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**TECHNICAL JOB
SPECIFICATION**

181/1

REVISION 1

DATE 02/11/2011

**LNG PLANT
PRESSURE TESTING**

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CHANGES LOG

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REFERENCE DOCUMENTS

- ELOT EN 1473
[Installation and equipment for liquefied natural gas. Design of onshore installations]
- ELOT EN 13480 Series
[Metallic Industrial Piping]
- ELOT EN 13445 series
[Unfired Pressure Vessel]
- EU Directive (97/23/EC) PED

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1.0 SCOPE

This General Specification outlines the minimum requirements for shop and field pressure testing of piping and items of equipment and describes the tests to be performed prior to completion of field construction.

The following constitutes the extent of Contractor's responsibility for testing:

Require a shop pressure test of equipment in accordance with standards and codes governing their design.

Require a field pressure test of vessels fabrication or modified in the field.

Prepare for the field pressure test of piping and equipment, and conduct the test.

This will extend to battery limit valve or blind unless otherwise stated.

It is essential responsibility of the Vendors and Contractor, the preparation and submission to the Owner for approval of a detail test procedure for all above cases.

Specially for cryogenic equipment and piping the "START UP AND OPERATING PHILOSOPHY", included in the Basic Engineering Package, shall be taken into consideration.

2.0 REFERENCES

The following documents are referred to in this General Specification. The latest editions of these Codes shall be used, except as modified by the standard.

- **ELOT EN 1473 Installation and equipment for liquefied natural gas - Design of onshore installations.**
- **ELOT EN 13480 series Metallic Industrial Piping.**
- **ELOT EN 13445 Series Unfired Pressure Vessels.**

3.0 SHOP PRESSURE TEST OF EQUIPMENT

Shop fabricated pressure vessels, boiler components and exchangers shall be hydrostatically tested in accordance with the applicable design code or standard and **ELOT EN 13445 series** and certified by a Notified Inspection Body in accordance with the provisions of EU directive **PED (97/23/EC)**.

Pumps, their turbine drives and compressors shall be shop hydrostatically tested as specified in the Material Requisition.

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4.0 PREPARATION FOR FIELD PRESSURE TEST OF PIPING AND EQUIPMENT

Restrictions to flow, such as orifice plates and mixing nozzles, shall not be installed or shall be removed. Where necessary, items removed shall be replaced with temporary spool pieces.

All valves within the system to be tested shall be in an open position but not back seated, so as to test the valve stem packing. It is particularly important the control valves be checked to assure that they are in an open position, or that they have a by-pass valve which is fully open.

All joints in the piping system shall be accessible during tests and shall not be painted, insulated backfilled or otherwise covered until satisfactory completion of testing in accordance with this specification.

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. Venting shall be ascertained to be adequate by Contractor before filling commences. All piping system DN 50 and above shall have hydrostatic testing vents at high points.

Equipment which is not to be subjected to pressure test shall be either disconnected from the piping or blocked off during the test.

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Temporary spades and blanks installed for testing purposes shall be designed to withstand the test pressure without distortion. All spades and blanks shall be clearly visible.

Pressure tests or line flushing shall not be conducted through control valves. All control valves and relief valves shall be removed or blinded off during pressure testing.

Piping shall be tested prior to installation of inline items such as relief valves, control valves, rupture discs, displacement and turbine meters, orifice plates, flow nozzles, level gauges rotor meters, strainers etc, or the connection of instruments to the piping system to be tested.

Expansion bellows and spring supports shall be restrained or removed during hydrostatic testing.

Drain points and fluid disposal after testing shall be subject to approval by Supervision.

4.1 INSTRUMENT LEAD LINES

Instrument lead lines in Group 1 dangerous fluids shall be pressure tested. Pressure testing of instrument lead lines may not be performed for Group 2 fluids. (Grouping of fluids as per EU Directive **PED 97/23/EC**)

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Piping ends intended for attachment of instruments shall be capped, plugged or blanked during the test. This may require that the instrument be both disconnected and moved on its support, temporarily removed, or scheduled for installation after conduct of the pressure test.

4.2 TEST SECTION BOUNDARIES

Equipment which is not to be hydrostatically tested in the field shall be effectively isolated from field tested equipment (if any) and piping.

In-line instruments whose maximum rated pressure is less than the hydrostatic test pressure, e.g., sight flow indicators, shall be removed. Insert-type instruments such as special flow meters and analyzer elements shall also be removed.

The project engineer shall both designate and determine the testing requirements for piping system, and shall define the fluid test medium and the test pressure in the Line List.

The selection of the piping to be tested in any one system shall be made to include the maximum amount of piping consistent with the test fluid and the test pressure.

A section isolated for testing shall be tested at the highest pressure required at any point in that section, if the stress will not exceed the minimum yield stress at any point.

This will be the criterion for designating the boundaries of test sections. All pneumatic instruments and controls shall be effectively disconnected from the air lines during blowing of instrument air systems.

Relief and safety valves shall be blanked off by bolting a blind to the mate of the inlet flange.

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Threaded relief and safety valves shall be removed and replaced with caps. Test gags shall not be used.

Flanged and threaded joints and all welds which have not been pressure tested shall be left bare of insulation and unpainted.

All underground pressure piping joints except those encased in concrete anchors shall be left exposed.

The function of the anchors is to prevent pull-out of O-ring, bell and spigot and mechanical joints.

Where such joints fail to hold test pressure, more or larger anchors shall be provided as necessary.

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Welded attachments, such as pipe supports and hangers, shall be made before pressure testing.

Lines containing check valves shall have the source of pressure on the upstream side of the valve. If this is impossible, swing checks shall be blocked open or their flapper removed, whereas ball and piston checks shall have their internal parts removed. All parts removed shall be put in a sack and wired to the valve. If none of these is practical, the check valve shall be blocked off or completely removed.

Expansion joints shall be provided with temporary restraints, if necessary, to enable them to withstand the test pressure or they shall be excluded from the test.

Hand-operated valves within a test section shall be temporarily tagged with large red "Caution" tags or a similar identification to avoid accidental operation during filling or testing. These will also help in identifying the test section.

Minor equipment (e.g. strainers, traps), may be included in a piping test system provided the equipment test pressure is equal to or greater than the piping system test pressure.

5.0 FIELD PRESSURE TEST OF EQUIPMENT

Field fabricated vessels shall receive a hydrostatic test where supports, foundations and subsoil permit, or where the static head of test fluid does not impose unreasonable thickness requirements. Drawings shall specify the exact testing requirements. When using water with chlorides content greater than 5 ppm the test time, including filling and draining, shall not exceed seven days.

The pressure test performed on field fabricated vessels shall be in accordance with the provisions of **EN 13445 series**. When a straight hydrostatic test cannot be performed, a combined pneumatic-hydrostatic test shall be performed.

Where valves are to be installed on vessel nozzles, it is preferable that the pressure test be made with these valves in place, rather than with blinds on the nozzles. In some instances, however, the test pressure may be above that of the closed valve seat, making use of a blind mandatory.

For field fabricated vessels (i.e. tanks & spheres) use of blind flanges is mandatory.

Tubing in the radiant section of a fired heater shall be pressure tested as specified in the requisition. Tubing in the convection section shall be inspected and stamped as described in Para.6.0 below.

Pumps, turbines, blowers and compressors shall not be subjected to a pressure test in the field. They shall be protected by removing plugs, opening drain valves

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and removing blind flanges. Flanged joints not tested shall be visually examined to insure that gaskets are installed, bolts tightened, etc.

During hydraulic test of tanks & spheres all pipes, if already connected, must be disconnected from the tank (or sphere) to avoid damages to pipes and supports during foundations settlement, even if foundation has been built on piles.

6.0 FIELD PRESSURE TEST OF POWER BOILERS

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Field assembled boilers, including Boiler External Piping, shall receive a hydrostatic pressure test using water at ambient temperature, but in no case less than 6 °C.

The test pressure for the boiler system shall be 1 1/2 times the maximum allowable working pressure (MAWP) as shown on the data report on the boiler nameplate.

The test pressure may then be reduced to MAWP and maintained at this pressure while the boiler is carefully examined. The metal temperature shall not exceed 49 °C during the close examination.

Where the superheater outlet piping has a design pressure less than the MAWP of the boiler, the hydrostatic test pressure shall not be less than:

1 1/2 time the MAWP at the superheater outlet.

1 1/4 time the MAWP of any part of the boiler nor shall the stress exceed 90% of any materials yield strength at test temperatures.

6.1 TEST PRECAUTIONS

Test pressure shall not be calculated using a ratio of allowable stress at test temperature to that at design temperature.

Boiler systems shall not be divided into test loops so as to allow testing of lines at various pressures such as pump shut-off, relief valve setting, etc.

The required test pressure shall not be exceeded by more than 6%.

6.2 INSPECTION AND CERTIFICATION

Based on regulatory (PED 97/23/EC) and certification requirements the boiler hydrostatic pressure test may be witnessed by a Notified Body in order to cover the requirements of the conformity assessment module that has been used.

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7.0 FIELD PRESSURE TEST OF PIPING

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General

Piping shall be pressure tested in accordance with the same European Standard edition to which that piping was designed and fabricated. Piping Material Requisition shall specify the European Standard.

Before starting pressure testing, the unit shall be divided into hydraulic circuits.

A hydraulic circuit is a piping system used for a specific product. Each hydraulic circuit shall be further divided into hydrotest sections, that in the piping systems to be tested at the same pressure.

Hydraulic circuits and hydrotest sections shall be marked-up and numbered on the corresponding Engineering Flow Diagrams (EFD), kept in piping contractor's file.

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Pressure Test Preparation

Contractor will prepare a marked up of p&id indicating the test limits and will divide the piping into suitable test sections.

All the required documentation for the proposed test sections shall be submitted for approval to Supervision.

Contractor shall not test through equipment without Owner's written approval.

Pressure Test Documentation

- Pressure test report for Piping
- Marked-up PID
- Blind check list
- Welding History Report and Welding Joint Marked ISO Drawing
- NDE Report
- PWHT and Hardness test Report
- Post – Test Punch List (contractor + Client)
- Copies of reinforcing pad pressure test certificates (If necessary).

Pressure test documentation will include the latest available revision of each isometric covering the scope of the test.

- a. Test limits, and highlight line to be tested.
- b. Size (thickness) and location of all test blinds and including those required at instrument connections e.g. orifice flanges.
- c. Identify location for the connection of the fill and drainage points for the system.
- d. Vent points
- e. Drain points
- f. Location and range of pressure gauges to be used. Minimum (2) Calibrate gauges enquired, one located at an accessible low point of the test and one gauge located at the highest points on the test manifold.
- g. Any other special requirements such as chloride content if applicable.

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Permit for Pressure Testing

All pressure test documentation shall be submitted to Supervision for review and approval. Pressure testing shall not be performed prior to completion of the documentation review. A written pressure testing permit shall be issued.

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Pressure Test Requirements

Piping shall be divided into test sections by closing valves when the valves are a part of a piping system and the test pressure on the valve shall not exceed that used in its seat test, normally 10% higher than the ambient temperature rating. If the system test pressure is to be higher, the valve shall either be opened and blanked or removed to allow blanking of the adjacent flanges or the system shall terminate elsewhere.

The minimum hydrostatic test pressure of a system shall be determined as follows:

The hydrostatic test pressure shall be not less than the greater of the two values determined by the following:

$$P_t = 1.43 PS$$

or

$$P_t = 1.25 PS (f_{test}/f)$$

where

P_t = Hydrostatic test pressure, bar

PS = Design pressure, bar

f_{test} = Nominal design stress for design conditions at test temperature in N/mm²

f = Nominal design stress for design conditions at design temperature in N/mm²

The line list will identify any low pressure piping with operating pressure below 1 bar and fluids that do not belong to group 1 dangerous fluids. Such piping need not be pressure tested. Sewers and non-pressure drains shall be filled with water to grade, but no pressure other than static head need be applied.

Short lines that are normally open to atmosphere (e.g., vents, drains, and safety device discharge piping) shall not be pressure tested. All joints in such lines shall be visually examined for proper installation.

Testing shall be performed on all interconnected lines able to contain the same test pressure, in preference to the testing of individual lines or single components of a system. The breaking of joints to insert blanks for hydrostatic testing shall be avoided wherever possible.

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The system under test shall be held at full test pressure until all joints are examined. Duration of pressure test will be on hour minimum on each system tested.

8.0 HYDROSTATIC TESTING

The pressure test procedure shall be as follows:

Piping and equipment shall be thoroughly vented of air during introduction of the hydrostatic test fluid.

The fluid used for hydrostatic testing shall be at 15 °C minimum when entering the piping system. The test pressure shall be applied when the metal and its contents are at about the same temperature. Metal temperature shall not be allowed to fall below 7 °C or its Nil Ductility Temperature (NDT), whichever is higher, while the metal is under stress.

These minima shall also apply to tightening of bolts to seal flange leaks which the test has disclosed.

Precautions shall be taken, by opening vents or by other means, to prevent building up excessive pressure in portions of the piping section under test. For example, this can occur where the test fluid will be subject to thermal expansion.

If it is proposed that the hydrostatic test fluid be other than water, or that a chemical be added to the water for any reason, Owner shall be consulted and approval granted in writing before proceeding with the testing operation, except as specified in the next item.

The chloride content of the water to be used for testing austenitic stainless steel piping and equipment shall be less than 20 ppm.

Test water shall be removed as rapidly as possible and in no case shall be left in contact with austenitic stainless steel for more than 72 hours. Finally the equipment or piping shall be totally dry out and maintained under 1 barg pressure of nitrogen. Drying shall be verified by dew point measurement to be not higher than -40°C.

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Exchangers or vessels already pressure tested may, at the option of the Supervision be included in the test of their connecting piping.

During such a retest, the test pressure shall neither exceed the lowest test pressure of any exchanger or vessel included nor create excessive support stress or foundation loading.

Where an exchanger or vessel has been blanked off a flanged joint during pressure test of the piping, it shall not be necessary to pressure test the joint after the blank is removed.

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Where piping has been tested to a capped weld because the equipment may not be hydro tested, the root pass of the final weld shall be subjected to magnetic particle or liquid penetrant exam and the complete weld to 100% radiographic exam in lieu of a pressure test.

Pumps, turbines, blowers and compressors shall not be subjected to a pressure test in the field. They shall be protected by removing plugs or opening drain valves.

Flanged joints not tested shall be visually examined to ensure that gaskets are installed, bolts tightened, etc.

Blowers, turbines, compressors must be segregated by any piping test system.

Test pressure readings may be taken at a low point in a system provided that the readings include the addition of the static head pressure required at the top of the system.

The hydrostatic test pressure for the entire system shall be the highest permissible pressure for the weakest component in the system.

Under certain design conditions the stress resulting from the test pressure (P_t) could exceed 90 percent of the minimum specified yield strength at test temperature. A check shall be made to determine if this condition exists.

In such cases the test pressure shall be reduced so that the stress does not exceed 90 percent of minimum specified yield strength at test temperature.

Note :

Austenitic stainless steel and certain other metals have an allowable stress at 90 percent or between 2/3 and 90 percent of yield strength at test temperature.

9.0 PNEUMATIC TESTING

The following shall be pneumatically tested at 110% of design pressure:

- a. Pressure points of instruments in gas or vapor service.
- b. Piping or equipment in vapor service whose supports are not capable of supporting the weight of water required.
- c. Piping or equipment which is refractory lined.
- d. Piping or equipment where moisture cannot be tolerated due to process considerations.
- e. Process air lines.

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All piping which is pneumatically tested shall be brought to final test pressure by easy stages. All joints, welds and connections shall be swabbed with soap solution to facilitate the detection of leaks.

If the pneumatic test pressure exceeds 1.4 barg the pressure shall be held at 1.4 barg until all joints have been inspected for leaks with soap solution. If no leaks are found, the pressure shall be increased in increments of 1 barg until final test pressure is reached.

Soap solution application and inspection shall be repeated at the next 1 barg increment as well as for the final test pressure.

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Pneumatic test pressures in excess 3,5 barg must be approved by the Supervision. Safety precautions to be taken during pneumatic test shall be submitted to Owner for approval.

Marking tape shall be applied across flanged joints, with a small hole for detecting leakage.

When testing instrument air lines and other small systems, a "bubbler" apparatus at the fill point may be used as a check on air leakage.

Note :

For leakage test with air a test pressure of 0.5 barg shall be used.

10.0 SERVICE TESTING

"In service" testing (i.e. testing at normal operating conditions and utilizing service fluid as the test medium) shall be performed on non-hazardous systems, as possible alternative.

Systems for this category are: air, inert gas, water, steam or other non-flammable, non-toxic fluids at design pressure not over 10 barg and design temperature not over 182 C.

A preliminary check shall be made at not more than 1.75 barg and the pressure increased gradually, providing time to equalize strains and examine for leaks.

11.0 VACUUM LINES TESTING

Vacuum lines shall be pneumatically tested at 1 barg.

12.0 TEST EQUIPMENT

Equipment to be used during testing shall have suitable capacity for the range of test pressures required. Pressure gauges shall have a full-scale range between

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150% and 200% of test pressure and an accuracy and sensitivity of 2% of full scale reading.

All pressure gauges and chart recorders shall have been calibrated within 30 days prior to testing. All calibration certificates shall be available on site prior to testing.

A minimum of 2 gauges shall be provided for each test system. One located at the highest point and one located at the pump at grade. A gauge shall also be located at the extremity of each system unless otherwise agreed by the Owner.

13.0 EMPTYING OF WATER

Upon test completion the piping section shall be completely emptied of water using dry compressed air or other suitable methods. Contractor is responsible for proper drying of the section and for proper disposal of the water.

14.0 TEST RECORDS

Records shall be made of each system tested. These records shall include:

- Date of test
- Identification of components tested
- Test fluid
- Test pressure
- Certification by examiner

Pressure test records shall be endorsed by all involved parties and submitted to the Owner as part of the Project Final Documentation Package (FDP).