



**HELLENIC GAS
TRANSMISSION
SYSTEM OPERATOR**

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**TECHNICAL JOB
SPECIFICATION**

400/3

REVISION 1

DATE 01/11/2011

**LIQUEFIED NATURAL GAS PLANTS
EXCAVATION AND CONCRETE
CONSTRUCTION**

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REFERENCE DOCUMENTS

DESFA Job Specification No. 400/2
[Concrete Design]

ELOT EN 197 series
[Cement]

ELOT EN 206 series
[Concrete - Part 1: Specification, performance, production and conformity]

ELOT EN 1008
[Mixing water for concrete]

ELOT EN 1992 (Eurocode 2)
[Design of concrete structures]

ELOT EN 1993 (Eurocode 3)
[Design of steel structures]

ELOT EN 1997 (Eurocode 7)
[Geotechnical design]

ELOT EN 1998 (Eurocode 8)
[Design of structures for earthquake resistance]

ELOT EN 10025 series
[Hot rolled products of structural steels]

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

ELOT EN 12390-3
[Testing hardened concrete - Part 3: Compressive strength of test specimens]

ELOT EN 12390-7
[Testing hardened concrete - Part 7: Density of hardened concrete]

ELOT EN 12390-8
[Testing hardened concrete - Part 8: Depth of penetration of water under pressure]

ELOT EN 12504-1 E2
[Testing concrete in structures - Part 1: Cored specimens - Taking, examining and testing in compression]

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ELOT EN 13670

[Execution of concrete structures]

ELOT EN 14188 series

[Joint fillers and sealants]

Hellenic Standard Specification ΠΤΠ Ο-155

ΠΔ 778/80, ΦΕΚ 193/Α/26-8-80

Π Δ 1073/81, ΦΕΚ 260/Α/16-9-81

N 1396/83, ΦΕΚ 126/Α/15-9-83

N 1568/85, ΦΕΚ 177/Α/18-10-85

ΕΑΚ 2000 – ΦΕΚ 2184/Β/20.12.1999

[Greek Seismic Design Code (Ελληνικός Αντισεισμικός Κανονισμός)]

ΕΑΚ 2000 – ΦΕΚ 781/18.06.2003

[Modification of Greek Seismic Design Code]

ΕΚΩΣ 2000 – ΦΕΚ 1329/Β/16.11.2000

[Hellenic Reinforced Concrete Code (Ελληνικός Κανονισμός Οπλισμένου Σκυροδέματος)]

ΕΚΩΣ 2000 – ΦΕΚ 447/5.3.2004

[Modification of Hellenic Reinforced Concrete Code]

ΕΚΤΣ – ΦΕΚ 315Β 1997

[Hellenic Concrete Technology Code (Ελληνικός Κανονισμός Τεχνολογίας Σκυροδέματος)]

CLIENT'S HSE MANUAL

EU Directives

89/106/EEC

[of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products]

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1.0 SCOPE

- 1.1 All reinforced concrete work including excavation materials, fabrication, mixing, placing, testing and inspection shall be in accordance with relevant standards and codes as referred in the REFERENCE DOCUMENTS in this specification and which are valid at the time of the execution of the contract.
- 1.2 Concrete design is covered by **DESFA Job Specification No. 400/2**.
- 1.3 This specification shall be read in conjunction with Final Soil Investigation Report.
- 1.4 In case of conflict between this Specification and Final Soil Investigation Report shall be brought to Owner's attention for resolution.

2.0 GENERAL INFORMATION

- 2.1 The design and construction of concrete structures, foundations, footings, and miscellaneous concrete work shall be in compliance with **Eurocode 2 ELOT EN 1992** and Hellenic National Codes as valid-

3.0 EXCAVATION AND HAULING

- 3.1 Excavation requirements shall be governed by the need to:
- Remove unsuitable soils under soil bearing foundations.
 - Allow placement of foundations at the specified bottom of footing elevation.
 - Provide ditches to drain plant site.
 - Allow backfilling and controlled compaction around selected foundations required by design calculations to develop passive resistance.
- 3.2 1 The specific extent of excavation required to meet requirements of **para 3.1** of this specification shall be determined on the field by Supervision.
- 3.3 1 The specific extent of excavation required to meet requirements of **para 3.1** of this specification shall be as defined in the applicable foundation drawings.
- 3.4 Excavation operations shall be carried out in a manner that allows drainage of the excavation at all times. Dewatering shall be provided in excavations until completion of work.
- 3.5 Bottom surfaces of excavations shall be graded to provide a firm uniform surface. Excavations shall be kept dry during the progress of work.
- 3.6 New excavation made adjacent to a greater depth than that at which existing foundations are based shall have the portion of the excavation below the existing foundation sloped at an angle of 2 horizontal: 1 vertical. In addition, no point of the excavation is to come closer than 0.5 m to the existing foundation. If the above is not possible, the existing foundation shall be underpinned or otherwise protected against settlement.

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- 3.7 Contractor shall provide excavation to fit the dimensions of the foundation structure to be constructed as shown on the drawings with adequate clearance for the proper construction activities avoiding any over excavations.
- 3.8 The base of excavations for spread footing foundations shall be protected from deterioration during construction. This can be accomplished by one of the methods given below:
- 3.8.1 Pouring concrete the same day the excavation is made.
- 3.8.2 By not excavating the 150 mm of soil above bottom of footing elevation until the footing is ready to be formed and poured.
- 3.8.3 For excavations that will remain open for a considerable time, a thin seal slab of lean concrete shall be poured on the exposed soil.
- 3.9 Excess excavated material, not required for subsequent backfilling operations, shall be located, hauled, unloaded and leveled in the area designated or approved by Supervision.
- 3.10 Ground water level shall be taken from the soil report.
- 3.11 For deep excavation dewatering system shall be provided by Contractor. Proposed dewatering system shall be submitted to Supervision for approval.
- 3.12 Over excavation below the specified level shall be filled with mass concrete.

4.0 BACKFILL AND COMPACTION

- 4.1 Structural fill shall be provided:
- 4.1.1 Under all soil bearing foundations not resting on natural ground.
- 4.1.2 Below all tank foundations.
- 4.1.3 Around foundations, if size of excavation exceeds foundation size.
- 4.1.4 Under all concrete paving and concrete ground slabs.
- The specific extent of structural fill required shall be as shown on applicable job drawings.
- 4.2 Non-structural fill shall be provided for non-load bearing structures to provide grade or drainage control.
- 4.3 Structural fill material shall be well graded granular material with
- not more than 3% fines (0.06 mm dia.),
 - 2% to 70% sand.
- The parent material for the structural fill shall be clean and of uniform quality.
- 4.4 Non structural fill shall be available material free of roots, wood, trash and any other deleterious material, and acceptable to Supervision.

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- 4.5 Prior to deposition of backfill, all formwork shall be removed from concrete surfaces.
- 4.6 Backfill behind retaining walls and around pits shall not be placed sooner than 14 days after the final concrete pour, unless means are provided to protect such structures from damage due to earth pressure.
- 4.7 Fill shall be installed in layers as indicated on relevant drawings.
- 4.8 All fill shall be compacted using the proper equipment for the excavated areas and for the fill material involved. Fill shall be moistened or aerated by whatever means the Contractor deems necessary to achieve the specified compaction. Compaction shall be carried out with optimum moisture. Degree of compaction shall be as indicated on relevant drawings.
- 4.9 1 Unless otherwise requested by Supervision, for every 100 square meters of structural fill required per **para 4.1.1, 4.1.2, or 4.1.3** of this specification and for every 400 square meters of structural fill placed elsewhere, there shall be a compaction test performed to confirm specified compaction. More stringent requirements based on Soil Investigation Report, shall be complied with.
- 4.10 Adequate slope for drainage shall be provided to the compacted surface at all times. Water shall not be allowed to pond on the surface of the compacted fill.
- 4.11 Backfilling under paved areas shall be structural fill of compacted well graded granular material per **Hellenic Standard Specification ΠΤΠ Ο-155**. Backfilling under unpaved areas shall be general fill.

5.0 MATERIALS FOR CONCRETE WORKS

- 5.1 Normal Portland cement shall be used, according to **ELOT EN 197**; low heat cement or special concreting procedures are required for large pours in hot weather. The use of other cement type shall be subjected to written Engineer permission.
- 5.2 Concrete aggregates shall be in accordance with **ELOT EN 206** and **EKTΣ 1997 para 4.3.2**. The composition of fine and coarse aggregates shall be within the "favourable range" of the grading curves of **ELOT EN 206** and **EKTΣ**. The maximum size of coarse aggregate for beams and columns shall be 32 and for foundations shall be 63 mm.
- 5.3 Water used in mixing concrete shall be clean and free from injurious amounts of coils, acids, alkalis, salts, organic materials, or other deleterious substances and shall be in accordance with **ELOT EN 1008**.
- 5.4 In cold weather special precaution shall be required, in accordance with **ELOT EN 13670** and **EKTΣ**.
- 5.5 Air entraining admixtures where used shall conform to **ELOT EN 206** and **EKTΣ 1997**. No other additives may be used.

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5.6 Concrete

Concrete shall be in accordance with **ELOT EN 206** and **EΚΩΣ 2000**. Grade C30/35 shall be applied as a minimum grade for reinforced concrete structures. Concrete Grade C40/45 shall be used for water retaining structures.

5.7 Reinforcing bars shall be new deformed steel bars grade S500 as per **ELOT EN ISO 17660**.

The following re-bar diameters are generally recommended applied as commonly available sizes 8/10/12/16/20//24/26 mm. Diameter 8 mm shall be used in general as concrete paving reinforcement, i.e. light reinforced concrete structures.

5.8 Welded wire mesh shall be Grade S500 per **ELOT EN 10080**.

Material for anchor bolts shall be Fe 360 as per **ELOT EN 10025** (old RSt 37-2 as per DIN 17100).

The minimum size for anchor bolts shall be 16 mm diameter. Anchor bolts details shall be in accordance with relevant standards.

Anchor plates shall be made from steel Fe 360 (RSt 37-2) and shall be in accordance with relevant standards.

Expansion joint filler shall be premoulded asphalt impregnated fiberboard conforming to **ELOT EN 14188 series**. Filler shall be full depth of joint and 15 mm thick unless noted.

Where required, i.e. concrete paving construction, sealing with oil resistant mastic shall be provided.

Contractor shall provide a report of a recognized expert to demonstrate the resistance of the joint against oil action.

Waterstops shall be polyvinyl chloride with minimum properties as follows:

- a. Tensile strength 12.5 N/mm²
- b. Ultimate elongation 300% 5.2.

5.2 GROUTING

Grout shall have a compressive strength at least equal to the one of the reinforced concrete on top of which it is placed.

Ordinary cement grout shall be made of one volume of Portland cement and two to three volumes of fine aggregate.

The materials shall be mixed dry, with minimum water added to achieve satisfactory placement.

Installation of grout under cold weather and freezing conditions should be avoided, unless special provisions are adopted and approved by Supervision.

On foundations for machinery equipment the grout shall be in accordance with the approved detailed construction drawings of the Contractor.

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6.0 DETAILING AND FABRICATION OF REINFORCING STEEL

6.1 DEFINITION OF DETAILING RESPONSIBILITIES

The Civil Contractor shall prepare and take full responsibility for the accuracy of all shop drawings (bar bending schedules). Shop details shall be in strict accordance with arrangement drawings and specifications. The practices outlined in this Specification shall be incorporated in the shop details.

6.2 MARKING

Reinforcing steel shall be bundled and marked.
Tags must be durable, readable, remain attached and serve their intended purpose even after a lengthy time in the field.

6.3 TESTS

The Civil Contractor shall furnish written certifications of compliance with physical and chemical properties and tests as defined in the applicable European Standards as in REFERENCE DOCUMENTS. In case of conflict the more stringent one will govern.

6.4 1 MISCELLANEOUS REQUIREMENTS

Reinforcing steel shall not be bent or straightened in a way that reduces the bearing capacity of the bar. No heating will be allowed when bending bars in the shop or in the field.

Particular attention should be given to tolerances on large bars which are a part of heavy beam column joints or other places where steel placement is particularly critical.

All reinforcing steel shall be maintained free of mud, flaky rust, oil and other coatings that will destroy or reduce bond. Damaged steel shall be rejected.

Splices in reinforcing bars shall be made in accordance with **ELOT EN 1992**. All splices in reinforcing bars shall be made by lap splices if practicable. Should weld splices be required, they shall be made in strict accordance with **ELOT EN 1992** and **EΚΩΣ 2000**.

Tack welding of stirrups to main bars to make cages for placing reinforcement shall not be permitted, unless specified on drawings.

7.0 FORMWORK

Design, materials, construction, support and removal of all formwork shall be in accordance with the relevant European Standards.

Civil Contractor shall be responsible for the design, performance and safety of all formwork.

Formwork shall be designed and constructed so that all concrete members, walls, slabs or footings shall be of correct dimensions, shape, alignment, elevation and position.

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Forms shall be sufficiently tight to prevent leakage of wet concrete.

Form coatings shall be applied in accordance with the Manufacturer's recommendations.

All exposed edges of concrete shall be chamfered 20 mm unless otherwise noted on the drawings.

7.1 TOLERANCES LIMIT

Variation from the plump and level 5 mm (or less than 10 mm) in 5.0 m. Variation in cross sectional dimensions plus 10 to minus 5 mm.

8.0 CONCRETE PROPORTIONS, MIXING, TRANSPORTING AND PLACING

In general the proportioning, mixing, transporting, and placing of concrete shall be in accordance with the appropriate provisions of **ELOT EN 206** and **EKTΣ**.

Ready mixed concrete shall be mixed and delivered in accordance with **ELOT EN 206** and **EKTΣ**.

Concrete structures shall be cast in single pours unless otherwise indicated on drawings or directed by Supervision.

Before placing new concrete on or against hardened concrete surface, the surface of the hardened concrete shall be cleaned and all laitance or other unsound material shall be removed. Joints shall be constructed as per **ELOT EN 206**.

Concrete shall be mechanically vibrated in accordance with **ELOT EN 206** and **EKTΣ** by an experienced operator. The vibrator shall not be used to move concrete in the shutters.

Addition of water in excess of design water-cement ratio to facilitate placement or to increase workability, shall not be permitted unless authorized by the Supervision.

Time spent by concrete materials in a truck mixer shall be limited as per **ELOT EN 206** and **EKTΣ** and in no case it shall be more than 2 hours.

Care shall be taken to avoid segregation of the ingredients and in no case shall the concrete be dropped from a height greater than 1.2 meters. Should it be essential to drop it from a greater height, proper chutes or conduits must be utilised.

9.0 TESTING

Testing shall be performed in accordance with the minimum requirements of **ELOT EN 206** and **EKTΣ** and the procedures shall be approved by Supervision. Test Certificates as per EU Directive **89/106/EEC** for cement and steel reinforcement shall be presented before work starts.

All tests of relevant materials and concrete shall be performed by Certified/Notified laboratory as required by the applicable European and National legislation and in addition by field laboratory provided by civil Contractor, if required any extra tests by Supervision.

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All concrete or reinforcement not satisfying applicable requirements shall be rejected.

9.1 SURFACES LEFT BY REMOVING FORMS

Form marks shall be left intact on all concrete surfaces. Other surface irregularities and voids shall be repaired.

Form ties shall be cut off below the concrete surface and the resulting depressions repaired.

10.0 CONCRETE CURING

Concrete shall be cured in accordance with **ELOT EN 206**, **ELOT EN 13670** and **EKTΣ**.

Concrete made with normal Portland cement shall be maintained in a moist condition for at least the first 7 days after placing and longer when low temperatures prevail.

Liquid membrane forming compounds for curing shall comply with **ELOT EN 13813** except that Supervision reserves the right to approve the compound to be used. Application of the compound shall be in strict accordance with the Manufacturer's recommendations unless the requirements of this specification are more restrictive.

The subgrade below footings, paving, slabs on grade etc. shall be sealed with vapour barrier or with a lean concrete layer 5 cm thick to prevent moisture loss to the subgrade.

11.0 JOINTS

Construction joints shall be made only where indicated on the drawings. Vertical joints shall be made by keying.

Horizontal joints may be made by keying or by roughened surface. Reinforcing steel shall be continuous through the joint. Roughened surface means roughened with total amplitude of approximately 10 mm.

In long walls above grade vertical contraction joints shall be provided from the top of foundation to the top of wall at 6 to 9 m intervals. The joint shall be made by grooves in the wall approximately 5 mm wide and 15 mm. deep. For walls 250 mm or less thick, grooves shall be on the outside face only and for walls greater than 250 mm grooves shall be on both faces. Reinforcing steel shall be continuous through the joint.

Waterstops shall be of size and type as indicated on the drawings. Waterstops shall be laid continuous by heat welding. They shall be nailed onto forms, using wood strips if necessary, so that they are not dislodged during pouring.