STUDY CALCULATION

FOR

STIFF PIPE CLAMP

CALCULATION NO. SR10855-SS27

PREPARED FOR

HOPE CREEK PROJECT

BY

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1.0 INTRODUCTION

1.1 BACKGROUND

ASME Section III Code Subsection NB3645 requires that the effects of attachments in producing thermal stresses, stress concentrations, and restraints on pressure retaining members shall be taken into account in checking for compliance with stress criteria.

In November 1983, the Nuclear Regulatory Commission issued IE Information Notice 83-80, use of specialized "stiff" pipe clamps. The information notice identifies three concerns with stiff pipe clamps: excessive bolt preload induced stresses in the pipe, small clamp contact bearing areas that could induce local overstress and the effect of clamp on elbow stress indices.

Attachments to piping are generally categorized as integral attachments and non-integral attachments. Lugs and stanchions welded to the pipe wall are integral attachments. Clamps used for attaching hangers and snubbers to the pipe by bolting are non-integral attachments.

For integral attachments, the design calculations are prepared by Bechtel to show that the requirements of ASME Section III Code and code cases have been met. The code does not provide the design rules for the evaluation of non-integral attachments; however, methods consistent with the intent of the code have been developed to address the concerns of information Notice 83-80 and the Code.

1.2 GENERAL DESCRIPTION

For BOP Nuclear Class I piping systems on Hope Creek Project, Bechtel has used total of 12 "stiff" pipe clamps as follows:

i)	Feedwater	5 locations
ii)	LPCI	3 locations
iii)	RHR System	2 locations
iv)	Core Spray	2 locations

All 12 "stiff" clamps are ITT Grinnell clamps. None of them are installed on elbows. By examining the piping stress levels and support loads at the locations where stiff clamps are used, and the temperature and pressure fluctuations of the piping system

it is determined that the stiff clamps on 12" and 24" feedwater line are the most severe cases among all the systems identified above. These two clamp assembly properties are given as follows:

FEEDWATER STIFF CLAMP ASSEMBLY

ME 101 DP	PIPE SA333 Gr. 6 Seamless		Bolt SIZE	BOLT PRETORQUE	CLAMP RATING, KIPS A&B/C/D LEVELS	DES. REPORT NO. PE-193-IB ITT-GRINNELL CLAMP IDENTIFICATION
	OD	t_{NOM}				
103	24"	1.531"	2 1/2Ø	200 FT-LBS	120/160/162	Fig. 315N, Size 120
171	12.75"	0.687"	1 3/4Ø	150-FT-LBS	33/40.2/ 43.22	Fig. 315N, Size 33A

2.0 PURPOSE

The purpose of this analysis is to evaluate the impact of piping local stresses induced by "stiff" pipe clamps attached to BOP Nuclear Class I piping systems.

3.0 SUMMARY

The piping stresses calculated per ASME Section III NB3650 are combined with the local stresses induced by "Stiff" pipe clamp for all the operating conditions. The results of calculations show that the primary stress intensities for all operating conditions and the cumulative usage factors meet the code requirements. The calculated stresses and usage factors are summarized in Appendix 2.

3.1 Primary Membrane Stresses

The existence of a pipe clamp will not affect the calculation for minimum wall, in fact, the primary membrane stresses is less than that of straight pipe due to clamp reinforcement of effective thickness.

3.2 Primary Membrane Plus Primary Bending Stresses

The primary membrane plus primary bending stresses introduced by the presence of clamp comes from two different loadings. First, the loading transmitted from pipe through the clamp pad to the support structure. This bearing load will result in local stress in the pipe wall. Secondly, the constraint of the clamp on the pipe under internal pressure will produce local stress in the pipe wall. These stresses are conservatively calculated and added to the membrane and overall bending stresses computed by equation 9 of the code. Satisfying equation 9 will prevent collapse of the piping system due to loads that produce primary stresses.

3.3 Stress due to Bolt Preload

The preload will produce stress in the pipe wall when the clamp is initially installed on the piping system and the bolts are tightened. Although local stress produced by preload is nonrecurring secondary type in nature it could result in damage to a pipe if a clamp was poorly designed. Stresses of this type need not be included in the stress evaluations required by NB-3600. Calculations have been made to ensure that bolt preloads could not result in local plastic deformation of the piping.

3.4 Clamp Design Criteria

The stiff type clamps were designed to provide a high strength attachment for the pipe which would not slip and would fit on the smallest practical length of pipe. Clamp design of the strap type are too wide to fit in many locations and required lugs to hold them in position. The stiffness of a compact high strength clamp is inherently greater than that of a strap type. In fact, all the clamps used are stiffer than the snubber attached to it. The stiffness requirement does not govern the design of stiff type clamps.

3.5 Protection from Loosening

In order for the clamp to hold its position during vibratory loads, it must grip the pipe with enough force to prevent sliding. All the bolts have double nuts to prevent backing off of the nuts. In addition, stresses have been calculated conservatively to assure the bolt will well remain in elastic range to prevent permanent deformation. The bolt material was selected to resist relaxation at the temperature of concern.

3.6 Stresses due to Constraint of Expansion from Internal Pressure

Clamp induced stresses caused by the constraint of pipe expansion due to internal pressure have been added to other appropriate primary and secondary stresses to satisfy the required criteria.

3.7 Stresses due to Constraint of Differential Thermal Expansion

Clamp induced stresses due to differential temperatures and material expansion coefficients have been calculated and added to other operating secondary and peak stresses.

3.8 Fatigue Usage

The fatigue usage at the clamp locations has been conservatively computed taking into consideration clamp induced stresses from pressure, temperature and support loadings. The clamp induced stresses were added to the stresses computed for each load set pair using equation 10 and 11 of NB-3650. Cumulative fatigue usage was computed by the code.

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APPENDIX 1

Loading Combination for Hope Creek Feedwater Lines

Condition	Design Loading Combinations
Design	PD
Level A/B	PO + DW + OBE
Level C	PO + DW + OBE
Level D	$PO + DW + (SSE^2 + AP^2)^{1/2}$

APPENDIX 2

Table 1 - Stress Summary

Hope Creek Feedwater Line (d.p. 103, OD=24 in.)

Item Evaluated (1)	Highest Calculated/ Usage Factor	Allowable Limits	Ratio Actual/Allowed
Primary Stress . Eq. 9 $\leq$1.5 Sm . Design Condition	Not governing	-	-
Primary Stress . Eq. 9 $\leq$1.5 Sm . Level A/B	10744	29180	0.368
Primary Stress . Eq. 9 $\leq$1.8 Sm . Level C	Not governing	-	-
Primary Stress . Eq. 9 $\leq$3.0 Sm . Level D	16914	58350	0.290
Primary + Secondary . Eq. 10 $\leq$3.0 Sm	29218	58350	0.501
. Cumulative Usage Factor $\leq$1.0	0.171 (2)	1.0	0.171

(1) All equations used are from ASME B&PV Code, Sec. III-NB-3650.

(2) To minimize the calculation all similar stress cycles are combined and the enveloped stress range is used in fatigue evaluation. As a consequence the usage factor is very conservative.

APPENDIX 2

Table 2 - Stress Summary

Hope Creek Feedwater Line (d.p. 171, OD=12.75 in.)

Item Evaluated (1)	Highest Calculated/ (Psi) Usage Factor	Allowable Limits	Ratio Actual/Allowed
Primary Stress Eq. 9 $\leq$1.5 Sm Design Condition	Not governing	-	-
Primary Stress Eq. 9 $\leq$1.5 Sm Level A/B	14805	29180	0.507
Primary Stress Eq. 9 $\leq$1.8 Sm Level C	Not governing	-	-
Primary Stress Eq. 9 $\leq$3.0 Sm Level D	20820	58350	0.357
Primary + Secondary Eq. 10 $\leq$3.0 Sm	55107	58350	0.944
Cumulative Usage Factor $\leq$1.0	0.288 (2)	1.0	0.288

(1) All equations used are from ASME B&PV Code, Sec. III-NB-3650.

(2) To minimize the calculation all similar stress cycles are combined and the enveloped stress range is used in fatigue evaluation. As a consequence the usage factor is very conservative.