finishing edges by grinding/machining as shown, fixing in line & level with temporary staging and bracing and removal of the same after erection, grouting with nonshrink/ordinary grout as specified, preparation of fabrication and erection drawings, and erection schedule and getting them reviewed, preparation and submission of as built drawings, preparing the surfaces for painting, surface cleaning, wire brushing, removal of mill scale, dust, rust, oil or grease and applying the coat of red oxide zinc chromate primer or any other primer as specified after fabrication, return of surplus materials to Owner's Stores and material reconciliation in the case of materials supplied by the Owner as per relevant contract conditions etc. all complete for all the operations mentioned in the foregoing clauses.

17.2. The weight for payment shall be determined from the fabrication drawings and respective bill of materials prepared by the Contractor. The bill of materials shall be checked and approved by the Owner's Representative before making the payment. The Contractor shall prepare full scale template in order to supplement/verify the actual cutting dimensions where so directed by the Owner's Representative. The weight shall be calculated on the basis of BIS Hand Book wherever applicable. In case sections used are different from BIS sections, the manufacturer's Hand Book shall be adopted. No allowance in weight shall be made for rolling tolerances.

17.3. Welds, bolts, nuts, washers, shims, pack plates, wedges, grout and shop painting shall not be separately measured. The quoted rate shall be deemed to include the same.

17.4. The rate shall include all expenses related to safety and security arrangements during erection and all plants and tools required for fabrication, transportation and erection.

18. PAINTING AFTER ERECTION

18.1. General

18.1.1. The scope of painting after erection shall be at the sole discretion of the Owner's Representative and the Contractor shall obtain written instruction in this regard sufficiently prior to taking up any procurement of paint and execution of painting work after erection of steel structures.

18.1.2. The Contractor shall carry out the painting work in all respects with the best quality of approved materials (conforming to relevant BIS Codes) and workmanship in accordance with the best engineering practice. The Contractor shall furnish characteristics of paints (to be used) indicating the suitability for the required service conditions. The paint manufacturer's instructions supplemented by Owner's Representative's direction, if any, shall be followed at all times. Particular attention shall be paid to the following:

- Proper storage to avoid exposure and extremes of temperature.
- Surface preparation prior to painting.
- Mixing and thinning.
- Applicable of paint and the recommended limit on time intervals between consecutive coats.

18.1.3. Painting shall not be done in frost of foggy weather, or when humidity is such as to cause condensation on the surfaces to be painted.

18.1.4. Surface which shall be inaccessible after site assembly shall receive the full specified protective treatment before assembly.

18.1.5. Primers and finish coat paints shall be from the same manufacturer in order to ensure compatibility. Painting colour code shall be as per Appendix – 'B'.

18.2. Rub Down and Primer Application

The shop coated surfaces shall be rubbed down thoroughly with emery/abrasive paper to remove dust, rust, other foreign matters and degreased, if required, in accordance with IS:1477, as applicable, cleaned with warm fresh water and air dried. The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry.

Primer coat of red oxide zinc chromate primer (conforming to IS:2074) or any other primer, as specified, shall be applied by brushing/spraying over the shop coat in a manner so as to ensure a continuous and uniform film throughout. Special care shall be taken to cover all the crevices, corners, edges etc. The final primer coat shall be air dried and shall have a minimum film thickness of 25 microns or as per specifications (tolerance ± 10%) after drying, as applicable.

In case a different cleaning procedure and primer specifications are specified in the drawing/Tender, the same shall be adopted.

18.3. Final Pain Application

After the primer is hard dry, the surfaces shall be dusted off and one coat of synthetic enamel paint of approved colour and shade (conforming to IS:2932) or any other paint as per specification shall be applied by brushing/spraying so that a film free from "holidaying" is obtained. The colour and shade of first coat of paint shall be slightly lighter than the second coat in order to identify the application of each coat. The second coat of paint shall be applied after the first coat is hard dry. The minimum thickness of each film shall be 20 microns (± 10% tolerance) after drying.

In case a different type of paint and painting procedure are specified in the drawing/tender, the same shall be adopted.

18.4. Inspection and Testing of Painting Works

18.4.1. All painting materials including primers and thinners brought to site by the Contractor for application shall be procured directly from reputed and approved manufacturers and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates shall not be accepted.

18.4.2. The Owner's Representative at his discretion may call for additional tests for paint formulations. The Contractor shall arrange to have such tests performance including batch wise test of wet paints for physical and chemical analysis. All costs shall be borne by the Contractor.

18.4.3. The painting work shall be subject to inspection by the Owner's Representative at all times. In particular, the stage inspection will be performed and Contractor shall offer the work for inspection and approval at every stage before proceeding with the next stage. The record of inspection shall be maintained. Stages of inspection are as follows:

a) Surface preparations

b) Primer applications

c) Each coat of paint

18.4.4. Any defect noticed during the various stages of inspection shall be rectified by the Contractor to the entire satisfaction of the Owner's Representative before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work the Contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period, as defined in General Conditions of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat. The thickness shall be measured at as many locations as decided by the Owner's Representative. The Contractor shall provide standard thickness measuring instrument such as elkometer (with appropriate range for measuring dry film thickness of each coat) free of cost to the Owner's Representative whenever asked for.

18.5. Payment

Payment for painting of structural steel works shall be made on the basis of admissible weight in metric tons of the painted structures accepted by the Owner's Representative.

The rate shall include supplying and applying two coats of synthetic enamel paint or any other pain specified in the tender of approved quality and shade over a coat of red oxide zinc chromate primer or any other primer specified in the tender over one coat of shop primer already applied to structural steel works of all types/shapes at all levels, locations and positions including storage, surface preparation, degreasing, cleaning, drying, touching up of shop primer coat, providing temporary staging, testing etc. all complete to the entire satisfaction of the Owner's Representative.

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APPENDIX – 'A'
(Clause 12.4)

MAXIMUM PERMISSIBLE ERECTION TOLERANCES

A.	Columns	
1.	Deviation of column aces at foundation top level with respect to true axes.	
	i) In longitudinal direction	± 5 mm
	ii) In lateral direction	± 5 mm
2.	Deviation in the level of bearing surface of columns at foundation top with respect to true level	± 5 mm
3.	Out of plumb (Verticality) of column axis from true vertical axis, as measured at top:	
	i) Upto and including 30 m height	± H/1000 or ± 25 mm whichever is less.
	ii) Over 30 m height	± H/1200 or ± 35 mm whichever is less.
4.	Deviation in straightness in longitudinal & transverse planes of column at any point along the height.	± H/1000 or ± 10 mm whichever is less.
5.	Difference in the erected positions of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance.	± 5 mm
6.	Deviation in any bearing or seating level with respect to true level.	± 5 mm
7.	Deviation in difference in bearing levels of a member on adjacent pair of columns both across and along the building	± 5 mm
B.	Trusses	
1.	Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord.	± 1/250 of height of truss in mm at centre of span or ± 15 mm whichever is less.
2.	Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss.	± 1/1500 of span of truss in mm or ± 10 mm whichever is less.
3.	Lateral shift in location of truss from its true position	± 10 mm
4.	Lateral shift in location of purlin from true position	± 5 mm
5.	Deviation in difference of bearing levels of truss from the true level.	± 1/1200 of span of truss in mm or 20 mm whichever is less.
C.	Gantry Girders & Rails	

1.	Shift in the centre line of crane rail with respect to centre line of web of gantry girder.		$\pm[\frac{\{\text{web thickness (mm)}\}}{2}+2 \text{ mm}]$
2.	Shift of alignment of crane rail (in plan) with respect to true axis of crane rail at any point.		± 5 mm
3.	Deviation in crane track gauge with respect to true gauge		
	i)	For track gauge upto and including 15 m.	± 5 mm
	ii)	For track gauge more than 15 m.	± [5 + 0.25 (S-15)] Subject to maximum ± 10 mm, where S in metres is true gauge.
4.	Deviation in the crane rail level at any point from true level.		± 10 mm
5.	Difference in level between crane track rails (across the bay) at		
	i)	Supports of gantry girders	15 mm.
	ii)	Mid span of gantry girders	20 mm.
6.	iii)	Relative shift of crane rail surfaces (at a joining) in plan and elevation	2 mm.

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APPENDIX – 'B'
(Clause 18.2)

PAINTING COLOUR CODE

WHICH MAY BE ADOPTED FOR STRUCTURAL STEEL MEMBERS

1.	Gantry Girder & Monorail	DARK GREEN
2.	Gantry Girder & Monorail Stopper	SIGNAL RED
3.	Building Structural Steel Columns, Brackets, Beams, Bracings, Roof Truss, Purlins, Sidegirts, Louvers, Stringers	DARK ADMIRALITY GREY
4.	Pipe Rack Structure & Trestle	DARK ADMIRALITY GREY
5.	Chequered Plate (Both Faces)	BLACK
6.	Grating	BLACK
7.	Ladder	RUNGS – BLACK VERTICALS & CAGE RED
8.	Hand Railing	
	- Handrail, Middle Rail, Toe Plate	SIGNAL RED
	- Vertical Post	BLACK

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