DESIGN OF PIPING SYSTEMS

COVER PAGE

Rev	Date	Prepared by	Approved by	Revision
A	17-Dec-07	R. Mathé	S. Peynet	Initial issue-Format update (replaces 350.09.GS)

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1 INTRODUCTION

1.1 Scope

1.1.1 Purpose

This specification gives the general rules governing design of industrial piping systems for plants engineered by L'AIR LIQUIDE. These rules may be detailed or modified by particular specifications peculiar to each project.

1.1.2 Scope of Application

This document applies to the following types of plants: ASU, Cogen, Syngas.

1.1.3 Specific Requirements

1.1.3.1 Equipment shall be constructed in accordance with the applicable provisions listed in section 1.3. Where any provision presents a direct or implied conflict with any jurisdictional regulation, the jurisdictional regulation shall govern.

1.1.3.2 It is the Vendor's responsibility that all aspects of the construction conform to the requirements of the specified codes, and meet the legal requirements of the authorities having jurisdiction over the installation and operation of the vessel.

1.1.3.3 The Vendor shall submit to Purchaser data and drawings listed in the project specific documents in compliance with the requirements of the specification W-GS-19-1-1.

1.2 Definitions

Not applicable

1.3 Applicable Codes, Standards, and Air Liquide Reference Documents

1.3.1 Industry Codes and Standards

The applicable codes and rules are laid down and described in the particular specification peculiar to each project. ("Main characteristics of the plant"). The most currently used codes are CODETI and ASME-B.31.3.

1.3.2 Associated Air Liquide Documents

Piping dimensioning is made according to the specifications of the pipe schedules retained for each project. These specifications comply with the applicable standards and with the corresponding codes of manufacturing.

	Dimensional Data Sheet: "TC-CEA" Transition Joints
E-DS-5-0-2	Dynamic Spring Washers
E-DS-5-2-88	Flexible Crossing Ducts for Safety Valves
E-DS-5-2-91	Cutting for Mittered Segments Acc. to Codeti - ASM

E-DS-5-2-92	Cutting for Mittered Segments Acc. to Codeti - ASM
E-DS-5-2-93	Reinforced Offset Angles
E-DS-5-2-94	Reinforced Mitter Bends
E-DS-5-2-101	Reinforcement Ring According to EN 13480
E-EP-5-0-11	Maximum Spans for Straight Steel Pipes
E-EP-5-0-12	Pipes Minimum Centre to Centre Distances
E-EP-5-0-14	Leak Protection to Cold Box Flanges
E-EP-5-2-2	Equipotential Connections for Flanges on Piping out of Cold Boxes
E-EP-5-3-14	Piping Systems for Steam Condensates and Boiler Water
E-EP-5-4-1	Manual valves and Check Valves - Design and Selection criteria
E-EP-5-5-5	Installation of the Automatic Cryogenic Valves of Sphere Valve Type in ASU Cold Boxes
E-DS-5-7-10	Partition Crossing Duct Plate
E-DS-5-7-11	Partition Crossing Duct Plate for Grouped Drains
E-DS-5-7-12	Partition Duct - Flexible Assembly - Horizontal Pipes - Cryogenic Valves
E-EP-14-0-1	Pressures and Temperature - Definition and Calculation
E-EP-14-2-10	Instrument Air, Seal Gas and Venting Gas Networks
E-EP-15-0-7	Stationary Fire Fighting Water Network
E-GS-1-0-4	Réseaux Enterrés
E-GS-5-4-1	Manual Valves - Check Valves
E-GS-7-0-2	Electrical Heat Tracing
E-JH-5-5-13	Perlite Thrust Loading
E-TRS-7-0-2	Electrical Heat Tracing
E-VDR-7-0-2	Electrical Heat Tracing
W-EP-1-4-2	Design of Gaseous Oxygen Systems Protective Barriers
W-EP-4-3-1	Material and Thickness Insulation Selection for Piping and Vessels
W-EP-5-3-4	Oxygen Piping Configurations
W-EP-14-2-1	Cryogenic Disposal Vaporizer System Selection
W-EP-14-2-6	Waste Water Collection Systems and Treatment
W-GS-19-1-1	Vendor Data Requirements

1.4 Conflicts, Omissions and Alternatives

1.4.1 In case of conflicting requirements between this specification and applicable requirements of the documents listed in section 1.3, the more stringent shall apply.

1.4.2 In case of conflicting requirements, the following items govern in descending order of precedence.

a. Agreements outlined in mutually approved minutes of review meetings subsequent to the issuance of the Purchase Order

b. Purchase Order and subsequent related correspondence

c. Project specific addenda

d. This specification and accompanying documents listed in 1.3.2.

1.4.3 Any exceptions, deviations, omissions, or alternatives to the requirements shall be submitted for Purchaser's approval prior to award of Purchase Order.

2 GUARANTEES AND WARRANTY

2.1 Vendor shall guarantee satisfactory performance at operating conditions and for the values specified in the project specific documents, or by Vendor's specification where accepted by Purchaser.

2.2 In the event of failure of the equipment to meet the requirements specified in 2.1, Vendor shall make any and all changes or repairs as may be required, at his own expense.

3 DESIGN RULES

3.1 General

The materials and equipment to be used in respect of the fluids, temperatures and design pressures are mentioned in the specification of piping classes referring to the project under consideration. All piping systems shall be designed and arranged so as to assure ready access to the plant and to facilitate maintenance in normal operating conditions.

3.2 Design conditions

3.2.1 Design pressure and temperature for strengh calculation

These terms are defined in the standard E-EP-14-0-1. The values taken into account are determined as per this standard and are set forth in the specification of the piping classes retained for a given project.

3.2.2 Corrosion allowance

Corrosion allowance is determined for each fluid in respect of its characteristics in operating conditions and of the properties of the material used. Corrosion allowance is indicated on the specification for each piping class retained for a given project.

3.3 Loads and load combinations

3.3.1 Definition of loads

Piping design shall be carried out by taking account of the following loads and stresses:

- Permanent loads
  - Dead weights of all piping components including lining (insulant...), i.e. the weight empty of the whole piping including equipment.
  - In the cold box, estimated insulant loads or thrusts (for perlite, refer to standard E-JH-5-5-13).
- Live loads :
  - Maximum load in operation of the liquid or solid products contained in the piping.
- Hydraulic test load :
  - Weights of water inside the piping subjected to test.
- Climatic loads :
  - These loads are determined as indicated in the particular specification "Main characteristics of the plant".
- Earthquake stresses :

When an analysis of piping design in earthquake conditions is required by customer, such examination shall be conducted by mean of a computerized dynamic method.

- Expansion stresses :

These are the stresses and moments on piping due to piping expansion (or contraction) and to possible displacement of the equipment (pumps, pressure vessels...).

- Vibration stresses :

These stresses may be due to pulsations of mechanical (machinery), hydraulical (biphase flow), or pneumatical (expansion...), origin.

3.3.2 Load combinations

The piping shall be designes or analysed for the following stresses.

Operating period : design pressure and temperature
permanent and/or cyclic loads
live loads
climatic loads,
and, if required :
earthquake stresses
expansion stresses
vibration stresses

Testing period (for piping subject to tests) :
test pressure and temperature

permanent loads
hydraulic test load

3.4 Permissible stresses

- Static pressure strenght and thermal strenght of materials checking is performed when the specifications of pipe classes are worked out.
- Thermal yield strenght (between operation and standstill) shall be analysed according to the ASME-B.31.3 Code (§ 319.4 for manual analyses), or by mean of a computerised programm.
- The design data, calculation results or judgement and an isometric sketch shall be specified on a document, for the relevant piping.
- Earthquake strenght, if taken into account, shall be analysed by mean of a dynamic calculation programm.

3.5 Flexibility and expansion

Thermal expansion and contraction of the piping shall be taken into account according to the applicable codes.
The loads and moments acting on equipment flanges (pumps, exchangers, compressors...), shall not exceed the permissible rating defined by equipment manufacturer. (see EUROPUMP code or AFNOR norms NF-E.44145 and NF-E.44146).
Everytime when feasible, expansion bends shall be preferred to expansion joints. The use of expansion joints is prohibited in case of vibration hazards (that means in the vicinity of reciprocating machinery, at relief valve outlets, or when mass velocity is very high (r*v2 > 10.000, with r in kg/m3 and v in m/s).

3.6 Dimensions

3.6.1 Pipes

Pipes with the following nominal diameters are to be avoided as far as possible, due to possible difficulties of supply (tubes as well as accessories).

NPS	1/4"	2"1/2	3"1/2	5"
DN	8	65		125

To solve problems due to the two-phase flow inside piping, nominal diameters DN 65 and DN 125 (NPS 2"1/2 and 5") are included in the cryogenic piping classes with DP $\leq$ 25 bar (pipes, elbows and reducers only)
The minimum permissible dimension for underground piping is NPS 2 (DN 50).

3.6.2 Elbows

Long radius or "3D" type welding elbows shall be used preferably (except if design conditions require short radius elbows).

Miter elbows can be used for large diameters, according to the applicable piping schedules.

In such a case, they will be designed in accordance with the relevant piping code (CODETI or ASME...). (CODETI code covers only pressures less than 20 bar, and requires specific calculation for use of mitre elbows at pressure upper than 20 bar)

Geometry of miter bend depends on tube thickness:

- when elbow tck = pipe tck: ends with angular offset welded on pipe.

E-DS-5-2-91: Mittered segments acc. to CODETI / ANSI R=DE and $\alpha \geq 30°$

E-DS-5-2-92: Mittered segments acc. to CODETI / ANSI R = 1.5x DE and $\alpha \geq 25°$

- when elbow tck > pipe tck: ends with straight offset welded on pipe, and chanffer

E-DS-5-2-93: Reinforced offset angles

E-DS-5-2-94: Reinforced mittered segments

Any angular offset upper than **3 degree** as per CODETI (§ C2.1.2.4) or upper than **1.5 degree** as per ANSE-B31.3 (§304.2.3) requires design consideration as a miter bend

3.6.3 Bolting

Dimensions of the studs and bolts used for homogeneous piping junctions are dealt with in the L'AIR LIQUIDE standards mentioned in the piping classes, in accordance with the following norms :

- NF-E.29203 and NF-E.29209 for french classes
- ASME-B.16.5 for american classes
- DIN ... for german classes

In case of "out of standard" connections, such as:

heterogeneous flanges material

addition of more than 2 spring washers (as per E-DS-5-0-2)

addition of conical filters, ...,

The lenght of studs used shall be such that a free port at either side protruding from the nut is at least equal to half diameter of the stud.

3.7 Heterogeneous connections

Only the heterogeneous connections between carbon steel and stainless steel are authorised.These connections are prohibited upstream the cold boxes, and are authorised downstream (dry gas).Considering this type of welded connection, it is necessary to limit as far as possible the dilution of carbon from the carbon steel to the stainless steel.

To use:

- A stainless steel welding material with a upper level of chromium and nickel than in the parent metal, such as E309L in the AWS classification.
- Only arc welding is to be performed, in order to limit dilution. However, a TIG root pass is acceptable

When the thickness ratio between carbon steel and stainless steel is ≥ 1,5 (case of buttwelded connections) and ≥ 2 (case of branch or socket welded connections), a prior agreement will be necessary, to demonstrate that, in the fusion area, the carbon content is lower than 150 % of the minimale content of the relevent stainless steel grade.

Example: connection with SS type Z3.CN.18.10 (carbon ≤ 0,03). Carbon is the fusion area is to be less than < 0,045.

4 INSTALLATION RULES

4.1 Guide lines

All piping entering and leaving a plot area or a processing unit shall be grouped together as far as possible. Inside plot (and outside the cold boxes), piping might be routed on overhead pipe bridges, or on above ground sleepers, or in conduits or open trenches ... Equipment that is a potential source of fire should not be located under pipe bridges.

If necessary (for some piping systems, see E-EP-5-2-2), static electricity is evacuated by interconnecting the flanges with a shunt braid and by ground-connecting each pipe section.

Each low point of moist gas transporting pipes shall be equipped with a drain. Overhead piping or their supporting racks shall have the following minimum clearances:

- 6,50 m above travelling crane passages
- 4,50 m above traffic areas and above the principal access roads (for fire-fighting vehicles...).
- 2,10 m above platforms and walkways
- 4,80 m minimum above railroads
- 3,50 m minimum above area outside roads

Above ground piping shall be installed with a minimum clearance above ground of:

- 1,00 m in areas of current service or maintenance work
- 0,60 m in areas of occasional access

4.1.1 Buried piping

shall be considered for :

- drainage or serverage
- fire-fighting water and other water lines, for protection against heat or frost
- main cooling water ducts, in order to improve access
- waste nitrogen outlet pipes, for reasons of installation or sound proofing

Buried piping shall have a minimum cover of soil:

- in areas inaccessible to heavy trafic : 0.3 m
- areas accessible to heavy traffic and at road crossing : 0.6 m

- cooling water pipes : non freezing depth

Piping crosses are to be avoided as far as possible

In ground, a 0.6 m minimum clearance shall be left between underground piping and main foundations, except in case of special arrangements (for instance common trenching).

When piping is run in banks:

- the bottoms of pipes shall be on the same plane
- the clearance between the nearest bottoms of pipes of two neighbour banks shall be more than 0.15 m
- the minimum clearance between pipes and electric cables shall be 0,30 m

4.1.2 Piping in concrete trenches

If non-buried needs to be installed below ground level it shall be laid in concrete trenches (e.g. drip-and-drain lines).

To avoid wet insulation, and for draining and cleaning purposes, the minimum clearance shall be 50 mm between the underside of any piping component and the trench bottom.

Process piping in oil and gas facilities shall not be installed in trenches, so as to prevent the accumulation of gas and liquid vapours in the trenches.

Concrete trenches shall be adequately drained into a liquid-sealed drainage system and shall be covered with grating. For plant access and road crossings, etc., a solid type of covering shall be used.

4.1.3 Piping interspace:

Overhead piping minimum interspace is mentioned in AL standard E-EP-5-0-12.

4.1.4 Piping through walls and concrete floors

Sleeves or holes through walls, floors of buildings and table tops shall have a size permitting the passage of a flange of the relevant pipe size, to facilitate the installation of prefabricated piping and to permit insulating work.

Holes through walls and floors shall be sealed after piping installation to avoid chimney draught in the case of fire and to prevent liquid drip onto a lower deck.

Special devices are used for wall crossing of the cold boxes (ref standards E-DS-5-7-10, E-DS-5-7-11, E-DS-5-7-12 and E-DS-5-2-88), as well as for protection screens around oxygen service pipes (see W-EP-1-4-2).

4.2 Additional requirements peculiar to certain pipeworks

4.2.1 Oxygen systems

The special requirements for oxygen piping systems are dealt with in standard W-EP-5-3-4.

4.2.2 Water mains for fire-fighting

The installation rules for overhead or underground water mains for fire-fighting purposes are set forth in standard E-EP-15-0-7.

4.2.3 Air or nitrogen utility systems

See standard E-EP-14-2-10.

4.2.4 Steam systems

See standard E-EP-5-3-14.

4.2.5 Cooling water

Entering cooling water lines DN ≤ 500 (20 in.) shall have blockvalves at the plot limit.

Block valves for cooling water lines DN > 500 (20 in.) are generally out of L'AIR LIQUIDE scope of supply.

For large cooling water lines the foundation requirements shall be considered.

Water flow shall be measured for each unit of group of integrated units.

Main distribution lines shall have facilities at the lowest points for complete draining within 6 hours. Venting facilities shall prevent air pockets.

Water lines which are exposed to freezing, even for a short duration, shall be protected as follows:

- open lines, particularly for intermittent flow, shall be buried or protected by heating or insulation. (For electrical tracing see E-GS-7-0-2, E-TRS-7-0-2 and E-VDR-7-0-2; for insulation see W-EP-4-3-1).
- closed cooling water systems may be protected against freezing by means of glycol.

4.2.6 Rain water and industrial water release

Refer to the standard E-GS-1-0-4.

4.3 Piping arrangement on pipe bridges

Special attention shall be devoted to piping arranged vertically to the bridge posts (flanges or valves shall not interfere with the outer beams).

The largest diameter lines shall preferably be installed along the bridge side.

Oxygen or Hydrogen bridge headers shall be arranged preferably along the outside of the bridge (safety precaution). Do not place oxygen and hydrogen pipe together.

Piping with long common runs (same origin and same destination) shall be arranged in groups.

All process piping shall be grouped on the one hand, and all utility piping, on the other hand. In case of double-level bridges, utility piping shall preferably be run at top level. Piping for low temperature liquids shall be run at the lower level.Pipe bridges shall mainly be provided for long, rectilinear pipe runs. Horizontal branch connections and elbows in horizontal plane are prohibited (except if the bridge changes direction itself).

4.4 Piping components

4.4.1 Pipe connection and bolting

The number of flanged connections shall be kept to a minimum consistent with maintenance, inspection on cleaning. Flange drill holes shall be located out of centre lines.

The here after table shows the different kinds of connections which are allowed, depending of temperature, pressure and materials.

Inside the cold boxes, flanged connection are to be avoided. Nevertheless, where they cannot be avoided, and if the insulating material is perlite (or equiv.), these connections must be protected with mineral wool (ref to standard E-EP-5-0-14). Flanges shall be implemented in special boxes insulated with mineral woole as far as possible.

Bolting is designed taking into account the minimal and maximal working temperatures, as well as the design pressure, as per hereafter table.

Use of "Invar" washer is justified whenever tightenness of the bolting is impossible in operation.

French and American piping classes

WORKING CONDITIONS				TYPE OF ALLOWED CONNECTION				
WT in °C	DP in bar	STAT (1)	Al/Cs	Al/Al	Al/SS	SS/SS	SS/Cs (2)	Cs/Cs
≥ 350	<10	G	No allowable			5	5	5
300<WT<350	All	G				4	4	4
50<WT ≤ 300	All	G or L				3	3	3
-30≤WT ≤ 50	All	G or L	6	6	6	3	3	3
-200≤WT<-30	All	G or L	No	2	1 or 0	2	No	
WT<-200	All	G or L	allow.	welded	0	welded	allowable	

(1) G = Gas; L = Liquid
(2) see § 3.7

0: Bi-metallic junction as per Dimensional Data Sheet: "TC-CEA" Transition Joints.

1: Stud bolt Z6-CN.18.09 cold drawed + spting whasher on S.S side + flat S.S washer on ALU side

2: Stud bold Z6-CN.18.09 cold drawed (A320 gr B8 cl 2)

3: Stud bolt 42CD4 (A193 gr B7)

4: Stud bolt 42CDV4 (A193 gr B16)

5: Stud bolt Z6-NCTDV.25.15 (A453 gr 660)

6: Stud bolt 42CD4 (A193 gr B7) + 1 cadmied washer on ALU side

German piping classes

WORKING CONDITIONS			TYPE OF ALLOWED CONNECTION					
WT in °C	DP inbar	STAT(1)	Al/Cs	Al/Al	Al/SS	SS/SS	SS/Cs(2)	Cs/Cs
≥ 350	< 10	G	No allowable			5	5	5
300<WT≤350	≤100	G				4	4	4
50<WT≤300	≤40	G or				3	3	3
	>40	L				4	4	4
- 10≤WT≤50	≤ 40	G	7	7	7	3	3	3
	> 40 ≤100	or	8	8	8	4	4	4
	>100	L	9	9	9	6	6	6
-200<WT<-10	All	G or	No	2	1 or 0	2	No	
WT ≤-200	All	L	allow	welded	0	welded	allowable	

(1) G = Gas; L = Liquid (2) see § 3.7

0: Bi-metallic junction as per Dimensional Data Sheet: "TC-CEA" Transition Joints.

1: Stud bolt A4-70 + spring whasher on S.S side + flat S.S washer on ALU side

2: Stud bold A4-70

3: Stud bolt 5.6

4: Reduced section stud bold Ck35

5: Reduced section stud bold Z1CrMoV5-7

6: Reduced section stud bold Z4CrMo4

7: Stud bolt 5.6 + 1 cadmied whasher on ALU side

8: Reduced section stud bold Ck35 + 1 cadmied whasher on ALU side

9: Reduced section stud bold Z4CrMo4 + 1 cadmied whasher on ALU side

4.4.2 Gaskets

These devices shall conform with the requirements of the specification sheets for each classes. Here above are the main choices criteria:

4.4.2.1 Flat gaskets

Flange facing: Ra = 6.3 to 12 micrometers. The use of flat gaskets made of asbestos with elastomers **is prohibited**. Recommanded practice consists to use flat gaskets agreed for use with O2 (BAM or L'AIR LIQUIDE D.T) :

- Expanded carbon with S.S reinforcement (Klinger KGL SLS) or nickel (Supranite NG).

- Fiber PTFE (Klinger TopChem 2000 or Supranite PGAC).

The specification must indicate the working conditions (pressure, fluids and temperature range...)

		PTFE	Graphite
Fluids	PC in bar	Temperature °C	
Air,nitrogen...	≤ 52	-196° < t ≤ 200°	200° < t ≤ 540°
Water		0° < t < 100°	
Steam		100° < t ≤ 200°	200° < t ≤ 500°
Oxygen		-196° < t ≤ 180°	

Unless otherwise stated, the thickness of flat gasket shall be:

- 1.5 mm : DN ≤ 250,
- 2 mm : 250 < DN ≤ 600,
- 3 mm : DN > 600

Note: PTFE (Klinger TopChem 2000) may be used if needed:
with air or nitrogen in case of regeneration at 1.8 bar and 300°C
for pressure >52 bar : verify with the supplier.

4.4.2.2 Graphit wounded gasket:

Flange facing: Ra = 1.6 to 3.2 micrometers

Fluids	PC in bar	Temperature °C
for all except hydrogen and CO	52 < PC ≤ 70	-196° < t ≤ 350°
Hydrogen and CO	≤ 70	-46° < t ≤ 300°

4.4.2.3 Ring-joint (RTJ)

This type of gasket is not included in DIN Norms.

Fluids	PC in bar	Temperature °C
for all except hydrogen and CO	>70	All
Hydrogen and CO	All	< -46°
	>70	≥ -46°

4.4.3 Caps

Caps shall be used instead of blind flanges whenever possible and when no operational or service requirement prevents the use thereof.

4.4.4 Tees and branch connections

Tees shall be of the buttwelding type, cast in one piece (or sometimes split and soldered). However, it is also possible to connect one pipe to the other by welding.

Bevel branch connections shall be avoided (allowed angles are 45° to 90°).

Branch connection reinforcement, if necessary, shall be calculated and made each time it is required by the pipe schedule concerned, in accordance with the relevant code.

For more details, see standard E-DS-5-2-101.

In the event of considerable expansions or vibrations (e.g. safety valves), the branch connection joint to the piping shall be made by brackets.

4.5 Valves

4.5.1 Choice of valves

The selection of the valves depends of fluids working pressure and temperatures. These devices are subject of specific standards, especially the specifications E-EP-5-4-1, E-GS-5-4-1.

4.5.2 Installation

The main installations rules for valves are indicated in the standards E-EP-5-4-1 and E-EP-5-5-5. Nevertheless, it can be noted:

- The maximum height of the centre of a valve handwheel above normal access level is 2 meters. These handwheels shall be readily accessible.
- Beyond that height of 2 meters, chain operators are permissible for non-screwed valves requiring little attendance.
- Control valves shall be readily accessible (transportable ladders are permissible).
- Stems or chain operators shall not "protrude" into a passage. The location of stems and handwheels shall be noted on the piping drawings.
- When butterfly valves are used, the disc shall have sufficient clearance to freely operate inside the piping inner diameter when the valve is in open position.

4.6 Drains and vents

A clear distinction shall be made between the various applicable drain systems considering the nature of fluids, safety aspects, recovery and cleaning possibilities.

The integration shall be initiated in the process engeneering flow schemes.

Concerning the air separation units, refer to the standard W-EP-14-2-1.

Concerning the hydrocarbon units, refer to the standard W-EP-14-2-6.

Drains shall be arranged at all low points of piping likely to transport liquids, steam or air (including the piping subjected to hydrostatic testing). Drain pipe outlets (into sewers) shall be visible to allow inspection for proper drainage.

High points of piping for liquid service shall be provided with vents (including the piping subjected to hydrostatic testing).

Drains and vents shall only have valves, when they are used in normal operation. Otherwise they are fitted with plugs. Such valves or plugs shall protude from the insulant, if any.

4.7 Safety valves installation

The requirements concerning the point of discharge to atmosphere and the installation of safety valves are defined in the standard W-EP-14-2-1.

For any particular problem, refer to API-RP.520 and API-RP.521 norms.

The piping lenght between the equipment to protect and the safety valve shall be kept to a minimum. The pipe shall be suitably supported in respect of the effects due to safety valve operation.

For hydrocarbon, toxical or hazardous gases, closed relief systems are required.

4.8 Flowmeters for 'contractual' flow measurement

All flowmeters for 'contractual' flow measurement shall be installed in straight runs of at least the lenghts set forth in standard NF-X.10102 (equal to ISO-5167).

No spiral welded tubes shall be used for the straight runs downstream and upstream of flowmeters.

The two following standard types shall be used : flanges with corner pressure taps and "vena contracta" type.

Thermometer taps should preferably be located downstream of orifice plates (min. distance from orifice plate 5 D). Except if otherwise directed in the particular specification, installation for the various fluids (dry or moist) shall conform with standard NF-X.10104.

4.9 Anchors and supports

The steel grades of supports welded on a pipe are to be in accordance with the grade of the pipe. Piping supports to be executed as per L'AIR LIQUIDE standard or particular drawing shall be designed by considering the permissible bending and the stresses due to expansion. Their location shall be noted on the piping drawing with a symbol showing the type of support. Maxi spans for straight pipe are indicated in E-EP-5-0-11.

Piping transporting low temperature or hot fluids shall be designed by considering expansion and flexibility. Expansion bends shall be provided whenever possible. Supports shall be installed such as to allow free expansion of the piping between the anchoring points.

When expansion joints cannot be avoided, the anchoring and guiding system shall be provided accordingly.

In addition to the supports shown on the drawings, secondary piping support could be provided, if considered necessary to avoid vibrations, lateral displacement and strains (subject to the approval of L'AIR LIQUIDE field manager).

5 DESIGN EXECUTION

5.1 Identification numbers, symbols, abbreviations

Each line on the drawings shall be clearly identified by its diameter, line number and pipe schedule.

This identification shall also be shown on the installation drawings, isometric drawings and list of piping.

The identification numbers and symbols used are set forth in the following standards :

- AL-RG.132.01 - Drawing up of diagrams
- AL-GR.132.13 - Valves

5.2 Drawing execution

Piping drawings shall comply with the requirements of standard AL-RG.155.33.

Isometric drawings shall be made in accordance with the instructions of standard AL-RG.155.34.

6 ENTITY SPECIFIC AMENDMENTS

The following is a list of specific engineering entity requirements that differ from those given in this standard.

These requirements are only applicable to the engineering entity(ies) for which they are listed.

Entity Specific Amendments		
Entity	Section	Description

Table of Revisions

Section	**Description**