



PTT Exploration and Production Public Company Limited

PTTEP Engineering General Specification

PEGS

Domestic Onshore Construction Specification (Mechanical and Piping – E205)

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1.0 PURPOSE

The purpose of this specification is to define the requirement for fabrication, erection, construction, nondestructive testing, painting, coating and wrapping. The content of specification is to achieve fitness of purpose, technical integrity and optimum cost for constructing PTTEP domestic onshore facility.

2.0 SCOPE

This specification defines the technical requirements for mechanical and piping construction. The specification is applicable to domestic onshore asset. For general requirement which not mention in this specification will be referred to international code and standard.

The scope of this document includes:

- Minimum requirements for the preparation and erection and setting of machinery and equipment.
- Minimum requirements for the welding of piping, pipeline, valves, fittings and piping appurtenances in accordance with all documents forming part of this specification.
- Minimum requirements for the fabrication, inspection, assembly and handling of piping and pipeline components in shop and field.
- Minimum requirements for the provision of nondestructive testing.
- Minimum requirements for precommissioning of piping systems and pipeline.
- The requirements for surface preparation and painting of process plant and associated equipment.
- Minimum requirements for thermal insulation inclusive of fastening materials and the installation.
- Minimum requirements for surface preparation, priming, and tape wrapping of pipes, pipeline and fittings.

3.0 DEFINITIONS

A number of different terms are commonly used to describe the work stages, processes, and approvals which take place during the early stages of a development. This can often be a source of confusion so the following section is intended to show the PTTEP preferred terminology as used in this document.

3.1 LANGUAGE

In this document, the words should and shall have the following meanings:

Should	Indicates a preferred course of action. Should is a non-mandatory word and is not forbidden, but use in the body of the text should be the exception. Where none mandatory terms are used, each paragraph within these clauses shall also have an associated commentary paragraph that provides the rationale for why the stated choices and modifications are appropriate and circumstance under which the stated choices and modifications might be different.
Shall	Indicates a course of action with a mandatory status. The term “shall” shall be used if a requirement is considered to be necessary to claim compliance with a PEGS document.

3.2 TERMINOLOGY

Terminology	Description
Approval	The authorization in writing given by the COMPANY to the Contractor to proceed the work without releasing in any way the Contractor from any of his obligations to conform with the technical specifications, requisitions, etc. The words “Approve”, “Approved” and “Approval” shall be construed accordingly
COMPANY	PTT Exploration and Production Public Company Limited and affiliates.
Contract	Means this signed Agreement together with the Exhibits and Annexes which are made part thereof, and any future amendment thereto.
Contractor	Per Contract: Contractor – ‘The contractor who is a PARTY to this Contract and where the context so requires including, Subcontractors utilized by Contractor for the performance of the WORK’
Manufacturer	The company or its sub-contractors selected by the COMPANY or the Contractor or the Supplier (as applicable) as the Manufacturer of the said material.
Purchaser	The company or the contractor or the Supplier (as applicable) which have placed the Purchase Order to the Supplier/Vendor/Manufacturer.
Purchase Order	The written order(s) awarded by COMPANY or Contractor to a Vendor/Supplier requesting to deliver all or any part of the GOODS at the specified date and referring to the terms and conditions of the Contract.

Terminology	Description
Supplier/Vendor	The company designed on the Purchase Order form or Contract as being the selected supplier of the said materials.
PPS	Designates Project Particular Specification detailing the particular requirements or the possible modifications to the present specification, based on the particular design conditions or the local legislation of the project.

3.3 COMMON ACRONYMS

Set out below in alphabetical order are common acronyms as found within this document:

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Material
ANSI	American National Standards Institute
AWS	American Welding Society
BS	British Standard
EN	European Standard
ISO	International Organization for Standardization
RT	Radiographic Testing
WPS	Welding Procedure Specification

4.0 REFERENCES

The reference documents listed below, including Industry Codes and Standards and COMPANY specifications, form an integral part of this Engineering General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published on the effective date of a contract.

The overall order of precedence of the applicable documents shall be:

1. Applicable Laws, Rules and Regulations of the country in which the system/equipment will be operated (if any);
2. Purchase Order/ Service Order/ Contract Documents (Only applicable for direct purchase by COMPANY);
3. Project Particular Specification (PPS), and relevant data sheet(s) if any;
4. COMPANY General Specification;
5. Codes and Standards in reference.

Any conflict between any of the Contract Documents, or between this specification and any other Contract Documents, shall be reported to COMPANY for decision. In such a case, and unless otherwise agreed or decided by COMPANY, it is understood that the more stringent requirement shall apply.

Exceptions to, or deviations from this specification are not permitted unless previously accepted in writing by COMPANY. For this purpose, requests for substitutions or changes of any kind shall be completed with all pertinent information required for COMPANY assessment. COMPANY's approval, nevertheless, will not, in any way, relieve the responsibility of the Contractor to meet the requirements of the industry Codes and Standards referred to and amended herein, in the event of conflict.

4.1 PTTEP INTERNAL REFERENCES

Internal documents applicable to this document are indicated in the table below.

Document Number	Document Title
PEGS-12060-ADM-006	Quality Requirements for Contractor/Vendor
PEGS-12139-CIV-022	Domestic Onshore Construction Specification - Civil section
PEGS-12139-COR-007	Domestic Onshore Particular Specification for Internal Coating of Pressure Vessels and Tanks
PPS-12123-COR-011	Painting of Onshore Structures and Facilities
PEGS-12060-INT-001	Inspection and Testing requirement
PEGS-12139-PIP-032	Domestic Onshore Project Particular Specification (PPS), Pipe support standard - Piping
PEGS-12139-PLR-024	Domestic Onshore Construction Specification (Pipeline-E206)

4.2 INTERNATIONAL STANDARDS

International standards applicable to this document are indicated in the table below i.e. ISO, IEC or ITU.

Document Number	Document Title
ISO 8501-1	Preparation of steel substrates before application of paints and related products
ISO 11699-1	Non-destructive testing – Industrial radiographic film – Part 1: Classification of film systems for industry radiography
ISO 12994	Protective coating
ISO 15614	Specification and qualification of welding procedures for metallic materials

4.3 CODES AND OTHER STANDARDS

Codes, standards and regional legislation applicable to this document are indicated in the table below.

Document Number	Document Title
ASME B1.1	Unified Inch Screw Threads
ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ASME B16.25	Buttwelding Ends
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B31.3	Process Piping
ASME B31.4	Pipeline transportation systems for liquids and slurries
ASME B31.8	Gas transmission and distribution piping systems
ASME BPVC Section V	Nondestructive Examination

Document Number	Document Title
ASME BPVC Section VIII Division 1	Rules for Construction of Pressure Vessels
ASME BPVC Section IX	Welding, Brazing and Fusing Qualifications
API 1104	Welding of Pipeline and Related Facilities
NACE SP0274	High-Voltage Electrical Inspection of Pipeline Coatings

5.0 SPECIFICATION FOR SETTING OF EQUIPMENT

Contractor shall ensure that the equipment data sheets are properly understood with regard to the shipping/packing details which indicate the required assembly effort. The detail of equipment setting will be specified in the equipment specification.

6.0 SPECIFICATION FOR WELDING OF PIPELINES AND PIPEWORK

This section defines the responsibilities and describes the systems for guaranteeing that all welding carried out at COMPANY facilities will be in accordance with approved and qualified welding procedures by qualified welders and/or welding operators in compliance to the requirements of the ASME Boiler and Pressure Vessel Code Section IX or ISO 15614 or design code as applicable. It also covers the minimum requirements for the welding of valves, fittings and piping appurtenances in accordance with the particulars herein and the drawings and documents forming part of this specification.

Standards of acceptability shall be as follows:-

- a. Pipes and fittings designated to be within COMPANY perimeter fences shall comply to “Process Piping” ASME B31.3 (latest edition) except where more stringent COMPANY condition are required by this specification.
- b. Pipelines and fittings designated to be outside COMPANY perimeter fences shall comply to “Pipeline Transportation Systems for Liquids and Slurries” ASME B31.4 (latest edition) and “Gas Transmission and Distribution Piping Systems” ASME B31.8 (latest edition) except where more stringent COMPANY conditions.
- c. Pipes and fittings designated as high pressure by the COMPANY shall comply to ASME B31.3 chapter IX (latest edition) except where more stringent COMPANY conditions are required by this specification. High pressure designation shall apply to all lines 6” and over, rated ANSI class 600 upwards and under 6” rated ANSI class 900 upwards, all longitudinal welds, and all lines with 12.7 mm (1/2”) and greater wall thickness.
- d. Pipes and fittings intended for steam purposes shall comply with the requirements of ASME B31.1, Power Piping or ASME code section 1 Power Boilers, latest editions, as applicable, except where more stringent company conditions are required by this specification.

6.1 RESPONSIBILITIES

The COMPANY shall have overall responsibility to ensure that codes and standards are established for the design, construction, inspection and the testing for all part of fluid handling systems installed on COMPANY facilities which are subject to pressures within the scope of the applicable codes, and that standards are rigorously adhered to.

Design Engineering is responsible to designed which code is applicable for each part of the fluid handling systems.

Project Engineering, or Maintenance Engineering are responsible to inform contractors by tender documents which standards and codes shall apply at COMPANY facilities. Those contractors are capable of meeting all COMPANY standards. Engineering are responsible to accept, on behalf of the COMPANY, the completed projects when they comply to COMPANY requirements.

Quality Assurance are responsible to ensure that all inspection, examination and testing of fluid handling system, installed within the scope of this section, meet with all the requirements of the applicable code and COMPANY standards. QA shall ensure that only qualified welding procedures are used by qualified welders on COMPANY facilities. Documented procedures shall be established to record that all welding completed on COMPANY facilities comply with the requirements of this specification.

The Contractor is responsible to comply with all the terms of the contract documents.

The Contractor shall keep documented control for all construction, examination, inspection and testing of pipelines and associated equipment installed on or at COMPANY facilities under the terms of the project contract.

Welding Procedures and Welders

- a. Prior to commencing the work, Contractor shall prepare and submit for approval to COMPANY an exact description of the proposed welding procedures.
- b. Contractor shall certify that all proposed welding procedures are qualified to the applicable codes and standards and as set out in qualification of welding procedures. The welders are qualified to use those procedures, using only materials stipulated by the certified procedures. Contractor may develop his own welding procedure using the procedure descried in 'Welding section 6.0' of this specification. However, he shall be required to qualify this method as if it were his own.
- c. Procedure and welder qualification test welds shall be inspected and tested in accordance with 'Qualifications of Welding Procedure'.

6.2 CODES, STANDARDS AND SPECIFICATIONS

6.2.1 WELDING PROCEDURES

Welding Procedures shall generally comply to the requirements of ASME Boiler and Pressure Vessel Code, Section IX, latest edition with addenda or ISO 15614 or design code as applicable. Procedures qualified to earlier editions of the codes and standards will be permitted if they have been proved acceptable by the COMPANY. Renewal of qualification

shall be effected under conditions as stated under QW-322, Section IX of the ASME Boiler and Pressure Vessel Code.

For pipeline material groupings in ASME B31.4 and B31.8 shall comply with API 1104.

GENERAL:-

- a. Contractor shall have the applicable standards available on site. In case of any discrepancy between this specification and the standards, the most stringent shall be applied.

Test coupons shall be made from pipe material within the proposed material grouping expected for any project procedural test positions shall be completed as follow :-

- a. For pipeline less than 6" NPS progression shall be up-hill and the pipe shall be orientated in the 6G position.
- b. For pipeline equal to or greater than 6" NPS progression shall be for root run up-hill for fill and cap down-hill the pipe shall be orientated in the 5G position.

Acceptance standards for the qualification of Welding Procedures shall be the same as those required for production welds.

Acceptance standards for the qualification of the welders shall comply to the requirements of the designated Code.

6.2.2 QUALIFICATION OF WELDING PROCEDURES

All welds intended for qualification purposes shall be made in Thailand under simulated field and environmental conditions and witnessed by COMPANY Qualification of Welding Procedures

Procedure qualification tests shall be made and approved prior to production welding. The test shall be carried out in accordance with Section IX of the ASME Code. These tests shall be carried out in Thailand under realistic field and environmental conditions and witnessed by COMPANY.

6.2.3 RECORDS

The details of each qualified procedure shall be recorded. This record shall show complete results of the procedure qualification tests. Forms similar to the sample forms in Section IX of the ASME shall be used.

6.2.4 REQUIRED TESTS

Visual and radiographic examination shall be made before destructive testing and the test result must comply with 6.8.2 of Article 6.9 'Standards of Acceptability' in this Specification.

Destructive testing, as per Section IX of the ASME Code, shall only be carried out on test pieces which have first passed nondestructive testing.

Charpy impact tests shall be according to the designated code requirements or, as specified by design Engineering.

The welding procedure shall be qualified only if all coupons and tests are approved by COMPANY.

6.2.5 QUALIFICATION OF WELDERS

Welder qualification test welds shall be made on any one of the grades and sizes of pipe to be used in the WORK. All materials required for qualification tests shall be provided by Contractor.

For line pipe 10" inch and above, each welder shall be required to make at least half of one complete circumferential weld with the axis of the pipe in the horizontal fixed position (5G), using welding procedure which has been qualified in accordance with 'Qualification of Welding Procedures' in this Specification.

Two welders shall weld simultaneously on the same test weld, starting top side. For the smaller piping and branches 6" and smaller each welder shall be required to make a complete weld, using the uphill technique in the 6G position (ASME Section IX), 45° to the horizontal.

COMPANY will qualify welders by visual examination, radiographical examination and bend test of the weld. The test results shall conform to qualification of welding procedures and standards of acceptability respectively.

The test results shall be submitted to COMPANY and no welder shall be permitted to perform welding until written notification is given. A form similar to sample form in Section IX of the ASME Code shall be used.

A welder who has successfully completed weld qualification tests in accordance with qualifications of welding procedures in this Article shall be qualified within the limits of variables described in Paragraphs QW-304 of Section IX of the ASME Code. If any of these essential variables are changed the welder shall be re-qualified using new procedure.

Contractor shall prepare weld history sheets as follows:

Section

Weld No./Welder Identification

Preheat

Film No.:

Result

2nd Repair Radiogr. Film No.:

Result

Cut-up Radiogr. Film No.:

Result

Ultrasonic Test

Result

Magna Flux

Test Repair No.:

Remarks

Contractor shall give each weld a number and mark these numbers on the drawings and on the pipe adjacent to the weld. This identification system shall be approved by COMPANY.

Each welder shall identify that portion of each weld on which he has worked with this symbol number marked with a weatherproof crayon.

Each stringer bead welder shall put his symbol near the top of the side he worked on. The remaining welders shall put their symbols in sequence below the preceding welders.

6.2.6 ALIGNMENT

Each pipeline/piping/fitting shall be aligned prior to being welded to the preceding pipeline/piping/fitting to form continuous section of pipe, fittings and appurtenances. Welds joining the sections of the piping, valve installations or similar welds classed as tie-in welds shall be tacked in position.

For line up before welding, line up clamps shall be used. For pipe to pipe connections of pipe diameter of 10" or more, pneumatic or hydraulic internal line up clamps may be used subject to COMPANY approval. For tie-in welds, pipe to valve, fittings and other welds where internal clamps cannot be used, external hydraulic or mechanical clamps shall be used.

Misalignment (high-low) exceeding 2.0 mm. shall not be allowed.

For pipeline, misalignment to the centerline of the string shall not exceed 50 mm. per 12 meters (double random), except as allowed by design.

Seam orientation of welded straight pipe shall be elected to ensure that, at the circumferential welds, two successive longitudinal weld seams shall be staggered by 30 degree or twice the wall thickness of the thicker pipe whichever is more. All longitudinal weld seams shall be located on the top side of pipe (at least 45° from bottom of the pipe) when the piping system is erected.

The alignment shall be such that no circumference welds occur within 0.5 meter from the centerline of sleepers/ supports.

6.2.7 PREHEATING

The preheating shall comply to the requirements of the designated Code and COMPANY's requirements as follows :-

For piping welding, the minimum preheat temperature for material of various P-number are given in ASME B31.3 table 330.1.1. The thickness intended in table 330.1.1 is that of the nominal thickness of the thicker component. Higher minimum preheat temperatures may be required by the WPS or by the engineering design.

The preheat zone shall be at or above the specified minimum temperature in all directions from the point of welding for a distance of the larger of 75 mm (3 in.) or 1.5 times the greater nominal thickness.

The base metal temperature for tack welds shall be at or above the specified minimum temperature for a distance not less than 25 mm (1 in.) in all directions from the point of welding.

For pipeline welding, the preheating which has been qualified in the applicable WPS shall be applied.

6.2.8 PREPARATION OF JOINTS FOR PIPE, VALVES AND FITTINGS, ETC.

Each beveled edge shall be either cleaned by grinding or with a power driven steel wire brush to bright metal appearance. The cleaning shall extend at least one centimeter from the edge on both the external and internal surface.

Burrs or small nicks in the beveled edges or excessive rust and scale shall be removed using a disc power grinder.

Repairing of damaged pipes, appurtenances and bevels by hammering and/or heating is not allowed.

Cleats welded to pipe to assist construction shall be removed by flame cutting, and ground smooth.

Unacceptable surface defects or defects which in the opinion of COMPANY cannot be repaired satisfactorily shall be removed by field cutting using oxyacetylene or mechanical cutting and beveling machine.

The flame cut edges shall be ground or filed to the dimensions, smoothness and regularity of the original factory bevel or as may be required by Contractor's welding procedure.

Immediately prior to line-up, Contractor shall inspect each pipe and fitting along its entire length on both internal and external surface for nicks, dents, gouges, laminations and other surface defects. He shall satisfy himself of the suitability of each pipe in regard to visual defects and shall accept all responsibilities thereafter.

Root gap spacing :-

- a. The root gap spacing between beveled ends of pipe shall be maintained as approved in the Welding Procedure Specification.

- b. Where fitting or equipment design call for close proximity COMPANY approval must be obtained prior to commencement of the work.

6.2.9 WELDING

For 10 inch piping and below welding shall be carried out by one welder using a technique in accordance with Section IX of the ASME Code.

Stringer beads for pipe larger than 10 inch shall be made by two or more welders. They shall work simultaneously on opposite sides of the pipe. Line-up clamps shall not be removed until the first weld pass is completed. No movement of pipes may occur before finishing the hot pass.

Second pass (Hot Pass)

The second pass shall be deposited immediately after deposition of the first pass but not before the first pass has been ground and cleaned and before the joint has cooled below 90° C.

Filler and Finish Weld Pass (3rd, 4th, etc.)

- a. The filler and finish passes shall be deposited with 4 or 5 mm electrodes, using as many welders as required to maintain the desired progress.
- b. All slag and excessive weld build-up shall be removed before deposition of each succeeding weld pass.
- c. All weld passes shall be completed around the entire circumference before commencing the succeeding weld pass. The starts and stops of weld beads from weld pass to weld pass shall be staggered. All slag and scale shall be removed by power tools from each bead for visual inspection immediately after deposition.
- d. After completion of the finish weld pass, the completed weld shall be thoroughly cleaned of all slag and weld spatter.
- e. There shall be no other welding on the pipe, except those required to deposit the circumferential welds and to attach appurtenances as shown on applicable construction drawings. Arcing on the surface of the pipe outside of the beveled ends shall be prohibited.
- f. The finish welds shall have a consistent continuous bead, 0.5 mm to 2.5 mm above the surface of the pipe. No undercutting will be accepted.

No section of pipe in which only 'stringer' and 'hot pass' beads have been applied shall be left at end of any working day.

For pipeline welding, shall be carried out by using a technique in accordance with API 1104.

6.2.10 STRESS RELIEVE

All welds in pipework shall be stress relieve to compliance with the latest edition of ASME B31.3. For pipeline work, the stress relieve shall comply to the latest edition of ASME B31.4 or ASME B31.8 which applicable to the specific design codes.

6.2.11 WEATHER PROTECTION

If, in the opinion of COMPANY "adverse weather conditions" demand protection of welding, an effective weather shelter shall be placed over the weld to be made so that the quality of the weld is not impaired. Contractor must have such sufficient purpose build weather shelters available to enable work to proceed unhindered.

6.3 QUALITY CONTROL OF PRODUCTION WELDING

A copy of the welding procedure(s) in use at any time at any location shall be displayed at the location in a protective plastic envelope for the reference of Supervisors and Inspectors.

When work is undertaken on site it shall be subject to a 'Permit to work' system. A copy of the permit must be displayed at all times that welding or preparatory work is in progress.

Work on pipework which has been in service shall be cleaned out in accordance with Permit to Work and Contractor to ensure timely request that all necessary actions are implemented in time to enable work to proceed in accordance with the program.

The nondestructive testing of welds will be carried out under the direct control of COMPANY. The company representative (or his nominee) shall have the right to inspect any aspect of the work at the fabricator's yard and in the field at any reasonable time during fabrication, testing or completion.

Welding will be visually inspected by COMPANY during each deposition and after completion. All welds shall be free from under-cut, spatter, craters, cracks and other surface imperfections. Weld reinforcement shall be of regular contour, even weld ripple and indicative of good workmanship. Contractor's Quality Control shall be responsible to ensure completeness of all welds prior to request for non-destructive testing. Nondestructive testing shall be performed on completed welds only.

Projection of weld metal into the pipe bore at welded butt joints shall not exceed 1.5 mm for pipe 8 in. and smaller or 3 mm for larger pipe. Excessive projections on accessible joints shall be removed. Welds attaching welding neck orifice flanges to pipe shall be ground smooth on the inside.

Fillet welds will be checked for dimensional tolerance and form. It is required that fillet welds shall develop a minimum full throat thickness. Each leg of the deposition weld shall have equal length. The principle dimensions of each fillet weld shall be checked using an approved fillet weld gauge.

The finished weld contour shall be uniform, with the toe or edge of the weld merging smoothly into the base material. Butt welds shall have a weld cap built up gradually from the toe or edge toward the center of the weld.

Contractor shall schedule his work in such a manner as to permit the radiographic inspection of completed welds not later than the day following the completion of the weld.

Welds for pipelines and fitting designed to comply with section 6.0 (a) shall be 10% (ten percent) radiographed, in a random manner to include 10% of each welders work, and 10% of each different procedure. The joints to be tested will be selected by the COMPANY nominated inspector. Lines containing air and drains to atmosphere will not be radiographed. The company representative can increase the percentage of radiography up to 100% for systems of specific importance.

This radiography shall be performed at random on a 10% basis progressively throughout the entire job and for every thickness. Parent metal shall be considered the same thickness when the nominal thickness difference does not exceed 3 mm. At least one of each type and position of weld made by each welder shall be examined.

Failure of a weld to pass radiography shall automatically result in 100% examination of all welds executed by the welder since his last weld passed inspection. Such future welds as are deemed necessary by the inspector shall also be examined to ensure continuation of consistent performance or early disqualification.

In order to prevent stress cracking after examination radiography shall not be performed unless the welding has returned to ambient condition.

Branch connection attachment welds shall be examined by magnetic particle or dye penetrant methods at the discretion of the inspector.

Welds for pipelines, pipings and fittings designated to comply with section 6.0 (b, c and d) shall be 100% [one hundred percent] radiographed.

Branch connection attachment welds shall be examined by magnetic particle or dye penetrant methods when a single radiographic technique gives no satisfactory result.

Welds which cannot be radiographed because of location or orientation shall be examined by Ultrasonic Testing. If the Ultrasonic Testing is neither not applicable then it shall be examined by Magnetic Particle Inspection (MPI). Results of the test shall be reported.

Welds required to be 100% radiographed shall conform to ASME B31.8, or ASME B31.3 section IX or ASME B31.1, as applicable Weldments shall be rejected if any of the following imperfections are indicated :-

- Any indication characterized as a crack, lack of fusion or penetration.
- Any undercut at the toes of the root or capping runs.

- Slag, indications which are elongated (where the length of the indication is more than three times the width) and have a length greater than 3.2 mm or $1/2t$ (t = material wall thickness) whichever is the lesser. Total cumulative length of slag inclusions shall not exceed $4t$ in 150 mm of weld length.

Burn through areas shall be repaired. Repaired areas shall be radiographed and show acceptability.

Spherical or elongated piping porosity shall not exceed 3 mm. maximum dimension or $1/4t$, whichever is the smallest.

Cluster porosity shall not exceed that shown in the acceptance charts of API 1104 figure 19.

Hollow bead (see API 1104 section 9.3.9.4) shall not exceed a total length of 13 mm in any 25 mm, the maximum dimension of any single hollow bead shall be 6 mm.

Tungsten inclusions are not permitted.

Welds required to be 10% radiographed [sub para 6.3] shall conform to ASME B31.3 applicable sections. Weldments shall be rejected if any of the following imperfection are noted:-

- Any indication characterized as a crack, lack of fusion or penetration.
- Any undercut greater than 0.8 mm deep or 12% of the material thickness, whichever is the lesser.
- Any undercut less than or equal to 0.8 mm or 12% of the material thickness whichever is the lesser, shall have a cumulative length not greater than 50 mm in any 300 mm of weld.
- Linear type discontinuities shall not exceed a length of 6 mm in material thickness less than 19 mm or $1/3t$ for material greater than 19 mm, to a maximum length of 19 mm, whichever is the lesser.

ASME B31.3 table 341.3.2 acceptance criteria for welds shall not be exceeded.

Tungsten inclusions are not permitted.

If a weld fails inspection by NDT techniques, as described above, then the welder who carried out the weld will be required to repair the weld after COMPANY's approval of repairing procedures. If the weld subsequently proves to be unsatisfactory, the welder will require to be requalified.

Except for pipework being shop fabricated, all sections of tacked or welded pipe shall be closed at night to prevent animals or foreign matter entering such sections.

For tie-in weld Contractor shall follow the following steps:-

- After completion of each pipeline/piping fabricated sections prior to welding to existing pipework Contractor shall run cleaning pig propelled by compressed air through the

string to assure removal of loose rust, scale, sand and all other extraneous materials to the COMPANY's satisfaction.

- The tie-in welds made after hydrostatic testing shall be considered as “guarantee welds” and subjected to 100% visual examination (after each weld pass) and, on completion of the weld 100% radiographic test. The number of “guarantee welds” shall be the practical minimum required.

6.4 CONSTRUCTION AND EXAMINATION

A copy of the welding procedure(s) in use at any time at any location shall be displayed at the location in a protective plastic envelope for the reference of supervisors and inspectors.

Contractor appointed by the COMPANY shall have trained quality control staff experienced in the examination of welding.

Contractor shall prepare and submit to the COMPANY for approval an inspection program applicable to the project. This program shall specify the examinations to be carried out by Contractors personnel. It shall also indicate the inspections to be performed or witnessed by COMPANY appointed Inspectors.

Examinations completed by Contractors shall be recorded and submitted for review by COMPANY QA and retained for record purposes for period of 2 years.

Inspections by COMPANY personnel shall be classed as “hold point”, beyond which work cannot proceed until written acceptance is received by the Contractor from the COMPANY.

Layout and alignment of piping and pipelines shall comply to the applicable code, in addition to which the following standards apply:-

- No packing, shimming or wedging shall be permitted to correct imperfect alignment unless specifically approved by the COMPANY.
- Fitted-up bolts and drift-pins shall not be used to correct misalignment if they shall cause a strain on finished work.
- Minimum spacing between girth welds shall be not less than six [6] times the maximum wall thickness of the materials to be joined or 50 mm, whichever is the greater.
- Socket weld fittings are not allowed in hydro-carbon fluid service or unless specified in project specification.
- Seal welding of threaded connections is not allowed.
- All welds, except fillets, shall be full penetration.
- Mitered bends are not allowed.
- The use of backing rings is not allowed.

- Beveled edges, complying with ASME B16.25, shall be ground to bright metal to remove any damaging grooves or heat affected zone caused by arc or cutting.
- Misalignment of the connecting pipe (or fitting) internal diameters shall be limited to an off-set of 1.5 mm or 1/4t whichever is the lesser. To achieve these fittings may be machined or counterbored or tapered to suit. Tapers must not exceed 1:4. The finished minimum wall thickness of the machined fitting shall not be less than that allowed by ANSI rating.
- Misalignment of centerlines of any string shall not exceed 1:240 (50 mm in 12,000 mm).
- Weld cap or root penetration contours shall blend gradually to the surface of the adjoining material, sharp shoulders shall be avoided. Weld preparation grooves for full-penetration welds shall be completely filled. Reinforcement on each face of the weld shall be permitted to ensure that the grooves are filled, the thickness of the reinforcement on each face of the weld shall not exceed :-

<u>Joint Thickness</u>	<u>Maximum Reinforcement</u>
$\leq 6 \text{ mm}$	$\leq 1.6 \text{ mm}$
$6 \text{ mm} < \leq 12.7 \text{ mm}$	$\leq 3.0 \text{ mm}$
$\geq 12.7 \text{ mm}$	$\leq 4.0 \text{ mm}$

- As-welded surfaces are permitted, however the surface of welds shall be sufficiently free of coarse ripples, grooves, overlaps and abrupt changes to permit proper interpretation of radiographs or other non-destructive examinations.
- See APPENDIX 1 of this specification for fitting dimension [tolerances].

6.5 INSPECTION AND TESTING

Inspection and testing of completed systems shall comply to the requirements of the applicable code and COMPANY standards.

At agreed “Hold Points” COMPANY appointed inspectors shall witness any specified inspection or testing, and confirm acceptance by the COMPANY in writing to the Contractor.

6.6 EQUIPMENT

Only DC welding machines with electrodes connected to positive terminal shall be used. Contractor shall tabulate proposed amperages in his welding procedures.

Welding machines shall be maintained in good order. Contractor shall appoint a person to make random checks on all machines in use, to verify that the parameters set forth in the qualified weld procedures are within tolerance. These random checks should ensure that each

machine is checked at least once per week. The check inspections shall be recorded and the records made available for review by the COMPANY.

All welders shall be identified by unique number. This number shall be marked on any weldment whereon the welder has performed. It shall be shown on radiographs of the weldment.

Contractor shall maintain a welders log on a daily basis. This log shall identify the string where the welder has worked and the procedure used.

Contractor shall make available to the welders (in a language understood by the welder) the instructions of each qualified welding procedure that he is required to use.

Each welder shall have an identity card which shall show the limits of his performance qualifications. These should be carried and be available for review at all times the welder is employed on COMPANY facilities.

6.7 STORAGE AND CARE OF CONSUMABLES

Consumables used by the Contractor shall be ordered to comply with AWS/ASTM standards. They shall be approved by an internationally recognized Inspection authority, e.g. L.R, ABS, DNV.

The receiving, storing, issue and return of un-used consumables shall be controlled by the Contractor with documented quality control system, acceptable to the COMPANY.

All electrodes used for production welding shall be of the same manufacturer, size, type and grade as used for the welding procedure and welder qualification test. Contractor shall report any changes to Company in advance. Contractor shall do the retest of WPS and WQT upon request by Company's surveyor to cover the change.

Consumables shall be stored in the manufacture sealed containers in a low humidity store as recommended by the manufacture.

When removed from the manufactures hermetically sealed containers, low hydrogen (basic coated) electrodes shall be stored in a holding oven held at a temperature recommended by the electrode manufacturer (or 150°C if not specified) for at least 1 hour before issue.

When issued, low hydrogen electrodes shall be put in heated quivers and maintained at a temperature not less than 70°C.

The issue of electrodes shall be limited to that necessary for a 5 hour shift. Any unused electrodes which are undamaged may be returned to store on completion of the shift. Returned electrodes shall be re-baked, the remaining unused electrodes in the quivers shall be placed in a drying oven and held at 250-300°C for four hours or a recommended by the manufacturer if at a higher temperature, and then transferred to a holding oven prior to reissue.

Partly used and damaged electrodes or have been in direct contact with water shall be scrapped and removed from work sites.

Each welder is responsible for the care of consumable which are issued to him.

Contractor shall have proper system of identification for re-baked/reissued welding consumables.

6.8 ACCEPTABILITY AND REPAIR OF WELDS

The acceptance requirement for repair or cut out of defective welds shall be based on the standards set forth in 'Standards of Acceptability' in section 6.8.1.

6.8.1 STANDARDS OF ACCEPTABILITY

Any weld which, as a result of radiographic examination, exhibits imperfections greater than the limits stated in the ASME B31.4 for gathering and flowlines and/or API standard 1104 section 9 for the other work and as indicated in sub section 6.3 of this specification if not superseded in this Article, shall be considered defective and shall be so marked with an identifying paint marker prior to repair by Contractor.

6.8.2 EXCESSIVE STRINGER BEAD DEPOSITS

Any individual instance of excessive stringer bead deposition shall not exceed 4 mm and shall not be longer than 20 mm.

The total length of excessive stringer bead deposits in any 300 mm length of weld shall be separated by at least 150 mm of sound weld metal.

6.8.3 CRACKS

Welds containing cracks regardless of size or location shall be unacceptable.

6.8.4 REPAIR WELDING

Welds which do not comply with the Standards of Acceptability shall be repaired in accordance with the approved repair procedure.

Contractor shall be responsible to repair the defective welding at their own expense.

In all cases where repairs are authorized and approved by COMPANY repairs shall be carried out in accordance with Section IX of the ASME Code. All repairs shall be carried out the day after examination or earlier.

All repaired welds shall be re-examined.

For 3 1/2 Ni materials and duplex / super duplex stainless steels, only one attempt of repair is acceptable in the same area. Should a defect occurs on a previously repaired weld area, the whole weld shall be cut and re-welded after restoring the base material to its initial condition (i.e. remove heat affected zones, damaged surfaces, etc.).

For all other welds, only two repairs shall be permitted on the same area of a given weld; should a third repair become necessary, then the whole weld shall be cut and re-welded as per above paragraph. This rejection will be considered a non-conformity and is to be reported to COMPANY.

7.0 SPECIFICATION FOR THE INSTALLATION OF PIPEWORK

This specification covers the minimum requirements for the fabrication, inspection, assembly and handling of piping components in shop and field.

This specification may be used with individual specifications and/or drawings. If conflict exists, the individual specifications and/or drawings shall govern.

7.1 CODES AND STANDARDS FOR INSTALLATION PIPEWORK

All piping shall be fabricated, inspected and assembled in accordance with ASME B31.3 Process Piping, Chapters V and VI.

Welding qualifications shall comply with the requirements of ASME Boiler and Pressure Vessel Code, Section IX.

NDE procedure shall be performed per ASME Section V, the acceptance criteria will follow the applicable construction code.

Threads shall be in accordance with ASME B1.20.1.

Butt weld end preparation for pipe, valves and fittings shall be in accordance with ASME B16.25.

Latest editions of all codes and standards shall be used.

7.2 EXTENT OF FABRICATION

The extent of fabrication will be detailed on approved piping drawings and/or isometrics and will include any attachments shown e.g. structural shapes for pipe supports, guides and anchors.

Special care shall be taken to ensure that the materials and components used are the same as those called for on the drawings and specifications.

COMPANY's approval shall be required for any deviations or substitutions from the materials specified.

7.3 FABRICATION

There shall be no fabrication without an approved welding procedure to which the welder is qualified.

Pipe cutting shall be accurate and smooth, true to template and beveled.

The dimensions shown on drawings and isometrics do not allow for necessary weld gaps.

Dimensional tolerance for finished fabricated piping shall at least conform to Appendix 1.

Minimum spacing of circumferential welds shall not be less than six times the pipe wall thickness between the centerline of the welds, or 50 mm whichever is the greater.

Socket weld fittings are not allowed in hydrocarbon service or unless specified in project specification. When socket weld fittings are used in other services there shall be a 1.5 mm gap between the male pipe ends and the internal socket to avoid excessive weld stress by bottoming in the socket.

Seal welding of thread connections is not allowed.

All branch connections shall conform to the piping material specification and isometric drawings and shall be joined to the header with full penetration welds.

Pulled bends shall not be used for pipe diameters of 2" and larger. The centerline radius of pulled pipe bends shall be at least five times the nominal pipe diameter.

Galvanized pipe shall not be bent, or welded. Otherwise, piping requiring bending or welding shall be repaired as appropriate.

Miter bends shall not be used.

Slip on flanges shall be positioned so that the end of the pipe is recessed from the flange face a distance equal to the pipe wall thickness plus 3.0 mm. The seal weld shall be applied so that the flange does not need facing.

For field fit up a minimum of 100 mm shall be left on piping. The division of isometrics into spool and the provision of field fit up shall be such as to provide the maximum ability to correct minor differences.

7.4 WELDING AND QUALITY CONTROL

Welding specifications and quality control of welds shall refer to section 6.3, Quality control of production welding.

7.5 TESTING

The pipework shall be subjected to hydrostatic testing in accordance with section 10 Specification for Pressure Testing of Piping Systems and Equipment, in this specification. This testing shall be carried out after erection unless otherwise specified.

7.6 PAINTING AND WRAPPING

For all pipework shall after fabrication and heat treatment be cleaned externally and internally to remove all loose scale, weld spatter, sand and other foreign materials, using mechanical means as required.

Tape wrapping pipes and fittings which are to be buried shall be carried in accordance with the specification. The painting shall be done in accordance with Section 11, Specification For Painting, in this specification.

For all pipework which specified by the COMPANY to be painted, the painting shall be done in accordance with Section 11, Specification For Painting, in this specification.

7.7 PREPARATION FOR TRANSPORT

Flange gasket contact surfaces shall be protected by coating with a removable rust preventative and a wooden, metal or plastic blank covering the full machined surface.

Threaded connections shall be fitted with a steel plug, external threads shall be greased and fitted with a steel cap.

Plain or beveled ends shall be closed with a metal or plastic cover to protect the inside of the pipe.

Specific applications (compressor piping, etc.) which require exceptional internal treatment may require internal inhibitors and sealing. Particular specifications would be provided by Vendor.

7.8 IDENTIFICATION

After application of the primer each fabricated spool shall be clearly marked in white paint with the piece number. This number shall be the line number and piece number as shown in the piping drawings and/or isometrics. An arrow indicating direction of flow shall also be painted on.

The number shall be applied in large letters, with a minimum size of 50 mm, on at least one location near the end or on lengths exceeding 5 m near both ends.

Permanent marking of pipework by stamping is not permitted.

7.9 HANDLING

All piping components shall be stored off the ground on temporary racks until fabricated.

All fabricated piping is to be stored off the ground until finally installed.

Fabricated piping shall be handled by nylon slings or y hand. The use of hooks, wire ropes or chains is not permitted.

When pipe sections are moved from one place to another to be installed, care shall be taken not to bend or over-strain long sections.

All closures and protection measures shall be reinstated after prefabrication and maintained until actual installation to maintain integrity and prevent handling/accidental damage.

7.10 ASSEMBLY AND ERECTION

There shall be no welding without an approved welding procedure to which the welder is qualified.

All piping shall be assembled and erected in accordance with Approved for Construction Drawings only. During erection and field installation the piping has to be supported on permanent pipe supports. The use of temporary pipe supports shall be kept to a minimum.

Special attention shall be given to ensure that in-line items such as orifice flanges, spectacle blinds, control valves, check valves, etc. are installed and orientated correctly as indicated on the drawings/isometrics.

There shall be no field attachments to stainless steel or alloy piping and vessels without COMPANY's approval of a welding procedure.

Contractor shall ensure that all components of piping systems shall be free of internal loose rust, scale, soil and debris before assembly.

Flanged connections shall be made up as follows :-

- Remove protective grease from flange gasket faces, check for damage and position for bolt up, Flange faces shall be parallel and aligned in horizontal or vertical planes. Position gasket and install bolts and nuts to hand tight.
- Flanged connections require extreme attention in assembly to ensure uniform loading on the gasket surfaces. Regardless of the method selected for flange joint assembly, i.e. just by hammering or by gauge between flanges, torque wrench or bolt elongation, it is important to tighten uniformly and not prematurely set the gasket. Hand tighten all nuts first, then gradually tighten opposite nuts on the joint. Do not bring a single nut to full tightness before the others have been carefully stepped up toward this final position.
- Flanged connections located close together in a piping system shall all be made up by hand before full tightening.
- Bolt and stud threads shall protrude a minimum of two full thread pitches past the nut. Thread protrusion of more than 5 thread pitches shall be corrected by shortening the bolts, Uniformity of bolt protrusion through the nuts of stud bolts shall be carefully observed.
- On completion of flanged connection, thread protrusion and nuts shall be protected by grease.

Threaded connections are not allowed in hydrocarbon service, except for connections to instrumentation and in vents, drains and sample connections downstream of a flanged valve.

Threaded connections shall be sealed with Teflon Threading Tape for operating temperatures up to 230°C.

Threaded connections shall never be seal welded.

8.0 SPECIFICATION FOR THE FABRICATION AND INSTALLATION OF PIPE SUPPORT

8.1 GENERAL

In general Pipe supports can be subdivided in the following groups:-

a) Fixtures

Fixtures consist of elements which transfer loads from pipes and/or structural attachments to the supporting structure or equipment. They include hanging type of fixtures such as hanger-rods, spring-hangers, sway braces, counter weights, turnbuckles, struts, chains, guides, anchors etc., and bearing type fixtures such as saddles, bases, rollers, brackets and sliding supports.

b) Structural Attachments

Structural attachments include elements which are welded, bolted or clamped to the pipe such as clips, lugs, rings, clamps, clevises, straps, dummies, pedestals etc.

c) Supporting Frames

The structural supporting frames consist of structures, built from steel sections and plate, to transfer pipe loads from the fixtures and/or structural attachments to the foundations. The shape of this type of pipe supports can vary from simple T-post to complicated spatial steel frames.

d) Concrete Pipe sleepers.

Pipe sleepers vary in shape and purpose, some are only installed to transfer the dead weight of the pipe while other sleepers are used as an anchor. The design of the ordinary sleepers will allow or horizontal reaction forces up to 400 Kg per meter sleeper length. (This is suitable for friction forces and small anchors).

In general all the pipe support elements are detailed on drawings in such a way that a proper fabrication is possible. All materials and fabrication have to be fully in accordance with this specification and the relevant drawings.

Unless otherwise specified, pipe support elements as mentioned under pipe support group (c) and (d) have to be fabricated and erected in accordance with the civil specification for earth and concrete works and the civil specification for structural steelwork and cladding.

Coding for pipe support elements as mentioned under pipe support group (a) and (b) is included in the standard for pipe supports in which only standard details have been adopted.

Coding for pipe support elements as mentioned under pipe support group (c) and (d) is arranged as follows:-

- SL = standard concrete sleeper

- AS = anchor sleeper
- PS = special pipe support. (This coding, with a numbering system above 100 is adopted for T-post's frames etc.)
- F = footing (for the supporting of single lines)

The concrete foundation footings for the support elements mentioned under pipe support group (c) shall be fabricated in accordance with the civil specification.

Unless otherwise indicated on the relevant drawings, structural steelwork which has to be fixed to concrete work, shall be bolted down with anchor bolts, which shall be supplied by Contractor. Contractor is to ensure that all necessary equipment for this exercise is available at site.

8.2 MATERIAL

Where possible, Thai industrial structure sections shall be used (metric units).

The structural steel shall have mechanical properties comply with PEGS-12139-CIV-022.

Slotted holes, for adjustments, shall be provided with shouldered bolts, spring washers and flat washers.

Screw threads have to conform to ASME B1.1 unless other threads are required for adjustment under heavy loads.

Turnbuckles and adjusting nuts shall have the full length of internal thread engaged. Any threaded adjustment shall be provided with a lock-nut, unless locked by other COMPANY approved means.

8.3 FABRICATION

Steelwork shall be fabricated in accordance with good working practice. Workmanship and testing in general shall follow PEGS-12139-CIV-022.

If in the opinion of Contractor it is more convenient to deliver parts of support structures as loose material to the place of installation, rather than prefabricate the complete support, he shall contact COMPANY for approval.

8.4 WELDING

- Welding shall be carried out only under the direction of an experienced and competent supervisor. Unless otherwise agreed by COMPANY, a record shall be kept to enable major welds to be identified with the welders responsible for the work.
- Electrodes and fluxes shall be used in accordance with manufacturer's instructions and shall be so chosen that the properties of the deposited metal are compatible with those of the parent metal. The use of welding processes other than those covered by BS EN 1011 part 1-2 shall be subject to the approval of COMPANY.

- The general welding program for shop and site welds, including particulars of the preparation of fusion faces, the method of preheating where required, the methods of making the weld, and the types of electrodes shall be submitted to COMPANY for their approval.
- The position of welds required for temporary fabrication, attachments shall be subject to approval by COMPANY.

All prefabricated pipe supports shall be delivered to the site in primed condition in accordance with the specification for painting.

8.5 INSTALLATION

Contractor shall supply adequate plant, tools, service bolts and other equipment to ensure that the supports will be erected in accordance with the design and detail drawings.

Contractor to familiarize himself with the situation on the general piping arrangements drawings, and confirm that support foundation are correctly installed. In the event of a discrepancy, Contractor shall immediately inform COMPANY.

Contractor shall ensure by adoption of the construction schedule that all necessary pipe support materials have been procured and are on the site. In case of shortage of materials Contractor shall be responsible for make-up, without delay to the construction program.

All pipe support elements shall be erected plumb and level to provide support as required to conform to the design.

Minor misfits which can be remedied by a moderate amount of reaming, slight cutting and chipping may be corrected by Contractor when in COMPANY's opinion it will not be detrimental to the strength or appearance of the structural item.

The maximum tolerance for line and level of the steel support elements shall be ± 5 mm. The steel elements shall not be out of plumb more than 1 mm. on each 3 m. section of height. Elevation correction for the pipe supports can be done within the 25 mm thick grouting fill between the support baseplate and the concrete footing.

The grouting shall be in accordance with engineering procedure PEGS-12139-CIV-022 Domestic Onshore Construction Specification - Civil.

The use of temporary supports during erection of permanent piping systems shall be subject to approval by COMPANY. To avoid a large number of these temporary supports during pipe installation, the contractor shall fabricate and erect the permanent supports either before or with the piping.

Pipe supports normally will be indicated on general arrangement drawings. However COMPANY representative may request additional support in specific instances.

The following general guidelines are provided;

- a) In general support locations, are dependent on pipe size, piping configuration, the location of heavy valves and fittings, proximity to expansion joints and the structure that is available.
- b) No firm rules or limits exist which will positively fix the location of each support on piping system. However for straight pipes of standard weight, on tracks and main pipe bridge, approximate distances in mm are given in PEGS-12139-PIP-032.

These distances should be considered as conservative. Exceeding these will be acceptable if the stresses prove to be within the limits as specified in the ASME B31.3

Contractor to complete the pipe supports as indicated in the general guide lines (in previous paragraph (a), (b)) to provide a complete piping system free from vibration with adequate flexibility for controlled expansion and contraction and to minimize the load on nozzles or equipment connections.

9.0 SPECIFICATION FOR NONDESTRUCTIVE TESTING SERVICES

This Article covers the minimum requirements for the provision of nondestructive testing services by contractor if included in the scope of work or by an independent NDT contractor if not included in the scope of work.

9.1 GENERAL

Selection of welds to be tested and interpretation of test results shall be done by COMPANY.

NDT personnel qualification shall be referred to the requirement in PEGS-12060-INT-001.

Inspection, selection and percentage of coverage of welds to be radiographed shall be at least the minimum required in the pertinent code ASME B31.3 or ASME B31.4 or ASME B31.8, latest edition and more particularly section 8 of the specifications and/or in accordance with the articles below. The most stringent requirement shall apply.

For non pressure containing fillet welds (attachments welds to pressure containing parts, weld in pipe support etc., they shall follow the table below.

Service conditions	Utility lines		Process or Hydrocarbon lines		Cryogenic service	
Pressure class	≤ 600	≥ 900	≤ 300	≥ 600	≤ 150	≥ 300
Non pressure containing fillet welds (attachments welds to pressure containing parts, weld in pipe support etc.	None	5% random MP or LP	5% random MP or LP	10% random MP or LP	5% random MP or LP	10% random MP or LP

The radiographic film recording shall be performed in accordance with ISO 11699-1, the requirements set forth in the specification and/or as required by COMPANY.

The Radiographic Procedures shall be in accordance with API 1104 as specified in the appropriate design code.

Contractor shall employ fully qualified and certified experienced technicians solely employed for the NDT services.

COMPANY reserves the right to require each technician to demonstrate his ability and proficiency.

Contractor shall supply and be responsible for all personnel monitoring, protection and safety equipment as required in API 1104.

Radiographic techniques and type of films shall be subject to COMPANY approval.

9.2 RADIOGRAPHIC EQUIPMENT

For sour service crude and gas lines, X-Ray radiographic inspection equipment shall be used. For other services X-Ray inspection is allowed for single wall radiography only.

Where X-Ray inspection will be carried out, the following equipment shall be required:-

- a) Gamma crawler single wall IR-192
- b) Gamma isotope single wall IR-192
- c) Type of film to be used shall be fine-grained, a high contrast, direct type, approved by COMPANY.
- d) Intensifying screen shall be "lead".
- e) Image quality indicators shall be of the wire type (ASME section V) selected to give the required level of sensitivity.

Where X-Ray inspection is carried out, the following equipment shall be required:-

- X-Ray equipment 200, 250 or 300 KV.
- Generators for supply of power to X-Ray equipment.

9.3 WORKING PROCEDURES

A tape measure with 5 cm division marked with lead numbers, shall be placed around the weld to be inspected so that the distance of any defects can be read off on the film from the zero point. The zero points shall be on top of the pipe and the division of the tape, seen in the direction of the flow, shall be in the clockwise direction.

Field welds on lines with a diameter of 8 inch and more shall be radiographed using an internal source of radiation wherever practical.

Prior to or at the start of radiographic inspection, contractor shall prepare a series of standard films to qualify the procedure (s) and to be used for comparison purposed. The series shall consist of the radiographs of a complete circumferential normal pipe weld.

When radiographing circumferential welds (360 degree) exposure on pipes with an external diameter of 16" or more at least one image-quality indicator shall be included in each

quadrant; on smaller diameter pipes, at least one image-quality indicator shall be used per film. For radiographs made using an external source of radiation, one image-quality indicator shall be placed at the limit of legibility and one in the middle of each film.

Contractor shall use the necessary techniques as indicated in the standard ASTM E 142-77 to obtain films which meet the necessary requirements.

The density measured on the welds shall be as described in Article 8.9 of API 1104.

The image-quality indicators to be used shall be in accordance with section 9.2 of this specification. The sensitivity for panoramic X-Ray shall be not worse than 1.5% on pipe, penetrometer on film side. For any other technique, the sensitivity shall not be worse than 1.8%.

Each film shall be marked according to Article 8.6 of API 1104 and subjected to COMPANY's approval.

The average H & D density through the thickest shown portion of the welds shall be in between 2 and 3 for transparent base film. The films shall be processed such as to meet the requirements described in Article 8.1 of API 1104. The radiographs shall be processed to allow storage for at least three years without discoloration.

Radiographs shall be stored in cartons by contractor systematically and indexed. Upon completion of welding of each hydrotest section or when requested to do so, contractor shall hand over the radiographs to COMPANY.

10.0 SPECIFICATION FOR PRESSURE TESTING OF PIPING SYSTEM AND EQUIPMENT

This procedure covers the requirements for site pressure testing of piping systems and equipment. It is also applicable for the testing of piping on skid mounted packages. The procedure has been divided into following articles.

10.1 GENERAL REQUIREMENTS APPLICABLE TO ALL TESTS

This specification covers the field pressure testing prior to commissioning of piping systems and is intended to lay down a framework - in which a systems testing procedure can be implemented.

A system, within the context of this specification, is a network of piping and equipment subjected to a certain test pressure. Such a system can be built up, if needed via temporary connections, of piping which after commissioning will serve independent purposes.

This specification sets practical limitations within which piping systems as defined above may be tested safely and in accordance with the requirements of the applicable codes and standards.

Pressure tests shall be performed in accordance with ASME B31.3 latest edition, "Process Piping".

All pipelines and systems installed by contractor shall be subjected to hydrostatic test by contractor, witnessed by COMPANY nominated representative. Contractor shall present a bar chart or precedence network to COMPANY, detailing the cleaning/hydrotest program and detailed hydrotest procedures and submit this procedure to COMPANY for approval at least one month before the commencement of these activities.

It is contractor's responsibility to prepare and/or update final versions of documents, such as pressure test diagrams and procedures. Contractor shall clearly indicate extent, limits, test pressures, special precautions (i.e. instrument removal, blinds, vent points, drain points) for each hydrotest.

All welding, RT., stress relieving, and other heat treatment of pipe and equipment shall be completed before testing.

No painting or other covering except single prime coat is allowed before hydrotesting.

Contractor shall provide all testing equipment, gaskets, studbolts, fittings, temporary works, blanks, blinds, closures, etc., all of which must be in accordance with the code and specification for the system under test.

Test Instruments

- a) The test instruments shall be of a suitable range and as a minimum requirement shall include :-
 - i. A deadweight tester for reading in 0.05 Bar.
 - ii. A self-recording manometer with 24 hours chart. Maximum reading 1.5 times the test pressure. Accuracy 0.5 Bar.
 - iii. Bourdon pressure gauges. Maximum reading 1.5 times the test pressure. Accuracy 1 Bar.
 - iv. Low pressure water flow meter of suitable range.
 - v. High pressure water flow meter of suitable range.
 - vi. Temperature indicator and/or recorder of suitable range.
- b) All manometer and pressure gauges to be used for tests shall be tested and calibrated by contractor with a dead weight tester in the presence of COMPANY representative or his nominee. A current test certificate shall be available for the dead weight tester (to be recalibrated annually) issued by an independent laboratory approved by COMPANY.

Each manometer, pressure gauge and deadweight tester shall have a calibration certificate not older than 3 months at start of testing. A copy of each calibration certificate shall be handed to COMPANY and the original certificates shall be shown to COMPANY. If COMPANY has reasonable doubts about the calibration of any

instrument to be used for the test, contractor shall at COMPANY's request, have the instruments in question recalibrated in presence of COMPANY.

- c) Contractor shall supply an enclosed test-van in which the test equipment can be operated efficiently and safety.

The sequence and composition of systems to be tested at any one time shall be agreed between COMPANY and contractor based upon erection progress, the Pressure Test Diagram and the Hydrostatic Program.

It is economically desirable and contractor's responsibilities to test at one time as much of the piping as possible without exceeding the allowable test pressure of the weakest element in the system, i.e. the test pressure on any line shall not exceed the design pressure of any appurtenance installed in the system and included in the test. Equipment and instrumentation shall be isolated from the piping undergoing test.

Where full hydrostatic tests are uneconomical, impracticable, or piping, insulation, refractory or attached equipment are liable to damage by water, pneumatic tightness test may be substituted if approved by COMPANY.

If blind flanges are necessary, they shall be indicated on the Pressure Test Diagram and installed prior to testing.

As far as practical and possible, consideration shall be given to the use of temporary gaskets when making connections that will be broken again for hydrotesting or after testing. The locations of temporary gasket shall be marked on the pressure test diagram and a final check be conducted to ensure their removal and correct replacement after testing. This of particular importance on lines where spiral wound gaskets are used.

Reuse of gaskets is not permitted, new gaskets shall be used when making up testing connections and reinstatement or repair work.

Where Compressed Asbestos Fibre (CAF) gaskets are used as temporary test gaskets they shall be replaced by gaskets specified for the service.

Provision shall be made for the venting of air from the test system and for fully draining the test fluid after testing, except for buried lines.

Instrument piping at orifice flanges and equipment, up to and first block valve shall be tested with their respective piping systems by the piping contractor. The balance of the instrument piping shall be tested pneumatically and separately by the instrumentation contractor, to avoid introduction of foreign matter.

Filling of long length pipe or bulkline/pipeline shall be filling foam pig propelled by suitable inhibited water from a high pressure filling pump complete with filter and flow meter. All necessary measures shall be taken to remove the air from the line during filling.

All pneumatic transmission lines are to be air tested at pressure specified in section 10.2) and by the procedure in section 10.3).

Pneumatic leak testing may be substituted with COMPANY's approval for a hydrotest when special supports, or other special arrangement would be required to enable a hydrotest to be performed on very large, very low pressure lines.

The procedure outlined is most commonly applied to large volume process systems and process pipelines in areas of high diurnal temperature range where 24 hours testing is mandatory.

Contractor shall carry out all inspection and testing required of him by this and shall correct all deficiencies evidenced by inspection and/or test. In the event that a weld fails during the hydrostatic test, contractor shall advise COMPANY of any repairs required and propose a repair procedure for approval by COMPANY.

The repair procedure shall be approved by COMPANY and executed by a qualified welder to that procedure.

Any welds or portions of welds that leak during the hydrostatic test and have not been radiographed previous to the test shall be radiographed at the affected areas before they are cut out and remade. Such radiography, repair and re-radiography shall be at contractor's expense.

10.2 TEST PRESSURES

The test pressures shall be determined by COMPANY and shall be listed on Hydrostatic Test Diagram.

The procedures given in this specification are to enable the strength and tightness of welded, flanged and screwed joints to be safely and thoroughly tested, and to prove the construction of anchors, restraints and supports under design conditions.

The piping hydrostatic test pressure to be used on each line in internal pressure service shall normally be not less than 1.5 times the design pressure in accordance with paragraph 345.4 of ASME B31.3.

The maximum test pressure which may be applied to any steel flange in a line is given in ASME B16.5, latest edition, 'Steel Pipe Flanges and Flanged Fittings'.

0.79 MPa (100 psig) shall be considered the minimum hydrostatic test pressure, except for the classes of line listed below :

- a) Lines normally open to atmosphere.
- b) Large diameter lines for which the test pressure will be specially calculated.
- c) Lines subject to pneumatic testing (paragraph below applies).

If piping is tested pneumatically, with written approval of COMPANY and subject to strict volume and safety limitations, the test pressure shall be 110% of the design pressure in accordance with paragraph 345.5 of ASME B31.3 limited to a maximum of 1.6 MPa (200 psig).

10.3 TEST PROCEDURES

All steps shall be taken to prevent damage to equipment and to ensure that all portions of systems are in fact properly tested. The requirements of the pressure test diagrams referred to in section 10.1 shall be closely adhered to. Connections to instrumentation shall be checked before any testing is commenced to ensure that damage will not be caused nor dangerous circumstances arise.

All joints and welds except those previously tested shall be left uninsulated for examination during the test. Equipment which is not to be included in the test shall be isolated from the piping by blinds. All compressor suction and discharge nozzle shall be blinded off to prevent water entering the compressor, and removed only after draining of suction and discharge lines. All lines shall be cleared of debris by flushing with water before testing. All soft seated valves, particularly ball valves must be installed in the open position and not operated until the lines have been thoroughly flushed. The valves shall be put in half open position during testing to allow test pressure into the body cavities.

Equipment and instrumentation shall not be subject to piping test pressure and shall be isolated from the test system. Expansion joints must be tested with the piping in order to check restraining devices. Care must be taken with stainless steel expansion joints to comply with section 10.1.

Control valves shall normally be replaced, before testing takes place, by a spool piece or blind flanges, unless otherwise indicated on the relevant pressure test diagrams.

Restrictions which interfere with filling, venting or draining such as orifice plates and flow nozzles, shall not be installed until testing is complete.

For hydrostatic testing, all piping in other than liquid service shall be adequately supported (by temporary supports if necessary) particularly on lines using spring or counter-weight supports. Spring gauging devices shall not be removed until the completion of testing. Adjacent large lines not in liquid service are not to be tested simultaneously where the weight of the combined test water load may overload the structure or supports.

Lines containing check valves should have the pressure source located on the upstream side. If this is not possible, the check valve is to be removed from the line, internals removed or locked open, and then action taken shall be noted on the pressure test diagram.

All vents and other connections, which can serve as vents shall be open during filling so that all air is vented prior to applying test pressure to the system.

Test pressure shall be maintained for sufficient time to permit inspection of the system under test and to determine small seepage type leaks. The minimum time allowed for a system undergoing a pressure test will vary for different systems, but will in no case be less than 1 hour. Any leaks shall be repaired and the lines retested. If pickled lines fall into this category, the affected area shall be fettled on the bore side and shall then be brushed with the pickling liquid. It is of extreme importance that all such fluid shall be washed from the pipe using clean water and that the pipe be subsequently dried. Drying may be by hot air, or any other approved means. All piping shall be fully drained and dried with compressed air after hydrotesting.

After hydrostatic testing of a system is completed and approved by COMPANY, all lines and equipment shall be completely drained of the test fluid. The system shall be vented while draining to avoid a vacuum. In the event of a pipe failing during pressure testing the system under test shall also be vented to avoid a vacuum. Special attention shall be given to points where water may be trapped, such as valve bodies or low points. All strainers both permanent and temporary shall be cleaned.

If a pressure test is to be maintained for a period of time and the test liquid in the system is subject to thermal expansion, precautions (such as surveillance by a suitable qualified person throughout this period) shall be taken to avoid excessive pressure. Under these circumstances a pressure/volume plot shall be maintained while the system is pressurized and liquids vented from the line to safeguard pressure ceilings shall be collected in a measuring device. The temperature factor causing the expansion shall then be verified by correlating the volume vented against the original volume of the system by use of the differential coefficient of expansion. As temperatures fall the vented fluid shall be re injected into the system again using a P.V. plot to verify the relationship of pressure volume and temperature is constant and no leaks have occurred.

When approved by COMPANY in writing, pneumatic testing shall be carried out in accordance with the following:-

- Bring the pressure to 1.72 barg (25 psig). Inspect all welds and connections for leaks with a soap solution. Gradually increase the pressure in steps providing sufficient time to allow the piping to equalize strains and to check for leaks. When the full test pressure has been attained, hold for a sufficient time to permit inspection of all piping welds and connections but in no case less than ten minutes.
- If a test performed in accordance with the specification requires a joint (flanged, screwed or welded) to be used for blocking purposes, then the adequacy of the remade joints shall be checked as part of the commissioning procedure.

10.4 TESTING MEDIA

Hydrostatic testing shall be done with clean fresh water containing a corrosion inhibitor which will inhibit or coat the pipe when the piping is drained.

The water quality for hydrostatic testing will depend on the water availability and material of construction

1. Portable water (or fresh drinking water) is taken directly from the mains. It can be used for hydrostatic testing of both carbon steel and stainless steel equipment and pipe work. In principle, if the chloride content does not exceed 25 ppm, no chemical treatment is required. If it is used for the hydrostatic testing of stainless steel (SS) equipment, the chloride content shall be less than 25 ppm.
2. The utility water (called raw water) is taken directly from river, lagoons or wells. The chloride content of utility water may be higher than that of portable water (with a maximum salinity of 3000 mg/l) and may not be suitable for testing of stainless steel. It may contain bacteria. It shall not be used for the hydrostatic testing of equipment and pipe work made of stainless steel and mixed metal/alloy if the chloride content is higher than 100 ppm.
3. Seawater and salt water (with salinity over 3000 mg/l), taken from estuaries or salt water well, are generally used for the hydrostatic testing of carbon and low alloy steels. It shall not be used for the hydrostatic testing of equipment and lines made of:
 - a. Aluminium alloys
 - b. Mixed metals/alloys
 - c. Stainless steel

The hydrostatic test for duplex and superduplex stainless steel shall be performed with water in accordance with above paragraph and containing less than 2 ppm (2 mg/l) of total iron. Piping must be thoroughly drained and dried on completion of testing where practical.

Kerosene is an acceptable alternative testing medium for austenitic stainless steel piping and equipment.

For pneumatic testing the medium shall be oil free air or inert gas subject to COMPANY approval.

10.5 TESTING FOR WELLSITES FACILITIES

Terminology

Production Flowline =	Crude piping connects from wellhead flowarm to production manifold in wellsite's trap base.
Gaslift Flowline =	Pipe connects from gaslift manifold in wellsite's trap base to wellhead.

10.5.1 WELLSITES FACILITIES

For well site facilities, manifolds, crude production flowline, gaslift flowline, etc. pressure test shall be performed in accordance with ASME B31.3 latest edition.

Buried production flowline/gaslift flowlines shall be pigging prior to hydrotest. Where practical all field run piping shall also be pigged prior to hydrotest before testing using a pipe cleaning foam pig.

Pigging shall be done with pipe cleaning foam pig with urethane criss-cross coating and spiral wound wire brushes, using a temporary pig launcher/receiver.

Line filling will be from the lowest point at by suitable inhibited water from a high pressure pump.

When filling process is completed all the same rated lines can be connected into one system for hydrotest.

Charge the lines to the strength test pressure while checking for entrapped air and conducting of the strength test including visual inspection.

Hold test pressure for a minimum of 1 hour and recorded every 15 minutes all pressure and temperature reading of the pipes and air.

Depressurize the buried line and leave the line filled with inhibited water until commissioning.

The area around the temporary pig launchers will be barricade and flagged off with sign board.

10.6 TESTING FOR CRUDE BULK LINES AND GASLIFT PIPELINES

Terminology

Crude Bulkline = Crude pipeline from wellsites to wellsites and/or to Production Station.

Gaslift Pipeline = Gaslift pipeline from wellsites to wellsites and/or to Production Station.

10.6.1 GENERAL

Generally for all bulklines/pipelines hydrostatic testing shall be pressure tested in accordance with ASME B31.8 & 31.4 latest edition.

The hydrostatic testing of the pipeline shall be performed at the pressures and in sections as shown in the drawings.

The sequence of hydrostatic testing shall be as follows:-

- a) Installation of test heads at each end of a pipe section to be tested. Permanent scraper traps may be used if available in time.
- b) Removal of debris from the test section by running full brush cleaning pigs propelled by compressed air. This is additional to the cleaning runs made for separate strings.
- c) Gauging run using compressed air as propellant.
- d) Filling of the test section with suitably inhibited water.
- e) Charging of the line to the strength test pressure while checking for entrapped air and conducting of the strength test including visual inspection.

- f) Tightness test.
- g) Depressurize the test section.

Crudelines are to be left filled with inhibited water until commissioning. Gas lines are to be dewatered, dried and filled with inert gas in accordance with specification PEGS-12139-PLR-024 Onshore Domestic Construction Specification (pipeline-E206)

A list of instruments, instrument ranges and instrument spares proposed for use in the hydrostatic testing program shall be submitted to COMPANY for approval together with the procedure as per section 10.1.

All measurements and calculations shall be agreed with COMPANY and submitted to COMPANY for assessment.

During testing operations contractor shall ensure that adequate measures are taken to safeguard all personnel involved in the operations and to safeguard the general public. These measures must be approved by COMPANY.

10.6.2 CLEANING AND GAUGING

Contractor shall run brush and hard foam type cleaning pigs through the test section by using compressed air at a maximum of 7 Barg as a propellant until visual inspection by COMPANY of air and debris emitting at the receiving end reveals that the line section is sufficiently clean to start the gauging run without undue risk. The type of pig shall be approved by COMPANY. The first pig launched in each section shall be provided with a pig detector approved by COMPANY.

Contractor shall use compressors suitably rated to ensure a pig travelling speed controllable between 1.2 and 1.7 m/sec.

A pig with aluminum gauging plate to be approved by COMPANY shall be launched through the test section, propelled by compressed air. The minimum diameter of the gauging plate shall be 97.5% of the smallest internal pipe or fitting diameter.

Contractor shall locate spots and make all necessary repairs to the pipeline if the gauging plate shows any damage. Contractor shall not proceed with the testing procedure before the rerun gauging plate has been accepted by COMPANY.

Should the cleaning pig get stuck in the pipeline, contractor shall not employ pressures greater than 7 Bar differential to dislodge it. If a differential pressure of 7 Bar is insufficient to dislodge the pig, the pig must be located and removed from the pipeline by cutting or other methods to be approved by COMPANY.

Contractor shall install a 10 Bar pressure recorder and a 10 bar pressure gauge at the launching end of all test sections or segments of test section to enable recording of pressure during all air propelled pig runs.

Contractor must at all times ensure that a suitable pig receiver is in position during air propelled pig runs.

10.6.3 WATER FOR HYDROSTATIC TESTING

COMPANY shall determine whether water supplied for hydrostatic testing is suitable. Contractor shall procure and use such inhibitors as are necessary to render the water suitable. Contractor shall supply, install and remove temporary hydrostatic fill lines as required to complete testing of all pipelines installed under this contractor.

The water shall be filtered through 300 micron filters. If inhibitors are required then Contractor shall mix these with the test water on the pump suction side at a rate which results in a mixture conforming to the manufactures recommendations.

10.6.4 FILLING AND VENTING

Contractor shall provide and make operational suitable filling pumps and test pumps, each fitted with 50 mesh suction filters. The pumps shall be suitable for the required filling rates and rates for pressure build-up.

Water shall be injected behind suitable filling pigs into the section to be filled. All necessary measures shall be taken to remove the air from the line during the filling operation. Such measures shall include, but shall not necessarily be limited to :-

a) Controlling the filling rate.

The maximum allowable filling rate is such that the pig velocity does not exceed 2 m/sec.

The minimum filling rate shall be dictated by the following criteria, whichever governs:-

- minimum velocity of pigs
 - maximum life time of power soured in pig detector device.
- b) The filling pigs shall be of the proper size and in first class condition to preclude the possibility of air and/or water by-passing them.
- c) Limitation or elimination of fill pump shutdowns.
- d) Use of a break tank between the water supply source and the fill pump.
- e) Maintaining a suitable back pressure against the fill pigs, dependent on pipeline elevations.

Pigs selected for use during the filling operations must be capable of passing all side connections and valves without by-passing of fill water.

Filling pigs to be used shall be approved by COMPANY prior to the filling operation.

During the line filling operation, contractor shall install and operate a water meter and a 10 Bar recording pressure gauge and 10 Bar pressure gauge at the fill point for aid in determining the location of the filling pig, and a 10 Bar pressure gauge at the receiving end to facilitate checking of the back pressure.

After filling the bulkline/pipeline with water and before pressurizing the ground/pipe thermal stabilization shall be monitored at all locations. The line pressuring shall only commence once thermal stabilization has been achieved.

During pressurizing, tests and bleeding, globe and gate valves shall be fully opened and ball valves shall be halfway open.

10.6.5 ENTRAPPED AIR

During pressurization, contractor shall adhere to the following procedure to determine the volume of air trapped within the section under test. Contractor shall record pressure and volume readings at 5 minute intervals during pressurization and construct a pressure versus volume plot. The linear section should be extrapolated back to the volume axis at atmospheric pressure.

The approximate volume of entrapped air at atmospheric pressure can then be read from the volume axis and the percentage entrapped air calculated:-

$$\text{Percentage entrapped air} = \frac{\text{Volume of air} \times 100}{\text{Volume of line}}$$

If the measured volume of entrapped air at atmospheric pressure is less than 0.2 percent of the test section volume, then the filling of the line shall be deemed acceptable for proceeding with the hydrostatic test. If the volume of entrapped air exceeds 0.2 percent then contractor shall take measures to reduce the quantity of air in the test section, either by venting or by refilling the line before continuing the hydrostatic testing procedure.

10.6.6 STRENGTH TEST

The strength test shall commence after a temperature stabilization period of not less than 24 hours.

All pressure containing components or the pipeline and its appurtenances shall be subject to the strength test.

The section under test shall be subject to a 24 hours duration strength test at the pressure level indicated on the drawings which in general will be:-

- a) Maximum pressure at lowest point of the pipeline section to give a hoop stress or 95% of specified minimum Yield Strength based on nominal wall thickness and nominal outside diameter of the pipe.

- b) Minimum pressure at highest point of the pipeline section to give a hoop stress of 90% of specified minimum Yield strength based on nominal wall thickness and nominal outside of the pipe.

The test section shall be brought to 80 percent of the strength test pressure and allowed to stabilize for two hours.

During all stages of pressurization, the high pressure flowmeter reading shall be recorded at 1 Barg intervals and the pressure vs. volume plot constructed. To enable an accurate determination of percentage air entrapment, recording of pressure and volume shall commence at atmospheric or static head pressure.

An experienced operator shall be at the test pump controls during the entire period of the strength test. He must be advised by contractor of the required pressure at the pump corresponding to the strength test pressure of the section. The pressure is to be maintained at the required levels by bleeding or filling as required. All quantities of water drained off or added to the line shall be measured and recorded by contractor. The pressure is not allowed to fall more than 5% below the test pressure at any time during the strength test.

10.6.7 TIGHTNESS TEST

Just before the tightness test contractor shall repeat the entrapped air test.

An experienced operator shall be at the test pump controls while the test section reaches stability and until the tightness test commences. He must be advised by contractor of the required pressure at the pump which corresponds to the tightness test pressure of the section.

When the test section has reached a stable condition it shall then be subject to tightness test of 24 hours duration starting at the highest pressure level permitting that no water is added or removed or entrapped air vented for the duration of the test.

The pressure recorder shall record continuously the pressure at the test manifold. During the tightness test the following measurements shall be taken and recorded every 1/2 hour:-

- the pressure reading of the deadweight tester
- the temperature reading of the pipe
- the temperature reading of the soil
- the temperature reading of the air
- the barometer readings

All pressure containing components of the pipeline shall be subject to the tightness test.

On the basis of pressure and temperature measurements made during the 24 hours tightness test and measurements recorded during the entrapped air tests, and taking into account possible inaccuracies in measured or assumed parameters, COMPANY shall determine whether the section under test has leaked during the tightness test period.

If COMPANY suspects that a leak has occurred, then COMPANY may reject the section involved or decide to extend the test for a further 24 hours.

For tightness testing the theoretical final pressure shall be calculated by the contractor taking to account of water removal/addition and temperature variation over the duration of the test by a method approved by the COMPANY. The tightness test shall be deemed satisfactory if the difference between this pressure and the observed pressure does not exceed 0.3 bar.

10.6.8 REPAIRS

If any leak is found during the strength or the tightness test then the test shall be discontinued and the necessary repairs made. Contractor to supply, install and tighten gland packing on leaking valves, to replace gaskets, tighten bolts, etc. Contractor shall have materials and tools readily available at site.

Any repairs by welding during and after the strength or the tightness test shall be made in accordance with the specifications and to the satisfaction of COMPANY. The subject section shall be re-tested.

10.6.9 VISUAL INSPECTION

A thorough visual inspection (on foot) shall be undertaken at least three times:

- a) Immediately after the strength test pressure has been reached.
- b) Six hours after the strength test pressure has been reached.
- c) At the end of the tightness test.

10.7 TESTING OF PIPEWORK FOR PRODUCTION STATION

Pressure tests shall be performed in accordance with ASME B31.3 latest edition, "Process Piping".

Vessels, exchangers and mechanical equipment shall be isolated from the hydrostatic test system and this shall be indicated on the pressure test diagram.

If a test performed in accordance with the specification requires a joint (flanged, screwed or welded) to be used of blocking purposes, then the adequacy of the remade joints shall be checked as part of the commissioning procedure.

When approved by COMPANY in writing, pneumatic testing shall be carried out in accordance with section 10.9, Testing of Pipework for LPG Plant and Equipment.

10.8 TESTING OF VESSELS & EXCHANGERS

Vessels and exchangers which have been tested in the factory do not require individual testing at site unless they fall into one of the following categories:-

- a) Those, whose condition, resulting from transport, storage, handling or any other cause, is in the opinion of COMPANY, suspect.
- b) Those which have been subject to any site modification, which in the opinion of COMPANY, necessitates a site pressure test.

Pressure testing of vessels and exchangers, if required under sub paragraph above shall be performed in the presence of COMPANY representative.

With the exception of relief valves, all valves and fittings shall be installed on the vessel or exchanger and included in the test. Relief valves must be removed.

All external pressurized elements such as float chambers, shrinkage testers, thermowell pockets, pressure tappings to first isolation, etc. must be fitted to the vessel and open to test pressure. All floats shall be removed.

All plugs shall be removed from vent holes in reinforcing rings before the test pressure is applied.

Each reinforcing pad (or each segment thereof) and similar attachments shall be tested at pressure of at least 1.72 barg (25 psig) with air. Soap solution is to be used to detect air leaks. Test and vent holes shall be left open upon completion of the test except where moisture ingress to the vessel is feasible the holes must be plugged by heavy grease or non-pressure containing (plastic) plug.

For individual pressure tests of vessels and exchangers where required hydrostatic test pressure shall be as listed on the Nameplate/Data Sheet for the particular vessel or exchanger.

When site testing of vessels is not conducted the adequacy of joints on vessel trim shall be checked as part of the commissioning procedure. (As joints to vessel trim will not generally be tested when vessel is only tested in factory.)

On satisfactory completion of a pressure test, the vessels and/or exchangers shall be drained completely, spades inserted for test purposes removed, spectacle blinds turned and joints remade with new gaskets to the satisfaction of COMPANY.

10.9 TESTING OF PIPEWORK FOR LPG PLANT

The pressure testing for the LPG Plant piping shall be pneumatic using nitrogen only and in accordance with ASME B31.3. However, due to the hazards associated with pneumatic pressure testing, consideration and permission shall be given to hydrostatic testing case by case by COMPANY where the piping can be adequately drained and dried.

Except underground piping and loading line the test shall be hydrostatic using inhibited water. Water in the line shall be driven out by pig after testing. Volume of water before and after testing shall be measured and recorded. The line shall be dried with warm air after test.

Where nitrogen is used to clean/test or blowdown the lines care must be taken at the nitrogen release point as large scale of nitrogen can displace the air. All personnel must be mobilized from the area, sufficiency of oxygen in air to be tested and confirmed before allowing of personnel getting in the area.

The test pressure shall be 110% of the design pressure.

Equipment such as pumps and compressors shall not be subjected to test pressures and shall be blanked off prior to any pressure tests.

Lines which are normally open to the atmosphere such as non-pressure drains, safety valve stacks, shall not tested, but all joints shall be visually inspected for proper installation. The flare header and associated safety valve exhaust lines should be tested where possible at minimum test pressure 3.5 bar.

Flanged joints shall be pressured for pneumatic testing with soap by taping with masking tape and punching a small hole (1/8") through the tape.

Control valves with block valve and bypasses shall be lined up with the block valves closed and the bypasses opened wide. When the filling gas has flushed or blown the line relatively free of foreign material, the control valves and drains at the control valves shall be opened wide and then the block valves shall be opened for the tests. Control valves without block valves shall be opened for the test. These shall be taken out of the lines and cleaned after testing and/or air blowing has been completed and then these valves shall be reinstalled.

In general, piping lead lines to instruments shall be disconnected from the instrument during a pneumatic test.

In general, all instruments in the system shall be excluded from the test by isolation or removal unless otherwise permitted.

Relief valves shall be removed or blanked off equipment or piping system prior to hydrostatic testing, relief valve test gags may be used in place of blinds.

Orifice plates or other similar restrictions normally shall not be installed in the piping system until cleaning and testing have been completed.

Locally mounted pressure gauges shall be blocked off, or removed and their connections plugged when the test pressure exceeds the scale range. The gauges shall also be blocked off during cleaning.

Where a system is to be isolated at a pair of companion flanges, a blank shall be inserted between the flanges. Open ends of piping system where equipment or pipe spools have been removed or disconnected shall be blinded off, using standard blind flanges of the same rating as the piping being tested.

All lines subject to pressure testing shall be cleaned by blowing out with 6.7 bar air or nitrogen.

Where piping systems to be tested are directly connected at the battery limits to piping for which the responsibility rests with others, the piping to be tested shall be isolated from such piping by valve or blind.

Pneumatic testing shall start with a preliminary check at 1.7 bar using dry air or nitrogen, held for 15 minutes and then leak-checked. A second preliminary check shall be made at 7 bar using dry air or nitrogen, held for 15 minutes and then leak-checked.

After the preliminary air tests, a nitrogen test shall be undertaken. A test manifold shall be installed for nitrogen testing. The manifold includes a shut-off valve connected to the source of nitrogen, a safety relief valve set at less than 150% of the design pressure of the system being tested, a pressure gauge and a pressure recorder. The test shall be recorded on the pressure recorder. The test shall be conducted in four stages; first, the pressure shall be raised slowly (not faster than 15 minutes) to 25% of the final test pressure, held for 15 minutes and then joints leaks tested. This shall be repeated for 50%, 75% and 100% of the final test pressure.

No repairs of any nature shall be undertaken with pressure on the system.

Retesting of lines after repair of leaks, if any, shall start again with a preliminary air test at 1.7 bar, and proceed through each step outlined in previous sub paragraph.

During pneumatic tests all personnel shall be kept out of the area, at least 30 meters, where practical, from piping and equipment being tested until 15 minutes after the desire pressure has been reached and then only personnel directly involved in the test shall check joints for leaks by applying a soap solution to all screwed, welded and the flanged joints, under a sufficient time to permit inspection of all piping welds and connections but in no case less than 30 minutes.

Instrument piping shall be tested up to the block valve nearest to the piping header. If a union is provided downstream of the block valve, it shall be broken during cleaning and testing to prevent dirt or foreign matter from being introduced into the instrument inadvertently.

Lines containing check valves shall have the source of pressure located in the piping upstream of the check valve, so that pressure is applied under the seat.

Systems that have been pneumatically tested shall be brown by released large volumes of air as directed and controlled, if the release points are properly anchored and job personnel are not endangered.

10.10 TEST RECORDS

Contractor shall maintain records of hydrostatic tests conducted per system, indicating:

- a) Date of test
- b) Identification of equipment and/or piping system
- c) Design pressure and temperature

- d) Operating pressure and temperature
- e) Test pressure applied and time held (recorder chart to be attached)
- f) Temperature of test medium and ambient temperature. (recorder chart checked.)
- g) Testing medium and chloride content. (where applicable).
- h) Test medium volume, quantity added and/or drained
- i) Applicable remarks concerning defects and pressure compensations together with P.V. plots, calculations and repair reports, sequence of events, etc.

All accompanied by the relevant pressure test diagram.

Contractor shall submit for each completed test:-

- a) The applicable originals of test data-sheets, together with the pressure chart and test reports.
- b) A copy of the test certificates for each instrument used.

In addition to the specific information mentioned above, contractor shall collect, check and furnish to COMPANY all information required to enable COMPANY to prepare inspection records.

Test procedures, reports and test results shall be submitted to COMPANY on completion of the test of a system as a section of a complete test report for the work.

Test charts and data sheets shall be signed by contractor and COMPANY.

10.11 APPROVAL

The test is considered acceptable, when the pipeline/piping and its appurtenances have withstood the full duration strength test and the tightness test has proved to COMPANY's satisfaction that the test section is without leaks. The test is considered accepted as soon as contractor final pressure test report is signed for approval by COMPANY.

11.0 SPECIFICATION FOR PAINTING

This Article of the specifications covers the requirements for surface preparation and painting of process plant and associated equipment.

11.1 CONTRACTOR'S RESPONSIBILITY

The contractor shall furnish all labor, transport, plant, equipment, materials, paints and components required for correctly preparing surfaces and coating them in accordance with this Article.

The contractor shall notify the Inspector appointed by COMPANY in good time before any cleaning, surface preparation, painting work is carried out, and shall not proceed with further work on any one section until the previous work carried out has been formally accepted.

The contractor shall provide at all times on site, whilst work is in progress an experienced senior staff supervisor in charge of the work. The supervisor shall act as the contractor's site representative and must be able to understand, speak, and read the English language. The contractor's representative on site will comply with all instructions received from and issued by COMPANY.

The contractor shall provide at all times a high level of fully competent supervision to ensure that the specification is complied.

The contractor's representative shall be responsible for monitoring and keeping records of:-

- a) Weather conditions
- b) Relative humidity
- c) Dew point
- d) Ambient air temperatures (recording maximum and minimum each day)
- e) Steel temperature
- f) Wet and dry film thickness of applied coatings

The contractor shall carry out all the work detailed in the scope of work to the standard specified, to a high standard of finish and visual appearance. Any work which in the opinion of the COMPANY does not conform to this requirement will not be accepted even though it conforms to the specifications in all other respects.

The painting system to be applied shall be as indicated in PPS-12123-COR-011 or equal subject to COMPANY approval. Surface preparation and application methods and quality requirements shall be in accordance with this specification and the paint system manufacturer's instructions.

11.2 INSPECTION OF WORK

The COMPANY shall have the right to inspect at all times any paint stock, tools, plant, instruments, staging, or any other material or equipment used or to be used in the performance of the painting application. In addition the COMPANY shall have the right to inspect at any time, any and all painting, or cleaning, if completed, and reject any work, or materials, or equipment which does not conform to the specification. Condemned painting applications shall be marked up with paint of a contrasting colour. Any condemned painting work, defective with the specification shall be re-done by the contractor at no additional cost to COMPANY. Similarly any condemned tools, instruments, materials, or equipment shall be replaced or rectified at no additional cost to the COMPANY.

11.3 REPORTS

A daily record shall be submitted to the COMPANY at the beginning of each working day giving details of the following for the previous day.

Weather conditions, relative humidity, maximum and minimum air temperature, work carried out, paint etc. used and batch numbers, wet and dry film thickness achieved, anomalies, progress of work versus approved program, dew point, steel temperature.

11.4 CODES AND STANDARDS

In addition to this Article to the specifications issued by the COMPANY the following shall apply.

- a) Paints and varnishes — Corrosion protection of steel structures by protective coating systems ISO 12944 part 1-8.
- b) ISO 8501- Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness.
- c) Steel Structures Painting Council (U.S.A.) SSPC.
- d) SP1 : Solvent Cleaning
- e) SP3 : Power Tool Cleaning
- f) British Standards 4800 colour card.

11.5 PAINT AND COATING MATERIALS

11.5.1 PAINTS

All paints used must have been approved by COMPANY and shall conform to the following generalized composition:-

Zinc silicate primer shall be based on inorganic or ethyl silicate media and shall contain not less than 85% metallic zinc by weight in the dry film.

Zinc rich primers shall be based on two pack epoxy media and shall contain a minimum of 90% metallic zinc by weight in the dry film.

Zinc phosphate two pack primer shall be based on polyamide cured two pack epoxy media and may contain a minimum of 40% zinc phosphate pigment, and a minimum of 20% zinc phosphate by weight in the dry film.

Mordant solution shall comprise of a phosphoric acid solution incorporating copper salts in a solvent/water solution.

Two pack epoxy finishing paints shall be based on polyamide or amine adduct cured two pack epoxy media and may be pigmented with titanium dioxide and/or light fast coloured pigments to provide the necessary opacity, film build and weather resistance. A semi gloss finish is required.

Aluminium silicone paint shall be based on a one pack formulation with the aluminium pigment dispersed in silicone or modified silicone media. The paint shall be capable of withstanding continuous exposure to temperature between 120 – 500°C.

Recoat polyurethane shall be based on Isocyanate-free cured two pack formulation.

Glass flake polyester is a two component either Bisphenol A or Isophthalic polyester glass flake coating. The maximum content of wax shall be 0.1% (wt).

11.5.2 THINNER

Only thinners as specified by the paint vendors shall be used. Mixing and thinning directions, as furnished by the paint vendors, shall be followed.

11.6 SYSTEMS

As a general rule all painting, systems as well as all manufacturers, suppliers and applicators of such systems intended to be used on the work shall be subject to approval by the COMPANY. Contractor shall submit the painting procedure for COMPANY approval. See appendix 4 for the quality control system.

The contractor shall not substitute any other system for that which is specified, nor make any change of manufacturer or supplier, or in any other way change or vary the specifications without the written approval of the COMPANY.

Any work carried out where unauthorized changes in specifications have been made shall be rejected by the COMPANY and redone at contractor's expense.

11.7 APPLICATION, EQUIPMENT, WEATHER CONDITIONS

11.7.1 BLASTING EQUIPMENT

The compressed air supply used for blasting shall be free from water and oil. Adequate separators and traps shall be provided and these shall be kept emptied of water and oil. Accumulations of water and oil shall be removed from the air receiver by regular purging.

The blasting abrasive shall be discharged with a pressure at the nozzle (measured with a hypodermic pressure gauge) of 100 psi and shall not under any circumstances fall below 90 psi. Tungsten carbide venturi nozzles shall be used and discarded when wear reaches 50%. Blasting nozzle must be Dead-Man-Handle type, i.e. air pressure must be isolated as soon as the handle released. The blasting operators hood or headgear shall be ventilated by clean cool air served through a regulator / filter to prevent blasting residues from being inhaled by the operator. Blasting equipment shall be earthed and conductive hoses used to prevent build-up of static electricity.

11.7.2 ABRASIVES

Suitable abrasives for use in blast cleaning are: (not in sequence of any preference)

- a) Steel Grit
- b) Steel Shot

- c) Malleable Iron Shot
- d) Crushed Chilled-iron Grit
- e) Chopped Steel Wire
- f) Aluminium Oxide (Corundum)
- g) Copper Slag*
- h) Blast Furnace Slag*

* Copper slag and furnace slag shall not be used in tank lining or other applications where abrasive residues embedded in the steel surface may have a detrimental effect on coating performance.

Sand and other potentially silica-containing materials shall not be used in all cases unless approved by COMPANY.

Shot = the particles are as far as practicable spherical and solid and shall not contain more than the minimum practicable amount of “tails” and irregular shapes.

Grit = the particle show good angularity of form with sharp cutting edges and shall be substantially free from “half-rounds” (i.e. shot split in half).

11.7.3 PAINT SPRAYING EQUIPMENT

Personnel Protective Equipment must be provided for the painter as recommended in COMPANY’s PPE Standard.

The spraying equipment to be used shall meet the recommendations and instructions set forth by the paint supplier for each specific paint or coatings system.

An adequate moisture trap shall be placed between the air supply and the pump or pressure pot feed to the gun. The traps shall bleed off continually any water or oil from the air supply.

Suitable working regulators and gauges shall be provided for the air supply to the pump or pressure pot.

Spraying units shall be earthed and precautions taken to prevent buildup of static electricity.

11.7.4 STORAGE OF PAINT, THINNER, ETC.

All painting and coating materials, resin and glass fiber etc. shall be delivered to site in the suppliers original sealed containers with labels intact and seals unbroken. They shall be stored in secure, well ventilated storage place assigned for this purpose. Storage areas shall be kept clean and tidy. The storage area must be specified as “flammable storage” and all precautions and firefighting equipment must be provided to the area.

Drums should be regularly turned to prevent excessive settling out of pigment and care taken to rotate stock correctly to prevent any material exceeding its recommended storage life. Certain materials have a limited storage life in tropical conditions and special care shall be

taken in this case and if necessary air conditioning storage used to provide an adequate storage life.

Paint which has deteriorated during storage or has exceeded its shelf life shall not be used.

11.7.5 SCAFFOLDING, STAGING AND ACCESSIBILITY

If scaffolding or platform is required to be erected for painting works, such the scaffolding or platform shall be erected in accordance with the COMPANY's Operation Procedure Manual, No. OPM C-01.04 "Scaffolding and Temporary Access Equipment".

Fixed scaffolding or staging shall be used as required for surface preparation and painting and will be subject to the approval of the COMPANY. It shall be such that easy and sufficient access will be provided for correct preparation, paint or coatings application, and inspection of all surfaces. It shall be such that operators will be able to stand up with body and arms free of scaffolding or staging and the structure being worked on. It shall be provided with safety features that will help to prevent accidents e.g. boards shall be firmly secured to the scaffolding or staging, and firmly secured ladders provided. The practice of 'monkeying' on scaffolding or staging and not using scaffolding equipment needed to complete.

11.7.6 PROTECTION OF COMPANY EQUIPMENT

The contractor shall be responsible for and shall protect all equipment and structures, and any other areas required by the COMPANY to be protected from mechanical damage, damage from paint droppings or overspray to his entire satisfaction. Examples of areas to be protected are valve spindles, gauge glasses, name plates giving makers spec. etc. on vessels, motors etc., Instruments, Light fittings, machinery, electric motors, cables, stainless steel pipework, gratings, nearby vehicles, buildings, or any other areas of the structure not being painted at that particular time.

Ironmongery not required to be painted shall first be fitted and then removed before the preparatory processes are commenced. When all painting is completed the fittings shall be cleaned and refixed in their position.

11.7.7 WEATHER PROTECTION

Where environmental circumstances and/or contractor's program and/or construction methods require a weather protection of all or part of the structure to be painted the contractor shall provide plant and equipment such as tents, heating, ventilation or equipment for dehumidification, scaffolding, screening etc. at no additional cost to the COMPANY.

11.7.8 WEATHER CONDITIONS

The COMPANY shall have the right to stop all cleaning, surface preparation, or coating work in unsuitable weather conditions including but not limited to,

- a) High wind speeds

- b) Airborne dust or sand
- c) Rain, for or mist
- d) Steel temperature over 50°C or under 5°C
- e) Steel temperature less than 3°C above dewpoint
- f) Air temperature less than 5°C
- g) Relative humidity greater than 85%
- h) Where there is likelihood that weather conditions will change within 2 hours such that the above conditions apply.

It is expected that the contractor will include in the tender price an allowance for down time for the above reasons. Under no circumstances will the COMPANY make any additional payment for down time, loss of materials, damaged work in progress etc. due to adverse weather conditions.

11.8 SURFACE PREPARATION

11.8.1 BLAST CLEANING

Where specified, the contractor shall carry out blast cleaning to a visual standard in accordance with standard Sa 2.5 (ISO 8501) immediately prior to paint. Only dry abrasive blast-cleaning techniques shall be employed. Normally wherever possible i.e. in blasting tank internals and in vacuum blasting re-usable abrasive such as chilled iron grit shall be used. (Maximum abrasive particle size 22 mesh B.S.).

Where sand is used as the blasting abrasive it shall be of a maximum particle size of 16 mesh B.S. and washed free of clay etc.

All abrasives used shall be free from dust, moisture, salts and any other impurities.

The type and size of abrasive for any particular job shall be subject to approval by the COMPANY and shall be selected to give a surface profile of 100 microns maximum peak amplitude for normal painting work (A surface profile height of 40 microns is recommended).

11.8.2 BLAST CLEANING TECHNIQUES

Blast cleaning shall not be conducted when the steel surfaces are less than 3 degrees Celsius above the dewpoint of the air; or when the relative humidity of the air is greater than 85%. Blasting shall not be carried out in areas close to painting or coating operations and wet coated surfaces to avoid dust and grit contamination.

Blasting shall only normally be carried out during daylight hours, except where the written approval of the COMPANY has been granted.

The maximum speed and most effective cleaning is obtained by even, systematic blasting. Work should be blocked out in one-foot squares and each square blasted evenly until complete. (Except where spot blasting is specified).

All weld areas, crevices, bolt heads, etc. shall be given special attention. Prior to blasting all weld spatters, slag, weld strikes, laminations and sharp edges should be all removed by chiseling and grinding following by blasting. In cases where such defects are revealed by blasting e.g. laminations they shall be removed by grinding smooth, and afterwards be re-blasted to provide a correct profile to give a satisfactory paint adhesion.

Any blasted surface not primed within four hours or wet by rain or moisture shall be re-blasted. Under no circumstances may blasted areas be left overnight and primed the next day. If, exceptionally, surface preparation is authorized at night, the prepared surfaces shall be wiped the next morning. They shall be freshened with light sand blasting before the primer is applied.

11.8.3 POWER TOOL CLEANING

Power Tool Cleaning shall be carried out in accordance with SSPC:SP3 Power Tool Cleaning of the Steel Structures Painting Council (USA) and to a visual standard in accordance with ISO 8501-1 to St3.

Metal surfaces for which blasting is specified but which because of their location cannot be open blasted shall be prepared wherever practicable by vacuum blasting. Where this is not possible such areas shall be 100% power disc sanded using a cross technique to provide good adhesion. Where welds occur within these areas a Jason needle gun shall be used to prepare these.

Power tool cleaning shall continue a minimum of 25 mm into adjoining coated within four hours.

Areas prepared for painting by power and hand tool cleaning shall be primed within four hours.

11.8.4 SOLVENT CLEANING

Solvent cleaning shall be in accordance with SSPC:SP1 Solvent Cleaning of the Steel Structures Painting Council (USA). Solvent Cleaning shall be carried out normally prior to blasting. Should any traces or smudges of oil or grease be discovered on the blasted surface these shall be removed by solvent washing and the whole area re-blasted.

All bolt holes shall be solvent cleaned prior to blasting.

No acid washes, or other cleaning solutions, or solvents shall be used on metal surfaces after they are grit blasted prior to coating application. This includes inhibitive washes intended to prevent rusting.

11.9 PAINT APPLICATION

11.9.1 GENERAL

Any surfaces to be coated or primed shall be rendered dust free prior to the application of the coating or primer. This shall be done by blowing off the surface with clean, dry, compressed air or by using an industrial vacuum cleaner.

Piping and equipment to be insulated, shall be primed only, prior to the application of the insulation.

Any defect or damage that may occur shall be repaired before the application of further coats; if necessary the particular surface(s) shall be made paint-free.

Areas which are to be overcoated shall be thoroughly cleaned free from grease, oil and other foreign matter and shall be dry. The surfaces shall then be prepared to the standard as originally specified.

11.9.2 MIXING AND PREPARATION OF MATERIALS

No paint shall be used which has exceeded its marked shelf life, or has gelled, or has thickened to such an extent that more than 5% by volume (10% by volume for primer) of the correct thinners is needed to bring it to brushing consistency.

The oldest paint in stock should normally be drawn to ensure correct stock rotation.

The paint or coating mixing is critical and should be carried out under close supervision to ensure correct results. The drum should be opened and the bulk of the liquid portion poured into a clean drum of similar size with an open top. The residual stiff or lumpy paste should then be broken up by stirring with a wide strong wooden paddle. If it is found that the residue cannot be worked into a smooth and uniform paste by this treatment the paint must be condemned. The liquid portion which was originally poured off shall then be added in small quantities at a time, while stirring with a power driven stirrer which is moved in a figure 8 motion. When the paint appears to be completely uniform it should be 'boxed' by pouring repeatedly from one drum to the other. Before use the paint should be strained through 60 mesh BS fine metal gauze to remove any skin or small lumps.

11.9.3 PRIMER APPLICATION

Application of primer shall normally be by brush or by airless spray, except in the case of stripe coats which shall be by brush only.

Rollers and conventional spray shall not be used for application of primer. Brush marks shall be avoided as these indicate low DFT in the valleys of the marks.

Each coat shall be allowed to dry or cure for at least the time recommended by the manufacturer for minimum overcoating and care shall be taken not to exceed the maximum overcoating time where this applies.

No coating shall be applied within 50 mm of an edge prepared for a field weld and care shall be taken to prevent this by masking off. On completion of finish coating the plant identification marks, flow direction arrows, pipe identification colour bands, etc. shall be applied as requested and directed by the COMPANY.

11.9.4 SPRAY APPLICATION

All lines and pots shall be thoroughly cleaned before any addition is made of new materials. The spray gun shall be held not closer than 18" from the work surface, not further than 2' and shall always be held at right angles to it. Even parallel passes shall be made, each pass overlapping the other by 50%. Large surfaces shall be 'cross coated' by receiving passes in two directions at right angles to each other. The gun shall be triggered before and after each pass and not continuously 'gunned' to obtain the correct spray pattern and avoid runs and sags.

Spray width adjustment on the gun shall be made and the readjustment of atomizing pressure at the regulators shall be made until the desired spray pattern is found.

Each coat shall be applied uniformly and completely over the entire surface. Great care shall be taken to avoid areas of low DFT and misses. All runs and sags shall be brushed out immediately, or the paint shall be removed and the surface resprayed.

Before spraying each coat, all areas such as corners, angles, edges, welds, flanges, brackets, bolts, nuts and interstices shall be given a brush coat to ensure that these areas have at least the minimum specified film thickness.

Paint spraying from a single boatswains chair will not be permitted. A large selection of tips shall be available as recommended by the paint supplier for each type of paint and steel configuration.

11.9.5 BRUSH APPLICATION

The coating shall be brushed on to all areas which cannot be spray coated properly for any reason e.g. difficult access, complex shape etc. and a 'touch-up' or repairs to localized damaged paint as approved by the COMPANY.

Surfaces not accessible to brushes shall be painted by other suitable means to ensure a uniform paint film of adequate thickness.

Brushes used in brush application shall be of a style and quality that will permit proper application of paint.

The brushing shall be done so that a smooth coat, as nearly uniform in thickness as possible is obtained. There should be no deep or detrimental brush marks. Paint shall be worked into all crevices and corners. Runs and sags shall be brushed out.

11.9.6 FILM THICKNESS

All specified dry film thickness limits shall be adhered to strictly by the contractor. These thicknesses are to be checked with the calibrated film thickness gauges supplied by the contractor. Where dry film thickness does not meet that specified additional material shall be applied.

In order to achieve the specified dry film thickness correctly the contractor's supervisor shall make frequent checks on the wet film thickness being applied and by volume, verify that sufficient wet film thickness per coat is being applied to attain the specified dry film thickness.

The dry film thickness gauge must be conformed to SSPC-PA2 and may be of the magnetic pull-off or electronic induction type, in each case the gauge shall be calibrated twice daily by the contractor's Supervisor using shims of known thickness over a steel surface which has been prepared to the same specification as the work surface.

Recommended dry film thickness per coat is 65 microns.

11.9.7 FINAL APPROVAL

The completed paint system or coating should be free of defects such as runs, sags, pinholes and bubbles, misses or holidays, dry spray, grit inclusion etc. Any such defects must be made good before COMPANY is requested to give final approval. The correct minimum dry film thickness should have been attained and on external painting work a good standard of finish and visual appearance is expected and required, and any dust or sand contamination, or oil and grease removed by scrubbing with 2% Teepol or dilute ammonia and washing down with fresh water.

11.10 SITE CLEARANCE

As painting work proceeds the contractor shall each day clear up all empty paint and thinners drums, rags etc. and remove them to a suitable place for disposal. All over runs, paint droppings, smears etc. shall be removed and where gravel etc. has been oversprayed these areas shall be raked over or fresh gravel relaid by the contractor at no additional expense to COMPANY. On completion all waste resulting from painting work, surplus materials and equipment shall be collected and promptly removed and disposed of outside the working area.

11.11 APPROVED PAINT MANUFACTURER AND POINT APPLICATION SYSTEM

The approved paint manufacturer, paint systems and point application shall follow PPS-12123-COR-011 painting of onshore structure and facilities.

In order to ease detection of "Interrupted Application", intermediate coats shall be of a different colour. Piping in the flare area (within the 50 m safety fence shall be painted with a heat resistant paint to be approved by COMPANY.

11.12 PIPE COLOUR CODING

Once the pipework has been finish painted and accepted, piping systems shall be colour coded using coloured bands painted on the pipework.

Band widths shall normally be equal to pipe diameter but subject to a minimum width of 50 mm and a maximum width of 200 mm. Direction of flow shall be indicated by 2 black arrows painted on the band positioned so as to be easily visible.

Bands are to be placed at either side of every valve, bend, penetration, branch, etc. within 1 m, and then every 6 m. on straight lengths.

The colour coding system to be used is as follows.

<u>Service</u>	<u>Colour</u>
Process and Crude Oil	Light Brown
Fuel Oil/ Diesel Oil	Orange Brown
Hydraulic Oil	Buff
Process Gas, Fuel Gas	Pale Green
Instrument Air	Pale Blue
Starting Air, Service Air	Blue
Condensate	Brown
Glycol	Ivory
Methanol	Violet
Fresh/ Potable Water	Blue Green
Service Water, Heating Water	Dark Green
Firewater, Kill Systems (see note 1 below)	Red
Chemicals and Inhibitors	Light Yellow
Process Drains	Off White
Vents, Relief Lines (see note 2 below)	Orange

Note 1 Firewater lines, valves, etc. to be completely finished in red No. 11 rather than banded.

Note 2 Relief valves are also to be painted orange No. 33.

12.0 SPECIFICATION FOR THE INSTALLATION OF THERMAL INSULATION

This specification covers minimum requirements for thermal insulation inclusive of fastening materials and the installation thereof.

12.1 APPLICABLE CODES AND STANDARDS

Unless otherwise agreed by COMPANY, the installation of the thermal insulations shall be in accordance with following standards:

- ASTM C533
- AISI 3304
- ASTM B209
- ASTM B585

12.2 INSULATION MATERIAL

Unless otherwise agreed with COMPANY, contractor shall apply asbestos free calcium silicate performed block and pipe sections of 25 mm. thick.

The insulation shall have properties in accordance with ASTM C533 Type 1, however,

- bonded for service temperature up to 650°C
- average density 225 Kg/m³ with a minimum of 175 Kg/m³
- Ph value shall be preferably 7-8 and not more than 10
- Blocks for vessels and equipment shall be supplied in manufacturer's standard dimensions
- Insulation for piping shall be supplied in two-piece sectional or multi-piece segmental form. The number of segments shall be kept to a minimum. The length of each insulation section for piping shall be 1 m.

12.3 FASTENING MATERIALS

- BAND

The band material strapping bands and distance rings shall be minimum 0.5 mm. thick and be of 10, 20 or 25 mm. wide stainless steel AISI 304.

- SELF-TAPPING SCREWS

Self-tapping screws shall be 4.8 mm dia. x 12 mm. long hard aluminium or stainless steel with slotted pan head or round head.

- RIVETS

Rivets shall be hard aluminium or monel and of the expanding type, having a diameter of at least 5 mm.

- CLIPS AND QUICK-RELEASE TOGGLES

Clips and quick-release toggles shall be of stainless steel.

12.4 SHEET MATERIAL

Aluminium sheet shall be applied, half hard quality meeting ASTM B209, Alloy 1060, Temper H14. Thickness of sheet shall be as follows for outside diameters of insulation:

- 0.8 mm up to 500 mm.
- 1 mm over 500 mm.

12.5 INSTALLATION

Insulation shall be applied in the minimum number of layers to obtain 25 mm. thickness.

Rigid pipe insulation in semi-circular may be sized in accordance with ASTM C585.

All steel surfaces to be insulated shall be dry, clean and free from rust, loose mill scale, grease and dirt, and primed in accordance with the specification for painting before the insulation is applied.

For piping up to 400 mm. nominal size incl. the rigid insulation sections shall be fastened to the pipe with binding wire at intervals of 25 cm.

For piping over 400 mm. nominal size and vessels insulation sections shall be fastened at intervals of 50 cm. with strapping bands of:

- 10 mm for diameters up to 1.80 m.
- 20 mm for diameters from 1.80 m to 3.00 m.
- 25 mm for diameters from 3.00 m and larger.

For vessels and piping over 400 mm. angular support rings are required for vertical surfaces at suitable intervals (depending of the rigidity of the insulation) allowing for thermal expansion.

Protective sheeting shall be applied with a minimum overlap of 50 mm.

Openings in the sheets for nozzles, etc., shall be provided for. These openings shall be properly closed to prevent ingress of water.

Sealing shall be done by a silicone rubber compound, e.g. DOW Corning 781.

For bandages fire-resistive, vermin and rot proof materials shall be used.

If flanges, valves and fittings have to be insulated, these shall be provided with removable boxes. The stuffing box gland of valves shall be kept outside of the insulation box.

The boxes shall be secured by hinges and quick-release toggles, self tapping screws or strapping bands.

13.0 SPECIFICATION FOR WRAPPING AND COATING OF PIPE AND FITTING

This Article covers the minimum requirements for surface preparation, priming, and tape wrapping of pipes and fittings.

13.1 CONTRACTOR'S RESPONSIBILITY

The contractor shall notify the COMPANY in good time before any cleaning, surface preparation, priming or wrapping work is carried out, and shall not proceed with further work on any one section until the previous work carried out has been formally accepted.

The contractor shall provide at all times a high level of fully competent supervision to ensure that the specification is complied with.

The contractor's representative shall be capable of monitoring and keeping records of:-

- Weather conditions, relative humidity, dew point, ambient air temperatures (recording maximum and minimum each day), steel temperature.
- Wet and dry film thickness of applied primer. Surface preparation to ISO 8501-1. Assessment and measurement of surface profiles on blasted steel. Operating high voltage holiday detection equipment of an approved type.

13.2 INSPECTION WORK

The COMPANY shall have the right to inspect at all times any primer and tape stock, tools, plant instruments, staging, or any other material or equipment used or to be used in the performance of the tape wrapping application. In addition the COMPANY shall have the right to inspect at any time, any and all priming, or wrapping, or cleaning, or surface preparation work whether in progress or completed; and reject any work, or materials, or equipment which does not conform to the specification. Condemned coating applications shall be marked up with paint of a contrasting colour. Any condemned work, defective preparatory work, or any other work not conforming with the specification shall be re-done by the contractor at no additional cost to the COMPANY. Similarly any condemned tools, instruments, materials, or equipment shall be replaced or rectified at no additional cost to the COMPANY.

13.3 REPORTS

The COMPANY may require reports of the contractor at the beginning or each working day giving details of the following for the previous day, and subject to agreement prior to commencement of the work:

Weather conditions, relative humidity, maximum and minimum air temperature, work carried out, paint etc. used and batch numbers, wet and dry film thickness achieved, anomalies, progress of work versus approved program, dew point, steel temperature.

13.4 CODES AND STANDARDS

In addition to this general specification, the following shall apply:-

- a) Paints and varnishes — Corrosion protection of steel structures by protective coating systems ISO 12944 part 1-8.
- b) ISO 8501- Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness.
- c) Steel Structures Painting Council (USA) SSPC.

SP 1 :- "Solvent Cleaning"

SP 3 :- "Power Tool Cleaning"

In so far as any of the above Codes and Standards contradicts any paragraph of any one particular specification the former shall prevail.

13.5 SYSTEMS

As a general rule all tape wrapping materials as well as all manufacturers, suppliers and applicators of such systems shall be acceptable to and approved by the COMPANY.

All priming and coating system shall be applied in accordance with this general specification.

The contractor shall not substitute any other system for that which is specified, nor make any change of manufacturer or supplier, or in any other way change or vary the specification without the written approval of the COMPANY.

Any work carried out where unauthorized changes in specification have been made as described in previous sub paragraph shall be rejected by the COMPANY and redone at contractor's expense to this specification provided by the COMPANY.

13.6 APPLICATION

13.6.1 SAFETY

The contractor shall observe the COMPANY's safety regulations, and also/carry out immediately any additional fire and/or safety precautions requested by the COMPANY.

13.6.2 BLASTING EQUIPMENT

The compressed air supply used for blasting shall be free from water and oil. Adequate separators and traps shall be provided and these shall be kept emptied of water and oil. Accumulations of water and oil shall be removed from the air receiver by regular purging. The blasting abrasive shall be discharged with a pressure at the nozzle (measured with a hypodermic pressure gauge) of 100 p.s.i. and shall not under any circumstances fall below 90 p.s.i. Tungsten Carbide Venturi nozzles shall be used and discarded when wear reaches 50%. Blasting nozzle must be Dead-Man-Handle type, i.e. air pressure must be isolated as soon as

the handle released. The blasting operators hood or headgear shall be ventilated by clean cool air served through a regulator / filter to prevent blasting residues from being inhaled by the operator. Blasting equipment shall be earthed and conductive hoses used to prevent build-up of static electricity.

13.6.3 STORAGE OF WRAPPING MATERIALS

All wrapping materials, primer etc. shall be delivered to site in the suppliers original sealed containers with labels intact and seals unbroken. They shall be stored in a secure, well ventilated storage place assigned for this purpose. Storage areas shall be kept clean and tidy. Care shall be taken to rotate stock correctly to prevent any material exceeding its recommended storage life. Certain materials have a limited storage life in tropical conditions and special care shall be taken in this case and if necessary air conditioning storage used to provide an adequate storage life.

13.6.4 WEATHER CONDITIONS

The COMPANY shall have the right to stop all cleaning, surface preparation, or coating work in unsuitable weather conditions including but not limited to:

- High wind speed
- Airborne dust or sand
- Rain, fog or mist
- Steel temperature over 50°C or under 5°C
- Steel temperature less than 3°C above dewpoint
- Air temperature less than 5°C
- Relative humidity greater than 85%
- Where there is a likelihood that weather condition will change within 2 hours such that the above conditions apply.

13.7 SURFACE PRAPARATION

13.7.1 IRREGULARITIES

All weld spatter, slag, weld strikes, surface laminations, and sharp edges should be removed by chiseling and grinding.

13.7.2 SOLVENT CLEANING

Solvent cleaning to remove any oil or grease shall be in accordance with SSPC: SP1 "Solvent Cleaning" of the Steel Structures Painting Council (USA). Solvent cleaning shall be carried out normally prior to blasting or power tool cleaning. Should any traces or smudges of oil or

grease be discovered on the blasted surface these shall be removed by solvent washing and the whole area re-blasted.

No acid washed, or other cleaning solutions, or solvents shall be used on metal surfaces after they are grit blasted prior to priming application. This includes inhibitive washes intended to prevent rusting.

13.7.3 BLAST CLEANING

Where specified, the contractor shall carry out blast cleaning to a visual standard in accordance with ISO 8501-1 immediately prior to priming to standard Sa 2 1/2.

All abrasives used shall be free from dust, moisture, salts, and any other impurities.

Blast cleaning shall not be conducted when the steel surfaces are less the 3°C above the dewpoint of the air; or when the relative humidity of the air is greater than 85%. For the relationship between relative humidity, ambient air temperature, steel temperature, and dewpoint see appendix 5 should be referred to. Blasting shall not be carried out in areas close to priming operations and wet coated surfaces to avoid dust and grit contamination.

Blasting shall only normally be carried out during daylight hours, except where the written approval of the COMPANY has been granted.

The maximum speed and most effective cleaning is obtained by even, systematic blasting. Work should be blocked out in one-foot squares and each square blasted evenly until complete. (Except where spot blasting is specified).

All weld areas, crevices, bolt heads, etc. shall be given special attention. Prior to blasting all weld spatters, slag, weld strikes, laminations and sharp edges should be all removed by chiseling and grinding following by blasting. In cases where such defects are revealed by blasting e.g. laminations they shall be removed by grinding smooth, and afterwards be re-blasted to provide the correct profile to give a satisfactory paint adhesion.

Any blasted surface not primed within four hours or wet by rain or moisture shall be re-blasted. Under no circumstances may blasted areas be left overnight and primed the next day.

13.7.4 POWER TOOL CLEANING

In case it is accepted by the COMPANY that blast cleaning is not required; power tool cleaning will be carried out in accordance with SSPC:SP3 "Power Tool Cleaning" of the Steel Structures Painting Council (USA), and to a visual standard in accordance with ISO 8501-1 to St 3.

Areas prepared for priming by power tool cleaning shall be primed within four hours.

13.7.5 HAND BRUSHING

If not otherwise possible, hand wire brushing to a visual standard in accordance with ISO 8501-1 to St 2 shall be carried out. The application of this technique is subject to the written approval of the COMPANY.

13.8 WRAPPING APPLICATION

Any surfaces to be primed shall be rendered dust free prior to the application of the primer. This is normally done by blowing off the surface with clean, dry, compressed air.

13.8.1 PRIMING

No primer shall be used which has exceeded its marked shelf life or has thickened to such an extent that more than 10% by volume of the correct thinners is needed to bring it to brushing consistency. The oldest primer in stock should normally be drawn to ensure correct stock rotation. Only thinners supplied by the manufacturer of the primer/wrap package shall be used.

Application of primer shall be done according to manufacturer's recommendations, also with regards to film thickness, drying time, etc. In the case of conflict between this specification and the manufacturer's recommendation, the later will apply.

No priming shall be applied unless :

- The surface is clean, dry and free from dust, oil and grease.
- The surface is at least 3°C above dewpoint.
- The relative humidity is less than 85%. The ambient air temperature is above 5°C.
- The surface temperature is between 5 and 50°C.

In addition where there is a likelihood that within the hours there will be a change in weather conditions such that the above conditions would not be fulfilled, or where moisture may be deposited in the form of rain or condensation, priming shall not be carried out.

The film thickness is to be checked with the calibrated film thickness gauges supplied by the contractor. These gauges may be of the magnetic pull-off or electronic induction type, in each case the gauge shall be calibrated twice daily by the contractor's Supervisor using shims of known thickness over a steel surface which has been prepared to the same specification as the work surface.

13.8.2 WRAPPING

Both inner and outer wrap should be from the same manufacturer as the primer. For pipes up to 300 mm diameter it is good practice to use a tape of width matching approximately the diameter of the pipe. Alternatively manufacturer's specifications should be adhered to. The outer wrap should have an adhesive to ensure a firm bond to the inner wrap. After sufficient

drying of the primer as under section 12.8.1, the inner wrap will be applied with an overlap of 50% under sufficient consistent tension to avoid entrapment of air, wrinkles, lack of adhesion etc. Depending on the size of an occurring defect the tape should be cut and patched or renewed, subject to the approval of the COMPANY at the expense of the contractor.

After having made sure that above defects have been rectified, the wrapping shall be inspected for holidays using a holiday detector set at 10 kV or as per manufacturer recommendation and according to NACE SP0274 to suit to the layer thickness. Pinholes found should be patch repaired by the contractor.

After this inspection, necessary repairs and approval of the COMPANY, the outer wrap should be applied with an overlap of 50% under sufficient consistent tension to avoid entrapment of air, wrinkles etc. Occurring defects by visual inspection, should be repaired as for the inner wrap. Care should be taken not to damage the inner wrap during repair. The wrapping machine to be used shall be subject to approval by the COMPANY.

When a new roll of both inner and outer wrap starts, the end of the old one should be unrolled about 1/3 of the pipe circumference; the new roll starts beneath the flap.

13.8.3 FINAL INSPECTION

The COMPANY shall carry out a final inspection of the work with respect to adhesion, bubbles, wrinkles, etc., prior to giving approval to the work done. Areas with lack of adhesion shall be redone completely according to this specification at the expense of the contractor. Other anomalies will be repaired as under section 12.7.3.

13.8.4 LOWERING - IN

After final approval the pipe should be lowered in as soon as possible, but certainly within one week. A suitable backfill free of stones, etc. should be applied. Care shall be taken not to damage the wrapping during this operation.

Damage should be repaired as under section 12.8.2 at the discretion of the COMPANY. All handling equipment shall be maintained properly and kept in good order to minimize damage to the wrapping.

13.9 SITE CLEARANCE

On completion all waste resulting from the wrapping work, surplus materials and equipment shall be collected and promptly removed from the work site.

13.10 COATING

This Article of the specification covers the minimum requirements for the external field coating or wrapping of buried pipeline joints, pipeline fittings, miscellaneous piping and piping expected to be under water during the flooding season.

13.10.1 MATERIALS AND EQUIPMENT

COMPANY shall supply tape, primer, P.E. repair sticks and wrap around shrink sleeve kits as needed.

Contractor shall supply all consumables, equipment and manpower required for a skillful and adequate application of coating and wrapping in the field in accordance with this specification.

The materials shall be stored as long as possible in the Manufacturer's original packaging, away from direct sunlight and in accordance with Manufacturer's instructions.

Contractor shall furnish a fully automatic, adjustable holiday detection system to provide complete electrical inspection of the coated part of the pipeline.

13.10.2 FIELD JOINTS

COMPANY shall supply Nitto wrap around shrink sleeves for the field joints. The sleeves shall be of a high density radiation cross-linked polyethylene with an adhesive temperature and the pipe and ambient temperatures foreseen during construction.

Contractor shall propose the application procedure for COMPANY approval. The application procedure shall be at least in accordance with manufacturer's instructions and the minimum requirements specified below, whichever are the most stringent.

After the weld is completed and has passed non-destructive testing, the exposed steel shall be cleaned by power wire brushing to obtain a cleanliness equivalent to ISO 8501-1 St. 3. All burr edges of the coating and other sharp points shall be removed by filing or grinding. Grease and oil shall be removed by a volatile solvent. Polythene pipe coating shall be cut back and chamfered if corrosion is visible underneath the coating.

The pipe joint shall be preheated to 60°C. Propane torches of a suitable type can be used. To ensure that the required preheat temperature has been achieved, a pyrometer or temperature indicating crayons shall be used.

The wrap around sleeve shall be wrapped entirely around the joint with the closure patch to one side of the pipe undergoing layer facing upward.

Heat shall be applied in such a manner that all entrapped air is forced out either end using gloved hands and hand rollers. Special attention must be given to the closure patch and overlapping areas.

The installed sleeve must be left undisturbed until the adhesive solidifies.

The sleeves shall be visually inspected for the following points:

- a. Adhesive extruded from the ends of the sleeve indicates proper application. The ends of the sleeve shall be firmly bonded to the surface of the coated pipe.
- b. There shall be no sign of punctures or pinholes, the external appearance of the sleeves shall be smooth and without dimples.

All sleeves shall be inspected with a holiday detector set to a DC voltage of 22000 volts for PE coatings and 2000 volts for Epoxy coatings. In case of failure through pinholes or mechanical damage, the sleeve shall be removed and replaced.

Destructive testing criteria will be as follow:

- The sleeve backing shall be cut axially and removed. After removal the bulk of the adhesive shall still adhere to the pipe surface. The adhesive layer remaining on the pipe surface shall be essentially free from voids that include bare metal holidays.
- Voids that include bare metal holidays shall be measured from the nearest extremity of the holiday to the edge of the voids at its greatest distance. If that distance is over 1 inch, the test will have failed and will be repeated at the sleeves at both sides of the sleeves failed and so on.
- Small voids are acceptable as long as there are not bare metal holidays. Similarly an accumulation of voids may be acceptable at the option of COMPANY provide they are not interconnected.
- The tests will all continue until the sleeves inspected are acceptable.

Contractor shall replace rejected sleeves at no cost to COMPANY.

13.10.3 TAPE WRAPPING PROCEDURES

Tape wrapping or to be buried pipes and fittings shall be carried out in accordance with tape manufacturer's specification or, if more stringent, as follows:-

Clean the coated steel by power wire brushing or sandblasting to ISO 8501-1 St. 3. Apply by brush one coat of the primer delivered with the tape. Wait until the primer has dried to a sticky condition. Apply tape in four layers with 50% overlap, two in clockwise and two in anticlockwise direction. The end result is that each location is covered by four smooth layers of tape without wrinkles.

13.10.4 COATING REPAIR PROCEDURES FOR POLYTHENE COATING

The field coating repair procedure shall be in accordance with manufacturer's recommendation and subject to COMPANY's approval.

Minor damages of polythene coating may be smoothed out using a torch and a not iron.

For medium size damages of polythene coating which covers an area of 1 cm maximum, a thermoplastic repair stick may be used. All loose coating material is to be cut off.

Major coating repairs shall be accomplished with wrap around shrink sleeves in accordance with section 12.10.2 after all loose coating and adhesive has been thoroughly removed.

14.0 SPECIFICATION FOR PROTECTIVE COATINGS OF BELOW GROUND STRUCTURES AND PIPE FITTINGS

This specification covers the protective coating of buried structures with a site applied PVC/laminate tape system.

14.1 TAPE COATING

i. Scope

The materials, site application and testing of the tape coating shall be in accordance with AWWA C209 and this specification.

ii. Materials

Tape shall be a cold applied, self-adhesive type, comprising of a bituminous resin adhesive on a PVC backing layer generally complying with AWWA C209.

Total thickness of the tape shall be 1.65 mm minimum and thickness of the PVC backing shall be 0.75 mm minimum, unless fabric reinforcement is provided in the bituminous resin, in which case thickness of the PVC backing shall be 0.5 mm minimum.

Tape width shall be suitable to conform to the size and shape of the structure being wrapped.

Primer shall be that which is recommended and manufactured by the Tape Manufacturer and be a fast drying compound, suitable for cold application by spray or brush.

Mastic filler shall be suitable for profiling and be that recommended and manufactured by the Tape Manufacturer.

iii. Application

Surfaces shall be wire brushed to remove all rust, mill scale, weld spatter, dirt and other loose or deleterious matter.

Where applicable, factory coating ends shall be wire brushed for a minimum distance of 150 mm, ensuring coating ends are beveled.

Primer shall be applied immediately following completion of surface preparation in accordance with AWWA C209 and manufacturers recommendations.

All surfaces to be wrapped shall be primed and allowed to dry.

Primer application shall be limited to that amount that can be wrapped during the working day, after which re-priming or stripping and re-priming will be required.

Tape shall be applied in a spiral fashion by hand or hand operated machines to provide a 55% overlap and with sufficient tension to give constant adherence without voids or wrinkles.

Interleaving shall be removed and discarded as wrapping proceeds.

Where applicable, the tape wrapping shall commence and finish to give a minimum of 150 mm overlap to epoxy coating. On completion of the wrap, the surface of the tape shall be

smoothed by hand to ensure complete sealed overlaps and absence of air pockets under the tape.

14.2 BURIED VALVES AND FITTINGS

Buried valves and fittings shall be coated to the same standard as pipe. After surface preparation and priming, all protrusions and indentations shall be profiled with mastic before tape wrapping.

14.3 CABLE/PIPE CONNECTIONS

Pin brazed cable/pipe connections shall be coated to the same standard as pipe. After completion of the cable connection the cable tail shall be secured to the pipe cleaned, primed and profiled with mastic before tape wrapping. The tape wrapping shall have a minimum of three and a half circumferential pipe laps.

14.4 FACTORY COATING REPAIR

Damaged factory applied coating shall be repaired using the tape system.

Edges of the factory applied coating at the damage area shall be feathered and any bare steel prepared to ISO 8501-1 St 3 standard. The prepared area shall be then primed and mastic used to restore the original thickness of the factory applied coating. The complete area shall then be spirally tape wrapped with the wrapping beginning and finishing a minimum of 150 mm from the edge of the damaged area.

14.5 INSPECTION

Inspection of the coating shall be visual, for satisfactory adhesion and 100% 'holiday' inspection by a holiday detector set at the working voltage.

The applied tape shall be inspected for satisfactory adhesion by confirming that effective bond is formed between the pipe surface and the tape. This inspection shall be carried out not less than 24 hours after application.

The working voltage for 'holiday' inspection shall be set at least twice per working day by the following method :-

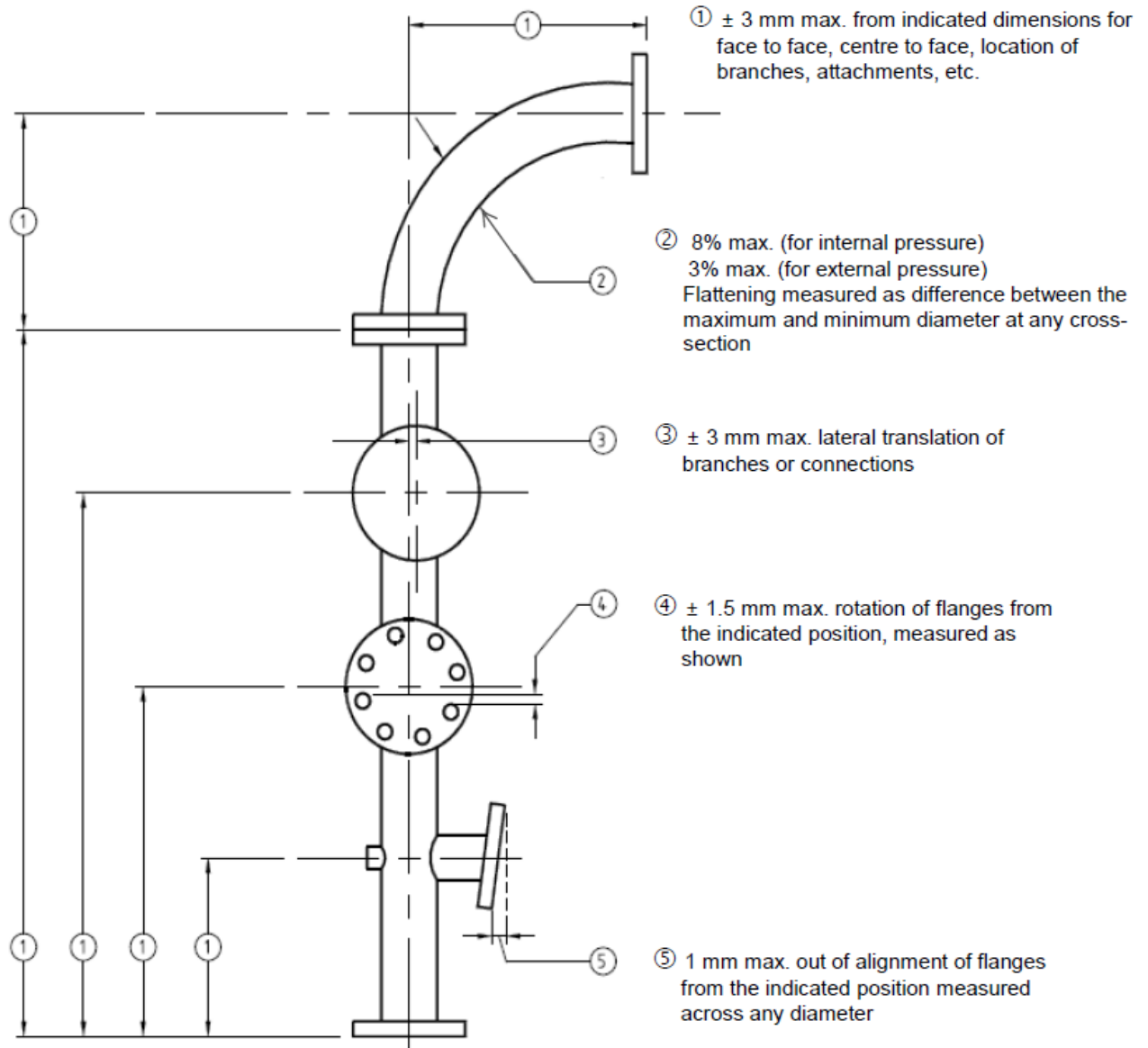
- Three layers of tape shall be applied on the pipe to form a patch.
- The center of the tape patched by punctured with a sharp instrument.
- The voltage of the holiday detector shall be just high enough to register the puncture in the three tape layers.

The working range of the holiday detector shall be minimum of 9,000 volts and shall not exceed 15,000 volts as recommended by NACE SP0274. Out of range voltage shall require COMPANY approval.

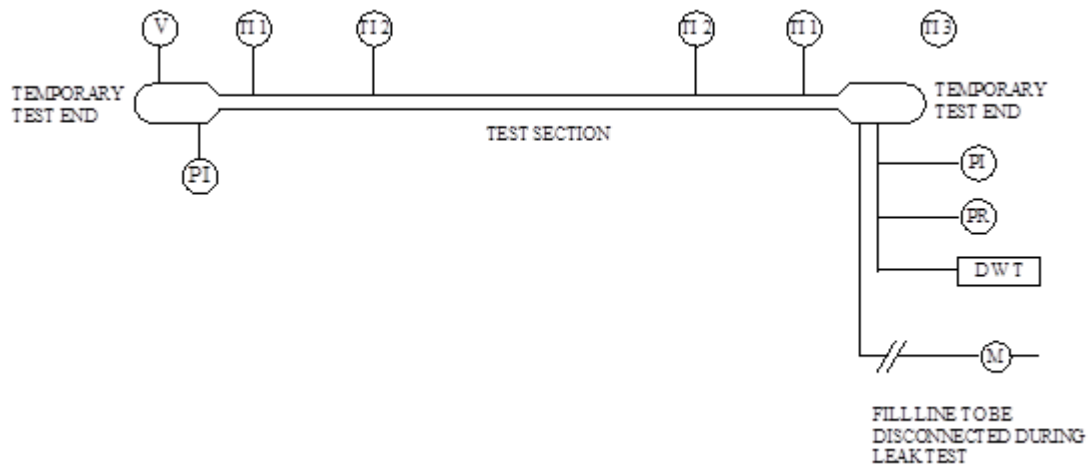
Contractor shall provide High Voltage-Resistance gloves for the tester to prevent from electrical shock in case of power leakage from the holiday detector.

15.0 APPENDICES

Appendix 1. Dimensional tolerance



Appendix 2. Typical schematic of test section



Legend :

PI = pressure gauge, range 1 1/2 times test pressure

PR = pressure recorder, range 1 1/2 times test pressure recording time 24 hrs. minimum.

DWT = dead weight tester, accuracy 0.01 bar, with current calibration certificate

TI 1 = pipe skin temperature probes, sensitivity 0.1°C.

TI 2 = intermediate pipe skin temperature probes, sensitivity 0.1°C.

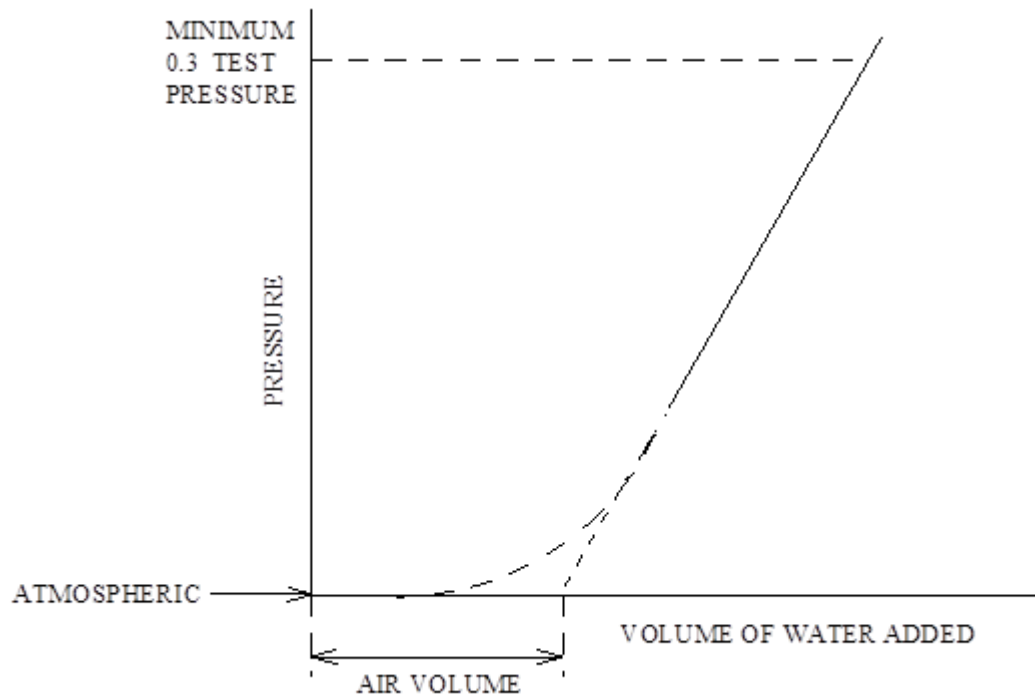
TI 3 = ambient temperature measurement, sensitivity 0.1°C.

V = vent system

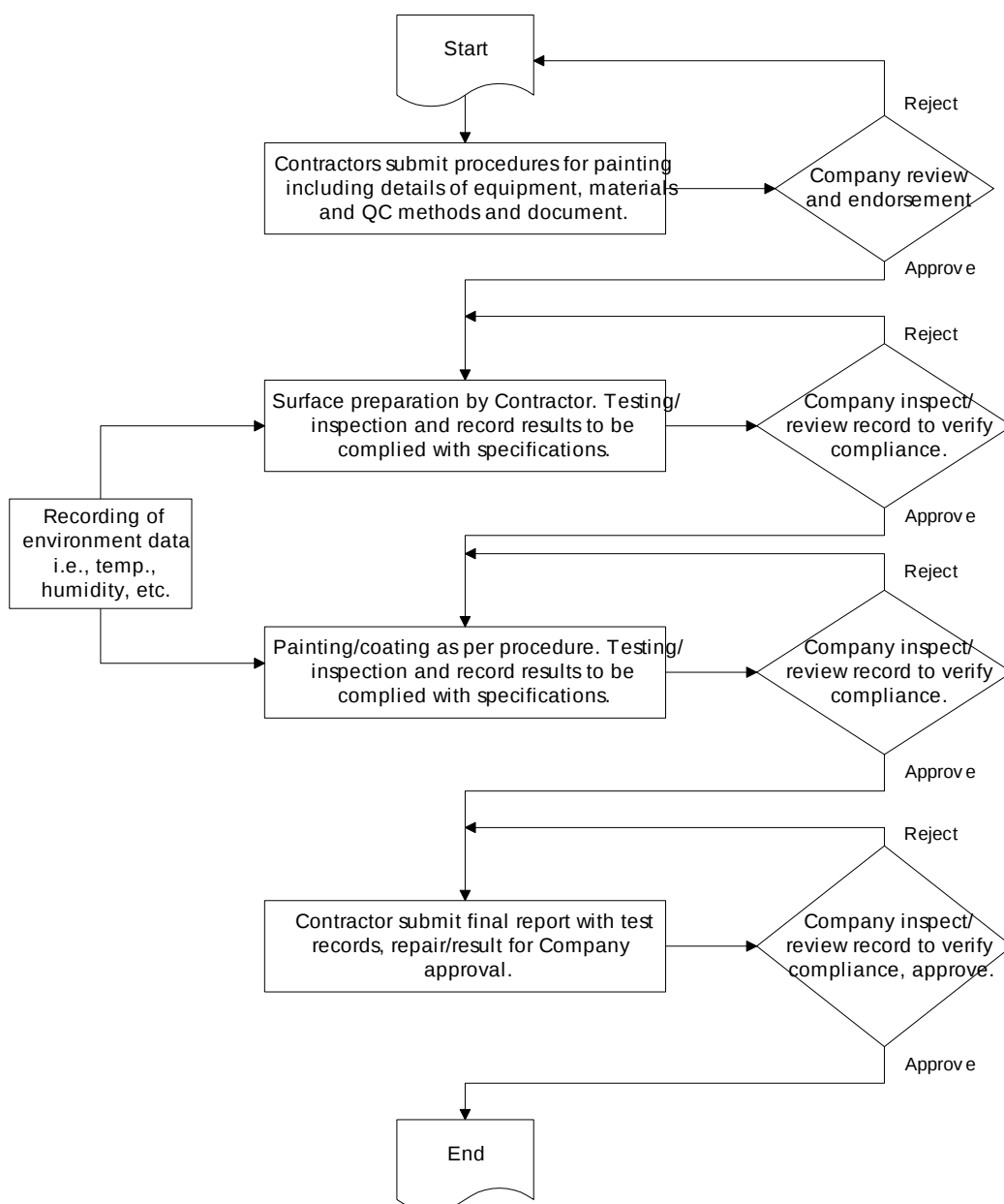
M = volumetric measurement device during pipeline pressurizing, i.e. flowmeter or pump stroke counter.

Note: The use of dead weight tester in pressure test section will subject to COMPANY discretion.

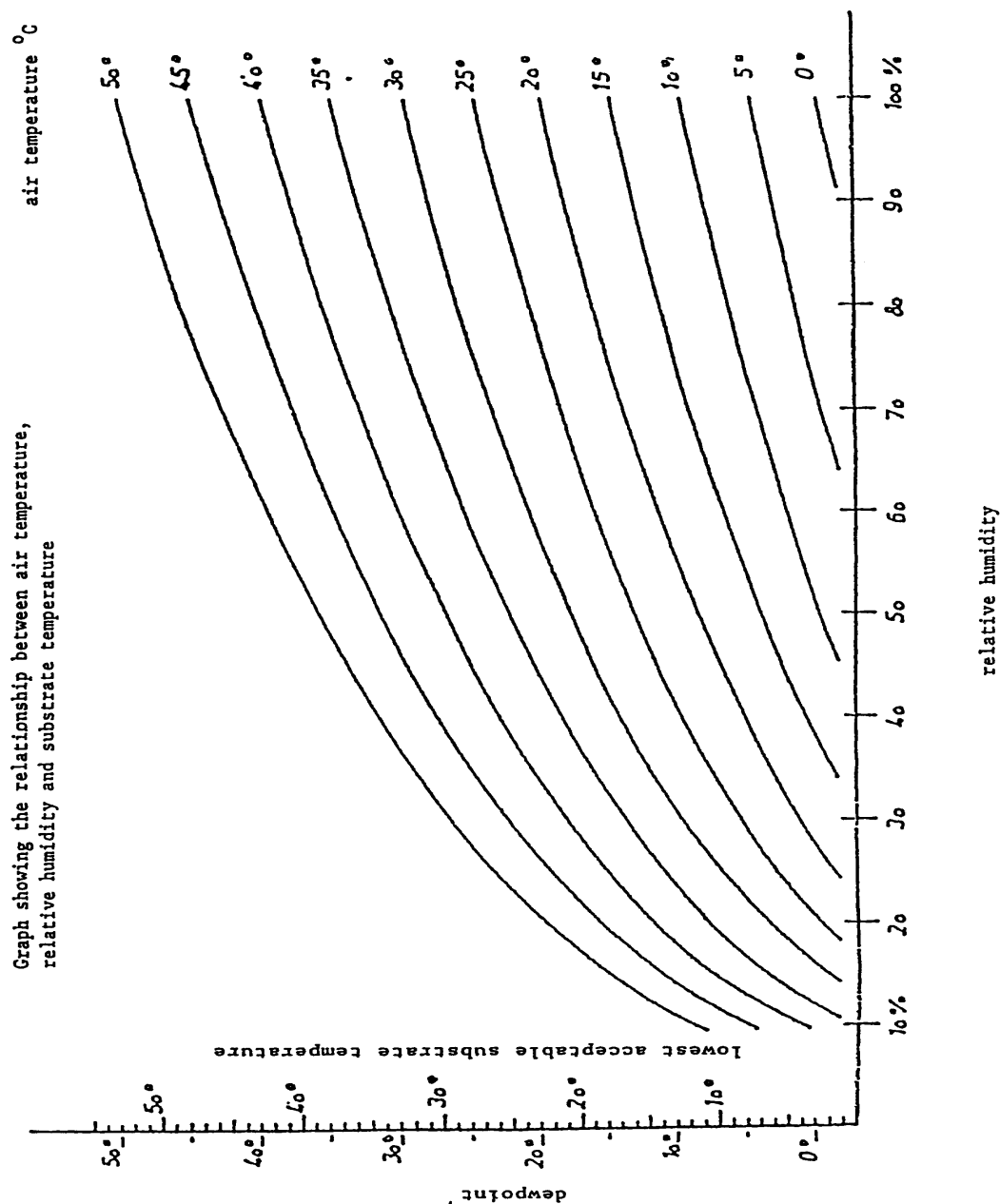
Appendix 3. Determination of residual air volume



Appendix 4. Process schematic for painting



Appendix 5. Relationship between air temperature, humidity and substrate temperature



Graph showing relationship between air temperature, relative humidity and substrate temperature

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