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Hellenic Gas Transmission System Operator

HELLENIC GAS TRANSMISSION SYSTEM OPERATOR

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TECHNICAL JOB SPECIFICATION

500/1

REVISION 1

DATE 02/11/2011

LIQUEFIED NATURAL GAS PLANTS

PIPING ENGINEERING

QUALITY ASSURANCE PAGE

CHANGES LOG

- Para 3.11
- Para 3.14
- Para 4.1

REVISIONS LOG

1	02-11-2011	DESFA COMMENTS	PQ DPT	V.G.
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REFERENCE DOCUMENTS

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DESFA Job Specification No. 500/6
[Mechanical Erection]

DESFA Job Specification No. 650/1
[Instrument Piping]

ELOT EN 1759-1
[Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, Class designated - Part 1: Steel flanges]

ELOT EN 13480 series
[Metallic industrial piping]

ASME16.47
[Large Diameter Steel Flanges: NPS 26 through NPS 60Metric/Inch Standard]

PED 97/23/EC
[Pressure Equipment Directive on the approximation of the laws of the Member States concerning pressure equipment]

1.0 SCOPE

This Specification is intended to govern the design of piping systems for Process, Utility and Offsite Units. This Specification is supplemented by:

a) Engineering Flow Diagrams (EFD's)
b) Piping Material Specification selected on the basis of fluid content, pressure-temperature conditions, corrosion allowance and other physical and metallurgical considerations.

2.0 BASIS OF DESIGN AND SELECTION CODE REQUIREMENTS

2.1 CODE REQUIREMENTS

As a minimum requirement, piping shall be designed according to the latest revision of **ELOT EN 13480-3** and **PED 97/23/EC.**

All steel flanges NPS < 600DN shall be designed and rated according to **ELOT EN 1591-1** and **ELOT EN 1759-1.**

For flanges NPS > 600DN not covered by the above standard, flanges with dimensions according to **ASME 16.47** Series **B** may be used for classes 150#,300#,600# and 900#.

All welding of pressure parts of pipe, whether shop or field, shall be done by welders qualified in accordance of **ELOT EN 287-1** and **PED 97/23/EC.**

2.2 PIPING MATERIAL SPECIFICATIONS

The Piping Material Specification for each line shall be selected using design pressure, temperature and the requirements of the applicable design standard.

Where infrequent variations in temperature or pressure will occur, the pressure rating or allowable stress at the temperature existing during these variations may be increased as follows:

a) For variations of less than 10 hrs. at one time or 100 hrs./yr:33%

b) For variations of less than 50 hrs. at one time or 500 hrs./yr:20%

The wall thickness of pipe shall be as follows:

a) Wall thickness of pipe shall be calculated as specified in the applicable section of the **ELOT EN 13480-3**.

b) The wall thickness given in the Piping Material Specifications provide allowance for corrosion and manufacturing tolerance in addition to the thickness required by design conditions.

The facing of flanges shall be submitted by Contractor to Owner's approval.

2.3. CORROSION ALLOWANCES

Adequate allowance or protection against corrosion or other chemical attack must be provided.

The minimum corrosion allowance used in determination of pipe wall thickness shall be as follows:

a) For carbon steel and ferritic alloys (low alloy steel), (1.6 mm).

b) For austenitic (high alloy steel) or stainless steel alloys (0.8 mm).

In special cases point a) and b) could be amended if not in accordance with special licenser design.

For greater corrosion allowances required in special conditions shall be submitted by Contractor to Owner's approval.

2.4. LINE CLASSIFICATION

The following criteria will be used:

a) the first number indicates the nominal diameter of the line

b) the following letter of group of letters indicate the type of fluid identified as follows:

A	Plant Air
A1	Instrument air
CH	Chemicals (foam, glycol etc)
FL	Flare
G	Natural Gas
L1	LNG
L2	Cryogenic Natural Gas
N1	Nitrogen, liquid
N2	Cryogenic gaseous Nitrogen
N3	Nitrogen, gaseous
0	Hydrocarbons (Diesel Oil, Propane etc.)
OF	Flushing Oil
OL	Lube oil, Seal oil
V	To atmosphere
VB	Blowdown to atmosphere
W1	Sea water Supply
W7	Fire water
W8	Cooling Water Supply
W10	Potable water
WL4	LNG Sewer
WR1	Sea Water Return
WR5	Water Sewer
WR8	Sanitary sewer
WR8 Return	Cooling Water

The following letters indicate the type of insulation requirements identified as follows:

HC = Heat Conservation
PP = Personnel Protection
CC = Cold Conservation
ET = Electrical Traced
Example :

$$\frac{\text{80DN 0-XXYYZZ-A}}{\text{(100°C-PP)}}$$

indicates:

Line diameter 80DN

Flowing fluid : Oil

Line number (XX = unit number, YY = **EFD** number, ZZ = progressive number)

Piping material specification "A"

Operating temperature: 100°C

Insulation requirements: personnel protection

The following lines will not be numbered although they show diameter or specification changes:

- Branch lines concerning equipment connected in parallel or in stand-by.
- Local by-passes going between inlet and outlet of the same piece of equipment.
- Hose connection lines.
- Inlet lines to pressure relief valves.
- Sample connection lines.
- Drains from lines to oily sewer system.

3.0 PROCESS SYSTEMS PRACTICES

3.1 ASSEMBLIES

Assemblies must be designed that:

a) the components are suitable and reliable for their duty.

b) the components are properly integrated and assembled.

3.2 PROVISIONS FOR FILLING AND DISCHARGE

Where applicable, the pressure equipment must be designed and provided with accessories, or provision made for their fitting, to ensure safe filling or discharge:

a) on filling; by over filling or over pressurization and fluid instability.

b) on discharge; by uncontrolled release of fluid.

c) on filling or discharge; unsafe connection or disconnection

3.3 PROTECTION AGAINST EXCEEDING THE ALLOWABLE LIMITS OF PRESSURE EQUIPMENT

The pressure equipment must be fitted with, or appropriate provision made for, the fitting of suitable safety devices which are determined on the characteristics of the equipment.

3.4 EXTERNAL FIRE

Where appropriate, the pressure equipment must be fitted with, or appropriate provision made for, the fitting of suitable equipment/devices to meet damage-limitation requirements in the event of an external fire.

3.5 PIPING

The design and construction must ensure:

a) the risk of overstressing from inadmissible free movement or excessive forces being produced is adequately controlled.

b) where there is a possibility of condensation occurring inside pipes for gaseous fluids there are means provided for drainage and the removal of deposits from low areas.

c) due consideration is given to the potential damage from turbulence and the formation of vortices.

d) due consideration is given to the risk of fatigue due to pipe vibration.

e) that, where fluids of Group 1 (PED 97/23/EC Classification) are contained in the piping, appropriate means are provide to isolate take-off pipes.

f) the risk of inadvertent discharge is minimized.

g) the position and route of underground piping is at least recorded in the technical documentation.

Piping at manual valves, control valves, meters, strainers, pumps, compressors, turbines, etc., shall permit equipment removal without dismantling adjacent equipment or piping, with the exception of connecting flanges at the equipment nozzles.

Additional requirements for design of cryogenic piping systems are given in appendix "A".

3.6 TOWERS AND DRUMS

Block valves shall be provided at tower nozzles in the following instances:

a. Permanent connections at vessels for inert gas, water, inhibitor and additive systems shall consist of block and 20DN bleed plus check valves all conforming to the higher specification in addition to the block valve normally provided at the header.

b. Wherever a line connects to a tower or drum below the liquid level, and no other valves appear in the system before the next nearest piece of equipment or where the next valve is located more than 15 m. on horizontal radius from the tower. If the line has a valve which is accessible from grade or platform, no valve will be provided at the tower nozzle.

c. A block valve shall be provided in tower vent lines and in tower drain lines to open sewers followed by a blind flange.

d. Each pump-out line which discharges to a closed pump-out system shall be provided with block valve.
One **"Figure 8"** shall be installed just before the block valve.

Block valves shall not be provided in the following instances:

a. At relief valve connections from vessels and drum, except for relief valves with spare.

b. In vapor overhead lines from towers.

c. In gravity inter-cooler suction and return lines.

Platforms on towers and vessels are to be kept to a minimum consistent with adequate access to manways, handholes, blinds, davit operation, control valves, valves size 50DN and over and relief valves.
Access to valves 40DN and smaller may be from the tower ladder.

Manway elevations above platform levels shall be between 450 mm and 1200 mm where practicable.

Relief valve vent piping, other than short stacks, shall be supported to permit valve removal without additional support of the vent line.

3.7 PUMPS (See figure 1)

A block valve shall be installed in both the suction and discharge lines of each pump. The valves shall be located as close to the pump nozzle as possible. The discharge valve's rating will be determined by the design conditions of the line; the suction valve will usually be rated for the suction line's design conditions. In the case of two or more centrifugal pumps for which piping is manifolded and warm-up is foreseen, the suction piping up to block valve included must be designed in accordance with discharge piping rating.

A check valve shall be installed in the discharge line of a centrifugal or rotary pump between the pump nozzle and the block valve, where two or more pumps are manifolded or where the pressure on the discharge side is continuous and could cause the pump to rotate in reverse.

All overhead suction lines shall drain toward the pump without vapour pockets.

Casing vents and drains shall be provided as shown on the Engineering Flow Diagrams.

Temporary strainers shall be provided for pumps before starting the pump. Strainers shall be Y-type for sizes < 50DN and Bath-tube type for sizes > 80DN.

A warm-up/cool down bypass system, as illustrated in **figure 1**, shall be provided with operating temperature differential over 200°C between a pump and its spare.

Suction lines to centrifugal pumps with side or end entry shall be installed with eccentric reducers (flat on top) adjacent to the pump nozzle. Suction lines should drop or rise vertically to the reducer.

For two or more pumps connected in parallel, under severe operating conditions (i.e. high delta-p, high liquid temperature, dirty liquid and/or carrying suspended solids and the condition for which a difficult operation of the check valve is expected) the suction piping up to the block valve shall be designed in accordance to discharge piping rating.

Piping at pumps shall have adequate flexibility to prevent expansion or dead loads from imposing damaging strains on the pump casing.

A 20DN drain shall be self-supported and installed on the discharge side of the check valve or downstream of the check valve, depending on size. **See** Figure **1.**

Pumps piping shall be arranged to allow the removal of the pump for maintenance.

The piping shall be supported directly from the foundation block of the pump. This support shall be adjustable unless it is used for an anchor point.

Piping connected to the top of pumps shall have removable spool pieces to permit removal of the pump without disturbing the pipe.

Check valves or flanged fittings, between discharge and suction block valves and pumps, may be considered a spool piece.

3.8 COMPRESSORS

3.8.1 SCOPE

a) Here are specified the additional requirements to be included in the design, fabrication, erection and cleaning of compressor piping components in order to prevent undesirable foreign matter from entering the compressor.

b) The piping and piping components considered shall include but not limited to:

b1) Lines from upstream knock-out drums or filters to inlets of all stages.

b2) Inter-stage lines.

b3) Bypass line from compressor discharge to suction, when it joins suction line downstream of suction knock-out drum or filter.

b4) Lubricating, seal and control oil lines.

b5) Suction pulsation dampers.

c) Prefabricated piping and appurtenances, including suction pulsation dampers, furnished by the compressor vendor, are excluded subject to visual confirmation of cleanliness.

3.8.2 DESIGN

a) The importance of starting any compressors with clean piping cannot be over-emphasized. Any dirt, rust, welding beads or pipe scale carried into the reciprocating type of compressor will cause scored packing rings, piston rods, cylinder walls and pitted and leaky valves. Foreign matter may damage the blades of centrifugal compressors or the rotors, seals and labyrinths of rotary compressors.

b) Centrifugal and axial compressors shall have only careful mechanical cleaning of inlet process gas and ambient air lines when size and configuration of piping can assure visual confirmation of cleanliness.

c) Reciprocating air compressors, particularly the non-lubricated type, may have inlet piping of non-corrosive metal or plastic or of metal lined with non-corrosive material. If so, only cleaning per **para. 3.8.4** is required. If not, the piping shall first be mechanically cleaned per **3.8.2 (b)** above or acid cleaned in accordance with **para. 3.8.4.**

d) A list of materials to be acid cleaned (pickled) shall be prepared for submittal to the cleaning contractor, who shall provide evidence that the materials used in cleaning will be non detrimental to the materials cleaned. OWNER shall also review the proposed cleaning materials for compatibility with the materials in the piping system.

e) Before a compressor is started, a temporary strainer shall be installed in its suction line, with the following exception:

Centrifugal and axial compressors, in process gas and ambient air service, whose piping size and configuration can assure visual confirmation of cleanliness.

f) Strainers shall be two ply conical type, 200% gross open area perforated with 40 mesh wire cloth outside, pointing upstream in a flanged spool piece, for lines 80DN and larger.
For smaller lines, Y-type strainers shall be used; strainer element to be 40 mesh wire cloth, woven using 0.010" dia. wire.

g) Strainer shall be located downstream of knock-out drums or filters and as close as possible to compressor inlet.

h) Vents and drains at high and low points of piping shall be a minimum of 20DN pipe size.

3.8.3 FABRICATION

a) Extra care shall be given to the removal of metal shaving produced by threading or weld preparation. All burrs inside the pipe shall be removed before shop welding or field erection.

b) Each weld should be inspected as soon as finished and while visible. Where there are welded joints that will not be accessible for internal inspection and cleaning, Inert Gas Arc Welding (TIG and MIG) may be used for the root pass with the balance of the passes done by the shielded metal arc process.
The use of Inert Gas root pass is to afford complete penetration without icicles in the pipe.

3.8.4 CLEANING OF STEEL PIPING

Piping and piping components listed in **para. 3.8.1 (b)** shall be cleaned in accordance with procedures outlined on para. 3.8.4 of **DESFA Job Specification No. 500/6** unless excepted by **3.8.1.(c), 3.8.2.(b)** or **3.8.2.(c).** Alternate cleaning methods of demonstrate ability may be substituted provided their use is approved by the OWNER.

3.8.5 ERECTION

a) Every precaution shall be taken during erection to prevent foreign matter from entering the piping system.

b) The cap or seal of an opening shall not be broken until final field erection is imminent.

c) Intake filters shall be located so as to be the least susceptible to taking in dust, moisture, corrosive gases, etc.

3.8.6 CLEANING AFTER HYDROTEST

a) A final cleaning of all piping systems covered by this standard shall be executed after the hydrostatic test of the piping and before the start-up of the compressors.

b) Lubricating, Seal, and Control Oil Systems

b1) After assembly of the lubricating, seal and control oil system at the site, the filter casings, cooler shells, oil sumps and other system components shall be opened and wiped clean.

b2) Y-type strainers with fine mesh screens shall be inserted at terminal points of compressor vendor-supplied piping. After the flushing period is completed the screens shall be removed.

b3) Heated flushing oil 65.5°C to 82.2°C shall be circulated until it runs clean, but not less than 8 hours total.

b4) During the circulation period, the piping shall be hammered to dislodge any possible residual mill scale.

b5) The cleanliness of the system shall be determined by inspecting filters for the pick up of foreign matter, of which there should be practically no trace before the system is certified as clean.

c) Suction Piping and Pulsation Dampers

c1) Where equipment has been previously tested and cleaned, or for any reason it is not to be part of a piping hydrostatic test, it may be desirable to use test blanks with flange OD and tapped bolt holes and to insert hex head bolts from either side. This will allow leaving blanks in place to protect the equipment while piping is flushed thru open ends and drain connections.

c2) Piping will then be blown with high pressure 7 kg/cm^2 steam or air at a velocity in the order of 30 m/s to obtain further cleaning. Normal velocity is lower, bur not considered adequate for removing foreign particles.

3.8.7 DISPOSAL

The acid cleaning contractor shall safely dispose of or recover all spent fluids.

3.9 SHELL AND TUBE EXCHANGERS

Block valves shall not be provided on the process side of shell and tube equipment in non-severe service, where isolation of exchanger tube bundle or shell is not necessary during operation. Block valves shall be provided only where shown on engineering flow diagram.

Isolating valves are required on cooling water supply and return lines when several units are in common service and the ability to take one or more out of service during operation is required to avoid shut-down.

Stacked units operating with shell sides in common service shall have only the top unit vented and the bottom unit drained, unless the shell cover diameter is larger than the shell. For this type of exchanger, vents and drains shall be provided on all shell covers. All vent and drain valves provided on shells and shell covers shall be 20DN size.

Where block valving is not required at the bottom connections on shell and tube nozzles, and drainage can be accomplished through existing piping, drain valves shall not be provided.

Where valves are to be located immediately adjacent to the nozzles of heat exchanger units, the 20DN vent or drain shall be located inside the valve, on the nozzle. If there is no valve and a vent or drain is required, it shall preferably be located on the piping rather than on the nozzle.

On heat exchangers provided with vapor belt, 20DN vents and drains shall be provided on the high and low points of these annular distributors.

The plugs for all connections that are not in use shall be of the material specification of either the inlet or outlet line, whichever has the higher classification.

Flushing or chemical cleaning nozzles shall be provided where indicated on the Engineering Flow Diagram.

3.9.1 BLOCK AND BY-PASS VALVES FOR HEAT EXCHANGERS

All heat exchangers (shell and tube, air coolers, etc.) shall be equipped with inlet and outlet block valves and by- passes, to allow their on stream isolation and cleaning (i.e. while the unit is operated within the design turndown ratio).

The arrangement of many heat exchangers in more than one exchanger train and the installation of block valves only in the inlet and the outlet of each train, is acceptable as alternative, provided that the unit can be operated within the design turn-down ratio while one train is isolated for cleaning.

For multiple bundle air coolers the above mentioned isolation valves shall be installed on each bundle. A safety valve, if required, shall be installed to protect the downstream equipment.

In case single bundle air coolers or one shell heat exchanger with downstream equipment not being a heat exchanger (e.g. single overhead condenser single bundle air cooler or one shell heat exchanger with relevant overhead drum) the block valves and bypasses could not be provided unless the isolation of the particular exchanger will not cause shutdown of the unit.

3.10 CONTROL VALVES, ORIFICES, FLOWMETERS AND DISPLACEMENT TYPE METERS

All control valve arrangements and details shall be in accordance with Typical Piping Details Sid drawing and in accordance with the Engineering Flow Diagrams.

Arrangement is based on removal for maintenance: no provision will be made for servicing internals in place.

Orifice flanges and the minimum straight run of pipe upstream and downstream of an office shall be in accordance with Typical Piping Details Std drawing. When using orifices in vertical liquid lines, the flow must be upward. For air, gas and steam, the flow must be downward.

3.10.1 BLOCK AND PY-BASS VALVES FOR CONTROL VALVES

Block and by-pass valves shall be provided for all control valves of 100DN body size and smaller, and for all valves of any size when required for process or safety reasons or when the control valves are located in elevated areas. Control valves in discontinuous services may not be provided with block and by-pass valves even when their body size is 100 DN and smaller.

All the rest control valves be equipped with hand wheels. For all the control valves that are not equipped with block and by-pass valves, piping shall be arranged to allow the installation of block and by-pass valves in the future.

3.11 RELIEF VALVES

Relief valves and other safety accessories shall:

a) be designed and constructed to be reliable and suitable for their intended duty, including maintenance and testing.

b) be independent or unaffected by other functions.

c) comply with appropriate design principles in order to obtain suitable and reliable protection.

1 When specifying relief valves for installation upgrade consideration shall be given to the already installed safety valve types for ease of maintenance and operation.

Relief valve discharge lines from adjacent equipment may be combined into a common discharge header, provided that the header is of a sufficient size not to affect the relieving capacities of the valves. When combining such lines, special consideration shall be given to thermal expansion of the piping system and back pressure on relief valve settings.

Relief valves that discharge into a common header shall discharge 60° sloped into the top of the header.
Valves shall be located above the header, if possible. If not, a drain valve shall be provided at the low point of the piping and shall be piped to a safe location.

Relief valves which discharge to atmosphere are to exhaust at a safe distance away from any personnel area.

Car sealed open (CSO) block valves at inlet and outlet of PRV's and one additional spare PRV shall be installed in critical services only. (i.e. in cases of increased plugging possibility, corrosive streams, etc.). In such cases the alternative solutions of purging the line with steam or installing rupture discs could be considered avoiding the installation of block valves and the spare PRV's.

For all the PRV's that are not equipped with block valves and spare PRV's, piping shall be arranged in such a way to allow the connection to the main flare header to be realized through a single connection (flare subheaders) per

each process unit on which a car sealed open (CSO) block valve shall be installed. This arrangement is necessary in order to avoid shutting down other process units due to malfunction of one PRV in a particular unit.

If block valves are installed upstream and downstream the safety valve, a bleed valve shall be installed between each block and relief.

Relief valves discharging to the atmosphere, shall be equipped with a riser to a 3 m. minimum height above the operating level.

A drain hole as specified in the standards shall be provided in the lowest point of the riser. Where there is a possibility of flame or damage from release on equipment, the drain shall be piped to a safe location.

3.12 VENTS, DRAINS AND SAMPLE CONNECTIONS

All piping systems and other pressure equipment must be provided with methods for draining and venting:

a) to prevent water hammer, vacuum collapse, corrosion and chemical reactions etc.

b) to permit cleaning, inspection and maintenance.

Vents and drains shall be 20DN minimum size, except where otherwise noted on the Engineering Flow Diagrams **or** equipment drawing. Those intended only for testing piping will not be shown on Engineering Flow Diagrams.

Vents and drains required while the unit is operating must be valved, and are usually shown on the Engineering Flow Diagrams. From 50 DN and larger lines, they will normally consist of a typical branch connection, nipple (length depending on insulation thickness), sw/ thdd valve and plug.

From 40DN and smaller lines, the branch and its reduction to valve size will use an appropriate combination of fitting, reducer, nipple and valve.

Vents and drains required only while the unit is not operating, as for hydrotests, will consist of a nipple and threaded cap, with the joint sealed with Teflon tape. Where the operating temperature is very high, extra length will be provided, if necessary, to allow heat radiation so that the maximum temperature of the sealing medium is not exceeded. When the connection is to be used, the cap can be temporarily replaced with a threaded valve.

High points of all lines shall be vented and low points drained except where the line can be vented or drained elsewhere; e.g., a line need not be vented where it is connected to a tower without a block valve and with no higher point.

Pumps and pump piping shall be vented and drained in accordance with **para. 3.7** hereabove.

Compressors shall be vented and drained in accordance with **para. 3.7** hereabove.

Heat exchangers shall be vented and drained in accordance with **para. 3.9** hereabove.

A 40 DN bleed valve shall be provided upstream of each control valve to relieve line pressure before maintenance work.

Operating drains shall be piped to the drainage system and the operational vents in toxic of flammable service shall be piped to the vent header, or to a safe area.

Sample connections indicated on Engineering Flow Diagram, shall be taken at grade level or at a platform accessible by ladder or stairway. Sample lines shall include a block valve at the header in addition to a valve where the sample is taken.

Where possible, sample lines shall include a bypass to a lower system pressure, to minimize product losses.

If sample lines are not by-passed into a process line, they must be drained into the appropriate drainage system.

Sample connections for liquids shall be made in the side of the pipe, rather than in the bottom.

Gas samples shall be taken from the top of the pipe or through a quill, to keep condensate from the wall out of the sample.

3.13 WINTERIZING

No winterizing protection is included unless specified on Engineering Flow Diagram.

3.14 COOLING WATER

Cooling water shall be distributed to the various users through-out the process and the utility units as an underground steel pipe system, where practicable. (When size is greater than 300DN this requirement is mandatory). In particular cases (i.e. limited number of users inside a unit, small pipe sizes etc.) an aboveground steel pipe system may be provided.
The Engineering Flow Diagrams or supplementary design data shall specify whether the cooling water system will be above or below ground.

Cooling water inlet and return lines shall have block valves at each area battery limit.

Each user shall be valved both at inlet and return lines and valving shall be aboveground and located at the users. Back-flush of each user shall also be provided.
Header valves on branch lines will not be necessary since each user should be valved.
All instruments and Unit Battery Limit block valves shall be installed in gravel bottom boxes.

All instruments and Unit Battery Limit block valves shall be installed in gravel bottom boxes.

Small branches (40DN and less) from the cooling water header shall be taken from the top of the header to avoid blockage. Larger branches may be taken from the top or the bottom of the header, to suit the specific layout requirements.

1 At the design phase of the cooling water system Contractor shall propose a monitoring corrosion configuration to be applied during operation.

3.15 PLANT AIR

Unless otherwise specified, the air supply for plant air shall enter the unit from an outside source, with a block valve installed in the line at the Unit Battery Limit. This air shall be used as follows:

a) For process or other purposes where indicated on the Engineering Flow Diagrams.

b) For utility stations.

Branch lines from the plant air header shall be taken from the top of the header. Block valves are required for every branch located at the user. No branch line valves will be provided at the header.

The plant air system shall be provided with drain valves at low points in the header to free the system of water that may collect.

Air filters or separators shall not be provided in the plant air system unless shown on the Engineering Flow Diagrams.

3.16 INSTRUMENT AIR

Unless otherwise specified, instrument air supply shall enter the unit from an outside source, with a block valve installed in the supply line at the Unit Battery Limit.

Branch lines from the instrument air header shall be taken from the top of the header. Block valves are required for every branch and shall be located at the header.

Instrument piping shall be as described in **DESFA Job Specification No. 650/1.**

3.17 FIRE WATER AND FIRE PROTECTION SYSTEM

Valves in underground lines shall be provided with a post indicator.

3.18 SEWERS

Not applicable.

3.19 VENT/FLARE PIPING

Flare header piping shall be arranged to avoid pockets where liquid may accumulate.

Provisions shall be made for gas purging vent of flare lines from the extremities.

3.20 UTILITY STATIONS

Combined utility stations consisting of permanent outlets for required services (fresh water, plant air, and nitrogen) shall be provided throughout the plant.

Stations shall be located to permit full plant coverage with the length of hose specified.

Provide 25DN utility connections complete with gate valves in the working areas so that each part of the unit can be reached with a 15 m. hose. Suitable hose racks to hold one 15 m. section of 25DN dia. hose shall be provided at each utility station.

4.0 OFFSITE PIPING

4.1. GENERAL REQUIREMENTS

Wherever possible, all pipes shall be located in banks at grade and supported by concrete piers of sleepers.

Where double pipe banks are required, steel columns and supports built up from the concrete piers or sleepers shall be used. A clearance of 900 mm between the two banks shall be provided.

Overhead pipe racks shall be kept to a minimum.

Where piping at grade is required to cross a road, it shall pass under the road which, per the crossing section, shall be executed with a reinforced concrete plate resting on the sides and suitable to withstand truck vertical load, i.e a culvert. Adequate drainage system will be provided.

Clearance between the high point of a road and the underside of the lowest overhead pipe support shall be 6.500 mm as a minimum.

The minimum height of concrete piers or sleepers shall be 300 mm.

Wherever possible, changes in direction shall be accomplished by flat turning.

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Changes in direction shall be made with fittings. Mitre bends shall be used for pipe 650DN and larger, provided that operational pressure is not higher than 7 bar.

Consideration shall be given to expansion of pipe as a result of process or climatic conditions. The expansion shall preferably be absorbed by the use of loops or bends.

Horizontal loops will be preferably used.

Consideration shall be given to providing flexibility in the piping at storage tanks to allow for future settlement.

Except at valves and line terminations, the use of flanges shall be avoided.

5.0 PIPING DESIGN

5.1 ARRANGEMENT

The piping shall be routed to provide a neat and economical layout, have the shortest possible run consistent with good engineering practice, and require the minimum number of fittings. The piping systems shall be arranged to prevent striking or stumbling hazards, interference with equipment maintenance or removal, plant operation, or inspection.

Where unavoidable, removable spool pieces shall be provided.

Piping, above and below ground, shall be run in a plant conventional N-S and E-W direction where possible, with adequate clearance between pipes crossing each other at right angles.

Piping shall be routed above ground.

Exceptions are sewers, drinking, cooling and fire water systems in process unit areas, which may be routed underground.
Lines which must be run below grade, and which must be periodically inspected or replaced, shall be placed in covered concrete trenches.

Overhead lines shall be suspended parallel to each other by pipe supports or sleepers at a common elevation for the bottom of piping, and shall be grouped economically for support, with allowances for future expansion. Clearance shall be allowed between lines to permit access for removal or repair. Insulation thickness, and movement due to thermal expansion or contraction, shall be considered when determining pipe spacing and bottom elevation.

Underground lines laid in trenches shall be parallel to each other. Clearance shall be allowed between lines to permit access for removal or repair. Insulation thickness and movement due to thermal expansion or contraction shall be considered when determining pipe spacing and bottom elevation.

Overhead valves and instruments shall be located to provide access for operation and repair. Access to operating vents, drains, instruments, safety valves, control valves, thermocouples, block valves three inches and larger, which cannot be effectively operated by chain wheel drives, shall be from platforms, or from grade. In the operation of valves two inches and smaller access may be accomplished with adjacent platforms or permanent ladders.

Pumps, compressors, etc., shall be accessible from both sides for operation and repair.

Pump suction lines from towers and receivers shall be run to the suction nozzles on pumps without liquid or gas traps in the line. Where traps are unavoidable, drain and vent connections shall be installed.

Piping in storage areas and certain yard piping shall preferably be run on concrete sleepers. Flexibility shall be provided where piping is attached to equipment, to allow for differential settlement.

Lines have consolidated blanking stations outside battery limits of each unit, including access platforms and ladders.
The lines at battery limits, including flare lines, shall have a block valve and bleed valve, with the blanking point installed on the unit side of the block valve.

The flare lines shall be provided with a knife type, wafer body, gate valve at these blanking stations. Where blanking stations occur in horizontal flare lines, the knife-type gate valve shall be installed in either an inverted or horizontal position.

5.2 PIPE EXPANSION AND FLEXIBILITY

5.2.1 GENERAL

The piping layout shall be designed for expansion and contraction due to temperature changes, with out placing excess stresses on piping materials or excess forces and moments on equipment connections or pipe anchors.

5.2.2 ALLOWABLE STRESSES

a) The allowable stresses used in design shall not exceed those values given in the applicable design standard.

b) Flexibility analysis for piping systems shall be made by using the greatest temperature differential (with respect to minimum or maximum ambient temperature) imposed by normal operating condition, start-up, shut- down, decoking or abnormal condition.

The metal temperature for each condition shall be the temperature of the contained fluid or the temperature of the heating or cooling medium for jacketed lines, while for traced lines will not be less of 75% of steam tracing temperature.

Metal temperature for lines without external insulation may be reduced by 5%.

c) Flexibility analysis shall be carried out using approved techniques and methods.

5.2.3 PIPING FLEXIBILITY

a) Piping flexibility shall be obtained through pipe routing or expansion loops limitations of pressure drop, space, or economic elevation justify the use of flexible elements.

b) Flexibility analysis shall be made for the most severe temperature conditions imposed during start-up, shut-down, normal operation, or regeneration cycles.

5.3 CLEARANCES

Piping and supports shall be designed to the following minimum vertical clearances:

Buried Lines	- Cover	450 mm
Lines at Grade	- BOP	300 mm
Above Floors	- BOP	300 mm
Above Operating Areas	- BOP	2.4 m.
Above Yard Areas & Track Areas	- BOP	3.7 m.
Inside Building	- BOP	2.8 m.
Above Platform Main Complex	- BOP	2.1 m.
Pipe Racks	- BOP	4.5 m.
Unit Pipe Racks	- BOP	3.7 m.
Major Plant Roads	- OVHD	6.5 m.

Piping and supports shall be designed to the following minimum horizontal clearances:

Around Mechanical Equipment	900 mm
Operating Aisles	900 mm
Track	2.5 m.

5.4 LINE SIZES

Piping systems shall be designed and sized on the basis of the minimum, initial, total capital cost, considering accepted fluid velocities, available pressure drops, initial equipment cost, operating cost, maintenance cost, fluid characteristics, etc.

Pipe of nominal size 32DN, 65DN, 90DN, 125DN and 180DN shall not be used except when necessary to connect equipment, and then changed to a conventional size immediately adjacent to equipment.

5.5 MATERIALS

Pipe materials shall be compatible with the flowing medium in each service.

Allowance shall be made for corrosion in each service, and specified in piping material specifications.

Refer to the individual piping material specifications for selected material and wall thickness.

5.6 JOINTS

A minimum number of flanges and unions shall be used to facilitate erection and dismantling.

Special type joints (VICTAULIC couplings, GRAYLOC connectors, etc.) may be used in special applications.

Refer to the individual piping material specifications for each system.

5.7 FLANGES AND BLINDS

Flanges in plant piping shall be as specified in the individual service specifications and kept to a minimum. They shall be installed to facilitate construction, maintenance, inspection, and where process conditions dictate. Flanges may be required on lines subject to corrosion or erosion.

Flange bolt holes shall straddle the natural piping centre lines.

Welding neck flanges shall be bored to match the connecting pipe. Mismatching shall be permitted only by the applicable code.

5.8 FITTINGS

Welded end closures shall be welded caps on lines.

Welded fitting materials shall be compatible with the pipe materials.

Butt welding fittings shall be the same nominal wall thickness as the attached pipe.

Refer to the individual piping material specifications for each service application.

5.9 BRANCH CONNECTIONS

The selection of the branch connection method shall be based upon cost, restriction of flow, cyclic life external forces due to expansion, loading, vibration, etc., ease of inspection and reliability.

Branch connections shall be in accordance with the applicable code or regulation.

Closely spaced nozzle welds shall be checked for overlap of reinforcement zones, adding the required reinforcement.
Refer to the individual piping material specifications for each service application.

5.10 BOLTING

Refer to the individual piping material specifications for each service application.

5.11 GASKETS

Gaskets shall be a manufacturer type as specified in the individual piping material Specifications.

5.12 VALVES

Available pressure drop and line specification shall determine the selection of reduced port, Venturi or regular pattern valves.

The number of valves used shall be the minimum required for operation and maintenance.

Bypass and shutoff valves shall have the design rating of the higher pressure line.

Gauge lines, controller lines, etc., shall have the same ratings as the process line to, and including, the first block valve.

Block valves with double block and bleed features, may be used to provide safe isolation of equipment and vessels for inspection and maintenance.

All check valves shall be examined for operation problems when mounted in the vertical (upward flow) or horizontal position.

Type of check valves shall be individually investigated for reciprocating pump or compressor discharge lines.

Electric, hydraulic or pneumatic powered operators shall be furnished when specified on the mechanical flowsheets.

Refer to individual piping material specifications for the recommended valve selection.

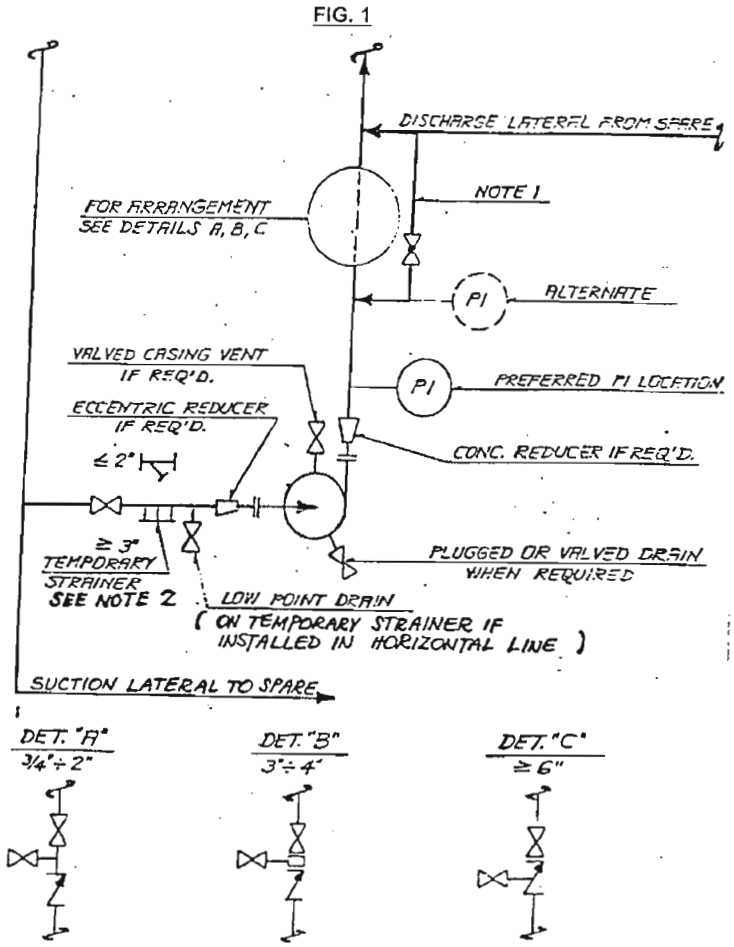
5.13 VALVES ACCESSIBILITY

Valves frequently operated shall be arranged so they can be operated from grade or platform level. The maximum distance above operating level to the centre line of the vale handwheels without using chains or extensions stems shall be 2.100 mm.

Valves 50DN and smaller may be accessible from a fixed ladder. Valves that require operating during an emergency shall be easily accessible or shall be equipped with remote operating devices with local convenient control. Unit isolating valves shall be grouped together, so they can be reached from main operating aisles. The outside edge of handwheels should not be closer than 50 mm. to avoid hand injuries.

TYPICAL PIPING AT CENTRIFUGAL PUMPS

FIG. 1



NOTES :

1) Warm up system for hot pumps or when necessary for winterization. Size for pump ratiang : 1" maximum
2) Where temporary strainers are provided, they will be "Y" type for sizes ≤ 2", and bathtub for sizes ≥ 3".

6.0 GENERAL NOTES FOR PIPING SYSTEMS

6.1 PIPE RACK ELEVATIONS

Select specific elevations for lines running north and south and other specific elevations for lines running east and west and maintain these elevations throughout the unit except where pockets must be avoided. Dimension between bands of pipes 900 mm.

6.2 PIPE ELEVATIONS (IN GENERAL AREA OF RACK COLUMNS)

Select specific elevations for short runs at pumps, control stations manifolds, etc., and maintain these throughout the unit 2.400mm min. clearance to H.P. of paving.

6.3 RACK-SPACE INSTRUMENTS AND ELECTRICAL

Provide standard space in pipe rack where specified by department concerned: Instruments 600 wide χ 300 high.

Electrical lighting 450 wide χ 300 high Electrical lighting and power underground. These dimensions to vary only when specified in writing.

6.4 ELEVATION OF PIPE USING COMMON SUPPORTS

All uninsulated lines rest directly on supports.
Hot insulated lines are on steel shoes 100 or more above support.

Insulation THK/S	Height of shoe
Up to 75	100 mm.
76 to 125	150 mm.
126 to 175	200 mm.
176 to 200	250 mm.

Note:

Shoes may be clamped on lines of low ferritic alloys (2-1/4 Cr 1/2 Mo; 1-1/4 Cr 1/2 Mo; carbon moly, etc.) or thin wall stainless steel.

6.5 BREAK FLANGES

Flanged connections must be provided to permit dismantling of lines for maintenance and inspections, or removal of equipment, only when specified on E.F.D.'s.

6.6 ELEVATIONS OF PAVING, FLOOR AND EQUIPMENT

To be as follows:

- Low point of paving (top of catch basins) -elev.150.
- High point of paving - elev. 0.0.
- HP. finished floor-enclosed buildings in paved areas -elev. 200.

- HP. finished floor-open buildings in paved areas - match adj.
- Paving with HP. of paving at bldg. edge.
- HP. finished floor-all buildings-unpaved areas 200 above adj. grade. (The following elevations are "top of grout" or "bott of base plate").

Horizontal equipment	- elev. min. 200
Centrifugal pumps	- elev. min. 200
Reciprocating pumps	- elev. min. 300
Vertical vessels	- elev. min. 200
Base of columns	- elev. min. 200
Pipe supports	- elev. min. 0.0

6.7 CHAIN AND GEAR OPERATED VALVES

Chain operated valves should be avoided. Should however be used, provide chain or extension stem for valves whose C.L. is more than 2.100 above operating level, chains to clear operating level by 900 and distance to centre line of valves shall not be more than 3.300 mm. above an operating level. Chains are not permitted on SCRD/SW valves or valves 50DN and smaller. Gear operations are required on gate valves 350DN and over in 150#, 300DN and over in 300#, 250DN and over in 600#, 200DN and over in 900# and higher ratings. Style of gearing must be specified by layout or isometric drawings.

6.8 ACCESS TO BATTERY LIMIT BLOCK VALVES

Battery limit block valves shall be made with platforms with relevant ladders.

6.9 CONTROL STATION LOCATION

Control valves to be located at grade or first level of structures unless otherwise specified on flow diagram.
Control valves which control level in a vessel must be located so that gauge glass is visible while operating the by-pass valve.

6.10 UTILITY STATION REQUIREMENTS

Steam air and water at grade spaced so that all area can be reached with 15 m. of hose.

Steam and air at alternative levels of structures and vessels (locate at levels with manways).

All lines to utility stations to be 25DN. Provide gate valve in each line at hose connection.

6.11 EQUIPMENT HANDLING FACILITIES

"Built in" handling facilities to be kept to a minimum.

Equipment shall be supported at or near grade to permit maximum use of mobile equipment for maintenance.

Exchangers with elevation less than 3.600 above grade to be handled with mobile equipment provided by others.

Horizontal exchangers with Center Line. 3.600 or more above grade will have suitable permanent steel of reinforced concrete structures with trolley beams and trolleys (excluding hoist) for handling individual exchanger parts. The design of such structures shall be based on the use of mobile equipment to pull tube bundles. The trolley hoist will assist in supporting the bundle during pulling and will be capable of lowering it to grade.

6.12 PLATFORMS ON TOWERS OR EQUIPMENT

To be provided only when valves, manways and **"figure 8"** or blind must be reached.

6.13 ORIFICE FLANGES

(Orifice plates to be 3 mm. thk. for size 350DN & smaller & 6 mm. thk. for sizes 400DN larger).

Horizontal orifice runs are preferred.

Vertical runs are permitted for liquid with up-ward flow and downward flow for gases. A minimum of 600mm clearance shall be allowed from O.D. of orifice flange to any obstruction for installation of meter leads. Orifices for pedestal mounted flow meters (except in air or gas service or underground lines) shall be located at a minimum elevation of 3.600 above grade or platform to allow the meter leads to slope to the instruments.

Orifices and line mounted flow transmitters as well as thermocouples, which are located less than 6.600 above grade may be accessible from portable ladders above 6.600.

They may be accessible from walkways, ladder, platforms and/or portable platforms.

Taps to be in horizontal for liquid and steam or 45° downhead on piperack (Instrument Dept. approval required).

Taps to be on top for air and gas service.

6.14 PUMP SUCTION LINES & STRAINER

All overhead suction lines shall drain toward the pump without pockets.

6.15 MAINTENANCE CLEARANCE

Piping and structures shall be arranged to permit mobile lifting equipment to approach pumps and make lifts without obstruction.

6.16 LINES WITH TWO PHASE FLOW

All two phase lines must be pointed out in the Line Classification List so layout man can give these lines special design consideration. Project eng. shall specify and point out testing medium.

6.17 SHIMS OR GROUT

Allow for 25 mm (or grout) above steel (or concrete).
For vessels over 4.500 dia allow 40 mm. for shims (or grout).

6.18 BRANCHES OFF HEADERS

Branches off the plant air, steam lines and gas headers to be from top of header; branches off water header to be from top of header for lines 40DN and smaller. Relief valves to discharge into top of header.

6.19 PLATFORMS REQUIREMENTS AT MANWAYS

Platforms shall not be provided for manways in horizontal or vertical vessels where the manway centerline is 3.600 or less from grade. Assume portable ladders will be used.

6.20 OVERHEAD CLEARANCES

Below pipe rack (and in truck areas) 3.600 x 3.000 wide.

Access aisles need not be straight thru process area.

Over main roads 6.500

Min. overhead. 2.400

Headroom 2.100

6.21 VALVES ACCESSIBILITY

All flanged valves, safety, relief and control valves, **figure "8"** and blinds, steam traps, strainers shall be covered by platform if located in elevated position, except unit limit and header valves which are located on pipe rack.

6.22 EXIT ON LADDERS

All ladders shall have side-step exit.

6.23 PRESSURE LIMITING DEVICES

These devices must be designed so that pressure will not permanently exceed the maximum allowable design pressure except for short pressure surges of 1.1 times the design pressure. The momentary pressure surge to be kept to 10% of the design pressure.

6.24 TEMPERATURE MONITORING DEVICES

These devices must have an adequate response time on safety grounds.

APPENDIX A

CRYOGENIC PIPING DESIGN

A.1 SCOPE

This Appendix complements the directives given in the main body of DESFA job Specification 500/1 and applies only to cryogenic piping design.

As far as cryogenic piping is involved, in case of contradiction between the foresaid Specification and this Appendix, the practices of this Appendix shall be followed.

As cryogenic piping is understood the pipes and fittings which are in contact with fluids at temperatures of -28°C or below, and the pipe supports in immediate contact.

As cryogenic area is understood the area in which the spillage of large quantities of cryogenic liquid is a probable event.

A.2 CRYOGENIC PIPING MATERIAL

Piping material classification for cryogenic lines shall be done considering design pressure and temperature.

A.3 PROCESS SYSTEMS

A.3.1 Pumps

a. Cryogenic Can-type Pumps shall be preferably installed skirt mounted above ground whenever possible.
Installation inside a pit is not recommended unless NPSH limitations at the pump suction are considered.

b. In the case of skirt mounted pump, a service platform shall be provided for the operation of pump related valves.

c. Pump vents to recondenser shall have a *10%* slope as minimum.

A.3.2 Loading Arms

a. Loading Arms shall be installed with ample space for the movement of their parts and free circulation of personnel.

b. The loading area shall be free of any obstacle so that, in case of LNG major spillage, personnel evacuation and spill drainage run-off be easy and fast.

A.3.3 Control Valves and Instrumentation

a. Control valve stations to be provided with nitrogen purge connections and vents hard piped to the flare system.

b. On-line instruments, on piping handling cryogenic fluids, shall be connected atop of horizontal pipes to provide a gas pocket between fluid and instrument.

On vertical pipes, connection must turn upward to create a gas pocket.

A.3.4 Expansion Joints

Expansion Joints are not allowed for cryogenic services.

A.4 PIPING DESIGN

A.4.1 Pipe shall be arranged to be self-draining and self-venting.

A.4.2 Cryogenic piping on pipe racks or pipe ways shall be grouped together and in location such that occasional spillages will not affect non-cryogenic lines or cabling.

If piping cannot be arranged as requested above or cryogenic piping passes over circulation areas (roadways, corridors, etc), means of contention of cryogenic spillages must be provided as protection for personnel and/or equipment.

Protection means can be decks, trays, etc. provided they are constructed of proper materials and dimensioned according to the maximum spillage rate expected.

Drainage from decks or trays shall be to paving or to spillage trench through drainage gutters of adequate size.

A.4.3 Ice formation is to be considered in loads calculations for uninsulated lines. Ice thickness to be calculated according to the local conditions.

All supports must be designed accordingly, to avoid contact of ice on the supporting structures.

A.5 STRUCTURES AND PAVING

A.5.1 Structures inside cryogenic areas supporting pieces of equipment and subject to probable events of massive cryogenic spillages shall be of concrete construction, with kerbed and sloped decks for spillage

contention. Any opening trough decks shall be kerbed, and sealed if applicable.
Drainage of decks shall be to paving or spillage trench by means of drainage gutters of adequate size.

A.5.2 For structures not subject to the conditions of item A.5.1 above, an open grate type platform is acceptable, if the area below is not intended for operation or transit. Otherwise, means of spillage contention and drainage must be provided.

A.5.3 Pipe racks can be metallic and shall be fire/cold protected at least to a height of 500 mm above base plate, provided that only piping is supported. Otherwise, full fire/cold protection is required for the frames involved.

A.5.4 Paved areas around equipment handling cryogenic liquids shall be fully kerbed and sloped to the nearest spillage trench.
All cryogenics areas shall be sloped to the spillage collection system. Dead corners or low points were liquid could be accumulated shall be avoided.

A.5.5 Sewers or rain water system of the underground type inside cryogenic areas is not permitted. Rain water will be collected by the spillage collection system which shall be dimensioned accordingly.

A.5.6 A thermal dam (hardwood or equivalent) shall be provided between cryogenic equipment and concrete base, with bolting arrangement to avoid thermal transmission.

Bolting shall be S.S. if a temperature of -10°C or below is expected. Special care must be taken to guarantee that foundations and bolting are not affected in case of spillage.

A.5.7 Underground electric and instrument trenching shall run outside the cryogenic areas and the spur ducts shall be carried into each item of equipment sloping away from the supply trenches.