



**HELLENIC GAS
TRANSMISSION
SYSTEM OPERATOR**

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**TECHNICAL JOB
SPECIFICATION**

400/2

REVISION 0

DATE 29/06/2011

**LIQUEFIED NATURAL GAS PLANTS
CONCRETE DESIGN**

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QUALITY ASSURANCE PAGE

CHANGES LOG

REVISIONS LOG

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REFERENCE DOCUMENTS

DESFA Job Specification No. 400/1
[Civil Design Loads]

DESFA Job Specification No. 400/3
[Excavation and Concrete Construction]

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

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)
[Seismic design]

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]

ELOT EN 12794+A1
[Precast concrete products. Foundation piles]

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ELOT EN 13479

[Welding consumables. General product standard for filler metals and fluxes for fusion welding of metallic materials]

ELOT EN 13670

[Execution of concrete structures]

ELOT EN ISO 3834-1

[Quality requirements for fusion welding of metallic materials. Criteria for the selection of the appropriate level of quality requirements]

ELOT EN ISO 15609-1

[Specification and qualification of welding procedures for metallic materials. Welding procedure specification. Arc welding]

ELOT EN ISO 17660 series

[Welding. Welding of reinforcing steel]

ISO 1920-10

[Testing of concrete - Part 10: Determination of static modulus of elasticity in compression]

EAK 2000 – ΦΕΚ 2184/Β/20.12.1999

[Greek Seismic Design Code (Ελληνικός Αντισεισμικός Κανονισμός)]

EAK 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)]

1.0 **SCOPE**

All reinforced concrete designs 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.

The following concrete works are excluded from this specification:

- Concrete pipes.
- Concrete for electrical conduits.

Concrete construction is covered by **DESFA Job Specification No. 400/3**.

2.0 **GENERAL INFORMATION**

The design and construction of concrete tanks, structures, foundations, and miscellaneous concrete works shall be in compliance with **Eurocode 2 ELOT EN 1992**.

Surveyed existing ground elevations at site areas are as defined in applicable job drawings.

High point of paving (HPP) shall be designated as conventional elevation $\pm 0,00$.

In areas where catch basins are used, the low point of paving (LPP) shall be set no lower than 150 mm below respective high point of paving. For other areas, see applicable job drawings.

Ground water table level for design purposes shall be as indicated in soil report. Safety coefficient against buoyancy shall be at least 1.3.

Unless otherwise specified, the top of foundation or of finished floors of buildings shall be set at the following distances above respective high point of paving or high point of finished grade:

For vertical vessels	200 mm
For reciprocating pumps	300 mm
For other pumps	200 mm
For enclosed buildings	200 mm
For unenclosed covered buildings	See NOTE 1
For other foundations	200 mm

NOTE 1

Floor height for unenclosed covered buildings in paved areas shall match the elevation of the adjacent paving. In unpaved area, the floor height shall be 150 mm above adjacent ground elevation.

The top of foundations for skirt supported vertical vessels shall be self-draining towards on the exterior surface of the skirt.

3.0 DESIGN LOADS

Loads and load combinations shall be in accordance with **DESFA Job Specification No. 400/1**.

4.0 MATERIALS

4.1 CONCRETE

In general concrete shall be Grade C30/35 as per **ELOT EN 206**.

Concrete grade C40/45 shall be used for water retaining structures as a minimum quality grade.

Reinforcing bars shall be Grade S500S as per **ELOT EN ISO 17660**. The following re-bar diameters are generally recommended to be 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.

Welded wire mesh (welded fabric) 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). For allowable stress design, anchor bolts shall be designed for a maximum tensile stress including for loads combination: dead, live loads, wind or earthquake of 120 N/mm^2 , and without wind or earthquake of 90 N/mm^2 at the root of the thread.

For ultimate limit state design to **Eurocode 3 ELOT EN 1993**, the partial safety factor for steel grade Fe 360 will be $\gamma_m=1,25$.

For non hot dip galvanized anchor bolts corrosion allowance to the nominal diameter shall be 3 mm.

Anchor plates shall be made from steel Fe 360 as per **ELOT EN 10025** (old RSt 37-2 as per DIN 17100).

5.0 CONCRETE DETAILS

Reinforcement shall be provided in the top, sides and recess openings of all foundations. For foundations less than 2.0 m long, minimum reinforcement shall be bars dia 8 mm @ 200 mm both directions. For foundations 2.0 m or greater in length, minimum reinforcement shall be bars dia 12 mm @ 200 mm both directions.

When it is unavoidable for a pipe to pass through a foundation, a pipe sleeve shall be cast in the foundation. The pipe length inside the sleeve shall be loosely wrapped with four layers of asphalt impregnated felt and the space between the pipe and the sleeve shall be filled with lean mortar. The portion of the foundation adjacent to the opening shall be adequately reinforced.

Minimum concrete cover for steel reinforcing bars shall be as indicated on job drawings and in accordance with the applicable European standards.

The following procedures apply to pedestals and to piers where applicable.

Pedestals 1.20 m diameter and larger shall be octagon shaped. Pedestals and piers less than 1.20 m shall be square or round.

Tops of pedestals over 1.0 m diameter shall be reinforced with mat reinforcement or mesh.

Anchor bolt length should not exceed the pedestal or pier depth, to avoid projecting into the foundation pad.

Pedestals and piers shall be dimensioned so that the minimum edge distance from the centre line of bolt shall be:

Anchor bolts less than 50mm diameter, generally	100 mm
Anchor bolts 50mm diameter and larger, generally	125 mm
Anchor bolts for tall vertical vessels	150 mm
Anchor bolts for compressors unless greater edge distance is indicated on Vendor drawings or 4 diameter of bolts, which ever is greater	150 mm

Also pedestals and piers shall be dimensioned so that the minimum distance from edge of base plate (base ring) to edge of concrete shall be :

For 500 mm long or less, base plate or base ring	50 mm
For more than 500mm long, base plate or base ring	75 mm

Between the top of foundation concrete and the underside of base plate, grout shall be provided. Nominal thickness shall be 25 mm for plates up to 500 mm long and 50 mm for larger ones.

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

Resting type pipe supports made of concrete, such as sleepers, shall be designed so that bare or insulated lines do not rest on the concrete. A steel surface shall be provided for bearing.

Vertical construction joints shall be made by keying; horizontal joints may be made by keying or by roughened surface. Reinforcing steel shall be continuous through the construction joint.

For long concrete structures above ground level vertical contraction joints shall be provided from the top of foundation to the top of structure at 6 to 9 m intervals. The joints shall be made by cutting grooves in the wall approximately 5 mm wide and 15 mm deep. For members 250 mm thick or less grooves shall be on the outside face only and for members thicker than 250 mm, grooves shall be on both faces.

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Reinforcing steel shall be continuous through the joint. If structures are longer than 15 m, expansion joints shall be required.

Minimum reinforcement ratio shall be 3‰ and shall apply also to foundations.

Special attention shall be given to complicated reinforcing steel layouts which may occur at heavy beam column joints and heavy slab column joints. Large scale layouts may be required to determine that all steel and anchor bolts can be satisfactorily placed in the joints.

Minimum foundation depth shall be as specified in soil investigation report.

6.0 RETAINING WALLS

For design of retaining walls, both static and seismic earth pressure shall be considered to **ELOT EN 1992** and **ELOT EN 1998**.

Design for walls of water retaining structures must satisfy the requirements of **Eurocode 7 ELOT EN 1997** and **EΚΩΣ 2000, EAK 2000**.

7.0 FOUNDATIONS

This paragraph shall be read in conjunction with Final Soil Investigation Report.

The maximum soil pressure under the most unfavourable load combination condition shall not exceed the allowable value specified in Soil Report.

The overturning stability ratio of process equipment foundations for the most unfavourable load combination condition shall be greater than or equal to 1.5 for erection and 1.8 for all other conditions.

For foundations on cohesionless soil supporting towers or other slender structures with heights greater than 30 m and a ratio of total height to skirt or case diameter greater than 10, 85% of the foundation shall be in compression for the design overturning moment during erection and 100% of the foundation shall be in compression for the design overturning moment during normal operation.