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Stress Analysis of pipe supports

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1. Introduction

The purpose of this study is to describe about the loadings for pipe supports and to maintain functional stability without exceeding appropriate allowables for the pipe support. The design criteria are presented to maintain stability of pipe supports.
The pipe supports comprise fabricated brackets, bolted to pads which are welded to the existing 254 mm in-pool box beam, which are also welded to the pipe covers. The brackets also support the in-pool piping by means of a turnbuckle and double ball-joint hanger. The boundary between the pipe support and the pipe cover is shown in Fig. 1.

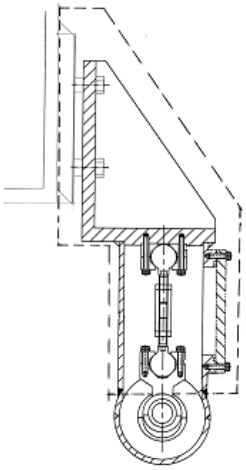

Fig. 1 Piping Support showing Boundary of class 3 Pipe Support

2. Design Requirements for pipe supports

2-1. Safety and Quality Classification

The Pipe Support Brackets are classified as Safety Class 3 and shall be designed and fabricated in accordance with the requirements of Subsection NF for the loads associated with Design, Service Level A, B, C, D and Test Conditions. The Pipe Support Brackets are classified as Quality Class Q and Seismic Category I.

2-2. Service Loadings

Level A Service

The Level A Service Loadings, assumed to occur in combination, shall be:

(1) Weight of supported pipe (1" NB schedule 80) including thermal insulation. The weight on each pipe support can be taken as 100 N.

(2) Part-weight of the pipe cover (4" NB Schedule 40), since the weight is shared between the pipe support and the IPS support frame, which can be taken as 644 N for the cold leg pipe support and 672 N for the hot leg pipe support. There are also moments on the supports as follows:

Cold Leg	Mx = - 53 Nm	My = 0	Mz = 231 Nm
Hot Leg	Mx = 19 Nm	My = 0	Mz = 89 Nm

(3) The vertical load on the turnbuckle resulting from constraint of piping thermal expansion which can be taken as 170 N.

Level B Service

The Level B Service Loadings shall be the following in combination with the Level A service loadings:

(1) Seismic loading from 1 OBE event/year over the design life with 50 cycles per event, to include the loads from 1" pipes and the pipe covers. Loads for the SSE are given below.

Level C Service

The IPS Level C Service condition resulting from a break of the main coolant pipe (hot or cold leg) in Test Room 1 does not generate any additional loading on the Pipe Supports.

Level D Service

The Level D Service Loading, each of which shall be assumed to occur in combination with normal operating conditions (i.e. Service Level A loadings) are:

(1) The load from the 1" pipe is 120 N vertically on the hanger. The loads from the pipe cover can be determined from the weights of the using the following accelerations:

$$Ax = 3.8\ m/s^2,\ Ay = 3.65\ m/s^2,\ Az = 1.4\ m/s^2$$

(2) The loads developed at the Pipe Supports due to a pipe break at the IPS nozzle pipe weld or at the IPS Hiltap Coupling shall be taken.

Test Conditions

There are no test conditions for the pipe supports.

2-3. Loadings

The following loads may be applied to the pipe supports:

- Pipe weight
- Pipe cover weight
- Load resulting from thermal expansion of the pipe
- Seismic load from the pipe
- Seismic load from the pipe cover
- Reaction due to pipe break

Tables 6 and 7 below summarises the loads used for the analysis which are in all cases conservative enveloping values. The loads are based on the Design Specification, the Piping Design Report and References 4 and 9.

	Fx	Fy	Fz	Mx	My	Mz
Service Level A & B	0	- 300 N	0	0	0	0
Service Level D	0	-10600 N	0	0	0	0

Table. 6 Loads applied to the Turnbuckle

	Fx	Fy	Fz	Mx	My	Mz
Service Level A & B	300 N	- 1300 N	300	- 250 Nm	0	250 Nm
Service Level D	1050 N	-11600N	1050 N	- 250 Nm	0	250 Nm

Table. 7 Loads applied to the Bracket of the Pipe Support

For the Level D in-pool pipe break it is assumed that the maximum transient hydraulic load is applied to the supports due to hanger swinging across and contacting the turnbuckle housing. The Service Level C events, pipe breaks in Room1, do not generate additional load at the pipe supports.

3. Stress Analysis Results

The results for the locations with the smallest margins relative to the code are given in Table. 8 and Table. 9.

Location	Type of Stress	Calculated Stress	Service Level A(B)	
			Allowable Stress	Reserve Factor
Turnbuckle housing cover screws	Shear	45.7 MPa	63.2 MPa (72.7 MPa)	1.4 (1.6)
M14 Bracket mounting screws	Tensile	19.9 MPa	153.0 MPa (175.9 MPa)	7.7 (8.8)
	Shear	14.3 MPa	63.2 MPa (72.7 MPa)	4.4 (5.1)
	Combined tensile & shear			3.8 (4.4)

Table. 8 Pipe Support Stresses for Service Levels A & B

Location	Type of Stress	Calculated Stress	Service Level D	
			Allowable Stress	Reserve Factor
Turnbuckle attachment screws	Tensile	87.8 MPa	177.9 MPa	2.0
Turnbuckle M12 threaded ends	Tensile	125.8 MPa	177.9 MPa	1.4
Turnbuckle	Tensile	93.1 MPa	177.9 MPa	1.9
Turnbuckle housing cover screws	Shear	67.4 MPa	161.3 MPa	2.4
M14 Bracket mounting screws	Tensile	75.3 MPa	268.9 MPa	3.6
	Shear	34.2 MPa	161.3 MPa	4.7
	Combined tensile & shear			2.8

Table. 9 Pipe Support Stresses for Service Level D

4. Conclusion

Stress results have been presented an allowable stress of pipe supports when applied loads by means of measuring location. Calculated stress is sufficiently lower than the allowable stress values. All these values are lower than the allowable stress.

As a result, it is regarded that pipe supports could maintain its structural integrity for the design loadings and service loadings.

REFERENCES

[1] ASME Design Requirements for Structural steel members, Section III NF-3322, 2001

[2] FTL Pool Penetration Stress Analysis Report, HAN-FL-E-074-RX-H005, Rev. A, 2004.

[3] Design Report for Supports (for IPS & Piping), HAN-FL-E-320-RT-R002, Rev. 0, 2005.