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May 31, 1984
5211-84-2125

Office of Nuclear Reactor Regulation
Attn: John F. Stolz, Chief
Operating Reactors Branch No. 4
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License NO. DPR-50
Docket No. 50-289
Seismic Capability of Backup Thermocouple Reading
And Display System

By letter dated April 25, 1984, GPUN was informed that the alternative method of reading incore thermocouple temperatures for the backup system is acceptable, provided the concerns resulting from the plant audit on January 4, 1984, are addressed adequately.

Enclosure 1 addresses all five (5) concerns and GPUN's responses. It is shown in the enclosure that (1) the tube carrying incore instrument channnel from the reactor vessel has adequate seismic capability; (2) the cables and electrical penetration assemblies have adequate seismic capability and are classified as safety grade; (3) the signal conditioning unit including its contents have adequate seismic capability; (4) the welded connections for the thermocouple lead cable sleeves have the required strength; and (5) procedures for converting hand held voltmeter readings into thermocouple temperatures do not require special test and verification.

This letter satisfies the concerns of restart certification item number 113.

Sincerely,

H. D. Hukill
Vice President - TMI-1

HDH/MI
Enclosure (1)
Attachments (4)

cc: R. Conte
J. Van Vliet

A001
1/1

Enclosure 1

Response to NRC comments on TMI-1 Seismic capability of backup thermocouple reading and display system.

Comment #1: Demonstrate that the tube carrying the incore instrument channel from the reactor vessel has adequate seismic capability.

Response: The subject tubing was reviewed as part of the NRC IE Bulletin 79-14 program and was analyzed for SSE Earthquake during original plant design. The analysis is filed under GAI analysis ME-101 and ME-102 by GPUN Letter No. LIL-307, dated October 23, 1981. The stress summary pages on these analyses are attached (Attachment 1). This analysis was checked against the criteria specified in the TMI-1 FSAR Section 5.1 and was found to be in compliance with those criteria.

Comment #2: Demonstrate that the non-safety grade cables and electrical penetration assemblies (EPA) have adequate seismic capability.

Response: Extension wiring for the thermocouples constituting the backup system are routed through safety grade EPA's. The Resistance Temperature Device (RTD's) are also routed through the same safety grade EPA's. The penetrations utilized are #204E (instrument channel A), #205E (instrument channel B), #313E (instrument channel C) and #314E (instrument channel D). These penetrations were designed by G. E. and the test results are documented in "Qualification Test for F01 Electrical Penetration Assembly, General Electric Co., April 30, 1971".

Qualification of these electrical penetrations has been submitted to the NRC in compliance with rule 10CFR50.49 (Environmental Qualification of Safety Related Electrical Equipment). In addition, these documents are available at GPUN Headquarters in Parsippany, NJ.

The wires and connectors used inside containment at these EPA's are safety grade and consist of cables (GPUN B/M E15AA), #16 wires and butt splice and heat shrink tubing connections. Furthermore, the connectors at the incore detectors are potted.

Comment #3: Demonstrate that the signal conditioning unit including its contents has adequate seismic capability.

Response: The above mentioned seismic qualification is addressed in the Acton Environmental Testing Corporation technical report No. 140496 "Evaluation by Dynamic Analysis of Foxboro Base Assembly D0126WJ mounting for N2ES instrument Rack," (page #2) dated 8/16/78. The Foxboro manufacturer, does not provide serial numbers for instrument racks of this kind, however, GPUN will place an equipment number on the instrument rack for identification. Furthermore, GPUN will obtain the design drawings from Foxboro and will check the subject instrument rack for its compliance with design criteria by cycle-6 outage.

The test report, along with other Foxboro documents including Certificate of Compliance is available at GPUN Headquarters in Parsippany, NJ. A copy of relevant pages are attached for your information (See Attachment 2).

The qualification of the cabinet and its contents as a free standing cantilever is conservative compared to a redundant cantilever which is its as-built condition. This is demonstated by the analysis in Attachment 3.

Comment #4: Demonstrate that the welded connections for the thermocouple lead cable sleeves have the required strength.

Response: The cable sleeve to the seal plate welds have been analyzed and added to the subject document (Calc. #C-1101-625-5320-001, rev. 1). This analysis indicates the welds are capable of withstanding the seismic event (SSE), without loss of structural integrity or safety function, and is attached. The two 1/2 in. diameter bars connecting the cable sleeve to the seal plate are detailed in the aforementioned calculations. A copy of the above referenced calculation is included as Attachment 4.

The floor response spectrum (FRS) used in the analysis has been incorporated into the reference calculation.

Due to the high flexibility of the cable analyzed and its close proximity to anchor points, the differential seismic anchor movements will have a negligible effect on the final analysis of the cables.

Comment #5: Demonstrate that proper calibration procedures are adopted for converting handheld voltmeter readings into thermocouple temperatures.

Response: The instrument loop that comprises the backup incore thermocouple system consists of several compensating signal conditioning modules that provide a linear 0-10V DC signal to the digital meter that represents 100-2300°F temperature. The voltmeter used in place of the digital meter that has comparable accuracy would display the same 0-10V that normally drives the digital meter. The conversion from voltage to temperature for the voltmeter is the same as the conversion utilized by the digital meter.

i.e., Temp. (°F)= (220) (volts) + 100

Both primary and backup thermocouple systems are calibrated through the temperature range stated in NUREG 0737.

The portable voltmeter is periodically calibrated per Plant Procedures per Standards for Measuring and Test Equipment certified by NBS.

GPUN contends that the portable voltmeter is very reliable (as demonstrated at TMI-2). Since this physical phenomena will affect both primary and backup incore systems in the same manner, results will be consistent. Although, a test comparing the primary and backup readout is not required, GPUN will compare the computer readings with the results of the portable voltmeter at various power ranges during the Start-up and Test Program per T.P. 846/1, Incore Thermocouple Operation Test.

The physical phenomena discussed in item 6 of the subject letter results in an anomaly which is independent of the display device. Hence, it seems that the non-linear thermocouple behavior at high temperature is a generic issue and should be dealt with separately.

In addition, item number 5* of the attachment to the subject letter refers to item (8) of II.F.2, NUREG 0737 and infers 99% availability for the display channels following a large earthquake. However, it is not credible to assume seismically qualified thermocouples will fail during a large earthquake.

Although, the discussion (item 5) was correct in its conclusion that tapping into the primary system thermocouples to substitute a new thermocouple for a failed backup system thermocouple would be quite time consuming, the closest source to access any primary system thermocouple would not be at an electrical penetration as stated, but at the plant computer termination cabinet terminal. This is about seventy feet away from the PLF console to which the thermocouple would be routed.

*NOTE: Paragraph 5 states the backup system consists of 32 thermocouples..., the correct number is 16 thermocouples.

ATTACHMENT 1

STRESS SUMMARY

PIPE LINE: MX-102

REFERENCE ISOMETRIC: B-302-676.0

LINE SPEC: B & W DRAWING

MAXIMUM LONGITUDINAL AND DEADLOAD STRESSES COMBINED: 3015 PSI @ PT. 29

MAXIMUM SEISMIC STRESSES DURING AN X-Y DESIGN EARTHQUAKE: 783 PSI @ PT. 28

MAXIMUM SEISMIC STRESSES DURING A Y-Z DESIGN EARTHQUAKE: 1655 PSI @ PT. 31

S SEISMIC = 2 x 1655 PSI = 3310 PSI **

S_h = 15,300 PSI (304L STAINLESS STEEL TUBING @ 110°F)

COMBINATION OF STRESSES @ DIFFERENT POINTS

S MAXIMUM = 3310 PSI + 3015 PSI = 6325 PSI ***

1.2 S_h = 1.2 x 15,300 PSI = 18,360 PSI

1.2 S_h > S MAXIMUM

18,360 PSI > 6325 PSI

THERMAL SUMMARY

S_A = f (1.25 Sc + .25 S_h)

= 1 [(1.25)(17,500 PSI) + (.25)(15,300 PSI)]

= 21,875 PSI + 3825 PSI = 25,700 PSI

S MAXIMUM = 1292 PSI @ PT. 31

S_A > S MAXIMUM

25,700 PSI > 1292 PSI

** Represents SSE Earthquake stress

*** Represents $\sigma_{DW} + \sigma_{press} + \sigma_{SSE}$ (Equation #12 stress)

METROPOLITAN EDISON COMPANY Three Mile Island Nuclear Station Unit #1	G. J. Clouper GILBERT ASSOCIATES INC.
Incore Monitoring - Incore Monitoring	044192-000 B-302-676
System Piping (typical arrangement)	ME-101

STRESS SUMMARY

PIPE LINE: ME-101

REFERENCE ISOMETRIC: B-302-676-0

LINE SPEC: B & W Drawing

MAXIMUM LONGITUDINAL AND DEADLOAD STRESSES COMBINED: 5913 PSI @ PT. 6 (DL)

MAXIMUM SEISMIC STRESSES DURING AN X-Y DESIGN EARTHQUAKE: 3519 PSI @ PT. 2 (X-Y,S

MAXIMUM SEISMIC STRESSES DURING A Y-Z DESIGN EARTHQUAKE: 3471 PSI @ PT. 15 (Y-Z,S

S SEISMIC = 2 x 3519 PSI = 7038 PSI **

S_h = 15,300 PSI (304 L Stainless Steel Tubing @ 110°F)

COMBINATION OF STRESSES @ DIFFERENT POINTS

S MAXIMUM = 7038 PSI + 5913 PSI = 12,951 PSI ***

$1.2\ S_h = 1.2 \times 15{,}300$ PSI = 18,360 PSI

$1.2\ S_h >$ S MAXIMUM

18,360 PSI > 12,951 PSI

THERMAL SUMMARY NOT APPLICABLE

** Represents SSE Earthquake stress

*** Represents $\sigma_{DW} + \sigma_{press} + \sigma_{SSE}$ (Equation #12 stress)

ATTACHMENT 2

Report No. 14096

Technical Report

EVALUATION BY DYNAMIC ANALYSIS
OF FOXBORO BASE ASSEMBLY DO 126 WJ
MOUNTING FOR N2ES INSTRUMENT RACK

ENVIRONMENTAL
ACTON TESTING
CORPORATION

Date August 16, 1978

	Prepared	Checked	Approved
By	M.Randall	K.Martini	M.L.Tolf
Signed	M Randall	K Martini	M L Tolf
Date	8-16-78	8-17-78	8/17/78

MR/hmf

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Report No. 14096

1.0 INTRODUCTION

This report documents the analysis performed to compare the dynamic performance of the N2ES Instrument Rack (fully loaded) as normally floor mounted to the dynamic performance when mounted on the D0126WJ Base Assembly, Rev D.

The purpose of the analysis was to ensure that under seismic loading, the rack mounted equipment would not experience significantly higher excitation than when the Base Assembly was used.

Detailed finite element models of the N2ES Rack and the Base Assembly were developed. A 1g response spectra was imposed on the floor mounted Rack and to the Base Assembly mounted Rack.

The resulting response accelerations were compared to evaluate the performance of the Base Assembly.

2.0 CONCLUSION

The acceleration levels realized at the instrument locations are not significantly increased by mounting the N2ES Instrument Rack (fully loaded) on the D0126WJ Base Assembly, Rev D.

Therefore, equipment qualified for service by test or analysis for a direct floor mounted application are qualified for service when the Rack is mounted on the Base Assembly.

Report No. 14096

3.0 RESULTS

Tables I and II give the response modal accelerations at the instrument face mounting locations. The four groups of nodal locations represent the instrument mount locations at each corner starting at the lower power supply mounting and working upward to the top. These locations are shown in Figure I. The accelerations are given for each axis independently and then the square root sum of squares value is calculated for each nodal location. The floor mounted rack and the Base Assembly mounted rack are similarly treated. Table III then offers the percentage increase in the response modal acceleration for the Base Assembly Mounted Rack over the Floor Mounted Rack at each instrument mounting location.

At the lowest location, the percentage difference is high, a maximum of 18.7% but the absolute numbers are low at this level in the rack. At the second location, the maximum difference is 8.41% and at the top where the absolute acceleration values are highest the maximum difference is 3.29%. Some of the percentage values shown on Table III are negative, arising from lower acceleration realized in the Base Mounted Rack. This condition results from slightly different dynamic mode shapes with the Base Assembly and we are concerned mainly with the maximum differences.

Report No. 14096

4.0 METHOD

Finite element models of the M2ES rack and the Base Assembly were developed.

The Rack model employs plate elements exclusively in the Base Weldment, D0126VB, which most accurately represents the stiffness and load paths in this critical area. Forty-four quadrilateral plates and thirty-two triangular plates are used. The structure above the Base Weldment: the Equipment Mounting Channels, the Center Frame Assembly, Equipment Supports and the Top Assembly, are all modeled with beams. Appendix II contains the Beam property calculations: centroid, moments of inertia and area. Figure I is the computer plot of showing the nodal locations, beam connectivity and plate outline connectivity. The nodal numbering for the instrument mounting locations reported in section 3.0, Results, is given in Figure I. All other nodal and element numbering sketches are provided in Appendix I.

The non-structural items, side covers, doors, top assembly and instrument weights were distributed as shown, Table IV. The rack model is given six degree restraint at the six 1/2" bolts.

The Base Assembly, model Figure II, is comprised of fifty-two triangular plates, twenty-four quadrilateral plates and is attached to the rack model by six common nodes at the 1/2-inch bolt locations. The Base assembly is given six degree restraint along the lower weld edge.

Attachment 3

Respo. se to Comment #3 Seismic Qualification of Foxboro Rack

GPUN has done a Preliminary Evaluation of the as installed N2E5 Foxboro rack, using dynamic test and analytical data supplied by the manufacturer. This data is obtained from a standard dynamic analysis of the subject rack and dynamic test done for Foxboro by Acton Environmental Corporation. The results of the GPUN Evaluation indicated that the first five modal frequencies for the rack are:

Mode	Frequency (Hz)
1	37.77
2	122.74
3	255.96
4	437.9
5	667.67

The above was based on a model for the rack as a uniform redundant Cantilever with a simple support at the free end, which GPUN considers conservative.

The associated G values based on the TMI-1 response curve in figure #1, for the as installed Foxboro rack are:

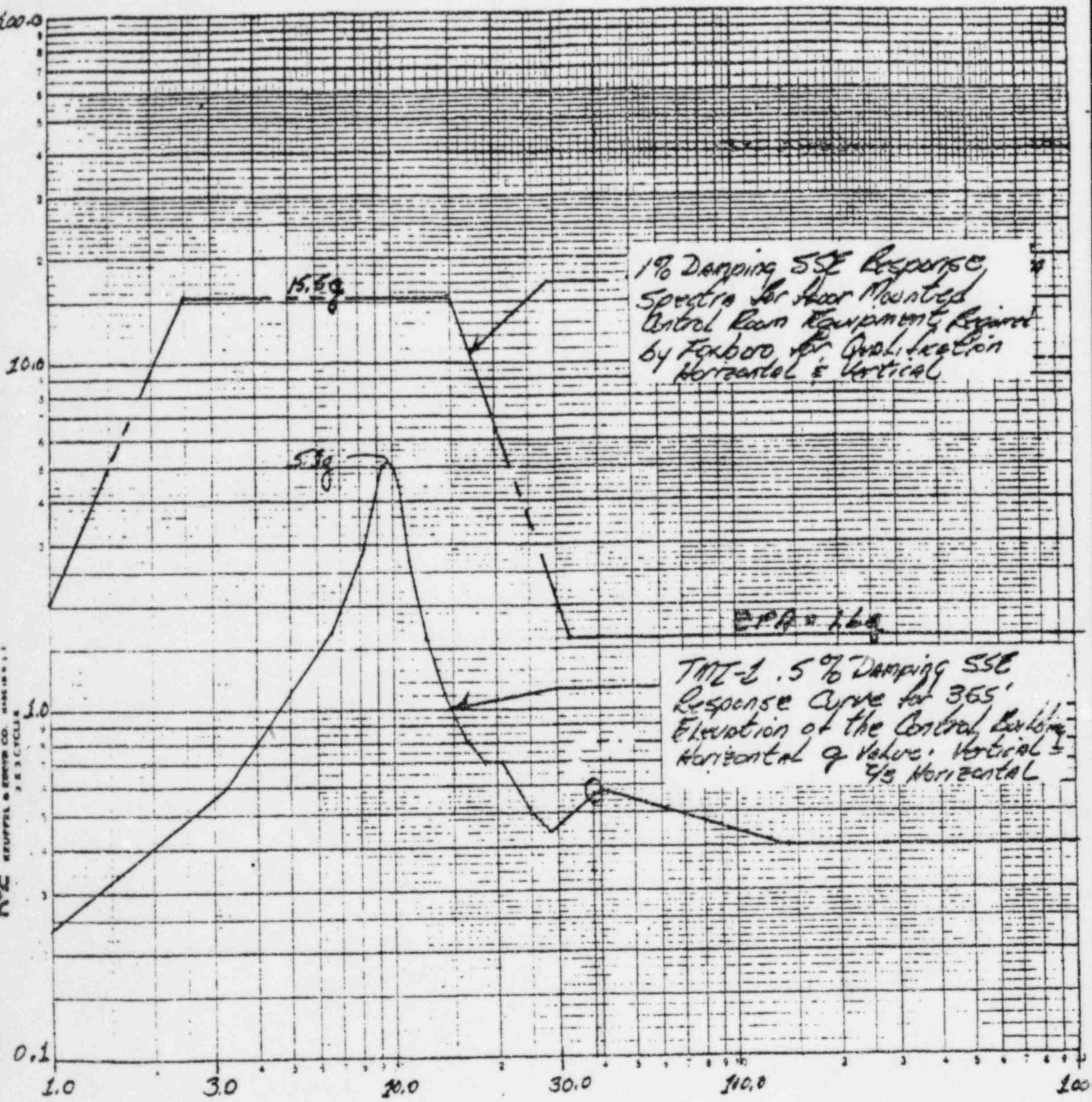
Mode	Frequency (Hz)	Horizontal Acc., g SSE (1/2% Damping)
1	37.77	.56
2	122.739	.40
3	255.964	.40
4	437.9	.40
5	667.66	.40

The above results indicate that all modal frequencies are above 33Hz. It is well known that components with modal frequencies above 33Hz will respond as rigid bodies during an earthquake, i.e., the dynamic amplification is unity. Consequently, the component can be analyzed in a static manner and transfer functions are such that the response of the component does not show amplification due to the dynamic input.

The qualification response spectrum used by Foxboro for the test of N2E5 racks (installed at TMI) is depicted in the attached figure. The TMI-1 SSE response spectrum for the floor where the rack is installed is also shown in the same figure. It should be noted that the former envelopes the TMI-1 spectrum by at least a factor of 3. Furthermore, during testing, the horizontal and vertical components of the curves were assumed equal and applied simultaneously. In the TMI-1 FSAR, the vertical acceleration is only 2/3 of the horizontal acceleration.

It is GPUN's conclusion that the subject rack (N2E5) is seismically qualified, i.e. it should maintain its structural integrity and remain functional during and after a SSE Event.

Figure #1 Response Spectras Used to Qualify Foxboro H2ES Signal Conditioning Rack at TMI-1



Response Acceleration in g's

Frequency in Hz.

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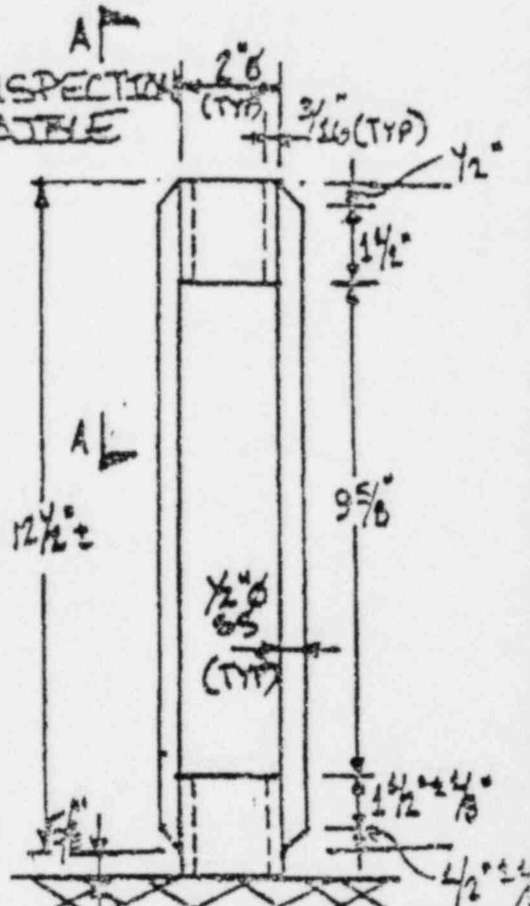
ADDITION "

CALC. NO. C-1101-625-5360-024 REV.
SHEET NO. A-1 OF A-2
DATE 1/16/84
COMP. BY/DATE 1/16/84
CHK'D. BY/DATE 1/20/84

SUBJECT: SEISMIC ANALYSIS OF INCORE THERMOCOUPLE CABLE, TMI-1

5. CALCULATIONS



QUALIFY 1/2"ϕ BAR WELD —

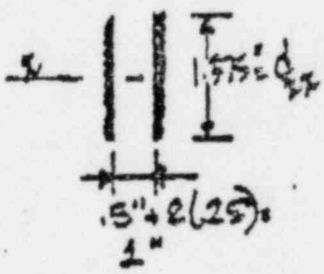
WELD LOAD CASES:

TORSION, BENDING, SHEAR

~~TORSION~~

$T = 9.37^{\#}(12.5") = 118''^{-\#}$

$f_T = \frac{M_T c}{J_W}$



WHERE

$J_W = \frac{d(3b^2 + d^2)}{6}$

$J_W = \frac{1.375(3(1^2) + 1.375^2)}{6} = 1.12$

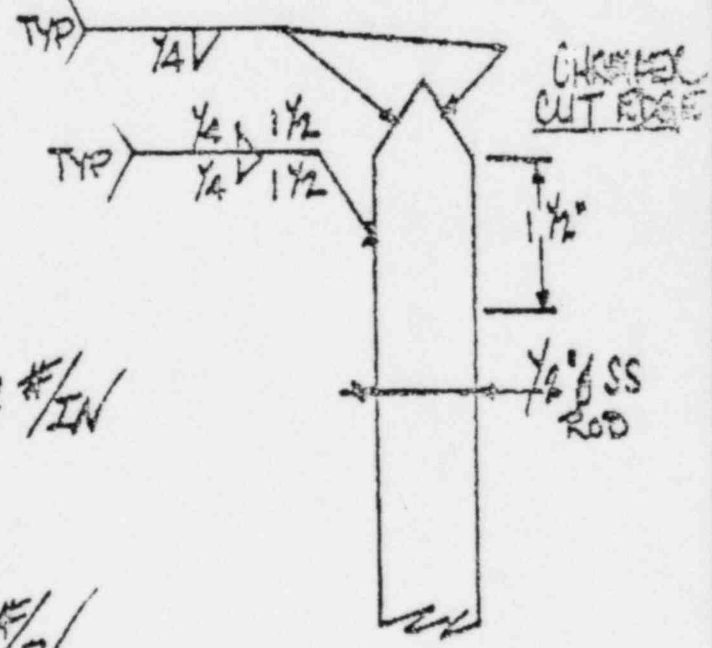
(REF. BLODGETT © 1966)

$A_W = 2(1.375) = 2.75$

S_W least $=$ x-x axis

$S_{W_{xx}} = \frac{d^2}{3} = \frac{1.375^2}{3} = .63$

$\therefore f_T = \frac{118''^{-\#}(1.375/2)}{1.12} = 72.4\ ^{\#}/IN$



SECTION A-A

BENDING

$f_B = \frac{M_B}{S_W} = \frac{9.37^{\#}(12.5")}{.63} = 186\ ^{\#}/IN$

"ADDITION"

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CALC. NO. [illegible] REV.:
SHEET NO. A-2 OF A-2
DATE [illegible]
COMP. BY/DATE [illegible] 1/20/84
CHK'D. BY/DATE [illegible] 1/20/84

SUBJECT SEISMIC ANALYSIS OF INCORE THERMOCOUPLE CABLE, TMI-1

5. CALCULATIONS (CONT'D)

SHEAR

$f_s = \frac{V}{A_W} = \frac{9.37^{\#}}{2.75''} = 3.4^{\#}/IN$

$\Sigma f_{WELD} = 71.4 + 186 + 3.4 = 262\ ^{\#}/IN$

$f_{allow} = .707(1/4'')(.3)(62000\ PSI) = 3288\ ^{\#}/IN$

(REF. AISC 8th ED.) ↗ F_y E6010 (BLODGETT © 1966)

$\therefore$ $262\ ^{\#}/IN \ll 3288\ ^{\#}/IN$ OK

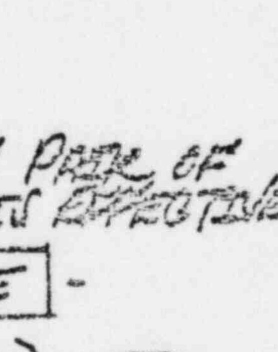
NOTE: ASSUMPTION ABOVE ASSUMES ONLY 1 PAIR OF 4 WELDS FOR CALCULATION PURPOSES, IS EFFECTIVE

CHECK SHEAR IN CABLE @ RAYCHEM SLEEVE -

TENSILE ALLOWABLE = .2 F_u = 6000 PSI (B31.1-1980)
(REF. PG 10 THIS CALC.)

WHERE F_u = 30,000 PSI

CABLE CROSS SECTION →



A_V

SHEAR ALLOWABLE = .1 F_u = 3000 PSI

$\therefore \sigma_V = \frac{V}{A_V}$ WHERE $V = 9.34^{\#}$

$A_V = .0144\ IN^2$ (9 WIRE)

SO THAT $\sigma_V = \frac{9.34^{\#}}{.0144\ IN^2} = 649\ PSI < 3000\ PSI$ OK