PETROBRAS	**TECHNICAL SPECIFICATION**	Nº: I-ET-3010.2D-1200-200-P4X-004	
	CLIENT: AGUP		SHEET: 1 of 31
	JOB: HIGH CAPACITY FPSO - GAS EXPORTATION ALL ELECTRIC		
	AREA: ATAPU 2 AND SÉPIA 2		
SRGE	TITLE: **REQUIREMENTS FOR PIPING SUPPORT**		INTERNAL
			ESUP

INDEX OF REVISONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL ISSUE
A	General Revision.

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	OCT/14/22	DEC/16/22							
DESIGN	EEA	EEA							
EXECUTION	CXDI	CXDI							
VERIFICATION	CJV5	CJV5							
APROVAL	U32N	U32N							

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SUMMARY

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1 SCOPE

1.1. This Specification defines the minimum requirements and recommended practices for design, fabrication and assembly of pipe supporting of production and utility piping systems for TOPSIDE and modules of offshore projects.

1.2. In case of conflicting requirements between this technical specification and other references or requirements on project, the most stringent shall prevail and must be brought to BUYER attention. If necessary, the CONTRACTOR may revert to BUYER for clarification.

2 ABBREVIATIONS

In addition to general definitions set in reference \1\, the following abbreviations are used in this specification.

2.1 ANSI American National Standards Institute.

2.2 API American Petroleum Institute

2.3 ASME American Society of Mechanical Engineers.

2.4 AWS American Welding Society

2.5 CPVC Chlorinated Polyvinyl Chloride

2.6 CS Classification Society

2.7 DNV Det Norske Veritas

2.8 FRP Fiberglass Reinforced Pipe

2.9 GRP Glass Reinforced Pipe

2.10 IOGP International Association of Oil and Gas Producers.

2.11 ISO International Organization for Standardization.

2.12 NPS Nominal Pipe Size.

2.13 Sch. Schedule

2.14 PSV Pressure Safety Valve

2.15 PVC Polyvinyl Chloride

2.16 PVC Polyvinyl Chloride

2.17 UNS Unified Numbering System

2.18 PWHT Post Weld Heat Treatment

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3 DEFINITIONS AND TERMS

For the purposes of this document, the following definitions and terms are applicable.

3.1 *Anchor*: A completely rigid restraint providing full fixation in three planes of translation and rotation.

3.2 *Anti-vibration pads*: pads that are manufactured in a liquid-solid properties that allow it to simultaneously absorb shock and vibration energy and make it preferable to one dimensional material like rubber and other polyurethanes.

3.3 *Adjustable support*: Support that can be adjusted on field using hand tools for the purpose of line alignment.

3.4 *Axial Stop*: A mechanical restraint used to control longitudinal movement of the piping in one or two directions, but not provide rotational fixation.

3.5 *Bracing for branch connection*: reinforcement to brace the branch connection to the parent pipe used to avoid fatigue failure due to the vibration from the parent pipe.

3.6 *Constant-Effort Support*: A support device capable of applying a constant force at any displacement within its operating range.

3.7 *Critical lines*: all lines defined as critical based on stress analysis criteria.

3.8 *Damping Device*: A frictional device that increases the damping of a system, offering high resistance against rapid displacements caused by dynamic loads while permitting essentially free movement under gradually applied displacements

3.9 *Dresser couplings*: A metallic sleeve with rubber gaskets with very low axial stiffness placed between two anchors or two axial stoppers. Dresser coupling produces high loads to supports due to buoyancy.

3.10 *Dummy Support*: is a piece of pipe (the same size or one or two sizes smaller) welded onto the back side of an elbow to extend the reach of the line to the next primary pipe support.

3.11 *Expansion Joint*: A metallic bellows with very low axial stiffness calculated according to EJMA, placed between two anchors or two axial stoppers. Expansion joint produces high loads to supports due to buoyancy.

3.12 *Fabricator*: a company which is responsible for fabricating.

3.13 *Guide support*: support used to restrict lateral movement of pipe.

3.14 *Grip support*: is a kind of support that holds the pipe firmly.

3.15 *Hanger*: A support by which piping is suspended, which functions by carrying the piping load in tension.

3.16 *Hold-down*: support used to restrict vertical upward movement of pipe.

3.17 *Hollow section:* structural profile, square, rectangular, or circular shaped with rounded corner, used to improve painting adherence and corrosion resistance.

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3.18 *Line*: a run of piping with a specific identification and isometric drawing.

3.19 *Line-stop*: support used to restrict axial movement of pipe.

3.20 *Owner*: the main contractor as described on general statement of ASME B 31.3

3.21 *Pipe stress engineer*: a person qualified and experienced to undertake the stress analysis of piping systems, within the contractor or subcontractor companies.

3.22 *Pipe shoe*: structure consisting of a saddle and integral base that is used to support the pipe by transmitting the load or forces to the adjacent structure. It can be welded or clamped type.

3.23 *Pipe support*: a structure built to support one or more pipes or services. This structure may consist of steelwork, standard components, springs, welded attachments etc.

3.24 *Pipe support engineer*: a person qualified and experienced to undertake the design and analysis of pipe supports.

3.25 *Reinforcement Pad*: the same as Wear Pad

3.26 *Rest support*: A device providing support from beneath the piping but offering no resistance other than frictional to horizontal motion.

3.27 *Standard Pipe Support:* a standard construction, which preferably shall be used to build up a pipe support. The standard pipe support indicates dimension, maximum loading, paint surface, weights, etc., and is related to pipe size and actual loading.

3.28 *Special Pipe Support*: A special pipe support shall be made when the pipe support function cannot be covered by a standard pipe support, e.g., when actual loading exceeds the maximum loading of the standard pipe support, or when exceptional pipe materials are used, etc. Dimension, weights, paint surface, loadings, etc. shall be calculated and indicated as per project.

3.29 *Subcontractor*: a company to which work within an area or package has been subcontracted.

3.30 *Three Way (3-way)*: Rest support with limit stop and guide.

3.31 *Trunnion*: is a two short stubs of pipe welded to the sides of a vertical line such as to provide a pick-up support for the line that runs vertically.

3.32 *U-bolt*: commonly used pipe support type in the shape of the letter “U” with screw threads on both ends. It can be grip or non-grip type.

3.33 *U-Clamp*: commonly used pipe support type in the shape of the letter “U” with flat sheet and hole on both ends to assemble studs and nuts. It can be grip or non-grip type.

3.34 *U-strap*: commonly used pipe support designed to absorb mechanical vibration from piping by inserting rubber.

3.35 *Variable-Effort Support*: Variable spring hangers and supports are vertically moving components to compensate height displacement of piping due to thermal expansion and/or forced displacements.

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3.36 Wear pad: protection plate or pipe fixture or structural attachment attached to pipe to enhance strength of pipe wall and to prevent direct damages from welded attachment or high bearing load.

4 NORMATIVE REFERENCES

The following standards and documents include provisions, which, through reference in this text or not, constitute requirements of this technical specification. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown that they meet or exceed the requirements of the standards referenced below.

4.1 CLASSIFICATION RULES

Refer to Project General Conditions and Data Specification for nominated Classification Society. Relevant Class Rules shall apply.

SELLER's responsibilities include documents submission to the certifying authority as described in the latest edition of their rules for equipment on offshore facilities.

4.2 CODES, STANDARDS AND REGULATIONS

In addition to rules and regulations set forth in reference \2\, the following codes and standards are applicable to piping supports.

AISC - American Institute of Steel Construction.

API RP 2A-WSD - Planning, Designing, and Constructing Fixed Offshore Platforms—Working Stress Design.

ASME B31.3 - Process Piping.

ASME B31.8 - Gas Transmission and Distribution Piping Systems.

EJMA - The Expansion Joint Manufacturers Association.

Energy Institute - Guidelines for the Avoidance of Vibration Induced Fatigue Failure in Process Pipework.

ISO/DIS 24200 – Petroleum, Petrochemical and Natural Gas Industries – Bulk Material for Offshore Projects – Pipe Support.

MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

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4.3 REFERENCE DOCUMENTS

The following documents are cited or not within this technical specification and therefore constitute requirements for the piping supports.

Ref. #	Doc. No.	Doc. Title
\1\	I-ET-3010.00-1200-940-P4X-002	General Technical Terms
\2\	I-MD-3010.2D-1200-940-P4X-004	Descriptive Memorandum – General
\3\	DR-ENGP-I-1.1	Piping Standard and Material for Oil Production and Process Facilities
\4\	I-ET-3010.2D-1200-200-P4X-005	Minimum Requirements for Piping Mechanical Design and Layout
\5\	I-ET-3010.2D-1200-200-P4X-006	Requirements for Piping Stress and Flexibility Analysis
\6\	I-ET-3010.00-1200-200-P4X-003	Design, Construction and Assembly of FRP Piping
\7\	I-ET-3010.00-1200-956-P4X-002	General Painting

5 DESIGN CRITERIA

5.1 The supports shall be designed to meet all static and operational conditions to which the piping system are subjected.

5.2 Designer shall adopt a recognized Code, Rule or Standard for the design criteria.

5.3 Pipe weld attachments shall be designed in accordance with the piping/pipeline Code.

5.4 The pipe supports shall be located to minimize deflection of pipe during normal design conditions. Liquid pockets are to be avoided.

5.5 Guides and supports allowable loads must be calculated considering ship inclining condition, mainly on thicker pipes. Lateral loads on guides are to be considered as 30% of vertical loads as basis, unless otherwise required by the piping stress analysis.

5.6 Lines according to ASME B31.8, clamps and supports shall be designed in accordance with the requirements of API RP 2A-WSD, Section 3.

5.7 It is the Piping Stress Analyst's responsibility to provide loads for non-structural pipe support steel frames as required. These calculations are to be numbered and filed for future reference.

5.8 Unless otherwise specified by the piping stress analysis all control valve sets shall be three way (3-way) at one end and rest plus guided at the other. Normally the three way (3-way) would be on the upstream side of the control valve.

5.9 Pipe supports attached to flange connections shall be avoided unless approved by Piping Stress Engineer.

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5.10 All guides for lines up to 6” will have Hold Down facilities provided, unless otherwise directed by stress analyst.

5.11 Support intervals shall be determined according to maximum pipe support span.

5.12 The typical gaps on either side of guides shall be 2.0 mm unless otherwise required in the piping stress Analysis. Lines subject to vibration may require no gap and this shall be indicated on the support draws.

5.13 The allowable loads for each piping support component shall be tabulated on the piping support standard detail drawings.

5.14 The load carrying capacity of a piping support consisting of a combination of standard components is limited to the lowest load of all components.

5.15 Where the load specified by the piping stress analysis is beyond the standard detail specified load the piping stress analysis shall provide an alternative design for piping layout or a special support shall be calculated.

5.16 Temporary supports shall be clearly identified on field and documented to ensure their correct removal, at least on isometrics and stress analysis report. Temporary supports shall be marked with a metal tag stamped ‘REMOVE AFTER INSTALLATION’ and yellow painted.

5.17 Pipe supports adjacent to strain sensitive equipment (i.e., compressors and pumps) shall be adjustable supports type. These adjustable supports shall be located adjacent to equipment nozzles unless otherwise specified by the piping stress analysis.

5.18 Lines up to NPS 1½ shall be guided on every rest support, and NPS 2 and up guided on every second support, unless otherwise specified by piping stress analysis.

5.19 Supporting pipes from other pipes is not allowed, unless approved by piping stress analyst.

5.20 Spring supports are to be kept to a minimum as much as possible.

5.21 Spring supports shall be according ASME B31.3, MSS SP-58 and requirements set forth in reference \5\.

5.22 Supports should not encroach on headroom clearance, escape/maintenance routes and lay down areas.

5.23 Rest support shall not sit directly on the grating but shall penetrate to a structural member.

5.24 For lines with multiphase flow or subjected to vibration the piping supports shall be installed on a rigid point on the floor (over or near a beam).

5.25 Standard Pipe Support shall have anti-vibration solutions for piping systems subject to vibration or pulsation according to piping stress analysis.

5.26 Use of U-bolt shall be limited to NPS 6 and below diameter pipes for guide and limited to NPS 3 and below for stopper and anchor purpose. Each condition shall be clearly identified on the support detail drawings.

5.27 U-bolt shall not be used as rest support.

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5.28 Support location and type shall allow for assembly and dis-assembly of maintenance component (such as flanges valves, strainers, etc.) without having to remove or disassemble support.

5.29 Sloping lines NPS 6 and up are to be on shoes with a preferred minimum height of 100mm. Height indicated is at the midpoint of the shoe.

5.30 Supports for insulated lines shall avoid damage to insulation due to line displacement and shall be pipe shoe type. Pipe shoe height shall be higher than insulation thickness.

5.31 Shoe standard height is 100mm unless noted otherwise. Shoe standard length is 300mm unless noted otherwise.

5.32 For cooling water HVAC systems lines, to consider the effects of low temperature and water condensation on the surroundings.

5.33 All pipe supports which transmit loads above 30 KN to a structural member shall be closely coordinated with, and approved by, the Structure Department.

5.34 Location of supports shall maximize the use of existing structure with additional structural members being kept to a minimum.

5.35 Generally, is not allowed unbraced Cantilever supports from double bottom deck plate, supports fixed to truss diagonals, supports which will cause torsion in the structural steel member and supports onto unstiffened deck plate.

5.36 All axial expansion joints or other coupling types (except swivel joints) shall be obligatorily placed between 2 anchor points or axial stops, and between those points there can only be one expansion joint. These anchors shall be calculated for the thrust forces and the structure of pipe racks shall also be calculated for these forces and reinforced if necessary.

5.37 First and second supports after a point of high delta pressure depressurizations shall be integrally reinforced, the element welded to the pipe shall cover all the circular pipe section.

5.38 For guides and hold-down, where the accomplish with item 10.4 is not possible, an escalope shape as per ISO 24200 shall be used.

5.39 Anchor and stopper support for metallic lines shall be welded. It is not allowed bolted type.

6 PIPE SUPPORT NUMBERING

6.1 Each pipe support shall be given its own unique identifying number.

6.2 Supports are indicated on isometrics with full indications. The full indication consists of a combination of letters and numbers, giving the type, size and material specification of the support parts, and its unique identifying number shall also be indicated.

6.3 Whenever possible, each pipe support should have code type identification number marked on the support.

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6.4 The project shall issue a support list easy to handle and understand, with instructions for anyone who does not belong to the project identify support drawings, locations, weight, allowable loads, materials, and painting.

7 MATERIAL

7.1 All welded wear pads shall have the same p-number material as parent pipe, with the following exemptions:

7.1.1 For duplex (e.g., UNS S31803) and superduplex (e.g., UNS S32760) stainless steel piping, the wear pads may be made from duplex or superduplex stainless steel, interchangeably, or from 316L (UNS S31603) stainless steel (the later for design temperatures below 60°C).

7.1.2 For nickel alloys (e.g., UNS N06625) the wear pad may be made from 316L (UNS S31603) stainless steel (the later for design temperatures below 60°C).

7.2 The material selection for supports shall consider the minimum and maximum operating temperature and the design temperature.

7.2.1 Materials shall be preferable according to ISO 24200.

7.2.2 Charpy testes may be required for low temperature operation/design temperature.

7.2.3 For carbon steel ASTM A36 Charpy impact test for service temperature below 0 °C is required.

7.3 Material for pipe supports is not required to be traceable to material certificates after fabrication. Fabricators must have a system to control and identify material grades during fabrication and be able to certify that the correct materials have been supplied in each component.

8 WELDING OF SUPPORTS

8.1 It is not allowed to weld lugs, clips, beams, trunnions, dummy legs direct or any other device on pipe outside wall, except using wear pads. All support or device shall be attached to wear pads.

8.2 Bonded pad, metallic or non-metallic, is not allowable on metallic pipes. It is not considered as welded.

8.3 All supports welding shall be performed by qualified welding procedures.

8.4 Welding symbols shown on pipe support drawings shall be in accordance with the symbols from the AWS. For detailed instructions, see their publication “Welding Symbols and Instructions”.

8.5 All tack welds on the base plate, low support (sliding type) with deck plate or structure shall be removed before final check of supports

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8.6 All support construction shall be continuously welded on sides of the support, unless otherwise indicated. Where continuous welds are impractical to be made, water penetration, fret formation and corrosion shall be avoided, epoxy may be used for this purpose. This item is also valid for structural member, e.g., H-beam, L-shape, hollow section, and welds between supports and structure.

8.7 When welding supports to the outside of an internally coated piping, the risk of burning internally the wall shall be taken into consideration and measures to recover the original material condition shall be done in case of burning.

8.8 Welded attachments to pipe classes that are galvanized shall be highlight on piping isometric.

8.9 For all piggable lines according ASME B31.8, when members are to be welded to the pipe they shall fully encircle the pipe and be welded to the pipe by a full encirclement weld. The support shall be attached to the encircling member and not to the pipe.

8.10 Welding of supports directly to a main structural member (piles, legs, bracings etc.) shall be prohibited without double plates.

9 CORROSION PREVENTION

9.1 Corrosion rates in the marine atmosphere are high. Pipe support details shall be designed to minimize corrosion. Details that should be avoided are stitch welding, details that cannot be coated, bolted connections, details that hold weld attachment (allows weld attachment accumulation between pipe and support).

9.2 Spring support, dampers and snubbers shall be indicated on purchase documents that it will be applied on maritime environments.

9.3 Due to the risk of fretting corrosion and leakage, it is not permitted the use of bonded/glued wear pads on metallic pipes in substitution for welding. Some welded supports have no access to be fully weld, for example guides because of the small gaps. In that case, it is required to use bonded/glue or epoxy to cover the inner fret.

9.4 Support and structural members shall be made by hollow sections profiles (Figure 1).

9.4.1 NOT APPLICABLE.

9.4.2 It is not acceptable the use hollow section made of welded profiles or plates.

9.4.3 Hollow section shall not have crevice.

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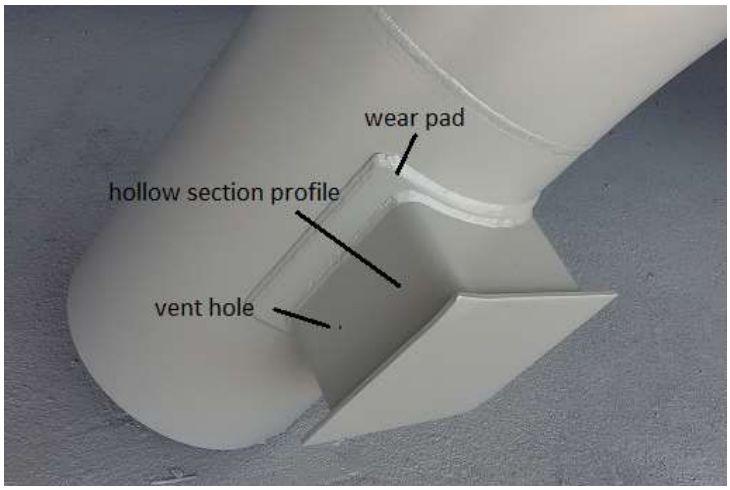


Figure 1 – Hollow section piping support

9.5 Whenever hollow sections profiles are not possible to be used, all corners shall be grinding (rounded) with a radius from 2 to 3 mm.

9.6 All non-pressure retaining pipe attachments that are enclosed (e.g., reinforcing pads, trunnions) must have a vent hole (minimum 6 mm diameter). This vent hole must be sealed with mastic to avoid corrosion within the attachment. On Figure 1 either hollow section and wear pad shall have the vent hole.

9.7 Direct contact between pipe material and structure / structural steel / Non-coated U-Bolt / Clamp / U-strap is not allowed. For piping NPS 6 and higher the use of welded wear pad is required. For piping below NPS 6 a half round bar from Acetal / phenolic cotton of at least 11/13” thickness shall be inserted between support and pipe to avoid any direct contact, independent of material. The sheet from PTFE / Bakelite / Neoprene shall be grip or fastened by support. The U-Bolt, clamp and U-strap shall be similarly isolated from the pipe.

9.8 Whenever possible the metal-to-metal contact of supports (support-support and support-structure) should be avoided using a half round bar from Acetal / phenolic cotton, independent of material, but always in case of dissimilar materials.

9.9 Clamp and support design shall avoid the corrosive effects of moisture retaining gaps and crevices and galvanic dissimilar metals. A half round bar from Acetal / phenolic cotton shall be used between clamp and pipe, the use of nonmetallic plate/sheet is not allowed.

9.10 Welding metallic pad on support or structure, even if it has the same material as pipe, do not exempt to attempt the item 9.7 and 9.8.

9.11 Pipe nonmetallic material as CPVC and GRP do not need to comply with item 9.7 and 9.8, except if required by vendor.

9.12 Supports nonmetallic material requirements:

9.12.1 The nonmetallic material used shall be non-hygroscopic and adequate to the loads that are expected. The material shall not deform, wrinkle, or crack during operation. The material properties may not change substantially during operation.

9.12.2 The used material shall be UV resistance.

9.12.3 For NPS 4 and higher the use of 2 or more half round bar closely on the same support is required.

9.12.4 The use of half round bar format may be substituted for plate/sheet on guides, trunnion, and stanchion, but never on rest supports.

9.12.5 The thickness of the half round bar shall be 11/13” or higher. Where acceptable the use of sheet, the thickness shall be 10 mm. Those thickness, half bar and sheet shall be achieved in one layer, it is not allowed to bond/attach two or more material layer to achieve the final thickness.

9.12.6 The material shall be hard enough to be compatible to piping loads that will be subjected. The maximum compressing and shear load shall be informed.

9.12.7 The maximum operating temperature shall be compatible with the intended use and informed on documentation.

9.12.8 The half round bar and sheet shall be bonded and bolted to its base. The use of U-bolt is allowed for up to NPS 6.

9.12.9 The bolt shall be SS 316L or hot deep galvanized in accordance with ASTM A153. Bolts are to be in accordance with ASTM A193 / A193M, and nuts in accordance with ASTM A194/A194M.

9.12.10 Half round bar or sheet support design shall guarantee that will not have contact between bolt and pipe or support attached to the pipe, wear pad, pipe-shoe, cradle, saddle, or trunnion.

9.12.11 Despite the presence of the bolt, half round bar and sheet must be bonded to the structure. The adhesive shall be compatible with the involved material and have an explicit indication of use with the involved materials by manufacturer.

9.12.12 The use of the same sheet for more than one pipe/support is nor allowed.

9.12.13 The width of sheet shall be as narrow as possible.

9.12.14 The width of the nonmetallic material shall never be larger than the base where will attached.

9.12.15 It is allowed to bond the material to a painted surface. But the adhesive tests and the installation procedure shall reflect this condition.

9.12.16 The adhesive shall be tested. Its endurance and durability shall be evaluated and compatible with installation purpose and local, loads and unit design life.

- Test: Lap shear adhesion strength – Short Term.
- Test Methods: BS EN 1465, ASTM D3165, ASTM D5868.
- Property: Shear strength of bonding between PTFE and Metal.

Minimum Value: 4 MPa.

- Lap shear adhesion strength – Long Term / Ageing in salt spray.

- Test Methods: BS EN 1465, ASTM D3165, ASTM D5868.
- Immersion: Joints PTFE/Metal in salt-spray after 1000 hour (cycles with salt-spray and UV).
- Property: Shear strength of bonding between PTFE and Metal.
- Minimum value after ageing: 4 MPa.

- Test: Glass transition temperature (Tg)

- Test Methods: ISO 11357-2, ASTM E831, ASTM E1640, ASTM E6604
- Minimum Value: 70ºC.

- Test: Flame spread and Smoke generation

- Test Method: ASTM E84, ISO 14692 – requirements in the standards.

9.12.17 A procedure for the nonmetallic application shall be issued and send for BUYER comments.

9.12.18 The friction coefficient between the support surfaces shall be known and used on the stress analysis according to set forth in reference \5\.

9.12.19 Other solutions than half round bar shape for nonmetallic material may be sent for BUYER assessment and acceptance.

9.12.20 Other material than Acetal and phenolic cotton may be acceptable if comply with these requirements and the material shall be strong, rigid, and tough. The proposed material shall be sent for BUYER assessment and acceptance.

10 ATTENTION REMARKS

10.1 This section contains experiences to be taken into consideration before issue drawings supports for any intention. Failure to attend these recommendations shall be previously approved by BUYER.

10.2 Avoid wide guides and areas not accessible for painting.

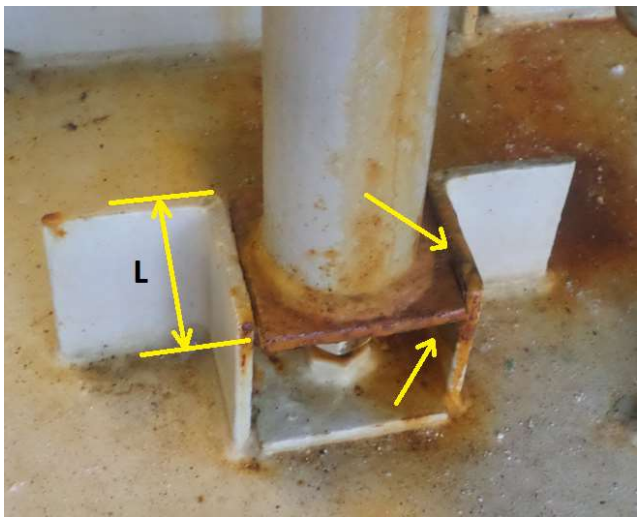
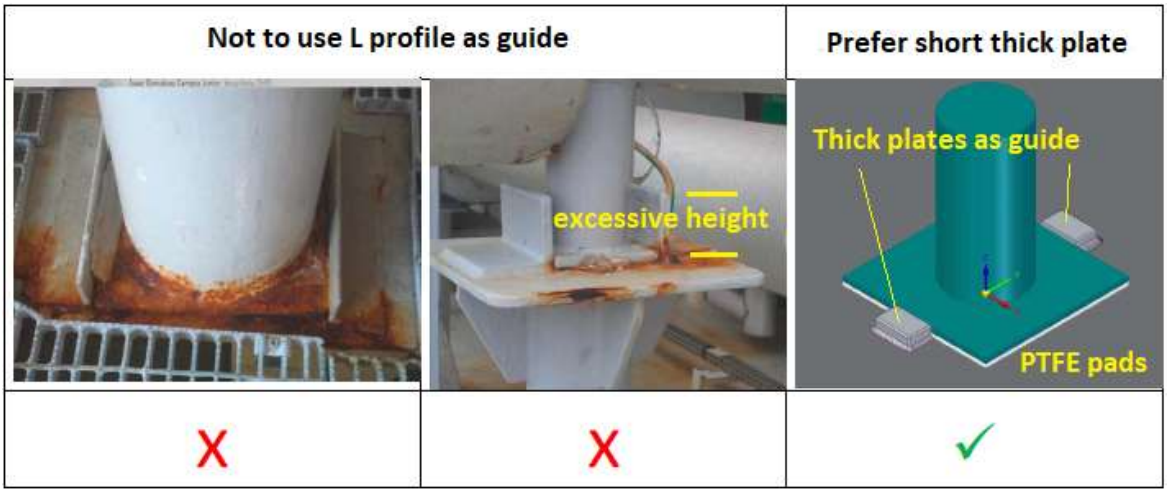


Figure 2 – Design of guide that shall be avoided

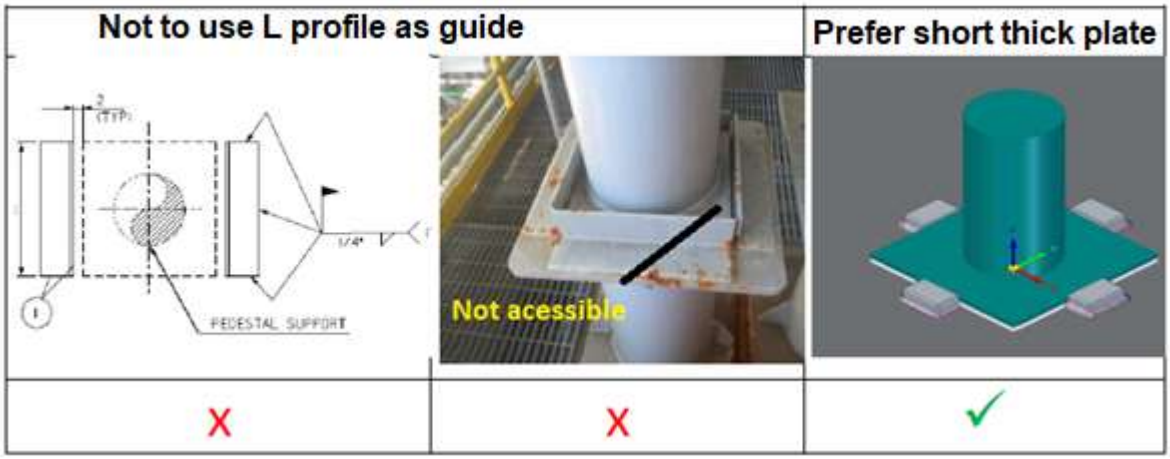
10.3 It is not indicated the use of L profile as guide Figure 3 (a) and (b). It shall be preferrable used thick plates as guides, Figure 3 (c).



(a) (b) (c)

Figure 3 – Design of guide support that shall be avoided (a) and (b), and design that is preferrable (c)

10.4 Avoid L profiles as stopper (Figure 4 (a) and (b)). This profile is not welded at the inner parts. Use thick plates (1 inch thick for example), Figure 4 (c) and weld all sides to avoid crevice and corrosion.



(a) (b) (c)

Figure 4 – Design of guide support that shall be avoided (a) and (b), and design that is preferrable (c)

10.5 Avoid L profiles as hold down (Figure 5 (a)). It is preferrable to use scalloped plates as indicated on ISO 24200 (Figure 5 (b)).

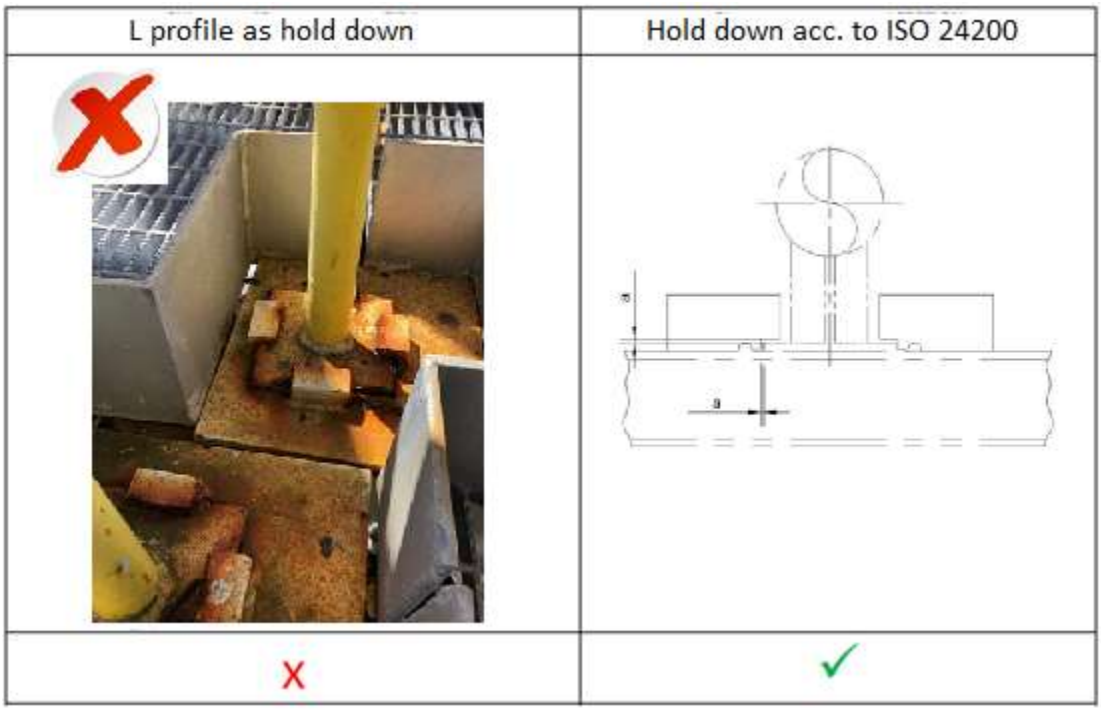


Figure 5 – Design of hold-down support that shall be avoided (a) and (b), and design that is preferrable (c)

10.6 Use hollow section whenever possible (Figure 6). When using U-bolts, the use of hollow section may be not possible. In this case use L profile with rounded sharp corners. It is indicated the use of appropriated tool to round corners (Figure 7).

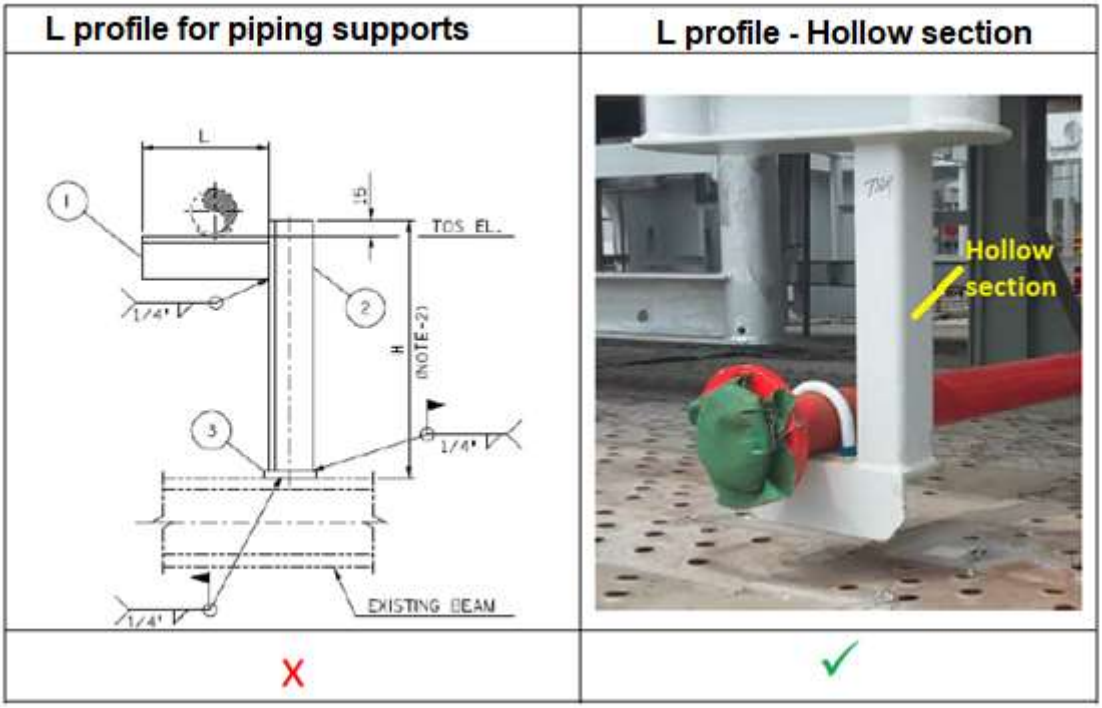


Figure 6 – Design of structural support that shall be avoided (a), and design that is preferrable (b)

Figure 7 – Design of structural support that shall be avoided (a), and design that is preferrable (b)

10.7 It shall be included on design support drawings a recommendation to paint the holes after drilling and before assembling bolted elements as for example U-clamp (Figure 8 example of what shall not be done). Assemble shall be done using metallic washer and PTFE washer at both ends to avoid painting damage during assembling. Preference for perforated L profile in small diameters. Avoid to open holes using torch. The hole and the area between nuts shall be fulfilled with grease, mastic or epoxy to avoid trapped oxygen.

Figure 8 – Hole for bolts drilled with no precaution for not damaging the paint and with no preservation during assemble

10.8 Support type clamp shall be avoided because it is the source of fretting corrosion (Figure 9).

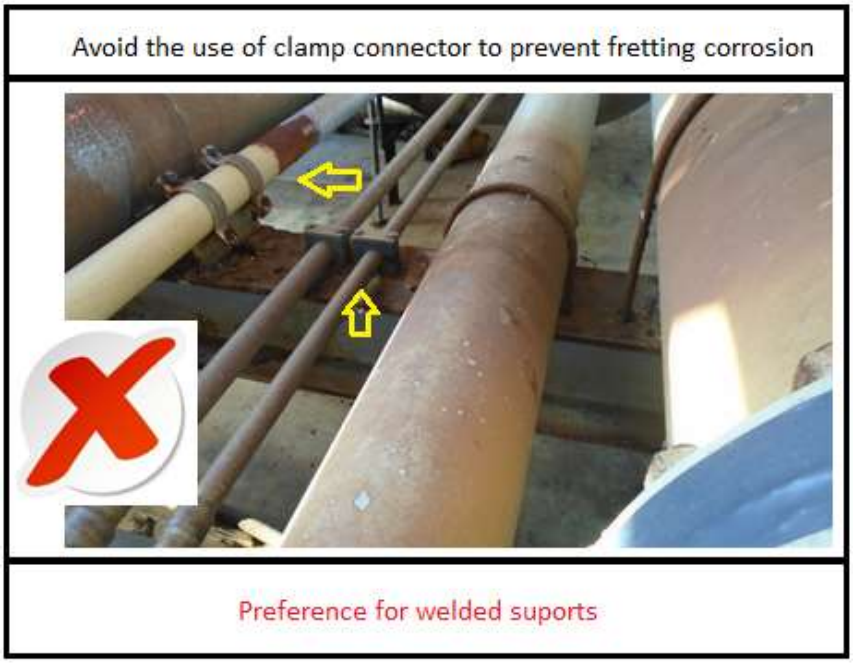


Figure 9 – The use of clamp supports shall be avoided

10.9 The drawing shall be issued with hollow sections and nonmetallic half round bar (Figure 10).

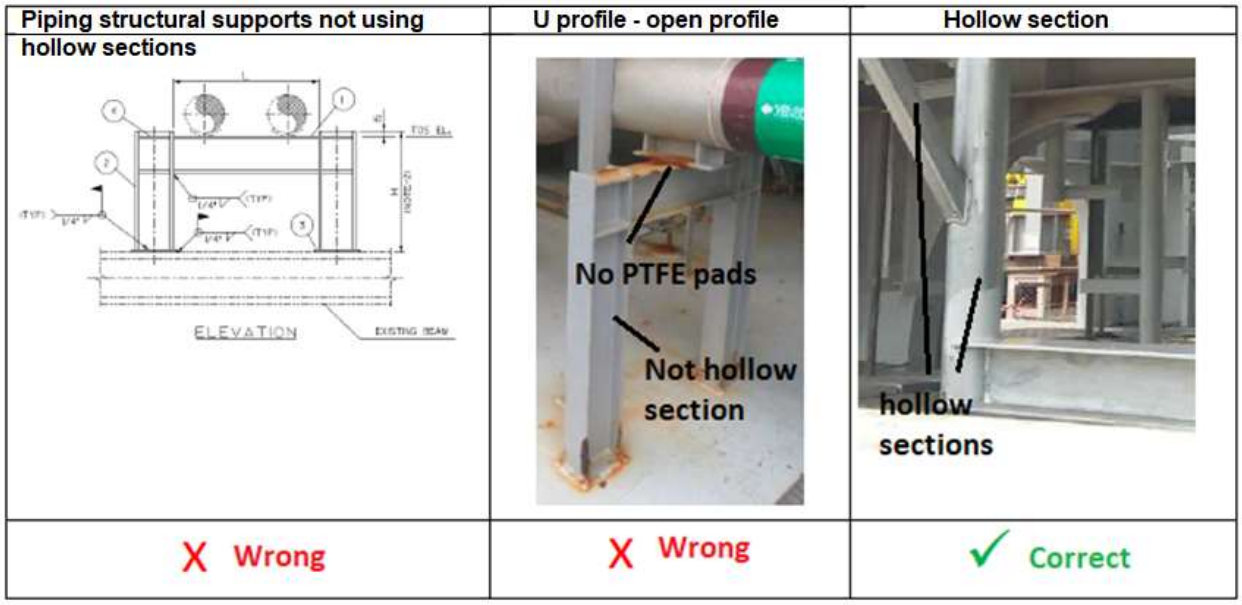


Figure 10 – Example of supports that do not use hollow section and shall not be used (a) and (b). Example of correct use of hollow section support (c)

10.10 Weld supports not directly on pipe surface, but on metallic wear pads (Figure 11).

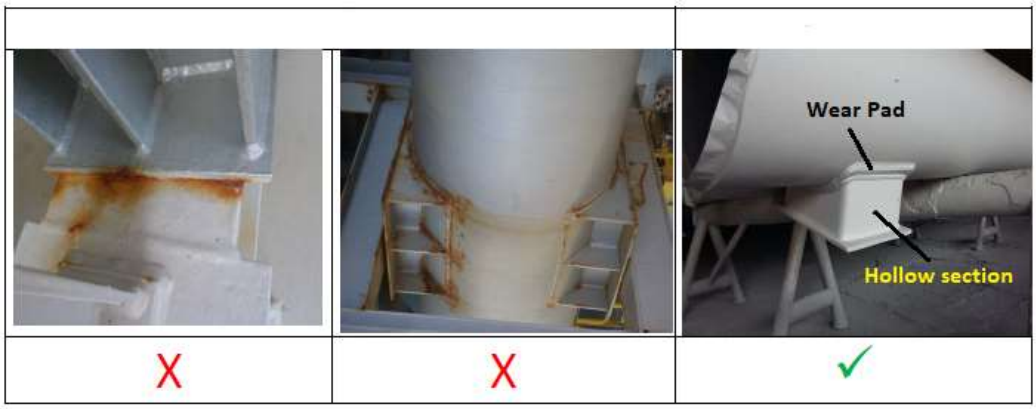
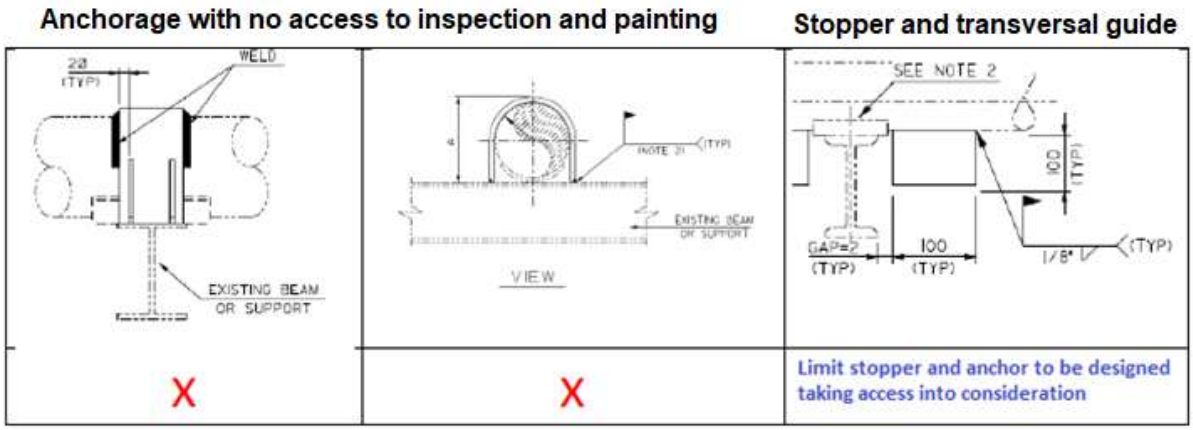


Figure 11 – Examples of supports thar are welded to the pipe without wear pad (a) and (b). Example of support that shall be used with wear pad (c)

10.11 It is not allowable to use welded clamps as anchor or limit stopper (Figure 11 (a) and (b)).



(a) (b) (c)

Figure 12 – Example of welded clamp that shall not be used (a) and (b). Example of appropriate limit stopper (c)

10.12 Bare U clamps shall not be used. U-bolt shall have nonmetallic material on pipe contact (Figure 13 (a)) and a non-metallic round half round bar shall also be used on clamps (Figure 13 (b)).

(a) **(b)**

Figure 13 – Example of preferable types of contact between U-bolt and pipe (a) and clamps and pipe (b)

10.13 Lines subject to vibration shall be supported with specific solutions, including supports from specialized companies (Figure 14). Dampers, snubber, special clamps and strut may be used as specific solution.

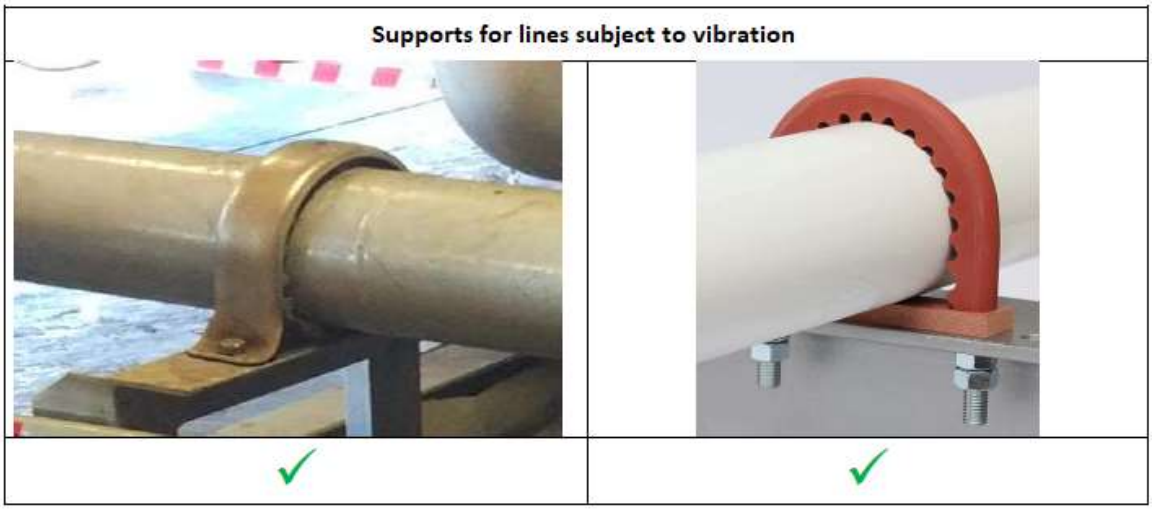


Figure 14 – Other example of solutions for lines subjected to vibration

10.14 The painting system shall be followed for piping supports.

10.15 Attention to the interface between piping and instrumentation (Figure 15).

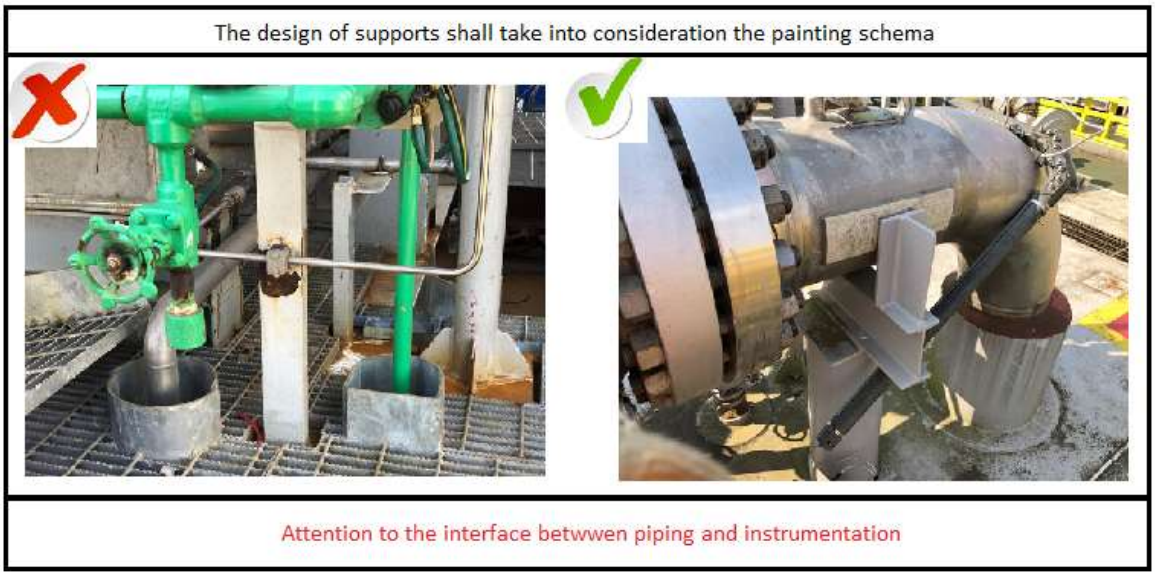


Figure 15 – Carefully with piping and instrumentation interface

11 PAINTING

11.1 WELDED ATTACHMENTS shall be painted in accordance with specification for parent pipe.

11.2 All pipe attachments e.g. clamped shoes etc. which are beneath insulation, shall be painted in accordance with specification for parent pipe.

11.3 Painting supports shall comply with requirements set forth in reference \2\.

12 FASTENERS

12.1 All bolts and nuts shall be hexagonal type confirming to ISO respectively with the thread specified as follow:

Class of finish: C in ISO 4759 /1

Accuracy of thread: Coarse in ISO 965

Basic Profile: ISO 68

General Plan: ISO 261

Basic Dimensions: ISO 724

12.2 Bolt hole diameters in supports and supporting steelwork shall be rod / bolt diameter + 2 mm for up to 24 mm diameter and + 3 mm for larger diameter.

12.3 All bolt holes shall be drilled on standard back marks.

12.4 All threads shall be metric “right handed”, unless otherwise specified.

12.5 Coatings for studs, bolts and nuts shall follow the same specification for coating of bolts and nuts on main pipe.

13 SUPPORT FOR SMALL BORE CONNECTIONS

13.1 Drains, vents, and instrument connections arrangement shall be according to Annex C set forth in reference \4\ and reference \5\.

13.2 Welded gusset plate clamps/braces support should be installed preferably rather than using non welded brace/clamp supports.

13.3 Two plane bracing of small-bore branch connections 2” and smaller is required for all piping subject to vibration, pulsation, or multiphase flow.

13.4 Plate as bracing shall not be used, as it does not have sufficient rigidity.

13.5 Two plane bracing of small-bore branch connections 2” and smaller is required for upstream and downstream lines of pumps, compressors, turbines, overboard lines, control valves, orifice plates, and PSV.

14 CALCULATION OF MAXIMUM SPANS BETWEEN SUPPORTS

14.1 A maximum span between supports shall be defined for piping that does not require stress analysis report (flexibility). For piping with stress analysis report the piping spam shall comply with reference \5\. MSS SP-58 maximum span may be used as reference.

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14.2 The maximum spam reference tables presented on Annex A shall be used as reference.

15 CALCULATION OF LOADS ON SUPPORTS

15.1 Calculation of loads on supports is for weights, frictional and anchor forces acting on the piping supports. In case of supports for many pipes, it is not necessary to consider the added weight of all piping full of water (hydrostatic test situation), only having to consider, at the designer's discretion, the water weight in some pipes which may be simultaneously tested, considering the other empty or the weight of all pipes full of operating fluid, whichever is higher. This criterion shall be submitted to approval of BUYER. An overload of 1500 N shall be considered as one to each support, and not to each piping in the same support.

15.2 For calculation of weights on supports, it may be assumed that half of the total weight of piping and accessories existing in the span between two supports is acting on each support. In case of supports for a large number of pipes, it may be assumed that the weights are equally distributed along the support, provided the weights of pipes are not very different among each other. This simplified calculation conditions may not be adopted for the calculation of weights in spring and counterweight supports.

15.3 The friction forces shall be calculated in all supports in which there may be a pipe (or pipes) movement in relation to the support in piping with nominal diameter above NPS 3. In the case of steel-on-steel movement approved by BUYER, a friction factor of 0.3 shall be considered. Otherwise, is required the use of PTFE/Bakelite/Neoprene to avoid metal to metal contact, then use friction factor equals 0.1. In any case, the friction forces shall be considered as acting in both directions. When the pipe has side displacement on the support, the friction force resulting from this displacement shall also be considered.

15.4 For calculation of resulting horizontal force due to frictional force of many pipes standing on the same support, consider a simultaneity factor in relation to the number of pipes, as indicated in Table 1.

Table 1 - Simultaneity Factor in Relation to Number of Pipes

Number of pipes	1 to 3	4 to 7	Above 7
Simultaneity factor	1	0.75	0.5

15.5 In piping restraint points (anchors, guides, and stops), there is the simultaneous action of reactions due to thermal expansions and to friction reactions resulting from friction forces developed in supports near the considered anchoring. The following procedure is recommended to calculate the joint action of these reactions: [Recommended Practice]:

a) Calculate the reaction due to expansions, in each restraint, without the friction effect on supports.

b) Calculate the reaction due to expansions, in each restraint, with the friction effect on supports.

c) Consider the most critical case among those above.

d) If b) results in the most critical condition, it may be considered that, at the designer’s discretion, the friction is simultaneously acting on 70 % of the supports.

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15.6 For dimensioning of supports, shoes and restraints, the forces resulting from the wind and hull deflection and blast shall also be considered.

15.7 For piping occasionally subjected to temperatures higher than those from normal operation, resulting from operating or maintenance transients, such as: steam out, random exothermic reactions, among others, the supporting solution shall consider the occasional nature of these transitional conditions, operating safety, and costs.

16 PSV and BDV

16.1 All lines downstream PSV or BDV shall have strength to resist the discharge forces (thrust load) and vibrations resulting from the rapid expansion of the gases and shall have a line stop.

16.2 Lines that discharge to open atmosphere to have special attention, recommending the use of clamps and stoppers to avoid large bending moments. These lines shall be fully supported.

17 FIXED WATER/FOAM WITH NOZZLE

17.1 All firefighting equipment type water or foam nozzle with thrust forces on operation, shall be supported with an anchor at its base to resist the forces and moments according to manufacturer brochure (Figure 16). This anchor is to avoid excessive loads on piping and accidents.

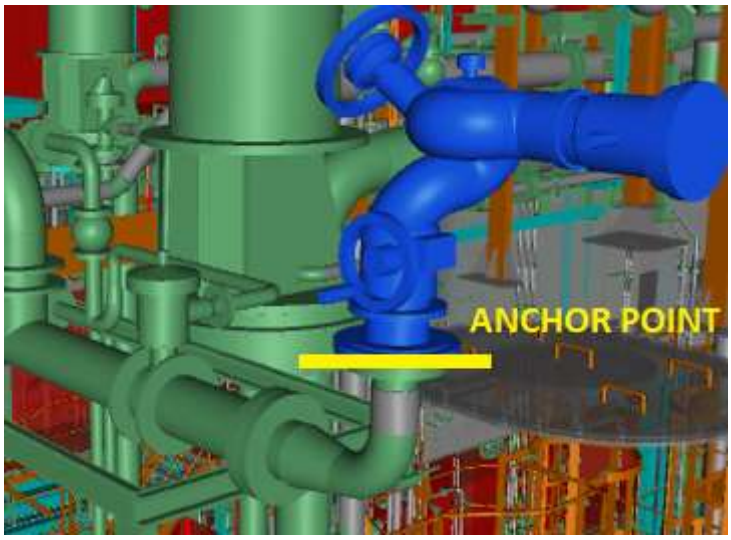

Figure 16 – Example of point for an anchor support at firefighting equipment base

17.2 Firefighting lines shall be fully supported.

17.3 This type of anchor point may be bolted on flange connection, this is an exception to item 5.39.

18 PRESSURE VESSELS AND TANKS

18.1 Support type clip on pressure vessels on lines susceptible to vibration, mainly on two phase fluids is not allowed. Before support any pipe on clips, verify if the flow is not turbulent or two-phase type and only proceed if there is no risk of vibration.

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18.2 The welding of pipe supports directly to vessels is not allowed. Where a support from a vessel is required, a clip shall be provided & incorporated in the vessel design.

19 PLASTIC PIPING

19.1 GRP, FRP, PVC, CPVC are considered plastic pipes.

19.2 All plastic piping shall be supported according to manufacturer recommendation.

19.3 All FRP piping are to be provided with a saddle, glued to the pipe, at the point of contact with the support.

19.4 For FRP/GRP system where there are long runs, it is possible to use the low modulus of the material to accommodate axial expansion and eliminate the need for expansion joints, provided the system is well anchored and guided. In this case, the designer shall recognize that the axial expansion due to internal pressure is now restrained and the corresponding thrust loads are partly transferred to the anchors.

19.5 In case of valves or other heavy attached equipment on plastic pipes, it shall be adequately and, if necessary, independently supported. For valve weight, take into consideration that valve actuator weight and torque shall also be considered.

19.6 Plastic piping shall not be used to support other piping.

19.7 It is important to ensure that the attachment of hoses at locations such as utility or loading stations does not result being pulled in a manner that can overstress the material.

19.8 Small pipe branches that are susceptible to shear damage, should be designed with reinforcing gussets and impact shielding may be required.

19.9 External dimensions of GRP may vary according to pipe thickness and may affect support dimensions. Some supports are to be specifically to be used within GRP and to be includes in Support Standard to be issued.

19.10 Hydraulic design shall be done by process discipline or pipe stress engineer and hydraulic loads, water hammer shall be taken into consideration when designing GRP supports.

20 SUPPORT STANDARD BOOK

20.1 A support standard document has to be issued by detailed engineering design company with all recommendations of this technical specification.

20.2 For any non-metallic pipe, the manufacturer recommendations for supports have to be included on support standard to be issued. Examples are PVC, CPVC, FRP, GRP, etc.

20.3 For tubing that are scope of piping discipline, shall be included the manufacturer recommendations for support on support standard to be issued by detailed engineering, including on isometrics.

20.4 Any other recommendation that are considered important for the good practice engineering to be included by designer.

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20.5 It is allowable to include on support standard commercial supports from specialized companies. This includes modular support for small bore pipes and tubing.

20.6 Designer shall submit a pipe support standard book which shall include the maximum allowable loads for each support.

20.7 Hydraulic design shall be done by process discipline or piping stress analyst and hydraulic loads, water hammer shall be taken into consideration when designing supports.

21 SPECIAL SUPPORT BOOK

21.1 A special support list with all drawings has to be issued by detailed engineering design company with all recommendations of this technical specification.

21.2 For these supports it is necessary to issue all the calculations report and maximum allowable loads.

21.3 For each support shall be indicated the support location.

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ANNEX A

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			Maximum spam 1.6 mm corrosion allowance						
			Pipe + water	Pipe + water + insulation					
			35 °C	35 °C a 200 °C		201 °C a 330 °C		331 °C a 400 °C	
Diameter		Thickness	spam	Insul	spam	Insul	spam	Insul	spam
DN	NPS	SCH	mm	mm	m	mm	m	mm	m
15	1/2	80	2,7	38	2,3	51	2,1	63	1,9
15	1/2	160	2,8	38	2,4	51	2,2	63	2,0
15	1/2	XXS	2,8	38	2,4	51	2,3	63	2,1
20	3/4	80	3,0	38	2,6	51	2,4	63	2,3
20	3/4	160	3,1	38	2,8	51	2,6	63	2,4
20	3/4	XXS	3,1	38	2,8	51	2,6	63	2,5
25	1	80	3,4	38	3,1	63	2,8	63	2,7
25	1	160	3,5	38	3,2	63	2,9	63	2,9
25	1	XXS	3,5	38	3,2	63	3,0	63	2,9
40	1 1/2	80	4,1	51	3,7	63	3,5	63	3,5
40	1 1/2	160	4,3	51	3,8	63	3,7	63	3,6
40	1 1/2	XXS	4,3	51	3,9	63	3,8	63	3,7
50	2	40	4,4	51	3,9	63	3,7	63	3,7
50	2	80	4,6	51	4,2	63	4,0	63	4,0
50	2	160	4,8	51	4,4	63	4,3	63	4,2
50	2	XXS	4,8	51	4,5	63	4,3	63	4,3
80	3	40	5,5	63	5,0	63	4,9	63	4,8
80	3	80	5,7	63	5,2	63	5,2	63	5,1
80	3	160	5,9	63	5,5	63	5,4	63	5,3
80	3	XXS	5,9	63	5,5	63	5,5	63	5,4
100	4	40	6,2	63	5,7	63	5,6	89	5,4
100	4	80	6,5	63	6,0	63	6,0	89	5,7
100	4	120	6,6	63	6,2	63	6,1	89	5,9
100	4	160	6,7	63	6,3	63	6,2	89	6,0
100	4	XXS	6,7	63	6,4	63	6,3	89	6,1
150	6	40	7,5	63	7,0	89	6,7	102	6,6
150	6	80	7,9	63	7,5	89	7,2	102	7,1
150	6	120	8,1	63	7,7	89	7,4	102	7,3
150	6	160	8,2	63	7,8	89	7,6	102	7,4
150	6	XXS	8,2	63	7,9	89	7,6	102	7,5

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			Maximum spam 1.6 mm corrosion allowance						
			Pipe + water	Pipe + water + insulation					
			35 °C	35 °C a 200 °C		201 °C a 330 °C		331 °C a 400 °C	
Diameter		Thickness	spam	Insul	spam	Insul	spam	Insul	spam
200	8	20	8,1	63	7,6	102	7,3	102	7,2
200	8	40	8,5	63	8,0	102	7,7	102	7,6
200	8	60	8,8	63	8,3	102	8,0	102	7,9
200	8	80	9,0	63	8,6	102	8,3	102	8,1
200	8	100	9,1	63	8,7	102	8,4	102	8,3
200	8	120	9,2	63	8,9	102	8,6	102	8,5
200	8	140	9,3	63	8,9	102	8,7	102	8,5
200	8	XXS	9,3	63	9,0	102	8,7	102	8,6
200	8	160	9,3	63	9,0	102	8,7	102	8,6
250	10	20	8,8	63	8,3	102	8,0	102	7,9
250	10	40	9,4	63	9,0	102	8,7	102	8,6
250	10	60	9,8	63	9,4	102	9,1	102	9,0
250	10	80	10,0	63	9,6	102	9,4	102	9,2
250	10	100	10,2	63	9,8	102	9,6	102	9,4
250	10	120	10,3	63	10,0	102	9,7	102	9,5
250	10	140	10,4	63	10,1	102	9,8	102	9,6
250	10	160	10,4	63	10,1	102	9,9	102	9,7
300	12	20	9,3	63	8,9	102	8,6	126	8,3
300	12	S	10,1	63	9,7	102	9,4	126	9,1
300	12	40	10,2	63	9,8	102	9,5	126	9,3
300	12	XS	10,6	63	10,1	102	9,8	126	9,6
300	12	60	10,7	63	10,3	102	10,0	126	9,8
300	12	80	10,9	63	10,6	102	10,3	126	10,0
300	12	100	11,1	63	10,8	102	10,5	126	10,2
300	12	120	11,3	63	10,9	102	10,6	126	10,4
300	12	140	11,3	63	11,0	102	10,7	126	10,5
300	12	160	11,4	63	11,1	102	10,8	126	10,6
350	14	10	9,6	63	9,2	114	8,8	140	8,6
350	14	20	10,1	63	9,7	114	9,3	140	9,0
350	14	S	10,5	63	10,0	114	9,7	140	9,4
350	14	40	10,7	63	10,3	114	10,0	140	9,7
350	14	XS	10,9	63	10,5	114	10,2	140	9,9

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			Maximum spam 1.6 mm corrosion allowance						
			Pipe + water	Pipe + water + insulation					
			35 °C	35 °C a 200 °C		201 °C a 330 °C		331 °C a 400 °C	
Diameter		Thickness	spam	Insul	spam	Insul	spam	Insul	spam
350	14	60	11,2	63	10,8	114	10,5	140	10,2
350	14	80	11,5	63	11,1	114	10,8	140	10,5
350	14	100	11,7	63	11,3	114	11,0	140	10,8
350	14	120	11,8	63	11,5	114	11,2	140	10,9
350	14	140	11,9	63	11,5	114	11,2	140	11,0
350	14	160	11,9	63	11,6	114	11,3	140	11,1
400	16	10	10,0	63	9,6	114	9,3	140	9,0
400	16	20	10,6	63	10,2	114	9,8	140	9,5
400	16	30	11,0	63	10,6	114	10,2	140	9,9
400	16	40	11,5	63	11,1	114	10,8	140	10,5
400	16	60	12,0	63	11,6	114	11,2	140	11,0
400	16	80	12,3	63	11,9	114	11,6	140	11,3
400	16	100	12,5	63	12,1	114	11,8	140	11,6
400	16	120	12,6	63	12,3	114	12,0	140	11,7
400	16	140	12,7	63	12,4	114	12,1	140	11,8
400	16	160	12,8	63	12,4	114	12,1	140	11,9
450	18	10	10,4	63	10,0	114	9,7	140	9,4
450	18	20	11,0	63	10,6	114	10,3	140	10,0
450	18	STD	11,4	63	11,0	114	10,7	140	10,4
450	18	30	11,8	63	11,4	114	11,0	140	10,8
450	18	XS	12,0	63	11,6	114	11,3	140	11,0
450	18	40	12,3	63	11,9	114	11,5	140	11,2
450	18	60	12,7	63	12,4	114	12,0	140	11,7
450	18	80	13,0	63	12,7	114	12,3	140	12,1
450	18	100	13,3	63	12,9	114	12,6	140	12,3
450	18	120	13,4	63	13,1	114	12,8	140	12,5
450	18	140	13,5	63	13,1	114	12,9	140	12,6
450	18	160	13,6	63	13,2	114	12,9	140	12,7
500	20	10	10,8	63	10,4	114	10,1	140	9,8
500	20	20	11,9	63	11,5	114	11,1	140	10,9
500	20	30	12,5	63	12,1	114	11,8	140	11,5
500	20	40	12,9	63	12,5	114	12,1	140	11,9
500	20	60	13,4	63	13,0	114	12,7	140	12,4
500	20	80	13,8	63	13,4	114	13,1	140	12,8
500	20	100	14,0	63	13,6	114	13,3	140	13,0
500	20	120	14,1	63	13,8	114	13,5	140	13,2

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			Maximum spam 1.6 mm corrosion allowance						
			Pipe + water	Pipe + water + insulation					
			35 °C	35 °C a 200 °C		201 °C a 330 °C		331 °C a 400 °C	
Diameter		Thickness	spam	Insul	spam	Insul	spam	Insul	spam
500	20	140	14,2	63	13,9	114	13,6	140	13,3
500	20	160	14,3	63	14,0	114	13,7	140	13,4
600	24	10	11,4	63	11,1	114	10,7	140	10,5
600	24	20	12,6	63	12,2	114	11,9	140	11,6
600	24	XS	13,4	63	13,0	114	12,6	140	12,3
600	24	30	13,7	63	13,2	114	12,9	140	12,6
600	24	40	14,1	63	13,7	114	13,4	140	13,1
600	24	60	14,7	63	14,3	114	14,0	140	13,7
600	24	80	15,1	63	14,7	114	14,4	140	14,1
600	24	100	15,4	63	15,0	114	14,7	140	14,4
600	24	120	15,5	63	15,2	114	14,9	140	14,6
600	24	140	15,6	63	15,3	114	15,0	140	14,7
600	24	160	15,7	63	15,3	114	15,0	140	14,8

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