NON-DYNAMIC

SEISMIC ANALYSIS OF PIPING

AND SUPPORTS BY STONE & WEBSTER

AT MAINE YANKEE

7904130203

ABSTRACT

This document describes the (non-dyanmic) analysis technique used to design (6 inch and smaller) piping systems to withstand seismic loading conditions. Using the general described methods, together with Maine Yankee site specific seismic information, calculations are performed to quantify the margin of safety inherently present in simplified/static seismic analysis. From the descriptions and comparative analyses performed here, it is concluded that piping and supports at Maine Yankee are conservatively designed to safely withstand design seismic loading conditions.

DISCLAIMER OF RESPONSIBILITY

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PIPING DESIGN (Hand Calculations)

The earliest design approach used for piping involved determining a span length between seismic restraints. The method involved selecting upper and lower bound span lengths based upon pipe size and end support conditions. Span bounds were based upon resultant span natural frequency and the bounds on span length insured the peak frequency of the appropriate ARS would be avoided.

It was observed that the length bound corresponding to the "rigid" frequency range was approximately the same as the pipe span table for deadweight in ANSI B31.1 Power Piping Code.

As an evolution "engineering instructions", (Stone & Webster PS-1A) were generated and required that span lengths be computed. This calculation used a standard frequency equation (from "Design of Piping Systems" by Kellogg Co.) and resulted in a maximum length which assured that the resulting span frequency would be 1.5 to 2.0 times the peak resonant frequency of the ARS (References 1 and 2).

In the references above, the decoupling of orthogonal response effects are addressed in the (first) step before computing support span lengths. This was accomplished by including supports at elbows, tees and concentrated masses, thus "grounding" their effect to the supporting structure.

In summary, the approach used in initial pipe design was to avoid the resonant range of the ARS by judicious pipe support span selections.

PIPING DESIGN - SPECIAL CASES

Whenever the support schemes dictated in PS-1A type instructions could not be achieved, computer analyses (using SHOCK-era programs) would be performed. In that case the analysis technique is outside the scope of this discussion.

In light of Maine Yankee ARS peak accelerations being moderately low, and with the consistency with which the rigid range length bound (using the earliest PS-1A L_{max} approach) approximated the B31.1 deadweight span lengths, the following approach would often be selected. The span lengths of B31.1, (intended for deadweight design) were used for seismic restraint span designs, (without calculation of natural frequency for the resulting span).

PIPING STRESS ANALYSIS

For all cases where span lengths were determined based upon rigorous determination of span natural frequency, the method of computing stress due to seismic loading is as given in Reference (1). Basically, a deadweight stress based on L_{max} was obtained from a Stone & Webster-approved monograph or chart. Seismic stresses would be computed by multiplying the deadweight stress magnitude by a G-factor reflecting the ARS. Typical G-factors were (a) half the magnitude of the peak ARS acceleration (in g-units) for piping known to be out of the resonant range, (b) not less than 0.5 g's.

For those cases where pipe spans were taken equal to or less than the B31.1 deadweight span lengths for seismic restraint spacing, for which no frequency calculation was performed, the G-factor used was 1.5 times the peak spectral acceleration.

SPECIFICS OF SEISMIC STRESS CALCULATION

In Reference (1) for Maine Yankee (as opposed to Reference (2)), the G-factors used in seismic stress calculation were taken from and intended to be horizontal spectral accelerations. No formal statement on combining deadweight with horizontal and simultaneous vertical earthquake inertia effects was made. Using the nomenclature

S_{PL} = Longitudinal internal pressure stress

S_{DW} = Pipe stress due to deadweight

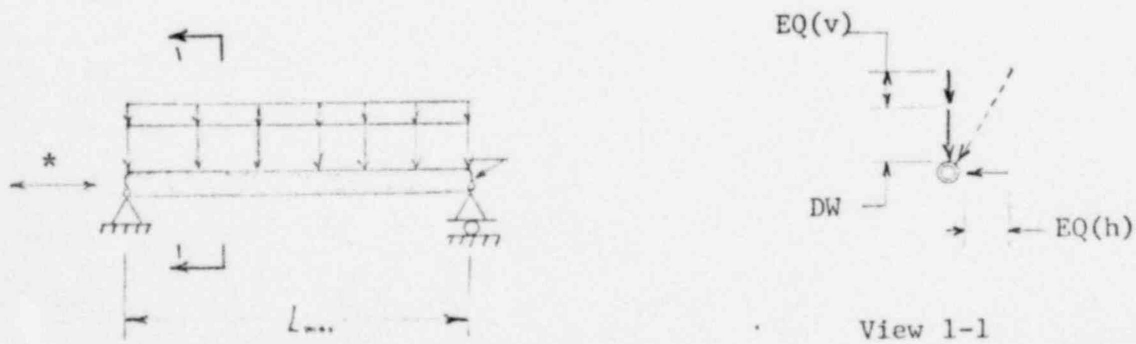
S_{EQ} = Pipe stress due to earthquake load

$$S_{LP} + S_{DW} + S_{EQ} < KS_h \quad \text{where}$$

for S_{EQ} -- OBE K = 1.2, and

for S_{EQ} -- DBE/SSE K = 1.8

was the B31.1 stress criteria. In order to reflect inclusion of horizontal plus vertical earthquake effects, and recalling no cross coupling of earthquake effects, consider:



View 1-1

*RESTRAINT provided by supports

1) no rotation restraint
2) no restraint in (pipe) axial direction
3) displacement restraint provided in all directions transverse to pipe axis

Appropriate (present day) load combination would be

$$S_{TOTAL} = \sqrt{\left(S_{DW} + S_{EQ(v)}\right)^2 + \left(S_{EQ(h)}\right)^2}$$

with $S_{EQ(h)} = f_g \times S_{DW}$

and $S_{EQ(v)} = (2/3)\ f_g \times S_{DW}$

$$S_{TOTAL} = S_{DW}\sqrt{\left(1 + 0.667\ f_g\right)^2 + \left(f_g\right)^2}$$

$$= S_{DW}\sqrt{1 + 1.333\ f_g + 0.444\ f_g^2 + f_g^2}$$

$$S_{TOTAL} = S_{DW}\sqrt{1 + 1.333\ f_g + 1.444\left(f_g\right)^2} \qquad \text{(EQUATION 1)}$$

The technique specifically spelled out in Reference (1) is as below:

$$S_{TOTAL(OLD)} = S_{DW}\left(1 + f_g\right) \qquad \text{(EQUATION 2)}$$

The tabulation in Table 1 is a comparison of design approaches between using the S&W PS-1A (Reference (1) approach) and B31.1 spacing table for seismic span procedure.

(Small) pipe sizes are considered with the weakest schedule (for most flexible result) selected from MY Piping Specifications.

TABLE - 1

Pipe Size and Schedule	W (lb/ft)	I (in^4)	S/W PS-1A L(ft)	B31.1 - Motivated L (ft)	fp (Hz)
1" SCH 80	2.481	0.106	8.43	7	16.807
1½" SCH 80	4.40	0.391	10.13	---	---
2" SCH 80	8.42	1.160	11.31	10	14.83
2½" SCH 10s	5.89	0.988	11.88	---	---
3" SCH 10s	7.94	1.82	12.84	12	13.28
4" SCH 10s	11.78	3.96	14.13	14	11.82
5" SCH 40	23.26	15.20	16.69	---	---
6" SCH 40	31.50	28.10	18.04	17	13.06

$E = 29 \times 10^6$ psi

$$L_{PS\text{-}1A} = \left[\frac{0.371}{fs}\sqrt{\frac{EI}{W}}\right]^{1/2}, \quad fp = \frac{0.742}{L^2}\sqrt{\frac{EI}{W}}$$

Nomenclature is as follows:

$W = \frac{\text{weight}}{\text{ft}}$ of pipe and contents (water)

L_{SW-P1} = Pipe Length by PS-1A Equation

$L_{B31.1}$ = Pipe Length by B31.1 Power Piping Code (for deadweight)

fp = Pipe Span Frequency for $L_{B31.1}$ using PS-1A Equation

From containment ARS, the peak frequency is 5.8 Hz,

$2f_s$ = 11.6 Hz.

Therefore, utilization of B31.1 deadweight spacing for seismic restraints assures that the frequency criteria of Reference (1) is achieved.

With the conclusion above, in comparative analysis of current-day vs. PS-1A seismic stress calculation, PS-1A analyses envelope the designs based upon B31.1 spacing for deadweight applied to seismic restraint.

. Deadweight plus seismic stresses, computed using the PS-1A technique are the analyses of record and should result in more severe conditions (for which the system was ultimately designed) than those using current-day techniques and more detailed G-factor determination. Therefore, the pre-Robinson fix spectral acceleration data will be used and compared to "2f" values in Table 2.

The Maine Yankee containment ARS curves at various elevations, (up to and including El 96'-0"), were used in tabulating the following information: OBE & DBE "OLD", "NEW" (Robinson-Fix), and $2f_s$ (spectral acceleration corresponding to twice the peak frequency).

In all cases (Table 3), the analysis of record results in a more severe stress condition. The existing piping and support configuration was erected based upon the design requirements of the analysis of record. Hence, it is concluded that piping, designed by conservative analysis, is in accordance with and meets the requirements of B31.1 Power Piping Code

TABLE - 2

Elevation and Curve No.	OBE			DBE/SSE		
	New	Old	2fs	New	Old	2fs
27'-6", 1 & 2	1.1	0.90	0.125	2.2	0.683	0.20
34'-6", 3 & 4	1.1	0.994	0.1375	2.2	0.708	0.2125
50'-0", 5 & 6	1.1	1.1	0.150	2.2	0.90	0.225
96'-0", 7 & 8	1.51	1.51	0.2125	2.2	0.975	0.2875

All above acceleration values are in G-units.

TABLE - 3

Containment Elevation	G-Factors G - (Old)	G - (2FG)	Evaluation EQ-1	Equation EQ-2
27'-6"	0.90 (0.50)*	0.125	1.090 S_{DW}	1.90 S_{DW} (1.50)
34'-6"	0.994 (0.50)	0.1375	1.100 S_{DW}	1.994S_{DW} (1.50)
50'-0"	1.10 (0.50)	0.150	1.110 S_{DW}	2.10 S_{DW} (1.50)
96'-0"	1.51 (0.50)	0.2125	1.161 S_{DW}	2.51 S_{DW} (1.50)

All above factors are based on OBE-Level spectral accelerations.

All acceleration values are in G-Units.

*Minimum loading from Reference (1).

In summary:

(a) piping, designed based upon natural frequency criteria, was subjected to a conservative seismic load (in excess of the appropriate ARS acceleration).

(b) piping, designed using B31.1 deadweight span lengths for seismic, was subjected to factored peak acceleration loadings, despite the observed similarity between resulting spans in (a) and (b).

The comparative analyses presented herein show all the analysis techniques to be highly conservative.

Pipe Support Information

The following is a coarse characterization of pipe support data for "simplified analysis" piping at Maine Yankee:

(a) Field Run piping, discussed in Stone & Webster correspondence, Reference (4).

(b) Equipment/Anchor reaction load design calculation, Reference (5).

(c) Standard seismic restraint "decal load" approach with design loads based upon supported pipe size, Reference (6).

Field Run Piping

According to Reference (4), field run piping was supported in a manner dictated by (Stone & Webster field) stress analyst with "typical type of pipe support which can be used for (these) anchors and restraints".

The charting method served as the basis for the pipe span design length determination.

The support "typical type" reference, as explained by Gary Harper (S&W) meant that the direction of restraint (only) was determined by the field stress analyst; the actual design of the support would be based upon the loads tabulated in Reference (6), using classical techniques of engineering mechanics.

Standard Seismic Reaction Loads

For expedious seismic restraint design, a tabulation of conservative seismic support reaction loads was developed. These were commonly referred to as "decal loads" and reaction magnitudes were based upon the size of pipe that was being supported. The reaction load magnitudes versus pipe sizes are given in Reference (6). A comparison of the "decal loads" and reactions computed using simply supported beam is presented in Tables 4 and 5. Table 4 gives reaction loads based upon simply supported beams with uniformly distributed load (equal to pipe plus contents weight) for different pipe sizes. To consider seismic inertia effects, the reaction loads in Table 4 are multiplied by the G-factor tabulated values of Table 3. Although there is ample justification to use the EQ-1 factors, for added conservatism, EQ-2 factors are considered as well. (See Table 5)

In all cases using the Equation-1 seismic factors, the S&W standard seismic design loads are much greater than resulting EQ-1 reactions.

The standard seismic reaction loads of Reference (6) are even higher than the ultra-conservative reactions computed using EQ-2 factors

TABLE - 4

Pipe Size/Schedule	I (in)	W (lb/ft)	L (ft)	Reaction Force (lb)
3/4" SCH 80	0.0448	1.657	7.53	12.48
1" SCH 80	0.106	2.481	8.34	20.91
1½" SCH 80	0.391	4.40	10.13	44.57
2" SCH 80	1.160	8.42	11.31	95.23
3" SCH 160	4.210	16.64	13.16	218.98
4" SCH 160	6.620	26.52	13.12	347.94
6" SCH 160	13.30	54.46	13.04	710.16

E = 29000000 psi,

$L = \left[\frac{0.371}{fs} \sqrt{\frac{EI}{W}} \right]^{1/2}$, $R = 2\left(w\ell/2\right)$

each span reaction

contributions from
adjacent spans

TABLE - 5

Pipe Size Schedule	Equation - 1		Equation - 2		"Decal Load" S&W Reaction (lbs)
	G-Factor	Reaction	G-Factor	Reaction	
3/4" SCH 80	1.10	13.73	2.05	25.58	300
1" SCH 80	1.10	23.00	2.05	42.86	400
1½" SCH 80	1.10	49.03	2.05	91.37	500
2" SCH 80	1.10	104.75	2.05	195.22	750
3" SCH 160	1.10	240.88	2.05	448.91	1000
4" SCH 160	1.10	382.73	2.05	713.28	1500
6" SCH 160	1.10	781.17	2.05	1455.82	2000

Equipment/Anchor Reaction Loads

Reference (5) contains engineering instruction for simple, hand calculation of forces and moments due to seismic on equipment and/or pipe anchors. The technique is based on a beam fixed at one end (equipment/anchor) and pinned at the other (pipe restraint) model, subjected to uniform loading. The applied loads represent deadweight and a seismic component based upon 1.3 times the peak spectral acceleration, with applicable ARS, already reflecting the Robinson-fix procedure.

An assessment of conservatism is based upon consideration of natural frequencies. The seismic loading of 1.3 x Sa (max) are required for those systems where the natural frequency of the pipe span (f_p) is in the range of the structure's peak frequency (f_s) i.e. $0.9\ f_s \leq f_p \leq 1.1\ f_s$.

According to the Kellogg book, for the given restraint conditions:

$$f_p = \frac{1.16}{L^2}\sqrt{\frac{EI}{W}} \qquad \text{(EQUATION 3)}$$

Consider limiting $f_p \geq 1.1\ f_s$. Then the maximum span length is:

$$L^2 = \frac{1.16}{1.1 f_s}\sqrt{\frac{EI}{W}}$$

and

$$L = \left[\frac{1.055}{f_s}\sqrt{\frac{EI}{W}}\right]^{\frac{1}{2}}$$

where $f_s \approx 5.8$ Hz for piping supported off the containment.

Considering the most flexible pipe span cases for Maine Yankee, Table 6 contains resulting values of L_{max} based upon frequency.

TABLE - 6

Pipe Size and Schedule	W (lb/ft)	I (in^4)	$L_{max_{fn}}$ (ft)	L_{PS-1A} (ft)	$L_{B31.1}$ (ft)
1" SCH 80	2.481	0.106	14.23	8.43	7
1½" SCH 80	4.40	0.391	17.09	10.13	---
2" SCH 80	8.42	1.160	19.07	11.31	10
2½" SCH 10s	5.89	0.988	20.03	11.88	---
3" SCH 10s	7.94	1.820	21.66	12.84	12
4" SCH 10s	11.78	3.960	23.83	14.13	14
5" SCH 40	23.26	15.20	28.14	16.69	---
6" SCH 40	31.50	28.10	30.42	18.04	17

Modulus $E = 29 \times 10^6$ psi

f_s (peak) = 5.8 Hz

From Table 6 it can be seen that in order for the span natural frequency to approach the resonant range, lengths greatly exceed those tabulated in both B31.1 (for deadweight) and as computed using the S&W PS-1A technique. Further, even if such large spans were to occur, the fundamental, lowest natural frequency would fall into the resonant range, while other frequencies would be excited by "rigid range" accelerations. Based on the two previous facts, the 1.3 x Sa (max) seismic + deadweight load application to spans addressed in Reference (5) results in a conservatively severe equipment/anchor reaction load condition.

COMPUTERIZED (NON-DYNAMIC) SEISMIC ANALYSIS

According to G. Harper, D. Shave, and M. Pedell (S&W), "static" seismic analysis of piping for Maine Yankee was performed using a technique generally identical to that in the SHOCK (pseudo dynamic) era programs. In fact, the difference between static and dynamic analyses lay in the computation of (equivalent static) inertial loads. The system response due to a vector of inertial nodal forces (computed by pseudo dynamic or equivalent static analysis) was determined in an identical manner.

For static analyses, inertial seismic forces at system mass points were computed by multiplying the nodal lumped mass by the peak spectral (factored) acceleration from an appropriate ARS (Reference (9)).

(In dynamic analyses performed by Stone and Webster, inertial seismic nodal forces would be computed by statistically summing products of (modal) mass times a spectral acceleration value corresponding to the natural frequency of the vibration mode).

In general, the pseudo-dynamic method was preferred and subsequently, largely substituted for static analysis, Reference (10). All piping designed and analyzed by the static method prior to the "Robinson" resonance evaluation was re-evaluated with higher seismic loading and shown adequate or if necessary, redesigned.

References

1.0 S&W General Instruction PS-1A for Maine Yankee Project*

2.0 S&W General Instruction PS-1A for North Anna Project

3.0 Amplified Response Spectrum Curves Used for Maine Yankee, Obtained from Stone & Webster*

4.0 S&W Memo, L. M. Perry to J. V. A. Longcon dated January 22, 1971*

5.0 S&W Interoffice Correspondence, L. Neih to P. Puglisi dated July 25, 1971*

6.0 Stone & Webster "Design Anchors and Constraints for Force of (piping)", from S&W Earthquake and Thermal Constraints and Anchors Nomenclature for Plan View*

7.0 Maine Yankee Piping Specification

8.0 ANSI B31.1 Power Piping Code

9.0 "Design Notes - Earthquake Analysis as Applied to Equipment Components (at) Maine Yankee Atomic Power Company" by Stone & Webster, dated January 11, 1968.

10.0 S&W Memo, M. Pedell to J. Lance dated January 13, 1969.*

*excerpts attached

INTEROFFICE MEMORANDUM

SUBJECT See Below

40 28 General Instructions PS - 1A

DATE August 3, 1971

FROM [illegible]

TO All Pipe Stress Analysts

CC General Files

SIMPLIFIED SEISMIC DESIGN PROCEDURE FOR SMALL SIZE (6" DIAM AND UNDER)

APPROACH

The procedure below is to be used for Maine Yankee Atomic Power Company project.

The basic approach to the design of small size Classes 1, 2, 3 piping is to make the system rigid whenever good engineering design practice dictates. Spacing between pipe constraints should be determined, so that its fundamental frequency f_n will always be $2f_s$; f_s = peak resonant frequency of structure as determined from applicable response spectrum. Inertial loads ("G" factor) from O.B.E. and D.B.E. are conservatively set at one-half peak acceleration of O.B.E. and D.B.E. response spectrum, respectively. Dead load stresses can readily be calculated from design chart using this predetermined span. Multiply the deadweight stresses by "G" factor, which is set at one-half peak acceleration or 0.5 G minimum; this yields S_{OBE} and S_{DBE}, respectively. The "G" factor would be specified explicitly for each problem. Pressure stress can be easily hand calculated as $Pd^2/(Do^2-d^2)$. Thermal stresses can be read directly from piping flexibility nomograph.

The philosophy is to perform stress calculations for small size pipe in a sectionalized "between-supports" manner, without using computer analysis. This is justifiable because a rigid system with sufficient pipe supports closely represents many one-dimensional straight beam problems, wherein the coupling effects of three-dimensional piping systems are eliminated by placing constraints near all elbows, tees and concentrated masses (such as valves, etc.). These hand calculations provide sufficient and conservative data to satisfy requirements of ANSI-B31.1.0, dated 1967, as represented by Equations (2), (3), (4) and (9).

RULES

1. Elbows, tees and valves should be constrained to prevent the coupling effects of the attached piping and effect of concentrated mass (valve), providing there is no anchor nearby, viz:

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8/3/71 - 2.

2. Determine peak structural frequency f_s from the applicable response spectrum. Use Hinged-Hinged formula (conservative) to determine span of pipe supports L as follows:

$$f_n = [illegible] \geq 2f_s$$

$$L \leq ([illegible])^{\frac{1}{2}} \qquad (1)$$

3. Choose span of supports L, and read from the design chart the dead load stress S_{DL}, at gravity = 1.0.

4. Use specified "G" factor of seismic load furnished by Pipe Stress Engineer which is representative of floor response spectrum. Multiply S_{DL} by these "G" factors to obtain S_{OBE} and S_{DBE}, respectively.

5. Calculate $S_{LP} = Pd^2/(Do^2 - d^2)$

6. Check against primary stress criteria:

$$S_{LP} + S_{DL} \leq S_h \qquad (2)$$

$$S_{LP} + S_{DL} + S_{OBE} \leq 1.2S_h \qquad (3)$$

$$S_{LP} + S_{DL} + S_{DBE} \leq 1.8S_h \qquad (4)$$

7. Using piping flexibility nomograph, determine stress* caused by thermal deflection and check against secondary stress criteria:

$$S_{TH} \leq 1.25S_c + 0.25S_h \qquad (5)$$

8. If, due to various reasons, constraints cannot be located as shown in Step 1, the stress-intensification factor tabulated in Appendix D, ANSI-B31.1.0, dated 1967, should be applied to S_{DL}, S_{OBE} and S_{DBE} obtained in Steps 3 and 4.

9. If, for any reason, the actual pipe span exceeds the calculated L as determined in Eq. (1), a computer analysis must be made or the higher modes of seismic responses must be used by applying peak acceleration of the response spectrum as the "G" factor. The deviations as mentioned above may be due to the inability to locate supports where required or due to very low seismic excitation.

10. If desired, computations of exact interface forces/moments between small size piping and Classes 1,2,3 equipment (pump, heat exchanger, tank) are to be performed by computer analysis, based upon a physical model up to nearest pipe anchor point from the equipment nozzle.

*Formulation

$S_{TH} = 0.01042(E)(D_o)\Delta/L^2$ (6) - For Cantilever End Condition

$S_{TH} = .02084(E)(D_o)\Delta/L^2$ (7) - For Guided Cantilever End Condition

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8/3/71 - 3.

NOTATIONS

E = modulus of elasticity at operating temperature, lb/in.^{2}

I = moment of inertia of pipe, in.^{4}

W = weight of pipe per foot (including pipe contents and insulation), lb/ft

L = length between pipe supports, ft

P = operating pressure, psi gage

d = nominal inside diameter of pipe, in.

D_o = nominal outside diameter of pipe, in.

f_s = peak resonant frequency of structure, cps

f_p = predetermined fundamental natural frequency of pipe, cps.

S_{LP} = longitudinal pressure stress, psi

S_{DL} = dead load stress, psi

S_{OBE} = operational basis earthquake stress, psi

S_{DBE} = design basis earthquake stress, psi

S_{TE} = thermal stress, psi

S_c = allowable stress at ambient temperature, psi } Tables A-1 & A-2

S_h = allowable stress at operating temperature, psi } ANSI B31.1.0

Δ = thermal deflection

W. H. Pebbel

W. H. Pe[illegible]

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MAINE YANKEE CONTINUED

SITE EARTHQUAKE* OBE = .05 "g", DBE = .10 "g"

VERTICAL = 2/3 HORIZONTAL

ARS DAMPING VALUES*		OBE	DBE
STRUCTURAL	-	2	5
EQUIPMENT	-	1	2
PIPING	-	1	2

PRELIMINARY

ARS PEAK SPREADING*

±10% OF PEAK RESPONSE FREQUENCY

PEAK SPREAD WITH VERTICAL LINES AS ILLUSTRATED IN EMAG 49 ATTACHMENT 6.1

* SEISMIC DESIGN REVIEW, EQUIPMENT & PIPING
MAINE YANKEE ATOMIC POWER STATION
MARCH 15, 1972

NOTE

MINIMUM PEAK RESPONSE ACCEL. = 22 x MAXIMUM GROUND ACCEL.
= 22 x .05 OR 1.1 g FOR OBE
AND = 22 x .10 OR 2.2 g FOR DBE

FOR VERTICAL RESPONSE, USE 2/3 OF ~~MAXIMUM~~ LARGER HORIZONTAL RESPONSE

FOR STATIC ANALYSIS OF EQUIPMENTS & PIPING IN RESONANCE ZONE MULTIPLY PEAK RESPONSE ACCEL BY A FACTOR OF 1.3

YANKEE ATOMIC ELECTRIC COMPANY CALCULATION NO. ______ PAGE 27 OF 35

SUBJECT (REFERENCE - 3

PREPARED BY A.V.R. DATE 4/2/79 REVIEWED BY ______ DATE ______ WORK ORDER NO. 5103

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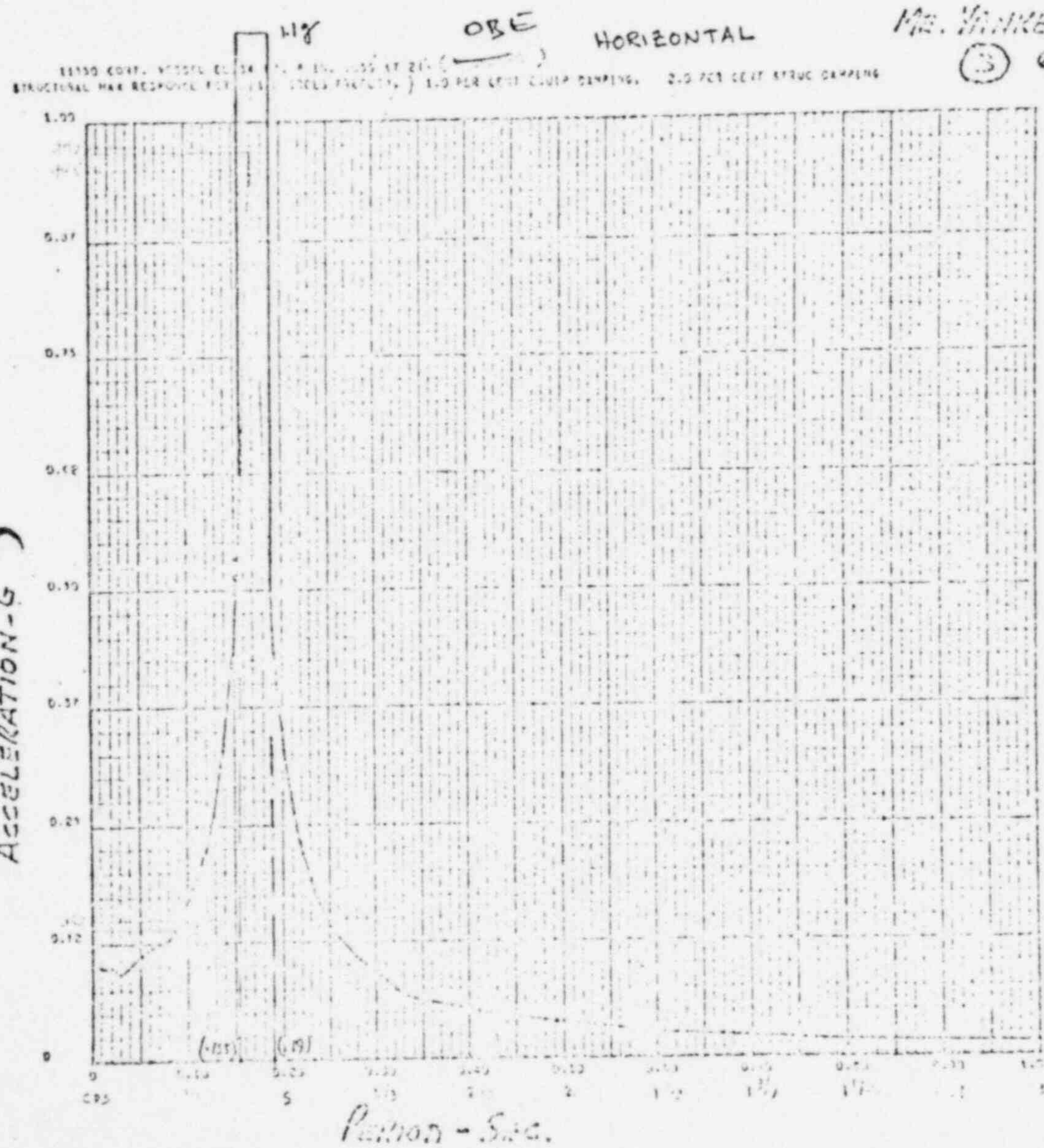
MULTIPLY BY 2/3 FOR
VERTICAL RESPONSE

PEAK SPREAD INCLUDED

PRELIMINARY

OBE HORIZONTAL

MT. YANKEE
(3) 6/3/71



POOR ORIGINAL

SUBJECT (REFERENCE - 3)

PREPARED BY A.V.R. DATE 4/2/79 REVIEWED BY ______ DATE ______ WORK ORDER NO. 5103

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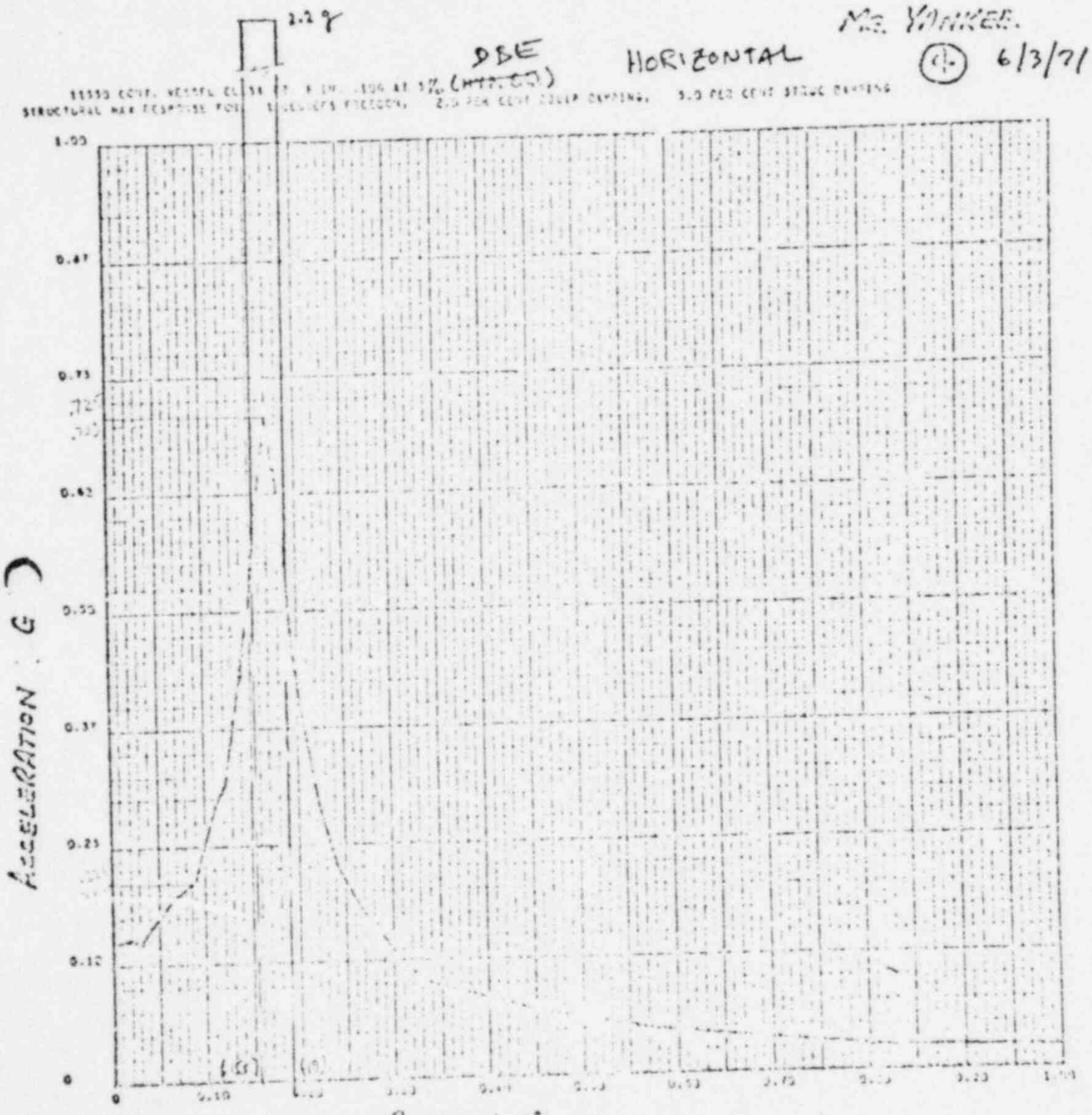
MULTIPLY BY 2/3
FOR VERTICAL

PEAK SPREAD INCLUDED

PRELIMINARY



POOR ORIGINAL

(2.2)

INTEROFFICE MEMORANDUM

J.O. OR W.O. NO. 11950

SUBJECT PROCEDURE FOR SEISMIC ANALYSIS OF DIAGRAMMATIC PIPING NOT ALREADY COMPLETED MAINE YANKEE ATOMIC POWER STATION

DATE January 22, 1971

FROM LMPerry:EMT

TO JVALongcor

CC General Files
MHPedell
RFKlause
WJLKennedy
CSargeoff
JAYkasala
KClark
NRGilbert
KRBrown
LMPerry/Job Book
EEErlandson-Wiscasset
ABOtwell-Wiscasset/encl.

ANSI B31.1.0 - 1967 Code for Pressure Piping does not require seismic analysis to be documented for diagrammatic piping nor had the AEC auditor expressed any interest in this matter during his visit late last year (11/70).

There is a considerable amount of diagrammatic piping already analyzed for earthquake. A list of this piping still to be analyzed was forwarded to the field for their use. A copy of that list is attached for your information. During our meeting with W. J. L. Kennedy on the afternoon of January 15, 1971, the procedure outlined below was agreed upon to complete the seismic efforts. It should provide for approximate locations of the seismic anchors and restraints while maintaining a minimum of documentation.

1. When a group of diagrammatic lines to be seismic analyzed has been erected in an area such as the Primary Auxiliary Building, the field will notify the Boston office (L. M. Perry).

2. A stress analysis engineer from Boston will then visit the job site to perform a survey for the purpose of locating only seismic anchors and restraints for these 2 in. and smaller lines.

3. The field will provide the engineer with prints of the piping (FP series) drawings which include the lines to be stress analyzed during his visit.

4. The stress analysis engineer, with the aid of one field man, will indicate the approximate locations for seismic anchors and restraints based upon the charting method and upon his judgment. These approximate locations will then be indicated and initialed by him on the field prints of the piping drawings which will be maintained in the field for that purpose only.

#2.2

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NOTED JAN 26 1971 JAKcb

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5. The stress engineer will also indicate a typical type of pipe support which can be used for these anchors and restraints. (During a recent visit to the field Mr. R. T. Klause gave a copy of some of the typical sketches mentioned above to Mr. Dave Morotto).

6. The field will furnish and erect those seismic anchors and restraints as indicated on the field-provided prints of the piping drawings in addition to those other non-seismic pipe supports normally provided by the field.

These prints are the only record that will be maintained regarding the calculations for diagrammatic piping which has not already been completed.

By copy of this memorandum, I am notifying the interested parties who attended an earlier meeting on the afternoon of January 18, to discuss this matter. I believe we will receive the cooperation of those people in successfully completing this work using the above procedure.

Lloyd M. Perry

Enclosures

POOR ORIGINAL

SUBJECT (REFERENCE - 5)

PREPARED BY A.V.R. DATE 4/2/79 REVIEWED BY ______ DATE ______ WORK ORDER NO. 5103

(2.3)

PRELIMINARY

INTEROFFICE CORRESPONDENCE

Manuf. Mnte.E
J.O. 11550

TO: P. Puglisi

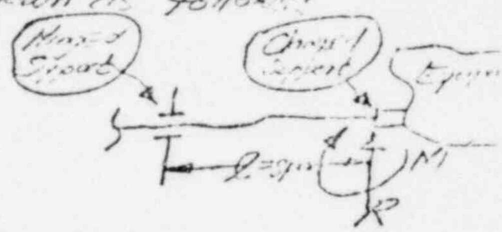
FROM: L. Nieh

SUBJECT OR REFERENCE: Method of Calculating Conservative Reaction Forces/Moments of Small Piping with Interfaces of G.E. and S&W Equipments

MESSAGE —

To Calculate Conservatively the piping reaction forces/moments with interfaces, a simplified method is shown as follows:

① R = reaction force due to dead load and seismic load $\begin{cases} 1.43g - O.B.E. \\ 2.86g - D.B.E. \end{cases}$



$R_{OBE} = \frac{5}{8}W(1+1.43) = 1.52\,W$ lbs.

$R_{DBE} = \frac{5}{8}W(1+2.86) = 2.40\,W$ lbs.

$M_{OBE} = \frac{W}{8}(1.43+1)\ell = 0.3\,W\ell$ ft.-lbs.

$M_{DBE} = \frac{W}{8}(2.86+1)\ell = 0.48\,W\ell$ ft.-lbs.

W = total weight of pipe in this span

② Reaction moment due to thermal displacement = M_{th}

Use piping flexibility monograph to obtain thermal stress,

M_{th} = (thermal stress) × (section modulus of pipe)

Finally, add absolute values of

SIGNATURE

REPLY:

$(M_{OBE} \pm M_{th})$ = O.B.E. reaction moment,

$(M_{DBE} \pm M_{th})$ = D.B.E. reaction moment,

R_{OBE} = O.B.E. reaction force,

R_{DBE} = D.B.E. reaction force,

In all three directions

Please use the above method to give upper-bound estimated forces/moments, for G.E. & S&W equipment design. Please document it, to be sent, these informations are needed by G.E. & Nuclear Division of S&W.

Copy To: J. Freeman
P. Nielsen
M. Pertell
J. Cook

NOTED

7-23-71

DATE

[signature]

SIGNATURE

NOTED JUL 23 1971

NOTED JUL 23 1971

POOR ORIGINAL

#2.3

PRELIMINARY

PAGE NO. X 10.4635

PROB NO. H.C.

J.O. 11550
MAINE YANKEE
WISCASSET
DESIGN STRESS ANALYSIS

PIPING SYSTEM - Secondary Component Water Cooling

LINE DESIGNATION -
Upper Bearing
P-27A, B, + C.

DWG. NO. 11550-FP-47 (ISSUE)

MSK DWG. NO. 11550-MSK-120K2

PAGE NO. X10.4625 THRU X10.4638 INCL.

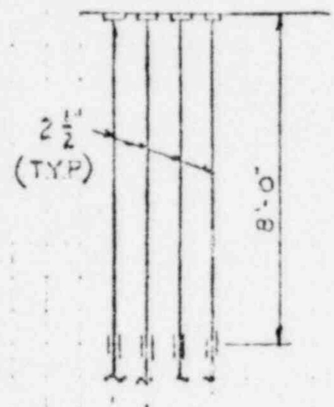
SUBJECT (REFERENCE - C)
PREPARED BY A.V.R. DATE 4/2/79 REVIEWED BY ______ DATE ______ WORK ORDER NO. 5103

X10.9631

STONE & WEBSTER ENGINEERING CORPORATION Page No 1 of 1
CALCULATION SHEET Preliminary ______ Item FP-47B

Client MAINE YANKEE Location WISCASSET, ME. MSK 120K2 J.O. No. 11552
Subject SECONDARY COMP. COOLING WATER PIPING Date 8-2-71 By R.M.SHEA
INBOARD & OUTBOARD EXCITER AIR COOLERS Checked By FHC
Based on (FP-47) Revised By

OUTBOARD EXCITER AIR COOLER



TEMP. = 120°F

COEFF OF EXP. = .00375 IN/FT

$\ell = \sqrt{(8.0)^2} = 8.0'$

WEIGHT DATA

ITEM	WT./FT	FT	TOTAL
2½ PIPE	5.79	8-0	46.32#
WATER	2.07	8-0	16.56#
			62.88#

ROBE = 1.52 × 62.88 = 95.55 LBS

RDBE = 2.40 × 62.88 = 150.91 LBS

MOBE = 0.3 × 62.88 × 8.0 = 150.91 FT-LBS

MDBE = 0.48 × 62.88 × 8.0 = 241.46 FT-LBS

$$S_A = \frac{0.01042 \times 27.9 \times 10^6 \times 0.00375 \times 12 \times 2.875}{(3.5)^2} = 3070 \text{ PSI}$$

MTH = 3070 × 1.064 = 3266 IN-LBS = 272 FT-LBS

MOBE ± MTH = 423 FT-LBS

MDBE ± MTH = 513 FT-LBS

STONE & WEBSTER ENGINEERING CORPORATION

(ATTACHMENT)

(2.4)

PRELIMINARY

EARTHQUAKE AND THERMAL CONSTRAINTS AND ANCHORS NOMENCLATURE FOR PLAN VIEW

1. ANCHOR — CONSTRAIN PIPE IN ALL DIRECTIONS INCLUDING ROTATIONS.
2. VERTICAL CONSTRAINT — CONSTRAIN PIPE IN VERTICAL DIRECTION ONLY.
3. AXIAL CONSTRAINT — CONSTRAIN MOTION ALONG LONGITUDINAL AXIS.
4. LATERAL CONSTRAINT — CONSTRAIN MOTION TRANSVERSE TO LONGITUDINAL AXIS.
5. VERTICAL AND AXIAL CONSTRAINT.
6. VERTICAL AND LATERAL CONSTRAINT.
7. AXIAL AND LATERAL CONSTRAINT.
8. HYDRAULIC TYPE SHOCK BRACE.
9. OTHER AND SPECIAL CONSTRAINTS ARE COMPLETELY DESCRIBED WITH LOCATIONS SPECIFIED ON PIPING PLANS.
10. DESIGN ANCHORS AND CONSTRAINTS FOR FORCES OF:

$\frac{3}{4}$" PIPE = 300 LBS.	3" PIPE = 1000 LBS.
1" PIPE = 400 LBS.	4" PIPE = 1500 LBS.
$1\frac{1}{2}$" PIPE = 500 LBS.	6" PIPE = 2000 LBS.
2" PIPE = 750 LBS.	

Decal Loads

POWER INDUSTRY GROUP		TITLE EARTHQUAKE AND THERMAL CONSTRAINTS AND ANCHORS NOMENCLATURE FOR PLAN VIEW		SCALE: N/A
CHECKED				DATE: FEB. 25, 1971
CORRECT				
APPROVED				SKETCH NUMBER
REVISIONS	(2)	(3)	(4) (5)	NA #2.4

SUBJECT (REFERENCE - 10)

PREPARED BY A.V.R. DATE 4/2/79 REVIEWED BY ______ DATE ______ WORK ORDER NO. 5103

INTEROFFICE MEMORANDUM

J.O. OR W.O. NO. J.O.No. 11550

SUBJECT PIPE STRESS ANALYSIS STATIC VS. DYNAMIC

DATE January 13, 1969

FROM MHPedell:EAY

TO JVALongcor

CC General Files
CTChave/WBAllred
WCWoodman
CFReeves

As you are aware, the Maine Yankee pipe stress work was to be accomplished by the static analysis method as instructed by W. C. Woodman. The static method would save many engineering man-hours and computer costs, but it would not indicate whether the piping system would be in resonance with the structure.

We also pointed out that the static analysis would require using the maximum acceleration of the response spectrum curve at the elevation at which the pipe is connected to the structure. Enclosed is a spectrum at ground elevation and a typical spectrum higher in the structure. You will note that the peak acceleration of the latter spectrum is much larger; this would cause higher stress levels which could mean more vertical supports or horizontal constraint to reduce stresses, if necessary.

On the other hand, the dynamic analysis does not use the peak acceleration. The program calculates the actual acceleration which, thus far (in other projects) always has been much less than the peak. Although the dynamic method is more costly than the static method, the saving in required piping supports and constraints will more than pay for itself.

We strongly recommend the dynamic method. The programming state of the art has advanced to such a degree that it will cost approximately $25,000 more than the primitive method.

M. H. Pedell

Enclosure

POOR ORIGINAL

ENCLOSURE B

STONE & WEBSTER ENGINEERING CORPORATION

245 SUMMER STREET, BOSTON, MASSACHUSETTS

ADDRESS ALL CORRESPONDENCE TO P.O. BOX 2325, BOSTON, MASS. 02107

NEW YORK
BOSTON
CHICAGO
HOUSTON
LOS ANGELES
DENVER
CHERRY HILL, N.J.
PORTLAND, OREGON

DESIGN
CONSTRUCTION
REPORTS
EXAMINATIONS
CONSULTING
ENGINEERING

Yankee Atomic Electric Company
Attention: J. Hoffman
20 Turnpike Road
Westboro, MA 01581

April 6, 1979
J. O. No. 12365.08

Dear Mr. Hoffman:

MAINE YANKEE PIPE STRESS/SUPPORT EFFORT

The SHOCK 1 subroutine has been reviewed generically. With respect to the requirements of the license and with respect to the order to show cause, namely that algebraic summation of directional forces not be used, it is believed that the treatment by SHOCK 1 is adequately conservative. Those systems whose design included analysis using PIPE STRESS/SHOCK 1 computer codes are believed to be adequate to perform their intended safety function in the event of the design earthquake.

Very truly yours,

C B Miczek

C. B. Miczek
Vice President

APR. 9, 1979

MAINE YANKEE
SHOCK II REANALYSIS - MASTER LISTING

ITEM #	PROBLEM #	CASS #. (SA-)	PRTY.	LINE NUMBERS	FM #	FP SERIES	RESOLUTION
1	16A	18	1	10"-CH-1	31B	14	RERUN WITH PSTRESS/SHOCK III
2	16B	18	1	10"-CH-2	31B	14	RERUN WITH PSTRESS/SHOCK III
3	803	21	1	12"-RC-29 / 14"-RH-1	30A & 32A	16	RERUN WITH PSTRESS/SHOCK III
4	795	24	1	18"-CS-11&12 / 16"-CS-13,14&40 / 14"-CS-15,16&17 / 16"-RH-3&4	32A	16 & 17	RERUN WITH PSTRESS/SHOCK III
5	728	25	1	20"-PCC-17 / 16"-PCC-18&19	34A	20	RERUN WITH PSTRESS/SHOCK III
6	70	17	1	4"-RH-2&35 / 3"-DRL-199&200	30A & 32A	13 & 16	RERUN WITH PSTRESS/SHOCK III
7	126	12	2	4"-PL-22	32A	6	NEW HAND CALCULATION
8	127	12	2	2"-PL-21	32A	6	NEW HAND CALCULATION
9	134	12	2	3"-WCPR-6	12A	6	NEW HAND CALCULATION
10	LINE #	12	2	1.5"-WCPR-5	12A	3 & 6	NEW HAND CALCULATION
11	11	15	2	3"-CH-61	31A	9 & 14	RERUN WITH NUPIPE
12	142	19	2	3"-CH-56	31A	10 & 14	RERUN WITH NUPIPE
13	LINE #	28	2	1.5"-PCC-161	34A	20	NEW HAND CALCULATION
14	77	31	2	3"-PCC-34	34A	20	NEW HAND CALCULATION
15	LINE #	36	2	6"-PCC-47	34A	20	RERUN WITH NUPIPE
16	LINE #	36	2	3"-PCC-56	34A	20	RERUN WITH NUPIPE
17	LINE #	36	2	1"-PCC-387	34A	20	NEW HAND CALCULATION
18	LINE #	36	2	1"-PCC-58	34A	20	NEW HAND CALCULATION
19	LINE #	36	2	1.5"-PCC-117	34A	20	RERUN WITH NUPIPE
20	73	29	3	6"-FP-6	36A	19	NEW HAND CALCULATION
21	12A	30	3	1.5"-GR-17	39A	23	RERUN WITH NUPIPE
22	124	30	3	2.5"-BRG-11	39A	23	RERUN WITH NUPIPE
23	128	30	3	3"-VRL-7	33A&B	24	RERUN (INCLUDING 2"-VRL-7) WITH NUPIPE
24	129	30	3	6"-VRL-4	33A&B	24	RERUN WITH NUPIPE
25	130	30	3	3"-DRL-31	33A&B	24	RERUN WITH NUPIPE
26	136	30	3	3/4"-DRL-135	33A&B	24	NEW HAND CALCULATION
27	140	30	3	1.5"-DRL-132	33A&B	24	RERUN WITH NUPIPE
28	400	12	4	1"-WASD-44	41A	4	
29	402	12	4	2"-SA-72	11A	4	
30	135	12	4	2"-CT-3	32A	6	
31	138	29	4	2"-BR-10	37A	18	
32	137	29	4	3"-BR-2	37A	18	
33	139	29	4	3"-BR-1	37A	18	
34	123	30	4	1.5"-GR-8	39A	23	NEW HAND CALCULATION
35	123	30	4	2.5"-BRG-12	39A	23	
36	125	30	4	2"-DRL-6	33A&B	24	
37	74	31	4	16"-HHPD-1&2	26A	41	
38	72	36	4	10" FIRE PIPING (RELIEF VALVE LINE)	N/A	FB-3A	
39	LINE #	36	4	2"-BED-1	37A	18	

PRIORITIES:
1 - SAFETY RELATED PIPING FOR WHICH MSK'S WERE ISSUED (GENERALLY, PIPING > 6")
2 - SAFETY RELATED PIPING <= 6"
3 - NON-SAFETY RELATED PIPING <= 6", IDENTIFIED BY YANKEE ATOMIC ELECTRIC CO. (3-31-79) AS NEXT GROUP TO BE REDONE
4 - NON-SAFETY RELATED PIPING, LAST GROUP TO BE REDONE

TABLE 1

ENCLOSURE D

STONE & WEBSTER ENGINEERING CORPORATION
P. O. BOX 2325, BOSTON, MASSACHUSETTS 02107

DATE	April 9, 1979
J. O. NO.	12365.08
P. O. NO.	
LTR. NO.	
REF.	

VIA

TO
Yankee Atomic Electric Co.
Attention Mr. J. Hoffman
20 Turnpike Road
Westboro, MA 01581

DEAR SIRS:

THE FOLLOWING ARE [XX] ATTACHED: [ ] SENT SEPARATELY:

___ COPIES ___ PRINTS ___ REPRODUCIBLES ___ MICROFILM APERTURE CARDS

EACH OF

[ ] DRAWINGS [ ] SPECIFICATIONS
[XX] DOCUMENTS [ ] NOTES OF CONFERENCE

STATUS		PLEASE NOTE	SENT FOR YOUR
[ ] FINAL	[ ] APPROVED	[ ] REVISIONS [ ] OMISSIONS	[ ] APPROVAL [ ] COMMENT
[ ] PRELIMINARY	[ ] APPROVED AS REVISED (AS DEFINED IN SPECIFICATION)	[ ] ADDITIONS [ ] CORRECTIONS	[X] USE [ ] INFORMATION
[ ] NO COMMENT	[ ]	[ ] COMMENTS [ ]	[ ] FILES [ ] CONCURRENCE
[ ] SUGGESTIONS AS NOTED	[ ]		[ ]

YOUR ATTENTION IS DIRECTED TO THE FOLLOWING:

RELEASED FOR: [ ] FABRICATION [ ] PURCHASE OF NECESSARY MATERIALS

[ ] PLEASE REVISE AND SUBMIT ______ PRINTS ______ REPRODUCIBLES ______ MICROFILM APERTURE CARDS.

[ ] PLEASE SUBMIT ______ PRINTS ______ REPRODUCIBLES ______ MICROFILM APERTURE CARDS OF [ ] DOCUMENTS [ ] DRAWINGS [ ] SHOP DETAIL

[ ] PLEASE RETURN ONE COPY EACH OF THIS MATERIAL BEARING YOUR APPROVAL OR COMMENTS.

[ ] PLEASE ACKNOWLEDGE RECEIPT OF THIS MATERIAL BY SIGNING AND RETURNING THE ENCLOSED COPY OF THIS FORM.

[ ] WE TRUST THAT THESE NOTES ARE IN ACCORDANCE WITH YOUR UNDERSTANDING: IF NOT, PLEASE ADVISE US.

IMPORTANT SHOULD ANY REVISION TO DOCUMENTS OR DRAWINGS RETURNED HEREWITH INVOLVE A PRICE INCREASE, THE SUPPLIER MUST NOTIFY STONE & WEBSTER PURCHASING DEPARTMENT WITHIN TEN (10) DAYS EVEN THOUGH A DEFINITE ESTIMATE CANNOT BE GIVEN AT THE TIME. OTHERWISE, THE PURCHASER WILL CONSIDER THE REVISIONS MADE WITHOUT COST.

MAINE YANKEE ATOMIC POWER STATION
PIPE STRESS/SUPPORT EFFORT

Enclosed is one copy of the base plate review for H-51 and H-53. Please note that this information begins with page 21 as it was copied from a set of calculations covering several hangers.

Very truly yours,

R W Watts
for J.P. Czaika
Project Engineer

A 029.5F

CALCULATION SHEET

J.O./W.O./CALCULATION NO.	REVISION	PAGE
		21

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
R. MARTIN 4/6/79		

SUBJECT/TITLE	QA CATEGORY/CODE CLASS
MY BASE PLATE REVIEW	

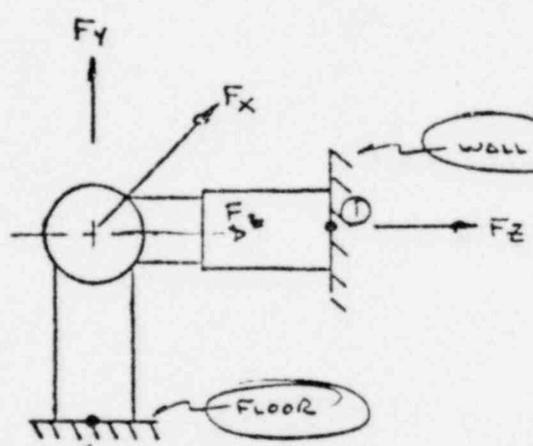
REF: FP-17A & 17F
MSK-1186 (...)
PT# 1208 13...

H-51 & H-53
(IDENTICAL SPRT STRUCTURES)

SPRT TYPE:

ANCHOR CONSTRAINING ALL SIX DIRECTIONS
COPY OF ANCHOR DETAILS ATTACHED (DET 13, FP-17F)

LOADING AT ANCHOR SUPPORT POINTS:

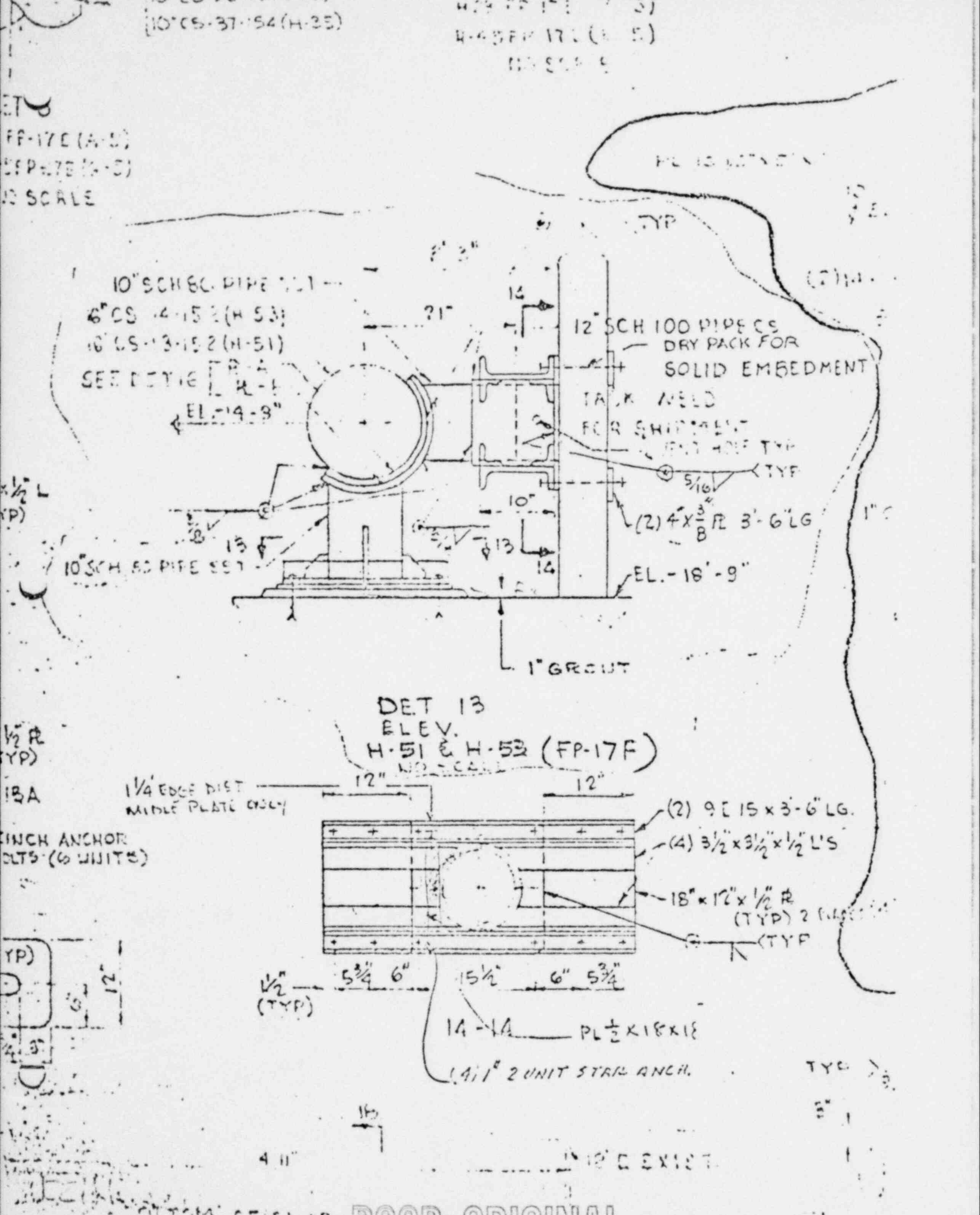


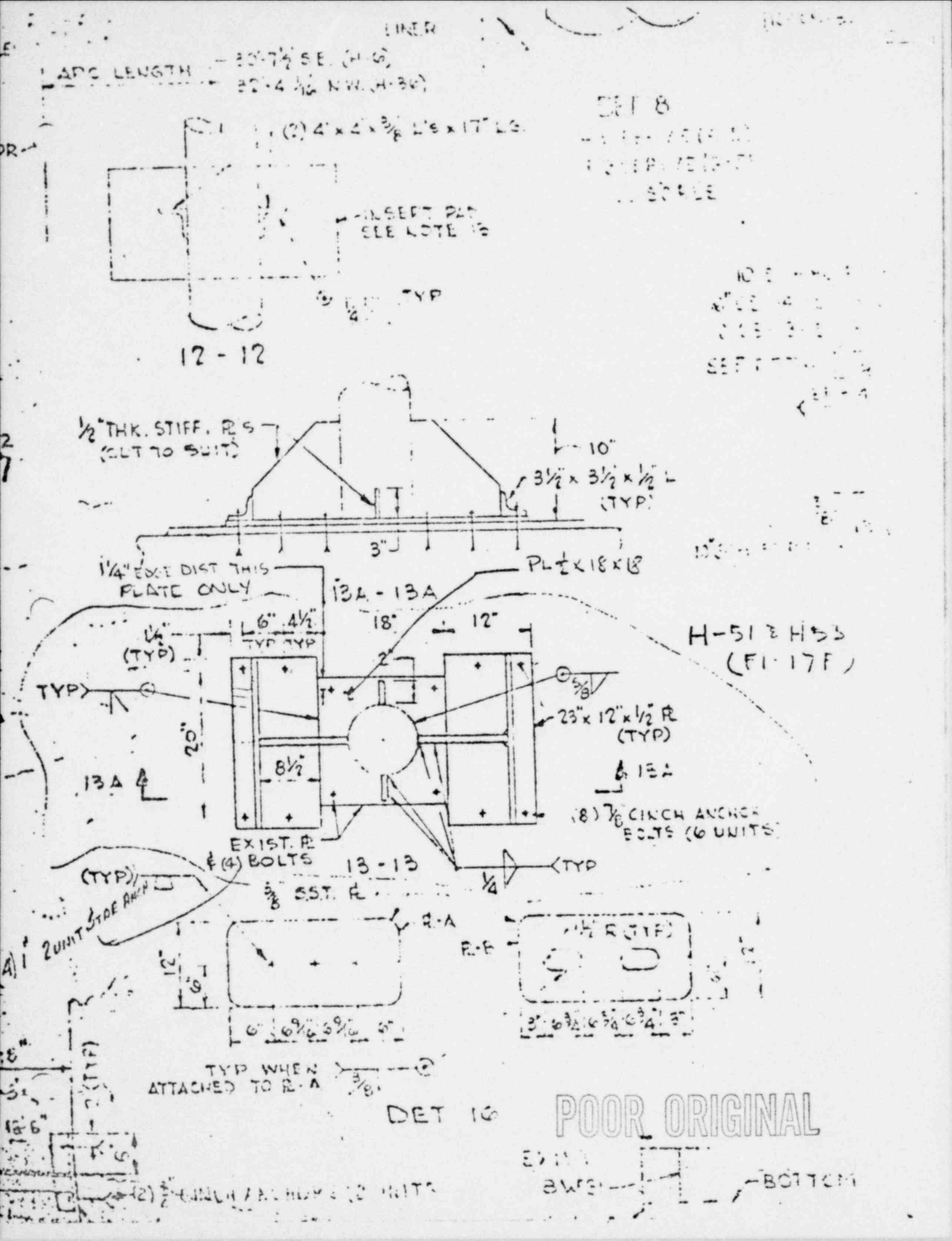
SKETCH OF DET 13 (ATT.)

in kips

SPRT No		Fx (KIPS)	Fy (KIPS)	Fz (KIPS)	Mx (KIPS)	My (KIPS)	Mz (KIPS)
H-51	WALL	-10.02	2.62	-12.11	+46.14	-161.26	-44.8
	FLOOR	21.32	19.89	-5.71	-38.35	-208.61	-304.99
H-53	WALL	-12.75	1.32	8.33	-26.98	156.77	-45.[illegible]
	FLOOR	23.02	16.44	5.41	33.5	241.16	-33[illegible]

POOR ORIGINAL


10"CS-36-154 (H-5)
10"CS-37-154 (H-35)
NO SCALE
10"SCH 80 PIPE
6"CS-14-152 (H-53)
10"CS-13-152 (H-51)
EL.-14'-8"
21"
14
12" SCH 100 PIPE CS
DRY PACK FOR
SOLID EMBEDMENT
TACK WELD
FOR SHIPMENT
TYP
5/16
10"
(2) 4"x3/8 PL 3'-6"LG
13
14
EL.-18'-9"
10"SCH 80 PIPE
1"GROUT
DET 13
ELEV.
H-51 & H-53 (FP-17F)
NO SCALE
1 1/4 EDGE DIST
MIDLE PLATE ONLY
12"
12"
(2) 9[15 x 3'-6"LG.
(4) 3 1/2"x3 1/2"x1/2"L'S
18"x12"x1/2"PL
(TYP)
1/2"
(TYP)
5 3/4
6"
15 1/2
6"
5 3/4
14-14
PL 1/2x18x18
2 UNIT STAR ANCH.
INCH ANCHOR
BOLTS (6 UNITS)
SCALE
12"
6"
TYP
16


LINER
ARC LENGTH
DET 8
(2) 4" x 4" x 3/8 L'S x 17" LG.
INSERT PAD SEE NOTE
TYP
12 - 12
1/2" THK. STIFF. PL'S (CUT TO SUIT)
10"
3 1/2 x 3 1/2 x 1/2 L (TYP)
3"
1 1/4" EDGE DIST THIS PLATE ONLY
PL 1/2 x 18 x 18
13A - 13A
6" 4 1/2" TYP TYP
18"
12"
1/4" (TYP)
2"
TYP
5/8
23" x 12" x 1/2" PL (TYP)
20"
8 1/2"
13A
H-51 & H-53 (F1-17F)
(8) 7/8 CINCH ANCHOR BOLTS (6 UNITS)
EXIST. PL
& (4) BOLTS
13 - 13
(TYP)
1/4
TYP
3/8 SST. PL
2 UNIT SIDE ANCH
PL-A
PL-B
TYP WHEN ATTACHED TO PL-A
3/8
DET 16
BOTTOM

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. 1

Preliminary

Item

Client: [illegible] Location: [illegible] Est. No. [illegible] J.O. No. [illegible]

Subject: [illegible]

Date: 4-5-79 By [illegible]

Checked: 4-6-79 By [illegible]

Revised: 4-7-79 By [illegible]

Based on

H-51 & H-53

REFER TO SKETCHES W/ SPEC H-51, 53 LD. INFO

H-51

CHECK @ WALL

BOLTS

BOLT TEN. : $\frac{12.11}{8} = 1.51$ K/BOLT FOR Fz

2 BOLTS - 7/8" ϕ THRD BOLT

$\frac{46.14}{15 \times 4} = (0.77)$ 0.85 K/BOLT FOR Mx

SEE CALC. No. 5.1

$\frac{161.86}{33.25 \times 4} = (1.2)$ 1.52 K/BOLT FOR My

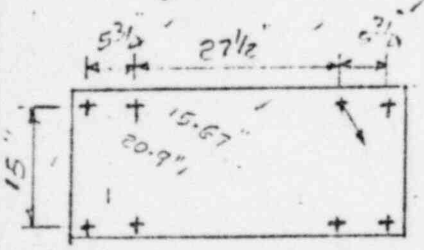
3.88 (3.5) K/BOLT

AS THE CHANNEL ON TOP OF PL. NOT WELDED TO BASE PL. - TAKE FLEXIBILITY OF PL. INTO ACCOUNT & USE 1/2 DIST. TO FIND TENSION DUE TO MOMENT (OK - CONSERVATIVE)

TENSION = 1.5 + 2 × (.77) 0.85 + 2 × (1.2) 1.52 = (5.5) 6.24 K/BOLT

SHEAR ON BOLTS

4 - 7/8" ϕ THRD BOLT



$\frac{2.67}{8} = 0.33$ K/BOLT ↑ [illegible] F

$\frac{10.0}{8} = 1.25$ K/BOLT → Fy

$\frac{44.84}{8 \times 15.67} = 0.36$ K/BOLT (APPROX) [illegible] Mz

$\left\{\frac{44.84 \times 20.9}{4(15.67)^2 + 4(20.9)^2}\right. = 0.3$

DUE TO Mz → = $0.36 \times \frac{7.5}{15.67} = 0.17$ K

↑ = $0.36 \times \frac{13.75}{15.67} = 0.32$ K

TOTAL SHEAR = $\sqrt{(0.33 + .32)^2 + (1.25 + .17)^2} = 1.57$ K/BOLT

$F_T = \sqrt{(F_x)^2 + (F_y)^2}$

[illegible] 7.95 K [illegible] 6.5 K

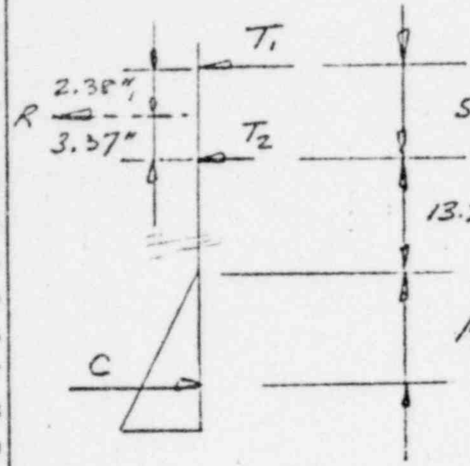
POOR ORIGINAL

A 5010 10 — STONE & WEBSTER ENGINEERING CORPORATION — CALCULATION SHEET

Page No. 5.1
Preliminary
Item

Client MAINE YANKEE — Location WISCASSET — Est. No. — J.O. No. 12365.0
Subject CHECK ANCHORS & BASE PL FOR PIPE SPRT — Date 9-6-79 — By [illegible signature]
Checked 9-7-79 — By K RADIA
Revised — By
Based on

FOR M_y



$T_2 = T$

$T_1 = \frac{13.75+5.75}{13.75} = 1.42$

$R = T_1 + T_2 = 2.42T$ ✓

$M = 2.42T(3.37'' + 13.75'' + 14)$

$= 161.26''^{-k}$

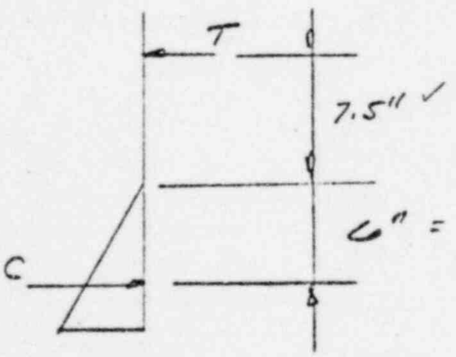
$\therefore T = 2.141^k$ ✓

$\therefore T_1 = 1.42(2.14) = 3.04^k$ MAX TENSION PER ROW ✓

$\therefore$ TENSION FOR BOLT $= 1.52^k$ ✓

$\left(P = \frac{T_1}{\text{NO. OF BOLTS}}\right)$

FOR M_x



$M = 13.5T = 46.14''^{-k}$

$T = 3.42^k$ PER ROW ✓

$P = \frac{3.42}{4}$ OR

P/BOLT $= 0.85^k$ PER BOLT ✓

$(P = T/\text{NO. OF BOLT})$

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. [illegible]
Preliminary
Item

Client [illegible] Location [illegible] Est. No. [illegible] .07

Subject [illegible] Date 4-6-79 By [illegible]

Checked 4-7-79 By S FANTANI

Revised 4-7-79 By K RADIA

Based on

CHECK COMBINED [illegible]

[illegible] $f_{v(act)} = \frac{1.6}{.4617} = 2.66\,ksi$

$F_{t\,allow} = 28 - 1.6 \times 2.66 = 23.7 > 20$ USE 20 ksi

$f_{ten.\,act.} = \frac{\overset{6.24}{(5.5)}}{.4617} = \overset{13.51}{(12)}\,ksi < 20\,ksi$ ok.

$(f = \frac{P}{AREA})$

(AREA @ THREAD = .4617□")

BASE PL.

TENSION ON PL. $= \frac{12.11}{3.14 \times 12} = 0.32$ K/in DUE TO FY

OR COMP. ON PL.

12" SCH 100 PIPE

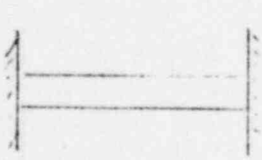
NO BENDING IN PL DUE TO MX AS C OR T TRANSFER TO STIFFER PT. DIRECTLY (i.e. @ 9C15 @ TOP & BOT)

$C = T = \frac{\overset{46.14}{(43.14)}}{12} = \overset{3.85}{(3.5)}\,K$

STRESS DUE TO My $= \frac{161.25 \times 6}{18 \times [illegible]} = 0.03[illegible]$ ksi

(USING RIGID BASE PL.)

TOTAL [illegible] = [illegible] ksi @ TRUNION



CHECK PLATE BENDING [illegible]

PIPE O.D.

[illegible] 11.75 [illegible]

$M = \frac{[illegible] \times 11.75 \times [illegible]}{12} = [illegible]\,K$

[illegible] $f_b =$ [illegible] ksi [illegible] $\frac{[illegible]}{[illegible]} = [illegible]$

SEE CALC. No. 28

[illegible] APPLIED [illegible] PIPE

POOR ORIGINAL

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Client [illegible] Location [illegible] J.O. No. 12365.0

Subject CHECK [illegible] Date 4-6-77

Checked 4-6-77 By S PANT[illegible]

Based on

Revised By

$$\text{[illegible]} = \frac{.6 \times .337}{.5 \times .5} = 0.85 @ 5"$$ — SEE CALC. No. 28

CHECK PLATE BENDING @ END OF 9715

$$M = \frac{0.031 \times 11.75 \times 11.75}{12} = 0.36''k$$

$$S_{req} = \frac{0.36}{20} = 0.018 \text{ in}^3$$

$(S = M/f)$

$$S_{prov} = \frac{11.5 \times .5}{6} = 0.0417 \text{ in}^3$$

POOR ORIGINAL

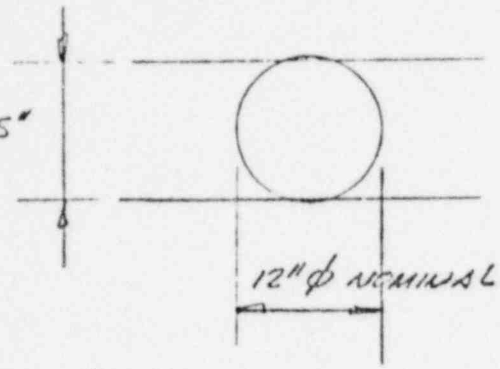
CALCULATION SHEET

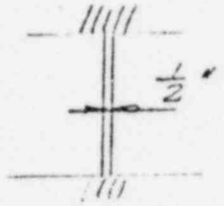
J.O./W.O./CALCULATION NO.	REVISION	PAGE
12363.09		7-8

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
S. FANTANI 4-7-79	R. RADIH 4-7-79	

SUBJECT/TITLE	QA CATEGORY/CODE CLASS
CHECK ANCHORS & BASE PL FOR PIPE SPRT	

CHECKING – APPLY 12.11^K PULLOUT UNIFORMLY ACROSS 12" φ OF TRUNNION





TOTAL LOAD = 12.11^K ✓

OR

$\frac{12.11^K}{12} = 1.01^{K/in}$

NOTE: A PORTION OF THE LOAD IS CARRIED BACK DIRECTLY TO CHANNELS ✓

(STRESS DUE TO M_y (0.031 KSI) @ THIS LOC. (N.A.) IS NEGLIGIBLE)

CHECK PL BENDING –

$$M = \frac{1.01(11.75)^2}{12} = 11.62^{\text{in-K}} ✓$$

USE $f_b = 20^{ksi}$; $S_{REQ'D} = \frac{11.62^{\text{in-K}}}{20^{ksi}} = 0.581^{in^3}$ ✓

$$b_{req'd} = \frac{6 \times .581}{(.5)^2} = 13.94^{in} ✓$$

∴ APPROX. 1" BEYOND THE TRUNNION AT EACH SIDE MUST BE ENGAGED TO PROVIDE SUFFICIENT S ✓

OK

Back-Up Calc for flexible plate

Appendix 2

▲ 8010 1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. 39
Preliminary
Item

Client: MAINE YANKEE Location: WISCASSET J.O. No. 17335
Subject: CHECK ANCHORS & BASE PL. Date: 4-6-79
FOR PIPE SUPT. Checked: 4-7-79 By: S PAUTA
Based on: Revised: By:

CHECK @ FLOOR

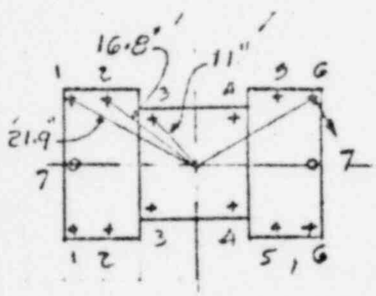
BOLTS

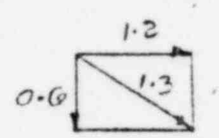
SHEAR :-

$\frac{21.32}{12} = 1.78$ K/BOLT DUE TO Fx →

$\frac{5.11}{1} = 0.48$ K/BOLT DUE TO Fz ↓

$\frac{208.61 \times 21.9}{4[(21.9)^2+(16.8)^2+(11)^2]} = 1.3$ K/BOLT DUE TO My





TOTAL SHEAR $= \sqrt{(1.78+0.6)^2 + (0.48+1.2)^2} =$ [illegible]
BOLT 1 & 6

FOR BOLT 3, 4 DUE My : $1.3 \times \frac{11}{21.9} = 0.66$

HORI. & VERT. COMP. $\frac{0.66}{\sqrt{2}} = 0.47$

TOTAL SHEAR BOLT 3, 4 $= \sqrt{(1.78+.47)^2 + (0.48+0.47)^2} = 2.45$ K.

7/8" ϕ - 6 UNIT CINCH ANCHOR (MIN. SPACING VALUES FOR RED-HEAD ANCHORS USED)

SHEAR ALLOW = 5100 lbs × .9 = 4590 lbs

TEN ALLOW = 5100 lbs × .9 = 4590 lbs

MIN SPACING = 8" FOR 100% CAPACITY

4" FOR 80% "

SPACING AVAILABLE 6" - USE 90%

POOR ORIGINAL

8010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

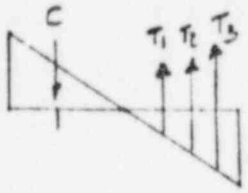
Page No. 30
Preliminary
Item

Client: MAINE YANKEE Location: WISCASSET Est. No. J.O. No.
Subject: CHECK ANCHORS & BASE PL. FOR PIPE SUPPORT Date: 4-6-79 By:
Checked: 4-7-79 By: S/...
Based on: Revised: 4-7-79 By:

TENSION

$$\frac{\overset{19.89}{\cancel{18.89}}}{12} = \overset{1.66}{\cancel{1.58}}\ \text{K/BOLT} \quad \text{DUE TO } F_y$$

$$\frac{304.99}{10.5\left(21\times\frac{2}{3}+15.75\right)} = 0.99 \times 2.5 = 2.5 \quad \text{DUE TO } M_x$$



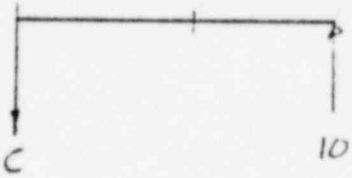
$$\frac{38.35}{7.2\left(9\times\frac{2}{3}+9.35\right)} = 0.35 \times 1.3 = \overset{.46}{\cancel{0.45}} \quad \text{DUE TO}$$

$$\overline{4.62\ (\cancel{4.57})\ \text{K/B}}$$

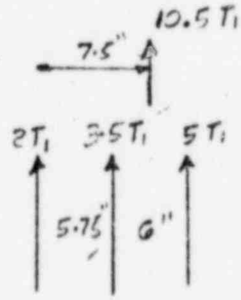
$T_1 = T_1$

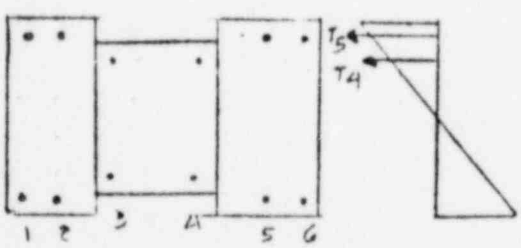
$T_2 = T_1 \times \frac{13.5}{7.75} = 1.75\,T_1$

$T_3 = T_1 \times \frac{19.5}{7.75} = 2.5\,T_1$



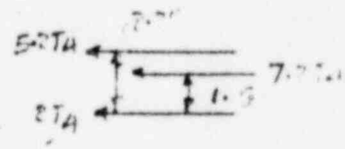
$T_1 = 0.99$





$T_4 = T_4$

$T_5 = T_4 \times \frac{10}{7.75} = 1.3\,T_4$



$$T_4 = \frac{38.35}{7.2\left(9\times\frac{2}{3}+9.35\right)} = 0.35$$

TOTAL TENSION = $\overset{4.62}{\cancel{4.57}}$ KIPS ON ONE BOLT

TOTAL $\overset{\text{SHEAR}}{\cancel{\text{TENSION}}}$ = $\overset{2.90}{\cancel{2.97}}$ KIPS ON

---- X ----

CHECK FOR COMBINE SHEAR & TEN BOLT N.G.

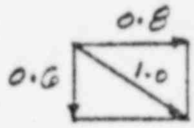
$$= \left(\frac{\overset{4.62}{\cancel{4.57}}}{4.59}\right)^{5/3} + \left(\frac{\overset{2.90}{\cancel{2.9}}}{3.54}\right)^{5/3} = \overset{1.011}{\cancel{0.978}} + 0.45 = \overset{1.476}{\cancel{1.44}} \quad \text{N.G.}$$

POOR ORIGINAL

Client MAINE YANKEE Location WISCASSET Est. No. J.O. No. 12...
Subject CHECK ANCHORS & BASE PL FOR PIPE SUPT Date 4-6-79 By
Checked 4-7-79 By S PANT...
Based on Revised 4-7-79 By K RADH...

CHECK BOLT 2 & 5

SHEAR DUE TO M_y = $1.3 \times \frac{16.8}{21.9}$ = 1.0 K



TOTAL SHEAR = $\sqrt{(1.78 + 0.6)^2 + (\ldots}$
= 2.7 K

TOTAL TEN. = $(\overset{1.66}{1.58}) + (\overset{0.46}{0.49})$ + ... = ($\overset{3.87}{3.7\ldots}$)

CHECK FOR COMBINE SHEAR & TEN. : $\left(\frac{\overset{3.87}{3.78}}{4.59}\right)^{5/3} + \left(\frac{2.7}{4.59}\right)^{5/3} = (\overset{.752}{0.724}) + 0.41\ldots$

CHECK BOLT 3 & 4

TOTAL SHEAR = 2.45 K/BOLT

TOTAL TEN. = $(\overset{1.66}{1.58}) + .99 + .35 = (\overset{3.00}{2.92})$ K

→ SEE CALC. No. 32
FOR REVISED VALUES FROM NUSEC

POOR ORIGINAL

CALCULATION SHEET

J.O./W.O./CALCULATION NO.	REVISION	PAGE
12365.09		

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
SPANTONI 4-7-79	R. RADIA 4-7-79	

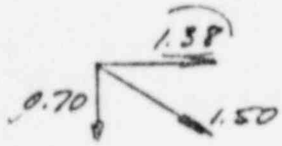
SUBJECT/TITLE	QA CATEGORY/CODE CLASS
CHECK ANCHORS & BASE PL'S FOR PIPE SPRT'S	

REVISED CONDITION - NEGLECT 4 - 2 UNIT STAR ANCHORS #3 & #4

REVISED SHEAR - ✓

BOLTS 1, 6 $\quad \dfrac{208.61 \times 21.9}{4[21.9^2 + 16.8^2]} = 1.50^k$/BOLT DUE TO M_y

1.34



$\dfrac{21.32}{8} = 2.67^k$/BOLT DUE TO F_x

$\dfrac{5.71}{8} = 0.714^k$/BOLT DUE TO F_z

∴ TOTAL SHEAR BOLTS 1 & 6

$= \sqrt{(2.67 + 0.70)^2 + (.714 + 1.38)^2}$

$= 3.97^k$/BOLT ✓

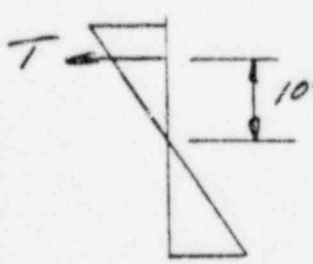
REVISED TENSION -

DUE TO F_y & M_z - FROM NUSEC RUN

SEE CALC. No.

MAX. TOTAL TENSION PER ROW $= 10.204^k$ or 5.102^k PER BOLT (2 BOLTS PER ROW)

FROM M_x



$T = \dfrac{38.35}{(\frac{2}{3} \times 9 + 10)}$ ✓ $= 2.40^k$ TOTAL ✓

or

$\dfrac{2.40^k}{4} = 0.60^k$ PER BOLT - 4 BOLTS PER ROW

∴ TOTAL TENSION = 5.102 + 0.60 = 5.7^k

TOTAL SHEAR = 3.97^k

PER BOLT

See Appendix # 4 for Values

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

5010.61

J.O./W.O./CALCULATION NO.	REVISION	PAGE
12365.09		

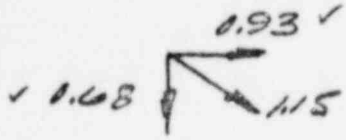
PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
S FANTANI 4-7-79	K RADIA 4/7/79	

SUBJECT/TITLE	QA CATEGORY/CODE CLASS
CHECK ANCHORS & BASE PL'S FOR PIPE SPRT'S	

BOLTS 2, 5.

SHEAR

DUE TO $M_Y = \dfrac{208.61 \times 16.8}{4(21.9^2 + 16.8^2)} = 1.15^{k}/\text{BOLT}$ ✓



DUE TO F_X = 2.67^{k}/BOLT ✓

DUE TO F_Z = 0.714^{k}/BOLT ✓

∴ TOTAL SHEAR IN BOLTS 2, 5

$= \sqrt{(2.67 + 0.68)^2 + (.714 + 0.93)^2} = 3.73^{k}$ ✓

TENSION

DUE TO F_Y & M_Z = 8.637^{k} MAXIMUM PER ROW FROM NISEC RUN SEE CALC. NO. ✓

OR, 4.32^{k} PER BOLT (2 BOLTS PER ROW) ✓

DUE TO M_X = 0.60^{k} PER BOLT (SEE CALC NO. 32) ✓

∴ TOTAL TENSION = 4.92^{k} ✓

TOTAL TENSION BOLTS 1, 2 = 5.7 + 4.92 = 10.62^{k} ✓

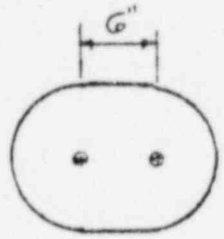
TOTAL SHEAR BOLTS 1, 2 = 3.97 + 3.73 = 7.70^{k} ✓

Client MAINE YANKEE Location WISCASSET Est. No. ___ J.O. No. ___
Subject CHECK ANCHORS & PIPE PL FOR Date 4-7-79 By ___
PIPE SPRIT Checked 4-7-79 By SPANTZ
Based on ___ Revised ___ By ___

FIND NEW CAPACITY OF 7/8" ϕ CINCH ANCHOR BOLTS

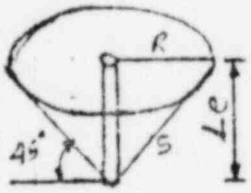
COMBINE SHEAR CONE FOR 2 BOLTS

7/8" ϕ CINCH ANCH - 8 1/4" EMBED LENGTH -
(SIX UNIT SET - SEE
EMD-79-04 ATTACHMENT "A")

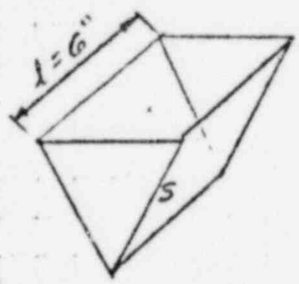


REFERING NELSON STUD CATALOG
(TRW, NELSON DIVISION, EMBED. PROPERTIES OF
HEADED STUDS, SECTION 4.3)
$S = L_e / \sin 45°$ $S = 1.414 \times 8.25 = 11.67$

AREA OF SHEAR CONE $A_{sc} = 3.14 \times 11.67 \times 8.$ ...
($A_{sc} = \pi S R$)



AREA OF PYRAMID PFT. : $2 \times 6 \times 11.67 = 140$ □"
(TWO 1/2 SHEAR CONE
$A_{tp} = 2 l \times S$)



TOTAL SHEAR AREA : 302 + 140 = 442 □"
A_{tT}

ULTIMATE PULLOUT CAPACITY OF 2 COMBINE
$= P_{uc} = \phi C K A_t \times \sqrt{f_c}$ - (REF. NELSON CAT. Equation 4, p. 8

$= 0.85 \times 1 \times 4 \times 442 \times \sqrt{3000} = 82311$ lbs
≈ 82 K.

USING SAFETY FACTOR 4 (CONSERVATIVE)

$P_{allow.} = 82/4 = 20.5$ K

Assume

$S_{uc} \cong P_{uc}$

POOR ORIGINAL

CHECK COMBINED TENSION & SHEAR FOR 2 BOLT GROUP

BOLT GROUP TENSION = 10.62^k ✓

BOLT GROUP SHEAR = 7.70^k ✓

ALLOWABLE TENSION = ALLOWABLE SHEAR = 20.5^k ✓
(SHEAR SAME AS [illegible]

∴ CHECK COMBINED ACTION

$$= \left(\frac{10.62}{20.5}\right)^{\frac{5}{3}} + \left(\frac{7.70}{20.5}\right)^{\frac{5}{3}} = 0.334 + 0.196$$

$$= 0.53 < 1.0$$

OK

OVERALL FACTOR OF SAFETY AGAINST CONCRETE FAILURE $= \frac{1}{0.53} \times 4.0$ (S.F. USE ON CALC. No 34

$= 7.55$ ✓

CHECK $\frac{7}{8}$" ϕ BOLT FOR COMBINE SHEAR & TENSION (INDIVIDUAL BOLT)

BOLT 1.6 TEN. ON BOLT = 5.7K

SHEAR ON BOLT = 3.97K

SHEAR AREA = 0.6 □"

TEN. AREA @ THREAD. 0.4617 □" TENSION STRESS ($f_t = P/A$) $= \frac{5.7}{.4617}$ = 12[illegible]

MAX. ALLOW SHEAR = 9.45^k ∴ MAX ALLOW STRESS $= \frac{P}{A} = \frac{9.45}{.6}$ = 15.75 ksi

SHEAR STRESS $f_v = 3.97/0.6 = 6.62$ ksi < ~~9.45~~ 15.75 ksi [illegible] ($f_v = P/A$) (EMD-79-CA [illegible]

TENSION STRESS allow. : $F_t = 28 - 1.6 \times 6.62$ (CONSERVATIVE) ($F_t = 28 - 1.6 f_v$) (AISC 1.6.3)

$= 28 - 10.6 = 17.4$ ksi > 12[illegible]

POOR ORIGINAL

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

A 8010 1D

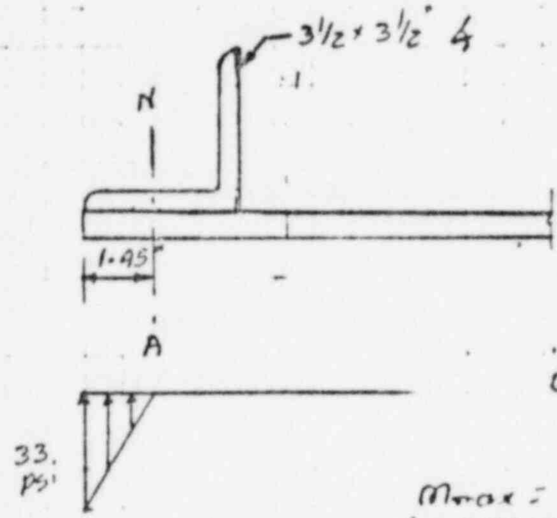
Page No. 36
Preliminary 160
Item

Client: MAINE YANKEE Location
Est. No. J.O. No. 1230
Subject: CHECK ANCHORS & BASE PL. Date 4-7-79 By R. K...
FOR PIPE SUP'T Checked 4-7-79 By S PANTA...
Based on Revised By

REFER TO COMPUTER OUTPUT - Appendix 4

N.A. AXIS LIES BET. BOLT NO. 1 & 2 & MAX.

STRESS : (66) PSI
33



BENDING OF PL. @ 1.45"

M_{max} = (CONSERVATIVE) $= \frac{33 \times 1.45 \times 1.45}{2} = 35$ lb·in.

$S_{req} = \frac{.035}{20} = 0.002$

S_{act} PL ONLY $\frac{1 \times .5 \times .5}{6} = 0.04?$ in³ > ...

3½ × 3½ × ½ ∠ SPAN BET BOLT & STIFF. PL

LOAD ON ∠ $w = \frac{33 \times 1.45}{2} = 24$ P/in = 0.02 K/in

$l = 10"$ $M = \frac{10 \times 10 \times .03}{8} = 0.375$ K ($m = \frac{wl^2}{8}$)

$S_R = \frac{0.375}{20} = 0.02$ in³ < 1.5 in³ ✓

POOR ORIGINAL

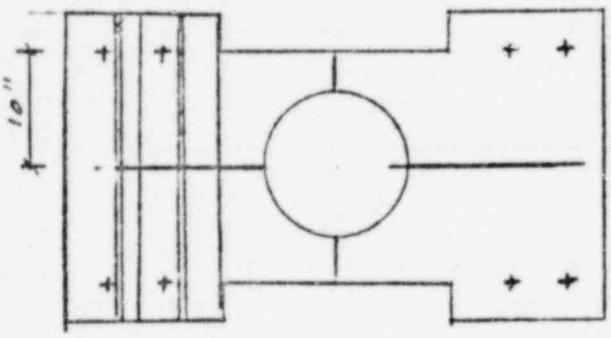
Client MAINE YANKEE | Location WISCASSET | J.O. No. 12365

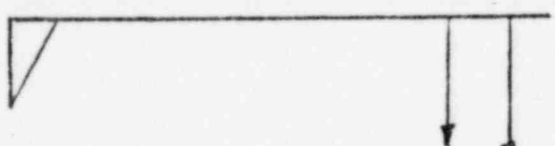
Subject CHECK ANCHORS & BASE PL FOR PIPE SUP'TS | Date 4-7-79 | By

Checked 4-7-79 | By SPANTAN

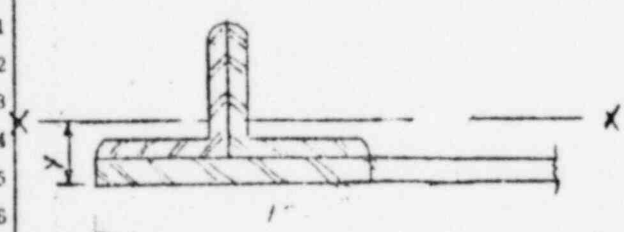
Revised | By

Based on





FOR PL. TO ACT RIGID ANCH BOLT LD SHOULD TRANSFER TO CENTER GUSSET PL.



TOTAL ANCH BOLT LD = 10.6

$m: 10.62 \times 10 = 106.2$ K

$S_{req}: \frac{106.2}{20} = 5.31 \ in^3$

ADD $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$ & C. WEIT

$$y = \frac{7 \times .5 \times .25 + 2 \times 3.25 \times 1.56}{7 \times .5 + 2 \times 3.25} = \frac{11.02}{10} = 1.102" \cong 1.1"$$

$$I_{xx} = \frac{1}{12} \times 7 \times (.5)^3 + 3.5 \times (.85)^2 + 2 \times 3.64 + 2 \times 3.25 \times (0.46)^2$$

$$= 0.07 + 2.53 + 7.28 + 1.38 = 11.26 \ in^4$$

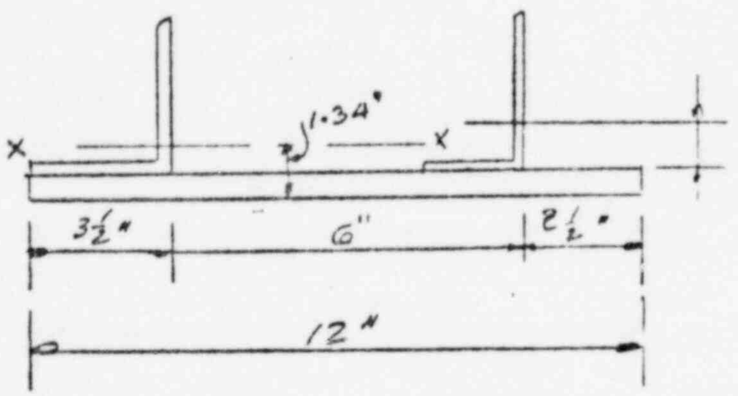
$S_{xx\,T} = \frac{11.26}{2.9} = 3.88 \ in^3$ $\quad S_{xx\,B} = \frac{11.26}{1.1} = 10.24 \ in^3$

NG

POOR ORIGINAL

Client MAINE YANKEE Location WISCASSET Ext No J.O. No. 12365.0
Subject CHECK ANCHORS & BASE PL Date 4-7-79 By S PANTAN
FOR PIPE SUPPORT Checked 4-7-79 By R RITTAN
Based on Revised By

$2 - L5 \times 3\frac{1}{2} \times \frac{1}{2}$



$2-L5 \times 3\frac{1}{2} \times \frac{1}{2}$ $\quad A = 2(4.0) = 8.0\ in^2$

$I = 2(9.99 in^4) = 19.98\ in^4$

PL $\frac{1}{2} \times 12$ $\quad A = 6\ in^2$

$I = \frac{12(.5)^3}{12} = 0.125\ in^4$

$\bar{y} = \frac{8.0(1.66+.5) + 6(.25)}{8.0+6} = \frac{18.78}{14.0} = 1.34$

$\therefore I = 19.98\ in^4 + .125\ in^4$
$+ 8.0(1.66+.5-1.34)^2 + 6.0(1.34-.25)^2$
$= 32.61\ in^4$

$S_{min} = \frac{32.61\ in^4}{(5+.5-1.34)} = 7.84\ in^3$

$M = 10.62^k \times 10'' = 106.2^{''-k}$

$f = \frac{106.2}{7.84} = \underline{13.5^{ksi}} < 22^{ksi}$ OK

FOR HORI. SHEAR $v = \frac{VQ}{I}$

$Q = 2(4.0 in^2)(1.66+.5-1.34) = 2(3.28 in^3)$

Client MAINE YANKEE Location WISCASSET J.O. No. 12365.0

Subject CHECK ANCHORS & BASE PL FOR PIPE SUPPORT Date 4-7-79 By S PANTAN

Checked 4-7-79 By K E...

Based on

∴ SHEAR FLOW

$$\gamma = \frac{VQ}{I} = \frac{2(10.62^{k})(3.28\ in^3)}{32.61\ in^4} = 2.14\ ^{k/''}$$

MIN WELD TO $\frac{1}{2}$" PL $= \frac{3}{16}$" (AISC 1.17.5)

CAPACITY $= 3(.928^{k/''}) = 2.78^{k/''}$ PER WG

or $5.56^{k/''}$ TOTAL OK

CHECK VERTICAL WELDS TO GUSSET

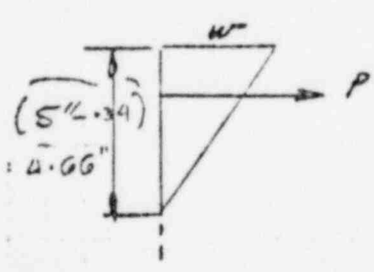
$$\text{VERT SHEAR} = \frac{10.62^{k}}{2\times 5''\ \ 5+4.5} = 1.062^{k/''}\ \ 1.12$$

HORIZONTAL SHEAR

ASSUME MOMENT OF THRU ONE ANGLE CONSERVATIVE $1.10 \times 5.7^{k} \times 10'' = 62.7^{''-k}$

MAX BOLT TENSION

BOLT DIST FROM GUSSET



(CONSERVATIVE VALUE)

$$M = \frac{2}{3} P (5'')\ 4.66 = 62.7^{''-k}$$

$$P = \frac{w(5'')\ 4.66}{2} = 18.81^{\#}\ \ 20.18^{k/''}$$

$$w = 7.52^{k/''}\ \ 8.66^{k/''}$$

WELD BOTH SIDES OF ANGLE

∴ LOAD IN WELD (RESULTANT) $\sqrt{\left(\frac{8.66}{2}\right)^2 + (1.12)^2}$

$$= \sqrt{f_v^2 + f_h^2} = \sqrt{\left(\frac{7.52}{2}\right)^2 + \left(1.062\right)^2} = 3.91^{k/''}\ \ (4.47)$$

USE $\frac{5}{16}$" WELD TO GUSSET

CAPACITY $= 5(.928) = 4.64^{k/''}$

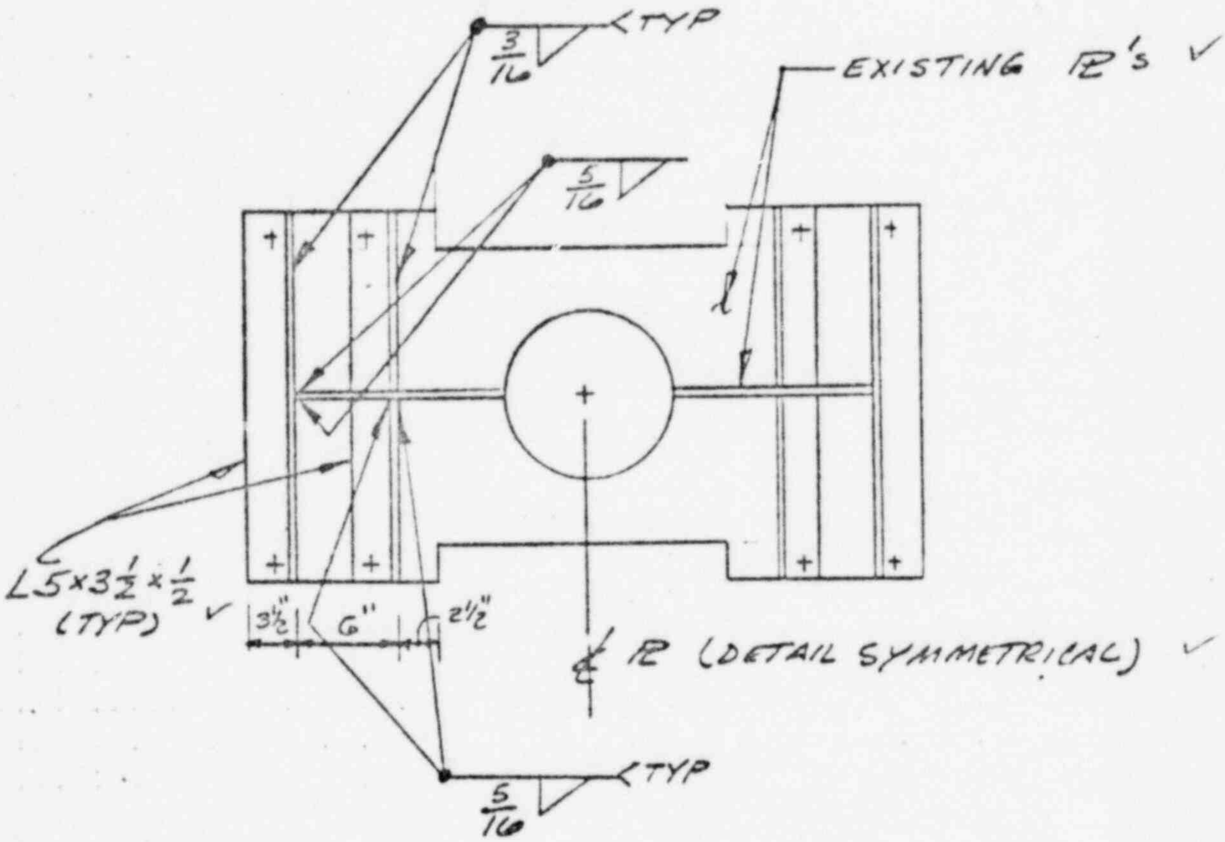
OK

5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Client MAINE YANKEE Location WISCASSET Ex. No. J.O. No. 12365.0
Subject CHECK ANCHOR & BASE PL FOR PIPE SUPPORTS Date 4-7-79 By A PANTELI
Checked 4-7-79 By K. RADI
Based on Revised By



REF: DWG No. 11550-FP-17F ✓
SECTION 13-13 (E-6)

DETAIL ✓

PIPE SUPPORTS H-51 & H-53

(FOR INFO NOT SHOWN SEE REF. DWG) ✓

(NOT TO SCALE)

A 8010 1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. 41
Preliminary
Item

Client MAINE YANKEE Location WISCASSET Ex. No. J.O. No. 12365
Subject CHECK ANCHORS & BASE PL FOR PIPE SPR'TS Date 4-7-79 By R K
Checked 4-7-79 By SPANTAU
Based on Revised By

SPR'T H-53

REFER TO LD INFO. PAGE

RATIO OF H-51 LD TO H-53 LD.

	F_x	F_y	F_z	M_x	M_y	M_z
WALL	.786	1.98	1.45	1.71	1.029	.92
FLOOR.	.926	1.21	1.05	1.145	0.865	.918

LD RATIO FOR H51 TO H53 IS VERY SMALL IT IS 50% MORE & 50% LESS. BY ENGG. JUDGEMENT H-51 CHECK ok FOR H-53.

POOR ORIGINAL