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September 7, 1983

IE HQ FILE COPY

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. John F. Stolz, Chief
Operating Reactors Branch No. 4

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287

Dear Sir:

A letter dated July 20, 1983 from J. F. Stolz transmitted a request for additional information concerning the on-going review of Oconee Nuclear Station's response to IE Bulletin 80-11. The request for additional information was a result of a May 25-27, 1983 site/headquarters visit by members of your staff and Franklin Research Center (NRC consultants). Please find attached Duke Power Company's response to the seven action items requested in J. F. Stolz's July 20, 1983 letter.

In addition, please note that with respect to Item 3, Duke provided an August 10, 1983 letter which expressed our concern of the understanding reached between my staff and your staff during the May 25-27, 1983 visit regarding the additional validation required of arching action. Further response to Item 3 will be provided following receipt of the Staff's confirmation and clarification in regard to the validation question.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

PFG:jfw
Attachment

ppr

IE11
1/1

cc: Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street NW, Suite 2900
Atlanta, Georgia 30303

Mr. J. C. Bryant
NRC Resident Inspector
Oconee Nuclear Station

Mr. John Suermann
Office of Nuclear Reactor Regulation
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Washington, D. C. 20555

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Enclosure 1

REQUEST FOR ADDITIONAL INFORMATION
STRUCTURAL AND GEOTECHNICAL ENGINEERING BRANCH
STRUCTURAL ENGINEERING SECTION A
OCONEE NUCLEAR STATION UNITS 1, 2, AND 3

IE BULLETIN 80-11
DOCKET NUMBERS 50-269, 50-270 AND 50-287

ITEM 1

Assess the influence of hairline cracks observed in two wall panels (-0633, -1215) on the wall qualification calculations. Provide NRC a copy of DPC's assessment.

RESPONSE 1

Duke Power has conducted a reevaluation of the masonry wall panels in question. Wall number -0633 has a vertical crack at the boundary of the concrete column and masonry wall. This wall was previously qualified by two-way flexure. Subsequent to the original qualification, a cable tray support attachment was revised removing it from the wall. A reanalysis of this wall was conducted considering the wall to span vertically. This analysis indicates that the masonry has a tensile stress under MHE (SSE) conditions of 27.8 psi. The allowable tensile stress is 44.8 psi for this loading condition. The crack observed at the vertical boundary does not influence the latest reanalysis. Therefore, this wall is acceptable by the Duke Power and SGEB allowable stress criteria.

Wall number -1215 was found to have diagonal hairline cracks. This wall was originally qualified by two-way flexure. The cracked areas were considered to be ineffective in resisting masonry tension. Because of the location of this ineffective area, the wall no longer satisfies the allowable stress criteria. An arching analysis was conducted, and the results indicate that the wall is acceptable with a factor of safety of 8.5.

ITEM 2

Duke will conduct a field surveillance of safety-related masonry walls at Oconee to identify existing cracks so their influence can be assessed. Provide NRC a copy of the results of the field surveillance.

RESPONSE 2

Duke has conducted the requested field surveillance and has evaluated the influence of the cracks on the masonry walls.

There are 62 walls (including the two walls in Item 1) which were identified as having hairline cracking. For these 62 walls, the following is a tabulation of the prior qualification techniques:

21 were qualified by one-way flexure
26 were qualified by two-way flexure
15 were qualified by arching analysis.

In the reevaluation to assess the influence of these cracks, the area identified as being cracked was treated as ineffective in resisting tension. Response to Item 1 discusses the assessment of the cracks in two of these walls. In addition to these walls and as a result of this reevaluation, four walls previously qualified by two-way flexure are now qualified by arching analysis and one wall previously qualified by one way (vertical) flexure is now qualified by arching analysis. The remaining walls were found to be acceptable by the qualification technique previously used. Therefore, the following summarizes the qualification techniques for these 62 walls:

21 qualified by one way flexure
20 qualified by two-way flexure
21 qualified by arching analysis.

All of the cracking that was found was hairline cracks, typically in the mortar joints at their interface with the masonry units.

ITEM 3

Duke commits to provide positive shear transfer to the boundaries of walls qualified based on stress allowables as stated in the Staff criteria, or to demonstrate to the Staff's satisfaction that the existing boundary joint is capable of transferring the design load. If arching action is validated and demonstrates shear transfer, this can be extrapolated to walls qualified using stress allowables. If arching action validation is not considered, Duke shall submit an implementation schedule by August 31, 1983, for Staff approval.

RESPONSE 3

Response is discussed in letter dated August 10, 1983.

ITEM 4

The response to question 6 from the June 15, 1982, submittal is to be revised to reflect the conservative use of lower damping ratios and typical spectra. Provide the revised response.

RESPONSE

As pointed out in Response 6 of the June 15, 1982 submittal, Duke's evaluation of the Oconee masonry walls requires the minimum input spectrum for wall analysis to be at least as great as the average between floor and ceiling enveloped response spectra. A value of 2% Critical Damping is used for both the Design Earthquake (OBE) and the Maximum Hypothetical Earthquake (SSE). By comparison, the SGEB position requires the use of an envelope of floor and ceiling spectra, but permits the use of higher damping values for the SSE typically on the order of 7% Critical Damping.

In order to assess the impact of these two different approaches, a study was made to determine the effect of varying each parameter.

a) Average of Spectra Versus Envelope of Spectra

For the purposes of comparison, 2% Critical Damping spectra were used. A review of all applicable spectra showed that the reduction in peak acceleration is typically 12% to 15% when average spectra are used. The maximum reduction was found to be 26%.

b) Damping Ratios 2% Versus Higher Damping Ratios

The SGEB criteria permits the use of 7% Critical Damping for SSE conditions. Oconee Response Spectra are not available for 7% Critical Damping; so for this comparison, 5% Critical Damping curves are used. A review of the response spectra curves at each elevation shows that by increasing the damping value from 2% to 5% reduces peak accelerations by approximately 35% for these given floor elevations. Increasing the critical damping to 7% would further reduce peak accelerations.

Since the use of the average response spectra method with 2% Critical Damping consistently yielded higher accelerations versus the enveloped response spectra with 5% Critical Damping, it is felt that the average response spectra method used by Duke is conservative.

ITEM 5

Justify neglecting out-of-plane drift for a generic panel by using a sample calculation. Provide the calculation results to NRC.

RESPONSE 5

Attachment 1 is the sample calculation.

ITEM 6

Duke will check walls qualified on the basis of dur-o-wall joint reinforcing to determine if allowable masonry stresses are satisfied neglecting such joint reinforcing. Provide NRC a copy of these results.

RESPONSE 6

In the process of upgrading certain masonry walls to achieve increased factors of safety Duke Power replaced seven masonry walls. The new walls were constructed of hollow core masonry with type 'M' mortar. C10x15.3 channels were anchored to the concrete columns and W10x33 beams were placed vertically between the supporting concrete frame. The masonry was then built between the structural steel beams and channels designed to span horizontally. 3/16" heavy duty joint reinforcement was placed in every horizontal bed joint. The maximum spacings for the W10x33 beams were determined based upon the moment capacity for the masonry assuming the joint reinforcement resists all tension.

Duke has reanalyzed the walls built in this manner neglecting the dur-o-wall joint reinforcement by two procedures. The first of these procedures assumes that the masonry spans horizontally between the steel members. For this analysis the acceleration was assumed to be the peak of the enveloped 2% Critical Damping curve. All masonry spans were found to be acceptable by the Duke Power and SGEB criteria for horizontal bending stresses when the dur-o-wall joint reinforcement is neglected.

In the second method, the masonry was modeled by finite elements pinned to the steel grid beams. This method includes the effect of vertical span bending being induced in the masonry by the deflection of the steel beams. This analysis shows that the masonry is acceptable by the Duke Power and SGEB criteria for both horizontal and vertical tensile stresses when neglecting the effect of the dur-o-wall joint reinforcement.

ITEM 7

Provide a detailed discussion with regard to the adequacy of the masonry missile shield in the Reactor Building as discussed in the May 27 meeting.

RESPONSE 7

Attachment 2 is table 3.5-3 through 7 from the Oconee Nuclear Station FSAR. These tables list all of the internally generated missiles in the Reactor Building. The following missiles from piping systems have been eliminated from consideration because their location and orientation precludes them from impacting the missile shields in question:

- L.P. Injection Line, Missile Class III, 12" C.V. Bonnet and Assembly
- Primary Pump Seal Water Return to M.P. System Line, Missile Class II, 3" Valve Stem

From the remaining missiles, the following would have the greatest calculated penetrations; if a strike were possible:

1) Core flood line, Missile Class III, 14" CV Bonnet and Assembly

2) Core flood line, Missile Class III, 14" PO Valve Bonnet and Assembly

3) RV Outlet Line to LP System, Missile Class III, 10" EMO Valve Bonnet and Assembly

4) Primary Pump Seal Water Return to HP System, Missile Class III, 3" EMO Valve Bonnet and Assembly

5) Letdown Cooler Inlet and Outlet Lines, Missile Class III, 1½" EMO Valve Bonnet and Assembly

All of these missiles are from piping systems. The maximum penetration calculated by the method presented in the Oconee FSAR (Section 3.5-Missile Protection, Subsection 3.5.1.1-Internally Generated Missiles) is 1.38' for missile 1 above. The calculated penetrations for missiles number 2 through 5 above are between 1.37 ft. and 1.28 ft. Because these missiles do not fully penetrate the missile shields, the location of and orientation for these missiles have not been determined; therefore, it is not necessary to determine if these missiles are actual design considerations for the masonry walls in question. The maximum penetration calculated for the remaining missiles from Attachment 2 is 0.89 ft.

ATTACHMENT 1

Consists of 7 Page Example Wall Calculation

Div./Station Oconee Nuclear Station Unit All File No. Attachment 1
Subject Sample Calculation
By Date
Sheet No. 1 of 7 Problem No. Checked By Date

Statement of Problem: Justify neglecting of out of plane drift for a generic panel by using a sample calculation.

Discussion: The floor and ceiling boundaries were considered to be pinned connections. As such out of plane drift would have negligible effects on the wall panel. If, however, the boundary support were fixed the out of plane drift would induce a moment in the masonry wall. The maximum moment in the masonry when considering the supports to be fixed will be compared to the maximum moment for simple supports to demonstrate the acceptability of the procedure.

Calculation:

Determine cases for consideration:

The following table summarizes the relative displacements and wall heights for various elevations.

Floor Elev.	Relative Disp. (Δ) in.	Wall Height (L) in. (max)	Wall Height (L) in (min)
838 + 0	.006	232.	204.
822 + 0	.006	184.	156.
809 + 3	.005	145.	120.
796 + 6	.006	145.	120.

2

Form 00184 (6-81)

DUKE POWER COMPANY

Dev./Station Oconee Nuclear Station Unit All File No. Attachment 1

Subject Sample Calculation

By ____ Date ____

Sheet No. 2 of 7 Problem No. ____ Checked By ____ Date ____

Calculation Cont'd :

Formulas :

$$M_\Delta = 6EI\Delta/L^2 \qquad (1)$$

$$f_1 = \frac{22.4}{2\pi}\left[\frac{EIg}{w l^4}\right]^{1/2} \qquad (2)$$

$$f_1 = \frac{9.87}{2\pi}\left[\frac{EIg}{w l^4}\right]^{1/2} \qquad (3)$$

$$M_F = a w l^2/12 \qquad (4)$$

$$M_S = a w l^2/8 \qquad (5)$$

References:

Formula (1) is for moment induced in a fixed end beam by support deflection Δ. From Matrix Analysis of Framed Structures, 2nd Edition, By Weaver and Gere, page 454.

Formula (2) is for the first natural frequency of a beam with fixed ends and uniform mass, from Formulas for Stress and Strain, 5th Edition, by Roark & Young, page 576.

Formula (3) is for the first natural frequency of a beam with simple supports and uniform mass from Formulas for Stress and Strain, 5th Edition, by Roark & Young, page 576.

Dev./Station Oconee Nuclear Station Unit All File No. Attachment 1
Subject Sample Calculation
By Date
Sheet No. 3 of 7 Problem No. Checked By Date

Calculation Cont'd :

Compute induced deflections due to drift :

$E = 1 \times 10^6$ psi max , $.6 \times 10^6$ psi min

$I = 308.7$ in^4/foot width

Tabulate results from Eq (1) (using $E = 1 \times 10^6$ psi)

Elevation of Floor	Wall Height L (in) max	M_Δ (in-lb)	Wall Height L (in) min	M_Δ in-lb
838+0	232.	206.	204.	267.
822+0	184.	328.	156.	457.
809+3	145.	440.	120.	643.
796+6	145.	529.	120.	772.

For E min $M_\Delta = .6 M_{\Delta \text{ tabulated}}$.

Compute frequencies for fixed end walls:

E, I as before
$w = 36.5$ lb/ft^2 = 3.04 lb/in/foot width

Tabulate results from Eq (2) (using $E = 1 \times 10^6$ psi)

Elevation	L	Freq (hz)	L min	Freq (hz)
838+0	232	13.1	204.	17.0
822+0	184.	20.8	156.	29.0
809+3	145.	33.6	120.	49.0
796+6	145.	33.6	120.	49.0

Dev./Station Oconee Nuclear Station
Unit All
File No. Attachment 1
Subject Sample Calculation
By
Date
Sheet No. 4 of 7
Problem No.
Checked By

Calculation Cont'd:

Compute Frequencies for pinned end walls

E, I, w as before

Tabulate results from EQ (3) (using $E = 1 \times 10^6$ psi)

Elevation	Lmax	Freq	Lmin	freq.
838+0	232"	5.77 hz	204"	7.49 hz
822+0	184"	9.17 hz	156"	12.8 hz
809+3	145"	14.8 hz	120"	21.6 hz
796+6	145"	14.8 hz	120"	21.6 hz

Comment: The effect of the interstory drift decreases as the walls increase in height and as the transverse accelerations increase. This shows the critical combination to be the 120" tall wall at floor elevation 796+6.

From the Oconee Response Spectra the following accelerations are found.

Fixed end case $a = 0.18\,g$
pinned end case $a = 0.22\,g$

Dept./Station Oconee Nuclear Station Unit All File No. Attachment 1
Subject Sample Calculation
By Date
Sheet No. 5 of 7 Problem No. Checked By Date

Determine Moments

Fixed end case

$$M_F = 0.18(3.04)(120.)^2 \div 12 = 657 \text{ in-lb}$$

The maximum moment for the fixed case occurs at the floor support where moments are additive:

$$M_{max} = M_F + M_\Delta = 657 + 772 = 1429 \text{ in-lb}$$

Pinned Case:

$$M_s = 0.22(3.04)(120)^2 \div (8) = 1203 \text{ in-lb}$$

Compute Bending stresses:

$$\sigma_{Fb} = 1429(3.81) \div 308.7 = 17.6 \text{ psi}$$

$$\sigma_{sb} = 1203(3.81) \div 308.7 = 14.9 \text{ psi}$$

The compressive stress due to the weight of the wall decreases the tensile stress.

Vertical acceleration = 0.4 g (MHE)

∴ .6 times wall weight can be considered to reduce tension.

Dev./Station Oconee Nuclear Station Unit All File No. Attachment 1

Subject Sample Calculation

By Date

Sheet No. 6 of 7 Problem No. Checked By Date

Calculation Cont'd:

Overburden for fixed condition

$P = .6\,w\,l_e = .6(3.04)(120) = 218.9$ lb

$A = 30\ in^2$ (effective cross sectional area)

$\sigma_o = 218.9 \div 30 = 7.30$ psi

Overburden for pinned condition

$P = .6\,w\,l_e = .6(3.04)(60) = 109.4$ lb

$A = 30\ in^2$

$\sigma_o = 109.4 \div 30 = 3.65$ psi

The net tensile stresses are:

Fixed: $\sigma_t = 17.6 - 7.30 = 10.3$ psi

Simple: $\sigma_t = 14.9 - 3.65 = 11.25$ psi

Form 00184 (6-81)

Div./Station Oconee Nuclear Station Unit All File No. Attachment 1

Subject Sample Calculation

By Date

Sheet No. 7 of 7 Problem No. Checked By Date

Conclusions: For this case the tensile stress in the pinned wall is greater than in the fixed end wall. For the walls at the higher elevations the effect of the induced moments decreases due to higher accelerations.

Duke Power is therefore justified to neglect out of plane drift.

Table 3.5-3
Properties of Missiles - Reactor Vessel & Control Rod Drive

Missile Class		Description	Weight (lbs.)	Impact Area (in^2)	Velocity (ft/sec)	Kinetic Energy (Ft-lbs)
I	1.	Closure head nut	80	38	97	11,680
	2.	Closure stud w/nut	660	71	97	96,400
	3.	1" Valve bonnet stud	0.5	0.6	73.5	42
	4.	C. R. nozzle flange bolt & nut	3.0	3.1	97	438
II	1.	CRD closure cap	8.0	7.0	215	5,742
III	1.	C. R. drive assembly	1000	64.0	90	125,777

Table 3.5-4
Properties of Missiles - Steam Generator

Missile Class		Description	Weight (lbs.)	Impact Area (in^2)	Velocity (ft/sec)	Kinetic Energy (Ft-lbs)
I	1.	1½" Vent valve bonnet stud	2.0	.8	73.5	167
	2.	Feedwater inlet flange bolt	0.3	.6	67.5	21
	3.	16" I.D. manway stud, tube side	8.0	2.1	67.5	566
	4.	5" Inspection opening cover stud	1.5	1.2	73.5	125
	5.	1" Valve bonnet stud	0.5	.6	73.5	42
II	1.	1½" Vent valve stem & wheel	5.0	.45	44.5	154
	2.	Sample line 1" valve stem & wheel	4.0	.3	35.8	80
	3.	Sample line 1" EMO valve stem and wheel	4.0	.3	35.8	80
III	1.	16" I.D. manway cover, tube side	955	615	515	1,950,000
	2.	16" I.D. manway cover, shell side	478	615	777	2,230,000
	3.	5" I.D. inspection cover, tube side	80	150	515	160,000
	4.	5" I.D. inspection cover, shell side	40	150	852	220,000
	5.	1½" Vent valve bonnet and assembly	24	38	371	51,180
	6.	Sample line 1" valve bonnet & assy.	30	27	243	27,460
	7.	Sample line 1" EMO bonnet & assy.	115	27	138	34,250

Table 3.5-5
Properties of Missiles - Pressurizer

Missile Class		Description	Weight (lbs.)	Impact Area (in^2)	Velocity (ft/sec)	Kinetic Energy (Ft-lbs)
I	1.	4" Valve bonnet stud	3.0	1.8	73.5	250
	2.	5" Valve bonnet stud	3.0	2.4	73.5	250
	3.	16" Manway cover stud	7.5	3.1	67.5	530
	4.	Heater bundle stud	25.0	7.0	73.5	2100
	5.	3/4" Valve stem stud	0.8	.45	73.5	67
II	1.	Spray line 4" EMO valve stem	9	1.0	135.0	2560
	2.	Sample line 3/4" valve stem	4	.3	72.7	330
	3.	Sample line 3/4" EMO valve stem	4	.3	72.7	330
III	1.	16" I.D. manway cover	250	615	375	546,000
	2.	Heater bundle assembly	2500	850	375	5,400,000
	3.	Spray line 4" EMO valve bonnet and assembly	325	150	521	1,370,000
	4.	2½" x 6 Relief valve bonnet and assembly	175	65	232	146,000
	5.	Sample line 3/4" valve bonnet	20	21	364	41,150
	6.	Sample line 3/4" EMO valve bonnet and assembly	115	21	258	118,400

Table 3.5-6
Properties of Missiles - Quench Tank and Instruments

QUENCH TANKS

Missile Class	Description	Weight (lbs.)	Impact Area (in^2)	Velocity (ft/sec)	Kinetic Energy (Ft-lbs)
I	1. 1½" Drain valve bonnet stud	0.6	.2	73.5	50
	2. 4" Valve bonnet valve	2.0	.3	73.5	167
II	1. 1½" EMO drain valve stem	5.0	.45	11.0	9
	2. 4" EMO valve stem	9.0	1.0	21.5	65
III	1. 1½" EMO drain valve & op.assy.	220	20	73.5	18,450
	2. 1½" Drain valve bonnet & assy.	20	20	73.5	1,670
	3. 4" EMO valve bonnet & op. assy.	355	65	73.5	29,780

INSTRUMENTS

Missile Class	Description	Weight (lbs.)	Impact Area (in^2)	Velocity (ft/sec)	Kinetic Energy (Ft-lbs)
III	1. RTE	1.0	.2	208	670
	2. RTE & Plug	2.0	4.0	448	6230

Table 3.5-7
Properties of Missiles - System Piping

Missile Class	Description	Weight (lbs.)	Impact Area (in^2)	Velocity (ft/sec)	Kinetic Energy (Ft-lbs)
	Core Flooding Line				
I	14" C.V. bonnet stud	2.0	1.7	73.5	167
I	14" Valve bonnet stud	3.5	4.0	67.5	248
II	14" C.V. check pivot stud	10.0	1.75	249	9650
II	14" P.O. valve stem	98.0	5.0	143	31,100
III	14" C.V. bonnet & assembly	525.0	125	448	1,640,000
III	14" P.O. valve bonnet and assembly	1900.0	650	558	9,180,000
	L.P. Injection Line				
I	12" C.V. bonnet stud	2.0	1.7	73.5	167
II	12" C.V. check pivot stud	10	1.75	249	9,650
III	12" C.V. bonnet and assy.	450	95	558	2,170,000
	R.V. Outlet Line to L.P. System				
I	10" Valve bonnet stud	2.5	1.7	73.5	177
I	Relief valve bonnet stud	0.5	.3	73.5	42
I	Relief valve stem assy.	40	12.5	35.3	768
II	10" EMO valve stem	50	3.1	130	13,200
III	10" EMO valve bonnet & assy.	1270	415	558	6,140,000
	R.V. Inlet Line from H.P. System				
I	4" C.V. bonnet stud	1.0	.8	73.5	83.5
II	4" C.V. check pivot stud	3.0	.8	158	1170
III	4" C.V. bonnet and assy.	30	19	558	145,000
	S.G. Outlet Line to Pump Inlet				
I	1" Drain valve bonnet stud	0.8	.6	73.5	67
II	1" Drain valve stem assy.	4.0	.3	84	438
III	1" Drain valve & bonnet assy.	30.0	27	448	84,380

Table 3.5-7 (Continued)
Properties of Missiles - System Piping

Missile Class	Description	Weight (lbs.)	Impact Area (in^2)	Velocity (ft/sec)	Kinetic Energy (Ft-lbs)
	Pressurizer to C.A. System Line				
I	3/4" Valve bonnet stud	1.0	.45	73.5	83
II	3.4" Valve stem	4	.3	73	330
II	3/4" EMO valve stem	4	.3	73	330
III	3/4" Valve bonnet and assy.	20	21	425	56,250
III	3/4" EMO valve bonnet and assy.	115	21	280	140,000
	Primary Pump Seal Water Return to H.P. System Line				
I	3" EMO valve bonnet stud	1.0	1.0	73.5	83.5
II	3" EMO valve stem	25.0	.3	125.7	6150
III	3" EMO valve bonnet and assy.	285.0	85	507	1,137,000
	Letdown Cooler Inlet & Outlet Lines				
I	1½" EMO valve bonnet stud	2.0	.8	73.5	167
II	1½" EMO valve stem	1.0	1.0	153.2	1830
III	1½" EMO valve bonnet and assy.	250.0	38	320	397,000
	Primary Pump Seal Water Inlet and Outlet Lines				
I	3" Inlet C.V. bonnet stud	1.0	.8	73.5	83.5
I	3" Outlet valve bonnet stud	2.0	1.0	73.5	167
II	3" C.V. check pivot stud	3.0	.8	158.4	1170
II	3" Outlet valve stem	25.0	2.4	125.7	6150
III	3" Inlet C.V. bonnet and assy.	25.0	85	558	120,800
III	3" Outlet valve bonnet and assy.	65.0	85	523	276,000

Table 3.5-7 (Continued)
Properties of Missiles - System Piping

Missile Class	Description	Weight (lbs.)	Impact Area (in^2)	Velocity (ft/sec)	Kinetic Energy (Ft-lbs)
	Primary Pump Vent & Drain Lines				
I	1½" Vent & drain valve bonnet stud	2.0	.8	73.5	167
II	1½" Vent & drain valve stem	5.0	1.0	153.2	1830
III	1½" Vent & drain valve bonnet and assy.	55.0	38	435.0	161,600