WORK INSTRUCTION FOR ABOVEGROUND PIPING DESIGN

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1 GENERAL

1.1 Scope and Field of Application

The purpose of this document is to provide guidelines and reference criteria for the design of aboveground piping layouts for oil and petrochemical plants.

1.2 Plant block identification

The homogeneous blocks are identified into which the Plant can be subdivided, and the overall dimensions are defined. A criteria that is often used for subdivision is functional homogeneity.
The following functional blocks can normally:

- Process Units;
- Utilities production Units;

→ On-site area

- Tank farms, pump rooms, loading system;
- Flares and effluent treatment;
- Office building, canteens, workshops, warehouses, etc.

→ Off-site area

1.3 Measurement Units

The units of measurement indicated in the documents are normally those specified in the Project Specifications.

If these documents do not prescribe any unit of measurement, the Unit of Measurement is International System of Unit (SI).

1.4 References

This Practice makes reference to the following documents:

- 3034.00.ED.PI.DCR.50000(A2)	'Job specification for layout and spacing'
- 3034.00.ED.PI.DCR.50001(A0)	'Technical specification for sewer e underground piping networks'
- 3034.00.ED.PM.PCR.AA401(A1)	'P&ID development procedure'
- 3034.00.ED.PI.DCR.50003(A0)	'Jacketed pipe specification'
- 3034.00.ED.PI.JSP.50003 (A0)	'Job specification for Steam tracing'
- 3034.00.ED.PI.JSP.50002(A0)	'Job specification for typical piping assembly'
- 00-GA-E-00060898.	'Work instruction for single-line drawing'

- 00.GA.E.00060897	'Work instruction for foundation'
- IPS.D.AR.012 Sh.4/5	'Retaining wall/dike and floors crossing'
- IPS.E.PR.845	'Engineering standard for process design of steam traps'
- IPS.D.PI.175	'Typical support for flexible hose'

1.5 Abbreviations

Company Departments:

- APRES Mechanical Equipment Department;
- SPRIV Piping Material Specification;
- MAPAF Package, Machineries and Heaters Department;
- PRC Process Department;
- SMAUT Instruments, Automation and Telecomunication;
- STRESS Stress Analysis;

Other Abbreviations:

- ND Nominal diameter;
- P&I D Piping and Instrument Diagram;
- RJ Ring Joint.

2 ACTIVITIES TO BE PERFORMED

The purpose of the work is to process the production of the documents needed for piping prefabrication and erection as well as of the relevant bill of materials. This is achieved in two phases:

- definition of the piping layout;
- production of the documents (isometrics and erection drawings) and of the material take-offs.

2.1 Piping layout

This activity consists to define the layout of the piping present on the Plant. Normally it is developed using the following operating methods, either singly or combined:

- Studies on paper;
- 3D model.

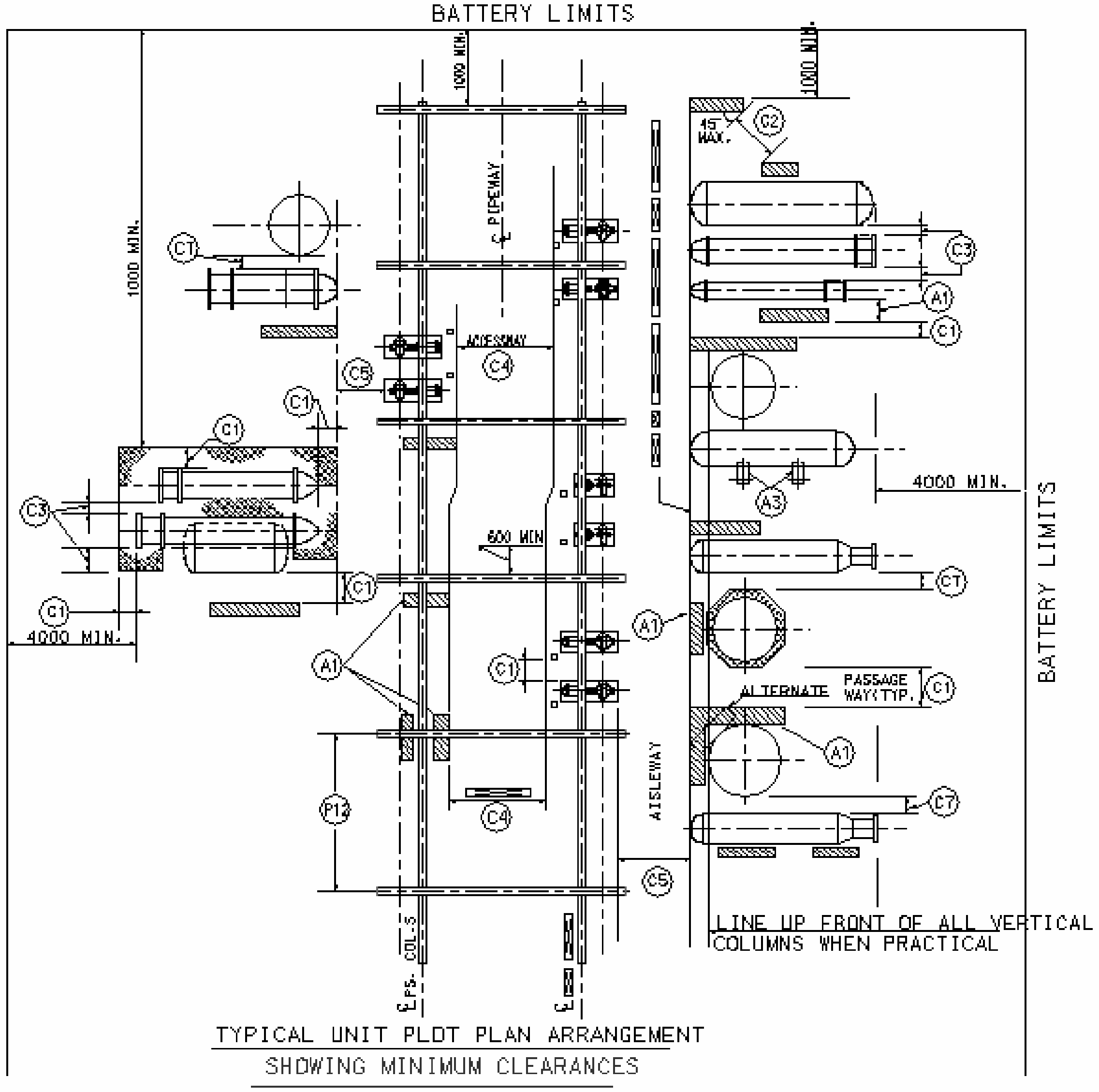
Studies on paper are generally utilized for the revamping of existing Plants, where only the erection drawings are available, or for the interconnecting or Off-site areas. The performance of this activity involves the solution of problems that are jointed to constraints as safety, cost-effectiveness, functionality and accessibility and dealt (see *Paragraph 3*). Normally, Plant process and utilities pipes are installed aboveground, gathering them, as far as possible, in orderly bundles on appropriate support structures, which are called piperacks.

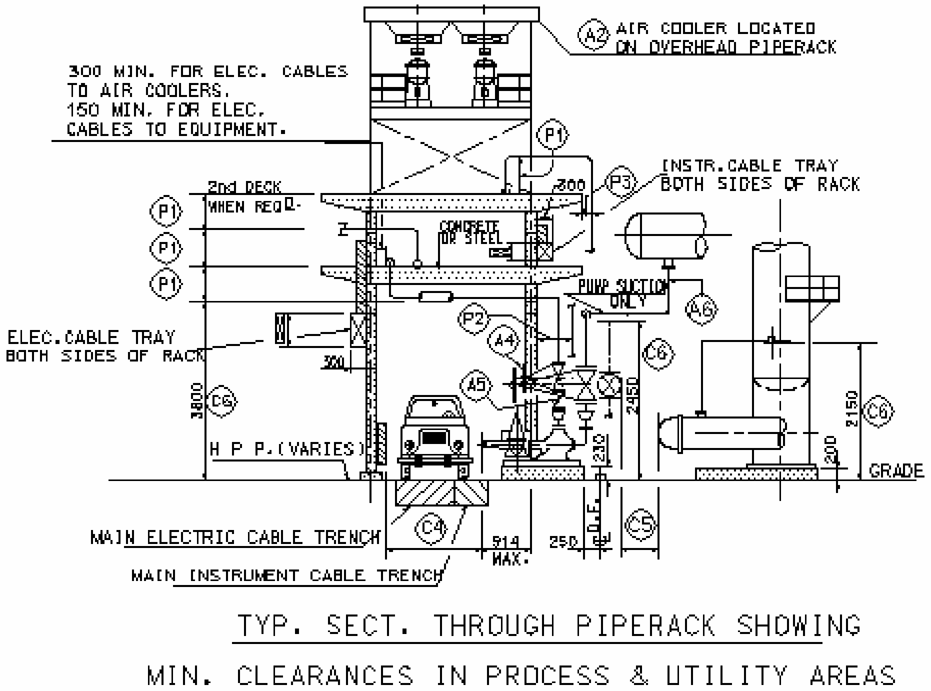
Exceptions are the sewer system sea cooling water, potable water and fire-fighting pipes which are installed below the Plant grade level. For the design of these type of pipes see 3034.00.ED.PI.DCR.50001 'Technical Specification for sewer e underground piping network'.

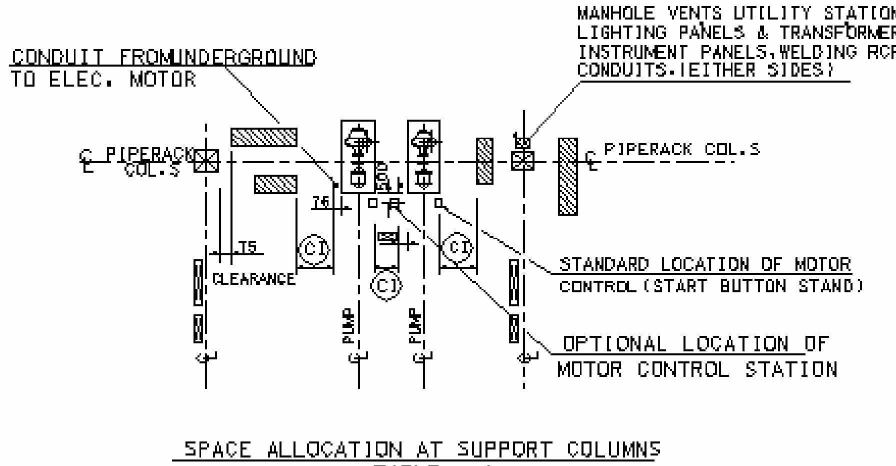
The aboveground piping layout shall have a simple and well-organized arrangement, the network configuration shall be in according to Mechanized P&I diagrams, moreover suitable access for operability and maintenance and economic supports shall be provided (see *Figure 2.1.1*).

The following activities are developed at the same time as the piping layout activities:

- Nozzles orientation and foundations aboveground profile;
- Single-line drawings of structures and auxiliary steel structures;
- Stress analysis and support of piping.







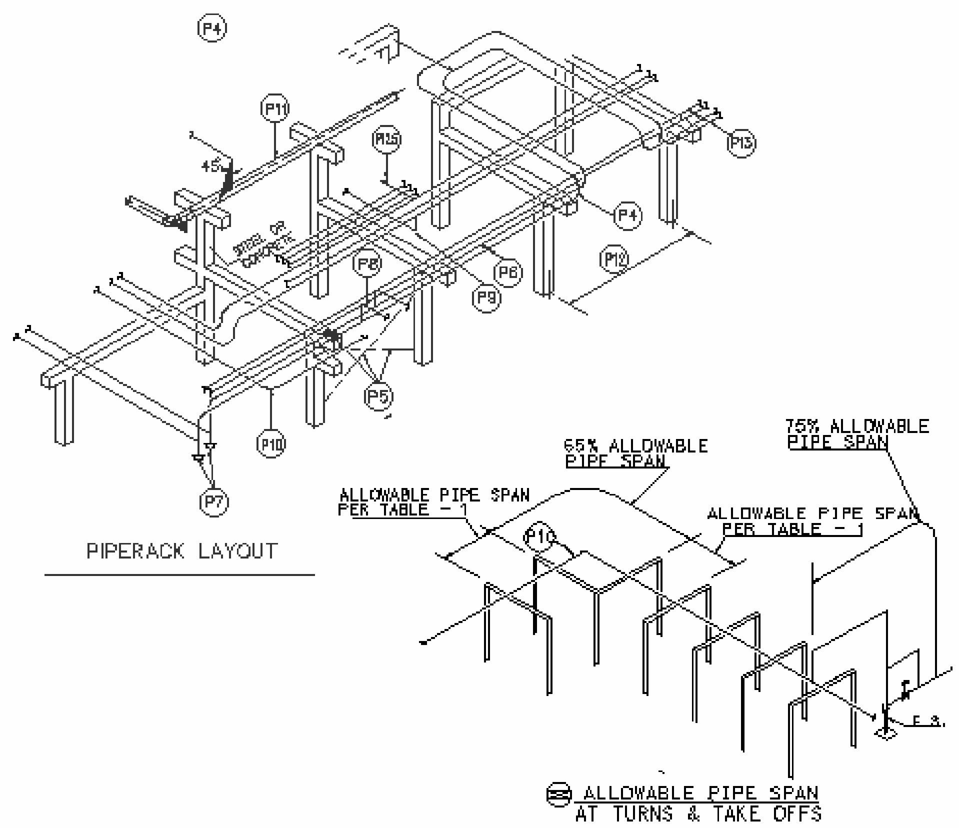


TABLE - 1

ALLOWABLE PIPE SPANS

BASED ON USING ASTM A53 GR.B. PIPE FILLED WITH WATER

PIPE SIZE		WALL THK.	93 °C & UNDER LIMITING STRESS=5000 Psi) UNINSUL. / 93 °C & UNDER LIMITING STRESS=34.47 N/mm2 (UNINS.)				93 °C 315 LIMITING STRESS=4325 Psi(INSULATED) / 93 °C 315 LIMITING STRESS=29.82 N/mm2(INSULATED)			
			MAXIMUM		RECOMMENDED		MAXIMUM		RECOMMENDED	
DN	NPS		SPAN	DEFLECTION	SPAN	DEFLECTION	SPAN	DEFLECTION	SPAN	DEFLECTION
20	3/4"	3.91	4400	19	3600	9	3600	12	3000	6
25	1"	4.55	5000	20	4300	11	4200	13	3700	8
40	1 1/2"	5.08	6000	20	5400	14	5200	14	4700	10
50	2"	5.54	6700	20	6000	13	5800	13	5300	10
80	3"	5.49	7800	18	7100	13	6900	13	6400	10
100	4"	6.02	8700	18	8000	13	7600	13	7200	10
150	6"	7.11	10200	17	9500	13	9000	12	8300	9
200	8"	8.18	11300	16	10500	12	10200	12	9400	9
250	10"	9.27	12400	15	11400	11	11200	12	10500	9
300	12"	9.53	13100	14	11900	10	11800	11	10900	8
350	14"	9.53	13400	14	12400	10	12100	10	11300	8
400	16"	9.53	13800	13	13000	10	12600	10	11900	8
450	18"	9.53	14200	12	13200	9	12900	9	12000	7
500	20"	9.53	14500	11	13300	8	13200	9	12500	7
600	24"	9.53	14900	10	14100	8	13700	8	12800	6

TABLE-1 IS MAINLY A GUIDE LINE FOR ABOVE CONDITION.
FOR OTHER CASES THIS TABLE MUST BE RECHECKED.

NOTES

1-ALL THK. VALUES & DIM.S ARE IN mm.
2-DESIGNATION ON IN "SI" UNITS IS USED FOR NOMINAL DIA.

ARRANGEMENT

A1- SPACE FOR PIPING CONTROL VALVE MANIFOLDS, BY PASSES, ETC. (USE 600 BEYOND ADJACENT EQUIPMENT FOR LAYOUT)
A2- IN A LIMITED PLOT WHEN PROCESS CONDITIONS PERMIT AND IT IS ECONOMICALLY, PREFERABLE, AIR COOLER MAY BE INSTALLED ABOVE OVERHEAD PIPERACKS.
A3- PUMPS WITH PROCESS REQUIREMENTS OF LOW SUCTION LINES SHALL NORMALLY BE LOCATED AS SHOWN IF ECONOMICALLY FEASIBLE PROVIDING SUFFICIENT SPACE OR ACCESS IS AVAILABLE FOR MAINTENANCE.
A4- PUMP SUCTION & DISCHARGE VALVES SHALL , IF POSSIBLE, BE ACCESSIBLE FOR OPERATION WITHOUT THE USE OF CHAIN OR EXTENSION STEMS.
A5- DISCHARGE CHECK VALVES SHALL, IF PRACTICABLE, BE LOCATED IN THE VERTICAL.
A6- PUMP SUCTION LINES SHALL BE AS SHORT AND DIRECT AS POSSIBLE UNLESS OTHERWISE REQUIRED FOR FLEXIBILITY REASONS.

CLEARANCE

C1- 1000 CLEAR WALKING SPACE FOR PASSAGE WAY.
C2- 1000 MAY BE MEASURED ON THE DIAGONAL OF 45° MAX.
C3- CLEARANCE BETWEEN FLANGES OF EXCHANGERS OR AROUND OTHER BOLTED EQUIPMENT CONNECTION WHICH MUST BE SERVICED OR MAINTAINED SHALL BE 600 CLEAR.
C4- A CLEAR ACCESSWAY SHALL BE PROVIDED WHICH WILL FURNISH SUFFICIENT SPACE FOR VEHICLE MANOEUVRING BUT WHICH MAY NOT NECESSARILY BE IN A STRAIGHT LINE. 4800 MIN. FOR A 6100 WIDE PIPERACK & 5800 MIN. FOR A 7600 & 8000 MIN. FOR A 10000.
C5- CLEAR AISLEWAY FOR EXCHANGER HEAD REMOVAL SHALL BE 2300.
C6- PIPERACK BOTTOM OF PIPE ELEVATION ABOVE GRADE OR HIGH POINT OF PAVING SHALL BE 2150 OVER PASSAGE WAYS, 2450 OVER AISLES AND 3800 OVER ACCESSWAYS.
C7- MINIMUM DIMENSION=760.

PIPERACK

P1- DIFFERENCE IN PIPERACK ELEV.S SHALL GENERALLY BE 1000 MIN.
P2- ALLOW 350 DROP SPACE FOR UTILITY, STEAM TRAP, VENT PIPING, ETC.
P3- GENERALLY THE CENTERLINE OF LINE DROPS SHALL BE BASED ON MIN. 50 CLEARANCE BETWEEN THE EDGE OF THE PIPE SUPPORT AND/ OR INSTRUMENT RACK AND THE BACK OF THE LARGEST PIPE AND/ OR INSULATION. OTHER DROPS SHALL BE ON APPROX. THE SAMELCAS THE LARGEST PIPE
P4- LOOPS ARE REQUIRED WHEN IT IS IMPRACTICABLE TO TAKE PIPING EXPANSION MOVEMENTS AT CORNERS OR AT EQUIP., THEY SHALL NORMALLY BE OBTAINED BY FOLDING BACK OVER THE PIPERACK.
P5- IF ANCHORS ARE REQUIRED TO MINIMIZE FORCES ON EQUIPMENT OR REDUCE PIPING EXPANSION MOVEMENT, THEY SHALL BE SO LOCATED THAT ANY NECESSARY BRACING DOES NOT INTERFER WITH PASSAGEWAY OR EQUIPMENT CLEARANCES.
P6- GENERALLY LARGEST PIPE DIAMETER AND/ OR HOT LINES SHALL BE ROUTED ON THE OUTSIDE PIPERACK TO PERMIT MAXIMUM EXPANSION MOVEMENTS IN A MIN. OF SPACE.
P7- WHEN CONDENSATE REMOVAL IS REQUIRED IN UTILITY AIR OR STEAM HEADERS, DRIP OR BOOT LEGS SHALL BE PROVIDED AT PIPING LOW POINTS OR OTHER CONVENIENT LOCATIONS.
P8- GENERALLY, PIPERACK HEADER BRANCH CONNECTINS FOR UTILITY & PROCESS GASES, AIR, STEAM, ETC. WILL BE MADE ON THE TOP OF THE LINE TO AVOID HEADER LOW POINTS WHERE COND. MAY COLLECT.
P9- PIPERACK HEADER BRANCH CONNECTIONS FOR LIQUIDS GENERALLY ARE ON THE BOTTOM OF THE HEADER TO AVOID BRANCH HIGH POINTS WHERE GASES MAY COLLECT AND PREVENTING LIQUID FLOW.
P10-WHEN ECONOMICALLY FEASIBLE, OR AS STIPULATED BY PROCESS CONDITIONS. FLAT TURNS & DIAGONAL RUNS SHALL BE USED WHEN PRACTICABLE.
P11-THE NORMALLY DESIRABLE LOCATION OF RELIEF AND BLOWDOWN HEADERS ELEVATED ABOVE PIPERACK IS OVER THE PIPERACK COLUMNS.
P12-THE CENTERLINE TO CENTERLINE OF PIPERACK COLUMNS SHALL BE 7600 WITH THE FOLLOWING EXCEPTIONS:
P12.1-IF THE PREDOMINATE PORTION OF THE PIPING IN THE RACK IS UNDER 3" (DN80) SEE TABLE-1 FOR ALLOWABLE PIPE SPANS.
P12.2-ALUMINIUM OR OTHER SPECIAL MATERIALS CONSTITUTE THE MAJORITY.
P12.3-SPANS MAY BE SHORTENED SLIGHTLY TO MAKE EVEN SPACING ACROSS A PLOT.
P12.4-SUPPORT SPACING SHALL BE INCREASED FOR SINGLE OR MULTIPLE LINES 200 & LARGER.(SEE TABLE-1 FOR ALLOWABLE PIPE SPANS.)
P12.5-SMALL LINES UNABLE TO SPAN THE NORMAL 7600 SPACING SHALL BE SUPPORTED BY INTERMEDIATE PICK-UP.
P13-FOR LINE SPACING SEE POINT 3.1.1

***Figure 2.1.1** Typical Arrangement and Piperack layout*

2.2 Isometrics

Isometrics are piping drawings by line. They are essential for shop prefabrication and, with the erection drawings, for the assembly on site.
In *Figure 2.2.1/2/3* examples of the criteria for the partition of the isometric in prefabrication and erection.

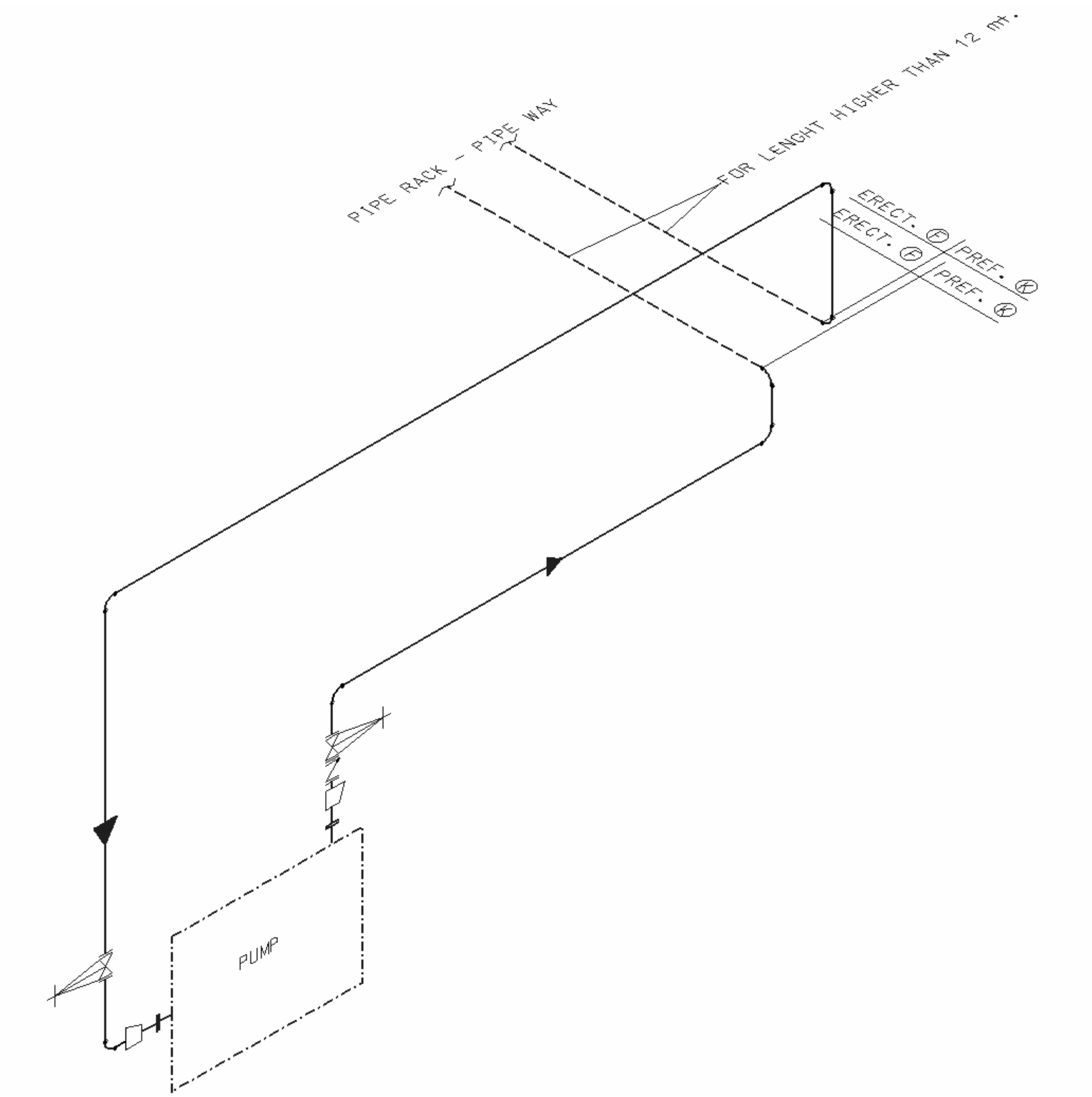


Figure 2.2.1 *Example of Isometric drawing*

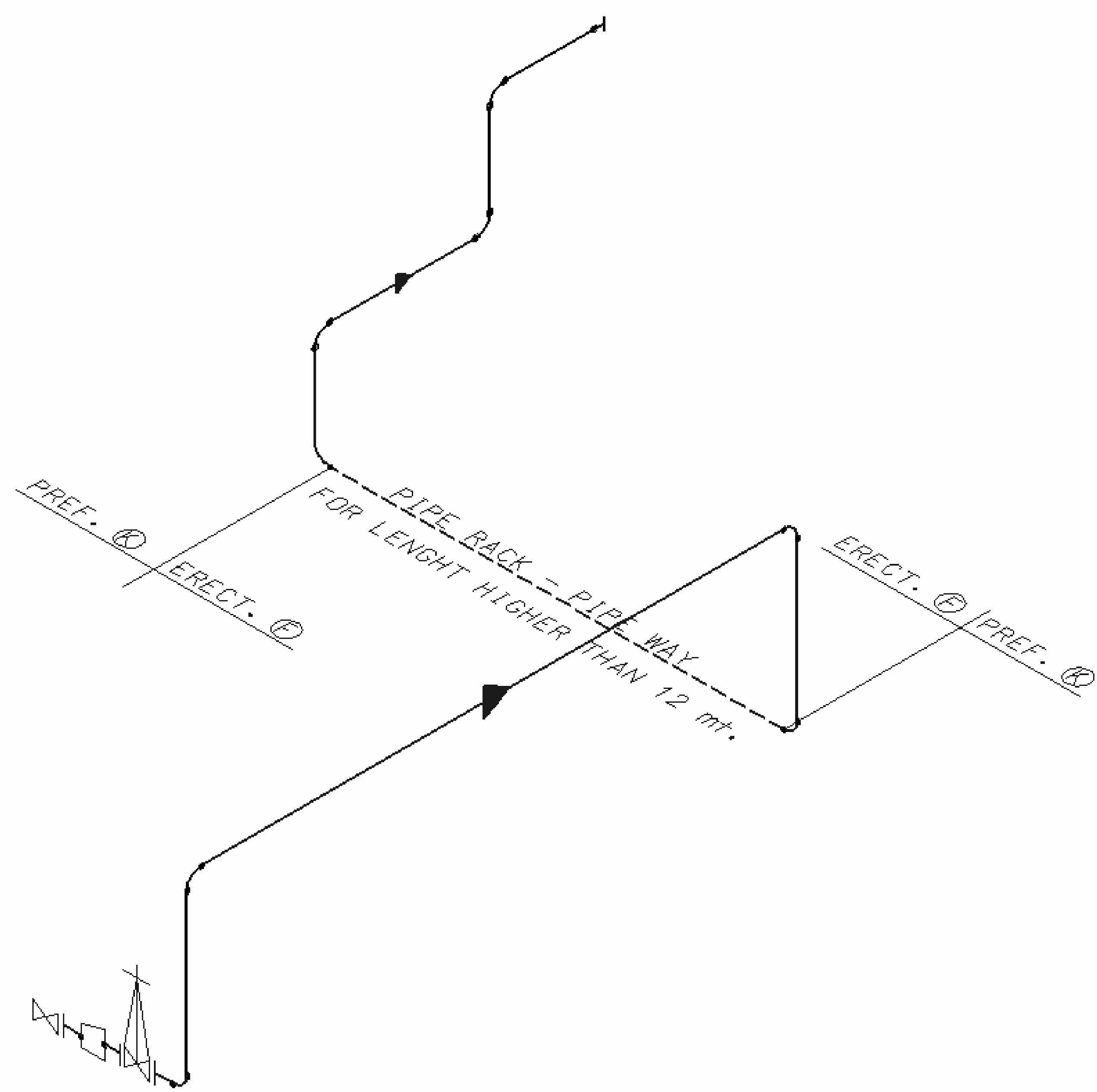


Figure 2.2.2 *Example of Isometric drawing*

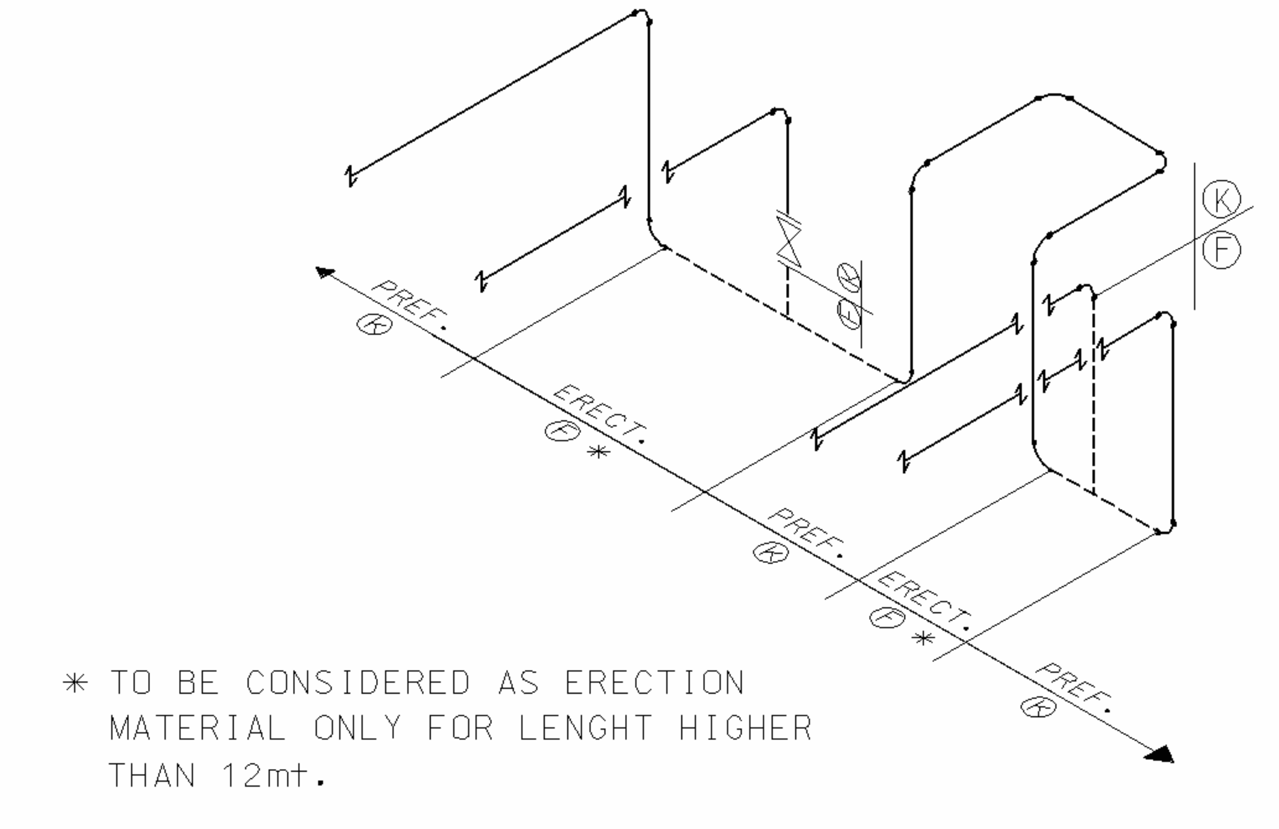


Figure 2.2.3 *Example of Isometric drawing*

2.3 Erection Drawings

Erection drawings are piping drawings. They are prepared by area, with plan, elevation or isometric views of all the Plant areas in which aboveground piping is present.
They provide, with the isometrics, the necessary indications for erection on site of piping and supports.

3 PIPING INSTALLATION

This Section gives the criteria for the installation of piping connected to equipment components of the Plant, with particularly attention to positioning, accessibility for operation and maintenance, and functionality.

3.1 Piperacks

For installation of pipes on piperack see 00-GA-E-00060898 ‘Work instruction for single-line drawing’.
Normally, when more than one level is needed, pipes are distributed as follows:
- process piping: lower and intermediate level;
- service piping: upper level.

A1 This distribution is necessary in order to allow branch off from the top or the bottom, as required (see *Paragraph 3.1.2*), and the utilization of the same cross beam for the greatest possible number of branch- offs.

3.1.1 Distances between centers of pipes

The pipes are installed on the pipe racks providing sufficient space between them. Space is necessary in order to allow the operations following installation, such as: tightening of the coupling flanges, joint welding, painting, insulation, etc.
Distances between centres 'L' of two side by uncoated pipes side by side shall have as a minimum the distance given by the following formula:

$$L(mm) = \frac{DF + Dt}{2} + 25$$

Where:
DF (mm) = external diameter of the flange of greater ND or rating piping;
Dt (mm) = external diameter of the piping with a smaller ND

Table 3.1.1.1.a/b gives the distance between centers 'L' that shall be normally respected between uncoated piping with a rating of 150#÷900#.

Note: in the case of diameters or ratings not covered by this table, apply the formula given in point 3.1.1

Applicable to piping with flanges rating 150# and 300#

1	130													
1-½	150	160												
2	150	160	160											
3	170	180	190	200										
4	190	200	210	220	230									
6	220	230	240	250	270	290								
8	240	250	260	280	290	320	350							
10	270	280	290	300	320	360	380	410						
12	300	310	310	330	350	390	420	450	480					
14	320	330	340	360	380	420	450	480	510	520				
16	350	360	370	390	410	440	470	510	540	550	580			
18	370	380	390	410	430	470	500	530	560	580	610	630		
20	390	400	410	430	450	490	530	560	590	610	640	670	690	
24	440	450	460	490	500	550	580	620	650	670	700	730	760	810
ND"	1	1-½	2	3	4	6	8	10	12	14	16	18	20	24

Applicable to piping with flanges rating 600#

1	130													
1-½	150	160												
2	150	160	160											
3	170	180	190	200										
4	200	210	220	230	240									
6	240	250	260	270	290	310								
8	260	270	280	300	310	340	370							
10	300	310	320	340	350	390	410	440						
12	310	320	330	350	370	410	440	470	500					
14	340	350	360	380	400	430	460	490	520	530				
16	370	380	390	410	430	460	490	530	560	570	600			
18	390	400	410	430	450	480	520	550	580	600	620	650		
20	410	420	430	450	470	510	550	580	610	630	660	690	710	
24	460	470	480	500	520	560	600	630	670	690	710	740	770	820
ND"	1	1-½	2	3	4	6	8	10	12	14	16	18	20	24

Table 3.1.1.1.a*- Distance between centers of uncoated pipes (mm)*

1	140													
1-½	160	170												
2	170	180	190											
3	190	200	200	220										
4	210	220	230	240	250									
6	250	260	270	280	300	330								
8	290	300	310	330	340	370	400							
10	320	330	340	360	370	410	430	460						
12	340	350	360	380	400	430	460	490	520					
14	350	360	370	390	410	450	480	510	540	550				
16	380	390	400	420	440	470	500	540	570	580	610			
18	410	420	430	450	470	510	540	570	600	620	640	670		
20	440	450	460	480	500	540	570	600	630	650	680	710	730	
24	510	520	530	560	570	620	650	680	720	740	760	790	820	870
ND"	1	1-½	2	3	4	6	8	10	12	14	16	18	20	24

Applicable to piping with flanges rating 900#

Table 3.1.1.1.b *- Distance between centers of uncoated pipes (mm)*

If one of the pipes or both of them are insulated or steam traced, the distance between centers must be increased by insulation thickness as in *Table 3.1.1.2/3/4*.
Moreover the space needed for the installation of instruments, as orifice flanges, whenever necessary, and of supports according to the results of the stress analysis, shall be provided.
Sometime the Licensor may request particular installations which need greater distances between centers such as, for example, an assembly of orifice flanges with horizontal branch pipes. In this case alternative solutions shall be provided like raising pipes by means of special shoes so as to avoid having to provide greater distances between centres than those previously indicated.

Outsider Diameter	Insulation Thickness				
	25mm (1″)	38mm (1 ½″)	51mm (2″)	64mm (2 ½″)	76mm (3″)
	Minimum Operating Temperature				
≤0.9m (3′-0)	10°C(50°F)	-1.0°C(30°F)	-6.5°C(20°F)	-12.5°C(10°F)	-20.5°C(-5°F)
1.2m(4′-0″)	10°C(50°F)	-1.0°C(30°F)	-4.0°C(25°F)	-12.5°C(10°F)	-20.5°C(-5°F)
1.5m(5′-0″)	10°C(50°F)	-4.5°C(24°F)	-4.0°C(25°F)	-12.5°C(10°F)	-20.5°C(-5°F)
1.8m(6′-0″)	10°C(50°F)	-4.5°C(24°F)	-4.0°C(25°F)	-12.5°C(10°F)	-17.5°C(0°F)
2.4m(8′-0″)	10°C(50°F)	-4.5°C(24°F)	-4.0°C(25°F)	-12.5°C(10°F)	-17.5°C(0°F)
3.0m(10′-0″)	10°C(50°F)	-4.5°C(24°F)	-4.0°C(25°F)	-12.5°C(10°F)	-17.5°C(0°F)
3.7m(12′-0″)	10°C(50°F)	-4.5°C(24°F)	-4.0°C(25°F)	-12.5°C(10°F)	-17.5°C(0°F)
Over 3.7m(12′-0″)	10°C(50°F)	-4.5°C(24°F)	-4.0°C(25°F)	-9.5°C(15°F)	-17.5°C(0°F)

Table 3.1.1.2 *Cold insulation thickness Table for vessels, equipment and pipe larger than 24”*

PIPE SIZE (INCH)	TEMPERATURE							
	Ambient to 260°C	From 261°C to 316°C	From 317°C to 371°C	From 372°C to 427°C	From 428°C to 482°C	From 483°C to 538°C	From 539°C to 593°C	From 594°C to 649°C
½	40	40	40	40	40	50	50	50
¾	40	40	40	40	40	50	50	50
1	40	40	40	40	40	50	50	50
1 ½	40	40	40	40	40	50	50	50
2	40	40	40	40	50	50	50	50
3	40	40	40	50	50	50	50	65
4	40	40	50	50	50	50	65	65
6	40	50	50	50	65	65	65	65
8	50	50	50	65	65	65	65	65
10	50	50	65	65	65	65	65	75
12	50	50	65	65	65	65	65	75
14	50	50	65	65	65	65	65	75
16	50	50	65	65	65	75	75	75
18	50	65	65	65	65	75	75	75
20	50	65	65	65	75	75	75	90
22	50	65	65	75	75	75	75	90
24	50	65	65	75	75	75	75	90
30	50	65	75	75	75	75	90	90
Larger Pipe and Equipment	40	50	65	75	75	75	75	90

Table 3.1.1.3 *Insulation thickness Table for heat conservation and personal protection*

Pipe size (inch)	COLD INSULATION				
	Insulation Thickness				
	25mm (1″)	38mm (1 ½″)	51mm (2″)	64 mm (2 ½″)	76 mm (3″)
	Minimum Operating Temperature				
½	10°C (50°F)	-12.5°C(10°F)	-31.5°C(-25°F)		
¾	10°C (50°F)	-4.0°C(25°F)	-23.5°C(-10°F)		
1	10°C (50°F)	-4.0°C(25°F)	-23.5°C(-10°F)		
1 ½	10°C (50°F)	-1.0°C(30°F)	-9.5°C(15°F)	-26°C(-15°F)	
2	10°C (50°F)	-1.0°C(30°F)	-9.5°C(15°F)	-26°C(-15°F)	
3	10°C (50°F)	-1.0°C(30°F)	-9.5°C(15°F)	-23.5°C(-10°F)	
4	10°C (50°F)	-1.0°C(30°F)	-6.5°C(20°F)	-17.5°C(0°F)	-34.5°C(-30°F)
6	10°C (50°F)	7.5°C(45°F)	-4.0°C(25°F)	-17.5°C(0°F)	-31.5°C(-25°F)
8		7.5°C(45°F)	-4.0°C(25°F)	-17.5°C(0°F)	-26°C(-15°F)
10		7.5°C(45°F)	-1.0°C(30°F)	-12.5°C(10°F)	-23.5°C(-10°F)
12		7.5°C(45°F)	-1.0°C(30°F)	-9.5°C(15°F)	-20.5°C(-5°F)
14		7.5°C(45°F)	-1.0°C(30°F)	-9.5°C(15°F)	-17.5°C(0°F)
16		7.5°C(45°F)	-1.0°C(30°F)	-6.5°C(15°F)	-17.5°C(0°F)
18		7.5°C(45°F)	-1.0°C(30°F)	-6.5°C(15°F)	-17.5°C(0°F)
20		10°C(50°F)	-1.0°C(30°F)	-6.5°C(15°F)	-17.5°C(0°F)
24		10°C(50°F)	-1.0°C(30°F)	-6.5°C(15°F)	-17.5°C(0°F)

Table 3.1.1.4 *Cold insulation thickness Table for piping*

3.1.2 Branch Pipes

Generally the header branch pipes are positioned:

- In the lower part, in the case of lines conveying liquids. This allows self-drainage, so the risks deriving from stagnation of the product in piping (corrosion, hammering, etc.) shall be avoided;
- In the upper part, in the case of lines conveying gas or steam. This eliminates the possibility of circulation of the related condensates that can cause erosion phenomena not taken into account when selecting the material for the fluid in question.

The branch pipes from the cooling water header, with lines with ND ≤1-1/2" (40 mm), shall be positioned in the upper part in order to avoid plugging due to dirt, which would prevent the water from flowing to the concerned equipment.

The connection of the discharge piping to the blow-down headers shall be positioned in the upper part, and shall be made at 90°, for lines with ND ≤1-1/2" (40 mm), or at 45° in the direction of the flow for lines with ND ≥ 2" (50 mm). This configuration is necessary for the following reasons:

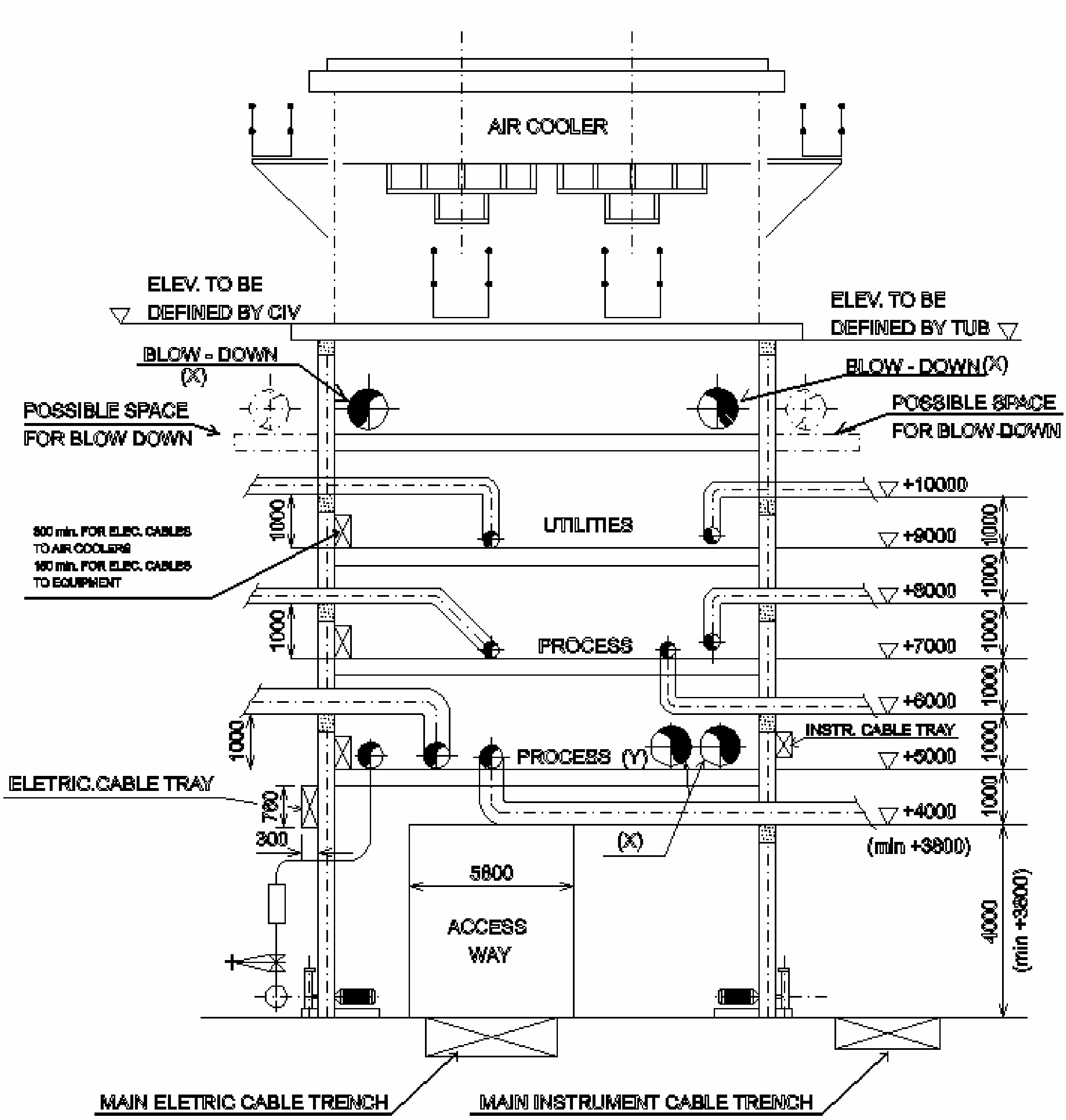
- Pressure drops, due to the low pressure inside the line, shall be limited, as far as possible;
- The stresses, due to pulsations on the couplings, shall be reduced as far as possible.

3.1.3 Positioning

Large diameter lines [ND > 12" (300 mm)] shall be positioned as close as possible to the stanchion of piperack in order to reduce the stresses of the support beams (see *Figure 3.1.3.1*).

The minimum ND allowed for the piping positioned on piperacks is 1" (25mm).

If, for process or stress reasons, pipes with ND < 2" (50 mm) are required they should be grouped in bundles with a single support for each bundle.



X see note 12 on notes for single-line drawings of piperack
Y space for process big and chemical lines

Figure 3.1.3.1 *Typical Section of piperack*

It is good to provide a flange/blind flange at the end of the distribution headers of utilities (steam, cooling water, instrument air, nitrogen) in order to permit the cleaning and blowing of the lines.
In the case of lines with a ND > 6" (150mm), the above is achieved by utilizing an eccentric reducer and a flange/ blind flange joining with ND of 6".
The steam and condensate headers, which generally require loops, shall be positioned so that the loop develops mainly inside the piperack.
Outgoing downward pipes (for control groups, utility stations, etc.) shall be positioned, if possible, along the piperack stanchions in order to make easier their support. They shall be orientated towards the outside of the piperack leaving a clearance between the pipe
A1 surface and the edge of the column of 350 mm.
The internal side of the columns shall be left free, if possible, to allow the installation of junction boxes for instrument multicables, panels, etc.
The control groups provided on large diameter lines [ND > 12" (300mm)] or with special control valves, pneumatic actuators, etc., shall be positioned between the piperack stanchions, avoiding interferences.
Every 30 m approximately, a span under the piperack shall be left free from pipes, machines and equipment in order to allow the passage of maintenance means.
For drain and vents of pumps, levels, control valves, manual drains with ND ≤ 2" to discharge on the blow down header, it's better to provide a 2" subheaders to recovery them (max five or six of lines) (see *Figure 3.1.3.2*).

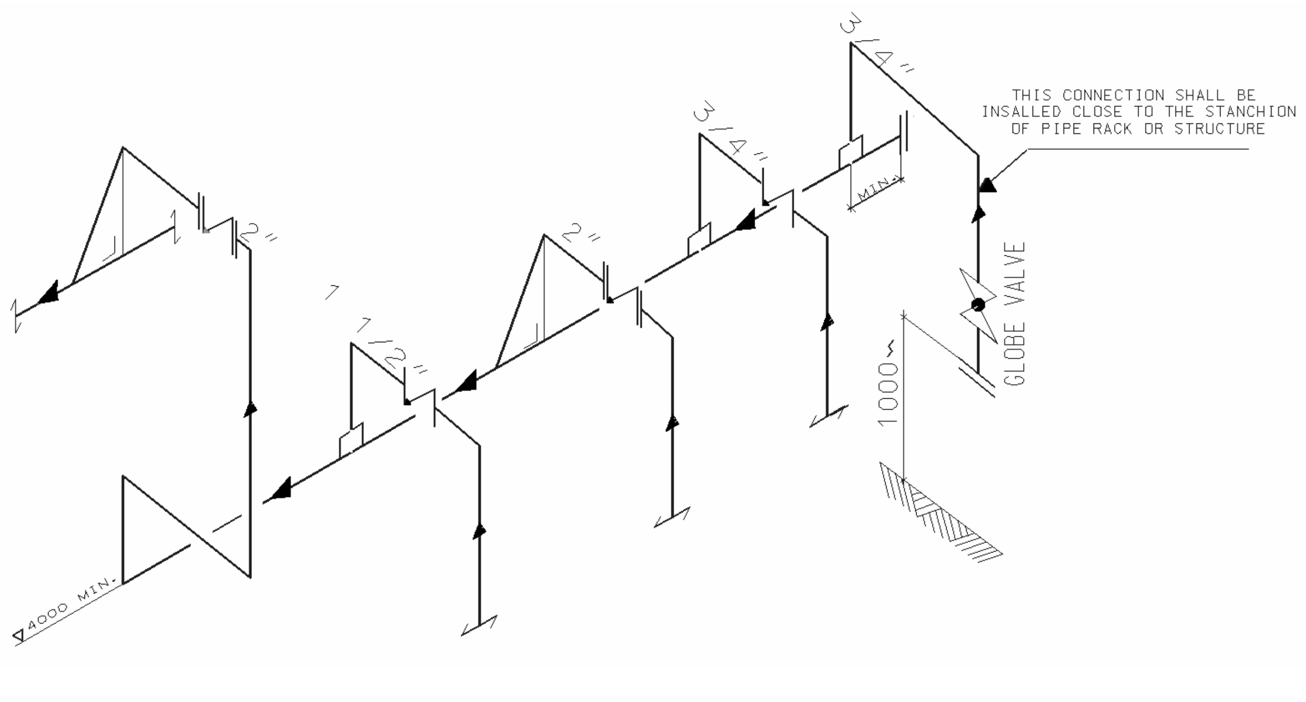


Figure 3.1.3.2 *Example of subheaders to recovery discharge lines*

3.1.4 Elevations

The pipe bottom elevation for insulated lines shall be calculated taking into account the presence of support shoes which are normally:

- hot insulated lines:
  - 60 mm, for lines with ND ≤ 1-1/2" (40 mm) and Temp ≤ 482°C;
  - 100 mm for lines with ND ≤1-1/2" (40 mm) and Temp ≥483°C;
  - 100 mm, for lines with ND ≥ 2" (50 mm);
- cold insulated lines: 150 mm.

In any case the elevations shall be checked with the table of thicknesses shown on the insulation specifications issued by SPRIV and with the Supports Standards.
For line in RTR o PVC, etc the elevation of bottom of pipe shall be calculated taking into account the presence of support shoes which are normally 100mm.
For the reasons given in point 3.1.3, the blow down headers shall have a minimum slope towards the KO Drums of 1:500, in order to avoid pockets. If this is impracticable, all the necessary precautions shall be taken (e.g.: tracing, traps, etc.) to avoid stagnant liquid in the headers.
In any case these precautions shall be in agreement with PRC.
For economical reasons, when there are changes of elevation and/or direction the following should be provided:

- piping with ND ≤ 4" (100mm) : 2 90° elbows;
- piping with ND ≥ 6"(150mm) : 1 90° elbow and 1 45° elbow.

In case of large diameter pipes, it is necessary to verify that there isn't any interferences between lines.

3.2 Pipeways

Pipeways are generally intended as the corridors where the aboveground piping will run, supported on sleepers, to connect the off-site areas and the process plants and utilities where there are no elevation constraints.
The criteria for the installation of piping on pipeways are the same as those described in chapter 3.1, with the exception that all the pipes, for both process and service purposes, shall be installed at the same elevation and that the minimum ND (see *Paragraph 3.1.4*) is 1-1/2" (40 mm).
On pipeways, the distances between centres of pipes with a ND ≥ 30" (750 mm) is calculated considering the possibility to access between them (about 300 mm of clearance).

3.2.1 Elevations

The pipes shall be installed with a pipe bottom elevation of 400 mm. This elevation is to be maintained for all process and utility lines, regardless of their diameter. In case of piping conveying steam, the pipe bottom elevation shall be established in according with *Table 3.2.1.1*.

Line ND	≤ 10"	12"÷ 20"	≥ 20"
Elevation(mm)	400	600	650

Table 3.2.1.1 *Minimum pipe bottom elevations for lines conveying steam*

This minimum elevation is required to permit the installation (in the lower part of the pipes) of condensate recovery and drain pockets. These pockets shall be installed at different distance from the ground (in function of the line's ND) as to permit operation and the relevant maintenance.

3.3 Columns

The layout of pipes that branch off from the piperack for connection to the columns shall be made avoiding pockets, so as to avoid any possibility of hammering due to the presence of the liquid along sections of the line (see *Figure 3.3.1*). The branches from main pipes (or headers) shall be therefore located:

- In the upper part, in the case of lines to/from column nozzles positioned at a higher elevation respect to the main pipe;
- In the lower part of the header in the case of connecting lines to/from column nozzles positioned at a lower elevation respect to the main pipe.

Any loops required for stress reasons on steam lines shall be developed so as to avoid any negative pockets.
Downcoming pipes shall, whenever possible, be grouped and orientated towards the piperack. The various service walkways and relevant connecting ladders shall be installed in the opposite part (see *Figure 3.3.1*).
For execution of fire fighting piping, see typical example in *Figure 3.3.2*.

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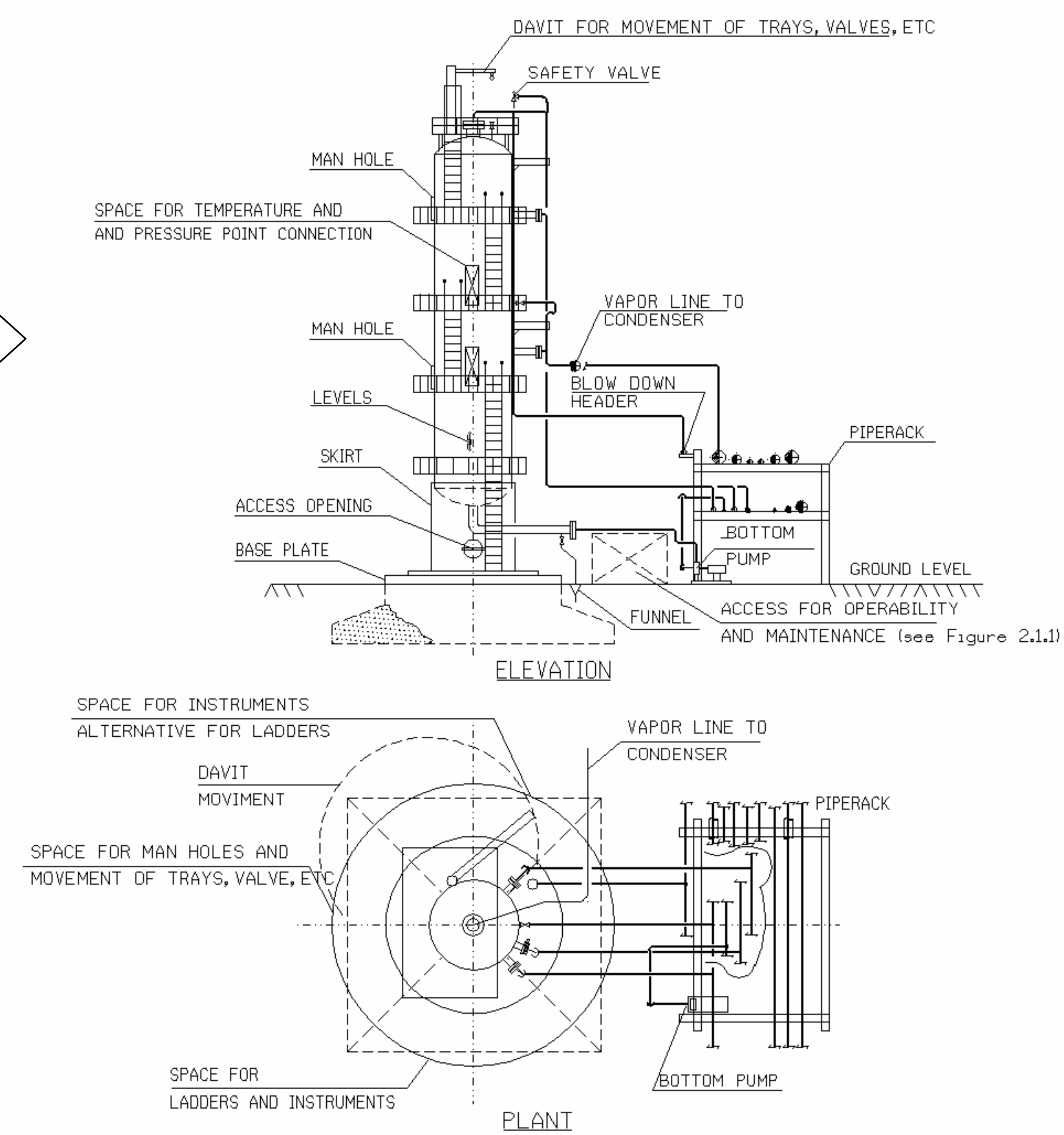
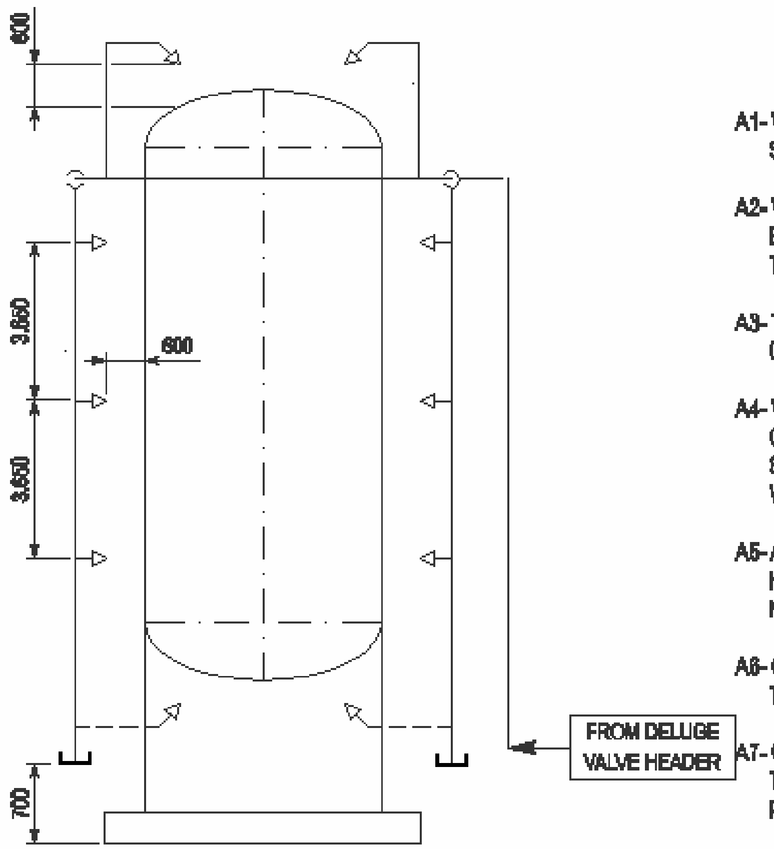


Figure 3.3.1 *Example of column general arrangement*

A1



NOTES:

A1- WATER SPRAY SHALL BE APPLIED TO VERTICAL VESSEL / COLUMN SURFACES (INCLUDING TOP AND BOTTOM SURFACES OF VERTICAL VESSEL) AT A NET RATE OF NOT LESS THAN 10.2 (l/min)/m2 OF EXPOSED SURFACE.

A2- WHERE RUNDOWN IS CONTEMPLATED, THE DISTANCE BETWEEN NOZZLES AT DIFFERENT LEVELS OR ELEVATION, PROTECTING VERTICAL OR INCLINED SURFACE, SHALL NOT EXCEED 3,65 m AS MEASURED ALONG THE SURFACE.

A3- THE MAXIMUM DISTANCE BETWEEN NOZZLES TIP AND VESSEL / COLUMN SURFACE TO BE COOLED SHALL BE 0,6m.

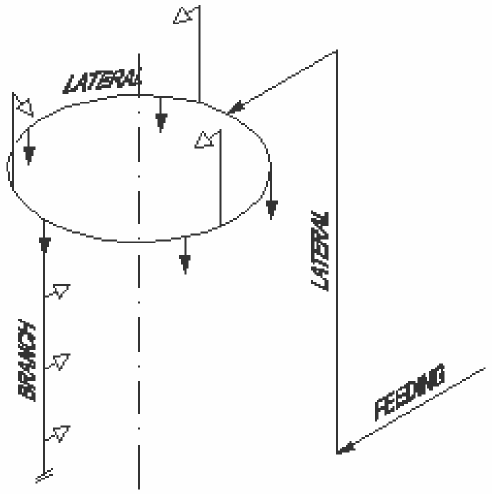
A4- WHERE PROJECTIONS (MANHOLE FLANGES, PIPE FLANGES, SUPPORT BRACKETS, RELIEF VALVES, ETC.) WILL OBSTRUCT WATER SPRAY COVERAGE, INCLUDING RUNDOWN ON VERTICAL SURFACES, ADDITIONAL NOZZLES SHALL BE INSTALLED AROUND THE PROJECTIONS TO MAINTAIN THE WETTING PATTERN THAT OTHERWISE WOULD BE SERIOUSLY INTERRUPPED.

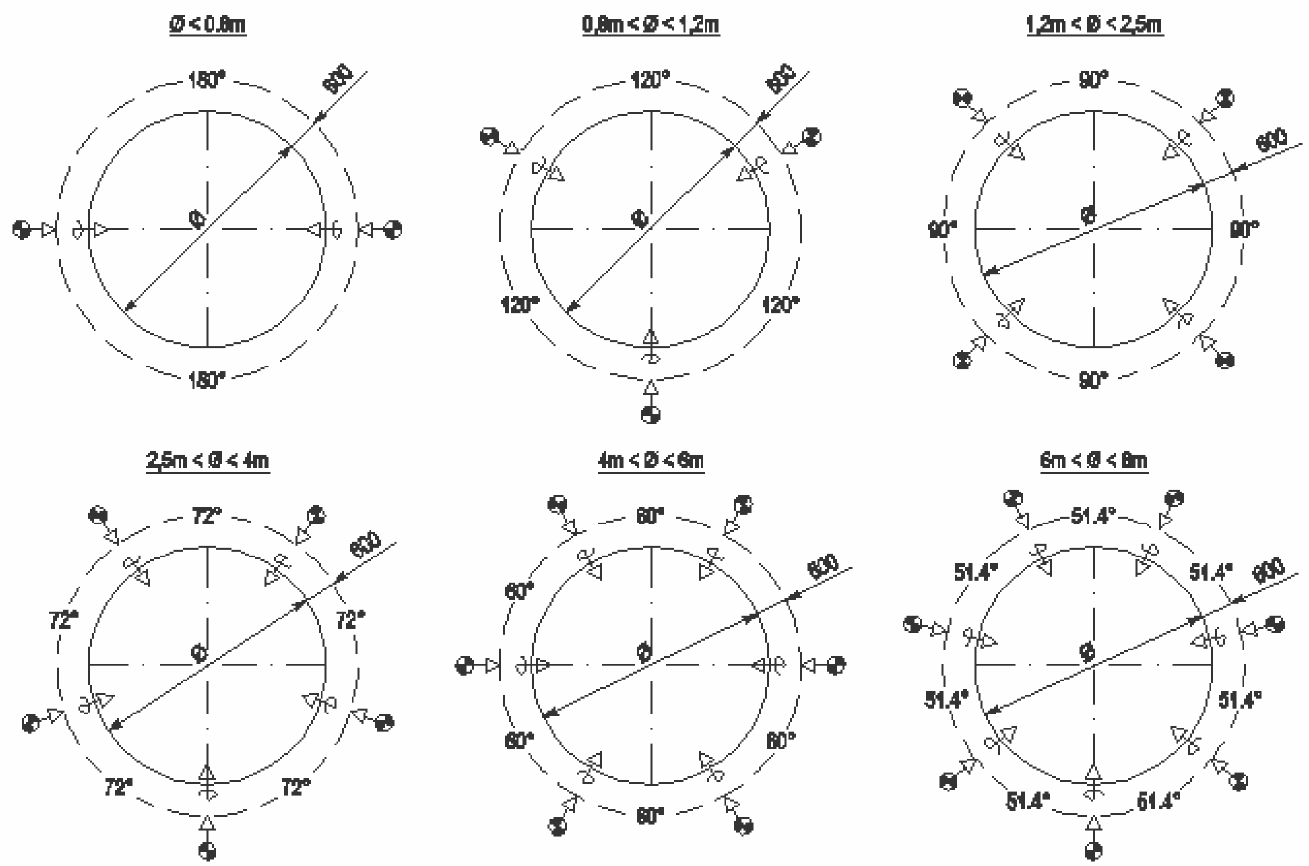
A5- ALL UNINSULATED VESSEL / COLUMN SKIRTS AND ANY UNINSULATED STEEL SADDLES GREATER THAN 305 mm HIGHT AT THE LOWEST POINT SHALL HAVE WATER SPRAY APPLIED ON THE EXPOSED (UNINSULATED) SIDE, AT A NET RATE OF NOT LESS THAN 10,2 (l/min)/m2.

A6- GENERALLY, FROM GOOD ENGINEERING PRACTICE, WATER SPRAY NOZZLE SHALL BE DIRECTED RADIALLY TO THE VESSEL / COLOUMN SHELL AND HEADS SURFACES.

A7- GENERALLY, FROM GOOD ENGINEERING PRACTICE, THE NUMBER OF WATER SPRAY NOZZLE DEDICATED FOR THE PROTECTION OF THE VESSEL HEADS IS THE SAME OF THE HALF OF THE NUMBER OF VERTICAL DOWNWARD PIPES (BRANCH), ROUNDED TO NEXT (EXCLUDED ITEMS WITH Ø < 1,2 m).

A8- VERTICAL SPRAY APPLICATION SHALL BE EXTENDED TO NO MORE THAN 12 m MAXIMUM HEIGHT FROM ANY POSSIBLE HYDROCARBON ACCUMULATION LEVEL.

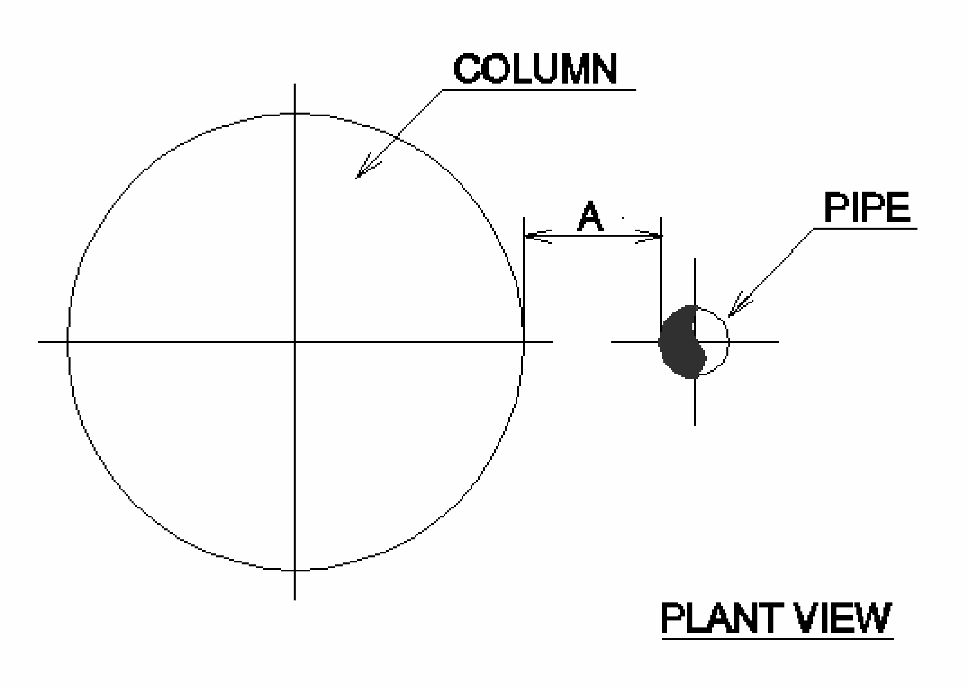




VESSEL DIAMETER (m)	SPRAY ANGLE OF NOZZLE
< 0,8	65°
0,8 < 1,2	65° ÷ 75°
1,2 < 2,5	75° ÷ 105°
2,5 < 4	105° ÷ 120°
4 ≤ 6	120° ÷ 130°
6 ≤ 8	130° ÷ 135°

Figure 3.3.2 *Water spray nozzle typical arrangement for vertical vessels and columns*

A minimum clearance of 350 mm shall be left between the pipes and the column. This space is needed to insert guides and any other supports required. If it's impossible to maintain the distance of 350 mm, it should be provided a minimum/maximum distance as shown in the table in *Figure 3.3.3*. When insulation of the column and/or pipes is required, this space shall be minimum 100 mm between the insulating material.



Pipe size (inch)	A	
	MIN	MAX
2	309	354
3	339	427
4	371	466
6	493	569
8	547	663
10	597	735
12	659	851
14	782	924
16	834	979
18	947	1092
20	1002	1162
22	1059	1279
24	1111	1357

Figure 3.3.3 *Distance between column and pipes*

A1

Flanged valves shall be installed, if possible, directly connected to the related nozzles in order to reduce the sources of possible leakage that could result from a large number of flanged joints.

Gate valves installed on horizontal sections of piping are preferably orientated with their stem in a horizontal position, so as to avoid blocking of the plugs. However, this is not always practicable.
Safety valves installed on the piping of vapour lines shall be positioned:

- Directly above the line if release to the atmosphere is required;
- At the lowest possible elevation, compatibly with the header elevation (towards which they shall self-drain) if discharge to blow-down is required. In this case, the line route shall be verified by PRC in order to check pressure drops.

All the valves and pressure/temperature instruments on the piping installed around a column shall be easily accessible, for operability and maintenance, by means of walkways and vertical ladders.

3.4 Vessels and Reactors

3.4.1 Vertical Vessels

For the installation of piping on vertical vessels, the instructions defined in *Paragraph 3.2.* - Columns shall be applied. An example of vertical vessel arrangement is shown in *Figure 3.4.2*.
For execution of fire fighting piping see typical example in *Figure 3.3.2*.

3.4.2 Horizontal Vessels

For the installation of piping on horizontal vessels, the instructions defined in *Paragraph 3.2.* - Columns shall be applied including, if applicable, the following points:

- In order to optimise, for an economic and operating standpoint, the routing of the associated piping, it’s better to group the nozzles for which a connection are to be made. To obtain this configuration it is normally necessary to relocate one or more of the equipment nozzles in according to APRES Department. If the relocations involve nozzles placed under constraint by PRC, it is necessary to inform the Department in order to make the required verifications.
- In general, nozzles can be relocated following the next constraints of functionality:
    a) The product inlet nozzle shall be positioned as far as possible from the outlet nozzle;
    b) The levels shall preferably be positioned in a calm zone and therefore far from the zone of turbulence created by the product inlet.

An example of horizontal vessel arrangement is shown in *Figure 3.4.2*.
For execution of fire fighting piping see typical example in *Figure 3.6.4*.

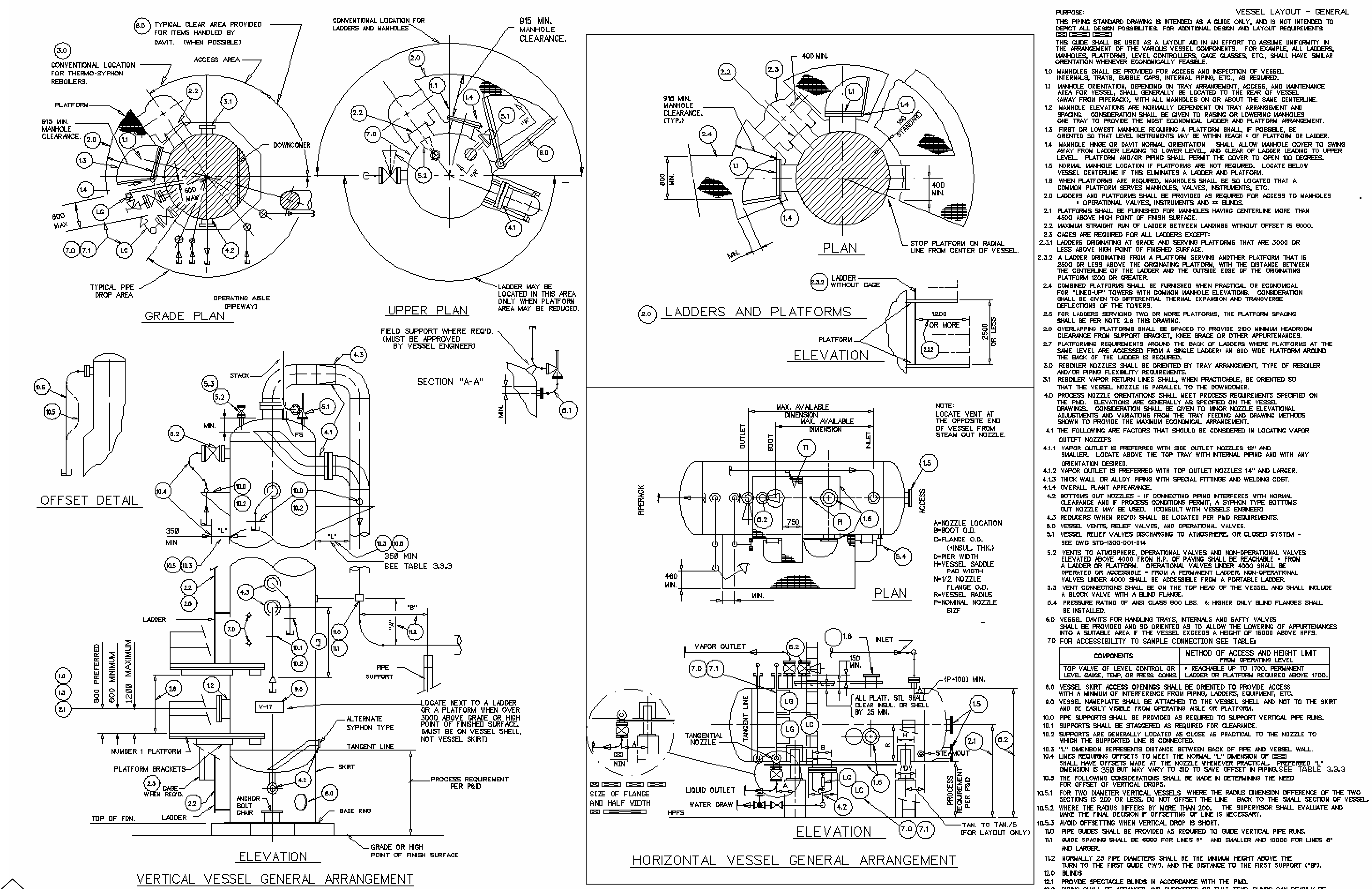


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Figure 3.4.2 *Example of vertical and horizontal vessel general arrangement*

3.4.3 Reactors

For the installation of piping for reactors, the instruction defined in *Paragraph 3.2*. - Columns shall be applied including, if applicable the following points:

- When a removable flanged elbow is required on the reactor head line, for catalytic loading purposes, it is necessary to check with APRES this elbow is included in the reactor supply. If it isn't, the piping shall be designed so as to provide the elbow and the flanged joint.

3.5 Storage Tanks - Atmospheric and/or Low Pressure

When installing the piping for tanks, it is necessary to avoid direct connections between the tanks and the pipe-way (direct connection doesn't guarantee the flexibility required to solve stress problems of the lines and problem due to settlement of foundation).
The concerning nozzles must therefore be offset, in respect of the corresponding joint point on the pipe-way, in order to allow an elastic connection for typical arrangement. Suction piping from tanks shall be installed at the minimum elevation, if possible on sleepers or in trenches (see *Figure 3.5.1/2*). It is therefore necessary to avoid the use of piperacks, stanchions, etc., whose height exceeds that of the tank suction nozzles, to avoid positive pockets on the line which will affect the operation of the pump and prevent the total emptying of the tank.
Fire-fighting piping, conveying mixtures of water and foam liquid, shall be installed inside the basin at ground level. This is to limit, as far as possible, the damage causes to piping in the event of fire.
Piping connected to inlet/outlet nozzles for product to/from tanks shall be grouped, as far as possible, in a single manifold. The relevant valves shall be positioned on both sides of the operating walkway, which shall be provided close to the foot of the spiral stairway. The distance between centres of manifold pipes shall be sufficient to allow access for assembly and maintenance of the valves.
Piping connected to nozzles for tank bottom drainage shall be positioned taking into account the necessity to optimise the route of the buried drain pipes and to have the valves within easy reach of the inlet/outlet manifold.
For execution of fire fighting piping see typical example in *Figure 3.5.3.*

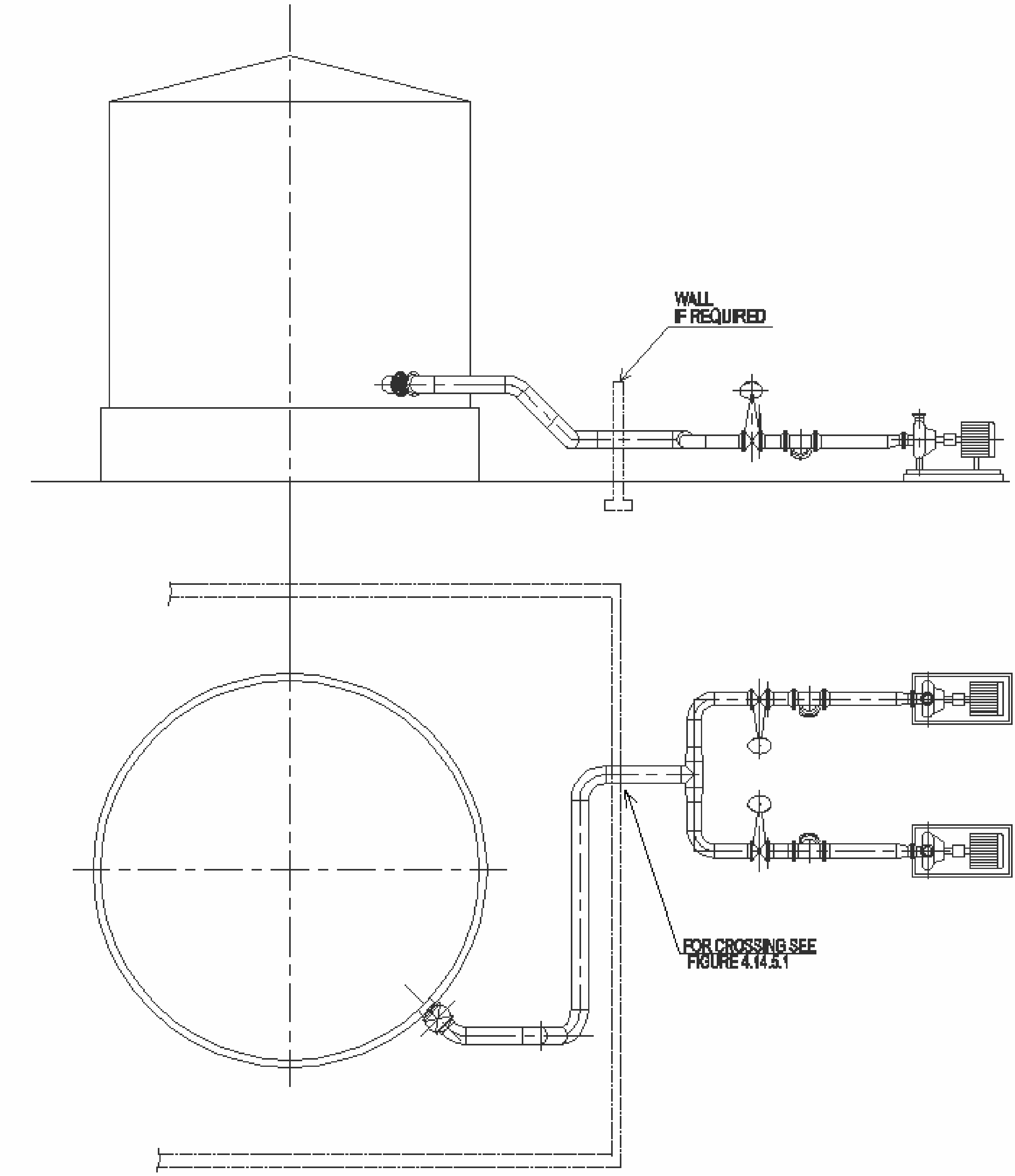

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***Figure 3.5.1** Example of storage tank general arrangement with concrete tank foundation*

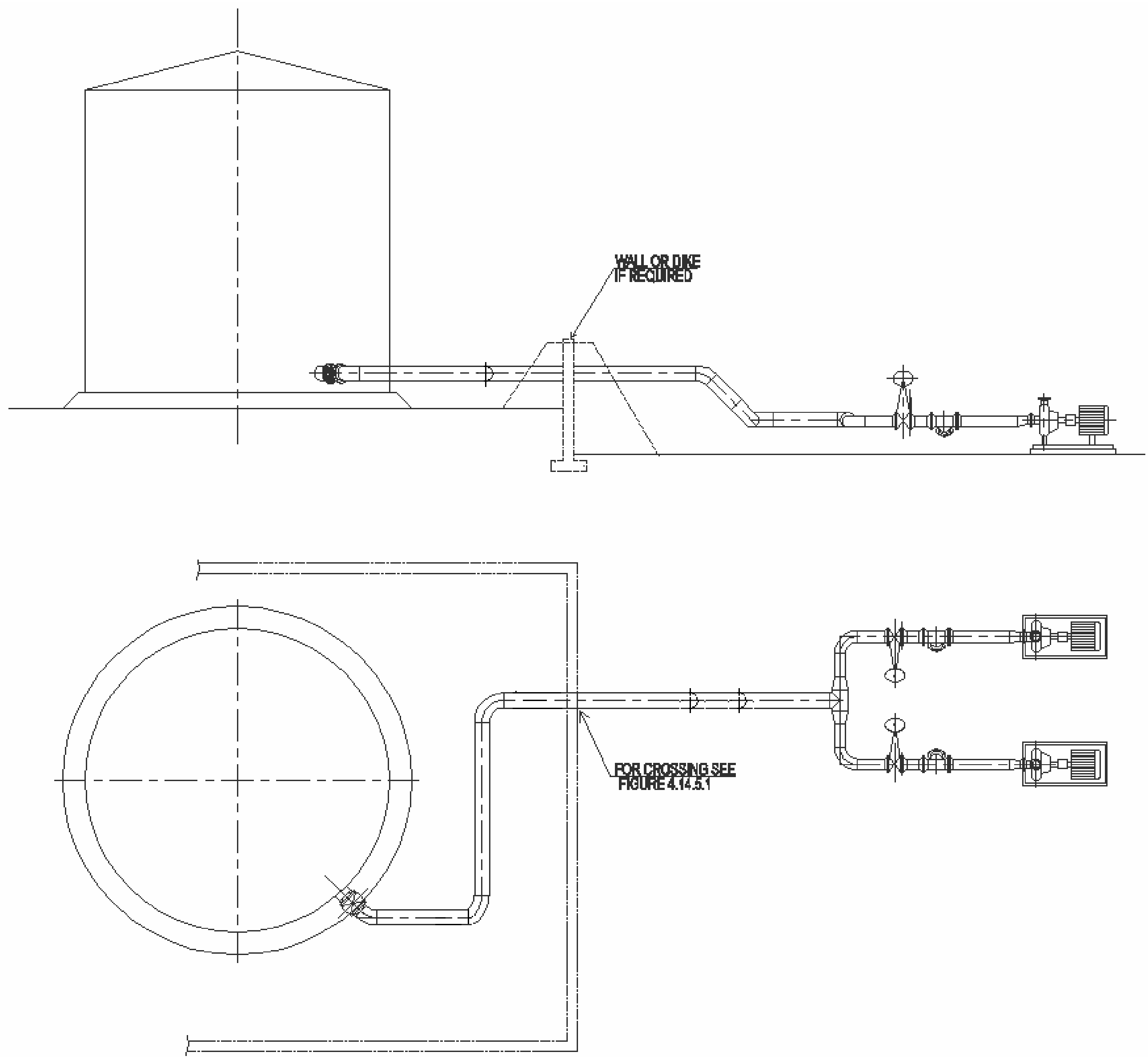

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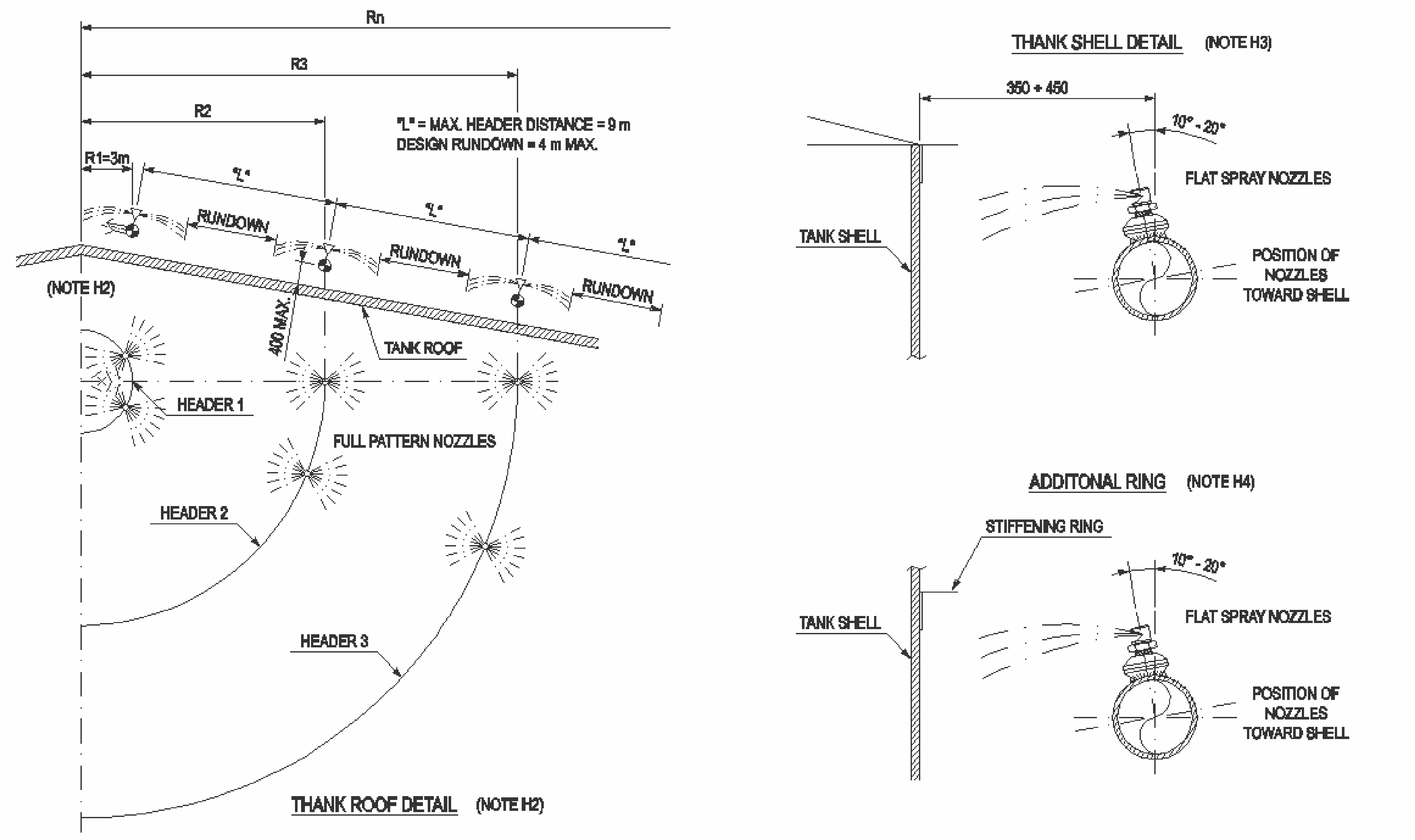
Figure 3.5.2 *Example of storage tank general arrangement with elevated tank area*



NOTES:

H1- ATMOSPHERIC STORAGE TANKS CONTAINING CLASS I AND II LIQUIDS SHALL BE PROTECTED WITH WATER COOLING SYSTEM.
WATER SPRAY SHALL BE APPLIED TO THE TANK SHELL SURFACE AND TO THE ROOF SURFACE AT A NET RATE NOT LESS THAN 4,1 (l/min)/m2.

H2- TANK ROOF (EXCEPTION: OPEN TOP FLOATING ROOF) :
FOR OPTIMUM WETTING AND PIPING LAYOUT, AT LEAST ONE INNER RING HEADER, WITH A RADIUS OF 3 m, SHALL BE INSTALLED.
THIS SHALL BE EQUIPPED WITH THREE SUB HEADERS (MIN. 2 INCH SIZE), EQUALLY SPACED ALONG THE INNER RING HEADER'S CIRCUMFERENCE AND POINTING RADIALLY INWARDS.
ON THE ROOF CIRCULAR HEADER(S) FULL PATTERN NOZZLES SHALL BE INSTALLED.
MAX. NOZZLE SPRAY DISTANCE: 2 m "UPWARDS" AND 2,5 m "DOWNWARDS" AND A MAX. RUNDOWN OF 4 m SHALL BE PERMITTED.

H3- TANK SHELL :
THE TANK SHELL SHALL BE PROTECTED BY A CIRCULAR RING HEADER SUPPORTED FROM THE TANK'S TOP CURB ANGLE OR WIND GIRDER.
MAX. DISTANCE BETWEEN WALL AND HEADER CENTRE LINE IS 0,45 m.
ON THIS HEADER FLAT SPRAY NOZZLE SHALL BE SPACED AT REGULAR INTERVALS, WITH AN INCLINATION FROM THE VERTICAL AXIS OF 10 TO 20 DEGREES, TO ACHIEVE COMPLETE AT OVERLAPPING SPRAY PATTERNS.
WHERE

H4- IF TANK SHELL IS PROVIDED WITH STIFFENING RING AN ADDITIONAL COOLING RING SHALL BE MOUNTED TO AVOID RUNDOWN INTERRUPTION.

Figure 3.5.3 *Water spray nozzle typical arrangement for storage tanks*

3.6 High Pressure Storage Vessels

For safety reasons, only piping that is directly connected to the associated vessels shall be installed in the area assigned for high pressure storage. This piping shall be adequately supported considering expansion, contraction, and vibrations requirements.
Normally, connection to vessels shall be made by means of a single line positioned on the bottom of the tanks. It will be used both for filling, emptying and drainage. When, for particular operating conditions, a return vapour line is required by PRC, this shall be connected to the top of the vessel (see *Figure 3.6.1*).
The inlet/outlet piping to products to/from vessels shall be grouped, as far as possible, in a single manifold which, for safety reasons, shall be positioned outside the protection wall.
In order to reduce as much as possible the risk of leaks, no expansion joints shall be installed on the piping, threaded connections shall not be utilized and the number of flanged connections shall be kept to a minimum.
A drain shall be provided on the suction and discharge piping. It shall be positioned after the first block valve in the section orientated towards the manifold. The relevant discharge, from which can come out inflammable vapours, shall be located in a safe position far from roads, work areas, etc. (see detail "X", *Figure 3.6.2*).
In the case of particular projects requirements (e.g.: drain connections on vessels) an acceptable solution from the point of view of safety and operability shall be chosen in according to PRC Department.
For the methods of execution of process piping assembly, see the typical examples illustrated in *Figures 3.6.3*, for execution of fire fighting piping see the typical example illustrated in *Figure 3.6.4.*

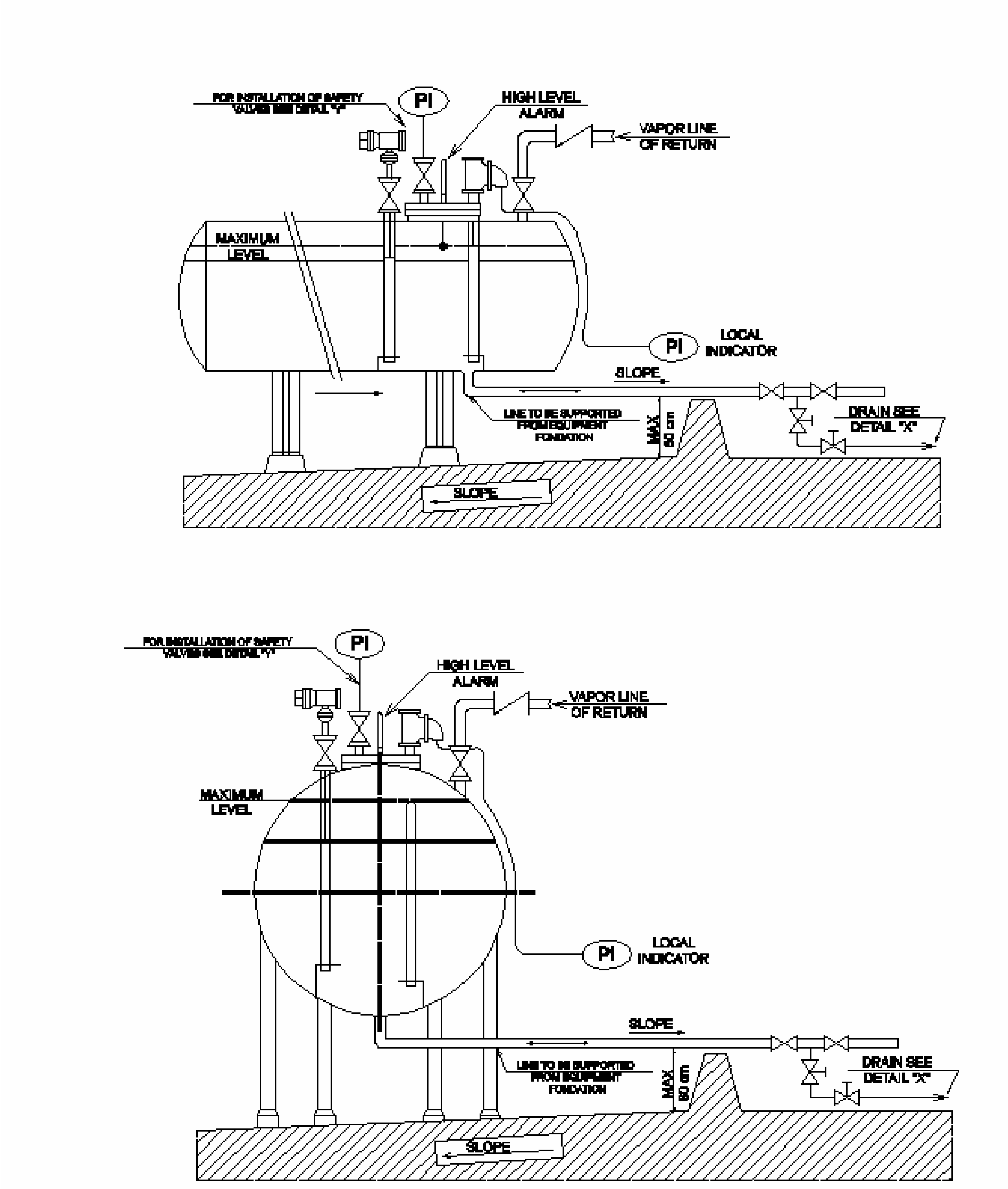


Figure 3.6.1 *Example of high pressure storage vessels general arrangement*

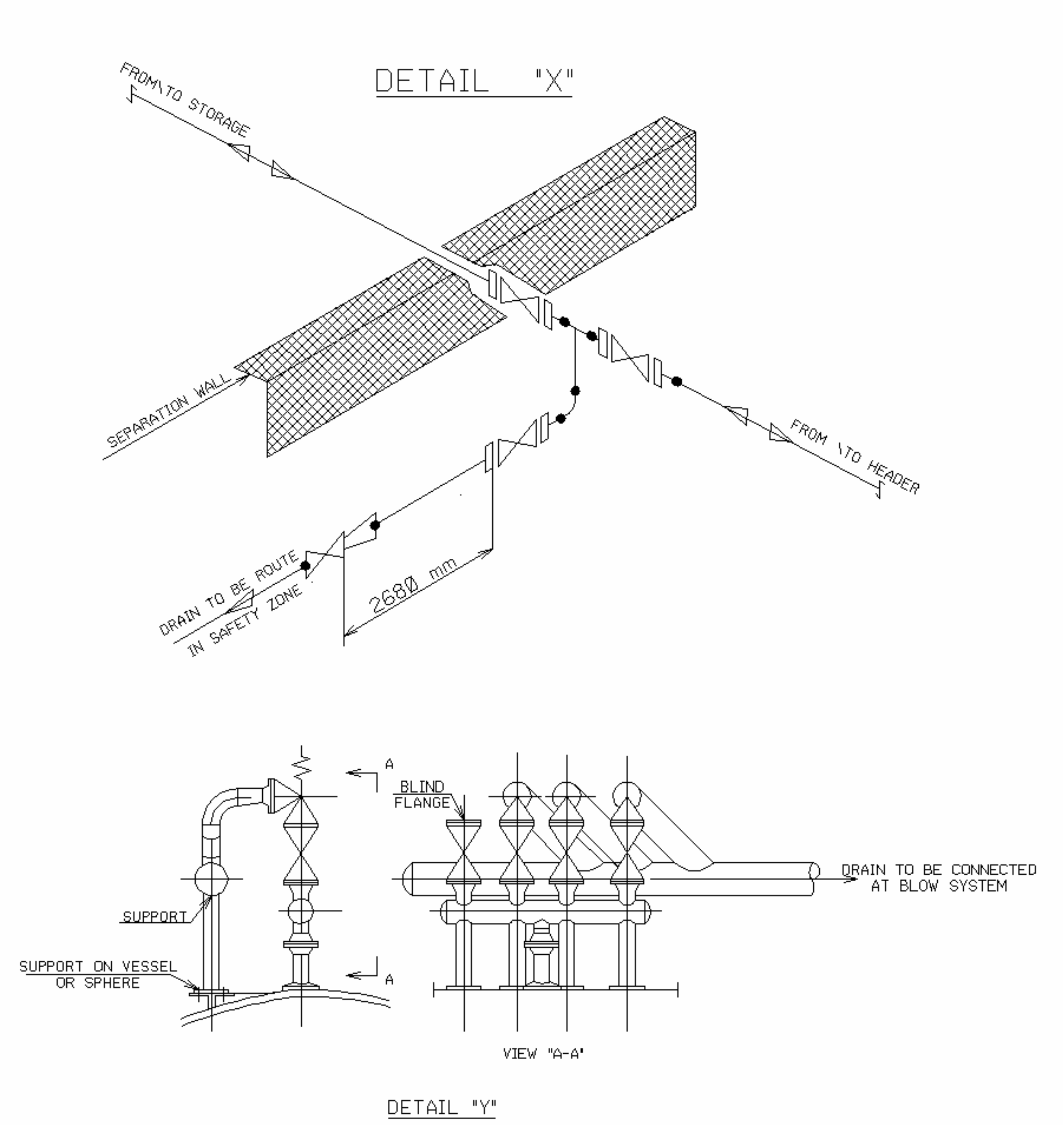


Figure 3.6.2 *Example of drains layout for high pressure storage vessels*

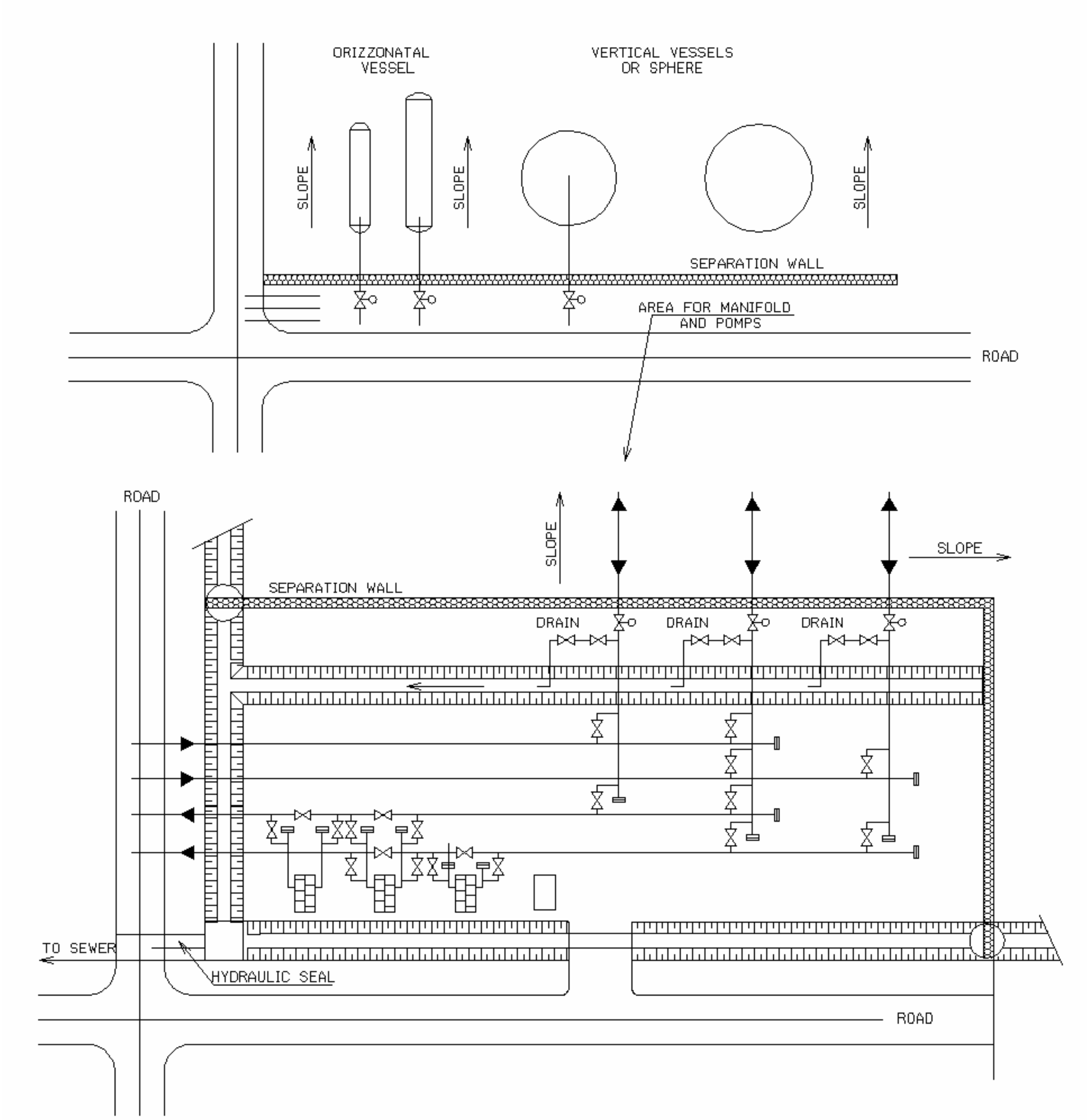


Figure 3.6.3 *Example of layout for pressure storage vessel*

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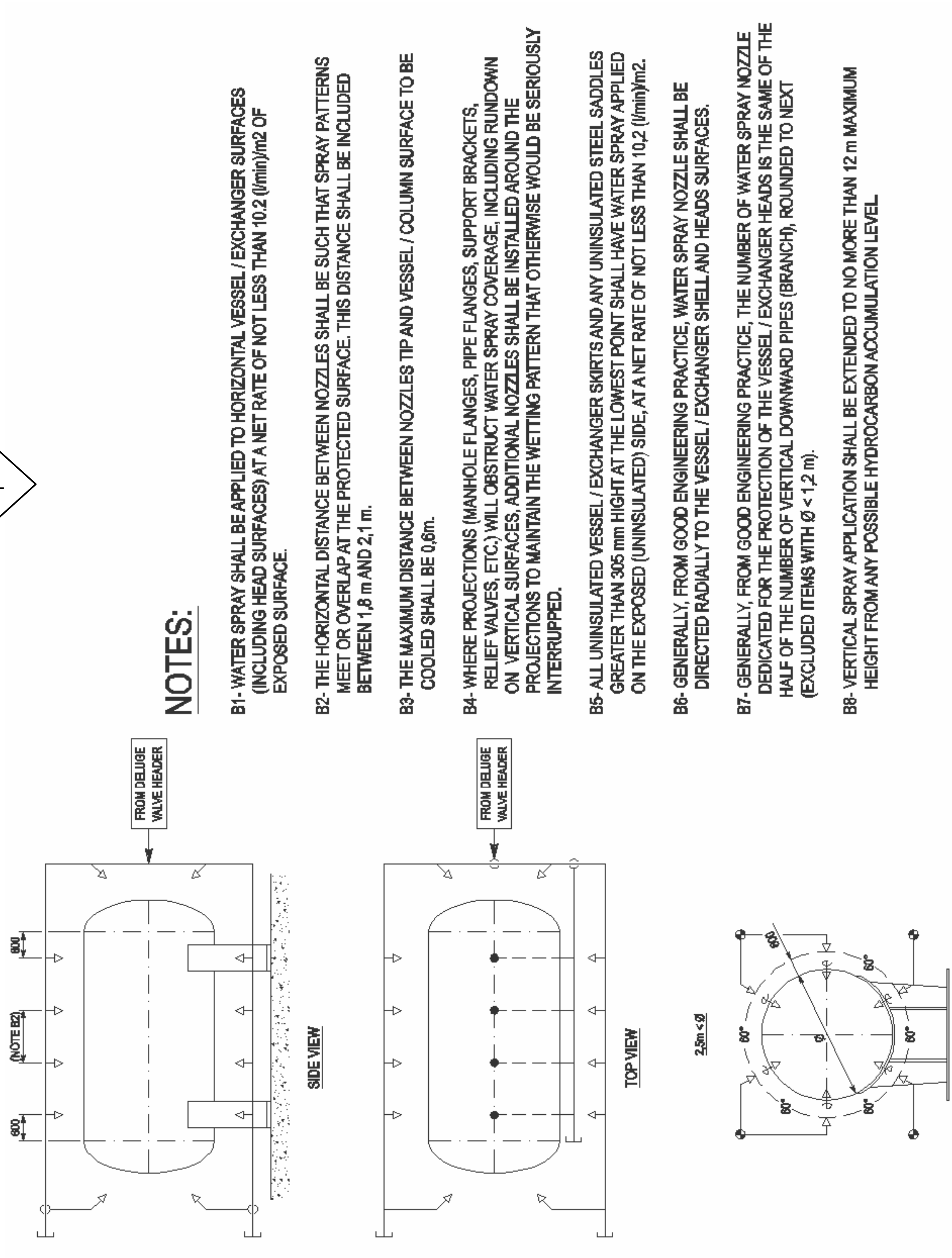

Figure 3.6.4 *Water spray nozzle typical arrangement for horizontal vessels and exchangers*

3.7 Heat Exchangers

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The installation of piping for heat exchangers shall be made at the side of the exchangers leaving a minimum net clearance of 50 mm between the pipe edge and the heat exchangers (for insulated applications the 50 mm clearance shall be applied to the outside of the insulation). Heat exchanger piping shall not be supported on the shell side and shall not obstructed the removal of the tube bundle and shell/channel covers. A removable pipe spool shall be required (see *Figure 3.7.2*)

If shell's removal is required, all piping connected to the upper nozzle of the exchanger shall be supported and flanged in order to allow removal.

Pressure and temperature taps, which are generally located on the exchanger nozzles, shall be positioned taking into account the piping arrangement, especially for the nozzles on the tube side, the temperature tapping shall be orientated on the free side of piping in order to allow removal of the thermocouple and/or thermometer (this operation requires a free space of 600 mm min.).

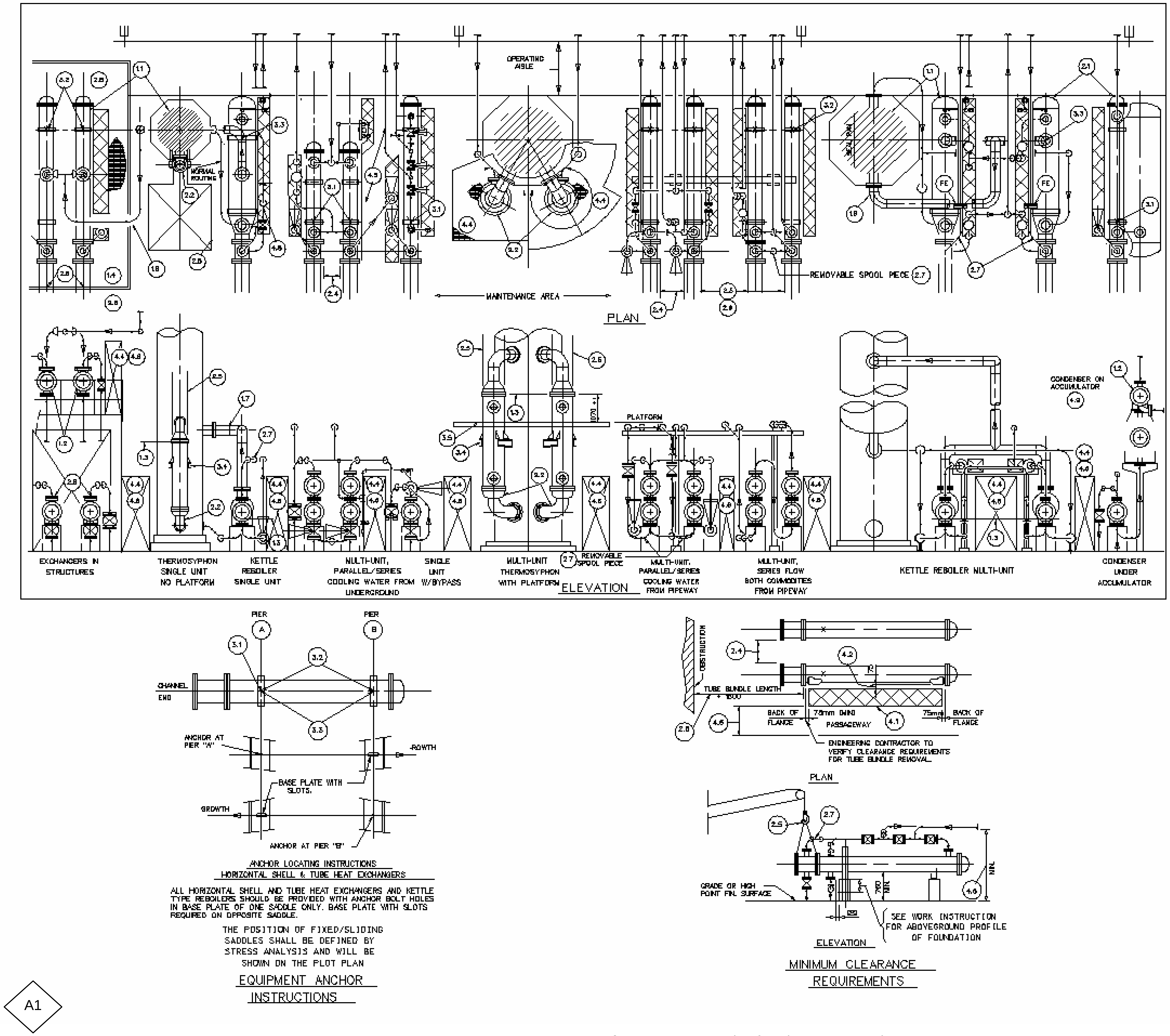
The stand pipe of level instruments on reboilers (kettles) shall be orientated so that the relevant instruments can easily be read by the Operator when positioned close to the relevant control valves (LCV).

Piping shall not be located over the longitudinal centerline of an exchanger. This is to avoid interference with the lifting equipment (e.g.: hook of hoist installed on a monorail) and so as to have sufficient space for access to the exchanger shell during disassembly for maintenance.

The cooling water inlet/outlet piping, which headers are buried or positioned on the opposite end of the fixed saddle of the exchanger, shall be installed so as to provide a sufficiently flexible route to allow the absorption of piping expansion. This is to prevent that any direct connections could damage the exchanger.

Figure 3.7.1/2/3 shows some typical installations of piping to exchangers.

For execution of fire fighting piping see the typical example illustrated in *Figure 3.3.3.*



PURPOSE:

THIS PIPING STANDARD DRAWING IS INTENDED AS A GUIDE ONLY AND IS NOT INTENDED TO DEPICT ALL DESIGN POSSIBILITIES. FOR ADDITIONAL DESIGN AND LAYOUT REQUIREMENTS, REFER TO POINT 3.7

APPLICATION:

BY USING THIS DRAWING FOR SUGGESTED ARRANGEMENTS, AS WELL AS APPLICABLE CONTRACT SPECIFICATIONS AND P&ID, THE DESIGNER SHALL CONSIDER THE FOLLOWING:

1.0 PROCESS CONDITIONS

1.1 EXCHANGERS SHALL BE LOCATED NEXT TO THEIR RELATED EQUIPMENT OR VESSEL IN THE SEQUENCE OF PROCESS FLOW, KEEPING LARGE DIAMETER AND ALLOY PIPING TO A MINIMUM LENGTH AND SATISFYING ECONOMICS, PIPING FLEXIBILITY AND SPECIAL PROCESS REQUIREMENTS AS INDICATED ON THE P&ID.

1.2 EXCHANGERS SHALL BE ELEVATED TO PROVIDE FOR THE FOLLOWING:

1.2.1 GRAVITY FLOW OF PRODUCT FROM ONE PIECE OF EQUIPMENT TO ANOTHER.

1.2.2 REQUIRED NET POSITIVE SUCTION HEAD ON A PUMP.

1.2.3 OTHER MECHANICAL OR PROCESS REQUIREMENTS.

1.3 THE MINIMUM ELEVATION REQUIREMENTS SHALL BE AS SHOWN ON THE P&ID. DEVIATIONS FROM THE MINIMUM ELEVATIONS MUST BE APPROVED BY THE PROCESS ENGINEER.

1.4 EXCHANGERS WHICH MUST BE ELEVATED SHOULD BE GROUPED TOGETHER WHENEVER PRACTICAL, IN A COMMON STRUCTURE WITH OTHER EQUIPMENT HAVING SIMILAR PROCESS REQUIREMENTS. LADDER AND PLATFORM WILL BE PROVIDED IN ACCORDANCE WITH SINGLE LINE STRUCTURE.

1.5 FLOW PATTERNS ARE ESTABLISHED ON THE P&ID. HOWEVER, FOR DETERMINING BASIC PIPING LAYOUTS PRIOR TO RECEIVING EQUIPMENT OUTLINE. FLUID BEING COOLED SHOULD FLOW DOWN THROUGH EXCHANGER. FLUID BEING HEATED SHOULD FLOW UP THROUGH EXCHANGER.

1.6 VAPOR RETURN LINE SHOULD BE ORIENTED SO THAT THE LIQUID IS NOT BLOWN OFF SEAL PAN. CHECK WITH PROCESS BEFORE RELEASING VESSEL ORIENTATION TO VESSEL DEPARTMENT.

1.7 PREFERRED METHOD IS TO KEEP VAPOR LINE AS SHORT AS POSSIBLE FOR FLEXIBILITY REQUIREMENTS. MINIMIZE PIPING RUNS AND ELBOWS.

1.8 PARALLEL AND SYMMETRICAL PIPING ARRANGEMENTS SHALL BE REVIEWED BY PROCESS.

2.0 MAINTENANCE

2.1 LINE UP ALL EXCHANGER SHELL COVERS ON OPERATING AISLEWAY FOR MAINTENANCE CLEARANCES, EXCEPT WHEN UNDERGROUND COOLING WATER LINES ARE ROUTED DIRECTLY BELOW CHANNEL NOZZLES. WHEN THIS CONDITION EXISTS, LINE UP CHANNEL END NOZZLES. CHANNEL END SHOULD BE DIRECTED TOWARD ACCESS ROAD OR MAINTENANCE AREA.

2.2 VERTICAL REBOILERS SHALL BE ARRANGED ON BACK SIDE OF VESSEL (SIDE OF VESSEL FACING AWAY FROM PIPEWAY). ALLOW SPACE TO BREAK FLANGES AND DROP REBOILER BOTTOM HEAD.

2.3 ALL TUBE REMOVAL SHALL BE BY MOBILE CRANE

2.4 HORIZONTAL CLEARANCE BETWEEN FLANGES OF EXCHANGERS SHALL BE 1000 MINIMUM.

2.5 CLEARANCE FOR MOBILE CRANE BOOM FOR TUBE REMOVAL AND ACCESS AREA AT GRADE FOR MOBILE HANDLING EQUIPMENT MUST BE RESERVED.

2.6 ENSURE THAT PLATFORM LOADING IS ADEQUATE FOR EXCHANGER CHANNEL OR HEAD TO REST ON PLATFORM DURING MAINTENANCE. PROVIDE FOR REMOVABLE HANDRAIL WHERE REQUIRED FOR TUBE REMOVAL.

2.7 BREAK-OUT FLANGES AND REMOVABLE SPOOL PIECES SHALL BE REVIEWED ON AN INDIVIDUAL BASIS FOR MAINTENANCE ACCESS AND TUBE REMOVAL. NORMALLY, FLANGES REQUIRED AT BLOCK VALVES OR ORIFICE FLANGES MAY QUALIFY FOR BREAK-OUT.

2.8 WHERE MOBILE CRANE ACCESS TO EXCHANGERS LOCATED AT GRADE OR IN A STRUCTURE IS IMPRACTICLE, A PERMANENT MONORAIL SHALL BE PROVIDED.
WHERE BUILT-IN HANDLING FACILITIES ARE NOT PROVIDED, CLEAR SPACE FOR TUBE-BUNDLE REMOVAL BY MOBILE CRANE WILL BE PROVIDED.

2.9 RESTRICTED OR UNIT ROADS MAY BE UTILIZED AS A TUBE PULL AREA. MAIN OR REFINERY ROADS SHALL NOT BE CONSIDERED FOR TUBE PULLING AREAS.

3.0 SUPPORT AND ANCHOR:

3.1 EXCHANGERS HAVING COOLING WATER FROM UNDERGROUND TO CHANNEL SHALL HAVE THE ANCHOR AT THE CHANNEL END.

3.2 ANCHOR LOCATIONS FOR EXCHANGERS WITHOUT UNDERGROUND PIPING CONNECTIONS SHALL BE DETERMINED BY PIPING FLEXIBILITY.

3.3 HORIZONTAL REBOILER ANCHOR LOCATION DEPENDS ON RELATIONSHIP OF VESSEL. ANCHOR ONE END ONLY.

3.4 THERMOSYPHON REBOILERS MAY BE SUPPORTED FROM THE ADJACENT VESSEL OR FROM INDEPENDENT STRUCTURES FROM GRADE. IN EITHER CASE, THE METHOD AND LOCATION OF SUPPORT SHALL BE DETERMINED BY PIPING STRESS. LOCATION OF THE SUPPORTS WILL BE DETERMINED ON THE BASIS OF MINIMIZING DIFFERENTIAL MOVEMENT BETWEEN THE REBOILER PIPING AND THE VESSEL.
IF STEAM IS TO BE CIRCULATED THROUGH THE REBOILER PRIOR TO START-UP OR IF THERE IS AN APPRECIABLE DIFFERENCE IN TEMPERATURE OF THE REBOILER AND VESSEL, THE REBOILER MAY REQUIRE SPRING SUPPORTS.

3.5 WHEN POSSIBLE SUPPORT THERMOSYPHON REBOILERS INDEPENDENT OF PLATFORM TO IMPROVE MAINTENANCE AND OPERATION ACCESSIBILITY.

4.0 PIPING LAYOUT:

4.1 PREFERRED LOCATION FOR PIPING CONTROL VALVE MANIFOLDS, BYPASSES, TRAPS AND ETC. ARE SHOWN CROSS HATCHED. EXAMPLE:

4.2 CHECK EXCHANGER INSULATION FOR CLEARANCE.

1.3 WHENEVER POSSIBLE, VALVE STEM SHOULD BE KEPT OUT OF AISLEWAYS AND HEAD OR EYE ELEVATIONS. VALVES SHALL BE IN ACCORDANCE WITH P&ID AND FIGURE 4.4.1/2.

1.4 PIPING SHALL BE ARRANGED TO PROVIDE CLEAR ACCESS FOR OPERATION AND MAINTENANCE.

1.5 CLEAR WALKWAY SPACE IS REQUIRED, BUT NOT NECESSARILY IN A STRAIGHT LINE.

1.6 FOR MINIMUM HEADROOM AND ACCESS REQUIREMENTS FOR PASSAGEWAYS SEE FIGURE 2.1.1.

1.7 LINES SHALL BE SUPPORTED AS REQUIRED TO MINIMIZE LOADS AND FORCES AT EQUIPMENT NOZZLES. DO NOT SUPPORT PIPING FROM EXCHANGER SHELL.

1.8 ALTERNATE ROUTING FOR ADDITIONAL FLEXIBILITY. LOCATE CONTROL VALVES OR TRAPS ON OPPOSITE SIDE.

1.9 THIS METHOD MAY BE USED AS AN ALTERNATE TO BUILDING A STRUCTURE. HOWEVER, ADDED COSTS ARE INVOLVED IN SUPPLYING ELBOW NOZZLES ON BOTH THE VESSEL AND EXCHANGER.

1.10 TWO SHELL HIGH IS THE PREFERRED STACKING ARRANGEMANT.

Figure 3.7.1 *Example of exchanger general arrangement*

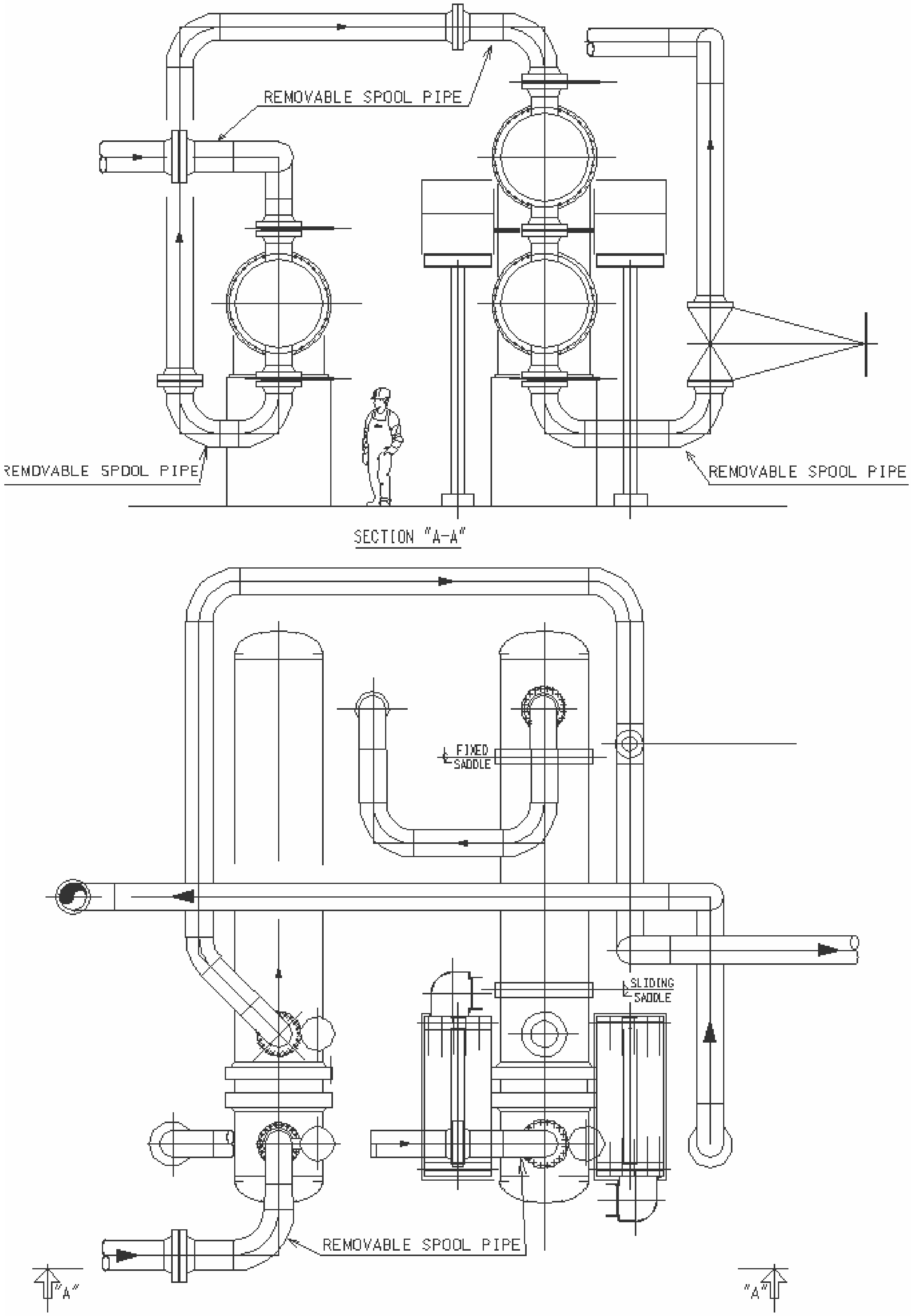


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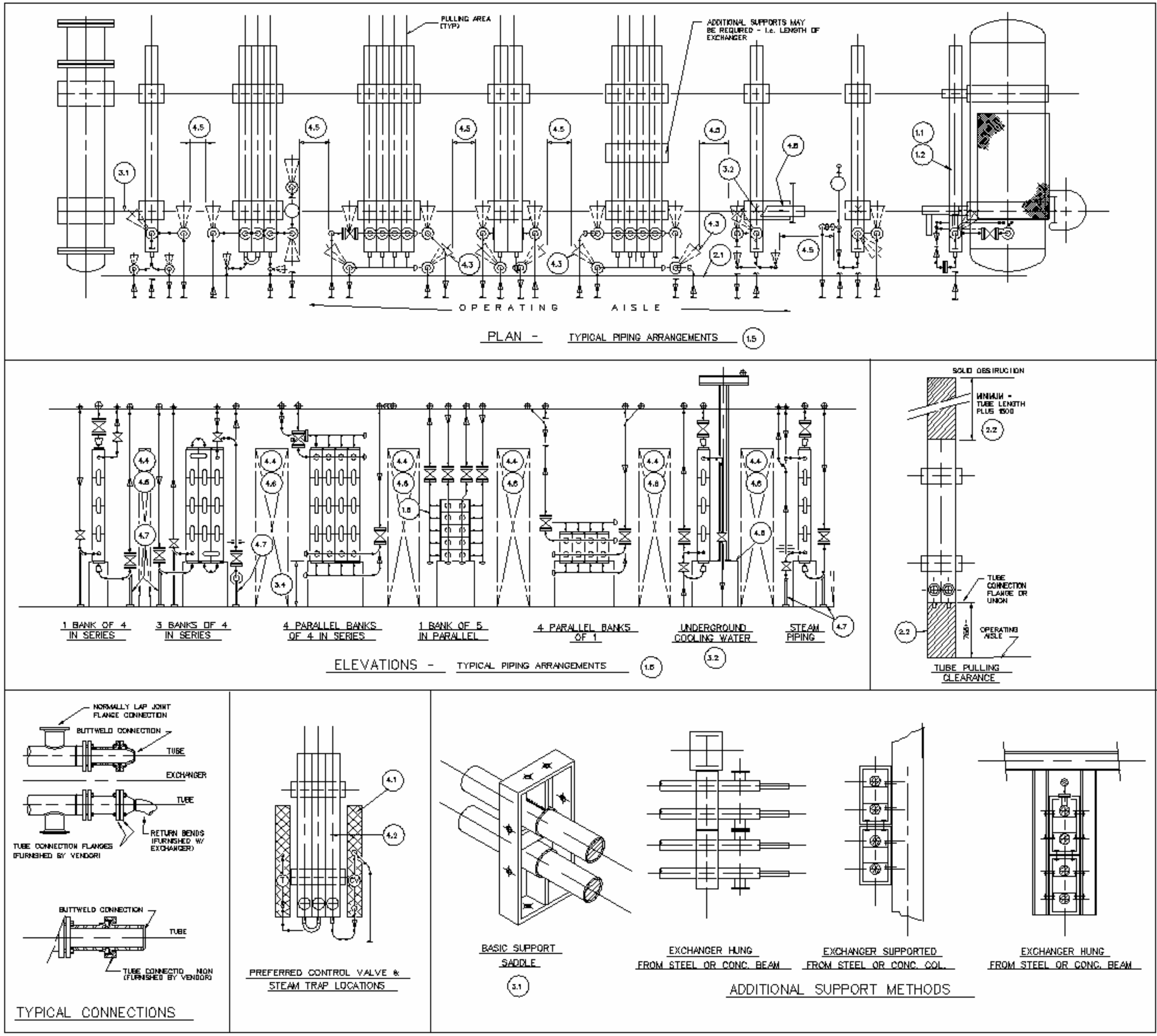
Figure 3.7.2 *Example of exchanger general arrangement*



GENERAL NOTES

PURPOSE:

THIS PIPING STANDARD DRAWING IS INTENDED AS A GUIDE ONLY, AND IS NOT INTENDED TO DEPICT ALL DESIGN POSSIBILITIES.
FOR ADDITIONAL DESIGN AND LAYOUT REQUIREMENTS REFER TO POINT 3.7.

APPLICATION:

USING THIS DRAWING FOR SUGGESTED ARRANGEMENTS, ALONG WITH THE APPLICABLE CONTRACT SPECIFICATIONS AND THE P&ID, THE DESIGNER SHALL CONSIDER THE FOLLOWING:

1.0 PROCESS CONDITIONS

1.1 EXCHANGERS SHALL BE LOCATED NEXT TO THEIR RELATED EQUIPMENT OR VESSEL IN THE SEQUENCE OF PROCESS FLOW, KEEPING ALLOY PIPING LENGTH TO A MINIMUM AND SATISFYING SPECIAL PROCESS REQUIREMENTS AS INDICATED ON THE P&ID.

1.2 EXCHANGERS SHALL BE ELEVATED TO PROVIDE FOR THE FOLLOWING:

1.2.1 GRAVITY FLOW OF PRODUCT FRON ONE PIECE OF EQUIPMENT TO ANOTHER.

1.2.2 REQUIRED NET POSITIVE SUCTION HEAD ON A PUMP

1.2.3 OTHER MECHANICAL OR PROCESS REQUIREMENTS AS DEFINED ON THE P&ID.

1.3 THE MINIMUM ELEVATION REQUIREMENTS SHALL BE AS SHOWN ON THE P&ID. DEVIATIONS FROM THE MINIMUM ELEVATIONS MUST BE APPROVED BY THE PROCESS ENGINEER.

1.4 EXCHANGERS WHEN ELEVATED, SHOULD BE GROUPED TOGETHER WHENEVER PRACTICAL, IN A COMMON STRUCTURE WITH OTHER EQUIPMENT HAVING SIMILAR PROCESS REQUIREMENTS. LADDER OR STAIRWAYS WILL BE PROVIDED PER SPECIFICATION DGS 1300 040.

1.5 FLOW PATTERNS ARE ESTABLISHED ON THE P&ID. HOWEVER, FOR DETERMINING BASIC PIPING LAYOUTS PRIOR TO RECEIVING EQUIPMENT OUTLINES, THE ARRANGEMENTS AS SHOWN MAY BE USED. FLUID BEING COOLED SHOULD FLOW DOWN THROUGH EXCHANGER. FLUID BEING HEATED SHOULD FLOW UP THROUGH EXCHANGER.

1.6 PARALLEL PIPING ARRANGEMENTS SHOULD BE REVIEWED BY PROCESS ENGINEERING.

2.0 MAINTENANCE

2.1 WHEN POS_IBLE, LINE UP ALL EXCHANGER PIPING ON OPERATING AISLE WAY TO MAINTAIN CLEARANCES. TUBE REMOVAL END SHOULD BE DIRECTED TOWARD ACCESS ROAD OR MAINTENANCE AREA.

2.2 TUBE PULLING AREA TO BE LEFT CLEAR ON END OPPOSITE THE PIPING CONNECTIONS. AREA IN FRONT OF EXCHANGERS SHOULD BE CLEARED OF PIPING, SO TUBE CLEANING CAN BE DONE. HOWEVER, THIS IS NOT NANDATORY.

2.3 ALL TUBE REMOVAL SHALL BE BY MOBILE CRANE OR MONORAIL.

2.4 CLEARANCE BETWEEN FLANGES OF EXCHANGERS OR AROUND OTHER BOLTED EQUIPMENT CONNECTIONS WHICH MUST BE SERVICED OR MAINTAINED SHALL BE KEPT AS CLEAR AS POSSIBLE.

2.5 RESTRICTED OR UNIT ROADS MAY BE UTILIZED AS A TUBE PULL AREA. MAIN OR REFINERY ROADS SHALL NOT BE CONSIDERED FOR THE TUBE PULLING AREAS.

3.0 SUPPORT AND ANCHORS:

3.1 LINE UP LONGITUDINAL CENTERLINES OF DOUBLE PIPE EXCHANGER FOUNDATIONS WITH OTHER HORIZONTAL EQUIPMENT FOUNDATIONS IF PRACTICAL. THE DESIGNER TO ANCHOR DOUBLE PIPE EXCHANGER. (THE DESIGNER SHALL CONSULT WITH THE STRESS ENGINEER AND MECHANICAL ENGINEER TO ASSURE PROPER ANCHORING OF EXCHANGER.

3.2 EXCHANGERS HAVING COOLING WATER FROM UNDERGROUND CHANNEL OR TUBES SHALL HAVE THE ANCHOR AT THE CHANNEL END.

3.3 ANCHOR REQUIREMENTS FOR EXCHANGERS WITHOUT UNDERGROUND PIPING CONNECTIONS SHALL BE DETERMINED BY PIPING FLEXIBILITY.

3.4 MINIMUM DOUBLE PIPE EXCHANGER FOUNDATION HEIGHT ABOVE FINISH SURFACE SHALL BE 600.

4.0 PIPING LAYOUT:

4.1 PREFERRED LOCATIONS FOR PIPING CONTROL VALVE MANIFOLDS, BYPASSES, STEAM TRAPS, ETC. ARE SHOWN CROSS HATCHED.

4.2 CHECK EXCHANGER INSULATION FOR CLEARANCE.

4.3 WHENEVER POSSIBLE VALVE STEM SHOULD BE KEPT OUT OF AISLEWAYS AND HEAD OR EYE ELEVATIONS. VALVES SHALL BE IN ACCORDANCE WITH THE P&ID AND DGS 1300 010.

4.4 PIPING SHALL BE ARRANGED TO PROVIDE CLEAR ACCESS FOR OPERATION AND MAINTENANCE.

4.5 CLEAR WALKWAY SPACE IS REQUIRED, BUT NOT NECESSARILY IN A STRAIGHT LINE.

4.6 MINIMUM HEADROOM AND ACCESS REQUIREMENTS FOR PASSAGEWAYS SHALL BE PER SPECIFICATION DGS 1300 040.

4.7 LINES SHALL BE SUPPORTED AS REQUIRED TO NINIMZE LOADS AND FORCES AT EQUIPMENT NOZZLES.

4.8 PIPE SUPPORTS WHEN REQUIRED SHOULD BE INCORPORATED WITH ONE OF THE EQUIPMENT FOUNDATIONS.

4.9 CONSIDERATION SHOULD BE GIVEN TO FIT-UP AND FLEXIBILITY WHEN USING 3 OR MORE BANK ARRANGEMENTS.

Figure 3.7.3 *Example of exchanger general arrangement*

3.8 Pumps

Suction, delivery and auxiliary piping of the pumps shall be installed in such a way as to leave sufficient space for the access of the personnel and lifting equipment needed during maintenance operations. This space shall be, at least, 1000 mm (see *Figure 3.8.1*).
Moreover, sufficient space shall be left above each pump for removal of the electric motor.
When installing the pump piping it is necessary to take into consideration the necessity of periodical maintenance of the hydraulic part and its possible removal. Therefore, connecting the valve directly to the pump nozzle should be avoided by means of if possible a removable flanged spool.
In case of the piping class of the line doesn't allow the use of flanged valves, it necessary to check, before inserting the flanged spool, that possible leakages can be a lee shore.
Piping for pumps conveying very hot fluids such as atmospheric distillation column bottoms, vacuum residue, etc., shall be installed providing a sufficiently flexible layout to allow the absorption of expansion and to avoid damage to the pump.
It is advisable to subject the layout of these pipes to STRESS, in order to check the route and stresses, before the 1st Material Take-Off.
In the case of vertical installation of suction and discharge pipes, the relevant shut-off valve shall be positioned so that the elevation of the stem centerline is at a minimum elevation of 1800 mm from ground (or working floor) in order to allow access to the pump.
If this elevation was exceeded (e.g.: due to the elevation of the nozzle of large pumps) the valves shall be positioned at the minimum possible elevation (see *Figure 3.8.1*).
Regardness of the type of assembly, the maximum operating height of a block valve used for plant operation, must not exceed 2000 mm from ground (or working floor) and in case of valves located above this height, the valves shall be operated by chain operated handwheels (see *Paragraph 4.1*.).
In the case of centrifugal pumps with top-top nozzles and with vertical pipe assembly, it is sometimes necessary, for clearance reasons, to ensure a greater spacing for the piping and valves than that provided for the nozzles.
In this case the space is achieved by providing an offset on the discharge piping, which diameter is smaller than that of the suction piping (see *Figure 3.8.1*).
Main pumps (defined by PRC) suction piping layout and routing with overall dimensions shall be sent to PRC to check the pressure losses.
In order to avoid the formation of gas/vapour pockets, even small ones, which could impair pump operation, the suction line shall always be as short as possible and the eccentric reducer, if required, and horizontally installed, shall be oriented with the flat part upwards.
A strainer shall always be installed on all the suction lines, between the block valve (gate valve) and the pump nozzle. The type of strainer is defined in the relevant P&I D. and will be permanent or temporary type. In the case of temporary strainers the section of piping shall be designed so that it can be easily removed (flanged), avoiding fixed supports to the ground or structures.
Permanent type strainers ("Y" or "T" types) with ND ≥ 2" (50 mm) shall be installed, if possible, on horizontal sections of pipe and orientated with the removal flange turned downwards to facilitate cleaning and removal of the strainer mesh. If there is not sufficient space under the strainer for such installation, an inclined installation is permissible to a maximum of 45° from the bottom upwards
Moreover, in order to permit disassembly, a drain (to be indicated on P&I D. and on the relevant assembly drawing) shall be provided on the flange.

A straight section of pipe shall be provided on suction lines of pumps, especially if they have a large discharge (e.g.: large cooling water circulation pumps) to avoid problems of pump cavitation. The length of this straight section is defined by MAPAF and by the pump Vendor.

When, for reasons of space, a 90° elbow is directly connected to the suction nozzle connection flange, it should be checked with MAPAF if it is necessary to insert a vortex breaker (cross type) or a baffle, in order to avoid "pre-rotation" of the fluid.

In case of pumps with double suction, the connection lines to the nozzles should be arranged so as to assure an equal distribution of the fluid.

In case of pumps conveying liquid gas (LPG, etc.) suitable vents should be provided on the suction lines with long horizontal sections, so as to avoid gas pockets and the consequently and that could result in a malfunctioning of the pump. For this purpose, a suitable slope should also be provided, in according with PRC and MAPAF Department.

For the elevation of pump suction piping from tanks see 00-GA-E-00060897 ‘Working Instruction for Foundation’, the formation of pockets shall be avoided to prevent the emptying of the tanks and the unefficiently of the pumps.

In Units, this route shall be maintained at a minimum elevation of 3000 mm from the ground to allow the passage of personnel and equipment.

In this case it should be verified that the nozzle of the equipment is positioned at least at this elevation. If the nozzle is found to be at a lower elevation, it is necessary to change the height of the supporting skirt, if possible, or the height of the baseplate.

The check valve, that is normally installed on the discharge lines, can be provided either in a vertical position, with the flow upwards, or in a horizontal position. The last solution is adopted when:

- It is necessary to reduce the elevation of the block valve (see *Paragraph. 3.8.4*.);
- The type of valve offers greater operating guarantees when is installed horizontally.

If the check valve is installed in a horizontal position it is also necessary to consider the necessity to leave sufficient space around the pump for access during maintenance. Therefore, the assembly should be made in order to this requirement in mind, moving the piping outside the pump baseplate section.

A check valve shall be installed on the closed drain piping coming from the lines and from body of pumps treating hazardous fluids when the vents and/or drains cannot be discharged into the atmosphere but have to be conveyed to a collection vessel or into the blow-down header.

This valve shall be installed at the highest point of the line and as close as possible to the suction equipment or to the blow-down header in order to avoid columns of liquid in the line which would cause vibrations during products’ discharge and conseguently damage to the line and leakage of the fluid.

A pressure gauge shall be connected to the discharge piping, using the appropriate piping assembly drawing, in a horizontal section between the nozzle and the check valve. This connection can be made directly onto a reducer (see *Figure 3.8.1*) for lines with a ND ≥ 8" (200 mm) otherwise a pipe spool must be inserted.

Drain funnels shall be provided in front of the pump baseplate, on the hydraulic side. In it the following product will discharge: leakages, drains, water from the frame gutter, cooling water from the bearings (if it has not been recovered), oily discharges, drainages from piping, etc..

When auxiliary lines are required for the cooling water, flushing, quench steam, etc., the installation of the piping should be made on the side of the pump, leaving free space around the same for maintenance and assembly. The primary valves shall be installed near the headers, while the operational valves shall be installed close to the pump. The last are normally supplied together with the pump.
Vent lines connected to blow-down shall be joined into upper section of the header in order to avoid the possibility that liquids present in the header should drain into the vent lines.
Figure 3.8.2/3 shows some typical installations of piping to pumps.
For execution of fire fighting piping see the typical example illustrated in *Figure 3.8.4.*

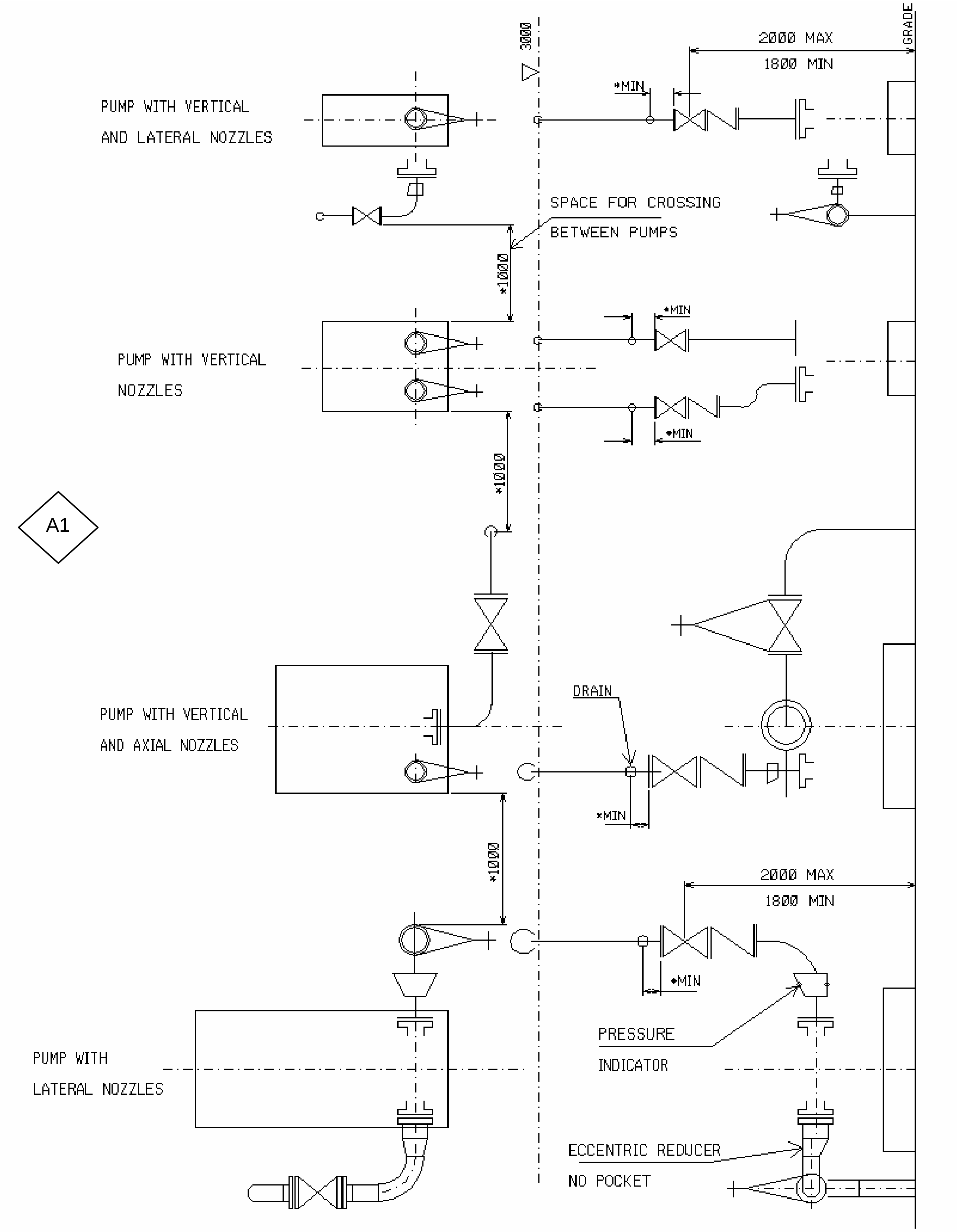
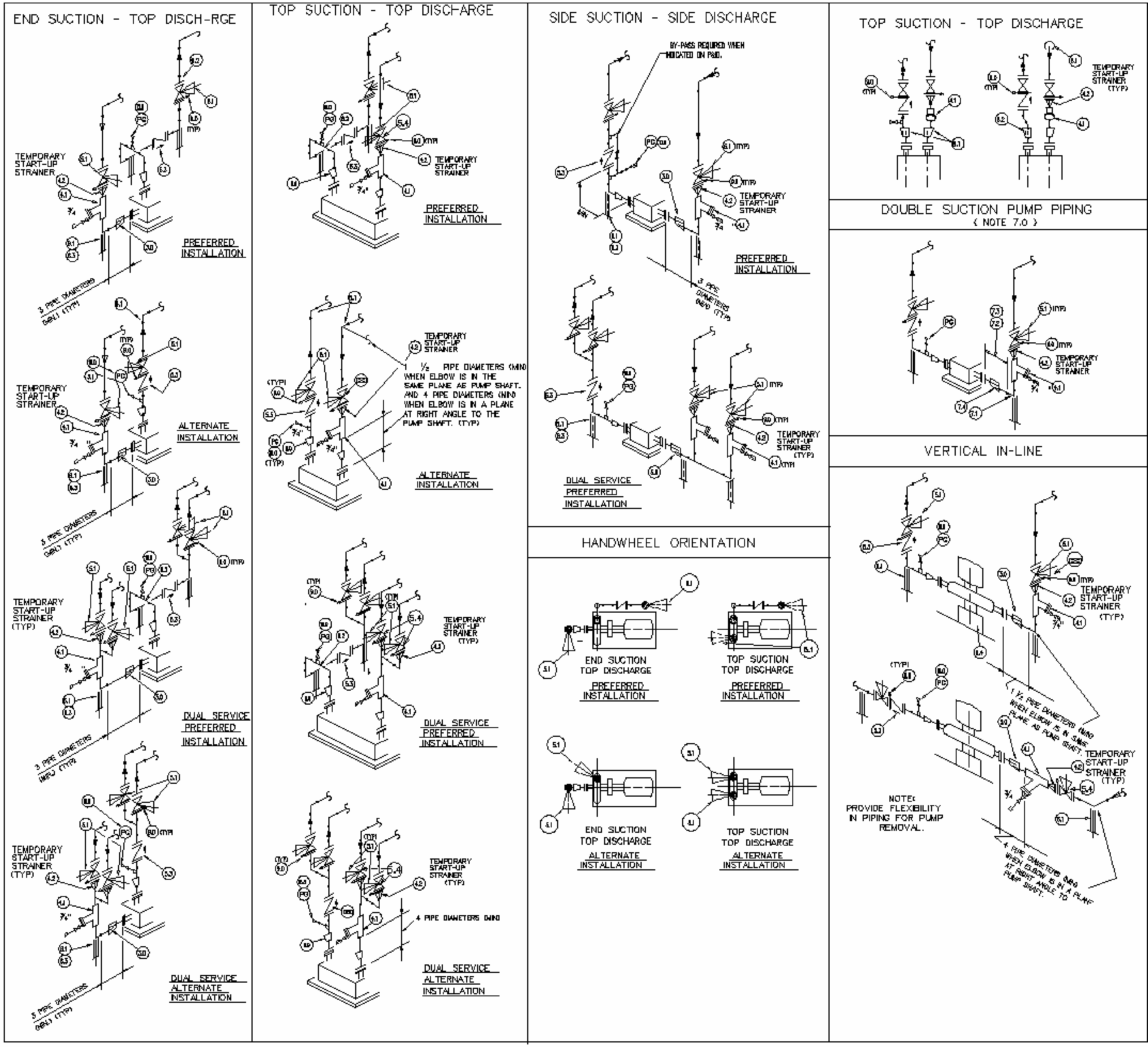


Figure 3.8.1 *Typical pump general arrangement*



GENERAL NOTES

PURPOSE:
THIS PIPING STANDARD DRAWING IS INTENDED AS A GUIDE ONLY AND IS NOT INTENDED TO DEPICT ALL DESIGN POSSIBILITIES. FOR ADDITIONAL DESIGN AND LAYOUT REQUIREMENTS, REFER TO POINT 3.8

1.0 PUMP PIPING SHALL BE ARRANGED TO PROVIDE CLEAR ACCESS FOR REMOVAL OF PUMP AND/OR DRIVER.

2.0 EQUIPMENT LOCATION SHALL BE PER FIGURE 2.L.

3.0 REDUCTION AND DRAIN REQUIREMENTS AT PUMPS SHALL BE PER POINT 3.8.

4.0 LINE STRAINERS
- 4.1 PERMANENT SUCTION STRAINERS WILL BE INSTALLED IN PUMP SUCTION LINES PER POINT 3.6. AND AS INDICATED ON P&ID'S.
- 4.2 TEMPORARY SUCTION STRAINERS WILL BE INSTALLED WHEN PERMANENT SUCTION STRAINERS ARE NOT REQUIRED.

5.0 VALVES
- 5.1 VALVE HANDWHEELS OR HANDLES SHALL BE ORIENTED IN SUCH A MANNER THAT IT WILL NOT INTERFERE WITH PUMP MAINTENANCE AND/OR CREATE HAZARDS FOR OPERATING PERSONNEL.
- 5.2 PUMP VALVES ARE OPERATING VALVES AND SHALL BE READILY OPERABLE FROM GRADE OR PLATFORM AS FOR POINT 3.8.
- 5.3 CHECK VALVES CAN BE INSTALLED IN THE VERTICAL AND/OR HORIZONTAL POSITION. LIFT CHECKS SHALL BE INSTALLED IN HORIZONTAL POSITION ONLY.
- 5.4 THE PRESSURE RATING OF THE SUCTION VALVE AND PIPING BETWEEN THIS VALVE AND THE SUCTION NOZZLE SHALL BE EQUAL TO THE RATING OF THE DISCHARGE.

6.0 SUPPORT
- 6.1 LINES SHALL BE SUPPORTED TO ENSURE COMPLIANCE WITH ALLOWABLE LOADS AND FORCES ON PUMP NOZZLES AND TO ENSURE ALIGNMENT OF PUMP AND DRIVER SHAFTS, AS REQUIRED BY STRESS ENGINEERING.
- 6.2 FOR LARGE LINES, IT MAY BE NECESSARY TO OFFSET DISCHARGE PIPING TO REMOVE DEAD LOADS FROM DISCHARGE NOZZLE AND FOR EASE OF ACCESS.
- 6.3 WHEN THERE IS A POTENTIAL FOR DIFFERENTIAL SETTLEMENT. BASE SUPPORTS AT PUMP PIPING MUST BE INTEGRAL WITH THE PUMP FOUNDATION.
- 6.4 HEAVY IN-LINE PUMPS SHALL BE REVIEWED FOR ADDITIONAL SUPPORT REQUIREMENTS BY STRESS GROUP.

7.0 DOUBLE SUCTION PUMP PIPING
- 7.1 ON DOUBLE SUCTION PUMP PIPING, AVOID USING HORIZONTAL ELBOWS ON SIDE SUCTION CONNECTIONS. SEE PREFERRED INSTALLATION FOR SIDE SUCTION PIPING ARRANGEMENT.
- 7.2 WHEN HORIZONTAL ELBOWS MUST BE USED, A STRAIGHT LENGTH OF 5 UP TO 10 NOMINAL PIPE DIAMETERS MAY BE REQUIRED AND CAN INCLUDE FLANGES, REDUCERS, ETC. SEE MECHANICAL ENGINEERING IF THIS OCCURS.
- 7.3 WHEN ELBOW IS IN A PLANE AT RIGHT ANGLES TO THE PUMP SHAFT, A MINIMUM STRAIGHT LENGTH OF 3 PIPE DIAMETERS IS REQUIRED.
- 7.4 SUCTION LINES TO PUMPS FROM SOURCE ABOVE THE PUMP SHOULD BE LEVEL OR SLOPE TO PUMP. AVOID POCKETS OR TRAPS. IF ECCENTRIC REDUCERS ARE USED AT PUMP SUCTION NOZZLES (END SUCTION PUMPS) THEY SHOULD BE FLAT ON TOP.
- 7.5 SUCTION LINES TO PUMPS FROM SOURCE BELOW THE PUMP SHOULD RISE TO PUMP. AVOID POCKETS OR TRAPS IF ECCENTRIC REDUCERS ARE USED, MAKE THE TOP FLAT AT PUMP SUCTION NOZZLE FOR LINE SIZE REDUCTION.
- 7.6 SUCTION LINES SHOULD BE AS SHORT AND DIRECT AS POSSIBLE, CONSISTENT WITH FLEXIBILITY REQUIRED FOR HOT SUCTION LINES, PER STRESS ENGINEERING.

8.0 CLEARANCES
- 8.1 ECCENTRIC REDUCERS MAY BE REQUIRED IF A CLEARANCE PROBLEM BETWEEN SUCTION AND DISCHARGE PIPING OCCURS.
- 8.2 WHEN USE OF ECCENTRIC REDUCERS SEE FIGURE 3.8.3

9.0 PROVIDE SPECTACLE BLINDS ON SUCTION AND DISCHARGE LINES IN ACCORDANCE WITH P&ID DIAGRAM

10.0 TYPICAL LOCATION FOR PRESSURE GAUGE TAPS IS SHOWN.

Figure 3.8.2 Example of pump general arrangement

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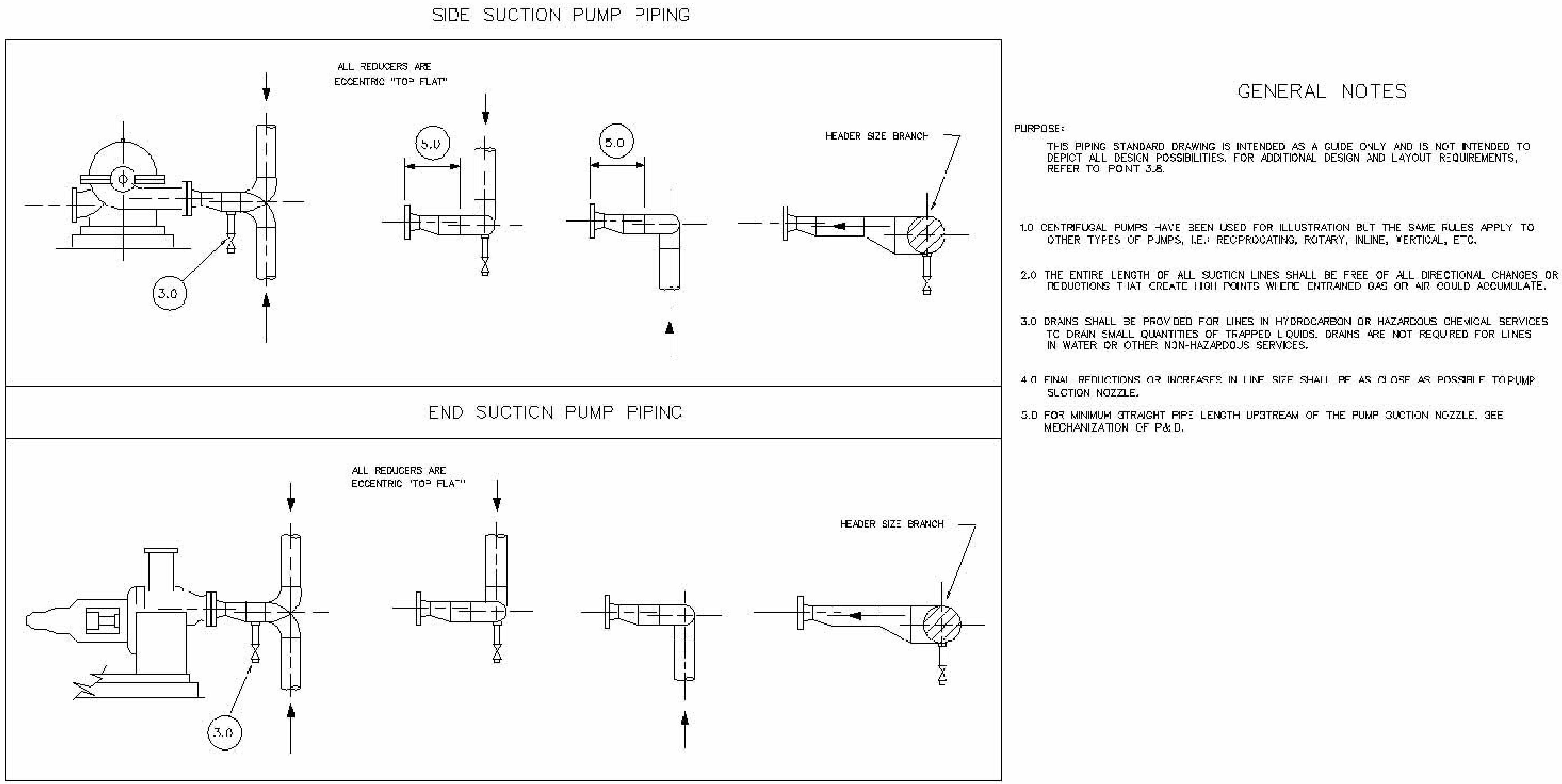
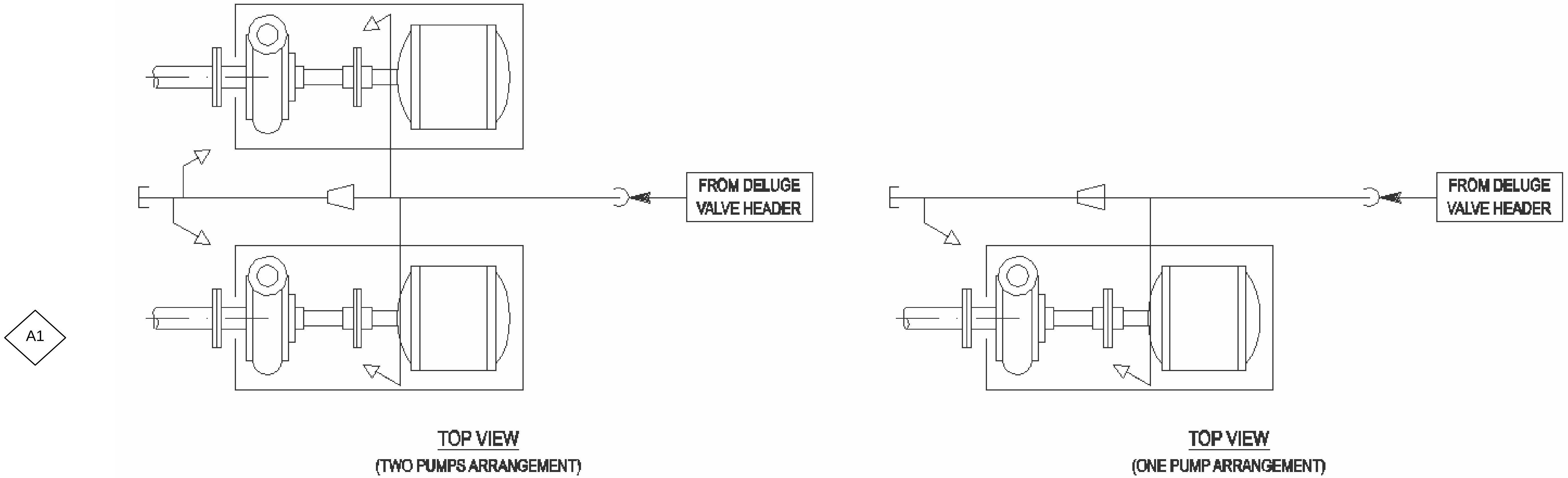


Figure 3.8.3 *Example of suction pump piping*



NOTES:

C1- PUMP THAT HANDLE PRODOUCTS CLOSE OR ABOVE THEIR FLASH POINT TEMPERATURE SHAL HAVE THE SHAFTS, SEALS AND OTHER CRITICAL PARTS ENVELOPED BY DIRECTED WATER SPRAY AT A NET RATE OF NOT LESS THAN 20.4 (l/min)/m2 OF PROJECTED SURFACE AREA OF THE EQUIPMENT INCLUDING ANOUTSKIRT OF AT LEAST 0,6 m.

C2- GENERALLY, THE NUMBER OF WATER SPRAY NOZZLE DEDICATED FOR THE PROTECTION OF THE PUMPS SHALL BE TWO.
MORE NOZZLES (UP TO A MAXIMUM OF SIX) MAY BE NECESSARY FOR LARGER PUMPS TO ACHIEVE THE REQUIRED WATER DENSITY.

C3- THE 2,5 / 3 m ELEVATION IS TYPICAL; THE ACTUAL ELEVATION SHALL BE SELECTED SO THAT THE SPRAY PATTERN COMPLETELY ENVELOPES THE PUMP.

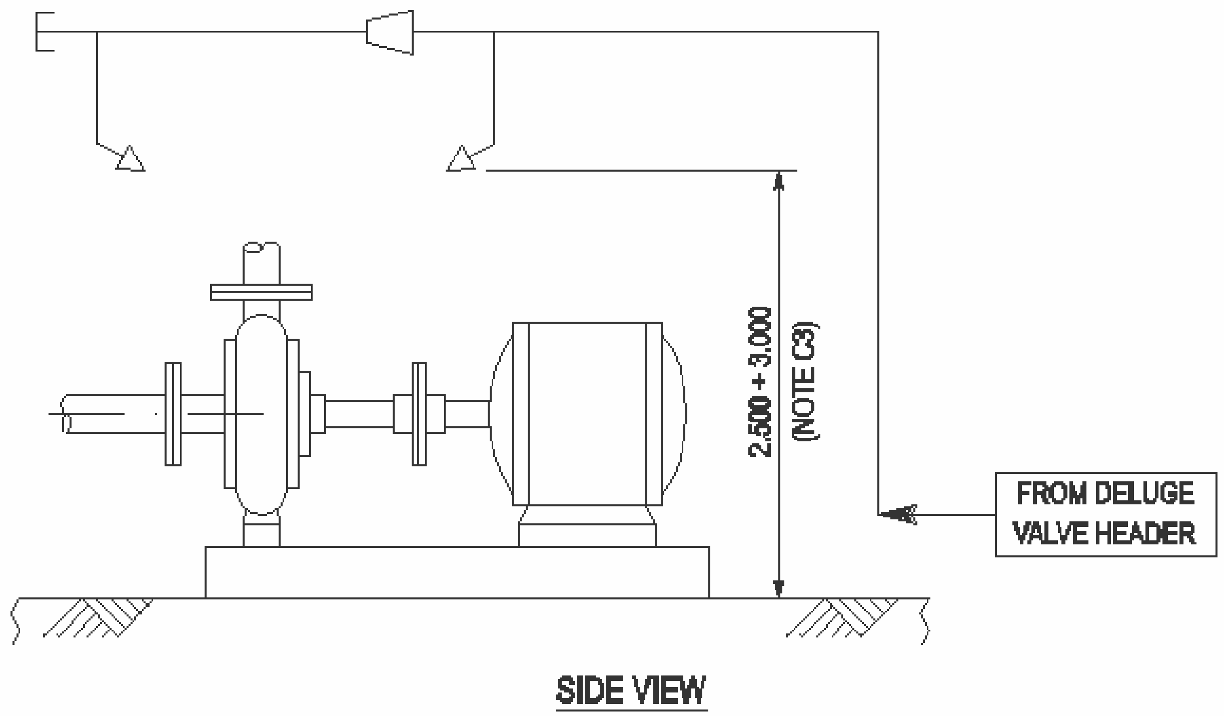


Figure 3.8.4 *Water spray nozzle typical arrangement for pumps*

3.9 Compressors

In a compressor room, the operation valves of the machines shall be aligned on a single bank which, as far as possible, shall be oriented towards the units.
The alignment shall be made adjacent, or even just outside the walkway, so as to leave sufficient space between the valves and the machines for the passage of personnel. In order to obtain this space without increasing the span of the shelter, a walkway can be installed outside the support columns.
All the main valves shall be installed at an height that allow easy operability (*Paragraph .4.1*.) an easy action of Operators.
During designing the piping, space shall be left for a compressor local panel board, if required, which shall be located such that it can be viewed while the valves are in operation.
Suction and discharge piping shall be installed at the lowest possible elevation so as to leave the machine as free and accessible as possible.
The supports of piping should not be directly connected to centrifugal compressor baseplates, in order to avoid possible fracture due to vibration. For the same reason piping connected to alternative compressors should not be supported by support structure.
The suction pipes of each compressor shall be as short as possible in order to avoid the formation of condensate. Therefore, the suction vessel (or surge drum) shall be located, whenever possible, close to the machine, generally next to the compressor room.
Pipes are therefore connected to the machine with a slope towards the separators.
The recycle valve shall be installed on the working floor (machine operating floor) without creating pockets in the piping. If the shelter is an enclosed one, this valve will be installed on an external platform (at working floor elevation) due to its high noise level.
Any gas vents, provided with valves that discharge into the atmosphere, shall be installed outside the shelter.
Check, the compressor drawings, specification and, if necessary, with MAPAF, the necessity of connection to utilities, such as:

- Cooling water for cylinder jackets;
- Cooling water for packing;
- Cooling water for lubrication system;
- Seal oil system;
- Steam for auxiliaries (lubricating and seal oil) turbines;
- Balance gas;
- Buffer gas.

In case of alternative compressors it is necessary to prepare, in cooperation with MAPAF and PRC, the documentation that is to be sent to the Vendor for the check of the system by means of an analog calculation (activities to be performed within times and schedules to be defined and agreed with job management).
For execution of fire fighting piping see the typical example illustrated in *Figure 3.9.1.*
A typical arrangement of piping around the centrifugal/alternative compressors is shown on *Figure 3.9.2.a/b.*

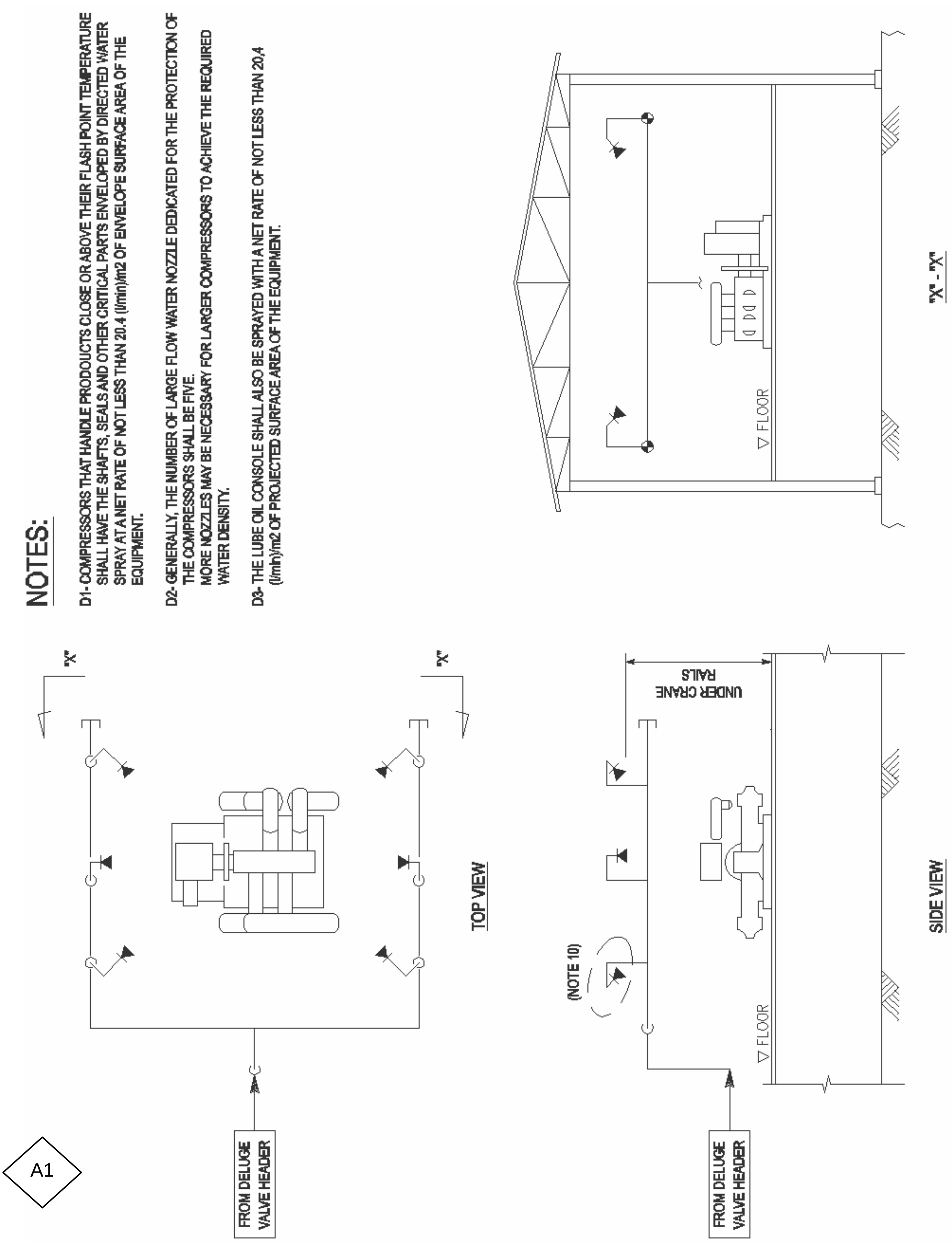


Figure 3.9.1.*Water spray nozzle typical arrangement for compressors*

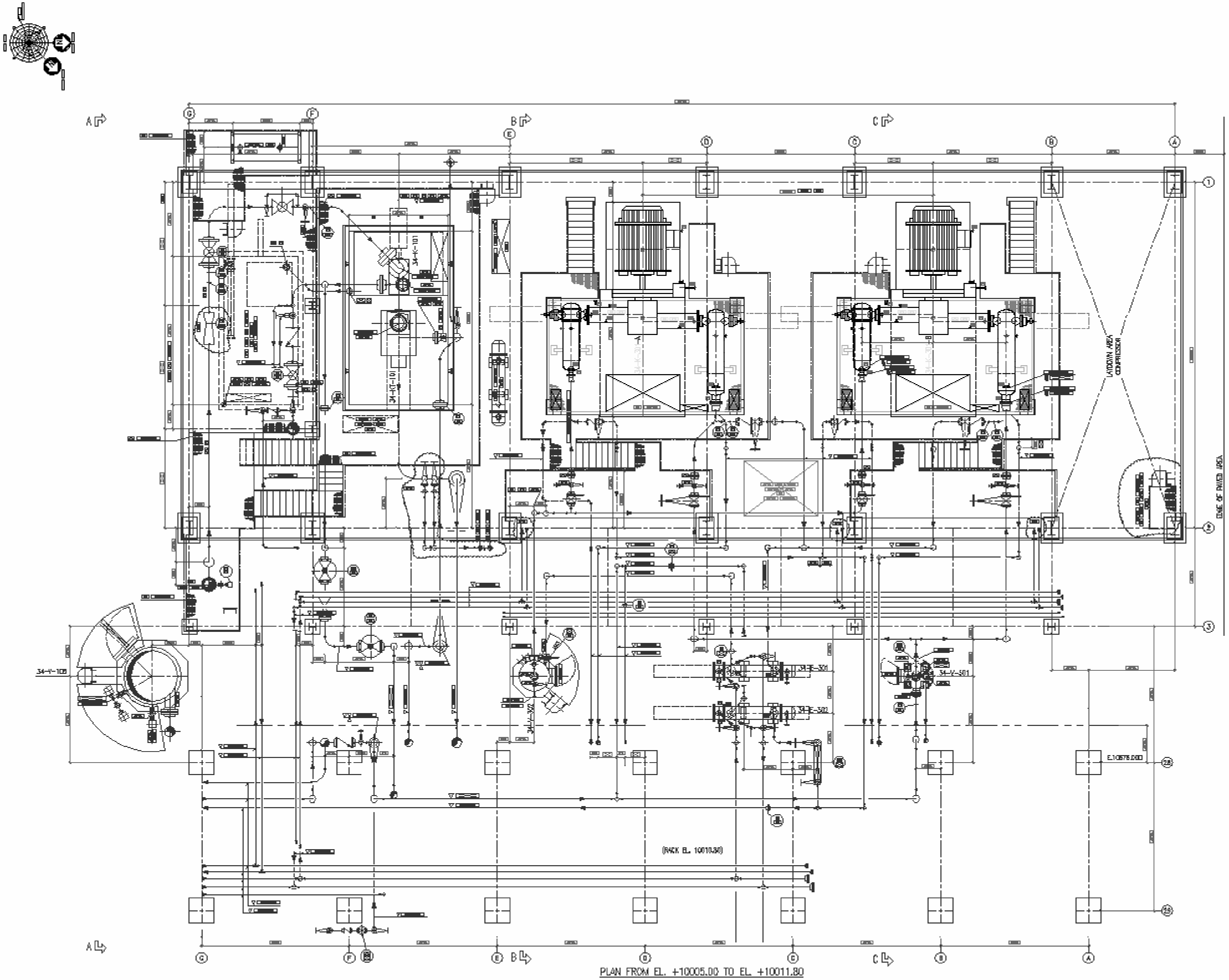


Figure 3.9.2.a *Example of compressor general arrangement*

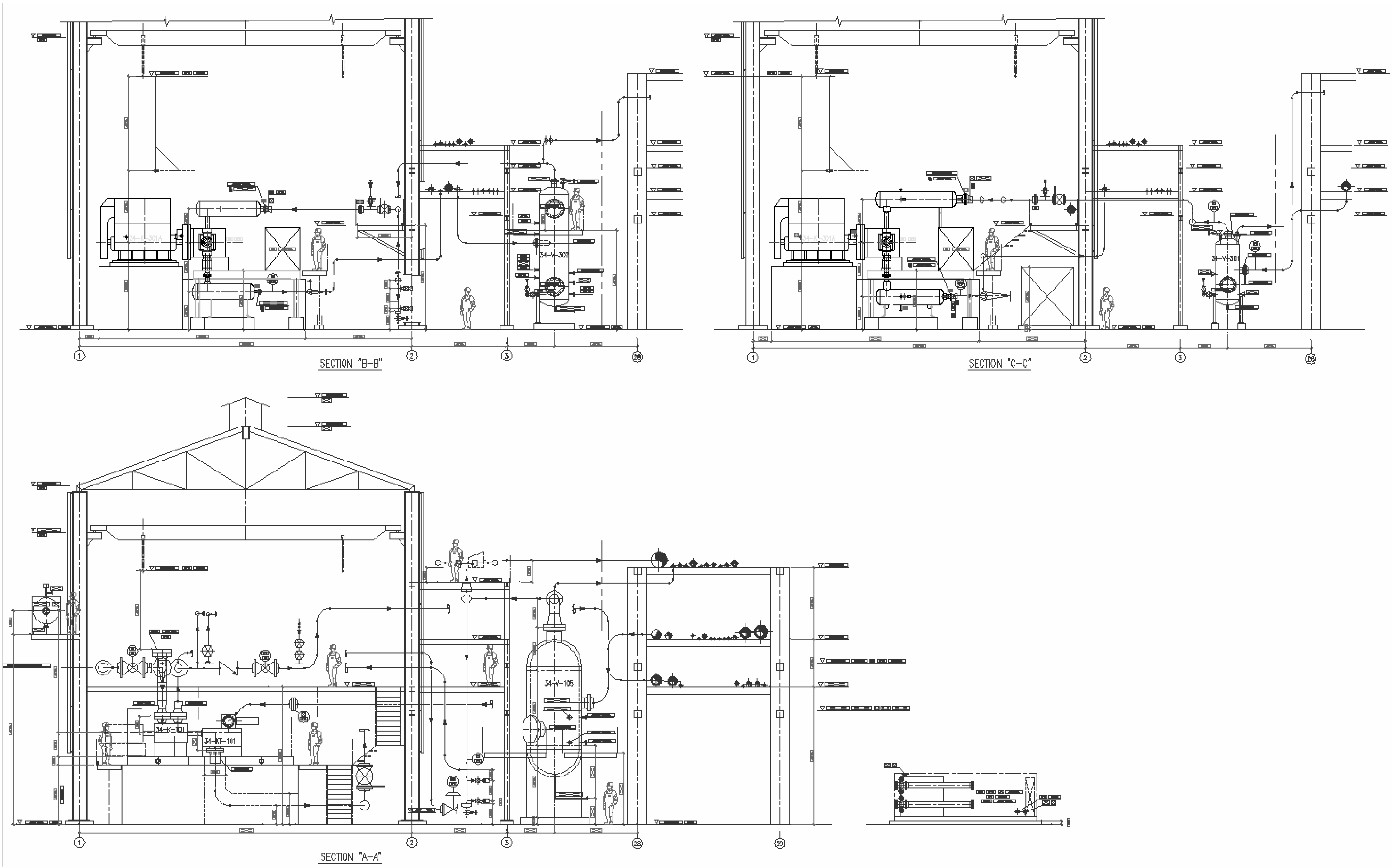


Figure 3.9.2.b *Example of compressor general arrangement*

3.10 Steam Turbines

The layout of the steam inlet and discharge piping connected to steam turbines shall be sufficiently flexible to allow the absorption of expansion, to avoid subjecting the turbines to higher stresses than the allowable ones.

On the steam inlet piping, the relevant valves shall be installed as close as possible to the turbine, with the provision of a condensate drip pot in the line so as to avoid condensate entrainment in the turbine, and a "Y" or “T” type strainer, if required, shall be located as close as possible to the turbine inlet (see *Figure 3.10.1*).

On the steam discharge piping, the safety valve (if required) shall be installed in a position that allows easy access for maintenance (see *Figure 3.10.1*).

The discharge pipe of safety valve shall extent to a safe area, particularly:

- Above the piperack, if the turbine is positioned under the piperack;
- Outside the shelter, if the turbine is in a closed area.

The discharge to atmosphere shall be a minimum distance of 3 m (in elevation) above the highest service platform located within a radius of 15 m.

The steam trap groups shall be arranged along the baseplate of the turbine in order to not obstruct access, remember that they shall be installed below the turbine body to prevent the accumulation of condensate inside it.

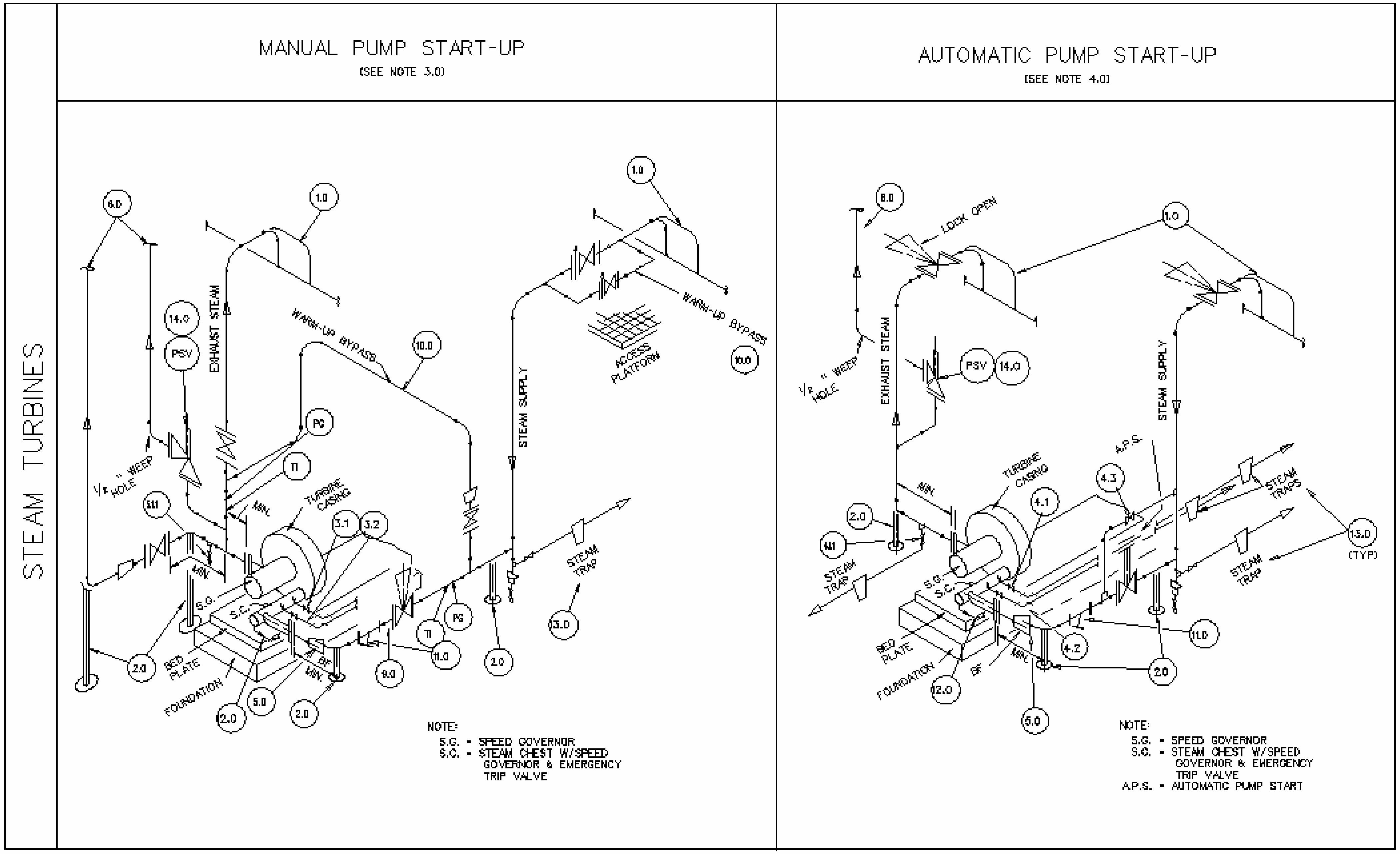
If no condensate recovery system is provided, the condensate will be discharged to sewer, through one of the drain funnels provided for pumps (see *Paragraph 3.8.*).

The operating floor of a turbine with a condenser shall be left free from piping. The pipes shall normally be installed under this floor, and shall rise to the height of nozzle groups.

The cooling water pipes to/from the condenser shall be installed leaving the front of the condenser free, so as to permit opening of the cover and to facilitate maintenance operations. If the condenser is a close coupled unit with the turbine (without an intermediate expansion joint) the water and other connecting piping shall have sufficient flexibility to absorb thermal expansion.

Check on the turbine specifications the necessity of connections to the lubricating oil cooling water systems.

The elevations of vacuum ejectors, lubricating and seal oil equipment recommended by the Manufacturer shall be followed.



GENERAL NOTES

PURPOSE:

THIS PIPING STANDARD DRAWING IS INTENDED AS A GUIDE ONLY, AND IS NOT INTENDED TO DEPICT ALL DESIGN POSSIBILITIES. FOR ADDITIONAL DESIGN AND LAYOUT REQUIREMENTS REFER POINT 3.10

1.0 OFFSET ONLY IF REQUIRED FOR FLEXIBILITY.

2.0 PIPE SUPPORTING:

2.1 ON LARGE TURBINES WHERE EXCESSIVE FORCE, VIBRATION, AND/OR WHERE DIFFERENTIAL SETTLEMENT CAN OCCUR, FOUNDATIONS FOR SUPPORTS MUST BE INTEGRAL WITH THE EQUIPMENT FOUNDATION.

2.2 STEAM SUPPLY AND EXHAUST LINES MUST BE SUPPORTED INDEPENDENTLY FROM THE TURBINE NOZZLE SO THAT THE FLANGE BOLTS CAN BE REMOVED AND THE FLANGE ALIGNMENT WILL NOT CHANGE. TYPE OF SUPPORT USED TO BE APPROVED BY STRESS ENGINEERING.

3.0 MANUAL START-UP, MANUAL CONTROL:

3.1 CASING DRAIN: CONNECT WITH PIPE, AND SUITABLE VALVE TO OPEN DRAIN.

3.1.1 PROVIDE CASING DRAIN HERE ONLY IF EXHAUST INVERT IS LOWER THAN TURBINE CASING.

3.2 STEAM CHEST DRAIN: CONNECT WITH PIPE, AND SUITABLE VALVE TO OPEN DRAIN.

4.0 AUTOMATIC START-UP, AUTOMATIC CONTROL:

4.1 CASING DRAIN: CONNECT WITH PIPE, SUITABLE VALVE, AND STEAM TRAP TO OPEN DRAIN.

4.1.1 PROVIDE CASING DRAIN HERE ONLY IF EXHAUST INVERT IS LOWER THAN TURBINE CASING.

4.2 STEAM CHEST DRAIN: CONNECT WITH PIPE, SUITABLE VALVE AND STEAM TRAP TO OPEN DRAIN.

4.3 BYPASS SHOULD BE PROVIDED AROUND CONTROL VALVE WHEN TURBINE IS TO BE KEPT IDLING (CHECK WITH PROCESS ENGINEERING FOR REQUIREMENT).

5.0 USE BOTTOM FLAT REDUCER AS REQUIRED TO PREVENT LOW POINT POCKET.

6.0 STEAM EXHAUST SHALL NOT DISCHARGE INTO PERSONNEL WORKING AREAS SUCH AS PLATFORMS, WALKWAYS AND AIR COOLERS. DISCHARGE PIPE TO TERMINATE A MINIMUM OF 3000 ABOVE PLATFORMS WITHIN 15000 RADIUS.

7.0 PIPING SHALL BE ROUTED TO ALLOW REMOVAL OF CASING SECTIONS AND INTERNAL ELEMENTS FROM THE EQUIPMENT WITH A MINIMUM DISTURBANCE OF PIPING.

8.0 PIPING SHALL BE DESIGNED TO PERMIT STEAM BLOWING UP TO THE INLET AND OUTLET FLANGES OF THE TURBINE BEFORE START-UP.

9.0 A SUITABLE STRAINER SHALL BE INSTALLED IN THE STEAM INLET LINE CLOSE TO THE TURBINE, IF NOT SUPPLIED WITH THE TURBINE.

10.0 WARM-UP BYPASS REQUIREMENTS TO BE REVIEWED WITH PROCESS ENGINEERING DURING DETAILED DESIGN.

11.0 Y OR T -TYPE STRAINER SHALL BE INDICATED ON THE P&ID.

12.0 VALVE STEM LEAKOFF: WHEN FURNISHED SHALL BE PIPED DIRECTLY TO OPEN DRAIN WITHOUT VALVES OR RESTRICTIONS.

13.0 STEAM TRAP CONFIGURATIONS TO BE AS FOR 3034.00.ED.PM.PCR.AA401 "P&ID development procedure"

14.0 IF THE EXHAUST SIDE OF A TURBINE CANNOT WITHSTAND THE SUPPLY STEAM PRESSURE, A RELIEF VALVE WITH ADEQUATE CAPACITY SHALL BE INSTALLED DIRECTLY DOWNSTREAM OF THE TURBINE AND UPSTREAM OF THE DISCHARGE BLOCK VALVE.

A1

Figure 3.10.1 *Example of pump general arrangement*

3.11 Heaters

When installing piping, both for process and utilities, leave free spaces all around the heater in front of sight, access and explosion doors. Moreover the box door could be opened the heaters that have headers.
The operation valves for utilities to burners shall be located along the heater wall and operated from a walkway which shall be wide enough to allow a free passage (a minimum of 1000 mm of net clearance shall be left between the rail and the valve handwheel).
The distance between centres of the operation valves for utilities to burners shall be sufficient to enable disassemble of a valve and to operate freely the handwheels or lever.
For utilities heaters, the groups of control valves should be gathered in a single zone, close to the heater.
Also the product control valves, if any, shall be located in the same zone in order to gather the instrumentation and controls to facilitate the work of Operators.
The utilities headers (oil and/or fuel gas, atomising steam) to burners are generally installed vertically and grouped in a bank, along the heater walls. This is to allow for a single support on the heater structure (see *Figure 3.11.1*),
When installing snuffing steam piping, remember that this steam is normally introduced into:

a) The radiant section (about 300/400 mm from the base slab);
b) The convection section (if required);
c) The header boxes (if provided).

The steam for points a) and b) is conveyed by a single header, for which branch take-offs to the connections provided on the heaters' wall. 752
The steam from point c) is conveyed through an independent header; one on each side of the heater that is equipped with headers.
In a case of a cabin heater that is provided with headers on both ends, for example, three headers shall be provided for the snuffing steam.
The group shut-off valves for the inlet to snuffing steam shall be located at a distance of at least 15 m (both for safety and quick Operator action reasons) from the heater, preferably in the direction of the control room.
If the Unit contains several heaters it is preferable to group all the snuffing steam connections in a single manifold.
The snuffing steam headers, the inlet control valves and the related branches shall not be insulated because, except in emergencies, these headers are always out of service and therefore empty.
Check on heater specification, the necessity of a connection of pilot to the burner network.
If this connection is required, a branch from the fuel gas header shall be provided downstream of the pressure control valve.
A valve having the same function shall also be installed on the pipe conveying the pilot gas. It shall be positioned just after the fuel gas header branch pipe.
In any case the sequences given on the relevant P&I D. shall be respected.
The piping layout shall be developed, as typical, showing a single burner feed unit only (see *Figure 3.11.1*), indicating the position of all the others axially only.

Piping associated to this unit has to be developed to a maximum detail, because a single mistake will affect the arrangement drawings and the material lists for all the other heater burners.

The steam feeding piping to the soot blowers are installed by providing a distribution sub-header with various feed lines (one for each blower).

The distribution sub-header branches off from the main steam header and shall be installed with a slope of 1: 500 towards the end point where a drip leg shall be provided, with the appropriate trap, to collect the condensate. The control valve shall be installed at the highest point, making sure that the pipe section upstream ensures selfdraining towards the main header.

The feed lines to the blowers shall branch off from the top of the distribution sub-header.

In addition to steam, soot blowers normally require:

- An instrument air line, needed for the pneumatic feeding of the panel (usually positioned on the ground);
- A utility air line, on which two branch pipes shall be provided (each supplied with shut-off valves, located as close as possible to the branch): one serves as a sub-header for the distribution to the blowers and the other for feeding the panel board. The valves shall be installed on the platform of the blowers.

When a decoking system is provided, the product inlet/oulet pipes shall be installed grouped with the decoking lines (checking any problems related to stress analysis). A flanged elbow shall be provided on the heater nozzles and designed such that by simply rotating the elbow, it is possible to connect both the product lines to the decoking system when required.

A1 A typical arrangement of piping around cylindrical and box heaters is shown on *Figure 3.11.2.a/b* and *Figure 3.11.3 a/b/c*

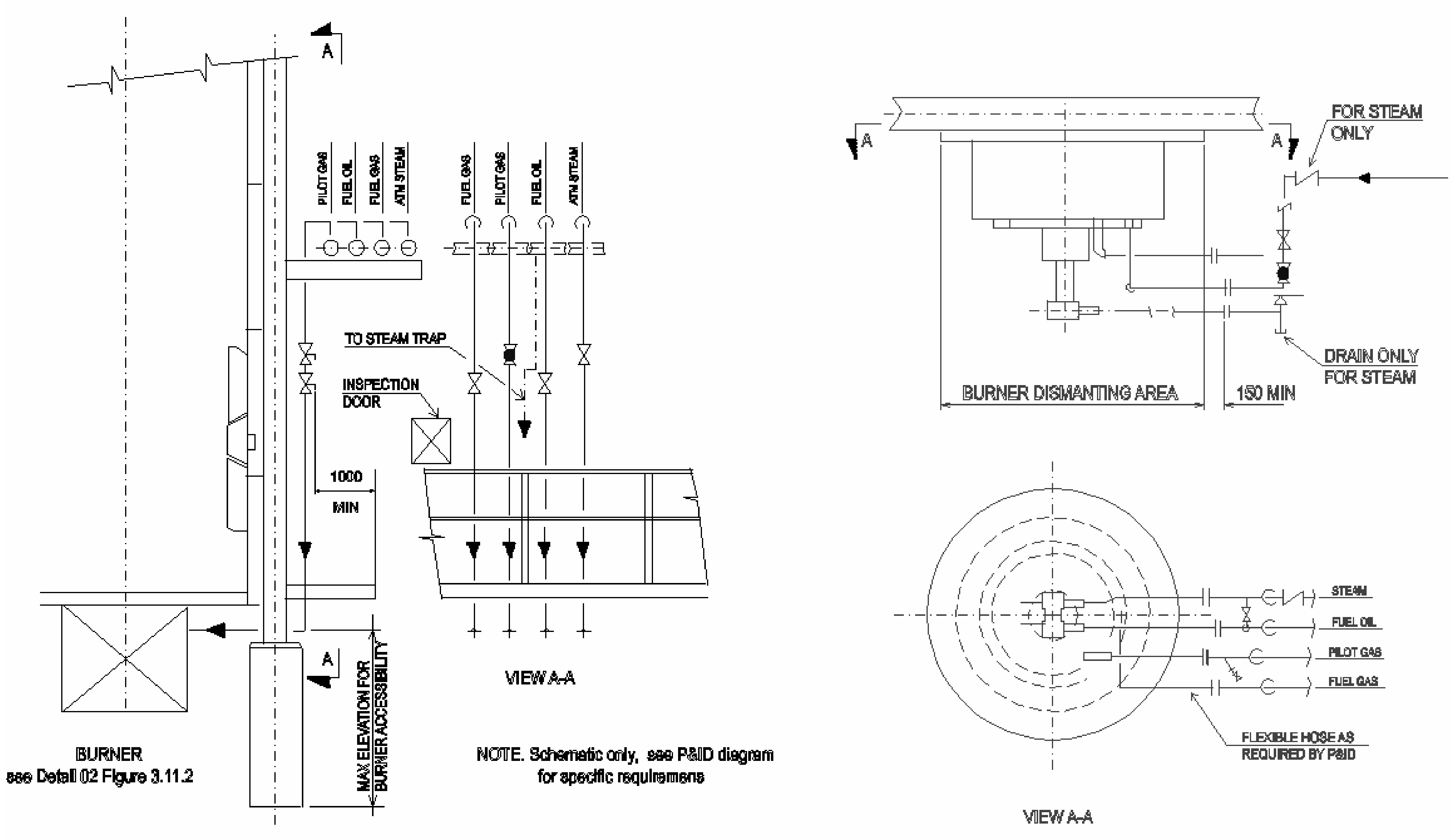


Figure 3.11.1 Burners utilities typical arrangement

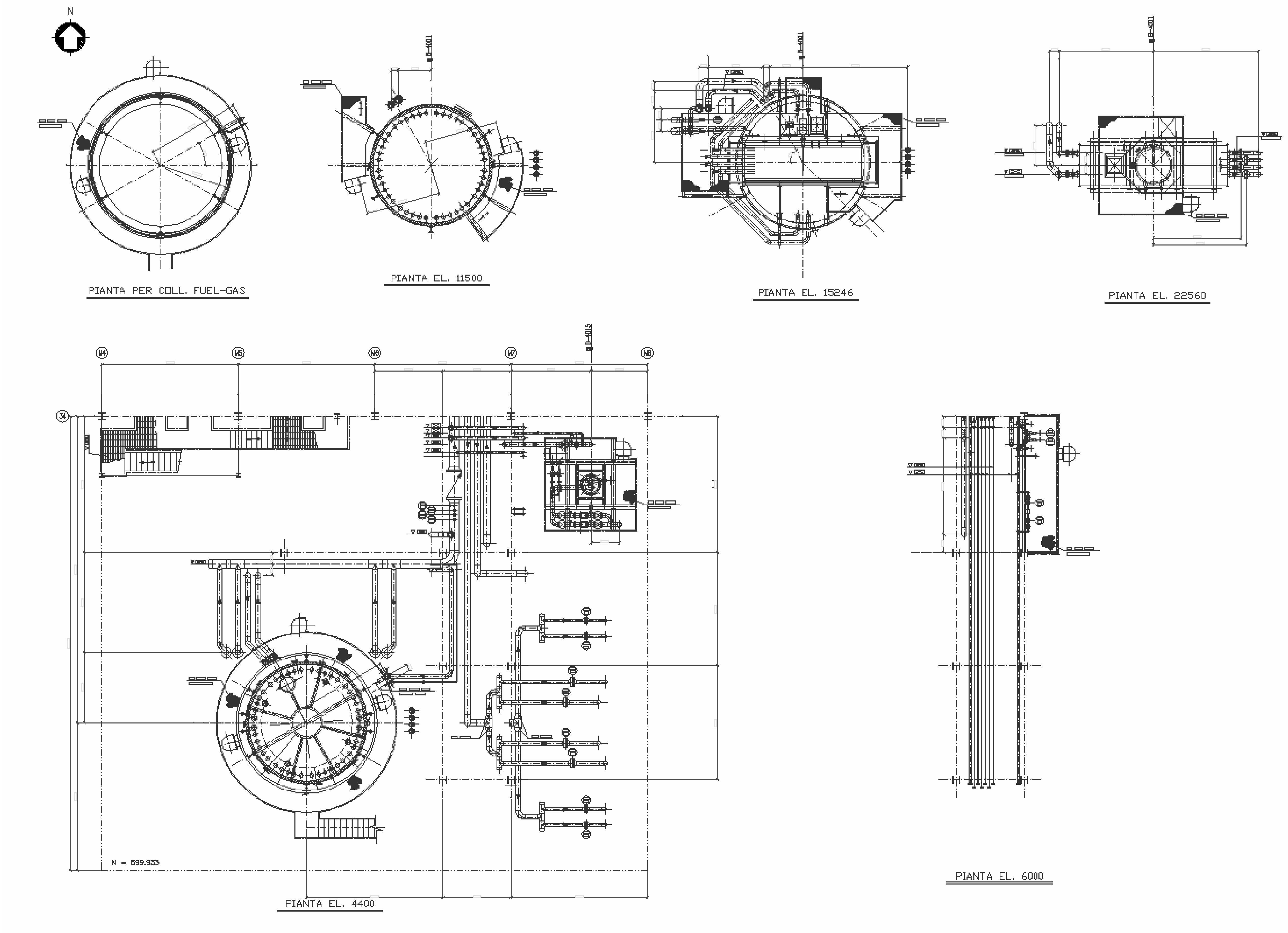


Figure 3.11.2.a *Example of typical installations of piping around cylindrical heaters.*

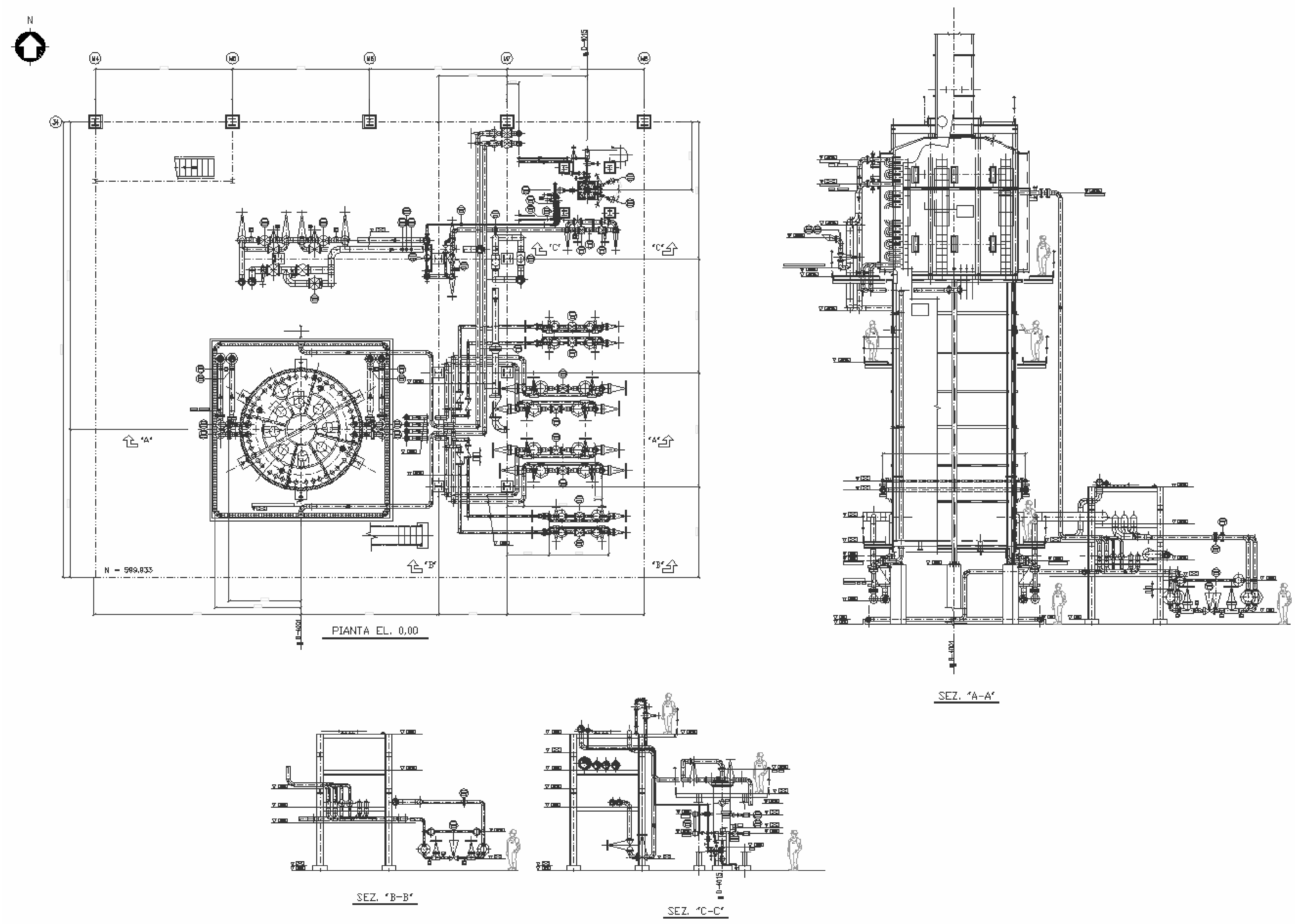


Figure 3.11.2.b *Example of typical installations of piping around cylindrical heaters.*

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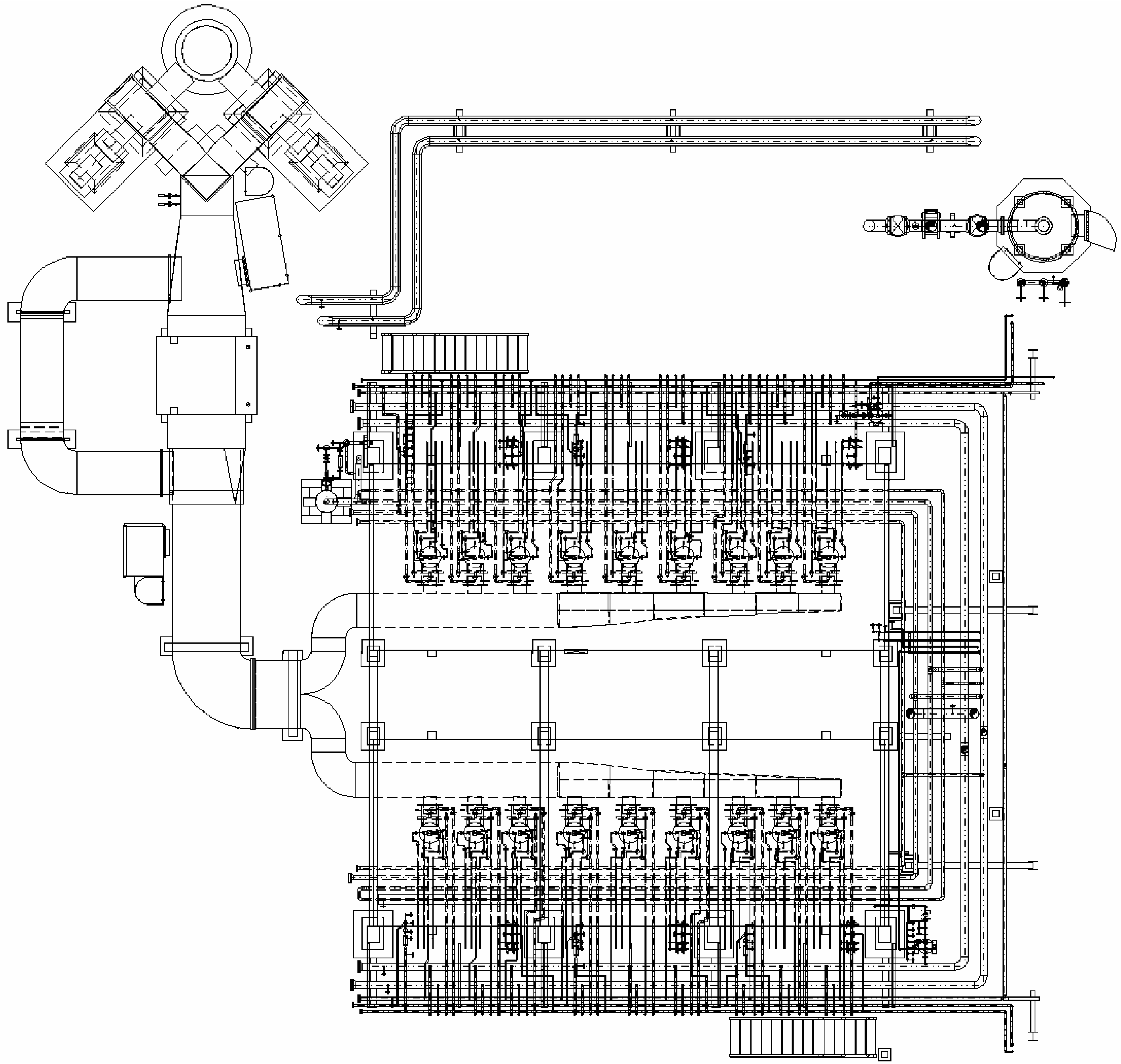

Figure 3.11.3.a *Example of typical installations of piping around box heaters*

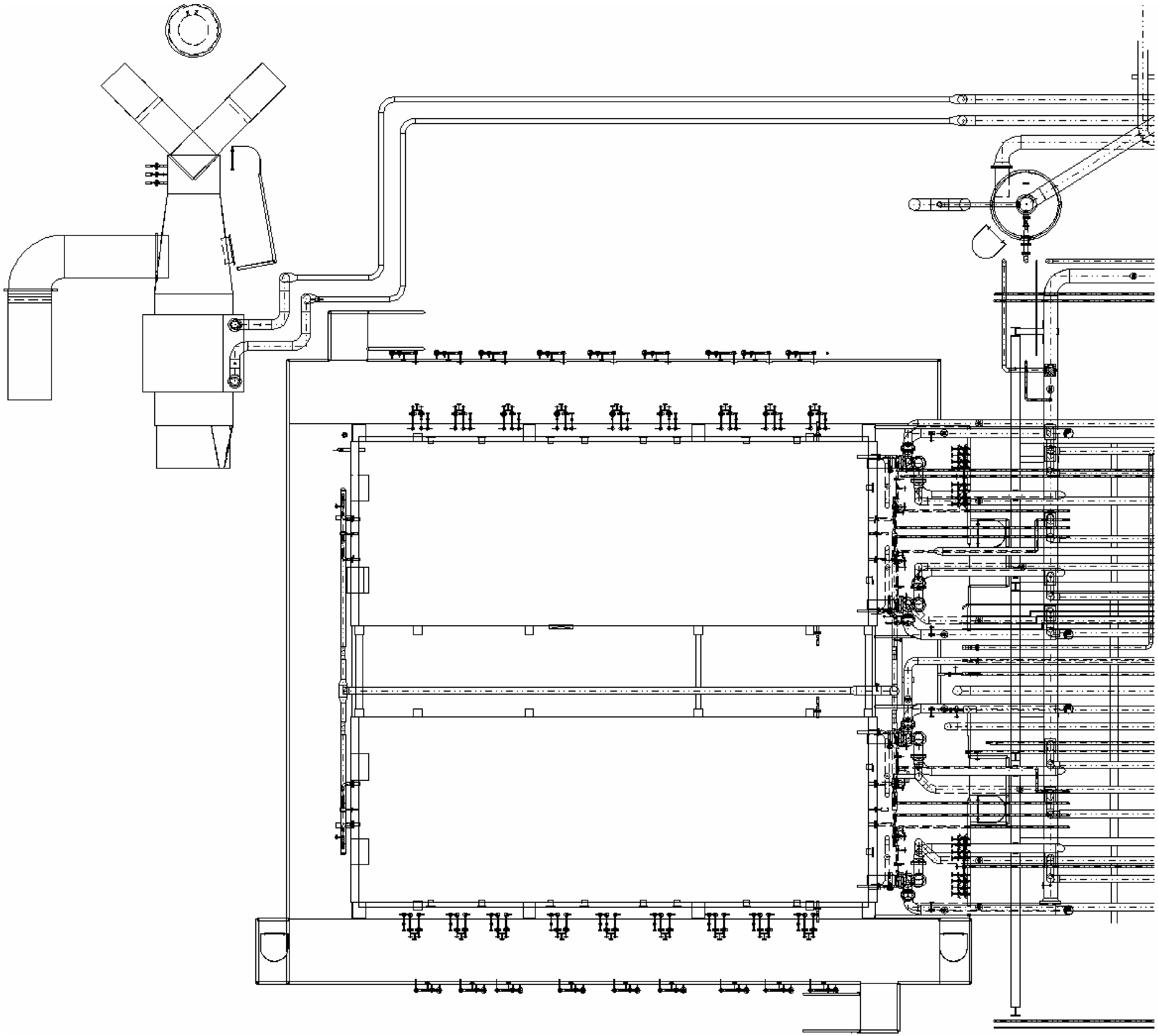

Figure 3.11.3.b *Example of typical installations of piping around box heaters*

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A1

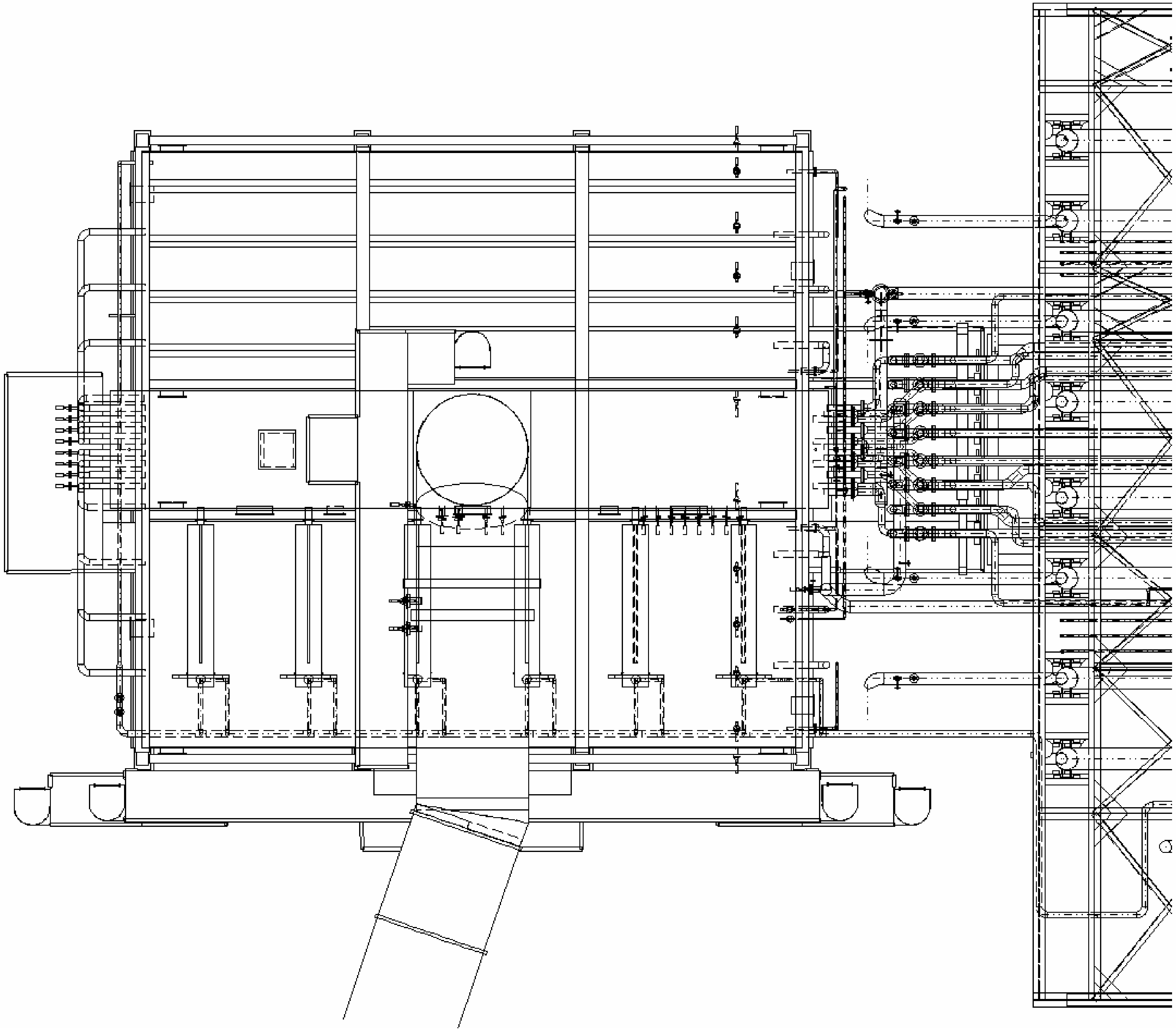

Figure 3.11.3.c *Example of typical installations of piping around box heaters*

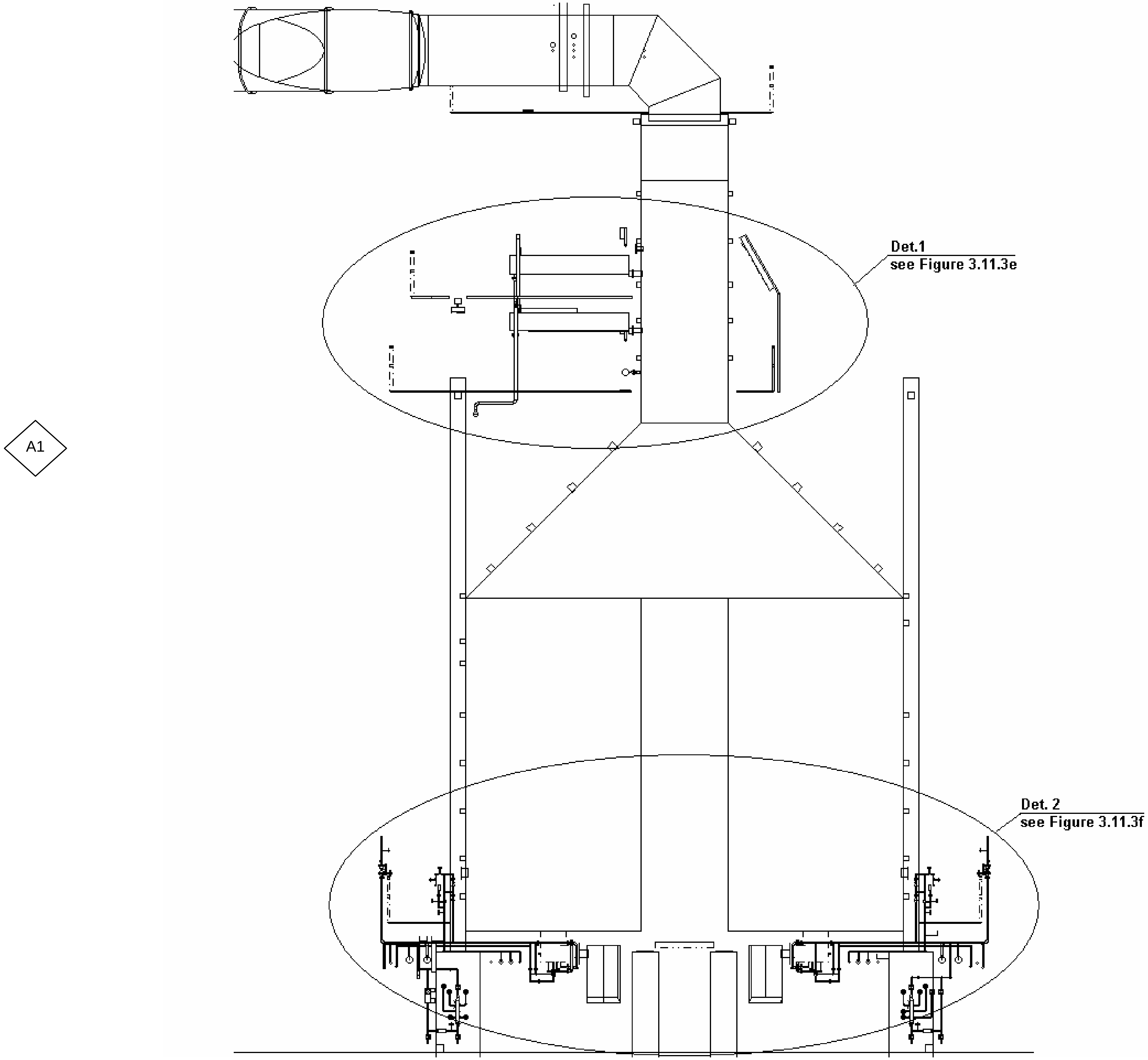

Figure 3.11.3.d *Example of typical installations of piping around box heaters*

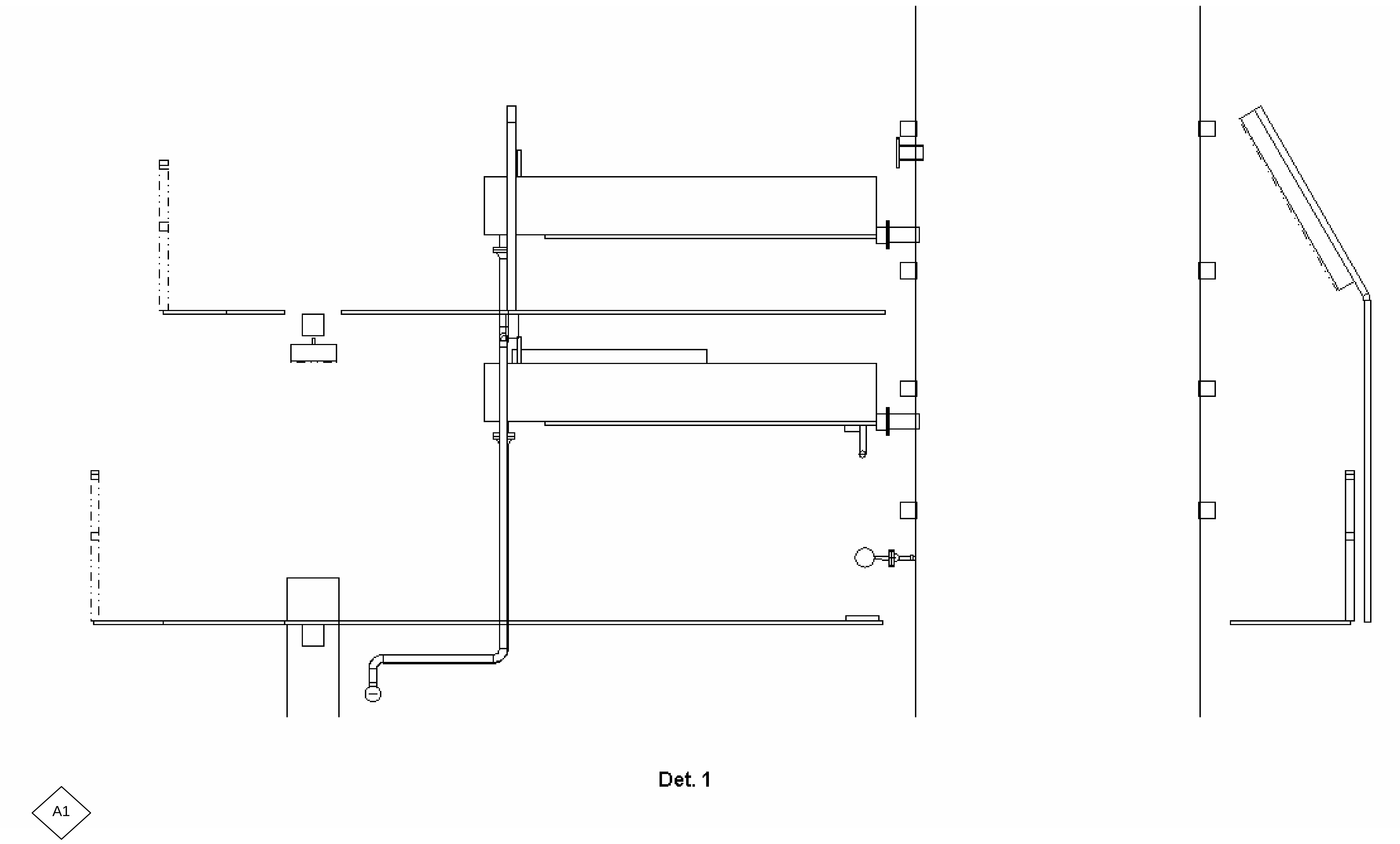

Figure 3.11.3.e *Example of typical installations of piping around box heaters*

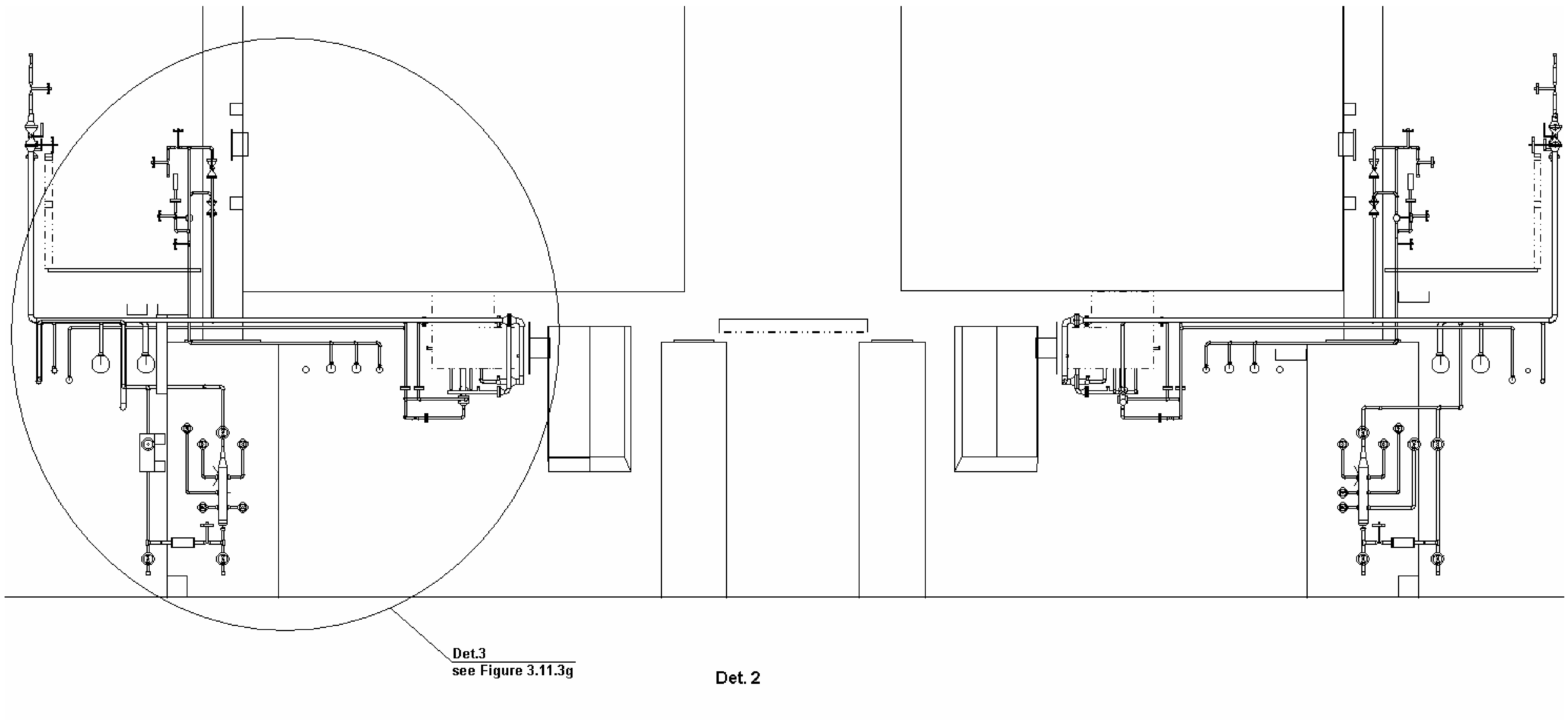

Figure 3.11.3.f Example of typical installations of piping around box heaters

A1

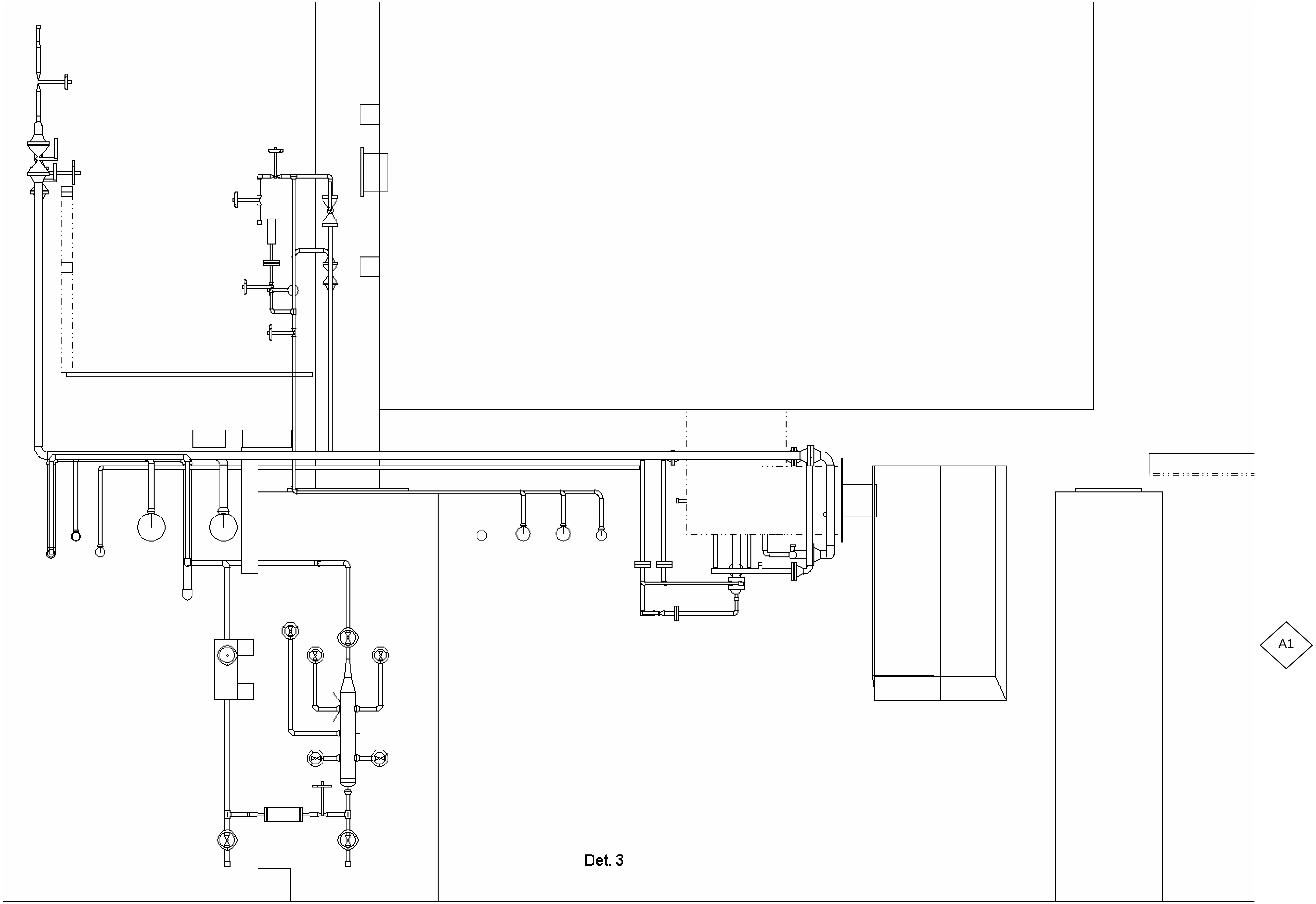

***Figure 3.11.3.g** Example of typical installations of piping around box heaters*

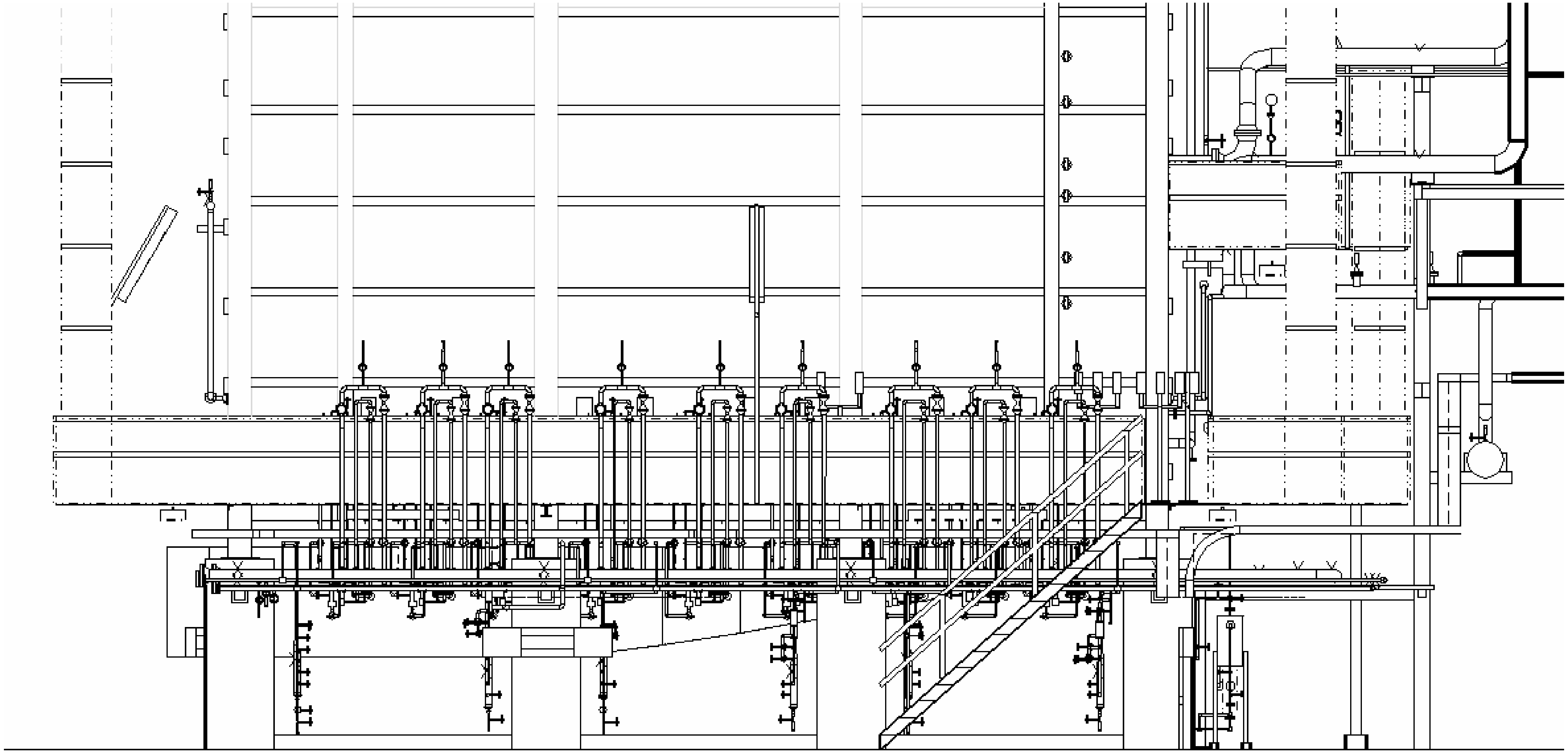

Figure 3.11.3.i *Example of typical installations of piping around box heaters*

A1

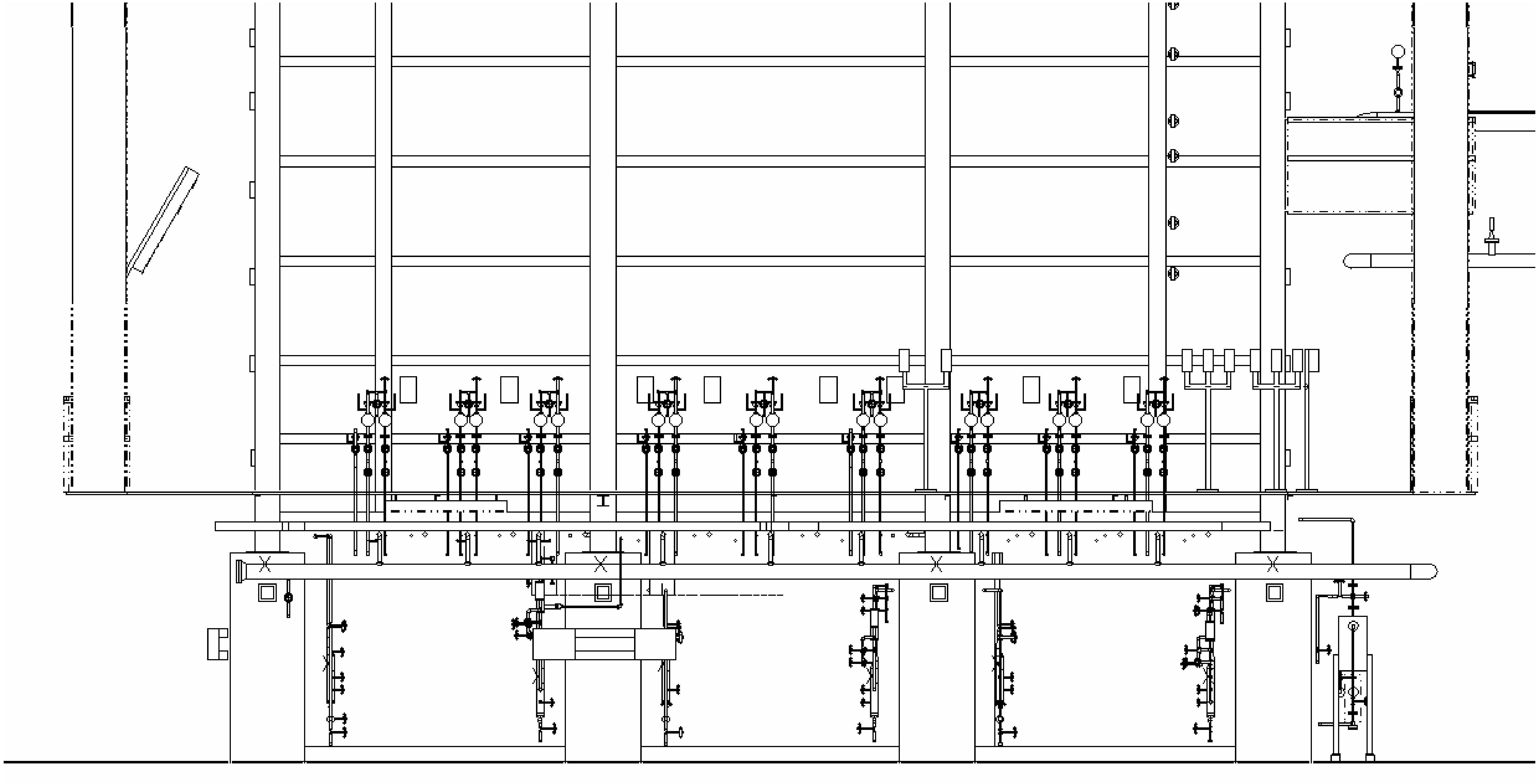

Figure 3.11.3.l *Example of typical installations of piping around box heaters*

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3.12 Loading Arms

Loading arms are the item of equipment/machine that allows loading or unloading of the product to the various treatment phases from the storage area to transportation on land road.
There is no particular limitation for the installation of piping, except the general principle of providing sufficient space for the manoeuvring and access required for service and maintenance.
Some typical sketches of piping installation are given, as an example, in *Figure 3.12.1*. For execution of fire fighting piping on land road loading arms, see *Figure 3.12.2*.

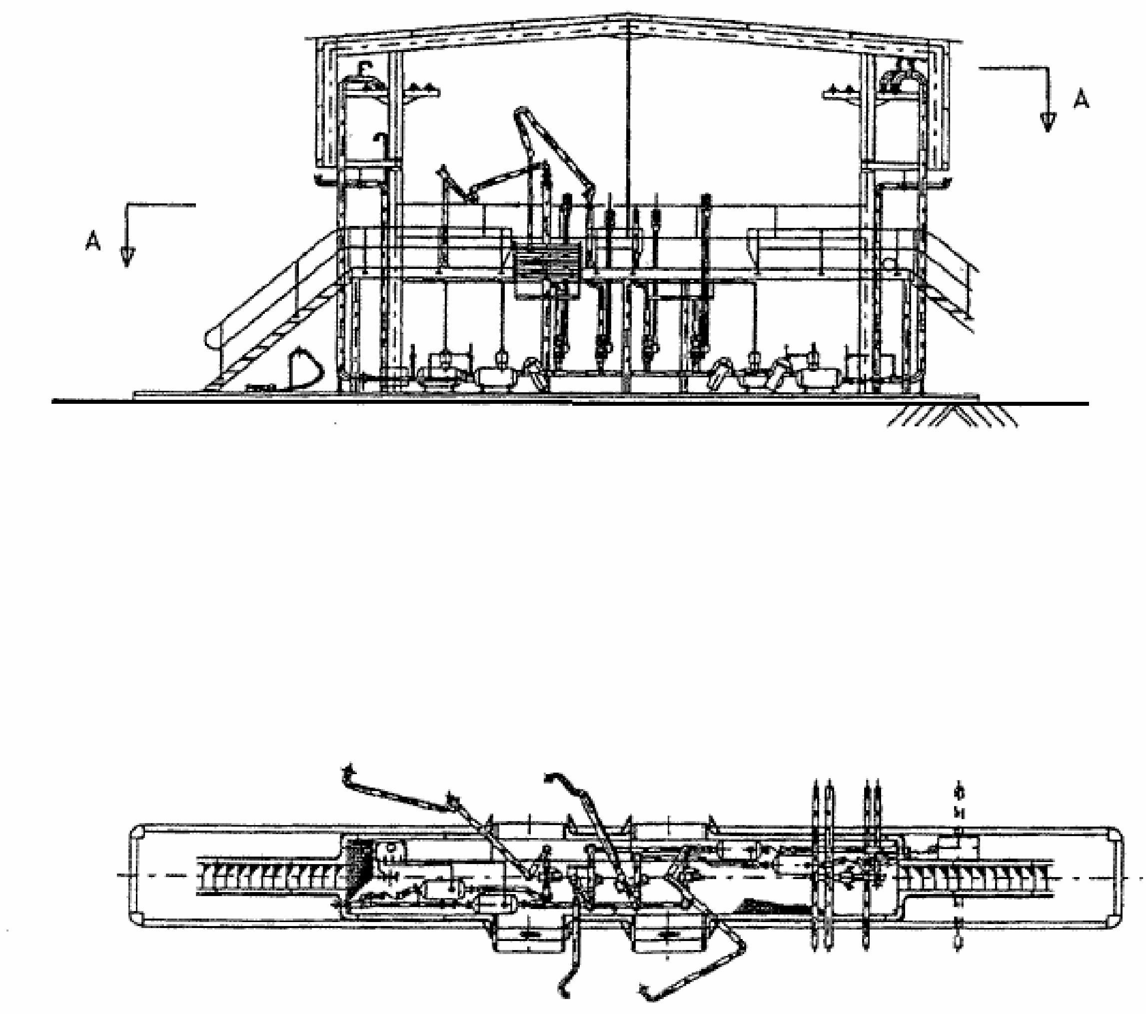
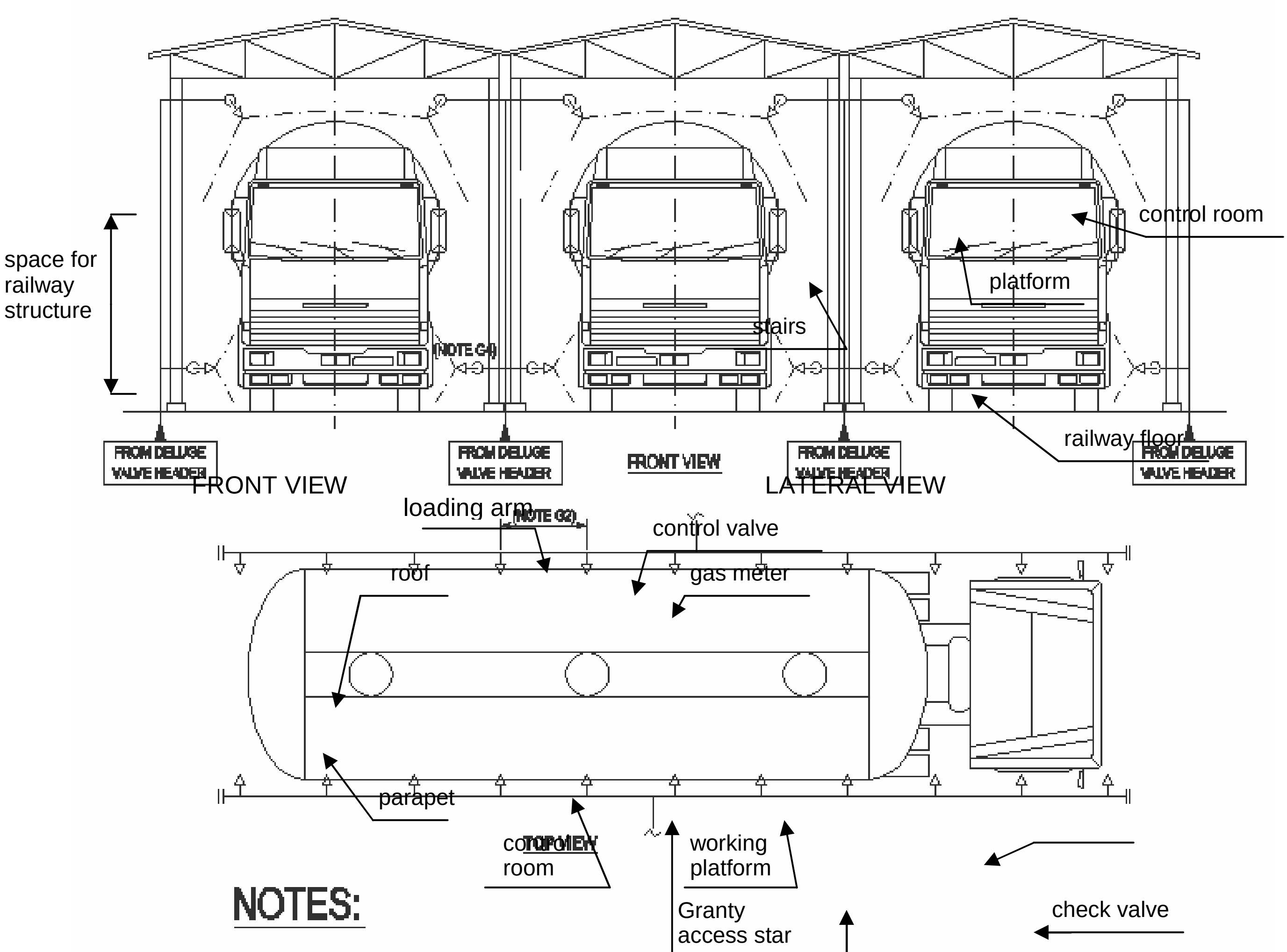


Figure 3.12.1 Typical sketch of piping installation on gantry for land road loading arms



NOTES:

G1- WATER SPRAY SHALL BE APPLIED TO LPG TRUCK LOADING AREA AT A NET RATE OF NOT LESS THAN 10,2 (l/min/m2) OF GROUND FLOOR AREA.

G2- THE HORIZONTAL DISTANCE BETWEEN NOZZLES SHALL BE SUCH THAT SPRAY PATTERNS MEET OR OVERLAP AT THE PROTECTED SURFACE.
THIS DISTANCE SHALL BE INCLUDED BETWEEN 1,8 m AND 2,1 m.

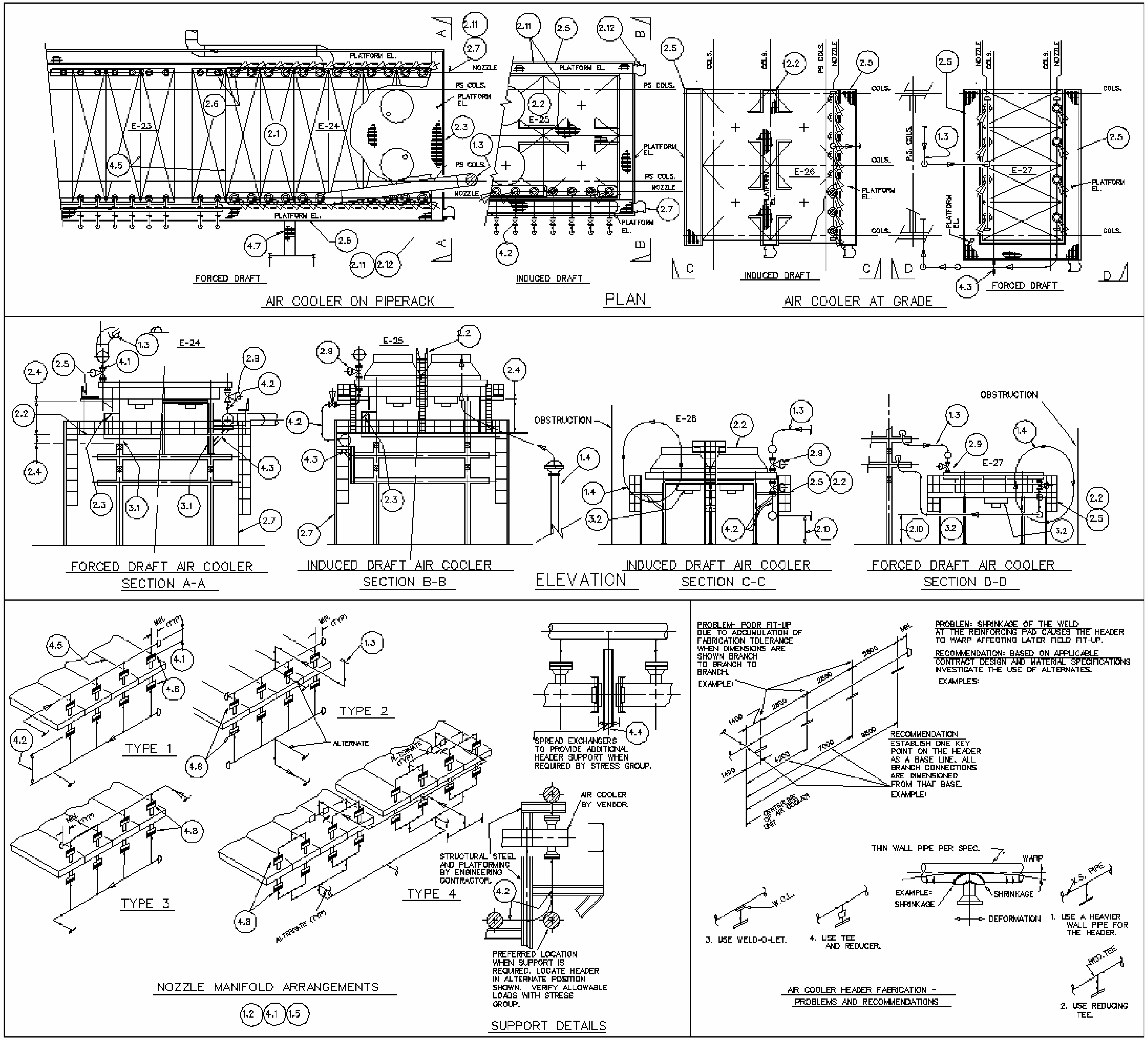
G3- GENERALLY, FROM GOOD ENGINNERING PRACTICE, WATER SPRAY NOZZLES SHALL BE DIRECTED RADIALLY TO THE TRUCK TANK.

G4- ADDITIONAL SPRAYER TO PROTECT TRUCK WHEELS.

Figure 3.12.2 *Water spray nozzle typical arrangement for lpg truck loading areas*

3.13 Air Coolers

Unless otherwise indicated, the inlet/outlet manifolds shall be installed vertically so that the lines are selfdraining, and don't obstruct the upper part of the air cooler (avoid passing over bundles, etc.) and allow the disassembly of the various components (hoods, tube bundles, etc.). Moreover, sufficient clearance shall be left for disassembly of the bundles.
The length, route and support of the lines connecting between the main header and the cooler nozzles shall be checked with STRESS.
Figure 3.13.1 shows a typical sketch of piping installation.



PURPOSE:

THIS PIPING STANDARD DRAWING IS INTENDED AS A GUIDE ONLY AND IS NOT INTENDED TO DEPICT ALL DESIGN POSSIBILITIES. FOR ADDITIONAL DESIGN AND LAYOUT REQUIREMENTS, REFER TO POINT 3.13.

DEFINITIONS:

FORCED DRAFT AIR COOLERS: THE FAN IS LOCATED BELOW THE TUBES AND "PUSHES" THE AIR UP PAST THE TUBES. INDUCED DRAFT AIR COOLERS: THE FAN IS LOCATED ABOVE THE TUBES AND "DRAWS" THE AIR PAST THE TUBES.

APPLICATION:

USING THIS STANDARD FOR SUGGESTED ARRANGEMENTS, THE APPLICABLE CONTRACT SPECIFICATIONS AND P&ID, THE DESIGNER SHALL CONSIDER THE FOLLOWING:

1.0 PROCESS:

1.1 AIR COOLERS ARE TO BE LOCATED AS CLOSE AS POSSIBLE TO RELATED EQUIPMENT AND VESSELS WITHIN AVAILABLE SPACE ABOVE OVERHEAD PIPERACKS OR AT GRADE.

1.2 CONFIGURATION OF MANIFOLD PIPING IS BASED ON FLOW AND PRESSURE CONDITIONS AND IS ESTABLISHED ON P&ID. IN LIEU OF FIRM P&ID, THE ARRANGEMENTS SHOWN HERE MAY BE USED FOR PRELIMINARY CONFIGURATIONS. THE PREFERRED CONFIGURATION SHOULD BE ECONOMICAL WHILE SATISFYING SUPPORT, FLEXIBILITY AND PROCESS REQUIREMENTS.

1.3 INLET PIPING TO COOLERS USED IN VESSEL OVERHEAD CONDENSING SERVICES SHOULD NOT HAVE VAPOR OR LIQUID POCKETS.

1.4 CARE SHOULD BE TAKEN WHEN LOCATING AIR COOLERS TO PREVENT STARVATION OF AIR FLOW. RECYCLING OF AIR FLOW AND INGESTING HOT EXHAUST AIR FROM LOWER AIR COOLERS OR EQUIPMENT IS NOT ACCEPTABLE.

1.5 NOT RECOMMENDED PARALLEL PIPING ARRANGEMENTS SHALL BE REVIEWED BY PROCESS ENGINEERING. MANIFOLD CONFIGURATIONS SHALL BE IDENTIFIED ON THE P&ID.

2.0 OPERATION/MAINTENANCE:

2.1 AIR COOLERS SHOULD BE GROUPED TOGETHER WHEN PRACTICAL TO SHARE COMMON SUPPORT STRUCTURE AND OPERATING PLATFORMS.

2.2 CLEARANCES AND ACCESSIBILITY SHALL BE PROVIDED IN ACCORDANCE WITH POINT 3.13.

2.2.1 INDUCED DRAFT COOLERS MAY HAVE ACCESS PLATFORMS BELOW THE TUBES TO SERVE FAN DRIVE AND GEAR AS WELL AS ABOVE THE TUBES TO SERVE THE FAN.

2.2.2 FORCED DRAFT COOLERS MAY HAVE ACCESS PLATFORMS BELOW THE TUBES TO SERVE THE FAN DRIVES AND GEARS.

2.3 ON AIR COOLERS MOUNTED OVER PIPERACKS THE PLATFORM SERVICING THE DRIVERS SHOULD BE DESIGNED TO PERMIT REMOVAL OF THE MOTOR AND GEAR BY DOLLY TO AN AREA WHERE IT CAN BE LOWERED TO GRADE BY DAVIT. LOCATION AND QUANTITY OF DAVITS TO BE DETERMINED DURING DETAILED ENGINEERING.

2.4 ELEVATIONS FOR AIR COOLERS MOUNTED OVER PIPERACKS ARE ESTABLISHED CONSIDERING CLEARANCE ABOVE THE PIPING ON TOP PIPE SUPPORT DECK AND HEAD ROOM CLEARANCE ABOVE THE FAN DRIVE PLATFORM.

2.5 PLATFORMS ARE REQUIRED AT BOTH HEADER BOXES.

2.6 IT IS PREFERRED TO LOCATE ADJACENT COOLERS TO ALIGN INLET NOZZLES ON A COMMON CENTERLINE AND VERIFY ALIGNMENT OF PLATFORM.

2.7 LADDERS FROM GRADE SHALL BE LOCATED IN AN ACCESSIBLE LOCATION, CLEAR OF OPERATION AND MAINTENANCE AISLE AT GRADE (SIDE STEP PREFERRED).

2.8 LOUVER CONTROLS WHEN SPECIFIED ARE PREFERRED TO BE LOCATED ON HEADER BOX PLATFORMS. VERIFY LOCATION REQUIREMENTS IN CONTRACT OR CLIENT SPECIFICATIONS.

2.9 INLET/OUTLET VALVES WHEN INDICATED ON THE P&ID ARE TO BE ACCESSIBLE FROM HEADER BOX PLATFORM.

2.10 ELEVATIONS OF GRADE MOUNTED AIR COOLERS ARE USUALLY DETERMINED BY HEADROOM CLEARANCE UNDER CONNECTING PIPING. IF THE COOLER COLUMN AREA IS FENCED, THE ELEVATIONS ARE DETERMINED BY HEADROOM CLEARANCE UNDER THE COOLER.

2.11 TWO MEANS OF ACCESS WILL BE PROVIDED FOR ESCAPE AT AIR COOLER PLATFORMS. MAXIMUM DISTANCE FROM ANY LOCATION ON AIR FAN PLATFORMS TO AN ESCAPE LADDER WILL BE 15000. THERE WILL BE NO DEAD ENDS IF PLATFORM IS LONGER THAN 3000.

2.12 STAIR ACCESS SHALL BE PROVIDED AT STEEL STRUCTURES SERVING AIR COOLERS.

3.0 EQUIPMENT SUPPORT

3.1 AIR COOLER SUPPORTS MAY BE CONCRETE OR STEEL. DURING LAYOUT, CHECK WITH THE STRUCTURAL AND MECHANICAL EQUIPMENT ENGINEERS FOR METHOD TO BE USED ON THE PROJECT.

3.2 FAN DRIVE MOTOR AND GEAR DRIVE SHALL BE SUPPORTED FROM THE COOLER. FACTORS AFFECTING THIS MAY INCLUDE CLIENT PREFERENCE, MANUFACTURES STANDARD, SOIL CONDITIONS AND HEIGHT OF THE UNIT ABOVE GRADE.

4.0 PIPING LAYOUT:

4.1 INLET HEADERS ARE CLOSE COUPLED TO NOZZLES WITH FEED ENTRY PREFERABLY LOCATED IN THE CENTER OF THE HEADER FOR MORE EVEN DISTRIBUTION. CHECK WITH PROCESS ENGINEERING.

4.2 OUTLET HEADERS, IF ON THE SAME END AS INLET NOZZLES, ARE NOT CLOSED COUPLED DUE TO DIFFERENTIAL TEMPERATURE OF INLET AND OUTLET PIPING. CONSULT WITH THE STRESS ENGINEER TO DETERMINE THE AMOUNT OF OFF-SET REQUIRED TO SATISFY ALLOWABLE FORCE REQUIREMENTS.

4.3 VERIFY ALLOWABLE LOADS PRIOR TO ATTACHING PIPE SUPPORTS TO PLATFORMS AND STEEL.

4.4 FOR LONG LARGE O.D. HEADERS, ADDITIONAL SUPPORTS AND RESTRAINT MAY BECOME NECESSARY DUE TO THE TYPE OF AIR COOLER CONSTRUCTION, PIPE WEIGHT OR WIND LOAD. IN MORE SEVERE CONDITIONS, COOLERS MAY REQUIRE SPREADING TO FACILITATE EXTENDING COLUMNS TO PROVIDE HEADER SUPPORTS, CONSULT WITH STRESS ENGINEER DETERMINING PRELIMINARY REQUIREMENTS AFFECTING PIPING LAYOUT.

4.5 SPACE WILL BE REQUIRED BETWEEN HEADER BOX AND SUPPORT FRAME FOR EXPANSION. CONSULT WITH STRESS ENGINEER FOR REQUIRED CLEARANCES.

4.6 INSTALLATION OF THRUST BLOCKS ON ALL MULTI-BUNDLE INSTALLATIONS SHOULD BE CONSIDERED. STRESS ENGINEERS APPROVAL IS REQUIRED.

4.7 ACCESS FROM ADJACENT STRUCTURE TO BE PROVIDED WHEREVER POSSIBLE.

Figure 3.13.1 *- Typical sketch of a piping installation on an Air Cooler*

4 PIPING COMPONENT INSTALLATION

This section gives instructions for the installation of piping components (valves, orifice flanges, traps, hoses, sample connections, etc.) that have particular positioning requirements to assure safety, functionality, and accessibility for operation and maintenance.

4.1 Manually actuated operation/shut-off valves

The operation/stut-off valves shall be installed so as to assure easy access for operation and maintenance.
Figures 4.1.1/2 show the recommended installation ranges, considering that the valves shall be reached from the ground level or platform.
Valves with a ND of 1-1/2" (40 mm) or smaller may also be operated using a ladder.
In order to avoid possible product leaks and to assure correct functionality, valves will be oriented with the handwheel upwards. The optimal range for installation goes from a valve with a vertical stem (handwheel upwards) to a valve with a horizontal stem. The inclination is defined considering that both the handwheel and the stem shall not obstruct access ways and platforms.
The exception to this rule is blow-down lines for which the optimal installation of valves is a valve mounted vertically with the handwheel downwards. This is to avoid possible plugging of the line due to breakage of internal parts of the valves.
Operating valves will not be installed on piperack except when they are located at battery limit, where a service walkway is normally provided. To avoid stagnation of liquid in the lines, block valves (root valves) provided on the branches from header will be installed, as far as possible, immediately downstream of the branch so that they can be actuated from walkways close to the piperack or from portable ladders.
To assure handwheel manoeuvrability, valves with a horizontal stem axis will have a maximum elevation of 2200 mm and the handwheel bottom is not more than 2 m above the ground or platform level.
If this value is exceeded, various installation criteria can be followed, such as:

- Valves with ND ≥ 2" (50 mm): the handwheels are provided with a chain. In this case the valves will be orientated so that the chain is not in the way. The chain shall reach up to 1 m from the ground or platform level;
- Valves with ND ≤ 1-1/2" (40 mm): the valves will be made operable by positioning them close to stairs or ladders, if available, or by means of portable ladders.

In areas where personnel access is foreseen, the installation of valves provided with chains shall be avoided as much as possible in order to not be in the way and preference shall be given to alternative solutions (e.g.: changing the piping route).
When a group of valves are operated from a platform, the last shall be at an elevation that permits access to the handwheels of the large diameter valves (therefore higher), providing appropriate extensions for any valves whose handwheels are not accessible.
Valves provided with a chain or extension will be identified on piping layout in order to allow, from the beginning, easy identification for the relevant Material Take-Off.

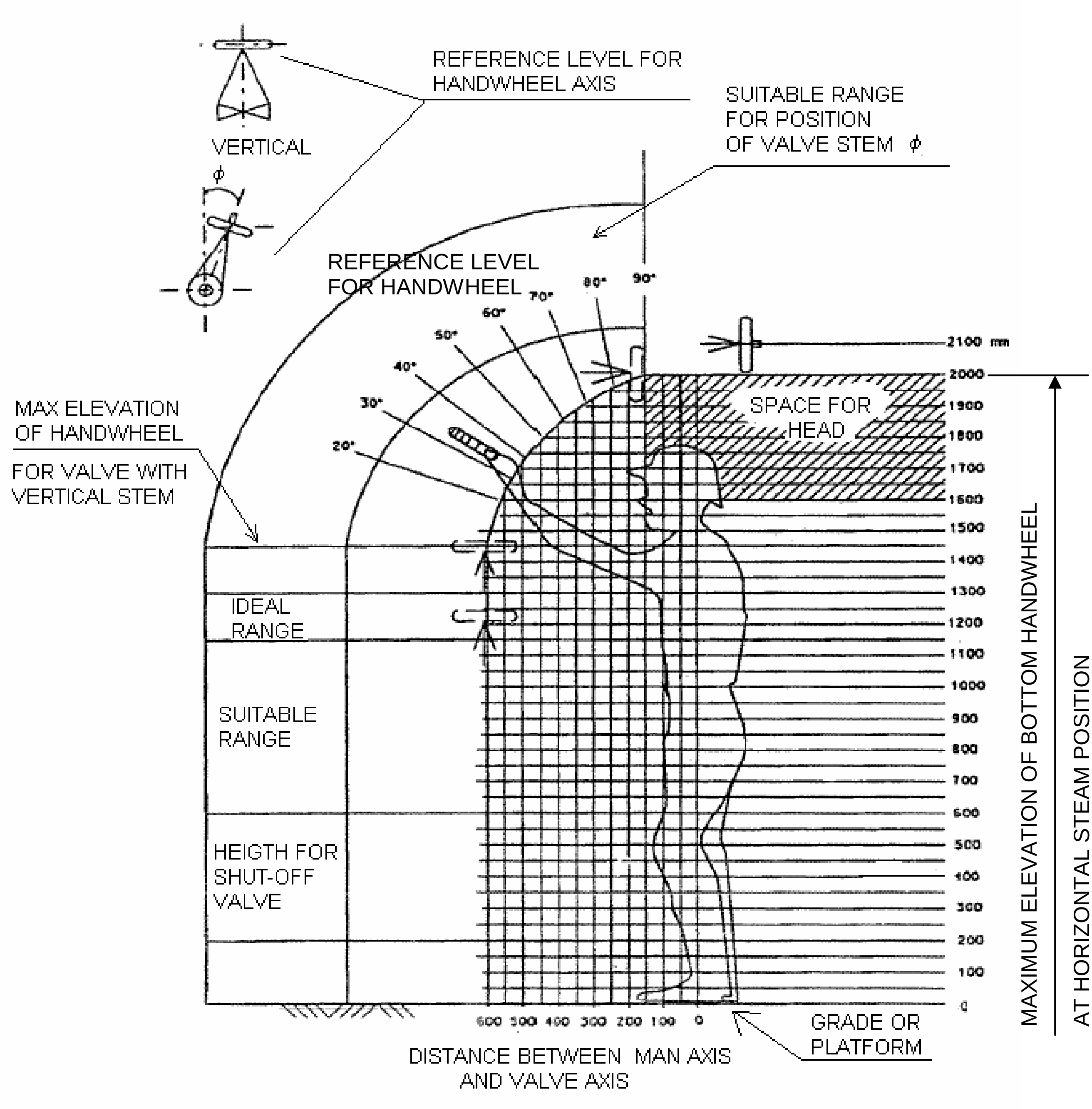


***Figure 4.1.1** Valves with vertical stem*

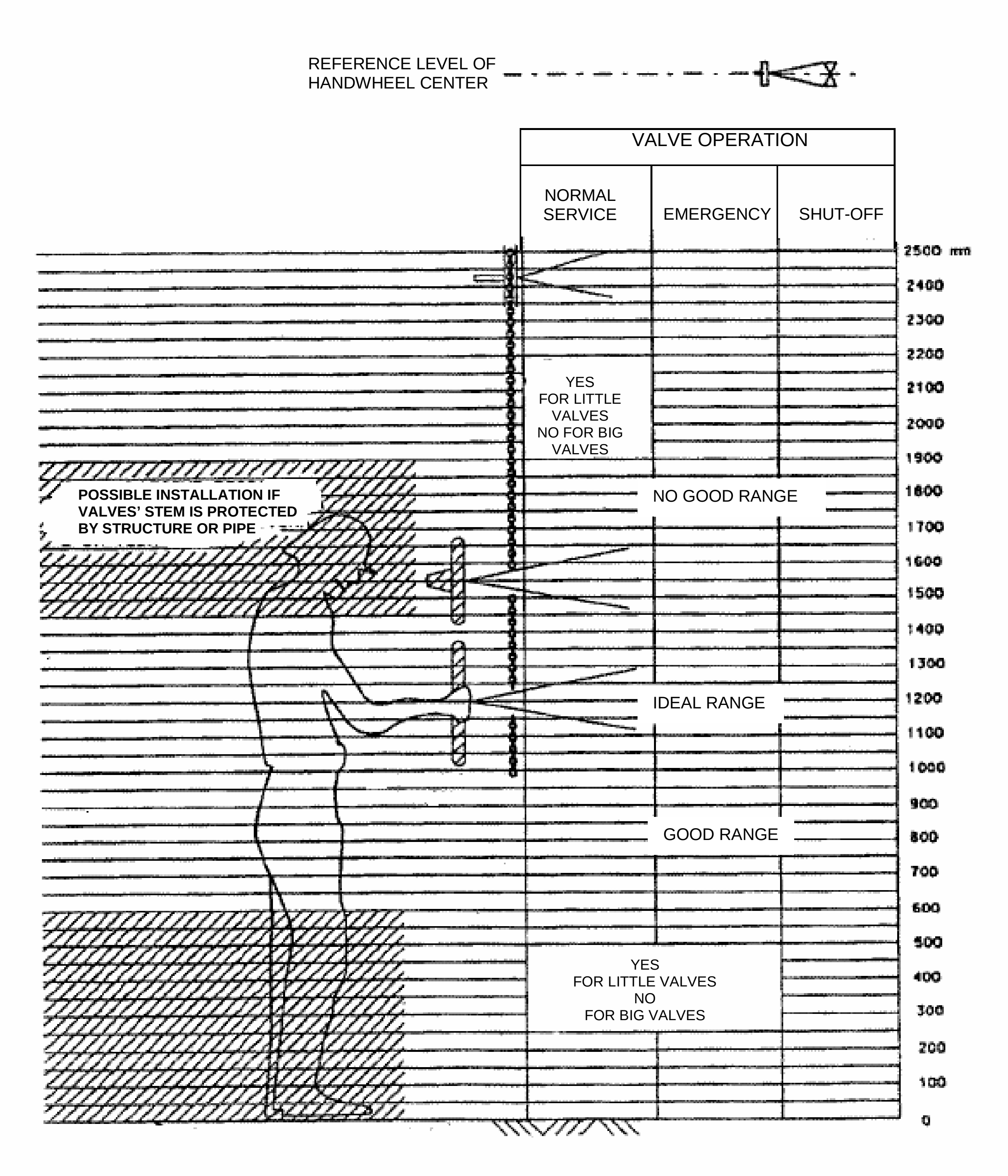
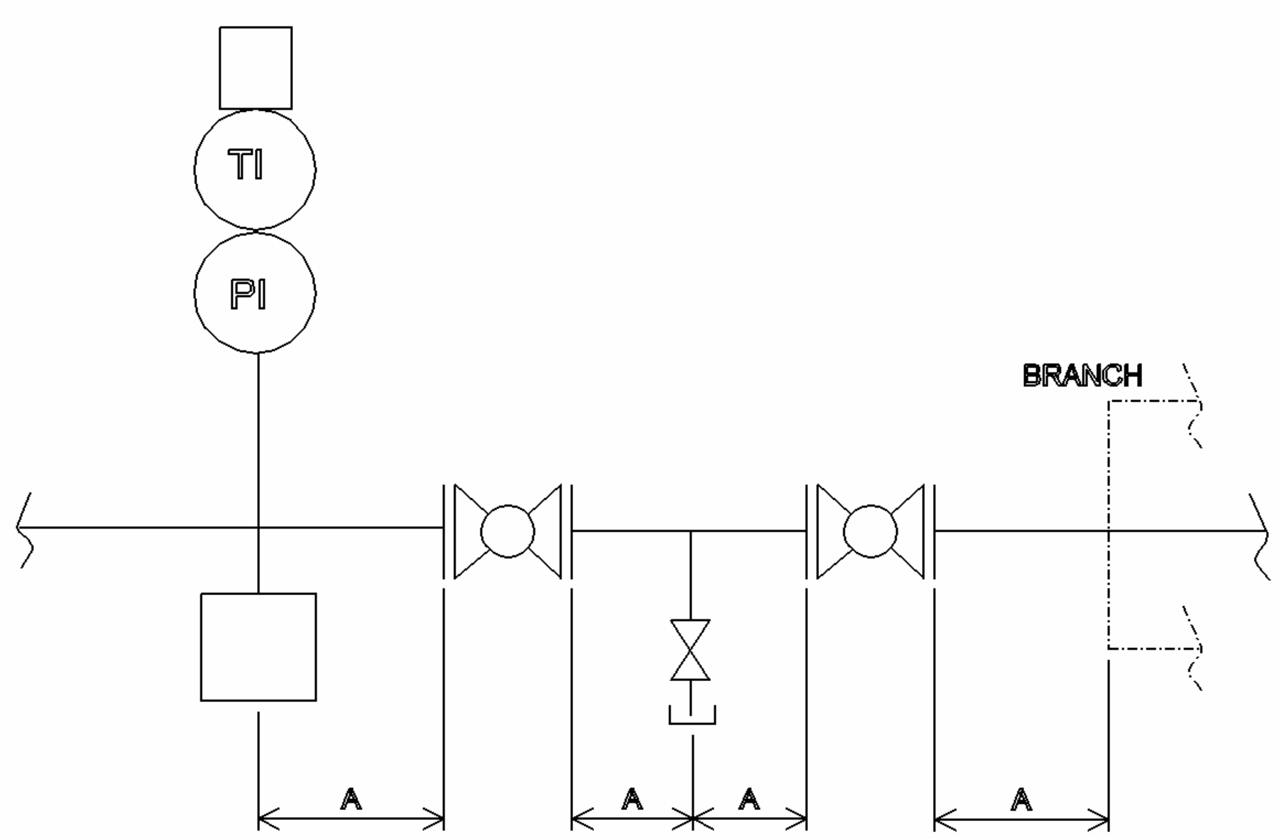


Figure 4.1.2 *Valves with horizontal stem*

In case of valves that are rarely operated (e.g.: only for unit shutdown) permanent accessibility is not required, and it is sufficient to assure the possibility of access by means of portable ladders or temporary scaffolding (check with PRC which valves fall within this category).
In order to not influence their functionality, when valves are used at termination points (e.g.: vents, drains, purges, etc.) they will be provided with blind flanges or plugs.
When on P&ID Diagram we find two ball valves connected directly in this case for maintenance and dismantly of the valve, it’s necessary to provide a spool piece between the valves (see *Figure 4.1.5*).



Ø (inch)	*A (mm)*
≤4”	*300*
6÷10	*400*
≥12”	*500*

Figure 4.1.5 *Minimum distance between branch and valve*

When on piping class is required a butterfly valve wafer type and on P&ID Diagram there is required a spectacle blind near the butterfly valve, it’s necessary to provide a separate companion flange for operability of spectacle blind (see *Figure 4.1.6*).

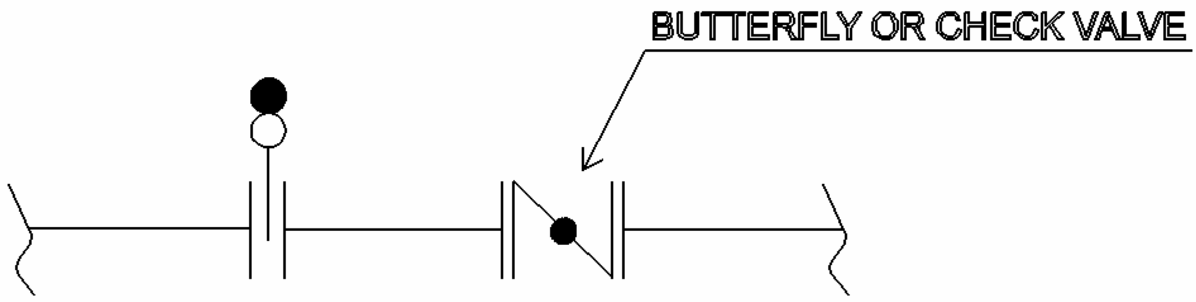


Figure 4.1.6 *Example of arrangement for butterfly valve*

4.2 Check Valves

Except in the cases envisaged in *Paragraph 3.8*, check valves will preferably be installed horizontally. Check valves can be installed vertically in the case of ND ≤ 6" (150 mm) provided that the flow is directed upwards. For valves with a ND ≥ 8" (200 mm), the vertical installation involves the verification of the inside pressure (a low pressure cannot open the valve clapper.

Installation in a horizontal or in a vertical position is determined, not only according to the pipe route optimization requirements, but also on the type of valve construction. In fact the type of drop check valves, provided on the high pressure lines of Urea units, can operate only if they are installed in a vertical position, with an upward flow, while valves with a lamellar flow (e.g.: Hoerbiger) operate better if they are installed in a horizontal position.

When on piping class is required a check valve wafer dual plate type and on P&ID Diagram a spectacle blind near the check valve is required, it’s necessary to provide a separate companion flange for operability of spectacle blind (see *Figure 4.1.6*).

4.3 Control Valves

Normally control valves are installed within a group called control valve set.

This group, in addition to the control valve, includes:

- The shut-off valves of the control valve;
- The by-pass with the relevant valve;
- Drains with the relevant valves;
- All the components (pipes, flanges, elbows, etc.) necessary for the connection.

Figure 4.3.1 shows some possible installations of control valve sets as well as different solutions for the arrangement of the relevant valves. In all cases the following should be remembered:

- Prefer installations with the control valve installed on the lower part (which is more accessible);
- Prefer installations with minimum overall dimensions;
- Avoid, especially when RJ type flanges are used, installation with the control valve in line between two shut-off valves.

The control valve sets are installed on a line considering that:

a) All control valve sets shall preferably be located on the ground floor so as to make access and control easier for Operators, also to facilitate maintenance work and the use of mobile lifting equipment;

b) When the development of the piping layout makes installation on the ground uneconomic, or when PRC has set some constraints for the elevations, the control group shall be positioned so as that the valves are easily accessible form the working floor (structure platforms or slabs);

c) For load capacity reasons, the control groups shall not be installed on columns platforms, except when there are elevation constraints (point b); in this case the loads bearing on the platforms shall be checked.

The control valve sets will be installed, as far as possible, close to walls, hand rails, pillars, sides of equipment, in order to:

- Not interfere with the passage ways, manoeuvring areas and clearance for maintenance;
- Protect the control valve and the actuator.

When installing valves in control valve sets it is necessary to consider that:

- The handwheels of shut-off and by-pass valves will be orientated so as not to be in the way of access in front of them;
- The control valve shall always be positioned at a pipe bottom elevation of 500 mm. This space is required to remove the bottom and actuator without disassembling the valve. Check in any case with SMAUT, on the basis of valve dimensions, that a clearance of at least 300 mm is left from the bottom of the control valve;
- The control valve sets, that are part of an interacting instrumentation system (e.g.: heater combustion control system), will be grouped in order to concentrate the area of control for Operators' control and to reduce the lengths of the controls and connections between the various groups;
- The sizing of the shut-off and by-pass valves, according to the line diameter, shall be those specified on the relevant P&I D.;
- It is necessary to provide, upstream and downstream of the control valve, two pair of flanges to allow disassembly of the valve when it has been supplied with threaded or socket-welding ends. In case of reduction nipples, these are positioned between the flanges and the valve so that the smaller threaded end is inserted directly into the valve;
- It is preferible to install eccentric reducers, when they are required, directly downstream and upstream of the control valve, in order to facilitate drainage of the line and to avoid the formation of deposits;
- A drain, as shown on the P&I D. shall always be installed upstream of each control valve, more precisely between the first shut-off valve and the control valve. This drain is used to empty the line after the hydraulic test and to depressurise the line whenever it is necessary to disassemble the valve while the unit is in operation;
- In addition to what is stated in point b), the control valve requires, above the actuator, a clearance of at least 300 mm to permit disassembly of the actuator and of the support bonnet. This space shall be checked with SMAUT.

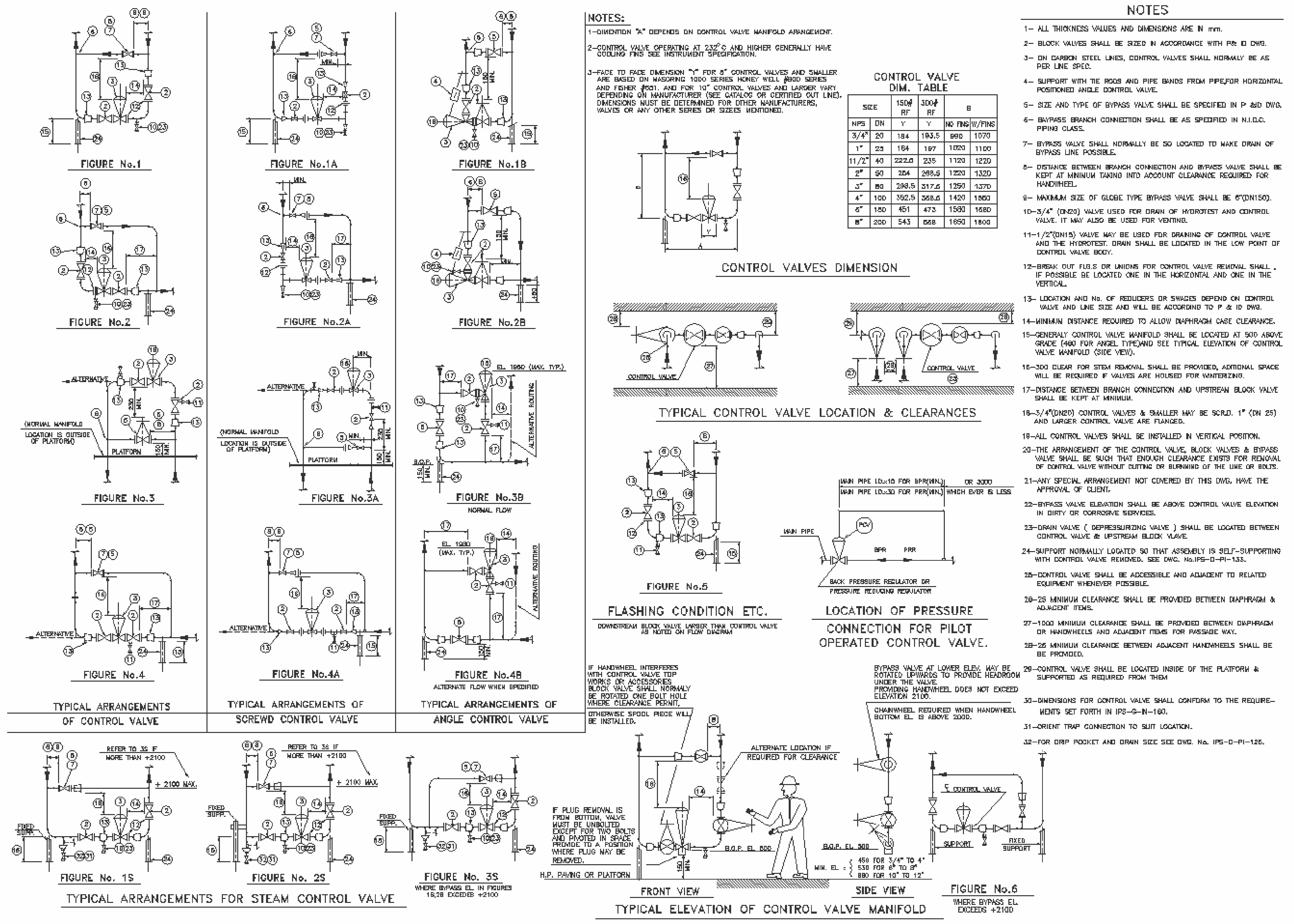
Pipes connected to control valves shall be supported so as to stable in the event of valve dissasembly.

Normally, angle control valve shall be installed with the product inlet in the opposite side to the plug. In some cases (e.g.: steam desuperheater valves, injection valves, etc.) the

valves are installed with the inlet in the same side as the plug (laterally in relation to the cap). In any case the type of installation required shall be checked with SMAUT.
Three-way control valves shall be installed so that they can be easily removed. Insert, if necessary, a couple of flanges shall be inserted in one of the two horizontal pipes, after the elbow closest to the control valve.
Control valves with a local level controller shall be installed so that the indicator instrument is clearly visible.
In the case of control valves without control sets, a handwheel for manual operation is normally provided. In this case:

- Check the position of the handwheel with SMAUT;
- Orientate the valve so that the handwheel is easily accessible.

In the case of particular control valves (Mokveld, Ball, Camflex, etc.) the orientation of the valve and of its accessories shall be defined with SMAUT.
For a typical arrangement for control valves see *Figure 4.3.1.*



CONTROL VALVE DIM. TABLE

SIZE		150# RF	300# RF	B	
NPS	DN	Y	Y	NO FINS	W/FINS
3/4"	20	184	193.5	980	1070
1"	25	184	197	1020	1100
11/2"	40	222.0	235	1120	1220
2"	50	254	266.5	1220	1320
3"	80	298.5	317.5	1250	1370
4"	100	352.5	368.5	1420	1550
6"	150	451	473	1560	1680
8"	200	543	568	1650	1800

Figure 4.3.1 *Typical arrangement for control valve*

4.4 Motorized Valves

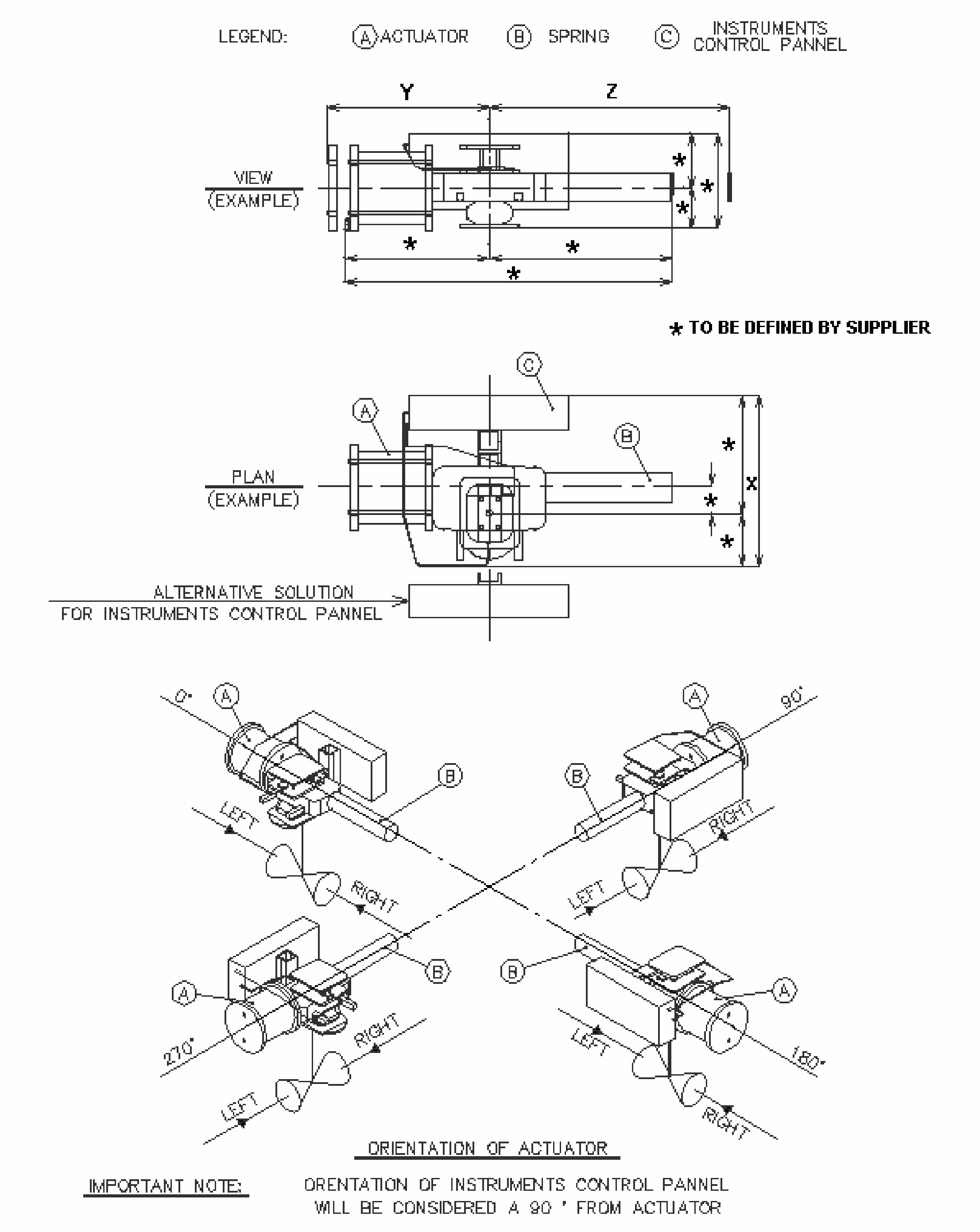
In case of motorized valves it is necessary to define the orientation of the stem and to notify this and other information (falling within piping scope) needed for purchasing to SMAUT.
This is done by engaging in the preparation of the relevant Project Specification issued by SMAUT.

4.5 Actuated Valves with/without Fire Proofing Protection

For pneumatic actuated or motorized valve, during modelling the dimensions of pneumatic actuator or electric motor shall be considered, see *Figure 4.5.1*.a/b.
SMAUT Department shall give the bill of actuated or motorized valves and, in the column of fireproofing shall fill out 'YES' for the valves for which the protection box shall be provided, or 'NO' in the other cases, see *Table 4.5.1*. In this table, moreover, it's necessary to define:

- 'Flow direction' , right or left;
- 'Orientation of instrumentation, 0°/90°/180°/270° as per *Figure 4.5.1.a/b*;
- 'Orientation of actuator', 0°/90°/180°/270° as per *Figure 4.5.1.a/b*;

The final dimensions of pneumatic actuator and motor, flow direction, orientation of instrumentation and orientation of actuator shall be checked in agreement with SMAUT Department.

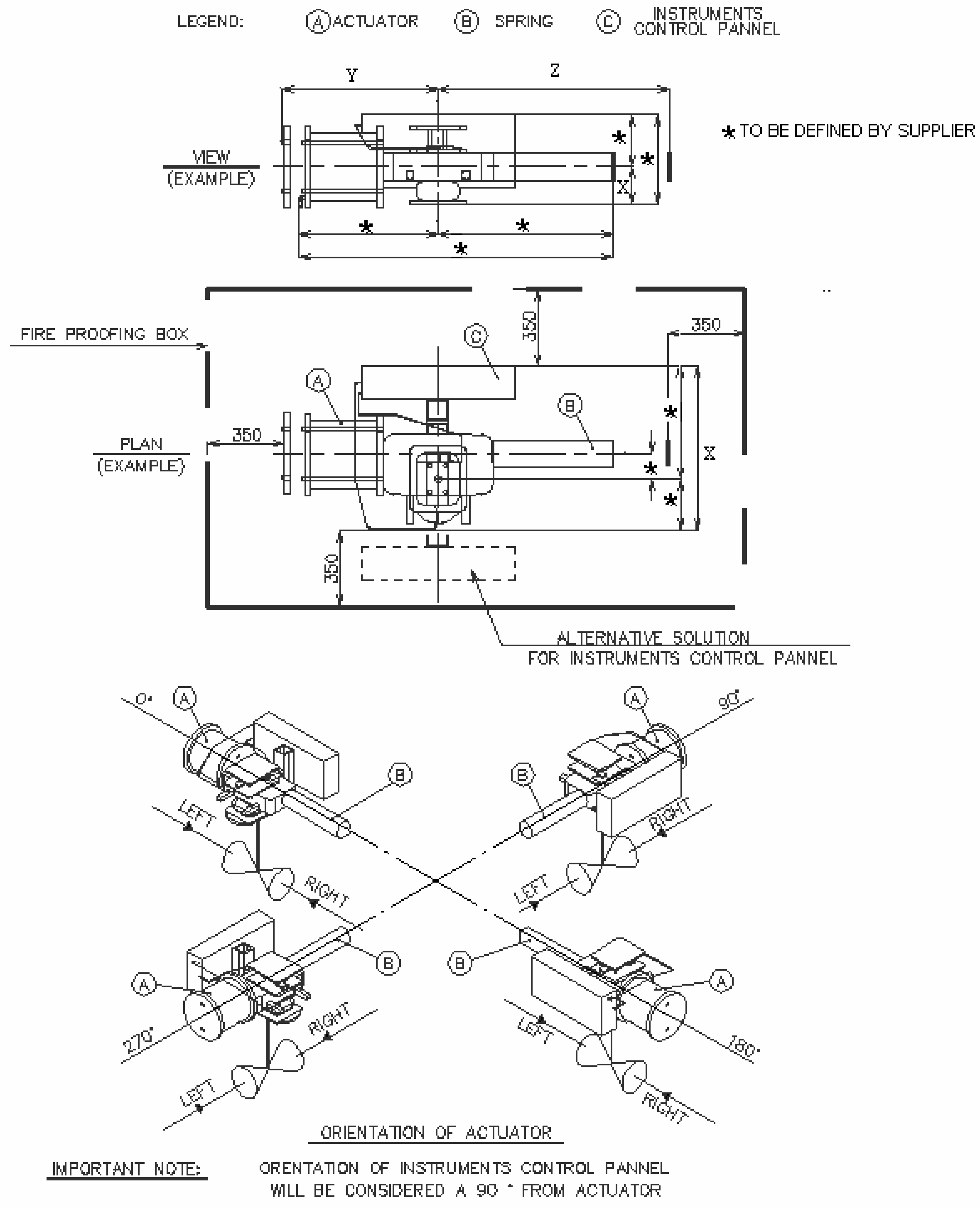


A1

EXTIMATED DIMENSIONS			
ND	**X**	**Y**	**Z**
≤ 4”	700	700	600
6”±10”	900	1000	1250
12”±16”	1200	1850	2000
18”±24”	1300	2000	2200
28”±32”	1350	2800	3200

Figure 4.5.1.a *Example of actuator and motorized valves without fire proofing protection*

A1



EXTIMATED DIMENSIONS			
ND	X	Y	Z
≤ 4”	700	700	600
6”±10”	900	1000	1250
12”±16”	1200	1850	2000
18”±24”	1300	2000	2200
28”±32”	1350	2800	3200

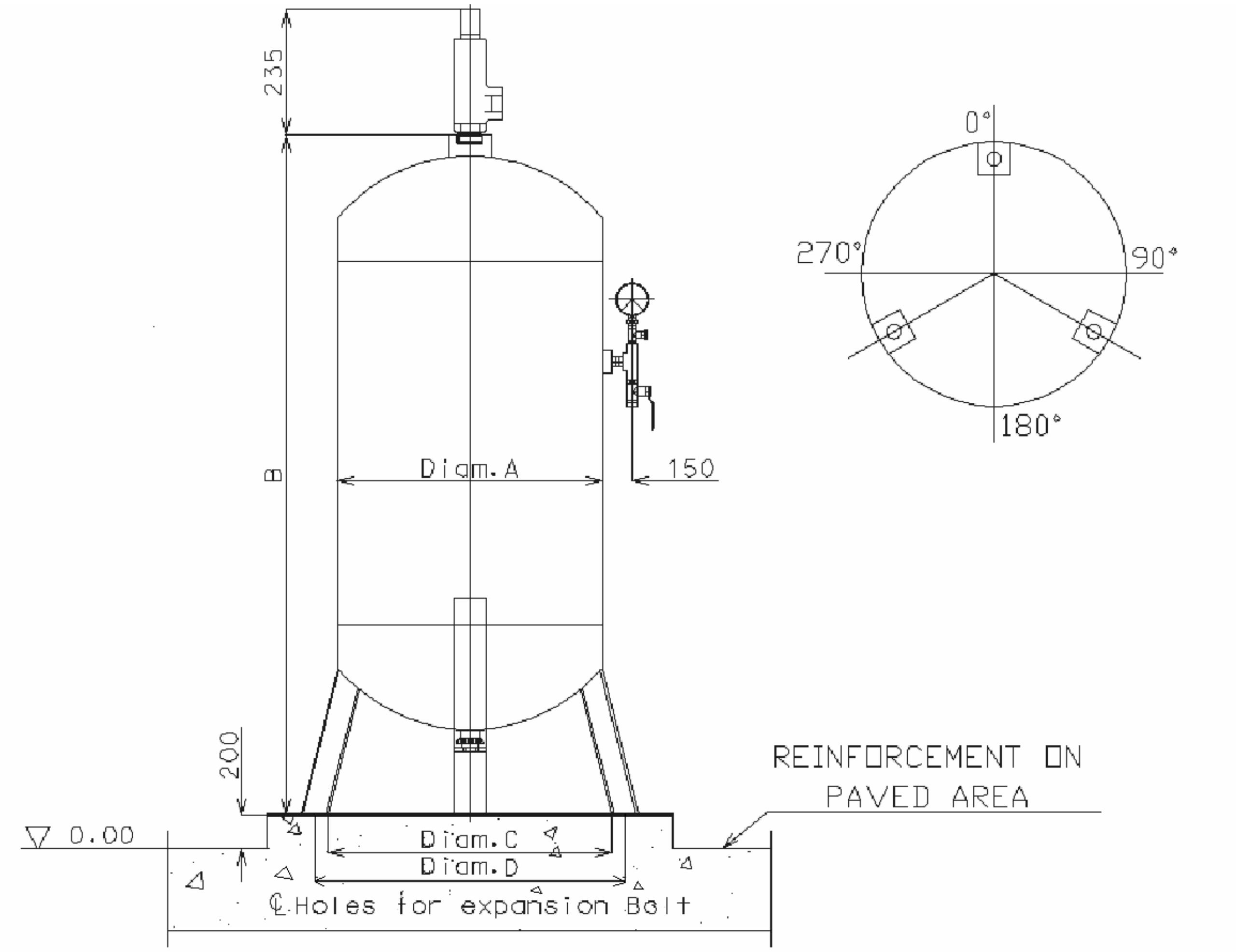
Figure 4.5.1.b *Example of actuator and motorized valves with fire proofing protection*

TAG_N.	SERVICE	P_ID	LINE_N.	INSTRUMENT TYPE	FIRE PROOFING	CLASSIFICATE D AREA WITH FIRE PROOFING	FLOW DIRECTION		ORIENTATION OF INSTRUMENTATION				ORIENTATION OF ACTUATOR			
							RIGHT	LEFT	0	90	180	270	0	90	180	270

Table 4.5.1 *Example of table for actuated and motorized valves*

4.6 Actuated Valves with emergency air storage vessels

For some actuated valves, an emergency air storage vessels (see *Figure 4.6.1*) shall be provided, its position shall be defined in agreement with SMAUT Department
The dimensional drawing shall be defined by SMAUT Department.
TUB Department shall send the length of pipes between air storage vessel and actuator to SMAUT Department, in order to check the diameter of connecting pipe.
The final position and of dimensions of air storage vessels shall be checked in agreement with SMAUT Department.



CAPACITY (Lt.)	A (mm)	B (mm)	C (mm)	D (mm)	WEIGHT (N)
*	*	*	*	*	*

All information shown with * shall be defined by SMAUT Department

Figure 4.6.1 *Example of air storage vessel*

4.7 Safety Valves

Safety valves will be installed so as to assure easy access for periodical checks, maintenance, or disassembly. Valves will be accessible for fixed or mobile lifting equipment (hoists, monorails, cranes, etc.).
Spring type valves will be installed with stem in vertical position.
When the valve discharge is connected to a closed circuit (blow-down), discharge into the header shall be from the top so as to create natural drainage.
Safety valves will be located as close as possible to the equipment or lines that they have to protect. When this is not possible (a distance of more than 3 m), it is necessary to inform SMAUT and to send a sketch with the approximate dimensions of the line route to PRC which will check the necessity to increase the diameter of the inlet line to the safety valve in order to avoid malfunctioning of the valve due to pressure drops (see API RP 520).
The pipe spool at the outlet of a safety valve, that discharge directly into the atmosphere shall be extended at least 3 m above the floor level of the highest platform or of the highest equipment located within a radius of 15 m, or at 30 m in the case of inflammable products or in presence of naked flames (e.g.: heater burners, etc.). The pipe spool at the outlet of a safety valve that discharge process liquids, or in any case contaminated liquids, shall be routed to the closest drain funnel (see *Figure 4.7.1*)
Each pipe discharging into the atmosphere shall be provided with a drain hole (ø 10 mm) at the lowest point. In case of hazardous fluids, a ND 3/4" drain shall be provided and connected to the ground.
The terminal part of pipes discharging into the atmosphere shall be cut at 45°. If necessary this discharge can be curved in order to direct the discharge away from any equipment and to send it in the right direction.
The layout of discharge piping from the safety valve to the blow-down header shall be sufficiently flexible to prevent excessive stress on the valve. Connection to the blow-down header shall be made from the top and have an inclination of 45° in the flow direction (see *Paragraph 3.1.3*).
Install a thermal expansion relief valve (generally ND 3/4" x 1") in each circuit subject to heating which can be shut-off. This valve shall be provided on each pipe length installed on pipeways, piperacks, etc., where there is the possibility that the product, at the liquid state, remaining trapped, for example, between two block valves. This valve shall discharge into the atmosphere in a safety location (see *Figure 4.7.1*).
Moreover, a thermal expansion valve is generally provided on branch pipes from tanks that can be shut-off or between the inlet and outlet of an exchanger when both the lines are provided with block valves (see *Figure 4.7.1*).
In any case, the installation methods, the relevant conditions and compliance with the requirements of the applicable Codes and Standards shall be checked with PRC.
To reduce as far as possible vibrations which can damage the piping, assembly should be designed to anchor the valve to a platform or structure.
When shut-off valves are involved, these will be installed with the handwheel horizontal or orientated downwards. Moreover, a drain shall be provided between the shut-off valve and the safety valve.
In some cases, when dual safety valves are provided (one spare to the other), the shut-off valves will be provided with an interlock system (mechanical or with keys) so as to have always a shut-off valve closed and the other one open (transflow type).

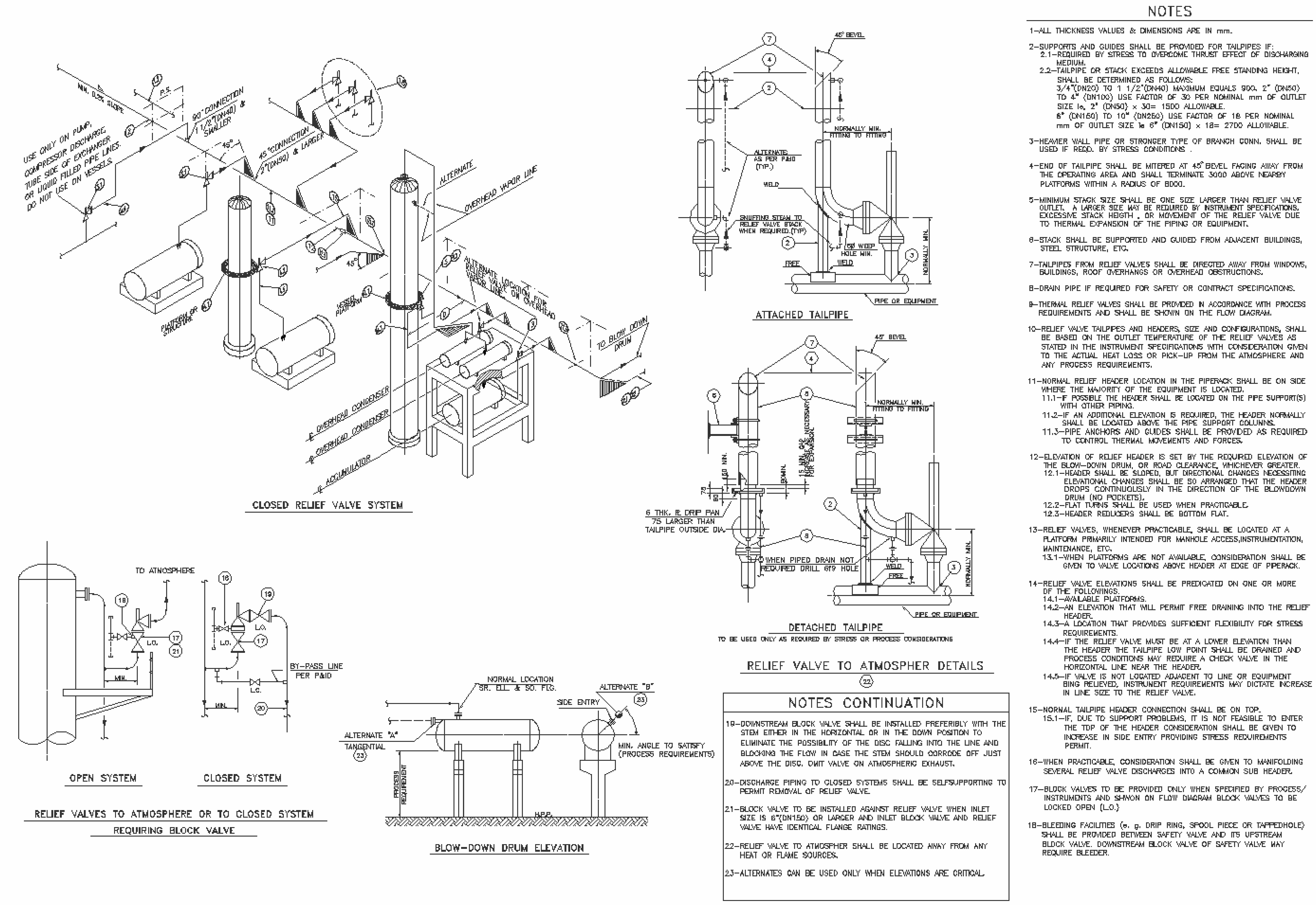


Figure 4.7.1 *Example of Safety valve typical arrangement*

4.8 Orifice flanges and Annubars

When installing orifice flanges on piping, always leave sufficient straight lengths upstream and downstream of the orifice flanges to avoid flow turbolence which affects measuring efficiency.
To identify the straight lengths upstream and downstream of a calibrated flange, it is necessary to follow the indication of table attached to the Project Typical Assemblies Specification (see also Standard ISO 5167).
When installing an orifice flange it is necessary to have sufficient space to assemble (or disassemble) the connecting pipes to the instrument and to removing the disc.
For the location and orientation of measurement connections in relation to the axis of a horizontal pipe, it is necessary to refer to Project Typical Assemblies Specification.
An orifice flange can be installed in a vertical pipe, provided that an upward flow and the location is checked with SMAUT.
Orifice flanges for flow rate control (FIC or FRC) shall be located as close as possible to the related control valve.
Orifice flanges shall be accessible in the following ways:

- From the ground: up to an elevation of 3600 mm;
- From platform: when the elevation is over 3600 mm.

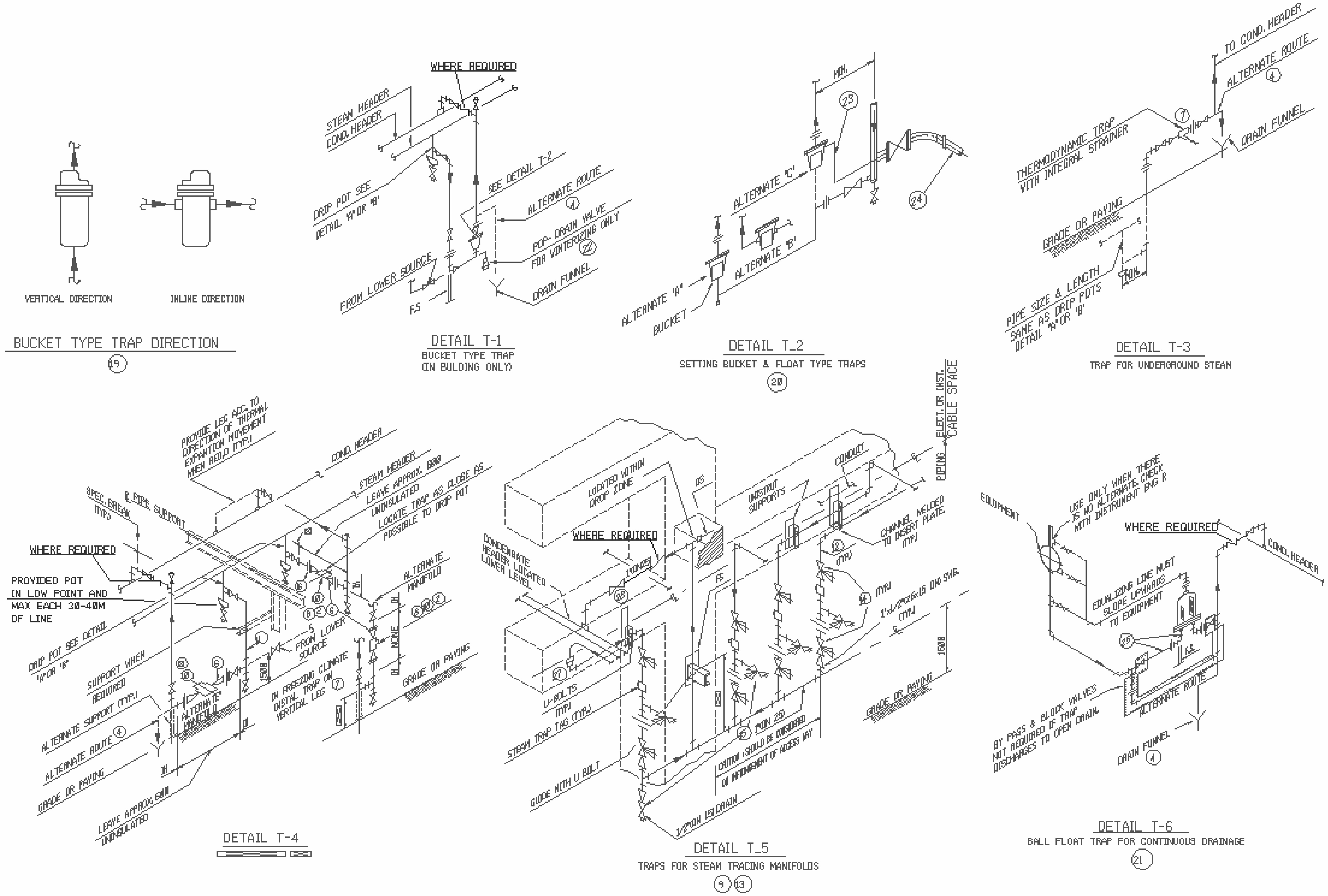
In case of "Annubar" and "Pitot tubes" type instruments, the fittings for connection to the line (as well the coupling to be welded on the line) are supplied together with the instruments. Therefore, the types of connections and sizes should be specified with SMAUT.

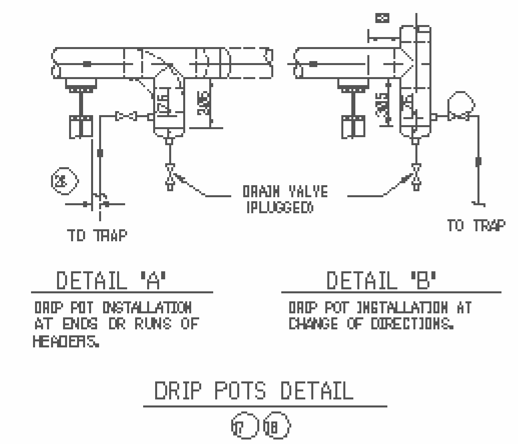
4.9 Steam Traps

Steam traps are automatically operated components that allow the extraction of the liquid originated by condensation of the steam conveyed in the piping and/or equipment.
The choice of type and characteristics of the users, the type of traps shall be in according with ‘Engineering standard for process design of steam traps’, IPS.E.PR.845; for the installation criteria see *Figure 4.9.1.*
Steam traps are generally installed on the working floor (on the ground or on platforms), with a line branching off from the following piping/equipment:

- Piping conveying steam: provide drip leg every 30 ÷ 40 m to be positioned preferably in the lowest points and/or at the terminal sections, as shown on the relevant distribution P&I D., for the installation of a connection line from the drip leg to the steam trap, see *Figure 4.9.1*;
- Steam piping at the inlet/outlet of turbines and control sets: provide the steam traps in the low points before and after the control and shut-off valves. *Figure 3.10.1* gives a sketch of a typical installation;
- Equipment, machines, tanks: provide steam traps wherever this is shown on the P&I D's.

A steam trap shall serve a single user (equipment or drip leg) and shall be installed to permit easy maintenance without having to shut-off the flow of the steam and condensate lines.
The drip legs are sized on the basis of the typical detail and table shown on the *Figure 4.9.1.*
The P&I D. also indicates the type of valves to be utilized.





DRIP POT CHART (26)

HEADER SIZE		POT SIZE		DRAIN VALVE SIZE	
NPS	DN	NPS	DN	NPS	DN
8" & SMALLER	200 & SMALLER	AS LINE SIZE		3/4"	20
10" THRU 16"	250 THRU 400	6"	200	1"	25
18" THRU 38"	450 THRU 950	12"	300	1 1/2"	40

NOTES

1-ALL THICKNESS VALUES AND DIMENSIONS ARE IN mm.

2-TRAPS SHOULD BE INSTALLED SO THAT THEY ARE WITHIN REACH OF GRADE, A PLATFORM, OR PORTABLE LADDER & ARE CLOSED TO AND PREFERABLY BELOW THE EQUIPMENT BEING DRAINED.

3-MAXIMUM SPACING OF TRAPS TO DRAIN STEAM HEADERS SHALL BE MAX 30-40 m

4-IN COLD CLIMATES AVOID DISCHARGING CONDENSATE TO OPEN DRAINS DIRECTLY WITHIN OPERATING AREA, AND UNDER STAIRWAYS AND LADDERS.

5-STRAINER NOT REQUIRED IF INTEGRAL WITH TRAP.

6-SWAGE AS REQUIRED FOR REDUCTION FROM LINE SIZE.

7-WHEN A TRAP IS USED FOR STEAM TRACING, THE STEAM AND CONDENSATE LINES MAY BE RUN TOGETHER IN A COMMON INSULATOR. SEE 'JOB SPECIFICATION FOR STEAM TRACING', 3034.00.EDF(.JSF.500.03.

8-WHEN A SIGHT GLASS IS PROVIDED, TRAP MUST BE INSTALLED IN A HORIZONTAL POSITION WITH GLASS IN FRONT OR IN A VERTICAL POSITION.

9-THIS DETAIL IS TYPICAL OF ALL STEAM TRACING TRAP INSTALLATION.

10-IF IMPULSE TRAP IS LOCATED IN HORIZONTAL, IT SHALL BE INSTALLED ON IT'S SIDE TO PREVENT FREEZING.

11-LOCAT BLOK VALVE HERE, WHEN LOCATION AT HEADER IS INACCESSIBLE FROM A PORTABLE LADDER.

12-VALVES AND PIPING AT TRAP SHALL BE SAME SIZE AS TRAP SIZE.

13-TRAP MANIFOLDING ARRANGEMENTS SHALL BE LOCATED ABOUT PIPE SUPPORT COLUMNS PER NOTE No. A1 REFER TO FIGURE 2.9.1.

14-FOR HEAT CONSERVATION SERVICE EACH TRAP SHALL HAVE A BLOCK VALVE UPSTREAM AND DOWNSTREAM OF TRAP. TRAPS WILL HAVE AN INTEGRAL STRAINER AND PLUGGED DRAIN.

15-IN WINTERIZING SERVICE NO BLOK VALVE WILL BE REQUIRED AT STEAM TRAPS, DRAINS WILL BE VALVED.

16- UNION SHALL NOT BE USED FOR STEAM PRESSURE MORE THAN 15 BAR.

17-USE WELD ELL. OR TEE, WHEN FULL SIZE, STUB-IN'S NOT PERMITTED.

18-INSTALL AT THE END OF HEADERS & AT CHANGE OF DIRECTION. NORMALLY NOT REQUIRED IN STRAIGHT RUNS.

19-STEAM TRAP CAN BE ORDERED WITH ANY DIFERENT INLET & OUTLET STEAM DIRECTION AS SHOWN.

20- CONDITIONS ARE APPLICABLE ALSO IN THE USE OF FLOAT TYPE TRAPS.

21-IF NO CONNECTION AVAILABLE ON EQUIPMENT, EQUALIZING LINE MAY BE CONNECTED INTO INLET PIPING AS NEAR TO EQUIPMENT AS POSSIBLE.

22-VALVE REMAINS CLOSED AT STEAM PRESSURE, OPENS WHEN PRESSURE DROPS.

23-WHEN TOP OF BUCKET IS ABOVE TURBINE OR EQUIPMENT CONNECTION BEING DRAINED REGULARLY BUCKET TRAP WILL NOT WORK BECAUSE IT S PRIME CAN NOT BE MAINTAINED. IN SUCH A SITUATION USE ALTERNATE "A" IF CLEARANCE BELOW CONNECTION IS ADEQUATE. WHEN CLEARANCE IS INADEQUATE USE ALTERNATE "B" (TRAP WITH SIDE INLET & OUTLET) OR ALTERNATE "C" IREGULAR BUCKET TRAP FURN WITH INTERNAL CHECK VALVE).

24-STEAM INLET OF TURBINE, THE SAME CONDITIONS APPLY TO ALL OTHER TRAPPED CONNECTIONS AT TURBINES PIPING & EQUIPMENT OR PIPING THAT IS BEING DRAINED THRU A BUCKET TRAP AT A POINT CLOSE TO GRADE OR PAVING.

25-STEAM TRAP INLET MUST BE LOWER THAN EQUIPMENT CONNECTION (SET TOP OF FLOAT MIN. 76 BELOW EQUIPMENT LOWEST POINT.)

26-ALWAYS CHECK DIRECTION OF THERMAL EXPANSION VERSUS PIPE SUPPORT.

27-VALVE TO BE INSTALLED AS CLOSE TO CONDENSATE HEADER AS POSSIBLE.

28-THE CHOICE OF TYPE AND CHARACTERISTICS OF THE USERS, THE TYPE OF TRAPS SHALL BE IN ACCORDINF WITH "ENGINEERING STANDARD FOR PROCESS DESIGN OF STEAM TRAP", IPS.E.PR.845

A1

Figure 4.9.1 *Example of steam trap*

4.10 Service Hoses

Service hoses are provided for cleaning and maintenance operations. They are connected by appropriate quick couplings to lines, with a ND ¾"(20 mm), conveying: compressed air (PLA - utility air), steam (LPS - low pressure steam), water (PWA - utility water) and, where required, nitrogen (NIT - utility nitrogen).

These lines are generally grouped in a bundle called utility station. This is to allow both a concentration of the necessary utilities at ground level and to allow a single support (see *Figure 4.10.1*).

The utility stations are normally provided in the following areas of the Plant:

- Off-site area: pump rooms, loading bays, effluent treatment, etc.;
- On-site area: piperack, compressor houses, columns, vessels, reactors, etc.

The utility stations are positioned so as to be able to cover the required area with hoses whose length (radius of action) is normally 15 m.

On columns of considerable height, the utility stations are positioned on the platforms for each manhole and so as to allow coverage of the upper and lower platforms by the hose radius of action (see *Figures 4.10.2/3*). In any case the maximum installation height of the hoses shall be in accordance with the pressure of the fluids conveyed.

Hose rack supports shall be provided on the piperack stanchion, close to the utility stations (see *Figure 4.10.4*).

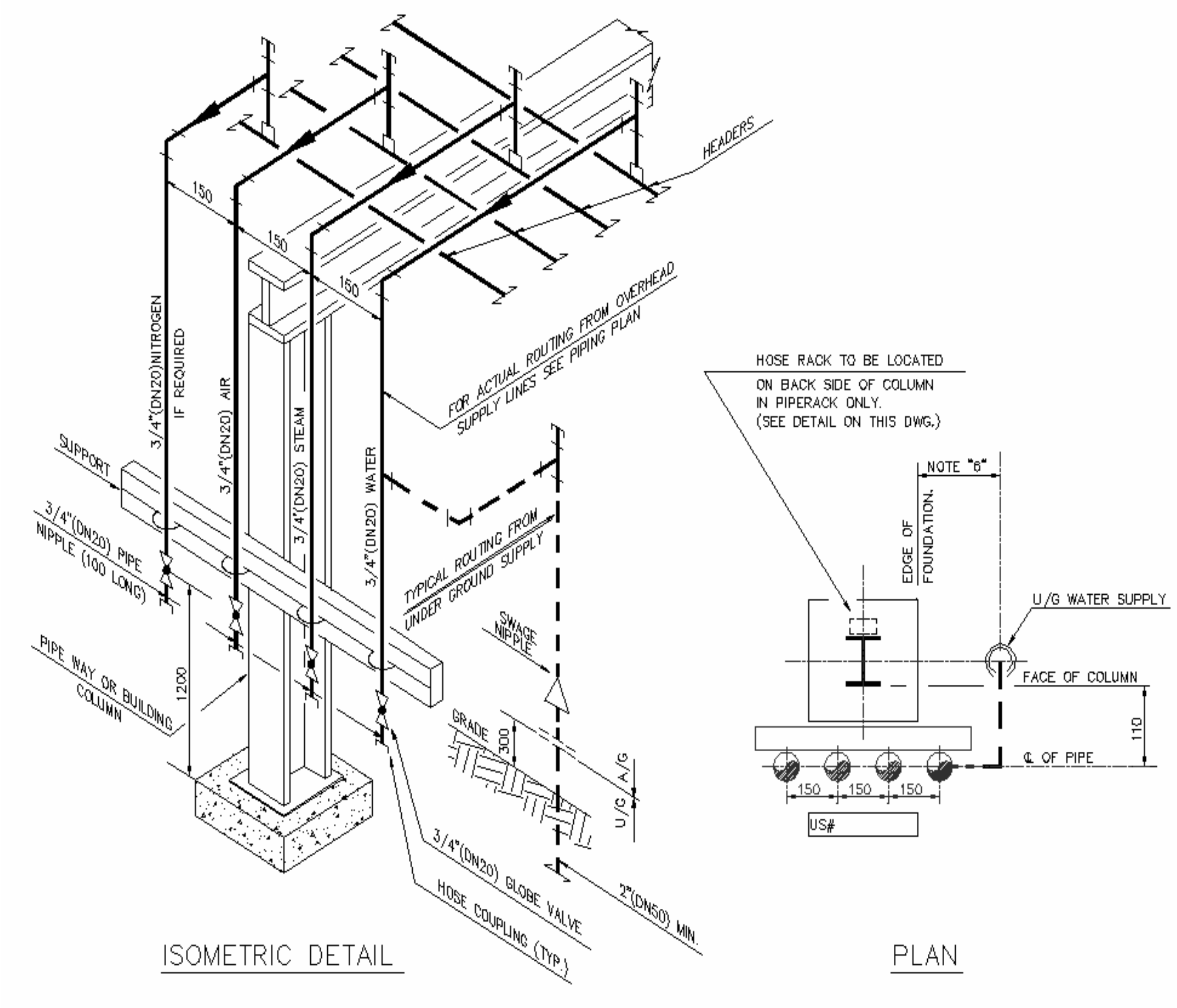


Figure 4.10.1 *Typical sketch of installation along a piperack*

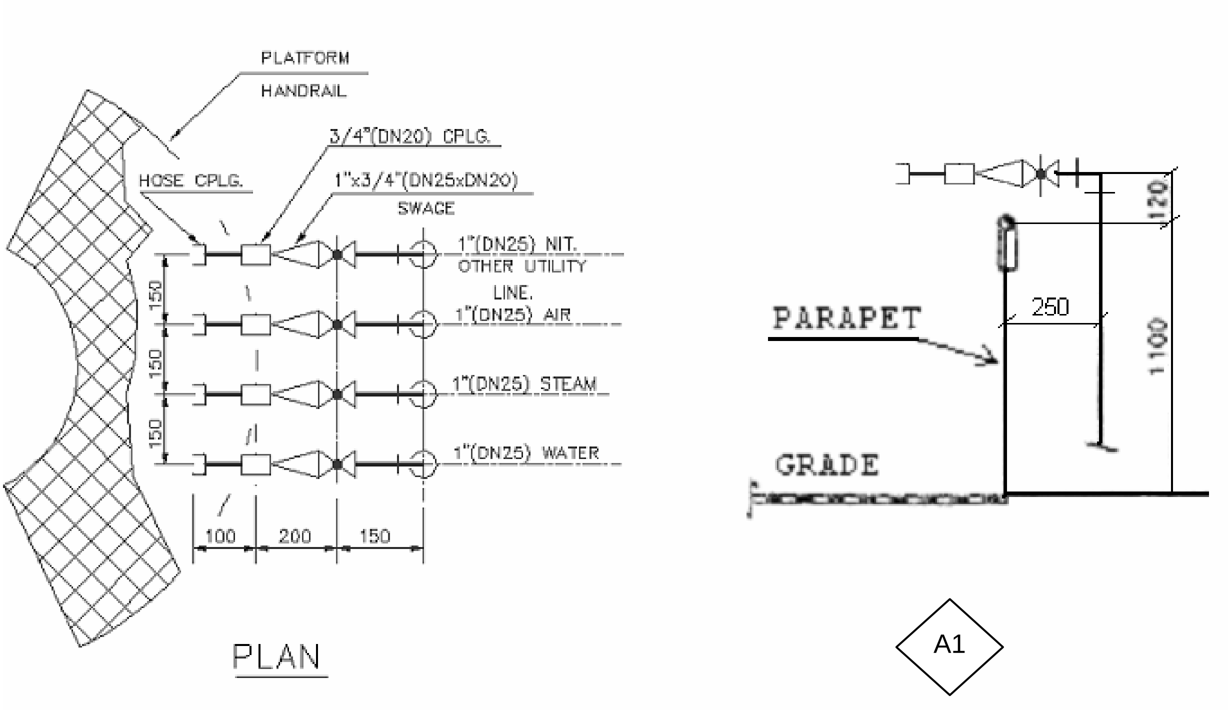


Figure 4.10.2 *Typical sketch of installation of utility station on platform*

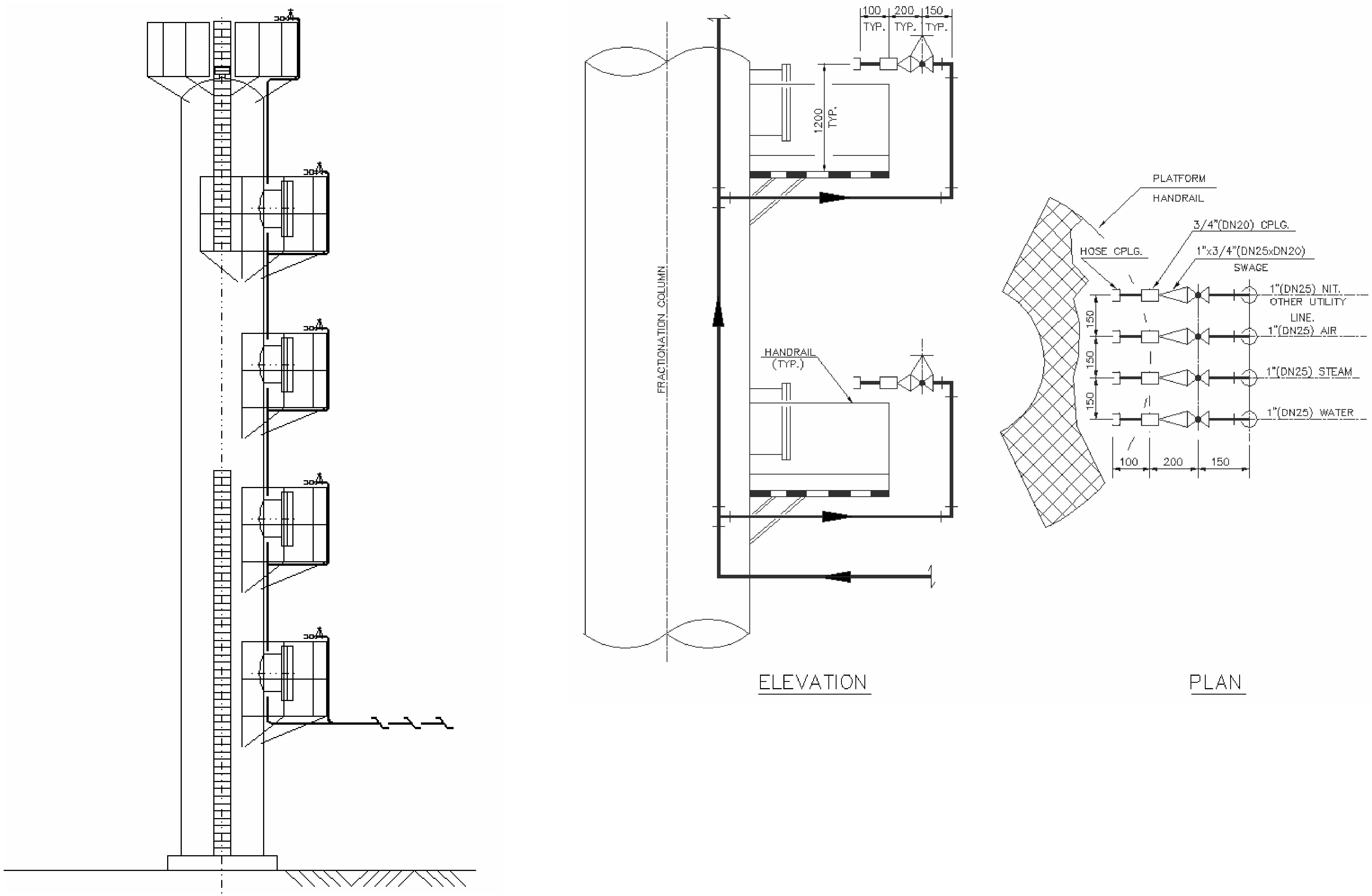


Figure 4.10.3 *Typical sketch of installation of utility station on column*

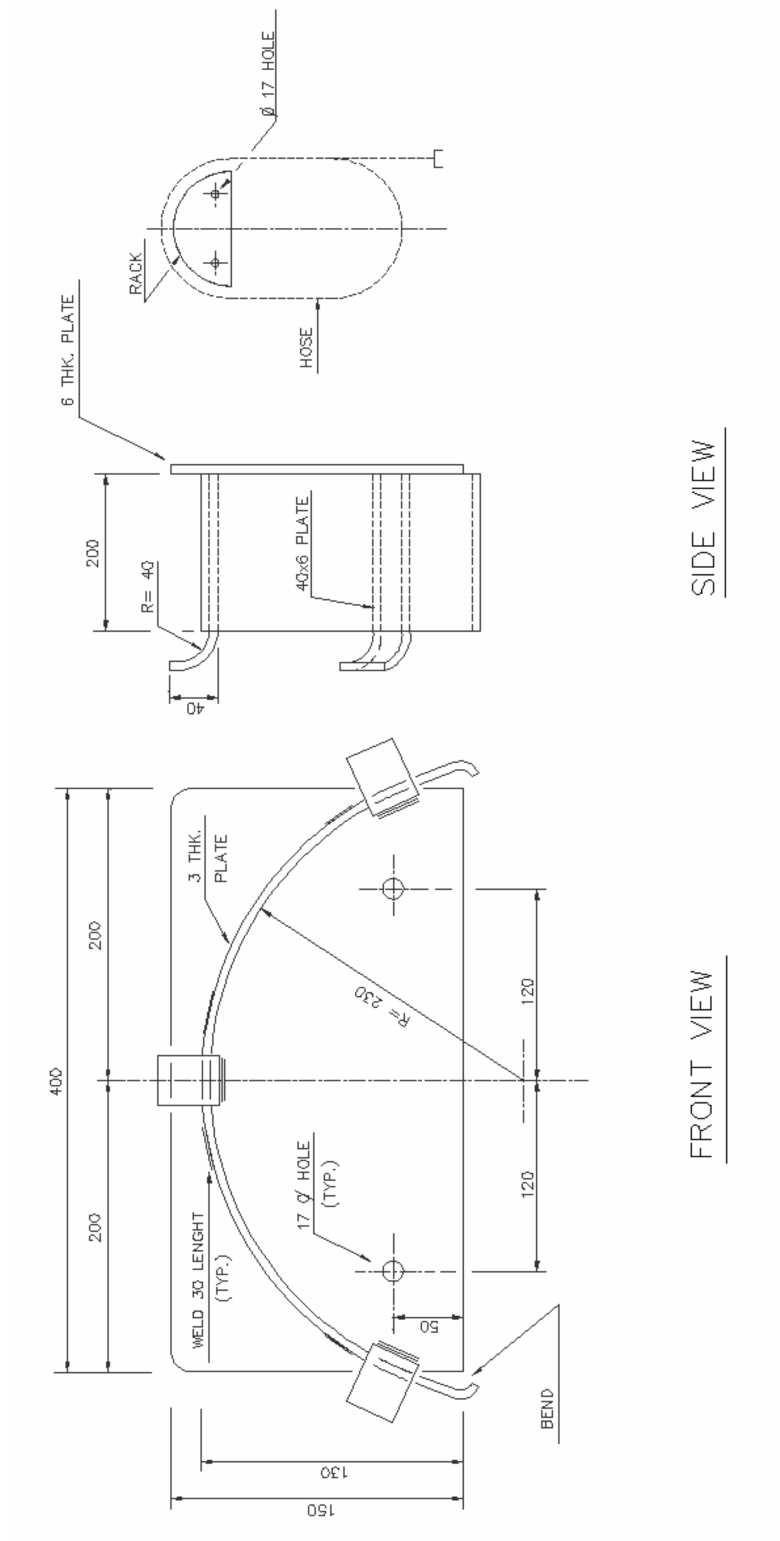


Figure 4.10.4 *Hose rack support details*

4.11 Sample connections

Sample connections can be normal or cooled type.
The type is normally specified by PRC on the relevant P&I D.
Branches from the main line can be made on both vertical and horizontal sections of the same. A branch pipe from a horizontal section, can be made from the top or side, preferably the first one, branch pipes from the bottom are not acceptable as they could convey deposits and condensates, which influence the results of measurements and the functionality of apparatus.
For the same reason branch pipes cannot be made on dead end sections, and the length of connection to the sample point shall be as short as possible.
Whenever possible, try to group the sample connections as far as allowed by the permissible pressure drops (to be checked with PRC), for the reasons given in the previous paragraph.
Figures 4.11.1/2 illustrate some typical installation of cooled sample connections (this however, does not constitute the whole range of sample connections used).

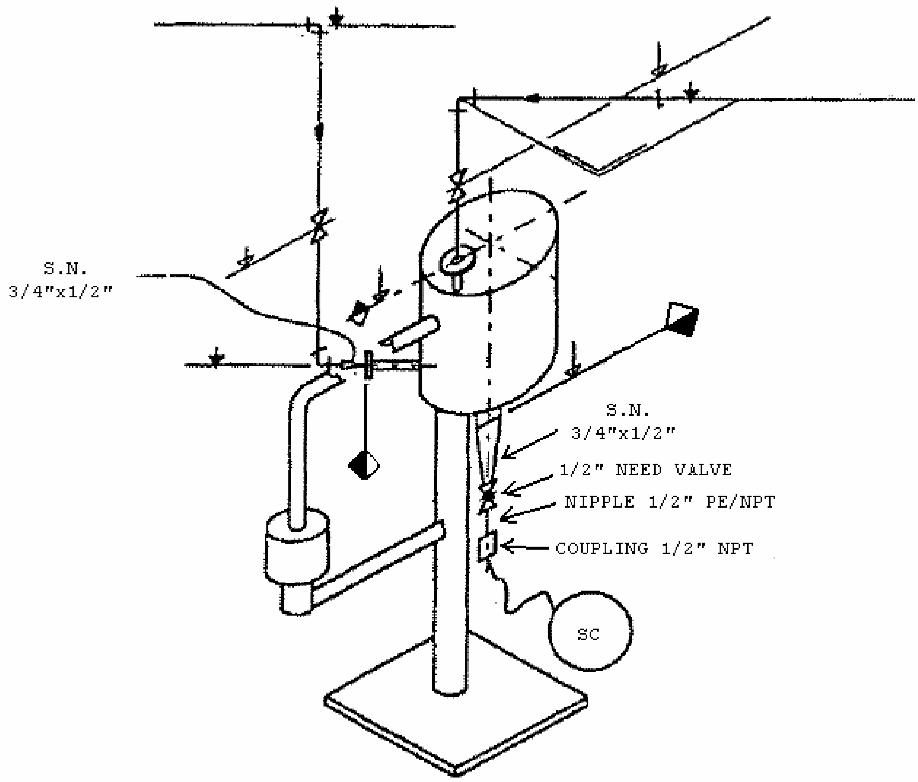


Figure 4.11.1 *Typical installation of a cooled sample connection (case 1)*

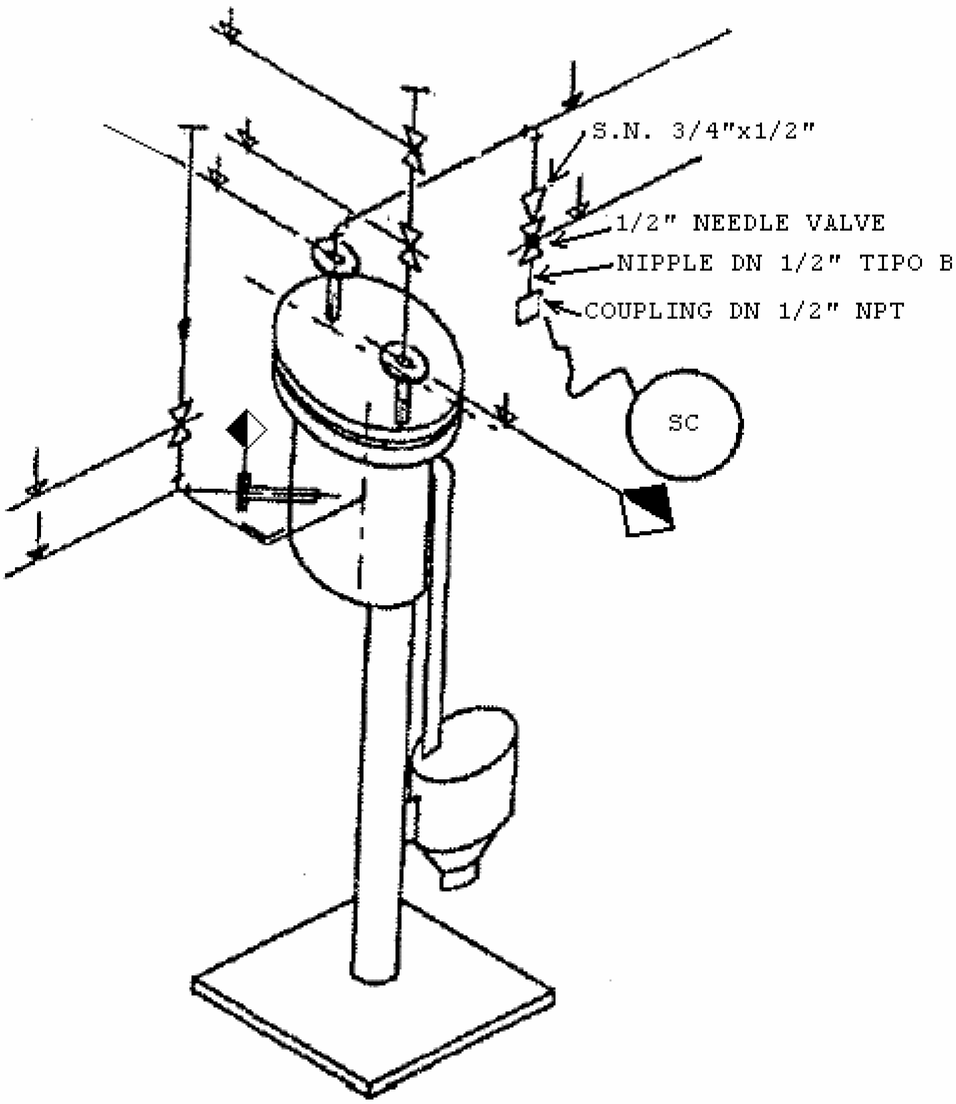


Figure 4.11.2 *Typical installation of a cooled sample connection (case 2)*

4.12 Instrument accessibility

Instrument process connection shall be designed to be located for maximum convenience for operating and servicing of the instruments.
The following general rules shall be adhered to, unless limited by other requirement in the design of the unit:

1. Connections shall be oriented so that instruments or piping will not obstruct aisles, platforms or ladder;
2. Connection for local pressure gauges, dial thermometers and test wells be located so that gauges will be at visible level and test points will be readily accessible;
3. Orefices, line mounted flow transmitters, and thermocouples shall be mounted in pipe-ways or shall be accessible from walkways, ladders, plaforms or grade;
4. Clearance shall be provided at flow meter orefices for valves, seal pots or instruments which may be located on the lines;
5. Connection on vessels for gauge glasses and level instruments shall be oriented to minimize the effect of inlet and outlet streams on the instruments;
6. Gauge glasses and level instruments shall be adjacently located and, if possible, the gauge glass shall be visible from any valve which controls the level in the vessel;
7. A1 Indicating instruments which must be readable for automatic control adjustment or manual operation shall be readable form the adjustment or operating point. If plot or piping arrangement precludes this, other provisions shall be made for indication at the adjustment or operating point. Indicating instruments which are not in the above category shall be visible from operating aisles or passageways;
8. All instruments required adjustment shall be accessible for servicing from grade, walkways, ladders or platforms;
9. Instrument shall be located so as to maintain clearance required for walkways, access ways and operation and maintenance of valves and equipment:
10. Instrument accessibility shall be in accordance with accessibility chart, see Table 4.12.1
11. When establishing the orientation of a temperature tap, it is necessary to leave a free space of about 600 mm to pull the thermocouple.

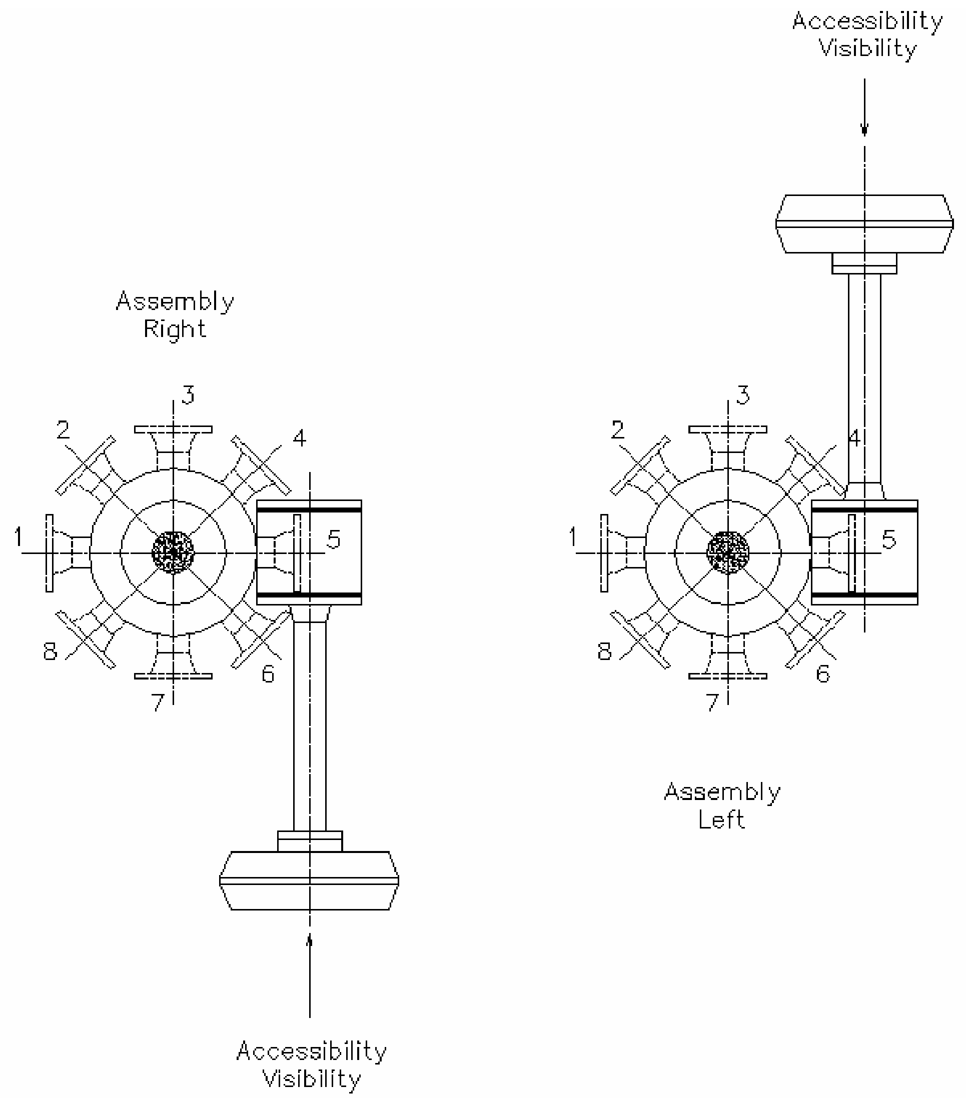
Instrument type	I	II	III	IV	V
Transmitters	X				
Local Indicators	X				
Pressure Gauge	X				
Thermowells	X				
Self-Contained Regulator	X				
Local Controllers/Recorders			X		
Process Actuated Switches		X			
Frequently Adjusted Instrument		X			
Line Accounting Flow Transmitters		X			
Emergency Instrument			X		
Thermocouples				X	
Line mounted flow transmitters				X	
Control Valves					X

I. *Grade, platform, stairway or permanent ladder below 4500mm (access from permanent ladder shall be limited to the instruments where plot or piping arrangement precludes accessibility from grade or platform);*
II. *Grade platform or stairway;*
III. *Grade only;*
IV. *Grade, platform, stairway or permanent ladder. Instruments in pipe-way, or line mounted flow transmitters where their location depends on the location of the flanged orifice, shall be accessible although the height may vary;*
V. *Grade or upon NIOEC'S written approval.*

***Table 4.12.1** Instrument access and visibility table* A1

4.13 Levels

A1 Level gauges shall preferably be positioned and orientated so that they are visible and accessible from the ground or from permanent platforms. If the valves or level instrument stand pipe are higher than the working floor or the operating elevation by 2100 mm, a fixed vertical ladder shall be provided. In this case the maximum distance to be considered between the ladder and instrument axes, or the valve handwheel axis, is 800 mm.
An example of Displacer is shown in *Figure 4.13.1*. For this type of level, it's necessary to define orientation by filling out *Table 4.13.1,* an X shall be entered on 'assembly right/left column' in correspondence to chosen assembling (1÷8). The type of assembly shall be chosen in agreement with SMAUT Department.
In *Figure 4.13.2/3/4*/5/6/7 same example of levels' arrangements are shown.



1,2,3,4,5,6,7,8: Possible orientation of vessels' nozzles

Figure 4.13.1 *Example of Displacer*

Unit	***Tag. N.***	***Instrument type***	***Equipment N.***	***Pis N.***	***Instrument mounting orientation*** *(Assembly Right)*								***Instrument mounting orientation*** *(Assembly Left)*							
					1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**

Table 4.13.1 *Table for Displacer*

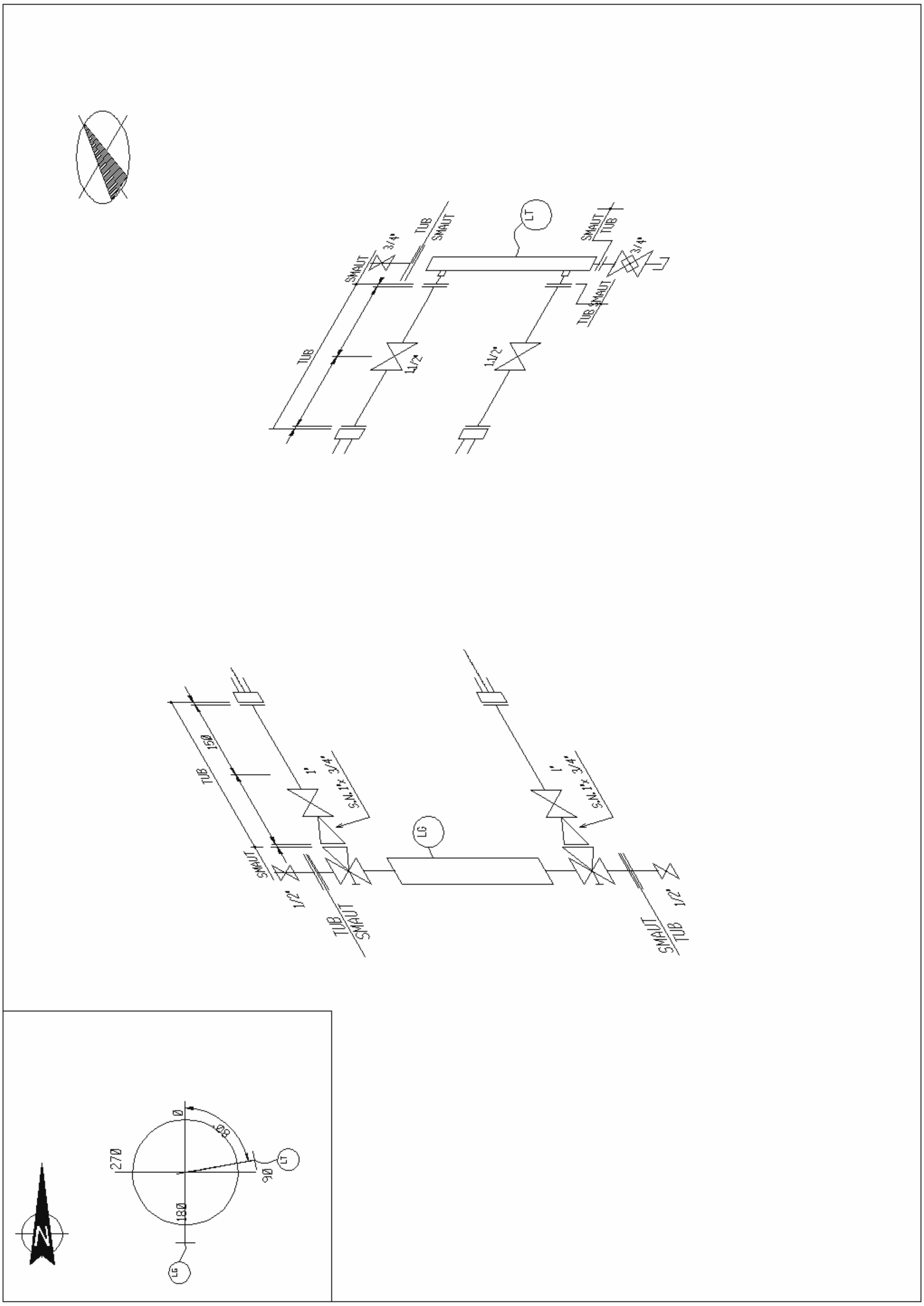
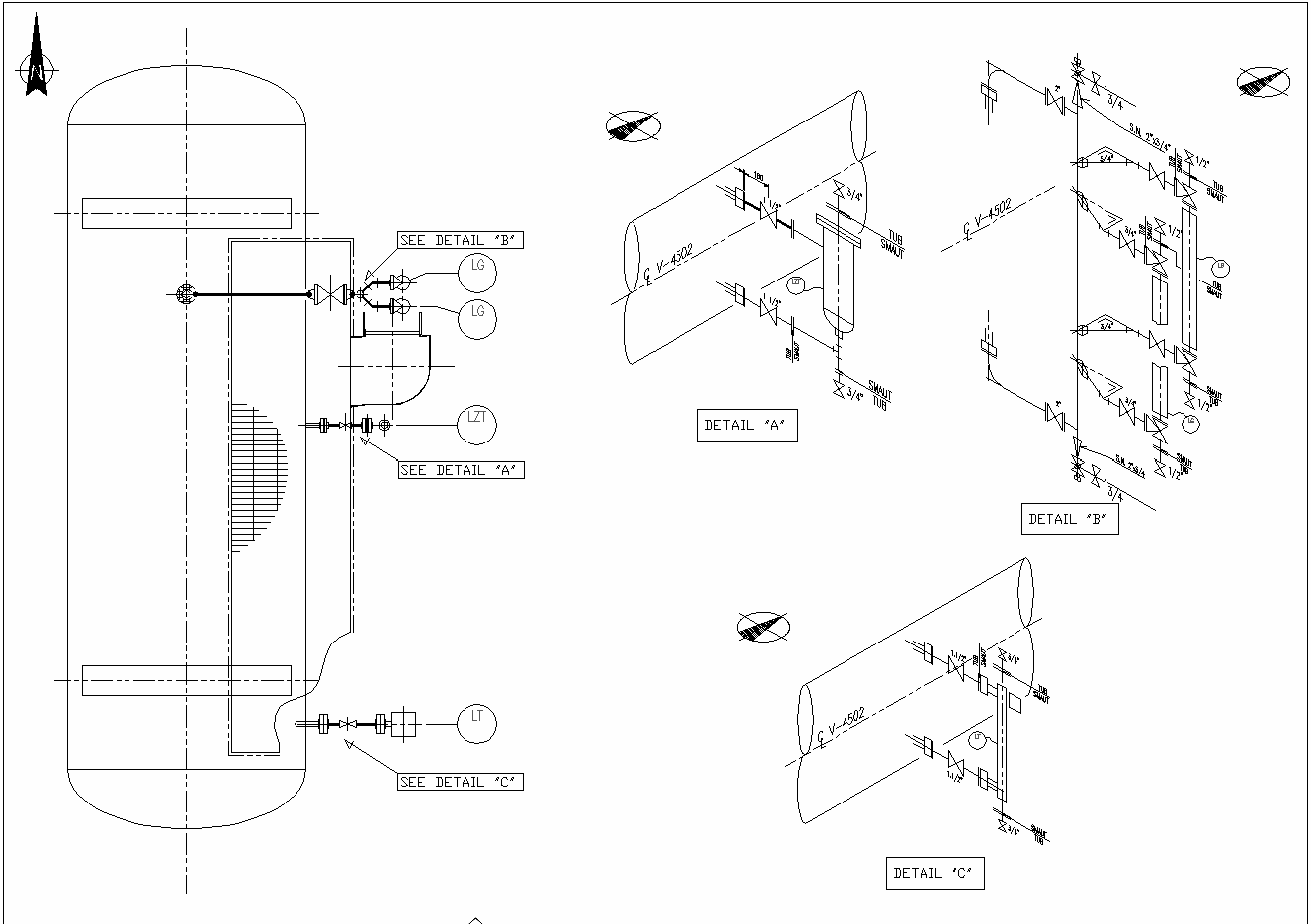
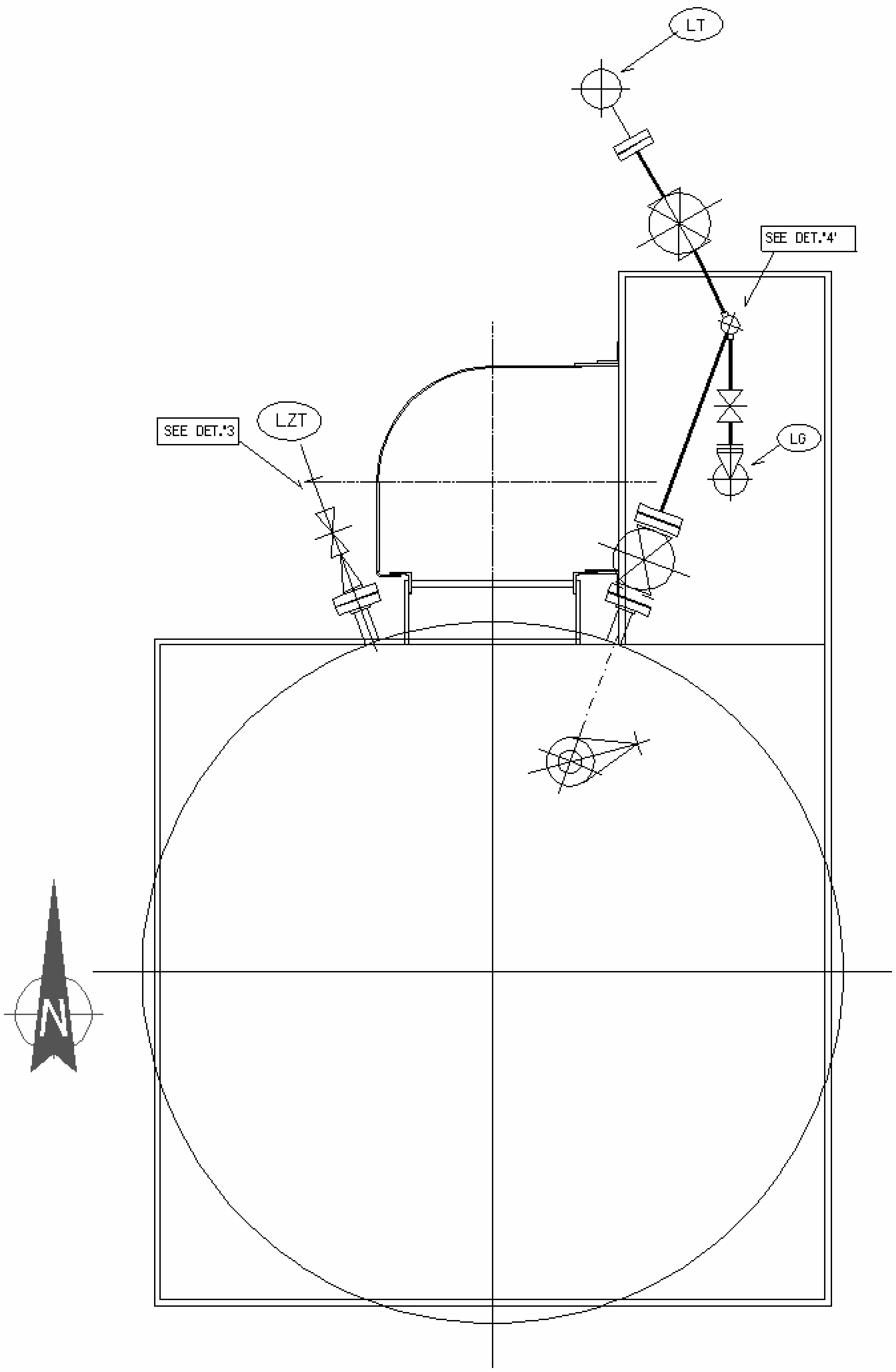


Figure 4.13.2 *Example of levels' arrangements*

A1

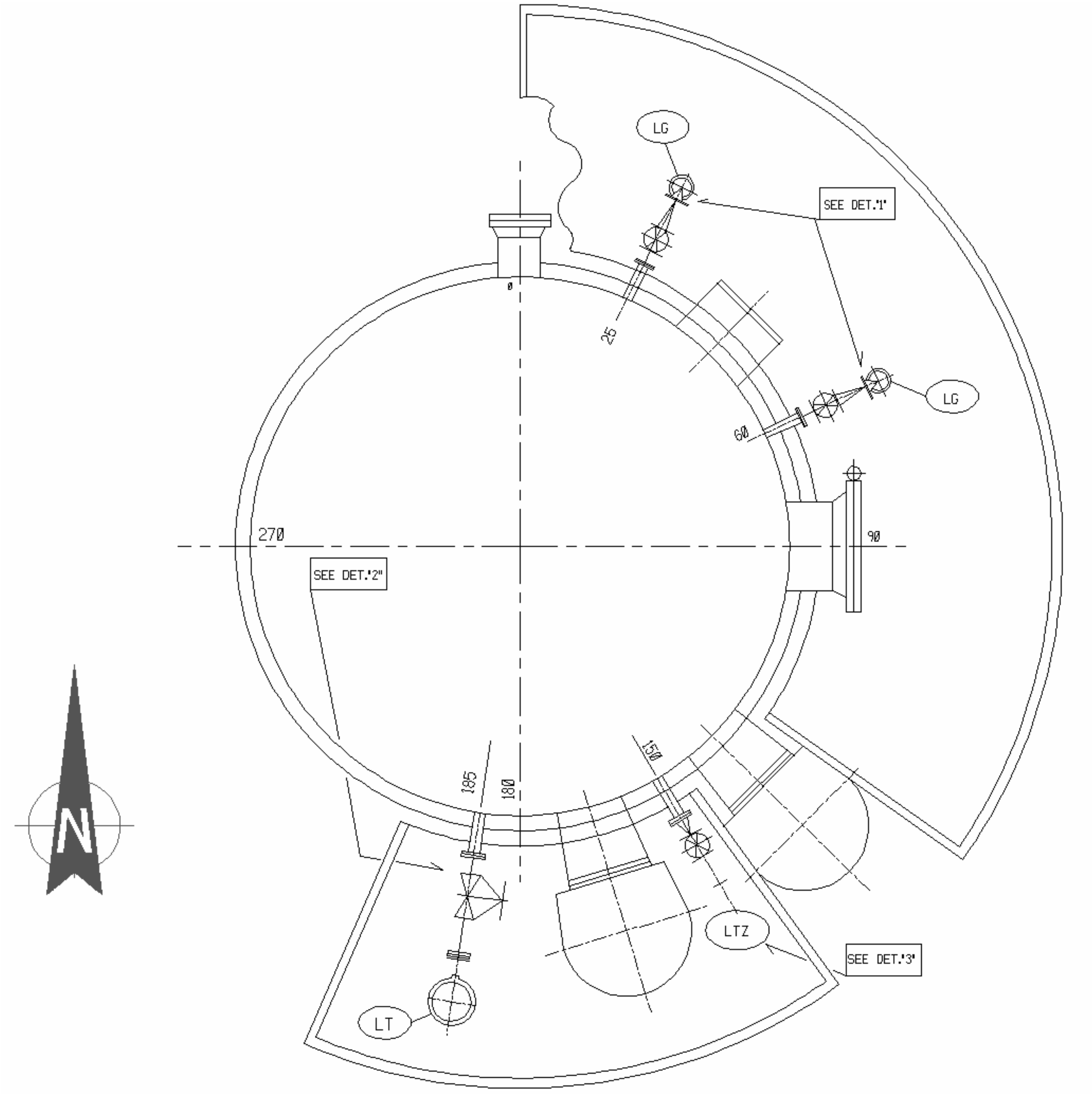


A1 **Figure 4.13.3** *Example of levels' arrangements*

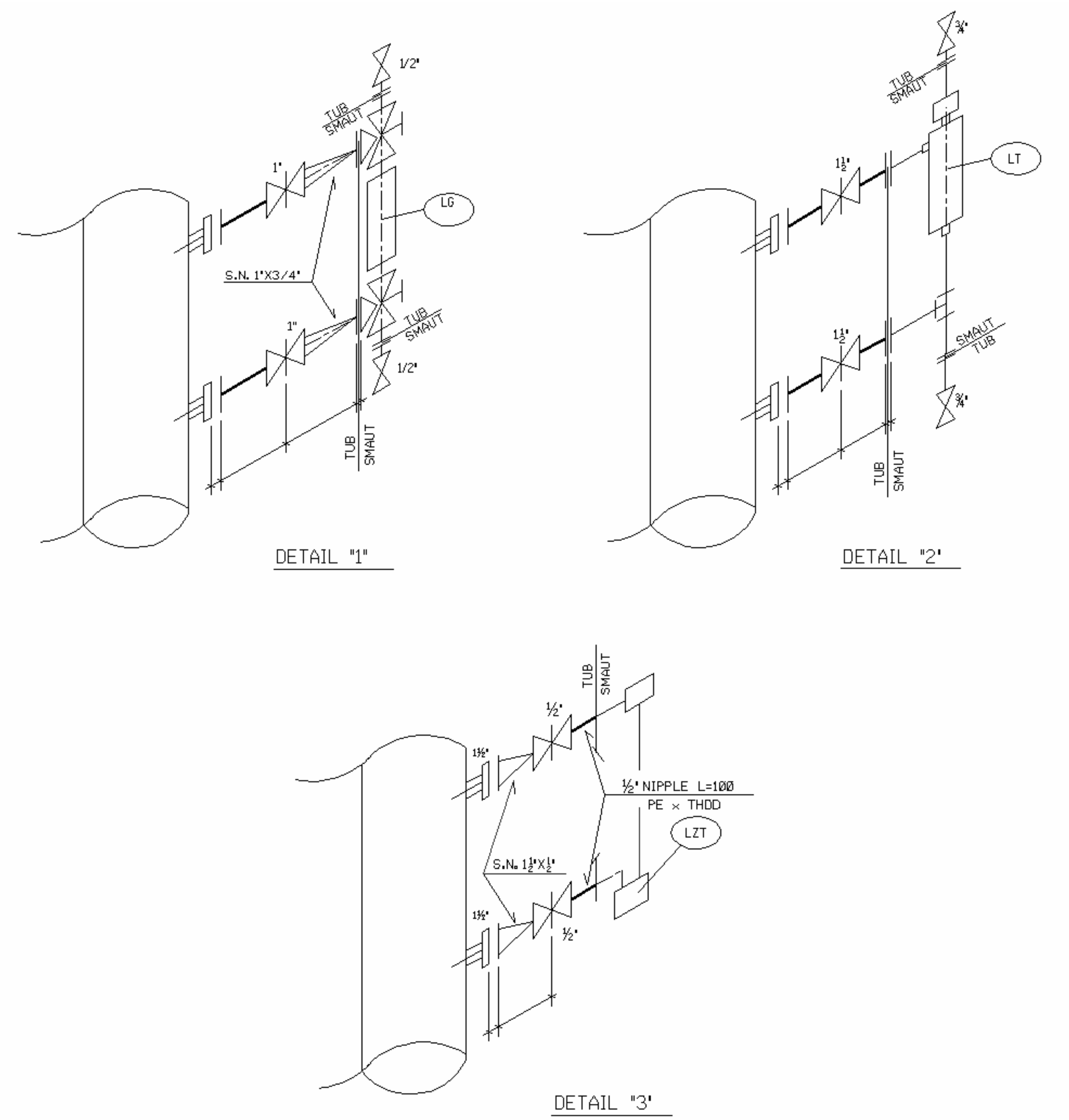


A1

Figure 4.13.4 *Example of levels' arrangements*

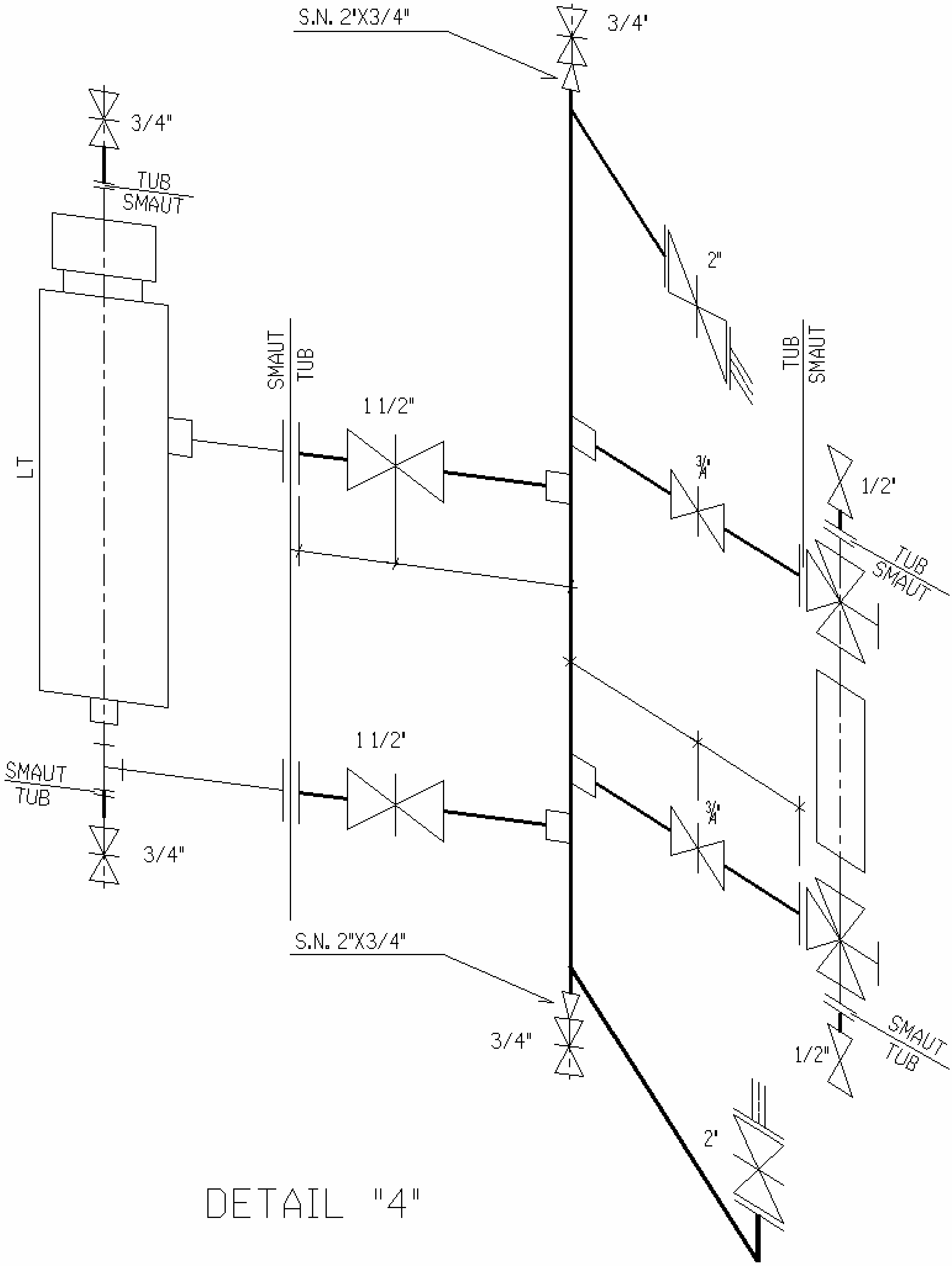


A1 ***Figure 4.13.5*** *Example of levels' arrangements*



A1

Figure 4.13.6 *Example of levels' arrangements*



A1

Figure 4.13.7 *Example of levels' arrangements*

4.14 Miscellaneous

4.14.1 Piping

Piping routes shall be as short as possible and contain the smallest number of connections, particularly in the following cases:

- Large diameter lines in alloy and/or stainless steel;
- Pump suctions;
- Suction and delivery of compressors;
- Transfer line;
- Steam line;
- Manifold of air coolers.

Lines conveying steam shall be installed so as to allow proper drainage to the steam traps and/or drains.

Connection lines between piperacks and equipment shall be located at a minimum elevation of 2500 mm and under the piperack a minimum elevation is 3800 mm to allow access of mobile lifting equipment.

If only personnel transit is envisaged, this elevation may be reduced to 2200mm.

Whenever possible, piping shall be installed so as to be selfdraining to the equipment, avoiding the formation of pockets and dead points.

When structures are utilized, lines shall be positioned as close as possible to these structures so as to facilitate their support.

Provide suitable points either flanges or couplings so as to allow easy assembly.

Vents and drains shall be installed in the high points (named positive pockets) and in the low points (negative pockets) of lines, respectively.

The type of the vents and drains are defined in ‘Job specification for typical piping assembly’ , 3034.00.ED.PI.JSP.50002

Jacketed piping shall be installed in accordance with ‘Jacketed piping specification’, 3034.00.ED.PI.DCR.50003.

Steam tracing shall be installed in accordance with ‘Job specification for steam tracing”, 3034.00.ED.PI.JSP.50003.

When designing piping (especially when weld treatment is required) ensure that, between two circumferential welds, a minimum distance equal to four times the pipe thickness. However ideally the spool thus obtained should not be less than 100 mm.

When designing plastic (PVC) or fiberglass (RTR) piping it should remembered that all the components are prefabricated with sizes defined by the Manufacturer and therefore the routes and lengths shall take these requirements into account.

Moreover, it is necessary to consider the particular requirements for performing the connections/joints to equipment and instrumentation, because it is not possible to manufacture on site any special parts necessary which should have been defined (and purchased) during the development of the detailed engineering.

In case of ebonised piping, the piperoute shall to defined bearing in mind that the pipes shall be prefabricated in flanged spools of a suitable length for oven annealing.

For this reason, after defining the layout complete with dimensions and elevations, it is necessary to prepare the isometrics of the lines under consideration (with all dimensions, connections to equipment/machines and with the relevant instruments).

4.14.2 Reinforced plate

For reinforced plate, unless other indication by STRESS, the following criteria shall be taken into consideration:

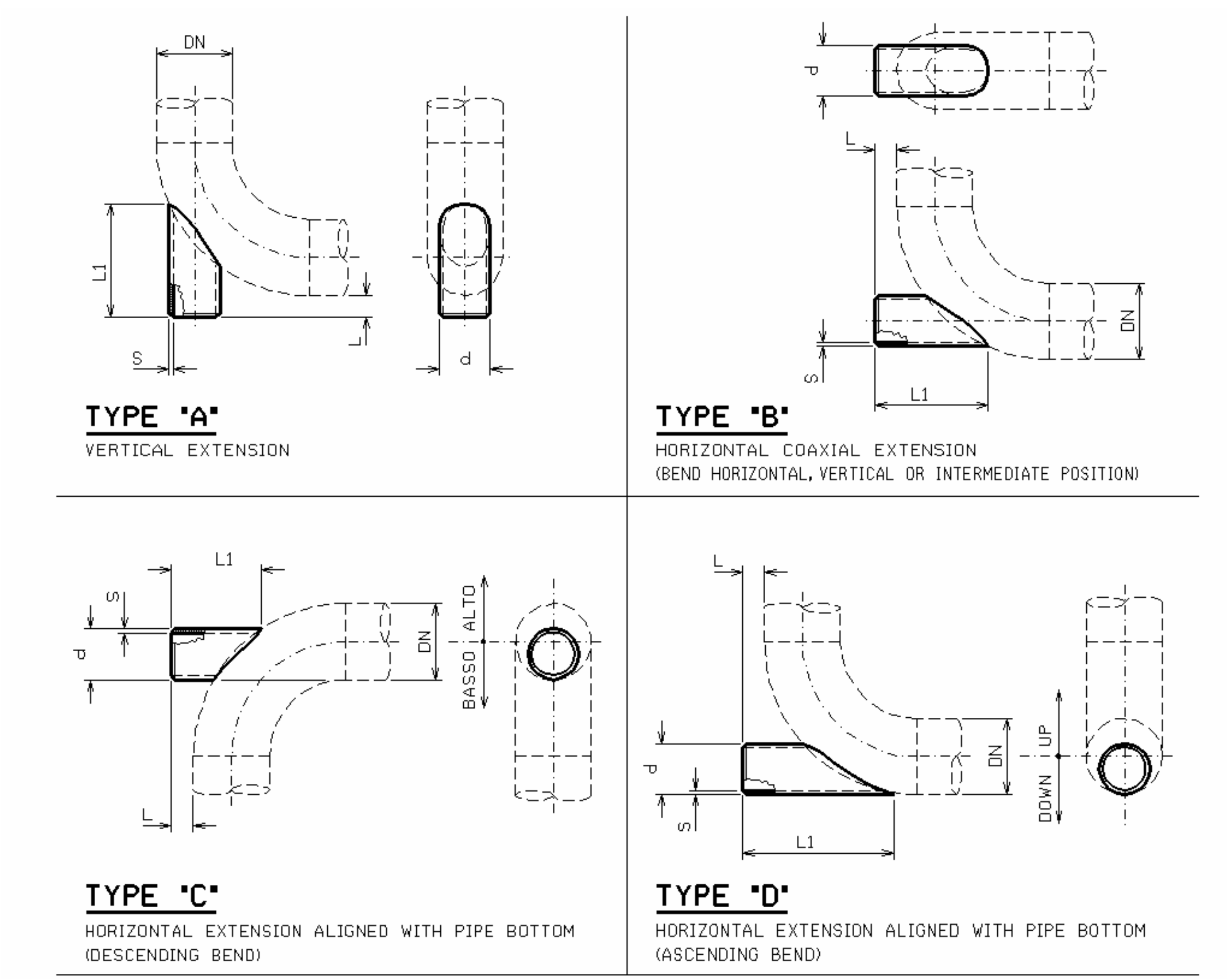
A1

For all flare lines with ND ≥ 2", plates shall be provided on all pipe to pipe intersection. The plates length shall be twice dimension of hole. Involved piping class are A1C3(X) and A1C6 (X);

- For carbon steel sewer lines, piping class A1K3 (U), reinforced plates don't shall be considered for any type of intersection;
- For all other process lines with 45° or 90° intersection, the necessity of reinforced plates shall be checked time by time.

4.14.3 Piping Trunnion for Support

For application of trunnion to be provided on elbows for vertical and horizontal piping see *Figure 4.14.3.1*.



<table>
<tr><th rowspan="3">ND</th><th>L
(is mandatory)</th><th colspan="4">L1</th><th colspan="2">d</th><th>S</th></tr>
<tr><th>TYPE</th><th colspan="4">TYPE</th><th colspan="2">TYPE</th><th>TYPE</th></tr>
<tr><th>A-B-C-D</th><th>A</th><th>B</th><th>C</th><th>D</th><th>A</th><th>B-C-D</th><th>A-B-C-D</th></tr>
<tr><td>2 - 3</td><td rowspan="10">50 ±3</td><td colspan="2">155</td><td colspan="2">150</td><td colspan="2">2"</td><td rowspan="10">ACCORDING TO PIPING PROJECT SPECIFICATION</td></tr>
<tr><td>4 - 6</td><td colspan="2">210</td><td>175</td><td>270</td><td colspan="2">3"</td></tr>
<tr><td>8 - 10</td><td colspan="2">340</td><td>280</td><td>355</td><td rowspan="2">6"</td><td>6"</td></tr>
<tr><td>12 - 14</td><td>410</td><td>520</td><td>450</td><td>655</td><td>10"</td></tr>
<tr><td>16 - 18</td><td colspan="2">630</td><td>510</td><td>830</td><td rowspan="2">12"</td><td>12"</td></tr>
<tr><td>20 - 24</td><td>700</td><td>780</td><td>625</td><td>1120</td><td>16"</td></tr>
<tr><td>26 - 30</td><td>910</td><td>1100</td><td>1000</td><td>1400</td><td>18"</td><td rowspan="2">24"</td></tr>
<tr><td>32 - 40</td><td colspan="2">1200</td><td>890</td><td>1890</td><td>24"</td></tr>
<tr><td>42 - 48</td><td>1300</td><td>1460</td><td>1090</td><td>2270</td><td rowspan="2">30"</td><td>30"</td></tr>
<tr><td>52 - 68</td><td>1750</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
</table>

***Figure 4.14.3.1** Support standard*

4.14.4 Battery limit

There are different solutions for battery limit installation, some examples are shown in *Figure 4.14.4.1/2..*

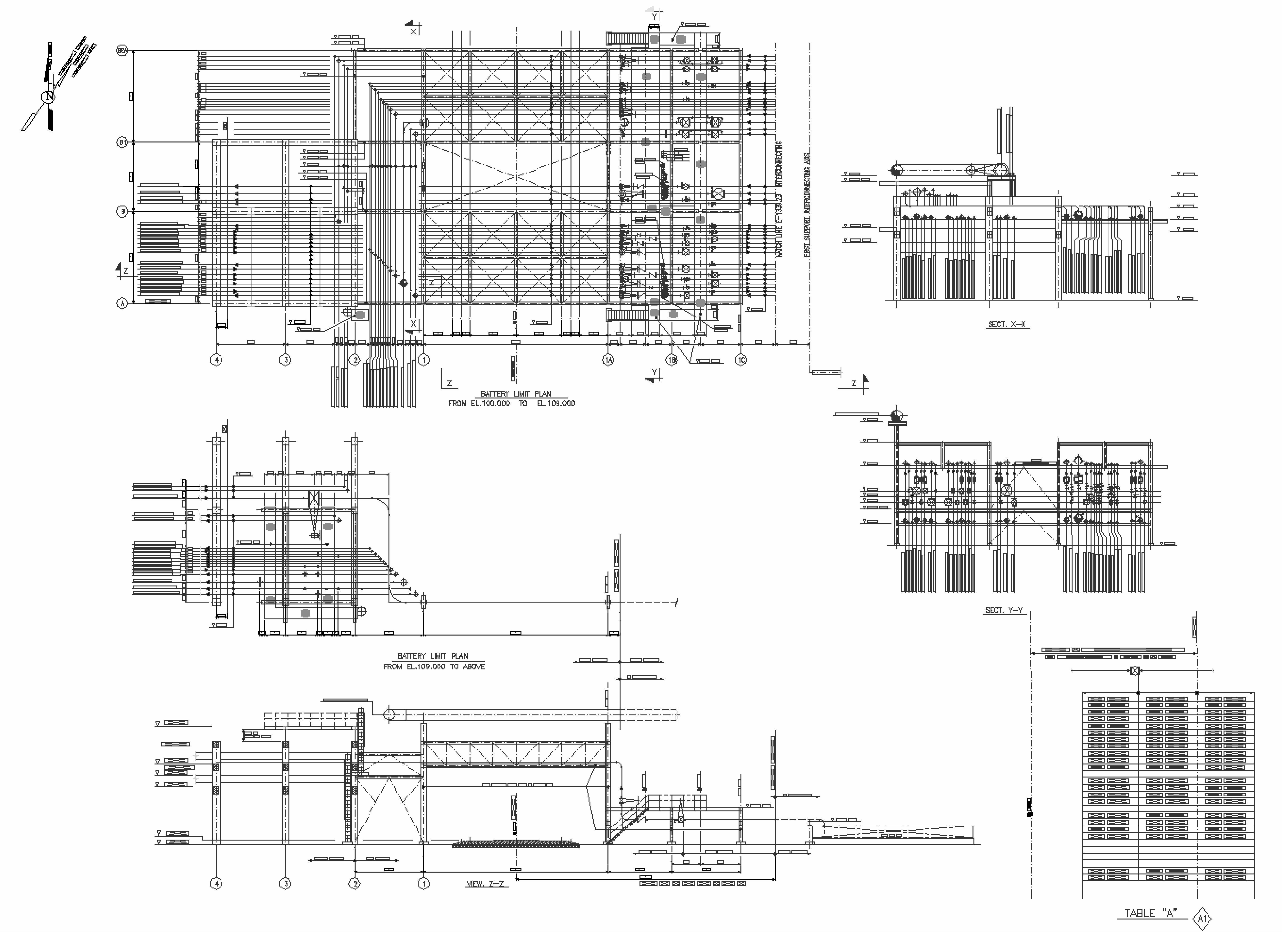


__Figure 4.14.4.1__ Typical example of installation at battery limit (on piperack)

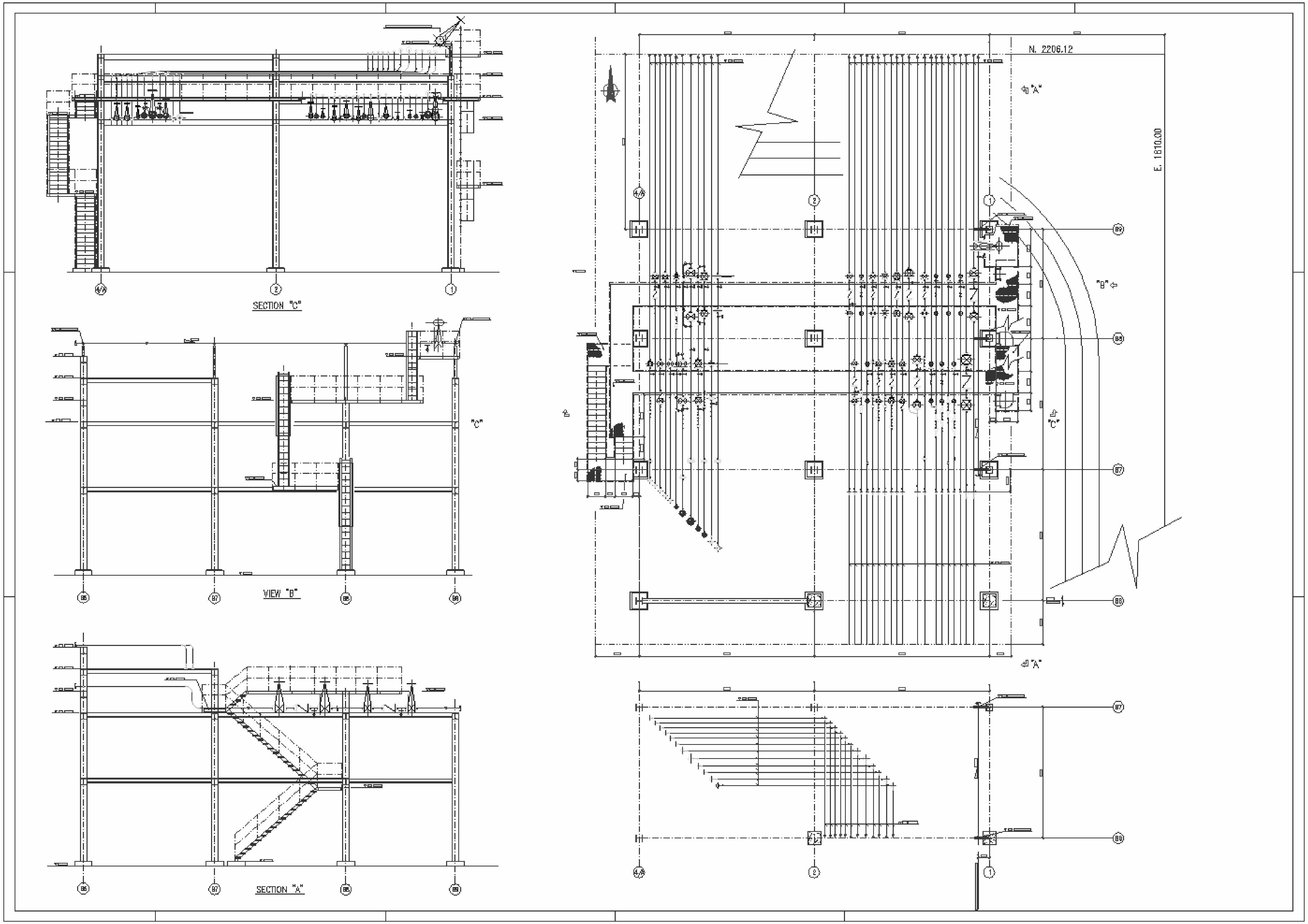
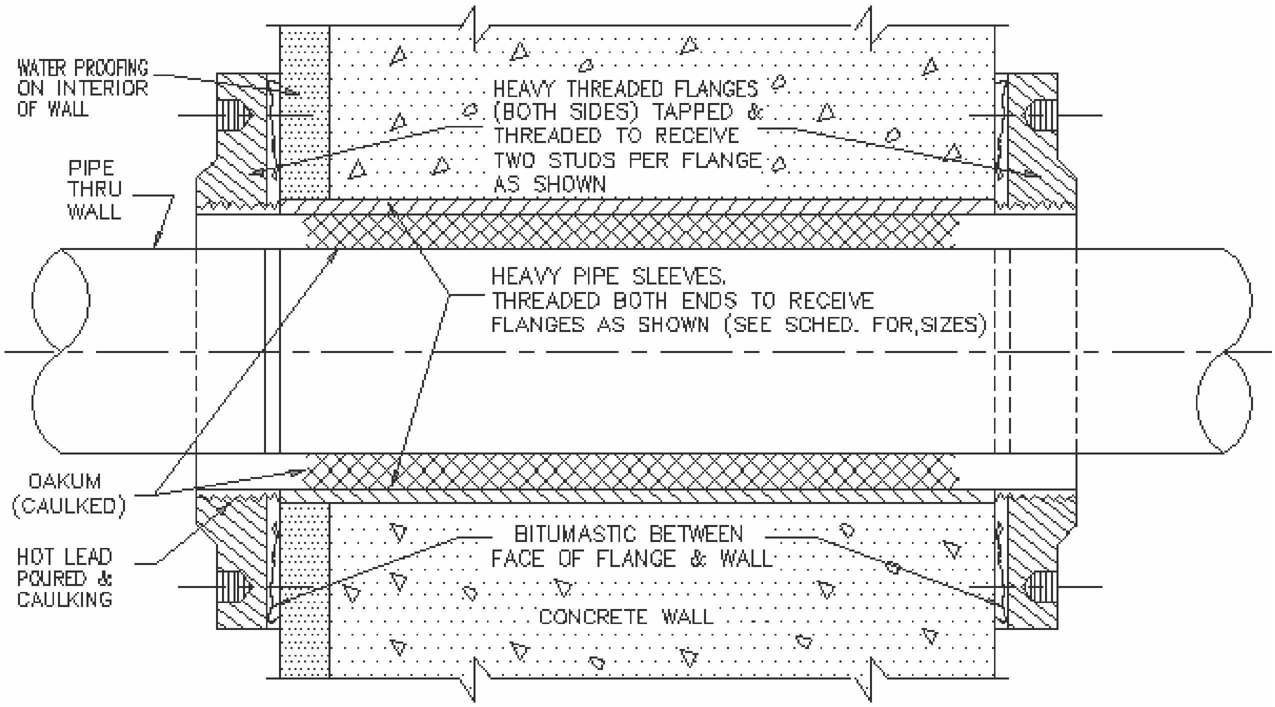


Figure 4.14.4.2 *Typical example of installation at battery limit*

4.14.5 Crossings

Pipes that penetrate walls, tank dikes or building roofs shall pass through appropriate sleeves, which shall be large enough for seal filling.
Wall penetrations in the case of tanks, basins, etc. for pump suction pipes, etc., is normally performed by providing crossing ad per *Figure 4.14.5.1*.
In case of the piping connected with underground piping installed in trench and pass through the floor, it's necessary to provide a sleeve as per *Figure 4.14.5.2.*
A1
Piping road crossing can be made with concrete bridges;
Crossing with concrete bridges are provided when the pipe track/rack is of considerable size (e.g.: pipeways, unit battery limits, etc.). In this case there is no particular piping design requirement except that if the bridge is too wide it will be necessary to provide intermediate piers which should be taken into account in the definition of the pipeway width (see *Figure 4.14.5.3*). The detailed drawing of the crossing shall be sent to CIV.
Moreover, it is necessary to check the thickness of the ground cover according to the loads that will transit, in order to avoid possible crushing.



PIPE SLEEVE SCHEDULE	
DIA. OF PIPE THRU WALL	DIA. OF SLEEVE REQUIRED
1/2" (DN15)	DN50 (2")
3/4" (DN20)	DN50 (2")
1" (DN25)_	DN50 (2")
1 1/4" (DN32)	DN80 (3")
1 1/2" (DN40)	DN80 (3")
2" (DN50)	DN100 (4")
2 1/2" (DN65)	DN100 (4")
3" (DN80)	DN150 (6")
4" (DN100)	DN150 (6")
5" (DN125)	DN200 (8")
6" (DN150)	DN200 (8")
8" (DN200)	DN250 (10")

NOTE:

PIPE SLEEVE FLANGES 1/2" THRU 2 1/2" CAN BE DELETED AS PER DESIGN ENGINEER RECOMMENDATION.

Figure 4.14.5.1 *Typical thru-wall sleeve detail exterior*

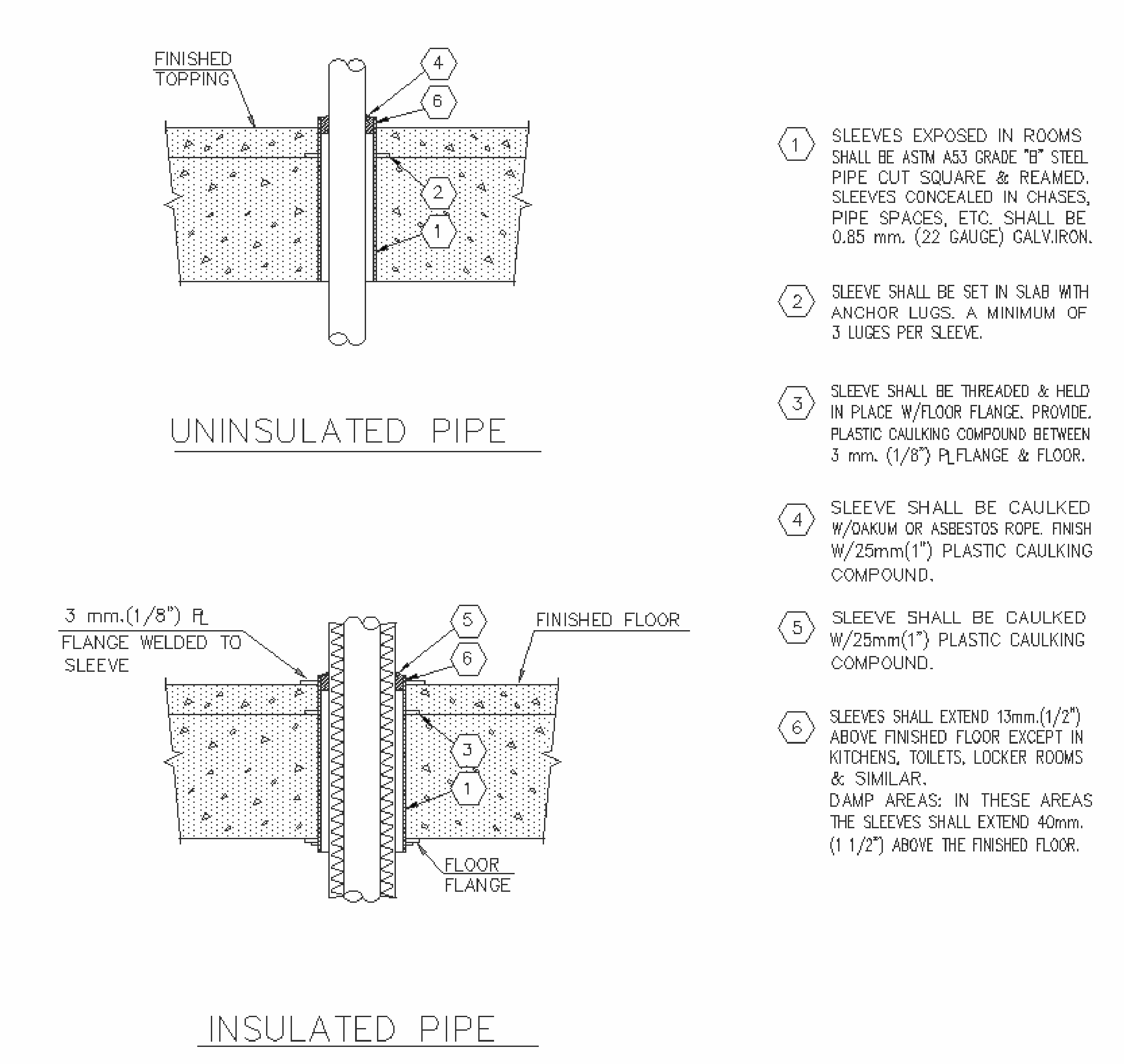


***Figure 4.14.5.2** Typical sleeve for underground crossing*

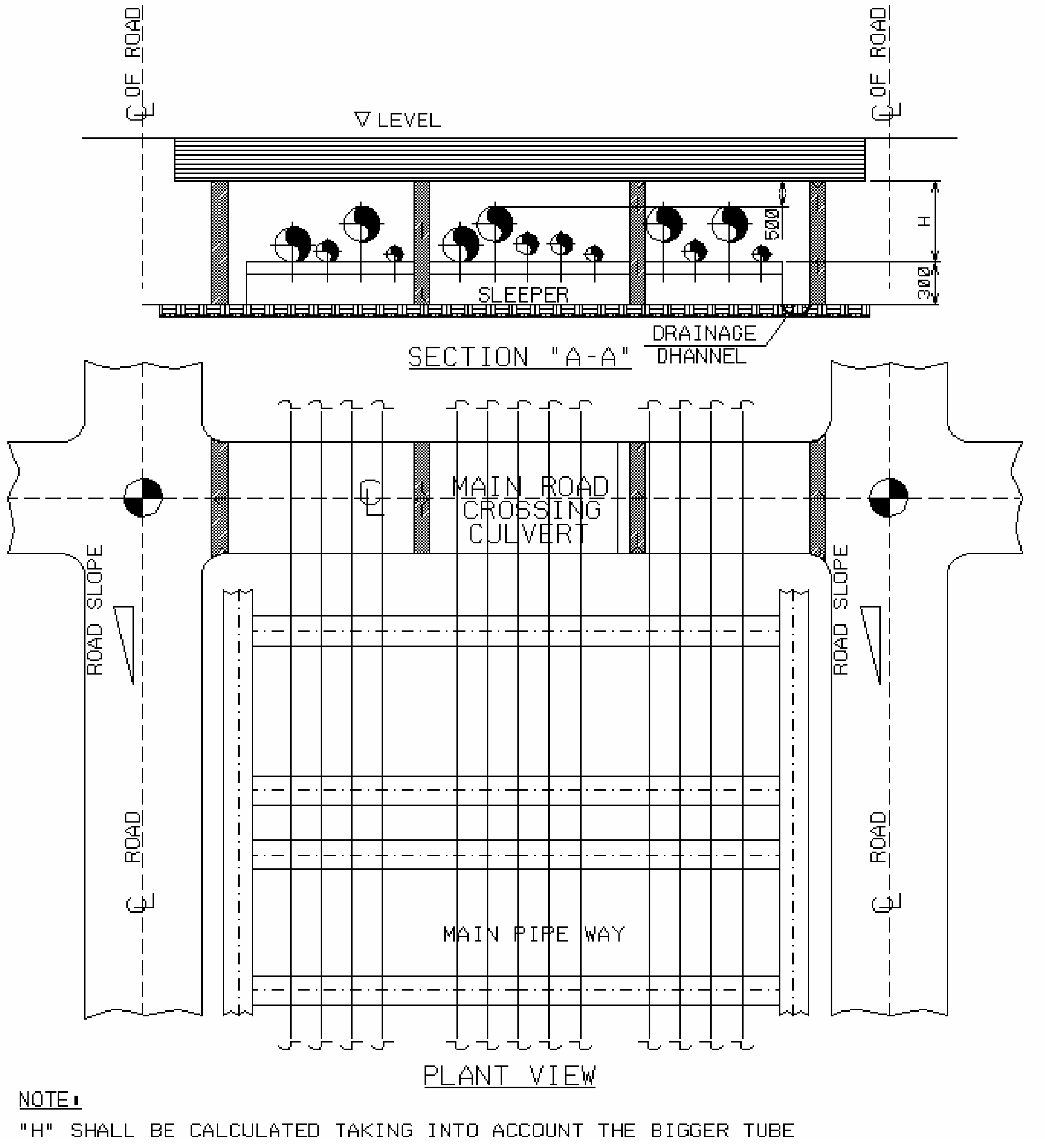


Figure 4.14.5.3 *Typical example of road crossing with culvert in reinforced concrete*

4.14.6 Utilities distribution

Utilities distribution (steam, water, air, nitrogen) to the users is made according to the type of utilisation required, as specified in 'P&ID Development Procedure', 3034.00.ED.PM.PCR.AA401.
Utilities station shall be located:

1. Process and utilities production area:
   - At ground level: hose station will be arranged to reach all equipment or pipes concerned, min hose length shall be 15000mm;
   - On structure: hose station will be arranged to serve all the floor;
   - On fractionation columns: hose stations will be provided on all manholes platform and on the highest platform, with the exception of water (unless P&ID requirement);
   - A1 For vertical structures and vessels: in general utilities stations will be installed on every other floor;
2. Hose connection for furnace (cylindrical type) will be provided on first platform;
3. Hose connection for furnace (box type) will be provided on top platform with two hose opposite each other;
4. Hose connection for air cooler will be provided at the platform under the electrical motor. (Hose air service only if required);
5. Off-Site area for storage and loading: hose station will be provided in pump room, in tack truck and/or railway loading area, in additive and waste tratments area,

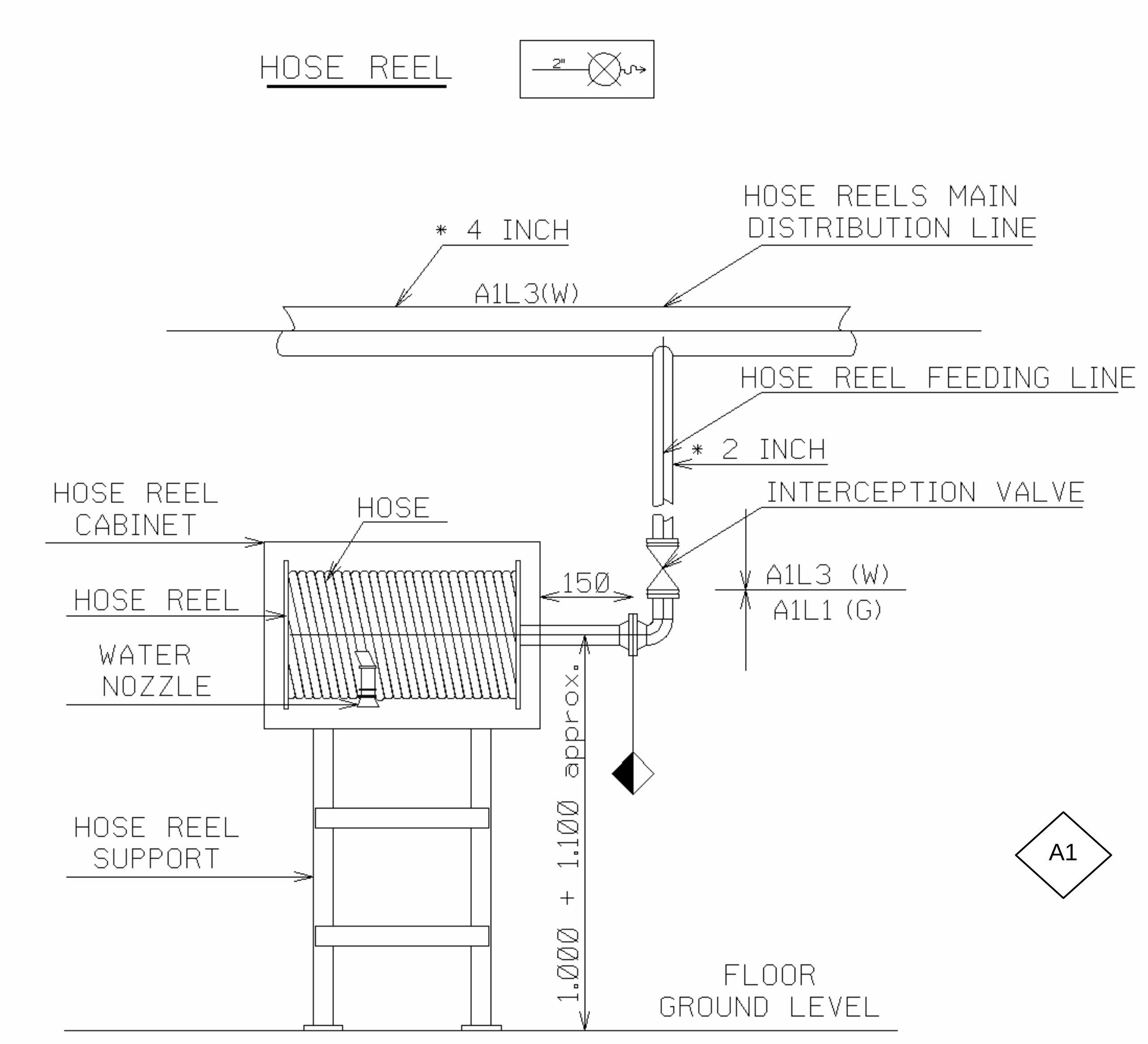
Moreover, the following should be borne in mind when installing the above mentioned lines:

- The need to ensure easy access (for operation and maintenance of valves);
- Functionality requirements (valves shall be positioned below the process product level);
- Operating requirements (for emptying purposes, a drain positioned upstream of the valves shall be provided).

However, when utilization is discontinuous, the connection between the utility lines and the process lines and/or equipment shall not be permanent and shall be made by flexible hoses, or by flanged spools, or by rotating flanged elbows, between the shut-off valves and the users.

4.14.7 Hose reels

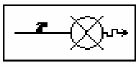
The layout arrangement of hose reels is decided according to the requirements of the relevant distribution P&I D. for the fire-fighting system. For its installation see *Figure 4.14.7.1/2/3*.

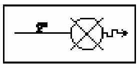


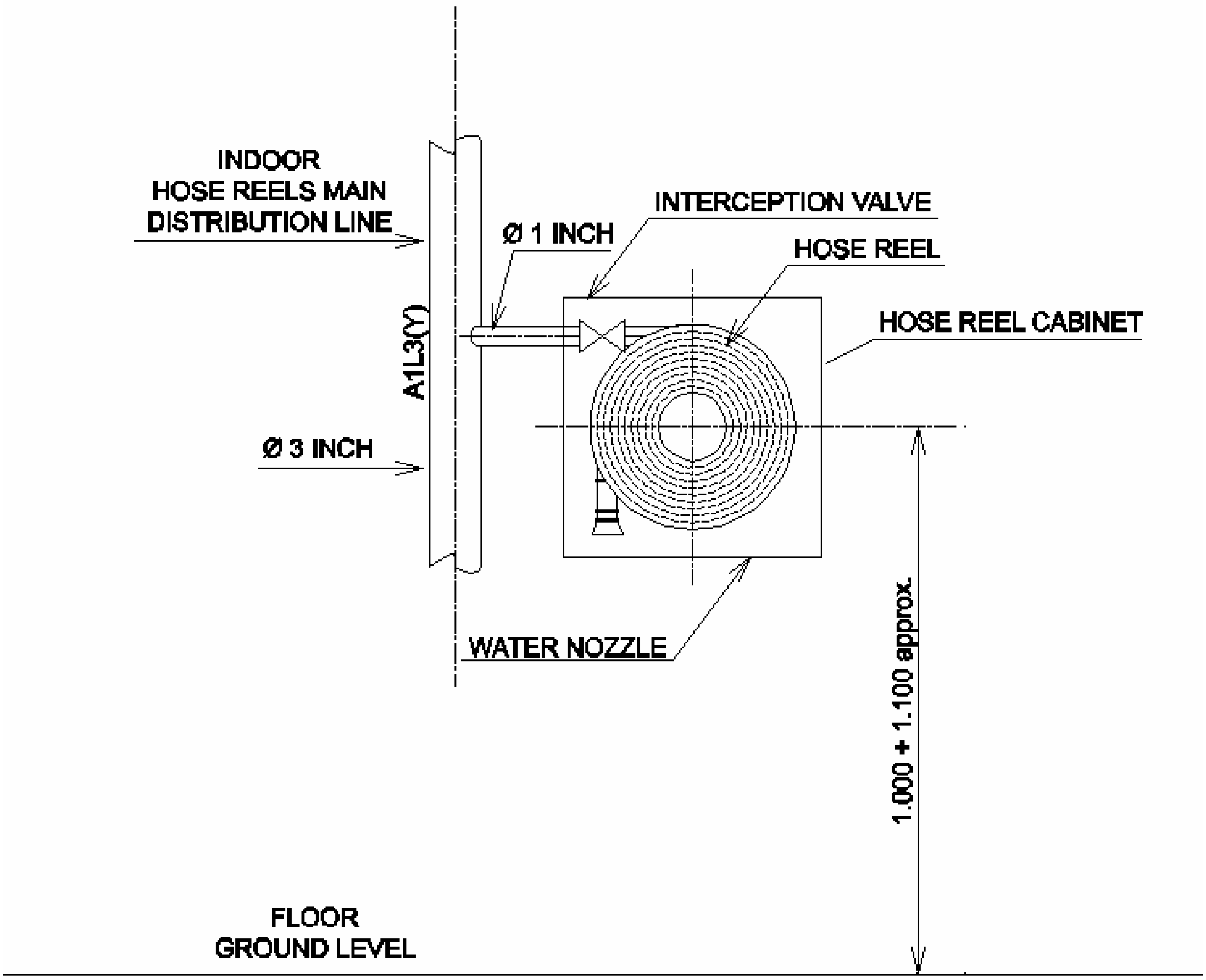
TECHICAL CHARACTERISTICS:

- HOSE REEL CABINET: made in Carbon steel for outdoor installation, suitable for ground assembly. It will be provided with side vents equipped with mosquito net, bottom drain holes and the use full internal dimension will allow any easy operation of the stored equipment.
- HOSE REEL: One galvanized carbon steel hose reel assembled with stainless steel screw. One spool piece terminating outside the cabinet flanged 2” 150 RF made in galvanized carbon steel.
- HOSE: One of 25 m of DN 1 ½”(40 mm) semi-flexible hose, rubber covered and rubber lined, wound on the storage drum and able to put into service without completely unwinding the hose from the reel.
- PORTABLE WATER NOZZLE: One adjustable from full to fog jet and shut down, water portable nozzle capable of delivering approximately 360 l/min (MAX 375 l/min) at 7 Bar g supply pressure. It will be constructed in brass/bronze and shall be equipped with instantaneous pressure release coupling in accordance with British standard BS-336.

Figure 4.14.7.1 *Example of typical installation for hose reel*

INDOOR HOSE REEL (WALL MOUNTED) 

INDOOR HOSE REEL (RECESS MOUNTED) 



TECHICAL CHARACTERISTICS:

- HOSE REEL CABINET: made in Carbon steel for outdoor installation, suitable for ground assembly. The use full internal dimension will allow any easy operation of the stored equipment.
- HOSE REEL: One galvanized carbon steel hose reel assembled with stainless steel screw. It shall be mounted on a swinging arm or the cabinet door which swings 180°.
- HOSE: One of 30 m of DN 1"(35 mm) semi-flexible hose, rubber covered and rubber lined, wound on the storage drum and able to put into service without completely unwinding the hose from the reel.
- PORTABLE WATER NOZZLE: One adjustable from full to fog jet and shut down, water portable nozzle capable of delivering approximately 150 l/min at 7 Bar g supply pressure. It will be constructed in brass/bronze and shall be equipped with instantaneous pressure release coupling in accordance with British standard BS-336.

Figure 4.14.7.2 *Example of typical installation for indoor hose reel*

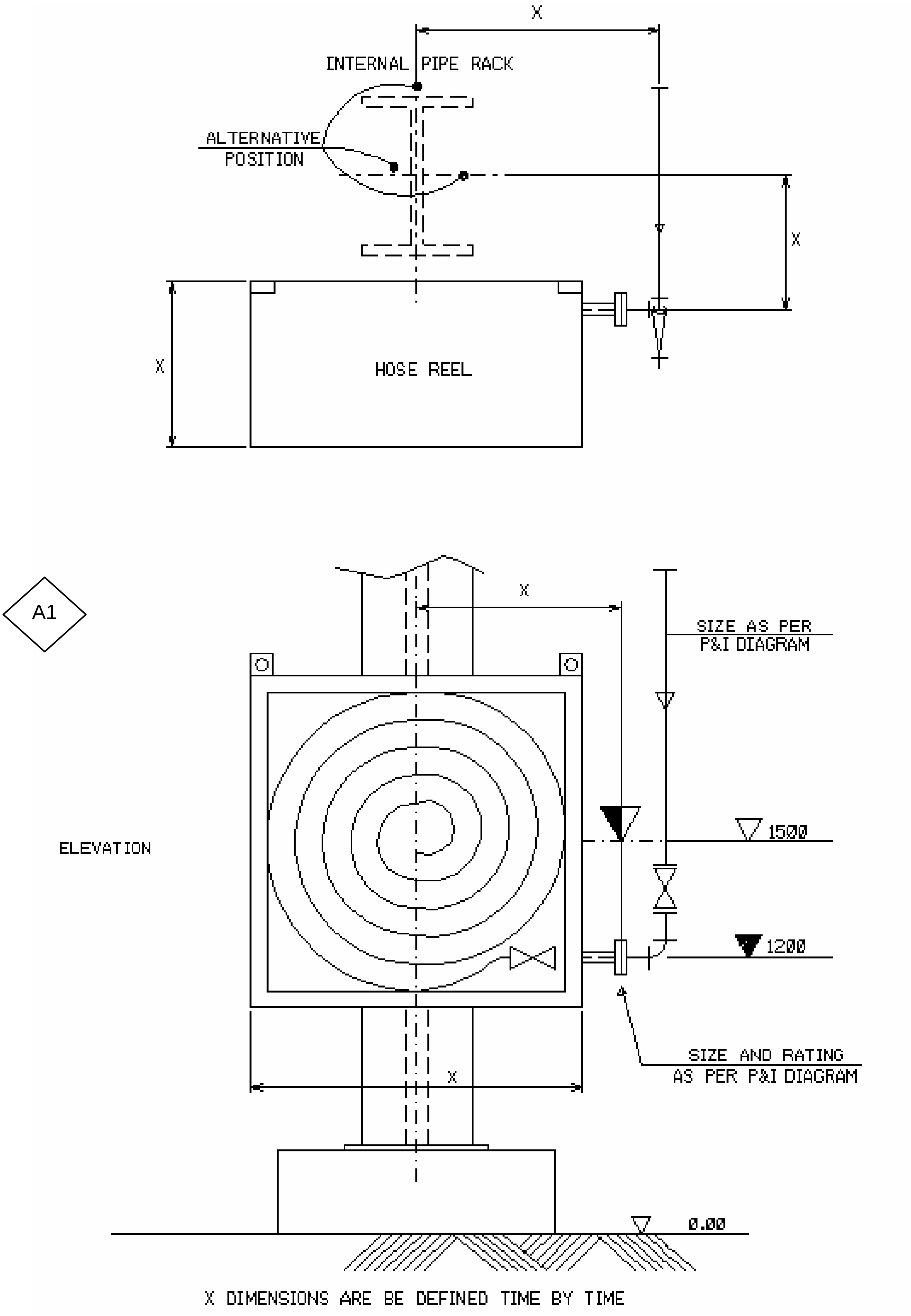


Figure 4.14.7.3 *Example of typical installation of hose reel on piperack*

4.14.8 Eye baths and Showers

The layout arrangement of eye baths and showers is derived according to the possible sources of contamination present in a Plant (e.g.: in the proximity of acids and chemical handling areas, in the proximity of ammonia pumps, etc.). In any case the detailed definition is checked by PRC.
For the relevant installations, see *Figure 4.14.8*.

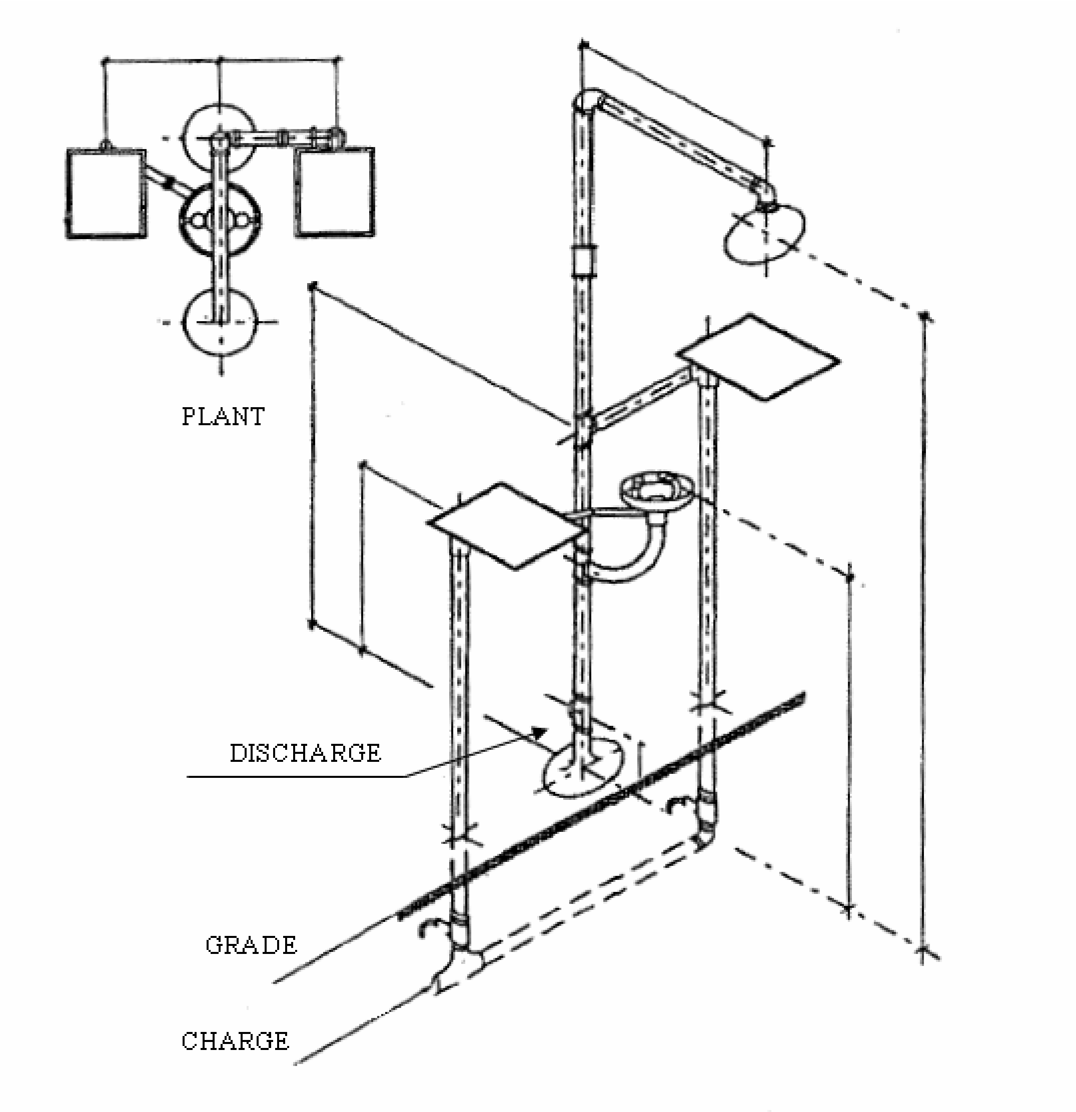


Figure 4.14.8.1 *Example of eye bath and shower installation*

4.14.9 Winterizing A1

In projects where the ambient conditions envisages freezing during the winter season, all connections to hose reels, eye baths and showers made underground shall be equipped with a suitable selfdraining valve (to be defined with PRC) so as to avoid water stagnation in the line as per ‘Job specification for steam tracing’, 3034.00.ED.PI.JSP.50003.