DESFA
Hellenic Gas Transmission System Operator

HELLENIC GAS TRANSMISSION SYSTEM OPERATOR

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TECHNICAL JOB SPECIFICATION
500/6
REVISION 0
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HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

MECHANICAL ERECTION

QUALITY ASSURANCE PAGE

CHANGES LOG

REVISIONS LOG

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CONTENTS

REFERENCE DOCUMENTS

EU Directive 97/23/EC "of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment" (PED)

Job Spec. 180/1
[Welding Inspection]

Job Spec. 500/3
[Shop and Field Fabricated Piping]

Job Spec. 500/5
[Piping Materials]

ELOT EN 1594
[Gas supply systems - Pipelines for maximum operating pressure over 16 bar - Functional requirements]

ELOT EN 13445

ELOT EN 287-1
[Qualification test of welders – Fusion welding]

1.0 SCOPE

1.1 GENERAL

Purpose of this Specification is to outline some basic rules (where applicable), to be considered as a minimum requirement, which are to be strictly followed by Contractor in the execution of the mechanical erection works.

This Specification is implemented by the Job Specifications, Codes and Regulations listed in paragraph 2.0, which are to be considered as an integral part of this Specification.

1.2 DEFINITIONS

> Owner :Gas Transmission System Operator

> Construction Management (Owner Supervisors) : To be defined

> Contractor : To be defined

> Vendors : Equipment Suppliers

2.0 CODES AND REGULATIONS

DESFA Specifications listed below are to be considered as an integral part of these Specifications.

2.1 DESFA JOB SPECIFICATIONS

Job Spec. 500/5 for "Piping Material".

Job Spec. 500/3 for "Shop and Field Fabricated Piping"

Job Spec. 180/1 for "Welding Inspection"

2.2 DESFA STANDARDS

Typical piping details and specifications.

3.0 MACHINERY

3.1 GENERAL

3.1.1 This section shall be the basis for the total performance of the machinery installation from the arrival of the equipment on the site up to acceptance of the equipment by the Owner ready for operation.

3.1.2 This section does not cover compressor installation. The term "pump" as used herein refers to pumps and other machinery items, as applicable, including their drivers.

3.1.3 The parties responsible for the proper execution of the installation are identified by the following abbreviations:

CM - Construction Management

C - Contractor

S - Supervisor

3.1.4 Prior to be accepted by the Owner, installed pumps may be subject to inspection and final acceptance by an inspector of the pump supplier, if specifically requested by Owner.

3.1.5 As the work progresses, acceptance reports shall be prepared in duplicate by Contractor for each pump. These reports shall include the following measurements:

a) Location and elevation.

b) First alignment.

c) Final cold alignment.

d) Final hot alignment check.

The format "Alignment Test Certificate" will mainly contain the required measurements to be recorded by Contractor and the acceptance reports have to be signed, as shown on the bottom of the format, by Contractor and installation must not be continued until each report has been counter-signed by the Owner's mechanical Supervisor.

3.1.6 On completion of the work an inspection and turn over report shall be prepared by Contractor for each pump in quadruplicate. Each report shall be signed by the installation inspector of the equipment supplier, if present at the site and the authorized representative of Owner.

One copy remains with the Owner, one with the Contractor, another with the equipment supplier's inspector, if present at the site, and the last with the construction management.

Once these acceptance and turn over reports have been prepared and signed as specified above, the mechanical equipment will be considered property of the Owner and the complete set of these reports covering all the mechanical equipment will be considered Basic Documents for establishing the division of responsibilities for mechanical completion by the Contractor and mechanical acceptance by the Owner.

From this point any further operation on the equipment (start-up and shut-down) will be performed by the Owners operators.

3.1.7 (C) To check performance of the installation, Contractor pump installer shall draw up lists containing the following:

a) Pump item No.

b) Arrival date storehouse of pump.

c) Arrival date storehouse of driver.

d) Date of first field rust proofing of pump.

e) Date of first field rust proofing of driver.

f) Date of setting up on the foundation.

g) Date of setting up driver on baseplate.

h) Dates of periodic rotation by hand (at least every 3 days).

i) Dates of checking of rust proofing (at least every 2 weeks).

j) Date of first alignment.

k) Date of final cold alignment.

l) Date of motor test run.

m) Date of completion - pump ready for operation.

n) Date of turn over to Owner.

o) Date of hot alignment check.

ALIGNMENT'S RECORD

Alignment for: Mechanical Completion

Ready for Start-up

Plant:---------- Contract:----------

Date:----------

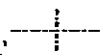
ITEM:---------- DRIVER: El Motor ---------- Turbine

Temperature: --------- Service: ----------

Dial's gage base on: Motor/ Turbine Shaft

Pump / Compressor Shaft

ALIGNMENT TOLERANCES	VALUES IN mm/100			
AXIAL	RADIAL			
Vertical - Lateral	Cold		Hot	
Cold - Hot	Vertical	Lateral	Vertical	Lateral

	RADIAL	AXIAL
Flanged Bolts Loosened		
Flanged Bolts Tightened		

For Cold Operation for Hot Operation

Note : _____

Owner	Owner Representative	Contractor
_____	_____	_____

3.1.8 (C) Pump installer's measuring tools used for pumps alignment (dial gauges, prismatic water level, hair ruler, feeler gauge, etc.) shall be in proper condition.

3.1.9 (C, CM) Reduction or exchange of Contractor's personnel during installation is subject to approval by the construction management.

3.1.10 Flushing and conservation of machinery with Varsol, RB357, etc. shall be only done if it is not in opposition to the Contractors specification.

3.2 **REFERENCE SPECIFICATIONS**

See page 5.

3.3 **RUST PREVENTIVE LIQUIDS**

3.3.1 Rust preventive liquids to be used shall be in accordance with Owner Field Procedure "Equipment Protection during Construction".

3.3.2 Pump installer shall use these liquids in accordance with applicable Vendor instructions.

3.3.3 All rust preventive liquids and application tools shall be procured by the Contractor. Use only absolutely dust-free and lint-free cleaning rags. Use of cotton waste is not allowed.

3.4 **INSTALLATION SECTION A**

3.4.1 STOREHOUSE WORK

(C) 1. On the day of each pump arrival, Contractor shall inform the Owner mechanical supervisor.

(C) 2. a) Contractor shall supervise the unloading of pumps and shall check the delivery for possible damages and shall also prepare reports.

(C) b) For unloading, slings shall not be attached to the couplings and shaft ends.

(C) c) Any damages shall be reported to the construction management immediately.

(C) 3. Check for completeness of delivery and that all loose parts delivered have been provided with Pump Item Tag.

(C) 4. Tapped holes on pumps and drivers, which may be open, shall be sealed tight by means of threaded steel plugs using RB 394 or Teflon. All required temporary steel plugs shall be furnished by Contractor.

(C) 5. Coupling and guards shall normally not be dismantled. As required for rust proofing and alignment and/or driver test run, remove coupling parts and (if required to store) arrange in the warehouse all spacers and couplings with the identification plate.

Note : Coupling guards shall always be reinstalled after completion of each installation pump.

(C) 6. Exposed machined surfaces of pumps, gears, drivers and couplings shall be protected with RB 373.

(C) 7. Pumps with mechanical seals specified will arrive at site with seals installed. Permanent packing rings of pumps, where specified, will be shipped separately. Permanent packing rings shall be installed immediately prior to start-up.

(C) 8. Pumps and bearing housing, seal chambers and rotors shall be flushed throughout with VARSOL. Use of kerosene and gasoline is not allowed.

(C) 9. For packed stuffing boxes provide the gland with a packing ring (rope) or cotton soaked with RB 357. Insert the gland only for enough to be held by the bolts.

(C) 10. All machines, if not otherwise protected, must be provided by Contractor with blind flanges, machined from plate, which have to be mounted on the nozzles of all pumps, turbines or compressors.

Contractor will supply plate from which blind flanges are machined, the relative gaskets and bolts. Blind flanges must be capable of retaining the RB 357 fill (para. 3.4.1.11). Blind flanges shall not be removed until beginning of final alignment, and may be used also for hydraulic test.

(C) 11. Horizontal centrifugal and rotary pumps, and inline pumps shall be rust-prevented as follows :

a) Fill pump casing with RB 357 until it escape through the circulation or flushing connection of the shaft seal. After filling rotate the pump several times by hand in direction of rotation.

b) Bearing housing of horizontal pumps, and gears of inline pumps shall be flushed thoroughly with VARSOL and filled complete with RB 357.

Bearing of inline pumps normally are integral with motor and do not require rust preventing as they are factory grease lubricated.

(C) 12. Submerged pumps and "can" type pumps shall be rust prevented as follows:

a) Spray inside of pump with RB 357 use splash-free atomizer gun.

b) Packing must be properly packed, tagged and stored. Provide the throat bushing with a packing ring (rope) of cotton soaked with RB 357. Fill the stuffing box with RB 357 and provide a second ring at the gland.

c) Retaining rings do not require removal. Protect rings by and exterior located packing ring soaked with RB 357.

d) Mechanical seals shall not be removed. Inside seal area shall be sprayed with RB 357, the outside area (quench) shall be filled with RB 357. The throttle bushing at the seal plate shall be sealed by an exterior RB 357 soaked packing ring.

e) Bearing housings do not need rust ban protection as bearings are integral with driver or factory grease lubricated.

(C) 13. Proportioning pumps shall be rust prevented as follows :

a) All exposed piston rods, plungers and machined surfaces to be protected by RB 373.

b) Permanent packing rings will be shipped separately and shall be installed prior date of completion (Re: para 3.1.7.m). A packing ring
(rope) of cotton soaked with RB 357 shall be inserted in the stuffing box. Gland shall be inserted far enough to be held by the bolts.

c) Pump cylinders and valve chambers shall be filled with RB 357.

d) Crank and eccentric motor drivers shall be flushed thoroughly with VARSOL and then filled with RB 357 at least up to the center of the driving system.

(C) 14. Horizontal electrical motor drivers suitable for oil mist lubrication where bearings are not filled with grease shall be rust prevented as follows :

a) Bearing housings shall be flushed thoroughly with VARSOL.

b) Bearing housings shall be completely filled with RB 357.

(C) 15, Gear type couplings shall be rust prevented as follows :

a) Flush teeth and other inside areas including spacer piece thoroughly with VARSOL.

b) Fill teeth area completely with RB 394. Coat other inside areas with RB 394.

c) After disassembling couplings coat faces with RB 394.

d) Cover and wrap all coupling parts in sheet plastic (after step 3.4.1.17).

(C) 16. After completion of rust prevention on all internals of pumps, gears, drivers and gear type couplings renew coating of all exposed machined surfaces with RB 373 as required.

(C) 17. Pumps to be stored outdoors shall completely be covered with plastic sheet. Pumps shall not be set directly on the ground, but placed on square timbers, at least 4 inch high. Plastic and timbers shall be provided by Contractor.

(C) Note: These plastic sheets shall also be used to protect pump equipment after being set into the foundation.

3.4.2 SETTING AND GROUTING

1. Before installing any pump foundation must be checked for verification of compatibility of such foundation with the pump. Care must be taken during transportation and settlement, of all pumps. Pumps will be set into position according to relevant Plot Plans. Should particular discrepancies occur during pump positioning on already installed suction and discharge lines, Owner will make the decision whether piping is to be revised or elevation of pump basement varies.

   Note : Vertical inline-pumps without flanged mounting base shall be set into the foundation not before complete erection of suction pipe. This will allow securing inline-pump by bolting up to suction flange.

2. Check base plate as to grout holes and vents and provide same if necessary. Vents if required to be added, shall be bored at the highest point. Care shall be taken that later on-no pump leakage can enter the grout vents.

3. On the foundation all pumps shall be aligned with :

   a) Pump axis location from foundation drawing.

   b) System dimension of discharge nozzle flange in sight angle towards the pump axis (rows of horizontal pumps will principally be lined up with the discharge nozzle).

   c) Elevation of discharge nozzle (flange face for vertical nozzles and flange centerline for horizontal nozzles). Elevations, transversal and longitudinal axis must be marked on all basements by Contractor.

(C) **Note : Inline-pumps without flanged mounting base shall be installed at correct location by performing alignment of suction pipe flange.**

(CM) As a matter of principle, installation and first alignment must be made according to the final revision of the foundation drawings. These foundation drawings will be made available by the Construction Management.

(C) 4. a) Pumps shall be leveled with the aid of shims. Shims must be smaller than 50x100 mm and shall be arranged on both sides of each anchor bolt, close to same. The outer base plate edge shall protrude the shims by approximately 10 mm. Shims shall be procured by the Contractor.

All shims to be cut by saw and to be debarred. Cutting by hammer, shears or punching is prohibited. Keep a space of at least 1 inch between upper edge of concrete foundation and lower edge of pump base plate (inline pump : level plate).

Leveling must be checked on all the base plate surfaces. Flanges must not be connected between the machine and the pipes during leveling operation.

b) The anchor holes to be grouted by fine-grained liquid concrete. Grout mix shall be as follows:

(C) Portland cement grout shall be prepared using Type I Portland cement and clean, fine sand thoroughly mixed with water. The amount of water used shall be such that the grout shall have a consistency too stiff to flow.

For critical applications such as for reciprocating and large centrifugal compressors, a factory mixed, shrink controlled, non-corrosive grout shall be installed in accordance with the manufacturer's recommendations. "Embeco" must be used for grouting all pumps with closed frames. Owner supervisor will decide the type of grout to be used, unless already specified on foundation drawings and relevant Civil Works General Specifications.

(C) c) For inline-pumps without flanged mounting base pump installer shall adjust the level plates.

(C) d) Foundation level plates will be supplied by Contractor.

(C) 5. After leveling loosen all adjusting screws of the base plate and tighten anchor bolts. Care shall be taken that base plate is fastened distortion-free.

(C) 6. With the anchor bolts being tightened as applicable :

a) Pumps shall be leveled with the aid of shims. Shims must be smaller than 50x100mm and shall be arranged on both sides of each anchor bolt, close to same. The outer base plate edge shall protrude the shims by approximately 10mm. Shims shall be procured by the Contractor.

All shims to be cut by saw and to be debarred. Cutting by hammer, shears or punching is prohibited. Keep a space of at least 1 inch between upper edge of concrete foundation and lower edge of pump base plate (inline pump : level plate).

b) Vertical pump shafts shall not deviate by more than 0,1mm per 100mm from the vertical (meet the requirements of the individual installation instruction form equipment suppliers).

(C, CM, S) 7. The pump installer shall record for each pump in the presence of Owner Representative and Owner equipment Supervisor all required and actual measurements. All parties concerned will undersign this report. The construction management will not release the pump for further installation, unless the report has been undersigned.

(C) 8. a) On release of the pump by the construction management, grout the pump base plate (Re : level plate for inline-pumps). After grouting make sure that no voids are left by hammering base plate.

(C) b) Pump installer has to supervise this paragraph. 3.4.2.8.a.).

(C) 9. When grout has set re-tighten anchor bolts.

(C) 10. a) Mating flanges with bolts and nuts for connection to suction (as applicable) and discharge nozzle to be obtained from the storehouse. Replace the blind flanges with the mating flanges.

Contractor shall take care that during connection of the piping to the pump, piping shall be free from contamination and will be kept clean during installation. Piping shall be made "free of strain".

The valves, piping etc. must not be supported from the pump nozzles during erection.

They shall be suitably supported and secured by sufficient temporary pipe supports.

(C) b) Contractor has to supervise this paragraph 3.4.2.10.a).

(C) 11. The piping, instrument and electrical installers are not allowed to weld any pipe brackets, clamps and other fittings to the pump or pump base plate.

3.4.3 INSTALLATION OF DRIVERS DELIVERED SEPARATELY

(C) 1. Driver coupling halves normally will be mounted in driver manufacturer's shop. Where couplings are requested to be mounted at jobsite, heat-coupling halves in oil bath as specified in the manufacturer's installation instructions and install them on thoroughly cleaned driver shaft end. Proper protective paste, such as Molycote or equivalent, has to be used.

Secure driver shaft against lateral movement by an outer support to avoid damage of bearings during installation of coupling.

(C) 2. a) Transport driver to install pump base plate and set up.
(C) b) Contractor has to supervise paragraph 3.4.3.2,a.

(C) 3. Horizontal Pumps

(C) a) Align driver with pump centerline and coupling spacer in vertical plane with driver centerline lower than pump centerline. Mark location of tapped holes on base plate for driver foot bolts. During alignment operation, for motor side drilling, the pump must be disconnected from flanges and pipes must be suitably supported.

(C) b) Lift driver from base plate and deposit beside the foundation.

c) Drill and tap holes in the base plate.

d) Reset driver and fasten to the base plate with foot bolts, which will be supplied by Contractor.

(C) *4.* Vertical Pumps

a) Required flange holes in driver bracket have already been drilled in pump manufacturer's shop.

b) Set and fasten driver flange to pump by bolts supplied with pump.

(C) 5. Protect coupling and free shaft end with RB 373.

3.4.4 INSTALLATION OF AUXILIARY PIPING FOR PUMPS - COMPRESSORS

(C) 1. Machines can arrive at jobsite with auxiliary piping installed or delivered separately. Contractor is required to check proper fit of threaded connections and to readjust connections if necessary.

(C, CM) 2. Construction and/or erection of all auxiliary pipes (oil - gas - water) are integral part of the machinery erection. Oil and gas circuit pipes, fabricated in field, must be mechanically cleaned before being erected. Further, temporary bypasses on oil circuit for flushing must be fabricated by Contractor.

Fabrication and installation of auxiliary piping by the Contractor is subject to Owner Supervisor inspection.

(C) 3. Pipe supports shall be cut to the required length and installed by welding into the base plate.

3.5 **FIRST ALIGNMENT**

General Note - Types of Misalignment

There are two forms of misalignment between the pump shaft and the driver shaft, as follows:

a) Angular misalignment - shafts with axes concentric but not parallel.

b) Parallel misalignment - shafts with axes parallel but not concentric.

A check for angular alignment is made by inserting the taper gauge or feelers at four points between the coupling faces and comparing the distance between the faces at four points spaced at 90 degree intervals around the coupling. The unit faces are the same distance apart at all points.

A check for parallel alignment is made by placing a straight edge across both coupling rims at the top, bottom and at both sides. The unit will be in parallel alignment when the straight edge rests evenly on the coupling rim at all positions.

Allowance may be necessary for temperature changes and for coupling halves that are not of the same outside diameter. Care must be taken to have the straight edge parallel to the axis of the shafts.

Alignment of Gear Type Couplings

Gear type couplings are aligned in the same manner as outlined above. However, the coupling covers must be moved back out of the way and measurements made on the coupling hubs as shown on.

3.5.1 FIRST ALIGNMENT SHALL BE MADE AFTER

(C) a) The following works must be carried out before beginning the alignment operation :

- Hydrostatic test.
- Erection and adjustment of all supports along the line.
- Flange alignment.

(C) b) Alignment must be performed with pipe flanges disconnected. When the optimum alignment is achieved, the suction and discharge flanges must be tightened and then checked to assure that the alignment obtained has not changed. In case of variation of the alignment values Contractor will modify and/or improve the pipes until the pump will be completely unloaded from all external forces and moments.

(C, CM) c) Written release is given to the pump installer through Owner piping and mechanical equipment supervisor.

3.5.2 Perform alignment by adjusting the driver. Shims or foils under the feet of the driver must rest on the entire foot surface. If the pump centerline is lower than the motor centerline, Contractor will shim the pump with shims properly machined.

Do not superimpose more than 3 shims. Shims and foils shall be furnished by the pump installer. Use foil thickness group I, from 0,01 to 0,10mm by graduations of 0,01mm and group II, from 0,1 to 1,0mm by graduations of 0,1mm. Shims must be in brass material.

3.5.3 (C) Alignment in axial and radial direction to be performed by dial gages graduated by 0.01 mm.In case of pin or clutch coupling alignment shall be made by feeler gage and hair ruler. All measurements to be made in 4 positions staggered at 90°.

3.5.4 (C) The following maximum deviations are allowed:

a) In radial direction, shaft displacement 0.05 mm (0.1 mm per revolution).

b) In axial direction 0.05 mm per revolution.

Allowable deviations for rigid type couplings shall refer to equipment supplier's installation instructions. However, the maximum deviations for each pump will be established by the Owner machinery supervisor, upon consultation with the Owner, and passed on to the Contractor.

3.5.5 (C, C.M) Contractor shall record for each pump in the presence of Owner mechanical equipment supervisor all required and actual measurements of the first alignment.

3.6 INSTALLATION SECTION B

3.6.1 FINAL COLD ALIGNMENT (AFTER FLUSHING OR BEFORE RUNNING TEST)

1. Final alignment shall be made after:

(C, P, CM) a) Draining pump housing filled with RB 357 and collecting the drainage.

b) Removing sheet covers (see paragraph 3.4.1.10).

c) Checking to ensure that start-up suction strainer and all permanent-piping gaskets except those at the pump nozzles are installed.

d) Installing dial gages on couplings for radial and axial measurements.

e) Checking of first alignment by rotating the coupling and measuring with dial gage.

(C) 2. Contractor shall make available the required qualified personnel who will, as far as possible, exclusively work on relief of piping stresses on pumps.

(C) 3. a) Connect suction piping tightly with the permanent gasket installed.

b) Check shaft alignment of equipment.

c) In case of deviation from the first alignment measurements, corrections to be made by Contractor.

(C) 4. Proceed with the discharge piping as with the suction piping.

(C) 5. If pumps cannot be aligned by dial gages due to their type of construction or type of coupling, check coupling with feeler gage for parallel and check both coupling halves from the outside by means of a hair-ruler for radial deviation.

(C) 6. a) After final alignment, stops on spring hangers (where installed to support piping) shall be released and the springs shall be precompressed to "cold condition" value which has been calculated by Contractor. This value shall represent the spring setting required to insure that the springs shall be compressed to their design position when the piping is hot and full of liquid. The "cold condition" setting shall be recorded for each spring.

(C) b) After the spring has been precompressed to "cold condition", the alignment deviation shall be measured and recorded.

(C) c) It is not anticipated that further adjustment of the spring hangers shall be required but the : "hot condition" position shall be observed and recorded after the plant is started up.

(C, CM) 7. Owner mechanical supervisor shall witness the final alignment measurements and recordings.

(C) 8. After final alignment all high-tension motors shall be doweled to the base plate.

(C, CM) 9. If, after final alignment, additional piping welding becomes necessary, pump and driver must be realigned and report revised.

(C) 10. Immediately following final alignment pump casing shall be flushed with VARSOL and refilled with RB 357. Blind side or end nozzle flanges and refill pump casing with RB 357 through flushing connection of the shaft seal.

3.6.2 PERIODIC PUMP MAINTENANCE

(C) 1. Rotate all pumps by hand twice a week.

2. Drain water every two weeks from all pumps protected with RB 357 and refill the lacking quantity. In case water will not separate by draining, drain pump, flush with VARSOL solution and refill with RB 357.

3. Contractor is responsible for the proper maintenance of equipment. Failures during start-up of motors, pumps, and compressors, due to lack of maintenance will be totally back-charged to Contractor.

3.6.3 MOTOR TEST RUN

(C) 1. Disconnect coupling. In the event that gear type couplings are installed, align (max. radial deviation 0.05 mm per revolution) and fix external part of driver half couplings to internal part by means of adapter flange. Different adapter flanges for each coupling size shall be prepared by Contractor. During run-in of electric motors Contractor will provide skilliful personnel for assistance.

(C, CM) 2. Prior to run-in the resistance measurement of motor windings is to be performed by Contractor.

(C, CM) 3. Perform test run over a period of 4 hours. During test run check : Direction of electrical supervisor shall inform Contractor in writing through Owner mechanical running, vibration, bearing temperature etc.

(C, CM) 4. Owner electrical supervisor shall inform Contractor in writing through Owner mechanical supervisor that the test run has been completed.

3.7 **INSTALLATION SECTION C**

3.7.1 MAKING THE EQUIPMENT READY FOR OPERATION

(C) 1. Drain RB 357.

(G) 2. Pump casings, seal chambers and bearing housings shall be flushed with VARSOL.

(C) 3. Fill bearing housing with oil (except oil mist lubricated electrical motors). Lubricants shall be in strict accordance with specified lube oils. A list to be prepared will be available through the construction management during machinery installation period. All lubricants will be furnished by Contractor.

(C) 4. Check stuffing boxes and shaft sleeves for smooth surface and clean them of any contamination. Shaft sleeves must not show any grooves. Then install permanent packing into stuffing boxes. Tighten glands only by hand (without wrench) on packed stuffing boxes.

(C) 5. After driver test run flush couplings thoroughly with VARSOL and assemble coupling parts, and check for proper fit. Fill gear couplings with lubricants as specified (Re: paragraph 3.7.1.3).

(C) 6. Finally install coupling guard.

(C) 7. Check whether all pipes and fittings have been connected properly and protection covers and slip blinds have been removed from pump nozzles.

(C) 8. Each pump must be capable of being rotated by hand at the coupling easily and uniformly, even with the driver being coupled.

Important: Do not rotate pumps with mechanical shaft seal by hand after rust-preventive oil has been drained. A check as to easy rotation must not be made, unless the pump is filled with the pumping fluid.

(C, CM) 9. Overspeed trip tests are required during turn over of equipment ready for operation. Pump shall be uncoupled prior to performance of such test and recoupled thereafter according to paragraph 3.7.1.5.

3.7.2 TURN OVER PUMP READY FOR OPERATION

(C) 1. Refer to paragraph 1.6.

(C) 2. After turn over Owner will be responsible for maintaining of the equipment.

3.7.3 FINAL HOT ALIGNMENT CHECK (AFTER RUNNING TEST OR DURING OPERATION)

(C) 1. After turn over and run in, Contractor is requested to make a final shaft alignment check at operating temperatures and report measurements.

(C) 2. If measurements are out of tolerances required by the installed couplings, Contractor shall re-align the equipment and revise reports. Dowels have to be renewed where installed.

3. Permissible shaft misalignment for hot alignment check of pump and driver with gear couplings.

(CM) 4. if, after repeated efforts, it is not possible to maintain the specified accuracy of alignment between the "hot" and "cold" condition, major remedial action may be required, such as piping changes. These shall be agreed to by Owner's construction management before being taken.

(CM) 5. During the final hot alignment check, the Owner will operate the equipment.

4.0 PRESSURE VESSELS (DRUMS)

4.1 GENERAL

This section shall cover the unloading, handling, inspection, erection and testing of all pressure vessels.

The fabrication and erection shall conform to **EU Directive 97/23/EC(PED)** and **ELOT EN 13445**.

No welding of lifting lugs, braces or pipe supports to any vessel shall be permitted without the approval of the Owners Construction Manager.

Unless lifting eyes or lugs have been provided by the fabricator, all unloading, handling and erection at the project site shall be done by using suitable cable slings and chokers around the body of the vessel. Wood softener blocks shall be used between the cable slings and the body of the vessel to avoid gouging, scratching and deforming of the shell.

No vessels weighing more than one metric ton shall ever be lifted by any nozzle or manway and care shall be taken to prevent cables from straining against any nozzle or coupling protruding from the vessel shell. Special precautions shall be taken in lifting heavy vessels with thin walls to prevent deforming the vessel out of round.

4.2 RECEIVING AND INSPECTING

4.2.1 On the day of arrival of each vessel, Contractor shall advise the Owner mechanical supervisor. These together shall make a careful inspection and report any damage in writing to the Construction Manager. In the event of damage, Contractor and the Owner's Supervisor shall agree immediately what action should be taken to effect repairs to avoid delay in the project schedule.

4.2.2 Any vessels not unloaded directly onto the foundation shall be placed on wood timbers arranged so the vessel is aboveground and not subject to deforming stress.

4.2.3 Any flange covers that may come off or been broken in transit shall be replaced and the vessel kept closed against the entrance of animals, dirt and debris.

4.2.4 Any scratches or damages to protective primers, coatings, insulation or jacketing, occurring during handling or storage at the site shall be repaired by Contractor.

4.2.5 An effort shall be made to place all vessels on their final position as soon as possible, at which time Contractor shall open them for inspection by the Owner's mechanical Supervisor.

4.3 ERECTION

4.3.1 When the foundation has been prepared for specific item or for the skid Contractor shall prepare a template of the bolt holes of the setting flange of the item and compare it in correct orientation to the foundation bolts prior to any attempt to set it on the bolts.

4.3.2 Where anchor bolts can readily be adjusted to fit the base plate, they should be centered in the template by placing one or more nuts on bolts and striking the nuts with a sledge. This will help avoid stripping the bolt threads when the vessel is set. No heating of the bolts shall be permitted without the field Supervisor's approval.

4.3.3 Off center bolts shall not be repaired by cutting them and welding stubs of bolts to the old bolt or to steel plates welded in turn to the old bolt.

4.3.4 If errors in the foundation or the setting flange will not permit proper setting of items, the Construction Manager shall be advised at once, so steps may be taken with Contractor to correct the problem.

4.3.5 The rigger shall handle the setting with proper rigging to safety set the item. Contractor shall provide and place such timber mats or other heavy timbers as may be needed for the support of cranes, winches or other equipment in soft soil

conditions. No guy lines or braces shall be anchored to piping, equipment or other foundation in the job site without written approval of field supervisor.

4.3.6 Equipment set on concrete foundations to be grouted shall be set on grout pads. These pads shall be made of two parts sand and one part Portland cement with just enough water to set the cement and maintain the pad without slump. The pads shall be spaced around the perimeter of the bolt circle in sufficient number to support the vessel without steel shims. Pads should be about 150 mm squares on the bottom, tapering to about 100 mm. square at the top. The top of each pad should be set with an instrument level to correspond to the final exact elevation of the top-of-concrete after grouting the vessel. Pads shall be placed at least 7 days prior to setting the item.

4.3.7 When the vessel has been set on the foundation, it shall be adjusted to the vertical by using a transit at, at least, four quadrants around the vessel. The vessel must be true to the vertical within a tolerance of 1.0 mm per 10.0 mm. The use of steel shims shall be kept to a minimum.

4.3.8 Contractor shall place cure and dry out all castable linings or internal insulation as called for on the drawings. Contractor shall conform to the best possible practice to avoid excessive loss or use of materials.

4.4 INSPECTION AND TESTING

4.4.1 After setting of the items, Contractor shall brush and sweep them free of dirt, debris, loose rust and scale. When this has been done the Owner's Mechanical Supervisor shall make an inspection for cleanliness and to see that all internals have been properly installed.

4.4.2 Contractor shall adjust, remove or rework internals until such are within the specified tolerances and have passed the prescribed leakage test.

4.4.3 Vessels shall be flushed with clean water, if required, to meet the required cleaning acceptance. After all internal inspections have been completed; the vessels shall be closed ready for hydrostatic testing (if required) and operation.

4.4.4 No vessels shall be tested under pressure with compressed air or nitrogen, nor shall pressure tests be made with vessels partly filled with air. Vessel vents must be open when filling with water until all air is displaced.

4.4.5 No hydrostatic testing shall be performed with water less than 7.0°C.

4.4.6 Pressure vessels shall be tested in accordance with the **EU Directive 97/23/EC (PED)** and **ELOT EN 13445** which is PED mandated standard. On approval from the Owner's mechanical Supervisor, vessels installed in a system may be tested with the associated piping by filling the entire system with clean potable water and testing the system at a pressure of 1.5 times the design working pressure (not the maximum design pressure of the vessel).

4.4.7 All vessels field fabricated or field assembled shall be field hydrotested. Field hydrotesting is requested also for shop-fabricated vessels ONLY if there is a specific request from Construction Management.

5.0 PIPING

5.1 GENERAL

The fabrication, erection and testing of piping shall be in accordance with **Job Specifications 500/3** for "Shop and Field Fabricated Piping" and **180/1** for "Welding Inspection".

5.1.1 SCOPE

This section is intended to supplement, amend and clarify, as required Job Specification 500/3 and 180/1 for specific application and utilization to the job site. It does not attempt to rigidly lay down procedures, but is indented to give guidance on procedures to be adopted. This section covers the shop and field fabrication, erection and testing requirements of cast iron, carbon steel, alloy and stainless steel piping components for field installation. This includes also underground piping.

5.1.2 SUMMARY OF ADDITIONAL REQUIREMENTS

1. The specifications, codes, standards and publications recalled in **Job Spec. 500/3** and **180/1** are mandatory to be used by Contractor.

2. DESFA Piping Specifications

3. Contractor shall perform the detail engineering and will issue all construction drawings, in which are included - but not limited to - the following :
   Piping and instrument Flow Diagram. – Plot Plans.

   Piping Design Drawings comprised of plans, elevations, sections, details and isometric drawings where required.

   Piping Line List. This list will show all pipeline numbers, line size, operating temperature, design pressure and temperature, hydrostatic or pneumatic (if permitted) test pressure.

   Piping Tie-ins List. This list will show all tie-in numbers, line size, description of the line, location of the tie-in and relevant drawings. All construction drawings will be approved by Owner.

4. Contractor shall prepare spool drawings, as may be required, for prefabrication of the piping systems and assume all responsibility for accuracy of his own drafting work.
   Contractor shall have complete control as to the quantity of spool sheets he has to produce and the amount of prefabrication he shall do, provided he is able to satisfy the Owner's Supervisor Construction Manager that Contractor is meeting his schedule of completion. Contractor shall be responsible for the accuracy of the pipe spool fabrication. He shall also be responsible for the length of fabricated in the field (straight run pipe way lines generally longer than 12.5m in length, underground piping etc.).

5.1.3 MATERIALS

1. Materials used must be identical in all respects to those called for in the bills of material or in the piping drawings. Any substitutions may be made only with the written approval of the field supervisor.

2. Contractor shall furnish all the welding electrodes and welding rods and specify same by filling in the appropriate sections in accordance with Welding Specifications. He shall also fill in the preheat and stress relieve in accordance with Welding Specifications.

3. Contractor shall qualify his welding procedures by "Welding Procedure Tests" as outlined in **ELOT EN 12732** and the relevant **EN ISO.** These tests are to

be carried out prior to start of field welds.

5.1.4 FABRICATION

1. All work must be performed by qualified craftsmen. All welders and welding procedures shall be qualified in accordance with requirements of **ELOT EN 287-1** and **ELOT EN 12732** and the relevant **EN ISO**. Each welder or welding operator for carbon steel, alloy steel or non-ferrous metals shall be currently qualified for the P number covering that material as prescribed in that Code. Results of weld procedure and performance qualifications shall be submitted to Construction Management for approval.

   Upon completion of a weld, the welder must affix his registration number besides the welded joint. This shall be done with metal stamps on carbon steel pipes; on alloy materials the numbers shall be painted on the pipes.

2. Pipe bending shall not cause distortion or thin the wall thickness below the minimum specified for the line pressure and temperature plus corrosion allowance. Wrinkle bends and "cut and shut" bends shall not be used.

3. Branch connection, if approved by Owner's Supervisor, on pressure vessels, heat exchangers, shall not be made with threaded couplings. Stub-in branch connections shall be reinforced as specified. Contractor shall supply the plate, cut, shape and install the reinforcing pads.

4. When seal welding of threaded connections, all exposed threads shall be covered.

5. Do not use compound or Teflon tape when threaded connections will be backwelded.

6. Vents and drains for hydrotesting shall be valved.

7. The Owner's Supervisor shall specify during erection, which piping connections DN 40 and smaller shall be braced with a welded gusset to prevent breakage by vibration. Contractor shall supply all material and labor to fabricate and install such braces.

8. For take-off connections and drains orientation and location see piping fabrication drawings.

9. For wall thickness of 4,5mm to 20mm, inclusive, the level angle of the stub end for welding shall be reduced to 30 degrees.

10. Pipe ends may be prepared by any mechanical means. For pipes wrapped with protective coating, the wrapper must be removed over a distance of at least 100mm from the weld end.

11. In cases where the inside diameters of adjoining pipe ends differ more than 3,2mm due to different wall thickness, the part with the thicker wall must be prepared as per **ELOT EN 12732**. Prior to swedging of pipe edges, approval must be obtained from the field Supervisor.

12. No backing rings shall be used.

13. Internal welds at the joint of orifice flange to pipe shall be ground smooth and flush with the inside diameter of the pipe.

14. Contractor shall obtain the mill test and chemical analysis reports required by the applicable **ELOT EN** standards with the special carbon, nickel chromium and molybdenum compositions for all stainless steel weld rods. All mill test reports shall be approved by the Owner Supervisor's authorized Inspector.

15. Precautions shall be taken throughout fabrication not to damage the gasket face on flanges.

16. Preheating shall conform to Welding Specifications. Preheat temperature shall be checked either by use of powders, temperature color pencils, thermo elements or pyrometers. Temperature reading records shall be submitted to the Field Supervisor for all stress relieving.

17. TIG welding shall be used for pigged lines. After completion of each weld, a gauging disc having a diameter equal to 97% of the nominal internal diameter of the pipe, shall be hand passed through each connection.

5.1.5 INSPECTION AND TESTING

1. All welds shall be subject to examination visually by the Owner Supervisor.

2. Arrangements for all work to be carried out in connection with welders and/or procedure tests must be made by the Contractor. Owner Supervisor will furnish the pipe.

3. All defects disclosed by any of the required inspection methods shall be repaired and shall be reinspected by radiography at Contractor's cost. All radiography films shall be retained by Construction Management.

5.1.6 WITHDRAWAL SHIPMENT. HANDLING AND STORAGE

1. All flanges faces, tube holes and tube ends shall be thoroughly protected with suitable timber or other substantial type covering to ensure their full protection. All female and male threaded endings shall be protected by suitable systems of protection.

2. The Mechanical Subcontractor shall mark all pipe spools with the pipe spool number. Stencil or paint the spool number on each pipe spool with waterproof paint. Spools, which are too small to have a painted spool number, shall be marked on aluminum tag. Securely wire the tag to the spool. Stamping of figures and number shall not be allowed on piping.

3. Each fabricated spool shall be colored coded with appropriate bands for both material identification and final location. The color scheme shall be determined at a later date by agreement with the Owner Supervisor.

4. Contractor shall check that all Vendors apply correctly the requested color code in case of some Vendors do not use the code. Contractor shall directly provide to clearly mark all the uncoded materials.

5.2 PIPING ERECTION AND TESTING

5.2.1 ERECTION

1. Flange misalignment data shall be entered for every rotating machinery connection flange over DN100.

2. Contractor shall inform the Owner Supervisor before using any foundations, pipe support steel, structural frames, etc., for lifting, tugging, anchoring, etc. The Owner Supervisor will control the forces permitted in such cases where permission is granted.

3. All piping connecting to pumps, compressors and other rotary equipment is to be fabricated so that no undue stresses shall occur at the equipment flange during bolting up of the connecting pipe flange.

   Contractor may stress relieve carbon steel piping by torch heating to eliminate minor stresses caused by misalignment at equipment flange connections. Such misalignment in alloy piping shall not be corrected by this method without specific approval of the Owner Supervisor.

4. Subcontractor shall conform to Owner Supervisor request in protection of piping material from time of arrival at the job site until it is placed in operation. Care should be exercised to ensure that materials remain free of rust and deterioration.

5. Flanges connections shall be fitted up so even gasket seating will result. On large piping it may be necessary to make up flanged connections with construction gaskets before welding, to ensure that there is no misalignment. Flanges shall not be made up without gaskets.

6. Piping shall be properly supported, anchored, guided or otherwise restrained in accordance with piping design drawing before testing commences.

7. Additional supports required for testing or construction purposes shall be provided by Contractor. The design of all Contractor's field supports will be checked by the Owner Supervisor. Care must be taken not to place excessive loads on other supports or equipment. Such temporary supports must be removed before start-up.

8. Contractor is warned not to use any Owner's piping material to fabricate permanent or temporary supports.

9. Machine bolts shall be installed so that the machine head is on the same side of flange for each bolt. Before installation all bolts, threads shall be given a coating of graphite and oil mixture for these piping services up to 288°C. For piping services over 260°C use type "MOLYDUVAL OILFREE PASTE P.G as manufactured by W.V. von Laar, DG, Ratigen, Germany or equal.

10. Stud bolts shall be installed so that the projection above the nuts is equal on both sides.

5.2.2 TESTING AND FLUSHING

1. All safety and relief valves shall be removed and inspected for pressure setting test in field shop. The connections will be blind flanged or capped, depending on the type of connection prior to the hydrotesting of the relevant lines.

2. Vessels or any other equipment, which are not a part of the fabricated piping system(s), will be isolated, unless specific permission is given by Owner Supervisor.

3. Paddles (blanks)of adequate pressure rating shall be placed between the nozzles of equipment and the connecting flange of the piping system when such equipment shall not be included with the hydrotesting of the piping system. Paddles (blanks) will be provided by Contractor.

4. All control valves shall be removed prior hydrotesting and flushing carried out in field shop and inspected. Spool pieces shall be installed prior to hydrotesting.

5. All orifice plates shall not be installed or shall be removed prior to hydrotesting of the piping systems and inspected in the field shop. All tubing leads shall be disconnected and the systems tested up to and including the orifice taps block valves.

6. Contractor shall never re-use asbestos or spiral wound gaskets, once they have been removed from the flange faces. Rings for RT joints shall be cleaned and inspected prior to re-use.

7. All flanged spacers used in place of control valves during hydrotest shall be re-used as much as possible in further fabrication.

8. Test results for all lines shall be recorded on form similar to the sample provided by Owner Supervisor. Fabricated spools will be field tested after erection. Contractor shall be responsible for the correction of any fabrication defects revealed by this test.

9. Fresh water shall be used for hydrostatic testing of all piping systems. For hydrostatic testing of stainless steel lines the following rules shall be observed :

   a) Water with a high chloride shall not be used for testing austenitic stainless steel piping. Water of moderate chloride content (50 to 100ppm) may be used provided 2% to 4% sodium nitrate is added. Test water shall not be left in contact with austenitic stainless steel for more than 72 hours.

   b) The content of dissolved salts shall not exceed 500 mg/lt (i.e. seawater shall not be used).

   c) Great care shall be exercised to assure that the lines are completely and properly drained immediately after testing and flushing and dried by blowing with air.

5.2.3 WELDING SPECIFICATIONS

Contractor will submit to Construction Management for approval all welding specifications and procedures, which will be used for the erection at the site and at the pipe prefabrication shop. Once these specifications and procedures are approved by Construction Management, they become integral part of this specification.