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TECHNICAL JOB SPECIFICATION
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LIQUEFIED NATURAL GAS PLANTS

SPECIFICATION FOR LOW TEMPERATURE TESTING OF CONCRETE REINFORCING BARS

QUALITY ASSURANCE PAGE

CHANGES LOG

REVISIONS LOG

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1 REFERENCE DOCUMENTS

ELOT EN 10080
[Steel for the reinforcement of concrete. Weldable reinforcing steel. General]

ELOT EN 14620-3
[Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperature 0°C and -165°C – Part 3: Concrete Components]

ELOT EN ISO 377
[Steel and steel products — Location and preparation of samples and test pieces for mechanical testing]

ELOT EN ISO 15630-1
[Steel for the reinforcement and prestressing of concrete — Test methods — Part 1: Reinforcing bars, wire rod and wire]

1. GENERAL

1.1 This specification defines the requirements for low temperature testing of concrete reinforcing bars to be performed by CONTRACTOR. These requirements are additional to the requirements covering re-bars in accordance with **ELOT EN 10080** "Steel for the reinforcement of concrete. Weldable reinforcing steel. General" or other equivalent accepted standards for the use of materials at normal temperatures. All re-bars used in the construction of the storage tanks shall fulfill the following requirements which must be checked in Qualification Testing prior to use in the works and later for Routine Control Testing during construction.

2. QUALIFICATION TESTING

2.1 Method of Testing

2.1.1 Tension testing shall be in accordance with the requirement of **ELOT EN ISO 15630-1** "Steel for the reinforcement and prestressing of concrete — Test methods — Part 1: Reinforcing bars, wire rod and wire".

2.2 Specimens

2.2.1 Specimens shall comprise:

(1) Un-notched.

(2) Notched.

Notch Charpy V as per **ELOT EN ISO 377**, "Steel and steel products — Location and preparation of samples and test pieces for mechanical testing" perpendicular to the bar and symmetrical with regards to a longitudinal rib with a minimum depth of 1.0 mm in the body of the bar (rib height excluded).

2.3 Criteria

1 2.3.1 For un-notched specimens:

(1) Yield strength shall be in excess of the requirements for normal temperatures.

(For materials associated with LNG tankage the increase shall be a minimum of 15%).

(2) Percentage of elongation

(a) On a gauge length of 10 times the diameter 6 %.

(b) If 10 diameters is greater than 150 mm then a 5 diameter gauge length can be taken with a 10% criteria in lieu of 6%.

2.3.2 For notched specimens:

(1) Yield strength shall be in excess of the requirements for normal temperatures.

(2) Average yield strength shall be greater than 0.9 times the corresponding average yield strength of un-notched specimens at low temperature.

2.4 Testing – Additional Requirements

2.4.1 Specimens:

(a) Full section.

(b) Length of specimen shall be sufficient to permit adequate testing with a gauge length of 150 mm.

2.4.2 Temperature Condition:

(a) Central portion of specimen: Stored Product Temperature ($\pm 2^0$C).

Stored Product Temperature shall mean – 170^{0}C for LNG service.

(b) Outer portions of specimen (adjacent to anchorage devices): 5^{0}C colder than the central portion.

(c) During testing up to yield point: maximum increase in temperature 15^{0}C.

2.4.3 Accuracy of measuring devices:

(a) Temperature : $\pm 1^0$C

(b) Load : $\pm$ 0.1%

(c) Elongation : $\pm$ 0.1%

1 **2.4.4 Speed of testing:**

(a) Rate of application of load up to yield point: Not greater than 690 N/mm2 per minute.

(b) Rate of extension of specimen beyond yield point: Not greater than 0,5 mm / mm per minute.

2.4.5 Record of properties:

(a) Stress / strain diagram until fracture.

(b) Determination of yield strength, ultimate strength, elongation after break.

(c) Temperature distribution along the bar.

2.5 Sampling

2.5.1 Samples per batch – 15 samples per batch shall be selected each with a length sufficient to have:

(a) One sixth for an un-notched specimen.

(b) One sixth for a notched specimen.

(c) Two third length to be held in reserve.

2.5.2 Number of batches – 3 no. batches of different diameters representative to usual range of diameter.

One batch shall mean one lot of bars with the same diameter of the same grade and coming from the same origin (but not necessarily the same heat).

Origin of batches: batches shall be taken from a minimum 2 heats and 25 tones minimum per heat.

2.5.3 Number of tensile tests per batch:

(a) For un-notched specimens – 15 No.

(b) For notched specimens – 10 No.

2.5.4 Method of sampling:

(a) Randomly within a whole batch.

(b) With the agreement of OWNER.

2.5.5 Allowances:

In the event that some results fail to meet the elongation requirements, then the following criteria may be employed: avoid possible rejection of materials:

(a) For 10 diameter gauge length:

Individual results not less than 4% if the average range of results is more than 8%.

(b) For 5 diameter gauge length:

Individual results not less than 8% if the average range of results is more than 12%.

3. ROUTINE CONTROL TESTING

3.1 The same requirements as outlined in paragraphs 2.1 to 2.4 for Qualification Testing shall apply for Routine Control Testing.

3.2 Sampling

3.2.1 Samples per batch – 5 samples per batch shall be selected with a length conforming to the requirements for Qualification Testing, paragraph 2.5.1.

3.2.2 Number of batches to sample:

(a) 1 per shipment of the same diameter and each 700 tn.

(b) 2 per shipment of different diameters and each 700 tn (2 batches with different diameters).

One shipment shall mean one or several batches delivered and accepted at the same time.

3.2.3 Number of tensile tests per batch:

(a) For un-notched specimens – 5 No.

(b) For notched specimens – 5 No.

3.2.4 Method of Sampling:

(a) Randomly within a whole batch.

(b) With the agreement of OWNER.

3.2.5 Allowances:

Allowances routine control testing shall be in accordance with the requirements for Qualification Testing, paragraph 2.5.5.