Pipe Support Design Considerations for Hydrocarbon Facilities

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Abstract: *Piping network running across a hydrocarbon facility are “arteries and veins” equivalent of a human body which carry vital fluids across the length and breadth of an operating plant so as to get it processed resulting in delivering an end user product such as Natural Gas into Liquefied Natural Gas. The pipe size ranges from small bore DN 15 (½”) to big bore DN 1050 (42”) pipes and requires adequate supporting at regular intervals so as to with stand various loads acting on the pipe or loads getting imposed on the pipe due to the fluid flowing through it.*

Keywords: Pipe shoe, Piping isometric, Pipe support span, Pipe Guide, spring support, Bracing, Vitonal vibration, PWHT – Post Weld Heat Treatment, PTFE –Polytetrafluoroethylene, DN - diamètre nominal/nominal diameter, NPS - Nominal Pipe Size.

1. Introduction

This article focuses on defining the minimum requirements for the design of pipe supports for a pipes in hydrocarbon facilities, Liquefied Natural Gas (LNG) facilities in particular. Supports are normally for pipe line sized between DN 15 (NPS - ½”) to DN 1050 (NPS - 42”).

2. Design Criteria

The pipes routed throughout the facility are to be properly supported, anchored or guided to prevent undue stresses, deflection and excessive vibration and to protect both piping and connected equipment from excessive loadings which may be due to thermal, weight, steelwork deflections, wind, earthquake etc. Support points are selected to optimize load distribution and weight balance, taking into consideration available building structures to which supports can be most readily affixed. Pipes are not allowed to be supported bare on top of structural steel. This is in order to avoid excessive pipe corrosion. All pipes are therefore supported on pipe shoes. Pipe shoes are preferably shop welded where possible. Supports are designed for the piping full water hydro-test condition, except those cases when the specific gravity of the flowing medium is greater than 1.0, when the actual operating load applies. A fireproofed “catch” beam should be installed beneath piping containing flammable material where such piping is hung by rods or spring hanger type supports in fire proofed areas. Where a support from a vessel is required, a clip is incorporated in the vessel design, the welding of pipe supports directly to vessels is not allowed. Supporting pipes from other pipes are also not allowed, spring supports and hanger type supports are to be kept to a minimum, PTFE slide plates are not to be used without client approval. Supports should not encroach on headroom clearance, escape routes and lay down areas. In areas of grated flooring the support should not sit directly on the grating, but should penetrate to a structural member. Supports local to pumps are designed as to be adjustable so as to assist the field in commissioning and alignment of pump. Supports at control valve sets are to be anchored or box guided at one end and guided longitudinally at the other. Piping systems that are subjected to vibration or pulsation should be isolated from the support structure by the use of

anti-vibration pads. Friction effects are to be considered at support points with the following coefficient, steel to Concrete = 0.45, steel to Steel = 0.3, Stainless Steel to PTFE = 0.1

3. Standard Pipe Support (Indication on Piping Isometrics)

The Supports are normally indicated on isometrics as a “PIPE SUPPORT CALL OUT”. The “PIPE SUPPORT CALL OUT” consists of a combination of letters and numbers, giving the type, size, length, material etc of the pipe support parts. A support for a pipe at a location can be a combination of standard support types or a special pipe support. These indications shall be written as separate items. A pipe support frame that supports multiple pipes is to be indicated only on one piping isometric drawing. For all other pipes, reference is made to the piping isometric drawing with the “PIPE SUPPORT CALL OUT” indication.

1) Special Pipe Support (Indication On Piping Isometrics)

Special pipe supports are indicated on the piping isometric. All components including support standard items will be listed on the individual special pipe support drawing. No support components will be listed on the piping isometric. A Special pipe support is indicated as SPS, where SPS - indicates Special Pipe Support.

2) Pipe Support Recommended Spans

Maximum recommended support spans for Carbon Steel, Galvanized Carbon Steel, Stainless Steel and Duplex is as per Table A-1. Maximum recommended pipe support spans for CuNi and GRE pipe is as per Table A-2. In process units, common pipe racks and major facilities the maximum spacing for pipe supports is 6m normally. Normally, for pipes DN 42(NPS - 24”) size and smaller, the spacing between supports are selected such that the maximum deflection does not exceed 16 mm (5/8”).

3) Pipe Support Recommended Guide Spacing's

Maximum recommended pipe support guide spacing for Carbon Steel, Stainless Steel, and Duplex & Galvanized Carbon Steel is as per Table A-3. Maximum recommended

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pipe support guide spacing for CuNi and GRE pipe is as per Table A-4.

4) Material Codes

Under In General, the minimum allowable thickness of any structural steel is to be 10mm for plates, bars and rods and 6mm for rolled steel sections. Normally, pipe support steel frames are to be hot-dipped galvanized as per ASTM A123. All support frame field connections to a galvanized structure are to be welded unless otherwise noted, after site welding, repair of the galvanized structure is to be carried out as per below: For weld repair and minor damage, clean the damaged area per SSPC SP 11. Touch up with two individual coats of organic zinc-rich coating having a zinc dust loading of not less than 92% zinc in the dry film, such as ZRC "Galviline" or ZRC "Cold Galvanizing Compound", Zinga, or equivalent. Coating Manufacturer's application instructions should be followed. Apply the specified topcoat. For major damage such as galvanized repair larger than 0.1 m² as per below: Abrasive blast clean damaged area to SSPC SP 10, sand intact galvanized surface to a feathered edge. Spray-apply a coat of zinc-rich epoxy primer per Table A-5 to a dry film thickness of 60 µm minimum; 100 µm maximum. Apply the specified topcoat. Only galvanized fasteners should be used to connect galvanized structural members. Pipe Support material selection can be divided into 3 main groups:

Group 1: Integral welded pipe attachments forming a permanent part with the pipe by connecting welds. As per Support Material Selection Table A-6.

Group 2: Integral clamped pipe attachments forming a permanent part with the pipe by a clamped unit directly to the OD of the pipe by metal-to-metal contact and to which other parts are connected by means of welds. As per Support Material Selection Table A-7.

Group 3: Other materials - Bolts and nuts are to be coated in accordance with. Rubber for special acoustic noise suppression purpose should be made from "Vitonil" vibration plate. Temperature constancy 2000C, Hardness shores 75, Maximum allowable load 3 N/mm². Rubber inlay for pipe clamps and U-bolts is material grade FR80 service temperature from -600C to 1500C, shore 80. Rubber inlay for pipe clamps and U-bolts is material grade FR80 service temperature from -600C to 3500C, shore 65. PTFE sliding pads are from PTFE-TFLG 3124 (or approved equivalent) with an allowable contact temperature from -350C to 1800C. All others, including individual indicated parts welded to table A-6 and A-7 material as per Support Material Selection Table A-8.

5) Bracing of Small Bore Connections Due To Vibration and Pulsation

Bracing of small bore branch connections DN 40 and smaller is required for all piping subject to pulsation or process induced vibration such as below:

a) Reciprocating Pumps – Connections to suction and discharge piping and equipment for reciprocating pumps (Includes first major equipment upstream and downstream of pump)

- b) Centrifugal pumps – Connections to pump piping within the greater of 6m or 20 pipe diameters, measured along the pipe axis, from the equipment nozzle.
- c) Compressors - Connections to piping within the greater of 6m or 20 pipe diameters.
- d) Relief Valves - Connections to PR piping within the greater of 6m or 20 pipe diameters, measured along the pipe axis, from the PR device.

Bracing of small bore branch connections DN 40 and smaller is required for all piping classes 900# and above. Bracing is not required if the branch size is equal to or one size smaller than the header and is by an integrally reinforced fitting. Bracing for Thermo-wells and hydrostatic test vents is not required. The use of vibration is normally identified on the piping isometric.

6) Spring Supports

Pipeline operating at high temperature moves upwards/downwards (depending on the pipe configuration) due to thermal expansion, any rigid support provided on such a line tends to lift pipe up/down and hence remain inactive during operating conditions. In such a case a flexible support (springs) is provided which is capable of taking the load in all the operating and cold conditions. The spring supports provides continuous support during expansion or contraction of the pipe. The spring support basically employs a spring element, which can get compressed or stretch-out depending upon the thermal movement of pipe and the corresponding loads. The spring vendor normally supplies the spring units with all associated rods, turnbuckles, beam attachments, clamps, pins etc. All spring supports are to be hot dipped galvanized, spring coil to be neoprene coated.

7) Pipe Shoe Selection

Shoe standard height and length should be normally 100mm high and 300mm long for pipes sizes DN500 and below, shoe height and length for pipe sizes DN600 and above should be 150mm high 450mm long unless noted otherwise on piping isometric. Shoe standard length in process units should be 300mm and is noted on the piping isometric. This length is suitable for thermal movement up to +/- 100mm. Shoe standard length in pipe racks should be 450mm and is noted on the piping isometric. This length is suitable for thermal movement up to +/- 175mm. If shims are required under pipe shoes, the shims should be welded to the support beams to ensure they remain in place.

4. Conclusion

All pipes supports such and supporting materials from plates, bars, rods, pipes, profiles, turn buckles, eye nuts, and bolts etc are a minimum requirement. Replacement parts should have at least equal strength and be acceptable in the total layout with respect to interference. All rods, bolts and nuts should have right-hand coarse thread. All bolts and rods should protrude through nuts a minimum of 5mm. All support construction should be continuously filleted welded. Other weld types should be made to avoid water penetration in seams where continuous welds are impractical; all welds should be 6mm fillet. Welding symbols shown on pipe support drawings should be in accordance with the symbols

from the American Welding Society (for detailed instructions, see their publication “Welding Symbols and Instructions for their use” should be referred). When welding supports to the outside of a pipe, care should be taken that welds do not burn through the pipe wall. Certain welded attachments on pipe classes that are Post Weld Heat Treated are to be highlighted on the piping isometric. Carbon steel process pipe with wall thickness 19mm or greater, “WA / PWHT” to the piping isometric should be added. Welded attachments to pipe classes that are galvanized are to be avoided, but where necessary they are to be welded to the pipe Prior To Galvanizing and highlighted by adding “WA / PTG” to the piping isometric. Sloping lines are to be on shoes with the base plate in the horizontal plane having a preferred minimum height of 100mm. Height indicated is at the mid-point of the shoe.

References

- [1] ASME B31.1 Power Piping
- [2] ASME B31.3 Process Piping
- [3] AS 4041 Power Piping
- [4] ASTM A 123 Standard Specification for Zinc (HotDipGalvanized) Coatings on Iron and Steel Products
- [5] SSPC SP 10 Near-White Metal Blast Cleaning (NACE NO. 2)
- [6] SSPC SP 11 Power Tool Cleaning to Bare Metal
- [7] MSS-SP-58 Pipe Hangers and Supports – Materials, Design, and Manufacture

Table A-1:

Maximum Recommended Pipe Support Spans			
Pipe Size DN	Max Span M	Pipe Size DN	Max Span M
20	2.0	200 & 250	8.0
25	3.0	300	9.0
40 & 50	4.0	350 & 400	10.0
80	5.0	450 to 550	11.0
100	6.0	600	12.0
150	7.0	650 to 1050	12.0

Table A-2:

Maximum Recommended Pipe Support Spans			
Pipe Size DN (CuNi)	Max Span M	Pipe Size DN (GRE)	Max Span M
		50 & 80	3.0
20	2.0	100	4.0
25	3.0	150 & 200	5.0
40	3.0	250 to 600	6.0

Table A-3:

Maximum Recommended Guide Spacing			
Pipe Size DN	Max Span M	Pipe Size DN	Max Span M
20	2.0	50 to 150	6.0
25 to 40	3.0	200 & Above	12.0

Table A-4:

Maximum Recommended Guide Spacing			
Pipe Size N/B (CuNi)	Max Span M	Pipe Size N/B (GRE)	Max Span M
20	2.0	50 to 350	6.0
25 to 40	3.0	400 to 600	6.0

Table A-5

Generic Product Identifier	DFT µm Min/Max (ea coat)	Carboline	Hempel	International	Jotun	Sherwin Williams	Sigma
Inorganic Zinc	60–100	CZ 11, CZ11HS, or CZ11 VOC	15700	Interzinc 22 or 22 HS	Resist 86	Zinc Clad II LV	SigmaGuard 750
Zinc Rich Epoxy	60–110	Carbozinc 859	17380	Interzinc 52	Barrier 90	Zinc Clad IV	SigmaZinc 109
Epoxy Primer	70–120	Carboguard 888	15570	Intergard 251 or 400	Jotacote Universa or Penguard HB	Copoxxy Shop Primer	SigmaPrime 200
NSF Epoxy	150–250	Carboguard 891	85671	Interseal 670HS (Buff/White)	Tankguard 412	Tank Clad HS	SigmaGuard CSF 585
3B Epoxy	130–165	Carbomastic 18 NT	17630/3 or 47741/3	Intershield 300	Jotacote Universal	SeaGuard 6000	SigmaPrime 200
Temperature Resistant Epoxy	125-150	Thermaline 450	85671	Intertherm 228	Tankguard Storage	Epo-Phen	Sigma Phenguard 930
Epoxy Phenolic for SS	125-150	Plasite 7122	85671	Intertherm 228	Tankguard Storage	Epo-Phen	Sigma Phenguard 940
HB Epoxy	130–200	Carboguard 888	45880/1 or 45080/3	Intergard 475HS	Penguard Midcoat	Macropoxy 646	SigmaCover 435
Urethane	40–75	134 or 134 HG	55210 or 55910	Interthane 990 or 990HS	HardtopAS or Hardtop XP	Acrolon 218 HS	SigmaDur 550
Epoxy Mastic	100–200	Carbomastic 15	45880/1	Interseal 670HS	Primastic Universal	Macropoxy 646	SigmaCover 630 (Alum.)
100% Solids Epoxy	300-400	Plasite 4550S	35530 or XO 35790	Interzone 485 or 954		Fast Clad ER Epoxy	SigmaGuard CSF 650 or SigmaShield 905
Silicone	20–35	4700 or 4700 VOC	5691	Intertherm 50	Solvalitt	Kem Hi Temp 1200	SigmaTherm 450
Broadcast Nonskid *	*	890	554US	Intergard 740HS	Jotacoat Universal	SeaGuard 5000 or	SigmaCover 456

Generic Product Identifier	DFT μ m Min/Max (ea coat)	Carboline	Hempel	International	Jotun	Sherwin Williams	Sigma
						5000 HS	
Pre- Blended Nonskid	200-300	Gripox 1210		Intergard 621 (EK5040H EBA744)		American Safety AS-250	
Epoxy Glass Flake (Not Used Onshore)	450-750	1209	35870	Interzone 1000 or 505	Marathon	Dura-Plate 154	SigmaShield 905
Shop Epoxy Primer	100-150	Carboguard 888	Not Available			Steel Spec B58 R8 B58 V8	See Note below
Epoxy Phenolic	100-125	Plasite 7122				Phenicon HS 920-R-A11 700-C-685/825	

Note(s): Apply in two stages – 1st layer 75-125 μ m, 2nd layer 50-75 μ m. A coat of urethane may be substituted for 2nd layer where required for color or aesthetics (gloss).

Table A-6

Material Group	Service Limits		Integral welded support parts							(Other) Connecting	
	Min OC	Max OC	Wear pad	Steel section and plate welded to		Pipe section welded to		Other plate or steel section	Other pipe section		
				Pipe	Wear plate	Pipe	Wear plate			Bolt	Nut
A Carbon Steel	-29	350	Material as per pipe class	A36	A36	Material as per pipe class	Material as per pipe class	A36	Material as per pipe class	A193-Gr.B7	A194-Gr.2H
B Low Temp Carbon Steel	-45	425	Material as per pipe class	A516-Gr65 See Note 1	A516-Gr65 See Note 1	Material as per pipe class	Material as per pipe class	A516-Gr65 See Note 1	Material as per pipe class	A320-Gr.L7	A194-Gr.2H
C Stainless Steel	-101	538	Material as per pipe class	A240-Gr.316 (L)	A240-Gr.316 (L)	Material as per pipe class	Material as per pipe class	A516-Gr65 See Note 1	N/A	A320-Gr.L7	A194-Gr.G4
D Duplex DSS	-51	280	Material as per pipe class	A240-Gr.316 (L)	A240-Gr.316 (L)	Material as per pipe class	Material as per pipe class	A516-Gr65 See Note 1	N/A	A320-Gr.L7	A194-Gr.G4

Note(s): 1. Material required to be normalized and impact tested at -45°C.

Table A-7

Material Group	Service Limits		Support part materials						(Others) Connecting	
			Support clamp			U-Bolt	Plate or steel section	Pipe section		
	Min OC	Max OC	Steel strip	Bolt	Nut				Bolts	Nuts
E Carbon Steel	-29	425	A36	A193-Gr.7	A194-Gr.2H	A36 (See note 2)	A36	A106-Gr.B	A193-Gr.7	A194-Gr.2H
F Low Temp Carbon Steel	-45	425	A516-Gr65 (See note 1)	A320-Gr.L7	A194-Gr.2H	A516-Gr65 (See notes 1 & 2)	A516-Gr65 (See note 1)	Material as per pipe class	A320-Gr.L7	A194-Gr.2H
G & H Stainless Steel & Duplex DSS	-101	538	A240- Gr.316 (L)	A320-Gr.L7	A194-Gr.2H	A276 Gr.316	A240- Gr.316 (L)	Material as per pipe class	A320-Gr.L7	A194-Gr.2H

Notes:

1. Material required to be normalized and impact tested at -45°C.
2. U-Bolt to be hot-dipped galvanized with a neoprene covering.

Table A-8

Material Group	Plate, Bar, Clamp	Steel Section, Rod, Pin	Pipe	Forged Steel	Bearing plate for PTFE	PTFE	Bolt	Nut
W	ASTM A36	ASTM A36	ASTM A106 Gr.B	ASTM A668 Gr.C	A240-Gr.304	PTFE	A193 Gr.7	A194 Gr.,2H