SUMMARY OF RESULTS FOR RTS ACTIVE VALVE AND EQUIPMENT EVALUATIONS

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1.0 INTRODUCTION

As part of the Return To Service (RTS) efforts for the San Onofre Nuclear Generating Station Unit 1 (SONGS-1), seismic evaluations were performed for mechanical equipment supports and valves. The methods used and the results of these evaluations are described in the following sections.

2.0 SCOPE

The components evaluated include 11 equipment types (14 equipment items) and 88 valves. The equipment items are listed in Table 2.1 and the valves are listed in Table 2.2.

3.0 EVALUATION CRITERIA

3.1 Equipment Supports

The evaluation criteria for the equipment supports are based on the requirement that the supports maintain their structural integrity during and after a design basis earthquake.

The criteria for all structural elements, with the exception of concrete expansion bolts, were based on Section III, Appendix F of the ASME Code for Level D service limits. These stress limits allow local yielding but ensure the overall stability of the structure. The more stringent criteria of Service Level A were applied to some components. Qualification to Level A limits demonstrates a large safety factor and envelopes all possible loading conditions. Criteria were established for bending, axial, and shear loads as well as checks on welds, bolting, and member stability.

The RTS expansion bolt allowables were established by applying a factor of safety to the ultimate bolt pullout capacity. For normal conditions the allowable load is taken as 1/4 of the ultimate capacity. This provides a safety factor of 4.0. The RTS evaluations are based on the Design Basis Earthquake (DBE), a one time event with an extremely low probability of occurance. Based on this low probability, interim criteria for the RTS have been established using 1/2 of the ultimate capacity. This provides a safety factor of 2 and meets the criteria established in [2].

A more detailed description of the equipment criteria is contained in [3].

3.2 Active Valves

Eighty-eight (88) valves have been designated as "active" by SCE and were evaluated. The evaluation criteria for the active valves was established to ensure the functionality and structural integrity of the valves during and after a design basis earthquake.

The seismic capacities of the valves were determined based on the bending, axial, and shear stresses in the critical section of the valve and the requirements of Section III, Appendix XVII of the ASME Code [1]. Qualification was demonstrated by comparing the seismic capacity of the valve to the seismic acceleration resulting from the actual pipe/pipe support configuration.

Functionality of the valves is ensured by limiting all stresses to the elastic range. The Level C allowable stresses of Apendix XVII maintain all stresses below the yield point.

In addition to demonstrating pressure integrity, the BOPMEP criteria for SONGS 1 [38] require that stresses in the valve bodies are limited to yield.

A more detailed description of the valve criteria is contained in [4].

3.3 Passive Valves

Passive Valves are not required to operate during or after the postulated seismic event. Therefore gross deformations in the extended structures (non-pressure retaining components) are acceptable and these parts were not included in Impell's RTS work scope.

The BOPMEP criteria [38] limit streses in the valve bodies to the level D limit of [1]. The evaluation of valve body stresses is described in Appendix C.

3.4 Load Combinations

3.4.1 Equipment Supports

Evaluations of equipment supports included SSE inertia loads, load applied by attached piping (nozzle loads), and gravity loads.

3.4.2 Active Valves

Evaluations of the active valves included gravity, SSE inertia, and operational loads.

4.0 EVALUATION METHODOLOGY

4.1 Equipment Supports

Equipment supports were evaluated using equivalent static analyses. These analyses were performed in 3 steps as described below:

1. Component Frequency. The fundamental frequency of vibration was determined using hand calculations or simplified computer models. The natural frequencies were used with the floor response spectra to provide the seismic load factor.

2. Seismic Loads. Seismic load factors were determined in accordance with Section II.2.a.(2) of [5]. The SSE inertial loads were calculated by applying the seismic load factors to the component CG. The seismic loads were combined with nozzle and deadweight loads.

3. Qualification Determination. Stresses resulting from the combined loads were calculated and compared to the allowables described in Section 3.1. The results of these comparisons are summarized in Appendix A.

4.2 Active Valves

In most cases, valves were evaluated by applying a 1.0g seismic load in the weakest directon of the valve. The seismic loads were combined with loads due to gravity and operation (such as stem thrust) to determine a "Total" load. Stresses in critical sections of the valve were calculated based on this "Total" load. By comparing the stresses due to the 1.0g seismic load to the allowable stresses described in Section 3.2, the seismic capacity of the valve in the weakest direction could be found.

The anticipated seismic acceleration of the valve was determined by calculating the resultant (i.e, SRSS of the vertical and two horizontial) acceleration at the CG of the valve from the data provided by the appropriate piping analysis. Qualification was determined by comparing the seismic capacity to the applied acceleration.

If the method described above did not show the valve to be qualified, a more detailed analysis was performed. The three components of acceleration, as determined by the piping analysis, were applied to the valves. Conservatively, the accelerations were assumed to be oriented such that the maximum orthogonal component was oriented in the weakest direction of the valve. The stresses were then calculated and compared to the allowables.

5.0 RESULTS

The Impell evaluations have shown that all items included in Tables 2.1 and 2.2 are qualified. No modifications to the equipment or valves are required to meet the RTS criteria. Also as discussed in Appendix C, the stresses in all valve bodies satisfy the requirements of the BOPMEP criteria for the RTS scope.

The results of the equipment evaluations are summarized in Appendix A. Valve qualification levels are listed in Appendix B.

6.0 REFERENCES

1. ASME Boiler and Pressure Vessel Code, Section III, Rules for Construction of Nuclear Power Plant Components, 1983 Edition.

2. IE Bulletin 79-02, Revision No. 1, (Supplement 1), August 20, 1979, "Pipe Support Base Plate Designs Using Concrete Expansion Anchor Bolts".

3. "Design Criteria for Return To Service, San Onofre Nuclear Generating Station, Unit 1, Equipment Supports", Revision 1, July 12, 1984, Impell Job No. 0310-036-1356.

4. "Design Criteria for Return To Service, San Onofre Nuclear Generating Station, Unit 1, Active Valves", Revision 1, August 9, 1984, Impell Job No. 0310-036-1356.

5. "Dynamic Testing and Analysis of Systems, Components, and Equipment", USNRC Standard Review Plan 3.9.2, NUREG-0800, Rev. 2, July 1981.

6. "AFW Turbine Driven Pump, G-10", Impell Calculation No. EQ-01, Job No. 0310-036-1356, Rev. 0, July 23, 1984.

7. "CVCS Test Pump, G-42", Impell Calculation No. EQ-02, Job No. 0310-036-1356, Rev. 0, 7/23/84.

8. "Seal Water Injection Filter C42, C42S", Impell Calculation No. EQ-03, Job No. 0310-036-1356, Rev. 0, July 18, 1984.

9. "Seal Water Supply Filter G2A, G2C (C-952A, C-952C)", Impell Calculation No. EQ-04, Job No. 0310-036-1356, Rev. 0, July 18, 1984.

10. "Seal Water Supply Filter G2B (C-952B)", Impell Calculation No. EQ-05, Job No. 0310-036-1356, Rev. 0, July 18, 1984.

11. "Seal Water Heat Exchanger, E-34", Impell Calculation No. EQ-06, Job No. 0310-036-1356, Rev. 0, July 30, 1984.

12. "Charging Pump Oil Cooler (Water Cooled)", Impell Calculation No. EQ-07, Job No. 0310-036-1356, Rev. 0, July 23, 1984.

13. "Air-Cooled Oil Cooler", Impell Calculation No. EQ-08, Job No. 0310-036-1356, Rev. 0, July 23, 1984.

14. "Qualification of Charging Pumps G-8A,B", Impell Calculation No. EQ-09, Job No. 0310-036-1356, Rev. 0, July 18, 1984.

15. "Auxiliary Feedwater Motor Driven Pump", Impell Calculation No. EQ-10, Job No. 0310-036-1356, Rev. 0, July 23, 1984.

16. "Seal Water Return Filter, C-40", Impell Calculation No. EQ-11, Job No. 0310-036-1356, Rev. 0, June 8, 1984.

17. "Valve Seismic Qualification", Impell Calculation No. CV 76-79, Rev. 0, June 6, 1984, Job No. 0310-036-1356.

18. "Valve Seismic Qualification", Impell Calculation No. CV 113, Rev. 0, June 6, 1984, Job No. 0310-036-1356.

19. "Valve Seismic Qualification", Impell Calculation No. CV 203, 304, 545, 546, Rev. 0, June 6, 1984, Job No. 0310-036-1356.

20. "Valve Seismic Qualification", Impell Calculation No. CV 410, 406B, Rev. 0, June 6, 1984, Job No. 0310-036-1356.

21. "Valve Seismic Qualification", Impell Calculation No. CV 528, Rev. 0, June 6, 1984, Job No. 0310-036-1356.

22. "Valve Seismic Qualification", Impell Calculation No. CV 530, 531, Rev. 0, June 12, 1984, Job No. 0310-036-1356.

23. "Valve Seismic Qualification", Impell Calculation No. CV 532, Rev. 0, June 25, 1984, Job No. 0310-036-1356.

24. "Valve Seismic Qualification", Impell Calculation No. CV 3201, Rev. 0, June 12, 1984, Job No. 0310-036-1356.

25. "Valve Seismic Qualification", Impell Calculation No. CV 3203, FCV 2300, 2301, 3300, 3301, Rev. 0, June 12, 1984, Job No. 0310-036-1356.

26. "Valve Seismic Qualification", Impell Calculation No. FCV 1115D, E, F, Rev. 0, June 6, 1984, Job No. 0310-036-1356.

27. "Valve Seismic Qualification", Impell Calculation No. LCV 1112, Rev. 0, June 12, 1984, Job No. 0310-036-1356.

28. "Valve Seismic Qualification", Impell Calculation No. MOV 356, 357, 358, Rev. 0, June 6, 1984, Job No. 0310-036-1356.

29. "Valve Seismic Qualification", Impell Calculation No. MOV 1100B, C, D, Rev. 0, May 21, 1984, Job No. 0310-036-1356.

30. "Valve Seismic Qualification", Impell Calculation No. MOV 18, 19, Rev. 0, May 21, 1984, Job No. 0310-036-1356.

31. "Valve Seismic Qualification", Impell Calculation No. MOV 14-17, Rev. 0, May 21, 1984, Job No. 0310-036-1356.

32. "Valve Seismic Qualification", Impell Calculation No. MOV 1202, Rev. 0, May 21, 1984, Job No. 0310-036-1356.

33. "Valve Seismic Qualification", Impell Calculation No. PCV, Rev. 0, May 25, 1984, Job No. 0310-036-1356.

34. "Valve Seismic Qualification", Impell Calculation No. RV 1-10, Rev. 0, June 6, 1984, Job No. 0310-036-1356.

35. "Valve Seismic Qualification", Impell Calculation No. RV 532, 533, Rev. 0, June 6, 1984, Job No. 0310-036-1356.

36. "Valve Seismic Qualification", Impell Calculation No. Solenoid Valves, Rev. 0, June 6, 1984, Job No. 0310-036-1356.

37. "Dynamic Qualification for Main Stop and Trip Valves", Rev. 0, August 8, 1984.

38. "Balance of Plant Mechanical Equipment and Piping Seismic Reevaluation Criteria (BOPMEP Criteria)", San Onofre Nuclear Generating Station Unit 1, dated May 20, 1983, Bechtel Power Corporation Job No. 14000-300/339.

39. Impell Letter No. 0310-036-015 to SCE, dated September 25, 1984, Subject: Valve Body Stresses for RTS Valves (included in Appendix C).

TABLE 2.1

EQUIPMENT ITEMS

Auxiliary Feedwater Turbine Driven Pump G-10

CVCS Test Pump G-42

Seal Water Injection Filter C-42 (C-42N), C-42S Note 1

Seal Water Supply Filter C-952A, C-952C (G2A, G2C) Note 1

Seal Water Supply Filter C-952B (G2B) Note 1

Seal Water Heat Exchanger E-34

Charging Pump Oil Coolers (water-cooled) E-906, E-907

Charging Pump Oil Coolers (air-cooled) E-908, E-909

Charging Pumps G-8A, G-8B

Auxiliary Feedwater Motor-Driven Pump G-10S

Seal Water Return Filter C-40

NOTE 1: Tag numbers in parenthesis also used for this equipment item.

TABLE 2.2

ACTIVE VALVES

MOV - 14
MOV - 15
MOV - 16
MOV - 17
MOV - 18
MOV - 19
MOV - 1100B
MOV - 1100C
MOV - 1100D
MOV - 1202
MOV - 356
MOV - 357
MOV - 358

RV - 1
RV - 2
RV - 3
RV - 4
RV - 5
RV - 6
RV - 7
RV - 8
RV - 9
RV - 10
RV - 532
RV - 533

FCV - 1115D
FCV - 1115E
FCV - 1115F

Main Stop
Valves (2)

PCV - 3000
PCV - 3001
PCV - 3002
PCV - 3003
PCV - 3004
PCV - 3005
PCV - 3006
PCV - 3007
PCV - 3021
PCV - 3022
PCV - 3023
PCV - 4051
PCV - 4052
PCV - 4054
PCV - 4055
PCV - 4056
PCV - 4057
PCV - 4058
PCV - 4059
PCV - 4060
PCV - 4061
PCV - 4063
PCV - 4064

CV - 76
CV - 77
CV - 78
CV - 79
CV - 406B
CV - 410

SV - 2401
SV - 2402
SV - 2403
SV - 2404
SV - 3401
SV - 3402
SV - 3403
SV - 3404
SV - 3200
SV - 3205
SV - 3211
SV - 135

CV - 2145
CV - 3203
CV - 532
CV - 3201

FCV - 2300
FCV - 2301
FCV - 3300
FCV - 3301

LCV - 1112

CV - 113
CV - 528
CV - 203
CV - 304
CV - 545
CV - 546
CV - 530
CV - 531

APPENDIX A - EQUIPMENT SUPPORT EVALUATION SUMMARIES

TABLE A-01

SUMMARY OF RESULTS FOR AUX. FEEDWATER TURBINE DRIVEN PUMP, G-10

Component	Calculated Stress	Allowable Stress	Remarks
Turbine Holddown Bolts	0.03 (Interaction)	1.0	OK, Level A Limits
Pump Holddown Bolts	0.05 (Interaction)	1.0	OK, Level A Limits
Base Holddown Bolts	0.60 (Interaction)	1.0	OK, FS = 4.0
Base Channel Flange	2.25 ksi	23.67 ksi	OK, Level A Limits

TABLE A-02

SUMMARY OF RESULTS FOR CVCS TEST PUMP, G-42

Component	Calculated Stress	Allowable Stress	Remarks
Motor Hold Down Bolts	.013 (Interaction)	1.0	OK, Level A Limits
Motor Base	3.45 ksi	21.6 ksi	OK, Level A Limits
Pump Hold Down Bolts	.08 (Interaction)	1.0	OK, Level A Limits
Foundation Bolts	.26 (Interaction)	1.0	OK, FS = 4.0

TABLE A-03

SUMMARY OF RESULTS FOR SEAL WATER INJECTION FILTERS, C-42, C-42S

Component	Calculated Stress	Allowable Stress	Remarks
Support Legs 2-1/2x2-1/2x1/4 Angles	.88 (Interaction)	1.0	OK, Level D Limits
Leg to Shell Weld	15.6 ksi	23.9 ksi	OK, Level D Limits

Note: The support legs are embedded in concrete, therefore no anchor bolts or base plates are evaluated.

TABLE A-04

SUMMARY OF RESULTS FOR SEAL WATER SUPPLY FILTERS, C-952A, C-952C

Component	Calculated Stress	Allowable Stress	Remarks
Upper Supports 2x2x1/4 Angles	.59 (Interaction)	1.0	OK, Level D Limits
Upper Supports Anchor Bolts	.57 (Interaction)	1.0	OK, RTS Limits (FS = 2.0)
Upper Supports Base Plates	16.2 ksi	40.6 ksi	OK, Level D Limits
Upper Supports Base Plate Weld	19.0 ksi	23.9 ksi	OK, Level D Limits
Upper Supports Pipe Clamp	.18 (Interaction)	1.0	OK, Level D Limits
Support Legs 2-1/2x2-1/2x1/4 Angles	.92 (Interaction)	1.0	OK, Level D Limits
Anchor Bolts (Structural Bolting)	.63 (Interaction)	1.0	OK, Level D Limits
Leg to Shell Weld	21.2 ksi	23.9 ksi	OK, Level D Limits
Leg to Base Plate Weld	5.8 ksi	23.9 ksi	OK, Level D Limits

TABLE A-05

SUMMARY OF RESULTS FOR SEAL WATER SUPPLY FILTER, C-952B

Component	Calculated Stress	Allowable Stress	Remarks
Support Legs: 2-1/2x2-1/2x1/4 Angle	.45 (Interaction)	1.0	OK, Level D Limits
Anchor Bolts	.77 (Interaction)	1.0	OK, FS = 4.0
Leg-Base Plate Weld	2.4 ksi	23.9 ksi	OK. Level D Limits
Leg-Shell Weld	10.4 ksi	23.9 ksi	OK, Level D Limits
Brace: 2x2x1/4 Angle	1.6 ksi	40.6 ksi	OK, Level D Limits
12" Pipe Clamp	.1 (Interaction)	1.0	OK, Level D Limits
Weld at Angle Brace	4.3 ksi	23.9 ksi	OK, Level D Limits

TABLE A-06

SUMMARY OF RESULTS FOR SEAL WATER HEAT EXCHANGER (E-34)

Component	Calculated Stress	Allowable Stress	Remarks
C6x10.5	.41 (Interaction)	1.0	OK, Level A Limits
W6x20	.05 (Interaction)	1.0	OK, Level A Limits
W4x13	.30 (Interaction)	1.0	OK, Level A Limits
C4x5.4	.07 (Interaction)	1.0	OK, Level A Limits
Group 1 Base Plates	.49" Required thickess	.75" Actual thickness	OK, Level A Limits
Group 1 Anchor Bolts	.61 (Interaction)	1.0	OK, Level A Limits
Group 2 Anchor Bolts	1.0 (Interaction)	1.0	OK, RTS Limits (FS = 2.0) (Note 1)
Group 2 Base Plates	15.6 ksi	21.6 ksi	OK, Level A Limits
Group 3 Base Plates	Extremely low loads, Qualified by Inspection		
Group 3 Anchor Bolts			
Group 4 Base Plates	.10 ksi	21.6 ksi	OK, Level A Limits
Group 4 Anchor Bolts	.27 (Interaction)	1.0	OK, Level A Limits
Support Saddles	.31 (Interaction)	1.0	OK, Level A Limits
Saddle Bolts	.82 (Interaction)	1.0	OK, Level A Limits

NOTE 1: Anchors were assumed to be expansion bolts with embedded length of 3-1/4" (minimum for 3/4" dia. bolts). Actual embedded length is expected to be much greater, therefore results are conservative.

TABLE A-07

SUMMARY OF RESULTS FOR THE WATER COOLED CHARGING PUMP OIL COOLERS

Component	Calculated Stress	Allowable Stress	Remarks
Cooler/Saddle Plate Bolts	.25" required Diameter	N/A	Actual bolt size not available, judged acceptable, See Note.
Saddle Plate to Support Plate Bolts	.206 (Interaction)	1.0	OK, Level A Limits
Support Plate/ Channel Weld	14.0 ksi	18.0 ksi	OK, Level A Limits
Support Plate	.96 (Interaction)	1.0	OK, Level D Limits

NOTE: All loads were combined by absolute sum, maximum nozzle loads were assumed to act simultaneously in the most severe direction. Therefore, results are conservative.

TABLE A-08

SUMMARY OF RESULTS FOR THE AIR COOLED CHARGING PUMP OIL COOLERS

Component	Calculated Stress	Allowable Stress	Remarks
Angle/Cooler Bolts	.60 (Interaction)	1.0	OK, Level A Limits
Support Legs	.19 (Interaction)	1.0	OK, Level A Limits
Anchor Bolts	.64 (Interaction)	1.0	OK, FS = 4.0
Leg/Base Plate Weld	.08 inch required size	.25 inch actual size	OK, Level A Limits
Base Plate	.185 inch required thickness	.25 inch actual thickness	OK, Level D Limits

TABLE A-09

SUMMARY OF RESULTS FOR THE CHARGING PUMPS, G-8A, G-8B

Component	Calculated Stress	Allowable Stress	Remarks
Motor Hold Down Bolts	.02 (Interaction)	1.0	OK, Level A Limits
Pump Hold Down Bolts	.79 (Interaction)	1.0	OK, Level A Limits
Foundation Anchor Bolts	3644 lb.	4250 lb.	OK, FS = 4.0 Note 1
Base Channel	20.6 ksi	23.76 ksi	OK, using Level A Allowables

Note 1: Foundation Bolts are J-Bolts with an embedment exceeding 12". Allowable is based on expansion bolt with 7-1/2" embedment in 4000 psi concrete. Results are conservative.

TABLE A-10

SUMMARY OF RESULTS FOR AUXILIARY FEEDWATER MOTOR DRIVEN PUMP, G-10S

Component	Calculated Stress	Allowable Stress	Remarks
1" Pump Hold Down Bolts	.36 (Interaction)	1.0	OK, Level D Limits
5/8" Motor Hold Down Bolts	.06 (Interaction)	1.0	OK, Level D Limits
Pump Pedestal	.44 (Interaction)	1.0	OK, Level D Limits
5/8" Anchor Bolts	.65 (Interaction)	1.0	OK, FS = 4.0
Base Skid	14.9 ksi (bending)	40.6 ksi	OK, Level D Limits

TABLE A-11

SUMMARY OF RESULTS FOR THE SEAL WATER RETURN FILTER, C-40

Component	Calculated Stress	Allowable Stress	Remarks
Support legs	.84 (Interaction)	1.0	OK, Level D Limits
Leg, Anchor Bolts	.70 (Interaction)	1.0	OK, RTS Allowables (FS = 2.0)
Base Plate	27.7 ksi	40.6 ksi	OK, Level D Limits
Top Support Member A	.24 (Interaction)	1.0	OK, Level D Limits
Top Support Member B	.10 (Interaction)	1.0	OK, Level D Limits
Top Support Bolts	.43 (Interaction)	1.0	OK, Level D Limits
Top Support Member C	.69 (Interaction)	1.0	OK, Level D Limits
Top Support Anchor Bolts	.55 (Interaction)	1.0	OK, Level D Limits
Top Support Weld	.91 kip/inch	4.2 kip/inch	OK, Level D Limits

APPENDIX B - VALVE QUALIFICATION LEVELS

TABLE B-1 VALVE QUALIFICATION LEVELS

	QUALIFICATION LEVEL			
VALVE	a_x	a_y	a_z	$a_{resultant}$
MOV-18 MOV-19	2.65	1.77	2.65	--
MOV-1100B MOV-1100C MOV-1100D	2.29	1.53	2.29	--
MOV-356 MOV-357 MOV-358	8.20	5.47	8.20	--
FCV-2300 FCV-2301 FCV-3300 FCV-3301	--	--	--	22.3
CV-3203	--	--	--	22.3
CV-3201	--	--	--	21.8
CV-532	--	--	--	19.6
CV-113	1.28	1.98	1.06	--
CV-410 CV-406B	--	--	--	11.07
CV-528	.73	.47	1.15	--
CV-76 CV-77 CV-78 CV-79	4.14	4.19	7.24	--
LCV-1112	2.74	3.15	2.90	--
CV-530 CV-531	4.53	2.81	3.02	--
FCV-1115D FCV-1115E FCV-1115F	1.36	5.14	1.31	--
MOV-14 MOV-15 MOV-16 MOV-17	.64	5.01	2.06	--
MOV-1202	4.71	3.14	4.71	--

TABLE B-1 VALVE QUALIFICATION LEVELS

	QUALIFICATION LEVEL			
VALVE	a_x	a_y	a_z	$a_{resultant}$
RV-532	--	--	--	14.2
RV-533				
CV-203	4.11	4.73	4.35	--
CV-304				
CV-545				
CV-546				
RV-1	--	--	--	10.41
RV-2				
RV-3				
RV-4				
RV-5				
RV-6				
RV-7				
RV-8				
RV-9				
RV-10				
SV-2401	--	--	--	7.75
SV-2402				
SV-3401				
SV-3402				
SV-2403				
SV-2404				
SV-3403				
SV-3404				
SV-3200				
SV-3205				
SV-3211				
SV-135				
CV-2145				
PCV-3000	1/2 inch diameter pressure control valves (regulators) qualified by inspection.			
PCV-3001				
PCV-3002				
PCV-3003				
PCV-3004				
PCV-3005				
PCV-3006				
PCV-3007				
PCV-3021				
PCV-3022				
PCV-3023				
PCV-4051				
PCV-4052				
PCV-4054				
PCV-4055				

TABLE B-1 VALVE QUALIFICATION LEVELS

	QUALIFICATION LEVEL			
VALVE	a_x	a_y	a_z	$a_{resultant}$
PCV-4056 PCV-4057 PCV-4058 PCV-4059 PCV-4060 PCV-4061 PCV-4063 PCV-4064	1/2 inch diameter pressure control valves (regulators) qualified by inspection.			
Main Steam Stop Valves	Stop valves are considered piping anchors. Valves were qualified for applied piping loads.			

APPENDIX C - VALVE BODY STRESSES FOR RTS VALVES [39]

September 25, 1984
0310-036-015

Southern California Edison Company
Post Office Box 800
2244 Walnut Grove Avenue
Rosemead, California 91770

ATTENTION: Mr. Duane Martin

SUBJECT: Valve Body Stresses for RTS Valves

REFERENCE: 1. Impell Report 01-0310-1305, Rev. 0, "Summary of Results for RTS Active Valve and Equipment Evaluations," transmitted to SCE with Impell Letter 0310-036-014, dated August 10, 1984.

Gentlemen:

Enclosed for your use is the justification of the valve body stress qualification to the BOPMEP criteria for RTS valves. We will also incorporate this discussion in the RTS valve and equipment report (Reference 1) and transmit the revised report to you later this week.

If you have any questions please call Mr. Ward Ingles or me.

Very truly yours,

GHan for

W. D. Gallo
Project Manager

WDG/WI/jb
Enclosure

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VALVE BODY STRESSES

The piping in the Return to Service (RTS) Scope at SONGS-1 was evaluated using equation (9) of NC-3652 [1]. The piping evaluations considered pressure, deadweight, and seismic inertia loads. The effects of valves on the piping system was addressed by including the valve body in the piping model. A lumped mass is included at the CG of the valve extended structure. The primary stresses in the piping, including the effects of the stress intensificaiton factors of Figure NC-3673.2 (b)-1 [1], were limited to $2.0S_y$.

Seismic qualification of valves is performed in two parts; evaluation of pressure retaining components and evaluation of non-pressure retaining parts.

Non-pressure retaining components, such as yoke legs and yoke to bonnet bolting are evaluated as linear type supports using Subsection NF or Appendix XVII of [1]. Passive valves are not required to operate during (or after) the DBE, therefore, gross structural deformations in the extended structure are acceptable.

The pressure retaining parts of the valve, including the body and bonnet, are evaluated according to the rules of NC/ND-3500 of [1]. These rules require that the valve body be stronger than the attached piping (NC-3521(a) of [1]). The weakest section of the valve body is at the welded joint to the pipe. At this section the valve body thickness is reduced to match the thickness of the attached piping. In the RTS piping evaluations the valve to pipe welded joints were qualified to the functionality limits. This demonstrates the pressure integrity of all the valve bodies in the RTS Scope.

In addition to demonstrating pressure integrity, the BOPMEP criteria for SONGS-1 require that stresses in the bodies be limited to yield for active valves and to Level D limits for passive (inactives) valves ([3], Table 3).

The following paragraphs discuss the evaluation of stresses in the bodies of the valves in the RTS Scope at SONGS-1. In each case the primary stress at the pipe/valve interface is conservatively assumed to be $2.0S_y$. Valves are connected to the piping systems using butt welds, flanges, or socket welds. These three connections are described below:

1. Socket Welds - For the small valves, including solenoid valves, a stress intensification factor of 2.1 is applied to socket welded joints. In addition, a comparison of the section modulus of standard 3000# socket weld fittings [2] with the section modulus of standard weight piping shows that the couplings have a moment capacity from 4.8 (for 1/2") to 3.1 (for 2") greater than the piping. Consideration of these two factors gives the maximum primary stress in the valve body:

$$S_{Valve} = \frac{2.0S_y}{(.75x2.1)(3.1)} = .41S_y$$

   Review of the stress qualification concluded that with this magnitude it reserves sufficient margins for the secondary stresses (thermal and SAM) and the total stress in the valve body is less than yield.

2. Flanged Ends - Relief valves are commonly constructed such that the limiting secion is the flanged ends. The valves in the RTS scope with flanged ends were qualified by evaluating the loads in the flanged connections using the rules of NC-3658. All connections were qualified to Level A or B service limits for all loading. This demonstrates that the stresses in the valve body are below yield, since the level A and B stress limits are approximately equal to the yield stress.

3. Butt Welded Ends - Control and motor operated valves greater than 2" NPS generally used butt welding ends. Butt welds are generally included in the piping model as as-welded butt welds using stress intensification factor of 1.8 or as tapered transitions using stress intensification factors of 1.5 to 1.9.

   A detailed review of 7 valve/pipe interfaces in 3 plants was performed in [4]. The sizes ranges from 2" NPS to 6" NPS. The data from [4] is summarized in Table 1. This data shows that the ratio of pipe section modulus to valve secton modulus ranges from 4.18 to 7.36. Consideration of the stress intensificaton factors and the difference in section moduli reduces the stress of $2.0S_y$ to:

$$S_V = \frac{2.0S_y}{(.75x1.5)(4.18)} = .43S_y$$

   Again, this reserves enough margins for the secondary stresses. Hence the total stress in the valve body is less than yield.

Conclusion:

Stress in valve bodies have been calculated based on pipe end loads (for flanged valves) or by assuming a primary stress of $2.0S_y$ in the attached piping. In all cases the basic stress in the valve body was found to be less than S_y. Therefore, the stresses in all valve bodies satisfy the requirements of the BOPMEP criteria for the RTS scope.

REFERENCES

1. ASME Boiler and Pressure Vessel Code, Section III, Subsection WC, 1983 Edition.

2. "Forged Steel Fittings, Socket-Welding and Threaded," AWSI Standard B16.11-1973, ASME, New York.

3. "Balance of Plant Mechanical Equipment and Piping Seismic Reevaluation Criteria (BOPMEP Criteria)," San Onofre Nuclear Generating Station Unit 1, dated May 20, 1983, Bechtel Power Corp. Job No. 14000-300/339.

4. "A Review of the 1-D and 2-D Thermal Transient Analysis of Piping Components," EDS Nuclear Report No. 01-9602-1113, July 2, 1981.

TABLE 1

Case	MPS	t_{pipe}	t_{valve}	$Zv/_{Zp}$(Note 1)
1	2"	.343	.922	4.18
2	2"	.343	.922	4.18
3	3"	.438	1.390	5.08
4	3"	.438	1.688	7.10
5	3"	.438	1.688	7.10
6	4"	.531	2.00	6.53
7	6"	.718	3.00	7.36

Note 1: $$\frac{Z_v}{Z_p} = \frac{(Do^4 - Di^4)\ do}{(do^4 - di^4)\ Do}$$

Where: Do and Di are OD and ID for valve.
do and di are OD and ID for pipe.

ENCLOSURE 2

CALCULATION/PROBLEM COVER SHEET

Calculation/Problem No: EQ - 01

Title: AFW TURBINE DRIVEN PUMP - G10

Client: SCE **Project:** SONGS - 1

Job No: 0310 - 036 - 1356

Design Input/References:

STATED WITHIN

Assumptions:

STATED WITHIN

Method:

STATED WITHIN

Remarks:

REV. NO.	REVISION	APPROVED	DATE
0	ORIGINAL ISSUE	M R Buch Jr	7/23/84

EDS 0008 5/78

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REFERENCE INFORMATION PROVIDED FOR INFORMATION, NOT INCLUDED IN TOTAL PAGES

AFW TURBINE DRIVEN PUMP - G10

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IMPELL CORPORATION

JOB NO 0310-036-1356

CALC NO EQ-01

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1. CALCULATION SUMMARY

COMPONENTS ANALYZED AND FINDINGS & CRITERIA FOR EACH, ARE LISTED BELOW:

COMPONENT	STATUS	CONDITION
TURBINE HOLDDOWN BOLTS -- 8 - 3/4" φ A307	QUALIFY	LEVEL A/B
PUMP HOLDDOWN BOLTS -- 4 - 1¼" φ A307	QUALIFY	LEVEL A/B
BASE HOLDDOWN BOLTS -- 10 - 7/8" φ A307	QUALIFY	LEVEL A/B
BASE CHANNEL FLANGE -- 21" x 3½" x ¼" A106, GRB	QUALIFIES	LEVEL A/B

AFW TURBINE DRIVEN PUMP - 910

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2. ASSUMPTIONS

1. SINCE DEADWEIGHT LOADS DUE TO GRAVITY ACT TO DECREASE UPWARD LOADS, DEADWEIGHT LOADS ARE NOT CONSIDERED IN THE EVALUATION OF THE TURBINE & PUMP HOLDDOWN BOLTS

2. THERE ARE NO NOZZLE LOADS ON THE TURBINE SINCE THE "TURBINE MUST BE RELIEVED OF ALL PIPING STRAINS" [1]

3. THE NOZZLE LOADS ON THE PUMP ARE AS WERE FOUND IN THE BECHTEL CALC [2] (SEE APPENDIX A)

4. WT OF PUMP LEG SUPPORT IS INCLUDED IN WT OF PUMP AND ACTS @ ITS CENTROID

5. SUPPORTING CHANNEL IS MC 6 x 18 AND IS MADE OF A36 (SEE p. 27)

(OTHERS AS NOTED WITHIN)

AFW TURBINE DRIVEN PUMP - 610

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3. REFERENCES

1. BECHTEL LETTER #BPC/N-84-161 DATED 3/30/84 FROM J.D. DUFFIN (BECHTEL) TO W.D. GALLO (IMPELL) WITH INFORMATION PERTAINING TO: AUXILIARY FEEDWATER TURBINE DRIVEN PUMP G-10

2. BECHTEL CALCULATION FILE # MC-884-21 -- FOR INFORMATION ONLY

3. AISC CODE 8th EDITION, c. 1980

4. ASME CODE, SECTION III, 1980 EDITION

5. WORTHINGTON CORP. DWG., "3-WTL-86 DIFFUSER PUMP ELEVATION," DWG. NO RY 146501, DATED 6-9-66. REV A. INCLUDED WITHIN [1]

6. "DESIGN CRITERIA FOR RETURN TO SERVICE: SONGS-1, EQUIPMENT SUPPORTS" JN #0310-036-1356 DATED 6/13/84

7. HILTI KWIK-BOLT CATALOG -- SEE APPENDIX B

8. WORTHINGTON CORP. DWG #LC-85816 DATED 3-14-60, OUTLINE DWG FOR FORM S2R STEAM TURBINE, INCLUDED IN [1]

9. "FORMULAS FOR STRESS & STRAIN" by ROARK & YOUNG 5th ED. McGRAW-HILL BOOK CO., 1975.

AFW TURBINE DRIVEN PUMP -G10

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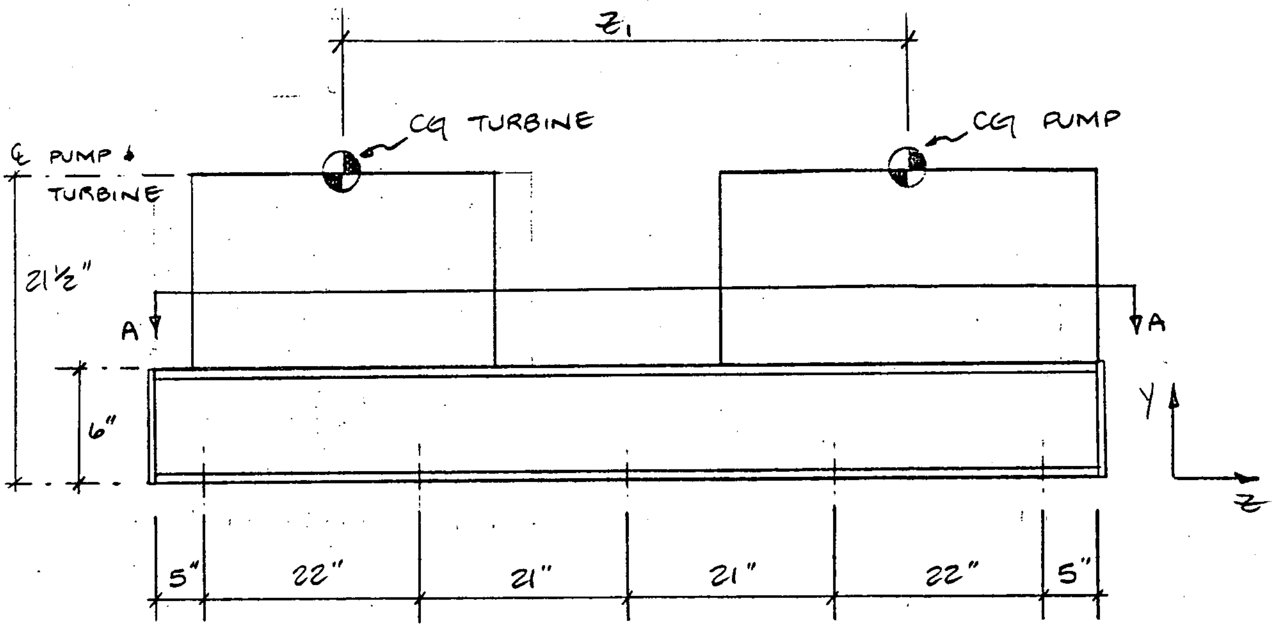
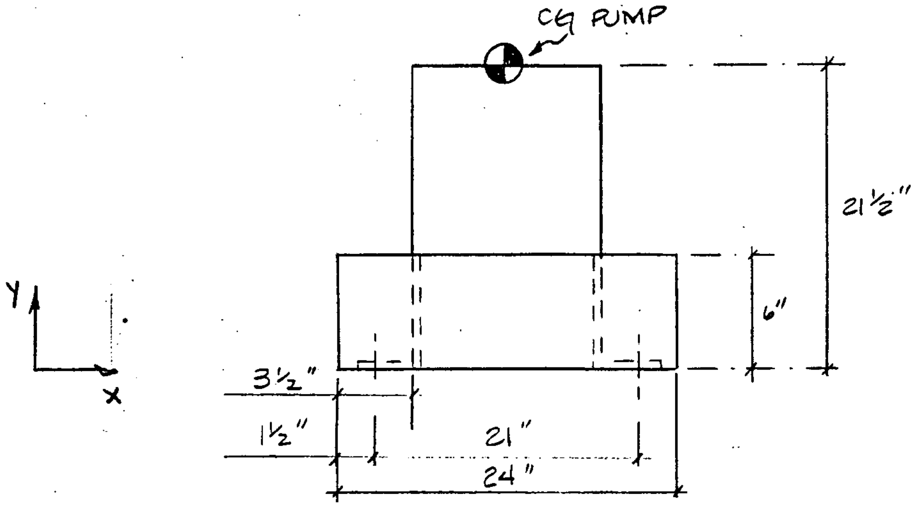
GEOMETRY -- FROM REF. 5





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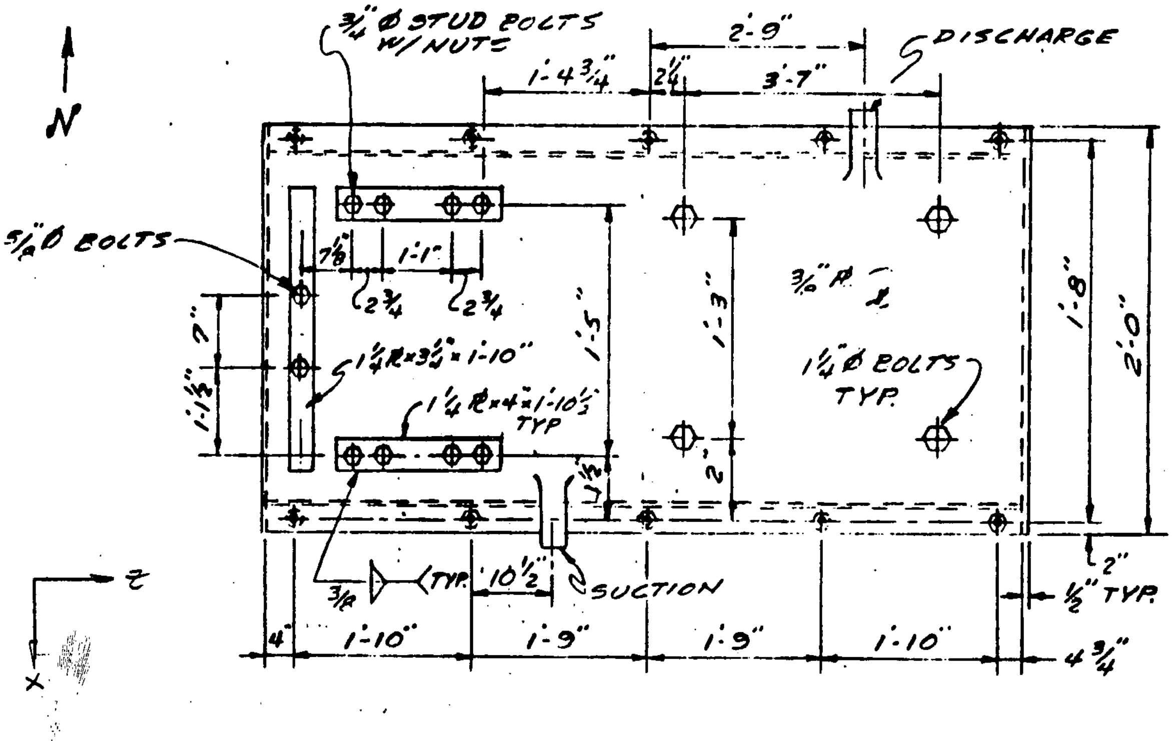
BOLT CONFIGURATION -- FROM REF 1



VIEW "A-A"

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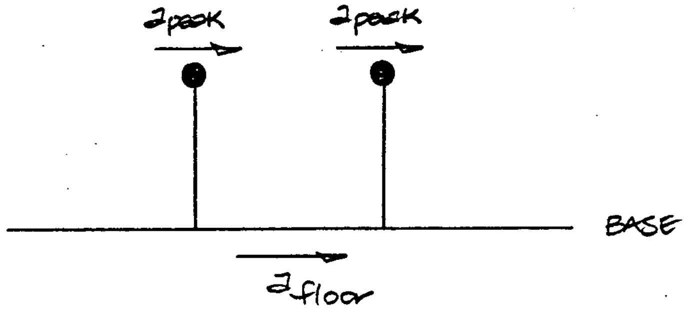
FREQUENCY

THE DATA AVAILABLE TO DETERMINE THE FREQUENCY OF THE SYSTEM IS INSUFFICIENT.

HOWEVER, THE SYSTEM MAY BE MODELED AS TWO MASSES INDEPENDENTLY CONNECTED TO A BASE WHICH VIBRATES WITH THE SAME FREQUENCY AS THE FLOOR, OR --



THEREFORE, REGARDLESS OF THEIR NATURAL FREQUECIES THE TWO MASSES SEE NO AMPLIFICATION BEYOND THE PEAK ACCELERATION OF THE FLOOR RESPONSE SPECTRA SHOWN ON THE FOLLOWING PAGE.

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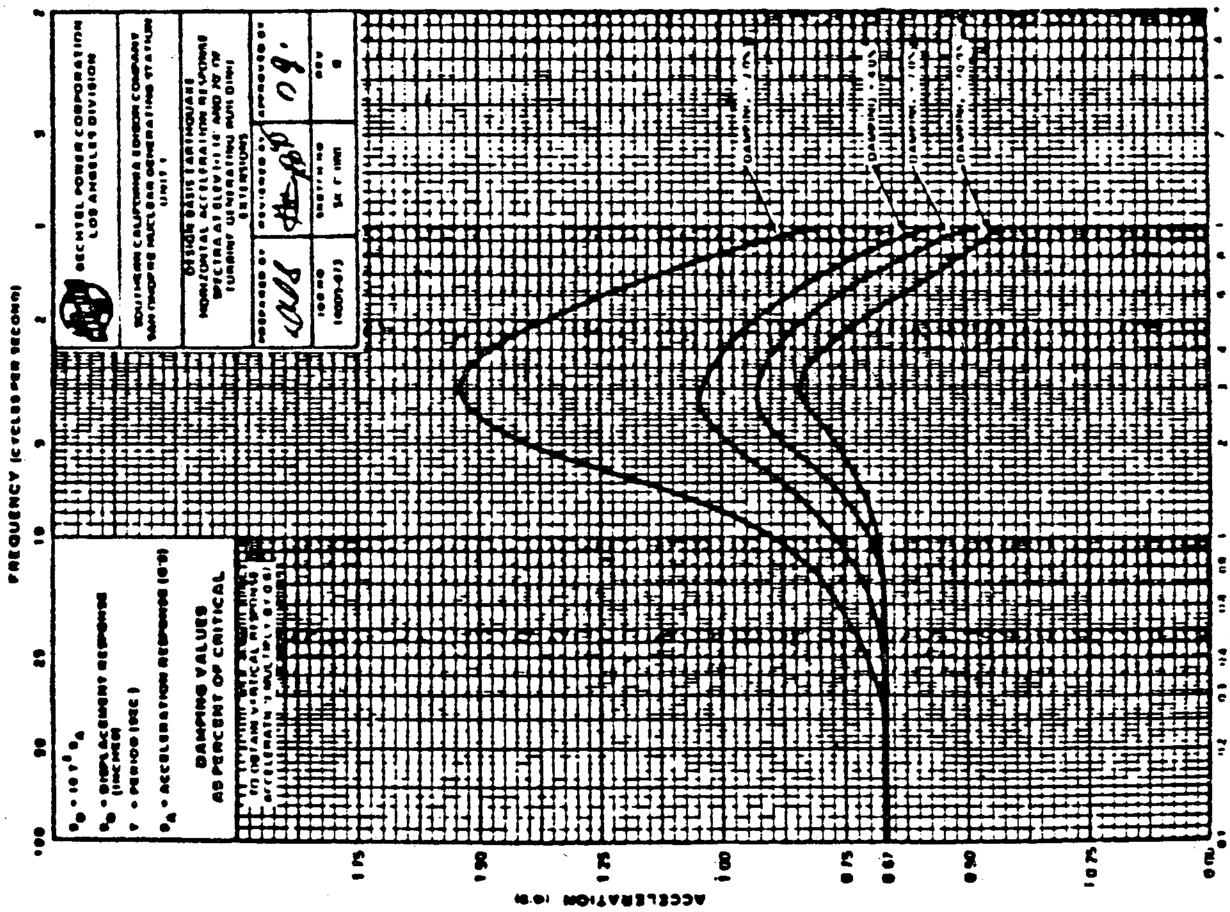
SEISMIC LOADS

FROM THE SPECTRUM SHOWN BELOW [2], SEISMIC ACCELERATIONS ARE ASSUMED. FOR CONSERVATIVISM, SPECTRAL PEAKS @ 4% DAMPING ARE APPLIED TO THE PUMP & TURBINE.

$$\therefore a_x = 1.05\ g$$
$$a_z = 1.05\ g$$
$$a_y = 2/3\,(1.05\ g) = 0.70\ g$$



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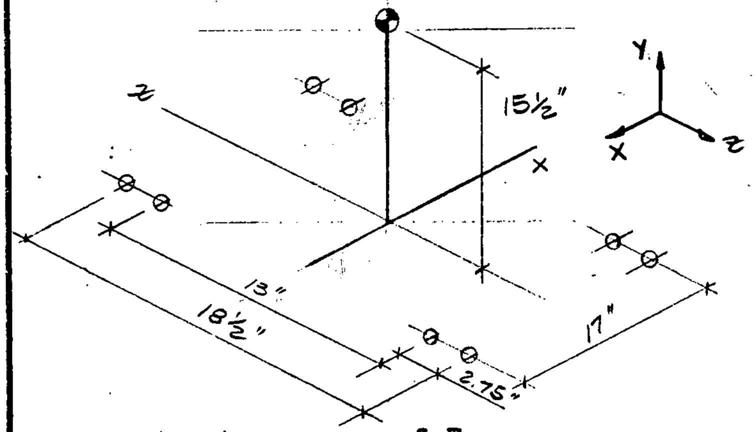
TURBINE HOLDDOWN BOLTS

ASSUMPTIONS: (1) NO NOZZLE LOADS SINCE "TURBINE MUST BE RELIEVED OF ALL PIPING STRAINS" [1]

(2) WT OF TURBINE IS CONCENTRATED @ THE CENTROID



DIMENSIONS FROM [1]

FROM [1]:

TURBINE: WT = 2200#

BOLTS: 8 - ¾" ϕ A307

p.4-141 [3] { ROOT AREA: 0.302 IN²
TENSILE AREA: 0.334 IN²

ASSUME: ΔZ BETWEEN THE 2 SETS OF 4-BOLTS IS:

$$\Delta z = \frac{18\frac{1}{2} - 13}{2} + 13 = 15.75"$$

TENSILE LOAD

DUE TO a_z: $\frac{(2200\,\text{lb})(1.05\,g)(15.5")}{(4\ \text{bolts})(15.75")} = 568.33\ \text{lb}$

DUE TO a_x: $\frac{(2200\,\text{lb})(1.050\,g)(15.5")}{(4\ \text{bolts})(17")} = 526.54\ \text{lb}$

DUE TO a_y: $\frac{(2200\,\text{lb})(0.7\,g)}{8\ \text{bolts}} = 192.5\ \text{lb}$

TOTAL TENSILE LOAD = 568.33 + 526.54 + 192.5
= 1287.4 lb

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SHEAR LOAD

DUE TO a_x : $\frac{(2200 \text{ lb})(1.05 g)}{8 \text{ bolts}} = 288.75 \text{ lb}$

DUE TO a_z : $\frac{(2200 \text{ lb})(1.05 g)}{8 \text{ bolts}} = 288.75 \text{ lb}$

RESULTANT SHEAR LOAD $= \sqrt{(288.75)^2 + (288.75)^2}$
$= 408.35 \text{ lb}$

STRESSES

$$f_t = \frac{P}{A_t} = \frac{1287.4 \text{ lb}}{0.334 \text{ in}^2} = 3.85 \text{ KSI}$$

$$f_v = \frac{V}{A_r} = \frac{408.35 \text{ lb}}{0.302 \text{ in}^2} = 1.35 \text{ KSI}$$

MAXIMUM ALLOWABLES

$S_u = 60$ KSI FOR A307 BOLTS
(ASME SECTION III, TABLE I-7.3)

$$F_t = \frac{S_u}{2} = \frac{60}{2} = 30 \text{ KSI}$$

$$F_v = \frac{0.62 S_u}{3} = \frac{(0.62)(60)}{3} = 12.4 \text{ KSI}$$

ASME CODE NF-3324.6 -- LEVEL A CONDITIONS

INTERACTION (PER NF-3324.6(a) [3])

$$\left(\frac{f_t}{F_t}\right)^2 + \left(\frac{f_v}{F_v}\right)^2 < 1 \ ?$$

$$\left(\frac{3.85}{30}\right)^2 + \left(\frac{1.35}{12.4}\right)^2 = 0.03 < 1$$ OK ∴ BOLTS QUALIFY

BOLTS ARE GREATLY OVERSIZED. IF ANY NOZZLE EXIST, THEY WOULD HAVE TO BE VERY LARGE IN ORDER TO OVERSTRESS THE BOLTS.

					AFW TURBINE DRIVEN PUMP -910		
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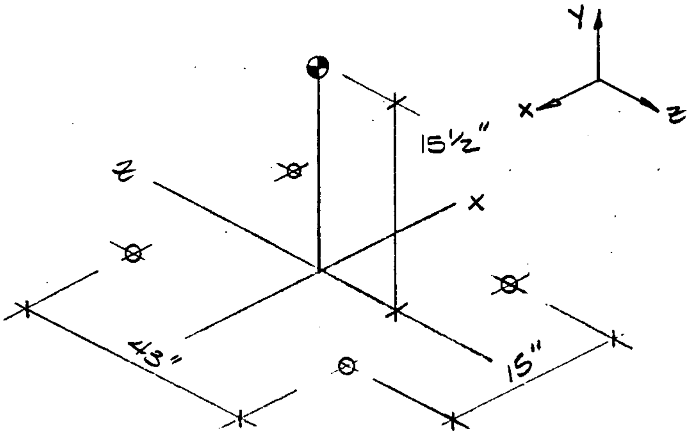
PUMP HOLDDOWN BOLTS

ASSUMPTION: (1) WT OF PUMP IS CONCENTRATED @ CENTROID
(2) NOZZLE LOADS ARE AS FOUND IN BECHTEL CALC [2]



FROM [1]:

PUMP: WT = 2590 #
FLUID: WT = 260#

BOLTS: 4 - 1¼" φ A307
p. 4-141 [3] { ROOT AREA : 0.890 IN^2
TENSILE AREA : 0.969 IN^2

DIMENSIONS FROM [1]

SEISMIC ACCELERATIONS

TENSILE LOAD

DUE TO a_z : $\frac{(2850 \text{ lb})(1.05g)(15.5")}{(2 \text{ bolts})(43")} = 539.35 \text{ lb}$

DUE TO a_x : $\frac{(2850 \text{ lb})(1.05g)(15.5")}{(2 \text{ bolts})(15")} = 1546.13 \text{ lb}$

DUE TO a_y : $\frac{(2850 \text{ lb})(0.7g)}{4 \text{ bolts}} = 498.75 \text{ lb}$

TOTAL TENSILE (SEISMIC) = 539.35 + 1546.13 + 498.75
= 2584.23 lb

AFW TURBINE DRIVEN PUMP - 610

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0	cgc	6/15/84	WI	7/11/84

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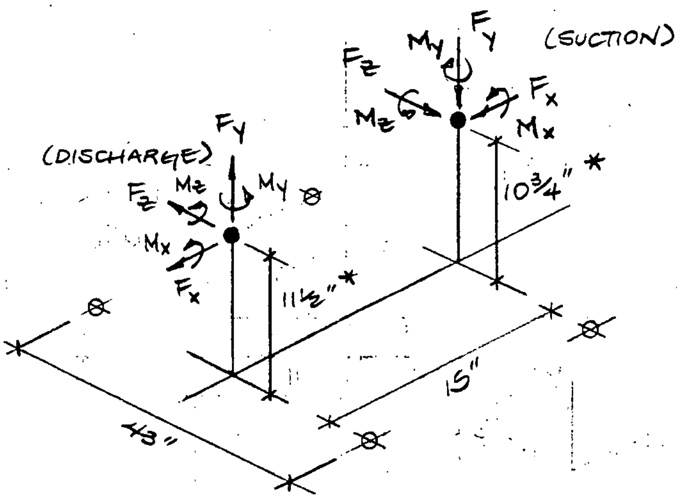
SHEAR LOAD

DUE TO a_x : $\dfrac{(2850\ \text{lb})(1.05g)}{4\ \text{bolts}} = 748.13\ \text{lbs}$

DUE TO a_z : $\dfrac{(2850\ \text{lb})(1.05g)}{4\ \text{bolts}} = 748.13\ \text{lbs}$

TOTAL SHEAR LOAD $= \sqrt{(748.13)^2+(748.13)^2}$
$= 1058$ lb

NOZZLE LOADS



SUCTION : 4" NOZZLE
--LINE # 8110-4"-JN

DISCHARGE: 3" NOZZLE
--LINE #381A-3"-EQ-2ACB

ASSUME ALL FORCES AND MOMENTS ACT @ CENTER OF BOLT PATTERN

* DIMENSION FROM EQUIP. DWG. [1]
WHERE,
SUCTION : 15½ - 4¾ = 10¾"
DISCHARGE: 15½ - 4 = 11½"

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ASSUME ALL COORDINATES ARE GLOBAL

FROM [2], SELECT MAXIMUM FORCES & MOMENTS
-- SEE APPENDIX B

		FORCES	MOMENTS
SUCTION	X	356 lb	860 ft-lbs
	Y	932 lb	1179 ft-lbs
	Z	1463 lb	1009 ft-lbs
DISCHARGE	X	218 lb	359 ft-lbs
	Y	134 lb	620 ft-lbs
	Z	800 lb	424 ft-lbs

TENSILE LOAD

-- @ SUCTION NOZZLE

DUE TO F_Z : $\frac{(1463\text{ lb})(10.75'')}{(2\text{ bolts})(43'')} = 182.9\text{ lbs}$

DUE TO F_x : $\frac{(356\text{ lb})(10.75'')}{(2\text{ bolts})(15'')} = 127.6\text{ lbs}$

DUE TO F_Y : $\frac{932\text{ lbs}}{4\text{ bolts}} = 233\text{ lbs}$

DUE TO M_x : $\frac{(860\text{ ft-lbs})(12)}{(2\text{ bolts})(43'')} = 120\text{ lbs}$

DUE TO M_Z : $\frac{(1009\text{ ft-lbs})(12)}{(2\text{ bolts})(15'')} = 403.6\text{ lbs}$

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-- @ DISCHARGE NOZZLE

DUE TO F_z : $\frac{(800\ lb)(11.50'')}{(2\ bolts)(43'')} = 107\ lbs$

DUE TO F_x : $\frac{(218\ lb)(11.50'')}{(2\ bolts)(15'')} = 83.6\ lbs$

DUE TO F_y : $\frac{134\ lb}{4\ bolts} = 33.5\ lbs$

DUE TO M_x : $\frac{(359\ ft\text{-}lb)(12)}{(2\ bolts)(43'')} = 50.1\ lbs$

DUE TO M_z : $\frac{(424\ ft\text{-}lb)(12'')}{(2\ bolts)(15'')} = 169.6\ lbs$

SHEAR LOAD

-- @ SUCTION NOZZLE

DUE TO F_x : $\frac{356\ lb}{4\ bolts} = 89\ lbs$

DUE TO F_z : $\frac{1463\ lb}{4\ bolts} = 365.75\ lbs$

DUE TO M_y^* : $\frac{(1179\ ft\text{-}lb)(12)}{(4\ bolts)(22.77'')} = 155.33\ lbs$

* SINCE M_y IS AT CENTER OF BOLT PATTERN
THEN, $d = \sqrt{(43/2)^2 + (15/2)^2} = 22.77''$

-- @ DISCHARGE NOZZLE

DUE TO F_x : $\frac{218 \text{ lb}}{4 \text{ bolts}} = 54.5 \text{ lb}$

DUE TO F_z : $\frac{800 \text{ lb}}{4 \text{ bolts}} = 200 \text{ lb}$

DUE TO M_y : $\frac{(620 \text{ ft-lb})(12)}{(4 \text{ bolts})(22.77")} = 81.69 \text{ lb}$

SUMMARIZING LOADS

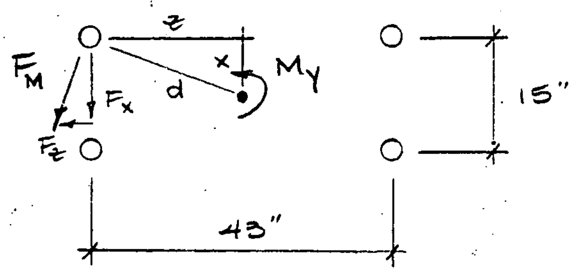
TOTAL TENSILE LOAD

$$\overbrace{(182.9 + 127.6 + 233 + 120 + 403.6)}^{\text{NOZZLE: @ SUCTION}} + \overbrace{(2584.23)}^{\text{SEISMIC}} + \underbrace{(107 + 83.6 + 33.5 + 50.1 + 169.6)}_{\text{NOZZLE: @ DISCHARGE}} = 4095.23 \text{ lbs}$$

TOTAL SHEAR LOAD:

IN ORDER TO COMBINE LOADS, RESOLVE LOAD F_M DUE TO M_Y INTO LOADS IN THE X & Z DIRECTIONS

I.E. GIVEN THE BOLT PATTERN --



$$\frac{F_x}{F_M} = \frac{z}{d}$$

$$\frac{F_z}{F_M} = \frac{x}{d}$$

AFW TURBINE DRIVEN PUMP - G10

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0	cgc	6/21/84	WI	7/10/84

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-- @ SUCTION NOZZLE

$$\frac{F_x}{155.3 \text{ lb}} = \frac{21.50}{22.77} \qquad \therefore F_x = 146.64 \text{ lb}$$

$$\frac{F_z}{155.3 \text{ lb}} = \frac{7.5}{22.77} \qquad \therefore F_z = 51.15 \text{ lb}$$

-- @ DISCHARGE NOZZLE

$$\frac{F_x}{81.69 \text{ lb}} = \frac{21.50}{22.77} \qquad \therefore F_x = 77.13 \text{ lb}$$

$$\frac{F_z}{81.69 \text{ lb}} = \frac{7.5}{22.77} \qquad \therefore F_z = 26.91 \text{ lb}$$

RESULTANT SHEAR LOAD --

$$\left[\left(\overbrace{89 + 54.5 + 146.64 + 77.13}^{\text{X-DIRECTION}} + \overset{\text{SEISMIC}}{748.13}\right)^2 + \left(\underbrace{365.75 + 200 + 51.15 + 26.91}_{\text{Y-DIRECTION}} + \underset{\text{SEISMIC}}{748.13}\right)^2 \right]^{1/2}$$

$$= 1783.71 \text{ lb}$$

AFW TURBINE DRIVEN PUMP - S10

0	cgc	6/21/84	WT	7/10/84
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STRESSES

$$f_t = \frac{P}{A_t} = \frac{4095.23 \text{ lbs}}{0.969 \text{ in}^2} = 4.23 \text{ KSI}$$

$$f_v = \frac{V}{A_r} = \frac{1783.71 \text{ lbs}}{0.890 \text{ in}^2} = 2.00 \text{ KSI}$$

MAXIMUM ALLOWABLES $S_u = 60$ KSI FOR A307 BOLTS (ASME SECTION III, TABLE I-7.3)

$$F_t = \frac{S_u}{2} = \frac{60}{2} = 30 \text{ KSI}$$

$$F_v = \frac{0.62\, S_u}{3} = \frac{0.62(60)}{3} = 12.4 \text{ KSI}$$

ASME CODE --NF-3324.6 LEVEL A CONDITIONS

INTERACTION (PER NF-3324.6(a) [3])

$$\left(\frac{f_t}{F_t}\right)^2 + \left(\frac{f_v}{F_v}\right)^2 < 1$$

$$\left(\frac{4.23}{30}\right)^2 + \left(\frac{2.00}{12.40}\right)^2 = 0.05 < 1 \quad \boxed{\text{OK}}$$

∴ BOLTS QUALIFY

					AFW TURBINE DRIVEN PUMP - 610
0	Cgr	6/21/84	WI	7/10/84	IMPELL CORPORATION
REV	BY	DATE	CHECKED	DATE	

JOB NO 0210-036-1356

CALC NO EQ-01

PAGE 19 OF 21

BASE HOLDOWN BOLTS

ASSUMPTIONS:

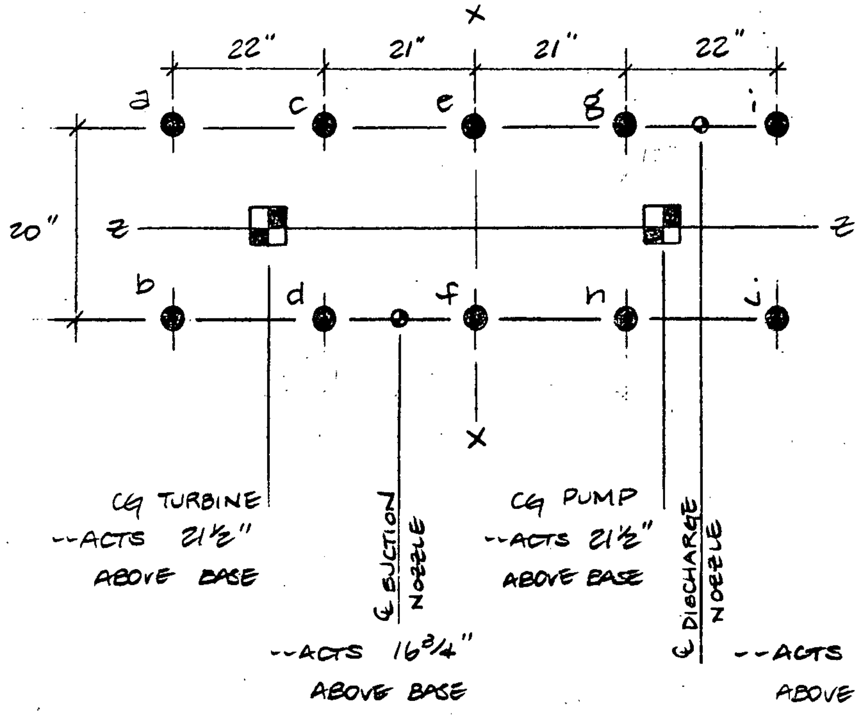
(1) WT OF PUMP ACTS ABOUT ℄ OF PUMP BOLTING
WT OF TURBINE ACTS ABOUT ℄ OF TURBINE BOLTING

(2) WT OF PUMP LEG SUPPORTS IS INCLUDED IN
WT OF PUMP & ALSO ACTS ABOUT ℄ OF PUMP BOLTING

(3) NOZZLE LOADS ARE AS FOUND IN BECHTEL CALC [2]

(4) ALL BASEPLATE BOLTS REACT TO ALL LOADS

(5) ALL FORCES & MOMENTS ACT @ CENTER OF BOLT PATTERN



FROM [1]:

BASEPLATE: 400 #

BOLTS: 10-⅞"ϕ HOOKS

p.4-41 [3] { ROOT AREA: 0.419 in^2
TENSILE AREA: 0.462 in^2

-- EMBEDMENT = 1'

					AFW TURBINE DRIVEN PUMP - 610		
0	Cgc	6/22/84	WI	7/10/84	IMPELL CORPORATION	JOB NO 0310-036-1356 CALC NO EQ-01	PAGE 20 OF 21
REV	BY	DATE	CHECKED	DATE			

SUMMARIZING FORCES ACTING ON BASEPLATE BOLTS :

		X	Y	Z
TURBINE	F	2310 lb	1540 lb	2310 lb *
	M	——	——	——
PUMP	F	2993 lb	1995 lb	2993 lb **
	M	——	——	——
PUMP SUCTION NOZZLE	F	356 lb	932 lb	1463 lb
	M	860 ft-lb	1179 ft-lb	1009 ft-lb
PUMP DISCHARGE NOZZLE	F	218 lb	134 lb	800 lb
	M	359 ft-lb	620 ft-lb	424 ft-lb

FROM BASEPLATE: (BASEPLATE WT: 400 #)

$F_x = F_z = (400\text{ lb})(1.05\,g) = 420\text{ lb}$

$F_y = (400\text{ lb})(0.7\,g) = 280\text{ lb}$ (UPWARD)

-- MOMENT DUE TO SKID OVERTURNING IS NEGLIGIBLE

* TURBINE WT: 2200 #

$F_x = F_z = (2200\text{ lb})(1.05\,g) = 2310\text{ lb}$
$F_Y = (2200\text{ lb})(0.70\,g) = 1540\text{ lb}$

** PUMP WT: 2850 #

$F_x = F_z = (2850\text{ lb})(1.05\,g) = 2993\text{ lb}$
$F_Y = (2850\text{ lb})(0.70\,g) = 1995\text{ lb}$

AFW TURBINE DRIVEN PUMP -G10

REV	BY	DATE	CHECKED	DATE
0	Cgc	6/22/84	WI	7/10/84

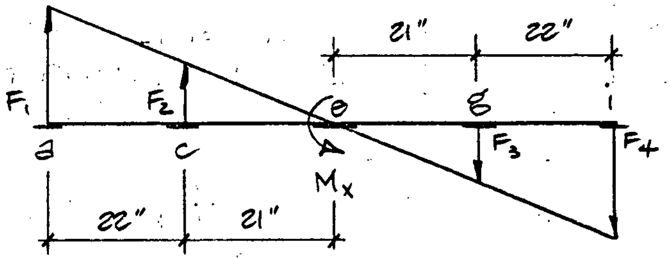
IMPELL CORPORATION

JOB NO 0310-036-1356
CALC NO EQ-01
PAGE 21 OF 27

TENSILE LOAD

DUE TO F_z & M_x --

LOADS ON BOLTS MAY BE MODELED AS:



WHERE, $\begin{cases} M_x = F_1(22+21) + F_2(21) + F_3(21) + F_4(22+21) \\ F_1 = F_4 \;\&\; F_2 = F_3 \end{cases}$

AND,

$$\frac{F_1}{22+21} = \frac{F_2}{21} \longrightarrow F_2 = \frac{21}{43} F_1 = 0.50 F_1$$

THUS, $M_x = 2F_1(43) + 2(0.5F_1)(21) = 107 F_1$

FOR 2 BOLTS ACTING @ EACH DISTANCE -- $M_x = 214 F_1$

$$F_t = \frac{\overset{\text{TURBINE}}{(2310\ \text{lb})(21.5'')} + \overset{\text{PUMP}}{(2993\ \text{lb})(21.5'')}}{214''} = 533\ \text{lb}$$

$$F_t = \frac{\overset{\text{SUCTION}}{(1463\ \text{lb})(16.75'')} + \overset{\text{NOZZLE}}{(860\ \text{ft-lb})(12)}}{214''}$$

$$+ \frac{\overset{\text{DISCHARGE}}{(800\ \text{lb})(17.5'')} + \overset{\text{NOZZLE}}{(359\ \text{ft-lb})(12)}}{214''}$$

$= 248$ lbs

					AFW TURBINE DRIVEN PUMP - G10	
0	cgc	6/22/84	WI	7/12/84	IMPELL CORPORATION	JOB NO 0310-036-1356 CALC NO EQ-01
REV	BY	DATE	CHECKED	DATE		PAGE 22 OF 27

DUE TO F_x & M_z --

$$F_t = \frac{\overset{\text{TURBINE}}{(2310\text{ lb})(21.5'')} + \overset{\text{PUMP}}{(2993)(21.5'')}}{(5\text{ bolts})(20'')} = 1140\text{ lbs}$$

$$F_t = \frac{\overset{\text{SUCTION NOZZLE}}{(356\text{ lb})(16.75'') + (1009\text{ ft-lb})(12)}}{(5\text{ bolts})(20'')}$$

$$+ \frac{\overset{\text{DISCHARGE NOZZLE}}{(218\text{ lb})(17.5'') + (424\text{ ft-lb})(12)}}{(5\text{ bolts})(20'')}$$

$$= 270\text{ lbs}$$

DUE TO F_y --

$$F_t = \frac{\overset{\text{TURBINE}}{1540\text{ lb}} + \overset{\text{PUMP}}{1995\text{ lb}} + \overset{\text{BASEPLATE}}{280\text{ lb}}}{10\text{ bolts}} = 381.5\text{ lbs}$$

$$F_t = \frac{\overset{\text{SUCTION}}{932\text{ lb}} + \overset{\text{DISCHARGE}}{134\text{ lb}}}{10\text{ bolts}} = 106.6\text{ lbs}$$

TOTAL TENSILE LOAD = ASUM(F_t) − DEADWEIGHT

$$\text{TOTAL TENSILE} = (533 + 248 + 1140 + 270 + 381.5 + 106.6) - \frac{\overset{\text{TURBINE}}{2200\text{ lb}} + \overset{\text{PUMP}}{2850\text{ lb}} + 400\text{ lb}}{10\text{ bolts}}$$

$$= 2134.1\text{ lbs/bolt}$$

AFW TURBINE DRIVEN PUMP - G10

REV	BY	DATE	CHECKED	DATE
0	cgc	6/22/84	WI	7/10/84

IMPELL CORPORATION

JOB NO 0310-036-1356

CALC NO EQ-01

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SHEAR LOAD

DUE TO F_z --

$$F_{v_z} = \frac{\overset{\text{TURBINE}}{2310\ \text{lb}} + \overset{\text{PUMP}}{2993\ \text{lb}} + \overset{\text{SUCTION}}{1463\ \text{lb}} + \overset{\text{DISCHARGE}}{800\ \text{lb}} + \overset{\text{BASEPLATE}}{420}}{10\ \text{bolts}}$$

$$= 798.6\ \text{lb}$$

DUE TO F_x --

$$F_{v_x} = \frac{\overset{\text{TURBINE}}{2310\ \text{lb}} + \overset{\text{PUMP}}{2993\ \text{lb}} + \overset{\text{SUCTION}}{356\ \text{lb}} + \overset{\text{DISCHARGE}}{218\ \text{lb}} + \overset{\text{BASEPLATE}}{420}}{10\ \text{bolts}}$$

$$= 629.7\ \text{lb}$$

DUE TO M_Y^* --

$$M_Y = 4(44.15)F_{v_a} + 4(23.26)F_{v_c} + 2(10)F_{v_e}$$

$$F_{v_e} = \frac{10}{44.15}F_{v_a} = 0.23F_{v_a}, \quad F_{v_c} = \frac{23.26}{44.15}F_{v_a} = 0.53F_{v_a}$$

$$(1179\ \text{ft-lb} + 620\ \text{ft-lb})(12)$$
$$= 4(44.15)F_{v_a} + 4(23.26)(0.53F_{v_a}) + 2(10)(0.23F_{v_a})$$

$$21{,}588\ \text{in-lbs} = 230.5\ F_{v_a} \quad \therefore \quad F_{v_a} = 93.65\ \text{lbs}$$
$$F_{v_c} = 49.63\ \text{lbs}$$
$$F_{v_e} = 21.54\ \text{lbs}$$

* SINCE M_Y IS AT CENTER OF BOLT PATTERN THEN,

$$d_e = 10''$$
$$d_a = \sqrt{(10)^2 + (43)^2} = 44.15''$$
$$d_c = \sqrt{(10)^2 + (21)^2} = 23.26''$$

					AFW TURBINE DRIVEN PUMP - 910
0	cgc	6/22/84	WI	7/10/84	IMPELL CORPORATION
REV	BY	DATE	CHECKED	DATE	

JOB NO 0310-036-1353

CALC NO EQ-01

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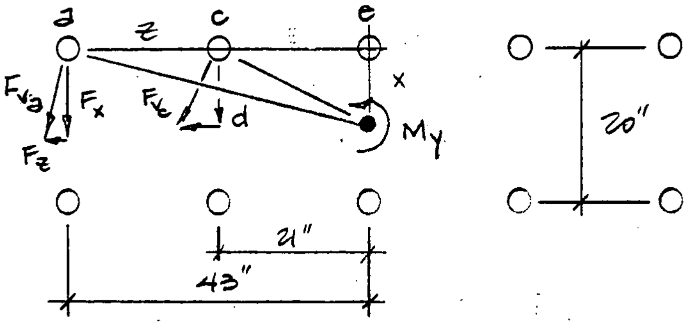
SUMMARIZING LOADS

TOTAL TENSILE : 2134.1 lb

TOTAL SHEAR:

IN ORDER TO COMBINE LOADS, RESOLVE LOADS $F_{V_a}, F_{V_c}, F_{V_e}$ DUE TO M_Y INTO LOADS IN THE X & Z DIRECTIONS

I.E. GIVEN THE BOLT PATTERN --



$$\frac{F_x}{F_V} = \frac{z}{d} \qquad \frac{F_z}{F_V} = \frac{x}{d}$$

EVALUATE FOR LARGEST FORCES -- @ BOLT a

$$\frac{F_{x_a}}{93.65} = \frac{43}{44.15} \quad F_{x_a} = 91.21 \text{ lb}, \quad \frac{F_{z_a}}{93.65} = \frac{10}{44.15} \quad F_{z_a} = 21.21 \text{ lb}$$

RESULTANT SHEAR LOAD --

$$F_V = \sqrt{(629.7 + 91.21)^2 + (798.6 + 21.21)^2}$$

$$= 1092 \text{ lb}$$

AFW TURBINE DRIVEN PUMP - 610

0	cgc	6/22/84	WI	7/10/84
REV	BY	DATE	CHECKED	DATE

IMPELL CORPORATION

JOB NO 0310-036-1356

CALC NO EQ-01

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MAXIMUM ALLOWABLES

ASSUME: CONCRETE J-BOLTS HAVE THE SAME ALLOWABLES AS EXPANSION BOLTS OF THE SAME SIZE AND SAME DEPTH OF EMBEDMENT

PER [1], J-BOLTS ARE 7/8" φ, 1' LONG (W/ 4" HOOK)

∴ ASSUME ALLOWABLES FOR 3/4" φ BOLTS
-- PER [7] IN 4000 psi CONCRETE
WITH 9" EMBEDMENT

PER [6], USE FACTOR OF SAFETY = 4 --

$$F_t = \frac{23500}{4} = 5875 \text{ lbs}$$

$$F_v = \frac{18466}{4} = 4616.5 \text{ lbs}$$

INTERACTION

$$\frac{f_t}{F_t} + \frac{f_v}{F_v} < 1$$

$$\frac{234}{5875} + \frac{1092}{4616.5} = 0.60 < 1 \quad \boxed{OK}$$

∴ BOLTS QUALIFY

REV	BY	DATE	CHECKED	DATE
0	cgc	6/22/84	WI	7/10/84

AFW TURBINE DRIVEN PUMP – G10

IMPELL CORPORATION

JOB NO 0310-036-1356

CALC NO EQ-01

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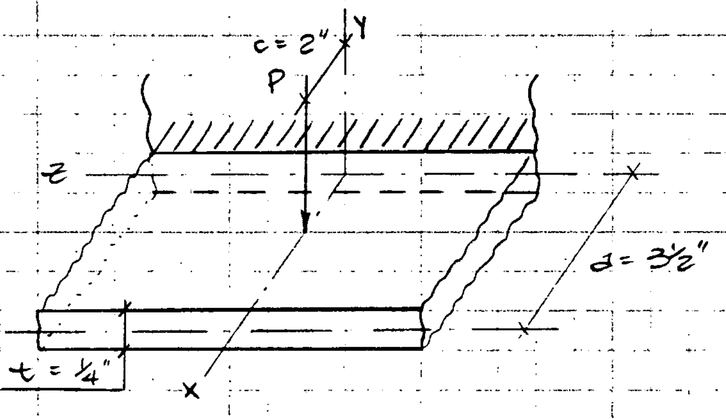
LOCAL STRESSES ON THE FLANGE OF THE BASE [

ASSUMPTIONS: (1) THE FLANGE IS RIGID
(2) CHANNELS ARE A36



FROM DIMENSIONS SHOWN IN [1], AND LIST OF MISC. CHANNELS IN [3], CHANNEL IS ASSUMED TO BE : MC 6×18

USING TABLE ON p. 190 [9] --

z ≈ 21" (DIST. BETWEEN BOLTS)

$$\sigma = K_m\left(\frac{6P}{t^2}\right)$$

$\left\{\begin{array}{l} P = 2134.1 \text{ lb} \\ t = 0.25" \end{array}\right.$

$$@ \quad \left.\begin{array}{l} \frac{c}{d} = \frac{2}{3.5} = 0.57 \\ \frac{z}{d} = \frac{21}{3.5} = 6 \end{array}\right\} K_m = 0.011$$

$$\sigma = 0.011\left[\frac{6(2134.1 \text{ lb})}{(0.25)^2}\right] = 2.25 \text{ KSI}$$

MAXIMUM ALLOWABLE --

BENDING : $F_b = 0.66F_Y = 0.66(36 \text{ KSI}) = 23.67 \text{ KSI}$

$2.25 < 23.67$ KSI (OK)

∴ FLANGE IS QUALIFIED

AFW TURBINE DRIVEN PUMP - 610

REV	BY	DATE	CHECKED	DATE
0	Cgc	6/25/84	WI	7/10/84

IMPELL CORPORATION

JOB NO 0310-036-1356
CALC NO EQ-01

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APPENDIX A

—	—	—	—	—
REV	BY	DATE	CHECKED	DATE

AFW TURBINE DRIVEN PUMP- G10

IMPELL CORPORATION

JOB NO 0310-036-1352

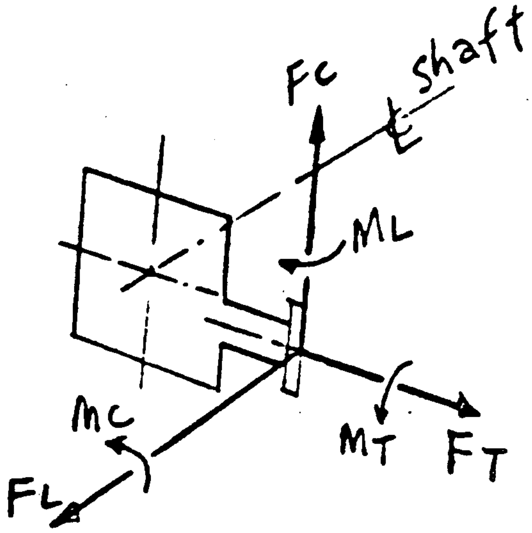
CALC NO EQ-01

PAGE

OF

AUX FW PUMP G10N (DISCHARGE)

NOZZLE SIZE 3"
LINE NUMBER 381A-3"-EG-3ACB
DATA POINT 1
STRESS PROBLEM: So. Cal. Ed. CALC Nº DC-859-1
P&ID 5155576
CC#2 SHT 2 OF 2
(BY EDISON LETTER, 11-22-82, Nº 708)



LOADS		WT+TH+DBE+SAMS Note 2		WT+DBE		TH+SAMS		COMMENTS
		F	M	F	M	F	M	
ALLOWABLE		290	1370	N.A	N.A	N.A	N.A	1. Calculation by So. Cal. Ed.
$-F_x=F_T$	+	218		0		224		2. SAMS is negligible, not included.
	-	8		8		0		
$F_y=F_C$	+	120		40		80		3. North Direction is (FT).
	-	134		134		0		
$F_z=F_L$	+	31		31		0		
	-	799		17		782		
$-M_x=M_T$	+		151		151		0	
	-		359		129		230	
$M_z=M_C$	+		424		197		227	
	-		211		211		0	
$M_y=M_L$	+		11		11		0	
	-		620		19		601	

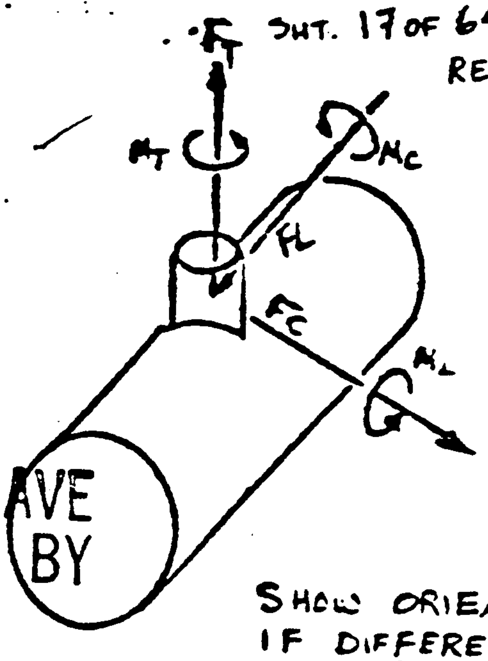
Prepared By: W. VAN METER Date: 11-17-82
Checked By: Date:
SONGS #1, Job Nº 14000-300

AF

[redacted] R. F [redacted]
[redacted] [redacted]

MECH. CALC # MC-384-21
EQUIPMENT Pump G-10 (Suction)
NOZZLE SIZE 4"
LINE NUMBER 8110-4"-JN
DATA PT. 650
STRESS PROBLEM PI-AF-02
P&ID NO. 5159570

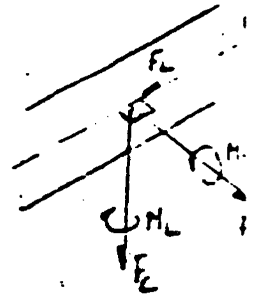
SHT. 17 OF 64
REV. 0



SHOW ORIENTAT
IF DIFFERENT T
ABOVE.

LOADS/ACCELERATIONS HEREIN HAVE BEEN REVIEWED AND APPROVED BY THE MECHANICAL DISCIPLINE
EGS CRMy
DATE 3/23/83

CALC #
MC-384-21

LOADS	WT+TH+DBE+SAM		WT+DBE		TH+SAM		COMMENTS
	F	M	F	M	F	M	
ALLOWABLE	2150 ~~40~~	7165 ~~205~~	N/A	N/A	N/A	N/A	
F_x = F_T	356/-354		+ -		+ -		
$-F_y$ = F_C	932/-263		+ -		+ -		
F_z = F_L	1033/-1463		+ -		+ -		
M_x = M_T	10320 —	860/-322		+ -		+ -	
M_z = M_C	12180	51/-1009		+ -		+ -	
$-M_y$ = M_L	14148	745/-1179		+ -		+ -	

UNITS — F (LBS)
M (FT·LBS)

APPENDIX B

					AFW TURBINE DRIVEN PUMP - 910
					IMPELL CORPORATION
—	—	—	—	—	JOB NO 0310-036-1356
REV	BY	DATE	CHECKED	DATE	CALC NO EQ-01

PAGE

OF

o. H2189-SJ
t No. 8783R

KWIK-BOLT

AVERAGE ULTIMATE TENSILE & SHEAR LOADS*

CONCRETE STRENGTH		2000 PSI		4000 PSI		6000 PSI	
Diameter	Embedment	Tension	Shear	Tension	Shear	Tension	Shear
5/8"	2 3/4"	5410	11198	6600	11562	7700	13500
	3 1/2"	6250	11198	9100	11562	9560	13500
	4 1/2"	7000	11198	12000	11562	14500	13500
	5 1/2"	7550	13378	14300	15437	20300	15437
	6 1/2"	8025	13378	16000	15437	21000	15437
	7 1/2"	9000	13378	17000	15437	21000	15437
3/4"	3 1/4"	8155	13257	10150	17133	10860	18102
	4"	9700	13257	13400	17133	13700	18102
	5"	11700	13257	16500	17133	17600	18102
	6"	13800	15195	18000	18466	22500	21009
	7"	15800	15195	21000	18466	23600	21009
	8"	16000	15195	23000	18466	23600	21009
	9"	16000	15195	23500	18466	23600	21009
1"	4 1/2"						
	5"						
	6"						
	7"						
	8"						
	9"						
	10"						

Actual Concrete Strengths

2178 psi 4027 psi 6119 psi

*See sheet A-3 for notes

APPENDIX C

—	—	—	—	—
REV	BY	DATE	CHECKED	DATE

AFW TURBINE DRIVEN PUMP - G10

IMPELL CORPORATION

JOB NO 0310-036-1356

CALC NO EQ-01

PAGE

OF

Bechtel Power Corporation
Engineers – Constructors
12400 East Imperial Highway
Norwalk, California 90650
MAIL ADDRESS
P.O. BOX 60860 - TERMINAL ANNEX, LOS ANGELES, CALIFORNIA 90060
TELEPHONE: (213) 807-2000

March 30, 1984
BPC/V-84-161

ROUTE :
WD GALLO
RLGRUBB
A SEIKEN
WR [illegible]
DGOMEZ

Mr. W. D. Gallo
Project Manager
Advanced Engineering
Impell Corporation
350 Lennon Lane
Walnut Creek, CA 94598

Subject: San Onofre Nuclear Generating Station, Unit 1
Bechtel Job No. 15691-384
Safe Shutdown Equipment Data For:
[redacted]
b) CVCS Test Pump G-42
c) Seal Water Injection Filter C-42 N/S

Dear Mr. Gallo:

The enclosed information is forwarded for your use in performing calculations to determine seismic capability of the subject equipment. Should you require further information, please contact Rick Gold at (213) 807-2466.

Very truly yours,

BECHTEL POWER CORPORATION

John D Duff

J. D. Duffin
Project Engineering Manager

RKG:jem/1925L

Enclosure: 1. Summary of Equipment Data
Transmittal to Impell
2. Equipment Data

cc: A. R. Guerrero
W. L. Nelson
G. W. Gartland
All with Enclosure 1 only

ENCLOSURE 1

SUMMARY OF EQUIPMENT
DATA TRAMSMITTAL TO IMPELL

Equipment No.	Description	Type of Data Provided
G-10	Auxiliary Feedwater Turbine Driven Pump	✓ 1. Component material, weight, nozzle and vessel thickness and pump foundation details.
		✓ 2. Pump, motor and base plate bolt patterns.
		✓ 3. Pump pedestal and base (channel) dimensions.
		✓ 4. Pump and turbine outline dwgs. (2 dwgs.)
		✓ 5. Pump and turbine data (2 sheets).
G-42	CVCS Test Pump	1. Component material, weight, nozzle and vessel thickness and motor base detail.
		2. Foundation detail.
		3. Pump outline dwg.
C-42 N/S	Seal Water Injection Filter	1. Component weight, material, nozzle and vessel thickness and horizontal support information.
		2. Filter installation information.
		3. Filter shell and base assembly dwg.
		4. Filter outline dwg.
		5. Seal Water Filters concrete enclosure plan and detail dwg.

A1

LIQUID PUMPED	Condensate
FLOW: XXXXXX/DESIGN (GPM)(LBS/HR)	300
FLOW TEMP/SPECIFIC GRAVITY	40-90F/1.0
VISCOSITY (XXXX)/VAPOR PRESS.(PSIA)	1.0/0.3
PRESSURE: SUCTION/DISCHARGE Ft. Abs. (XXXX)	30-60
DIFFERENTIAL: FEET/XXXX	2510
NPSH: AVAILABLE/REQUIRED By Bidder (FT)	30/18.5
BHP/DRIVER HP/EFFICIENCY (AT RATING)	292/292/65%
IMPELLER DIAMETER: BID/MAX	8-3/8"/8-3/8"
IMPELLER EYE: AREA/ENTRANCE VEL:	8.83 in
RPM/ROTATION (FACING COUPLING)	4400/CW
MAX. ALLOW WORK PRESS./NO. STAGES	1600 psig/6
WEAR RING (OR IMPELLER) CLEARANCE	
Material	Suggested Bidders
Trim	11-13% Chrome
CASE MATERIAL : INNER/OUTER	Cast Iron
IMPELLER MATERIAL	Chrome Steel 11-13%
WEAR RING MTL: CASE/IMPELLER	Chrome Steel 11-13%
SHAFT: MATERIAL/DIAMETER	Chrome Steel 11-13% /1.25" @ impelle
SHAFT SLEEVE MTL/EXTEND THRU GLAND?	Harden Chrome Steel/Yes 11-13%
COUPLING: TYPE/MANUFACTURER	Thomas Flexible
COUPLING GUARD REQUIRED?	Yes
BASEPLATE: TYPE/MATERIAL	Lip or Rim/Fabricated Steel
SHAFT SEAL: TYPE/SEALING CONN?	Packing/No
BEARINGS: TYPE: THRUST/RADIAL	Ball/Ball
LUBRICATION: THRUST/RADIAL	Oil/Oil
SUCTION CONNECTION: SIZE/RATING/FACING	600#/ASA FF 3"
(DOUBLE)(SINGLE)/POSITION	Right Side
DISCHARGE CONNECTION: SIZE/RATING/FACING	600# ASA FF 4"
POSITION	Left Side
PUMP MANUFACTURER	Worthington Corp.
TYPE & SIZE	3WTF - 86
NET WEIGHT (PUMP ONLY)/SERIAL NUMBER	2590#
DRIVER MFG./FURN BY Bidder	Worthington/Worthington
(MOTOR)(TURB.)/(XXXXXX)(CPLD.)	S2R/Coupled
SERIAL NUMBER/DRAWING REFERENCE	
INSPECTION/HYDROSTATIC TEST?	Yes/Yes
PERFORMANCE TEST?/WITNESSED?	Yes/No
COST CODE	
(PO NO)(XXXXX) (SPEC NO)	BSO-421

REV.	DESCRIPTION	ENG	DR	CHK	SUPV	MATL	APPROVALS	DATE
0								

BECHTEL CORPORATION
BECHTEL
POWER DIVISION ENGINEERING

HORIZONTAL CENTRIFUGAL PUMP DATA SHEET

AUXILIARY FEEDWATER PUMP,
TURBINE DRIVEN, G-10

JOB No 3246

San Onofre Nuclear
Generating Station,
Unit 1

REV.

VPS-E32-12/56

F2

(HORIZONTAL)([illegible])	horizontal
HP: REQD/BID/WITH MAX. HAND VALVES	292/292/None
RPM OF TURBINE WHEEL: BID/MAX	4400/4500
NUMBER OF HAND VALVES: BID/MAX	None/Three
STEAM: PRESSURE/TEMPERATURE	600 psig/486 °F
MAX. STEAM: PRESSURE/TEMPERATURE	600 psig/600 °F
BACK PRESSURE (PSIG)([illegible])	5
MAX. BACK PRESSURE ALLOWABLE ON CASE	75 psig
WATER RATE: FULL LOAD ¾ LOAD (LBS/BHP-HR)	27.7 #/BHP-hr
½ LOAD ¼ LOAD	34.2 #/BHP-hr
NO. OF STAGES/EFFECIENCY	Single
ROTATION: TURBINE/[illegible]	CW
GOVERNOR: TYPE/NEMA CLASS	Mechanical Shaft/Nema Class A
SPEED CHANGER: TYPE	Manual
CONTROLLED BY/LOADING PRESS.	
CASING RELIEF VALVE: SIZE/SETTING	Sentinel Warning Set @ 90 psig
ROTOR MATERIAL	Open hearth carbon steel plate
BLADE MATERIAL	Stainless Steel
CASING MATERIAL	Cast Steel
SHAFT: MATERIAL/NOM. DIAMETER	hot rolled steel alloy
STEAM STRAINER FURN?/BASEPLATE FURN	Yes - Integral & removable/W/pump
BEARINGS: TYPE: THRUST/RADIAL	Bronze & babbitt
LUBRICATION: THRUST/RADIAL	Ring oiled sleeve bearings
LUBE OIL COOLER: TYPE/MFR.	None
SHAFT PACKING: TYPE/NO OF RINGS	Carbon/4 per box
STEAM INLET: SIZE/RATING/FACING	600#/ASA RF 3 inch
STEAM OUTLET: SIZE/RATING/FACING	150#/ASA [illegible] 8 inch
CPLG TYPE/FURN BY	See Pump
TURBINE MANUFACTURER:	Worthington Corporation
TYPE & SIZE	Model S2[illegible] Class II
NET WEIGHT (TURBINE ONLY)/SERIAL NUMBER	1740#
INSPECTION?/DYNAMIC BALANCING OF ROTOR?	Yes/Yes
PERFORMANCE TEST?/WITNESSED?	Yes/No
(PO NO)(REQ'N NO.)(SPEC NO)/COST CODE	BSO-421

REV.	DESCRIPTION	ENG	DR	CHR	SUPV	MATL	APPROVALS	DATE
0								

BECHTEL CORPORATION
POWER DIVISION

AUXILIARY STEAM TURBINE DATA SHEET

AUXILIARY FEEDWATER PUMP
TURBINE DRIVER

JOB No 3246

San Onofre Nuclear Generating Station, Unit 1

REV.

AUX. FEE WATER PUMP (TURBINE DRIVEN)

G-10

1. MATERIAL

BASE PLATE - A36

BOLTS A307 4 - 1¼"ø PUMP
8 - ¾"ø TURBINE
10 - ⅞"ø FOUNDATION/CHANNEL

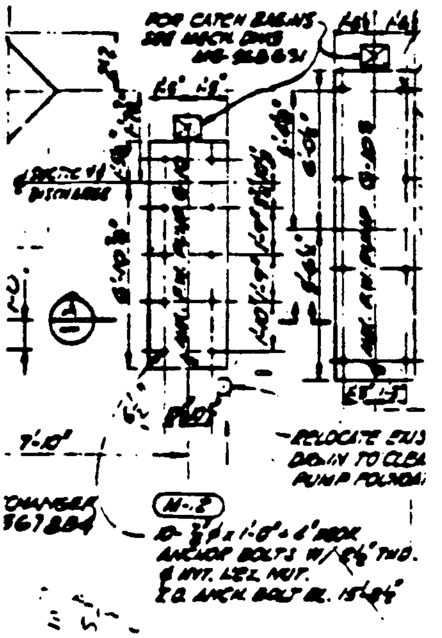
2. WEIGHT

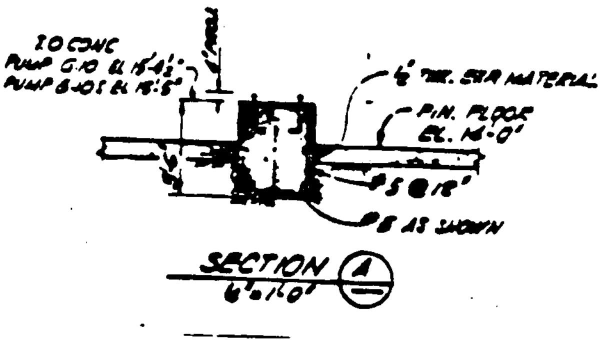
BASE PLATE ≈ 400 #
PUMP = 2590 #
TURBINE (TOT.) ≈ 2200 #
FLUID IN PUMP ≈ 260 #

3. NOZZLE AND VESSEL THICKNESS

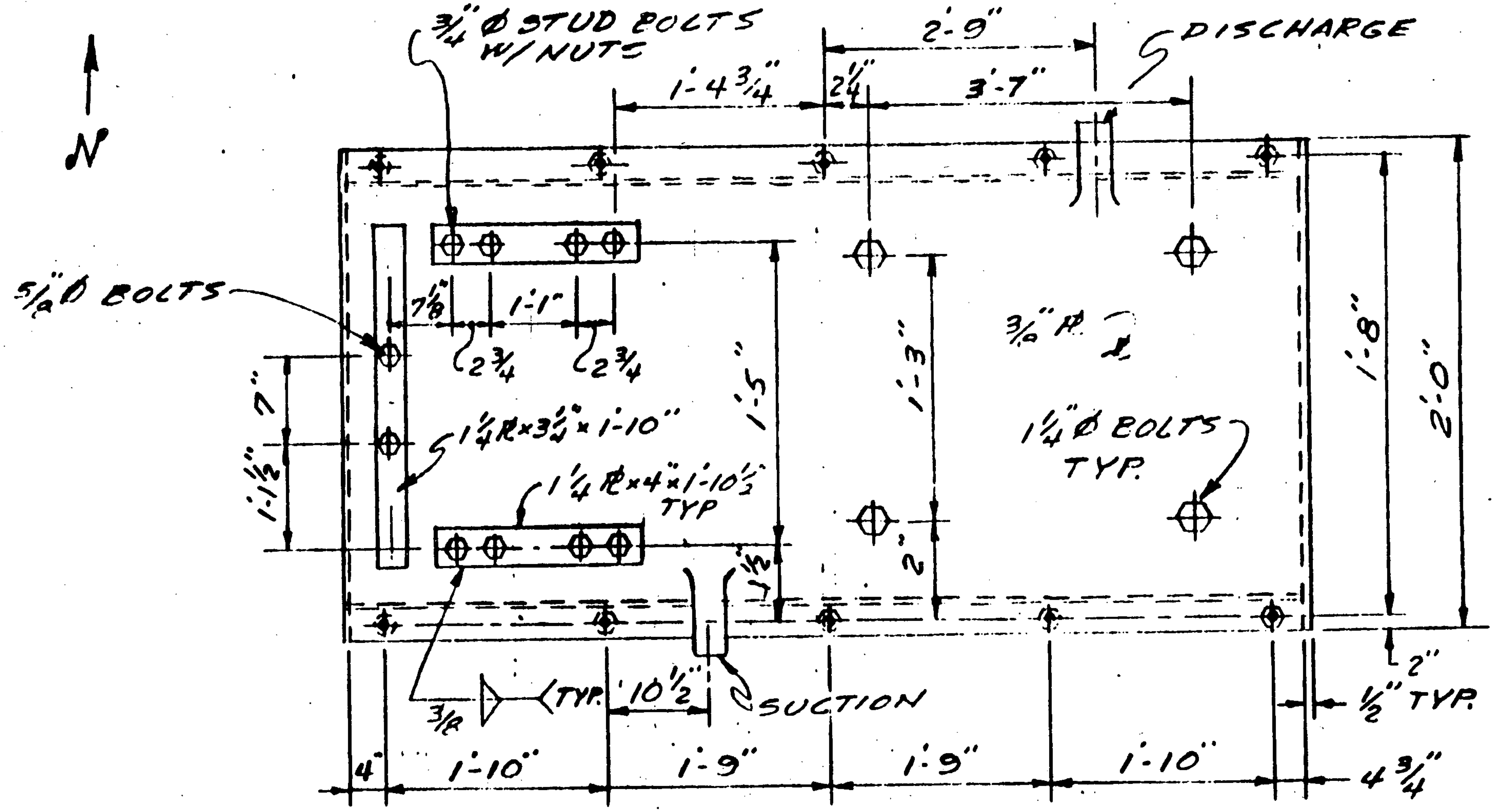
	NOZZLE THICK.	VESSEL THICK.
½" NOZZLES	.109"	1.25"
3" NOZZLE	1.25"	1.25"
4" NOZZLE	1.25"	1.25"

4. FOUNDATION DETAILS





V. Field Measurements and Sketches



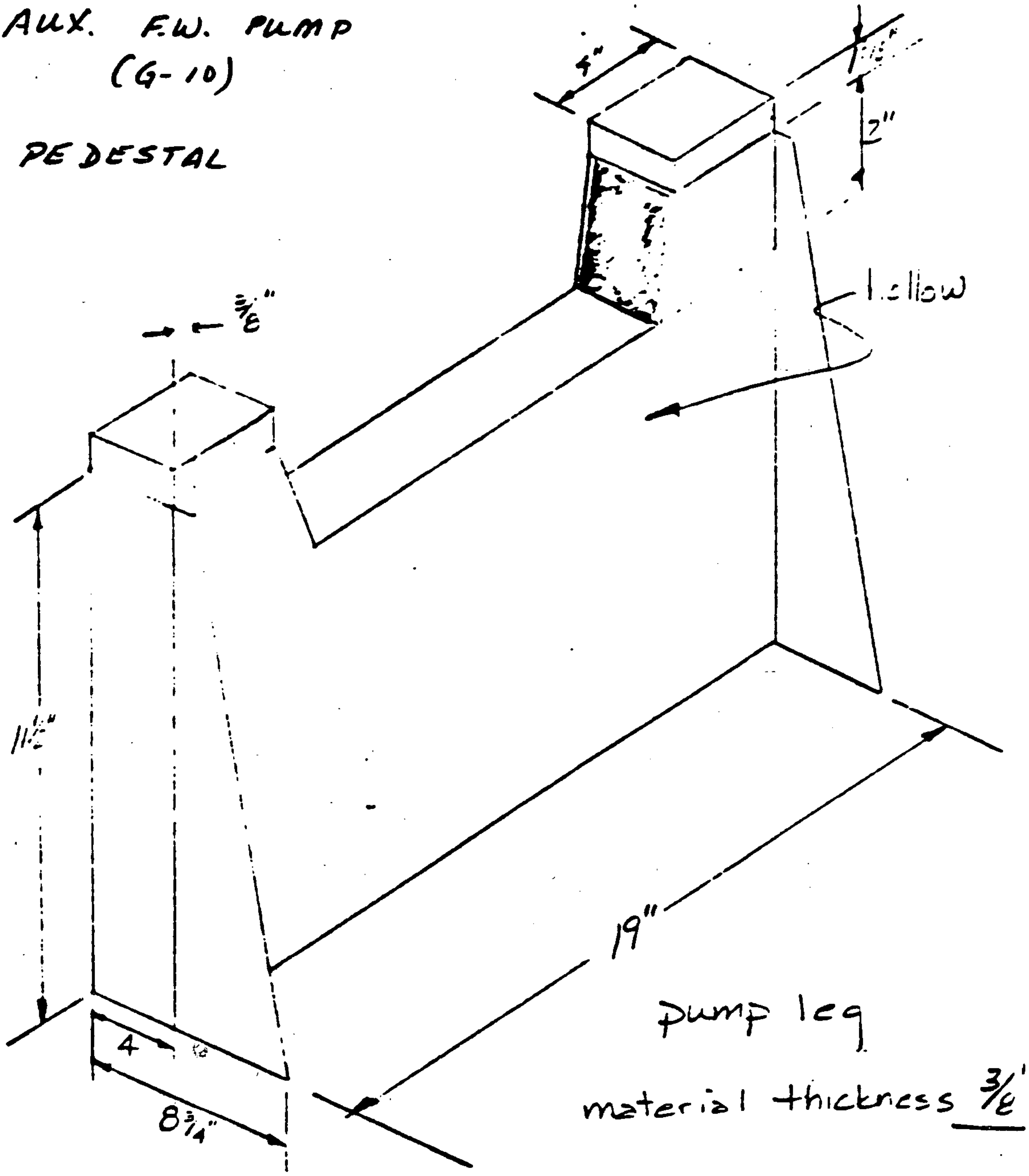
PLAN

STEAM DRIVEN AUX. FEEDWATER PUMP
(G-10)

SITE [illegible]
[illegible]

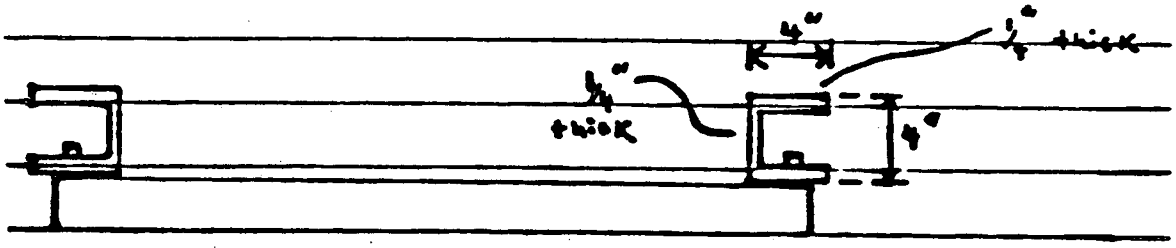
AUX. F.W. PUMP
(G-10)

PEDESTAL



pump leg

material thickness 3/8'



base (channel) dimensions

CALCULATION/PROBLEM COVER SHEET

Calculation/Problem No: EQ-06
Title: SEAL WATER HEAT EXCHANGER, E-34
Client: SCE Project: SONGS-1
Job No: 0310-036

Design Input/References:

SEE SECTION 3.0

Assumptions:

AS NOTED

Method: EQUIVALENT STATIC ANALYSIS

Remarks: QUALIFIED, NO MODIFICATIONS REQUIRED WI/ 7/26/84

REV. NO.	REVISION	APPROVED	DATE
0	ORIGINAL	WRBach J	7/27/94

EDS 0008 5/78

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APPENDIX A - REFERENCE MATERIAL
(NOT INCLUDED IN TOTAL PAGES,
FOR INFORMATION ONLY)

0	WI			
REV	BY	DATE	CHECKED	DATE

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-06

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1.0 RESULTS SUMMARY

COMPONENT	CALCULATED STRESS	ALLOWABLE STRESS	REMARKS
C6x10.5	.41 (INTERACTION)	1.0	OK, LEVEL A LIMITS
W6x20	.05 (INTERACTION)	1.0	OK, LEVEL A LIMITS
W4x13	.30 (INTERACTION)	1.0	OK, LEVEL A LIMITS
C4x5.4	.07 (INTERACTION)	1.0	OK, LEVEL A LIMITS
GROUP 1 BASE-PLATES			
ANCHOR BOLTS	.61 (INTERACTION)	1.0	OK, F.S. = 4.0
BASE PLATE	REQUIRED THICKNESS = .49in	ACTUAL THICKNESS = .75"	OK, LEVEL A LIMITS
GROUP 2 BASEPLATES			
ANCHOR BOLTS	1.0 (INTERACTION)	1.0	OK, FS = 2.0 (NOTE 1)
BASE PLATE	15.6 Ksi	21.6 Ksi	OK, LEVEL A LIMITS

REV	BY	DATE	CHECKED	DATE
0	WS	7/25/84		7-26-84

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RESULTS SUMMARY, CONT.

COMPONENT	CALCULATED STRESS	ALLOWABLE STRESS	REMARKS
GROUP 3 BASEPLATES			
ANCHOR BOLT BASE PLATE	LOADS EXTREMELY LOW, QUALIFIED BY INSPECTION		
GROUP 4 BASEPLATES			
ANCHOR BOLTS	.27 (INTERACTION)	1.0	OK, FS=4.0
BASE PLATE	.10 Ksi	21.6 Ksi	OK, LEVEL A LIMITS
SUPPORT SADDLES	.31 (INTERACTION)	1.0	OK, LEVEL A ALLOWABLES
SADDLE BOLTS	.82 (INTERACTION)	1.0	OK, LEVEL A ALLOWABLES

WELDS: QUALIFIED BASED ON EXTREMELY LOW LOADS IN STRUCTURAL MEMBERS. (MAX. INTERACTION IS .41.)

NOTE 1: RESULTS ARE BASED ON A MINIMUM EMBEDMENT LENGTH OF 3¼" FOR A ¾" DIAMETER BOLT. ACTUAL EMBEDMENT IS PROBABLY MUCH GREATER, ∴ RESULTS ARE CONSERVATIVE

REV	BY	DATE	CHECKED	DATE
0	WI	7/25/84	SR	1-26-84

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-06

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2.0 INTRODUCTION

THE ANALYSIS OF THE SEAL WATER HEAT EXCHANGER SUPPORT FRAME WILL BE PERFORMED USING THE EDSGAP COMPUTER CODE. A MODE/FREQUENCY ANALYSIS WILL BE PERFORMED TO DETERMINE THE FIRST NATURAL FREQUENCY OF THE STRUCTURE. THE SEISMIC ACCELERATIONS CORRESPONDING TO THE FUNDAMENTAL FREQUENCY WILL THEN BE APPLIED TO THE STRUCTURE USING AN EQUIVALENT STATIC METHOD.

DIMENSIONS FOR THE MODEL ARE OBTAINED FROM SUPPORT SKETCHES AND FIELD MEASUREMENTS (SEE [1] + [2]). THE DIMENSIONS USED IN THE MODEL CORRESPOND AS CLOSELY AS POSSIBLE TO THE CENTERLINES OF THE AS-BUILT FRAME. SMALL OFFSETS FROM THE ACTUAL MEMBER CENTERLINES ARE NOT SIGNIFICANT AND WILL NOT AFFECT RESULTS.

THE DIRECTIONAL RESPONSES FROM EACH OF THE THREE SEISMIC LOADS WILL BE COMBINED BY SRSS. THE RESULT IS THEN COMBINED WITH THE GRAVITATIONAL AND NOZZLE LOADS BY ASUM (ABSOLUTE SUM)

					SCE E-34 HX
0	WI	6/5/84	SR	7-20-84	IMPELL CORPORATION
REV	BY	DATE	CHECKED	DATE	

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CALC NO EQ-06

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3.0 REFERENCES

1. BECHTEL POWER CORPORATION LETTER NO. BPC/V-84-160, DATED MARCH 30, 1984. FROM J. D. DUFFIN (BECHTEL) TO W. D. GALLO (IMPELL); SUPPORT SKETCHES FOR SEAL WATER HEAT EXCHANGER, E-34

2. WALKDOWN NOTES AND PHOTOGRAPHS OF SEAL WATER HEAT EXCHANGER (E-34) DATED 5-14-84, INCLUDED IN APPENDIX A

3 AISC MANUAL OF STEEL CONSTRUCTION, 8TH EDITION, AMERICAN INSTITUTE OF STEEL CONSTRUCTION, CHICAGO, ILLINOIS.

4. BASCO, INC. DRAWING FOR SEAL WATER HEAT EXCHANGER, DATED 11-18-64, DWG NO (ILLEGIBLE) (ATTACHMENT TO [1]).

5. EDSGAP USERS MANUAL VERSION 3/1/80. IMPELL CORPORATION, SAN FRANCISCO CA.

6. HILTI FASTENING SYSTEMS, TEST DATA FOR 1" DIAMETER HILTI-KWIK-BOLTS (INCLUDED IN APPENDIX A)

7. COMPUTER RUN ACCQACRV, DATED 84/06/09, MODE/FREQUENCY ANALYSIS FOR THE SCE SEAL WATER HEAT EXCHANGER.

8. COMPUTER RUN ACC QACRY, DATED 84/06/09 EQUIVALENT STATIC ANALYSIS FOR THE SCE SEAL WATER HEAT EXCHANGER.

9 BECHTEL POWER CORP. CALC. NO. MC-384-9, E-34 SEAL WATER HEAT EXCHANGER, FOR INFORMATION ONLY

					E-34 Hx
0	WI	6/10/84	SE	7-20-84	IMPELL CORPORATION
REV	BY	DATE	CHECKED	DATE	

JOB NO 0310-036
CALC NO EQ-06

10. FIELD NOTES (DATA FILLED IN ON TELECOPY FROM WARD INGLES TO PIUS KAO) BASE PLATE DIMENSIONS, SEE APPENDIX A

11. ROARK AND YOUNG, "FORMULAS FOR STRESS AND STRAIN", 5TH EDITION, McGRAW-Hill Book Co. New York, 1975

12. "BASE PLATE DESIGN PROCEDURE" IMPELL CORP TECHNICAL PROCEDURE NO. 2.6.1, REV 1, 5/28/83

13. CV-11 SUPPORT LOADS GENERATED BY BECHTEL, ME 101 ANALYSIS FOR CVCS SYSTEM, DATED 031684 (SEE APPENDIX

14. IMPELL CALCULATION NO SUP-CV-11-01, "PIPE SUPPORT EVALUATION FOR PIPE FUNCTIONALITY", JOB NO 0310-033-1355, REV. A, 5/23/84

15. EDSGAP ANALYSIS FOR NOZZLE LOADS ON SEAL WATER HEAT EXCHANGER, DATED 25-JUL-1984 10:40.

0	WI	7/20/84	SL	7.26.84
REV	BY	DATE	CHECKED	DATE

IMPELL CORPORATION

4.0 COMPUTER MODEL

THE EDSGAP ([5]) COMPUTER MODEL IS DESCRIBED ON THE FOLLOWING PAGES. THE MODEL CONTAINS TWO SUPPORTING STRUCTURES, DESIGNATED FRAME 'A' AND FRAME 'B', THE HEAT EXCHANGER SHELL AND THE SADDLE SUPPORTS CONNECTING THE SHELL TO THE SUPPORT FRAMES. THE SADDLE SUPPORTS ARE ASSUMED TO HAVE THE SAME SECTION AND MATERIAL PROPERTIES AS THE EXCHANGER SHELL.

DIMENSIONS ARE FROM [1], [2], AND [4].

THE FOLLOWING ASSUMPTIONS ARE USED IN THE MODEL.

- BOTH SADDLES ARE RIGIDLY ATTACHED TO THE SUPPORT FRAMES
- SADDLES HAVE THE SAME SECTION PROPERTIES AS THE EXCHANGER SHELL.
- VESSEL IS FULL OF FLUID, NO SLOSHING
- OTHERS AS NOTED

SCE E-34 HX

REV	BY	DATE	CHECKED	DATE
0	WI	6/6/84	SSE	7.2.84

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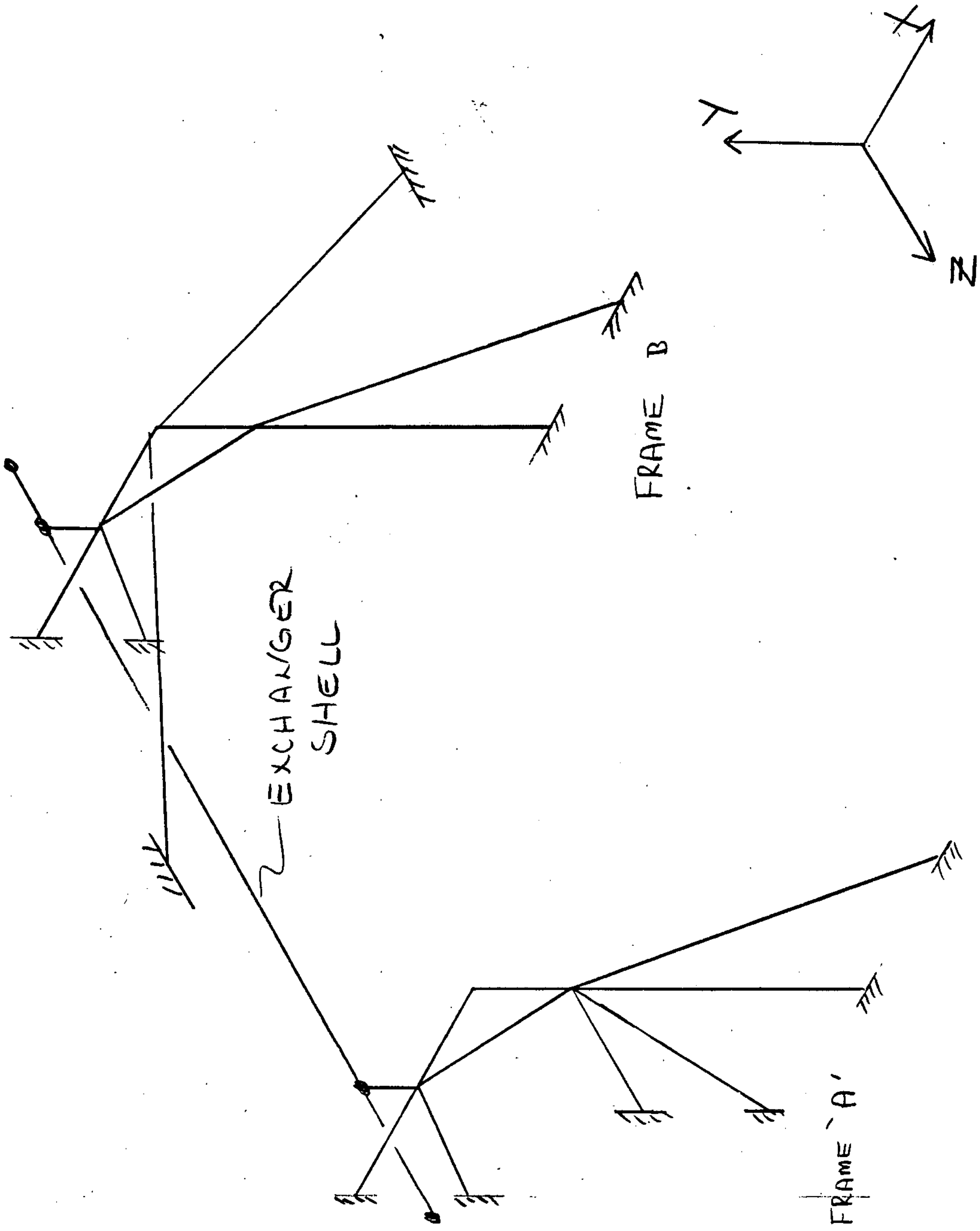
JOB NO 0310-036

CALC NO EQ-06



EDSGAP MODEL OF SEAL WATER HEAT EXCHANGER - E-34

SCE E-34 HX

REV	BY	DATE	CHECKED	DATE
0	WI	6/5/84	SK	7.18.84

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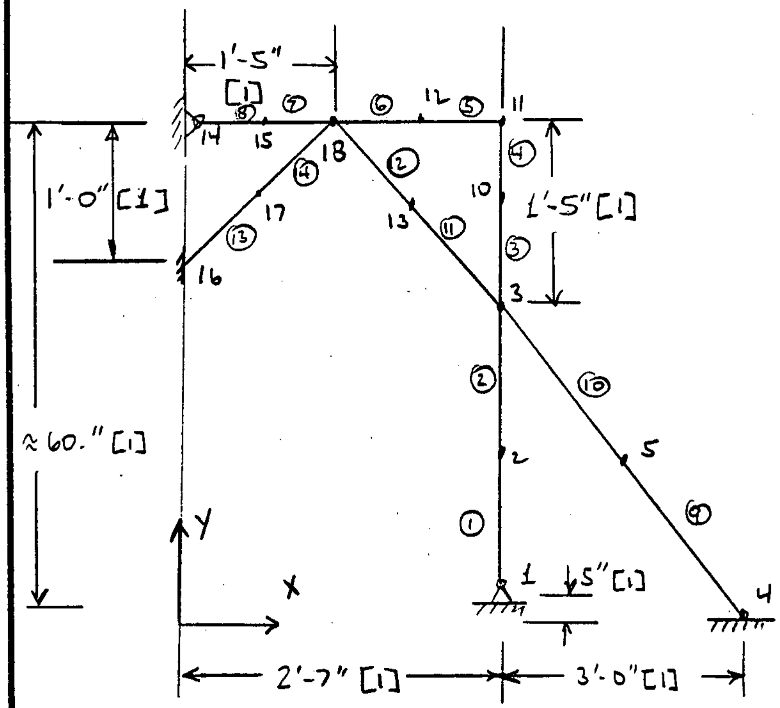
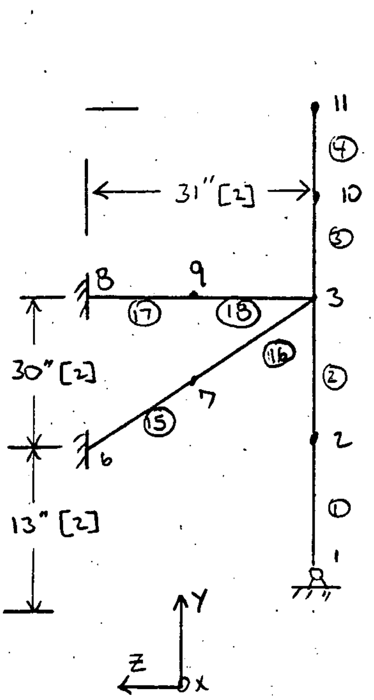
FRAME "A", EDSGAP MODEL





NODE	X	Y	Z
1	31.	5.	99.
2	31.	24.0	↓
3	31.	43.	
4	67.	0.	
5	49.0	21.5	
6	31.	13.	130.
7	31.	28.0	114.5
8	31.	43.	130.
9	31.	43.	114.5
10	31.	51.5	99.
11	31.	60.	↓
12	24.0	60.	

NODE	X	Y	Z
13	24.0	51.5	99.
14	0.	60.	↓
15	8.5	60.	
16	0.	48.	
17	8.5	54.0	
18	17.	60.	

X = NODE NUMBERS
Ⓧ = ELEMENT NUMBERS

					E-34 HX
					SCE
0	WI	6/5/84		7-20-84	IMPELL CORPORATION
REV	BY	DATE	CHECKED	DATE	

JOB NO 0310 - 036
CALC NO EQ-06
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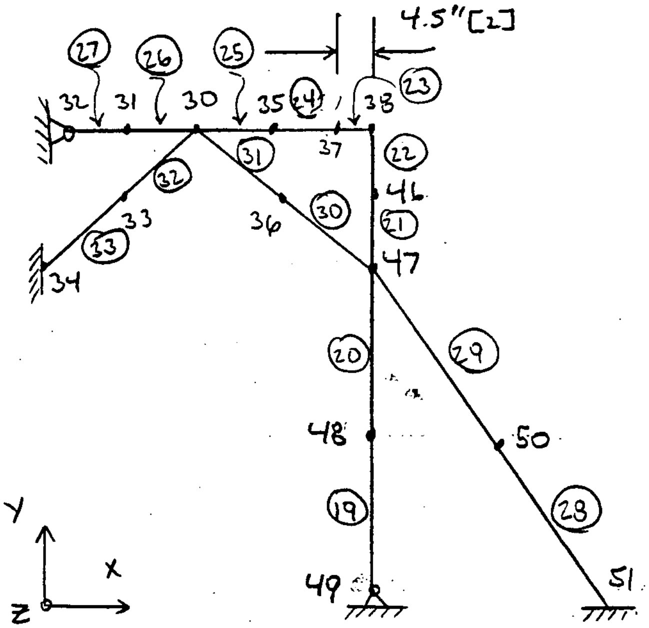
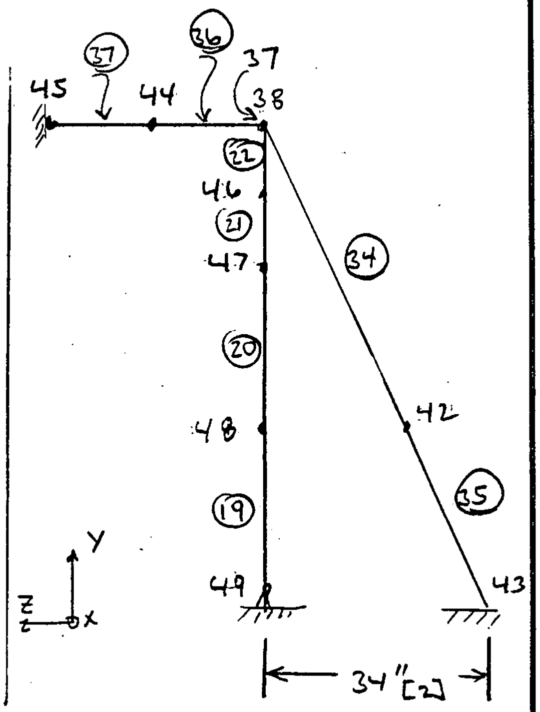
FRAME B





NODE	X	Y	Z
30	17.	60.	0.
31	8.5	60.	↓
32	0.	60.	↓
33	8.5	54.0	↓
34	0.	48.	↓
35	21.7	60.	↓
36	24.0	51.5	↓
37	26.5	60.	↓
38	31.	60.	0
39			
40	0,0,0	NOT USED	
41			
42	31.0	30.0	-17.
43	21.0	0.	-34.
44	13.3	60.	15.6
45	0.	60.	31.3

NODE	X	Y	Z
46	31.	51.5	0
47	31.	43.	↓
48	31.	24.	↓
49	31.	5.	↓
50	49.0	21.5	↓
51	67.	0	0

CCE E-34 HX

REV	BY	DATE	CHECKED	DATE
0	WI	6/5/84	SSL	7-20-84

IMPELL CORPORATION

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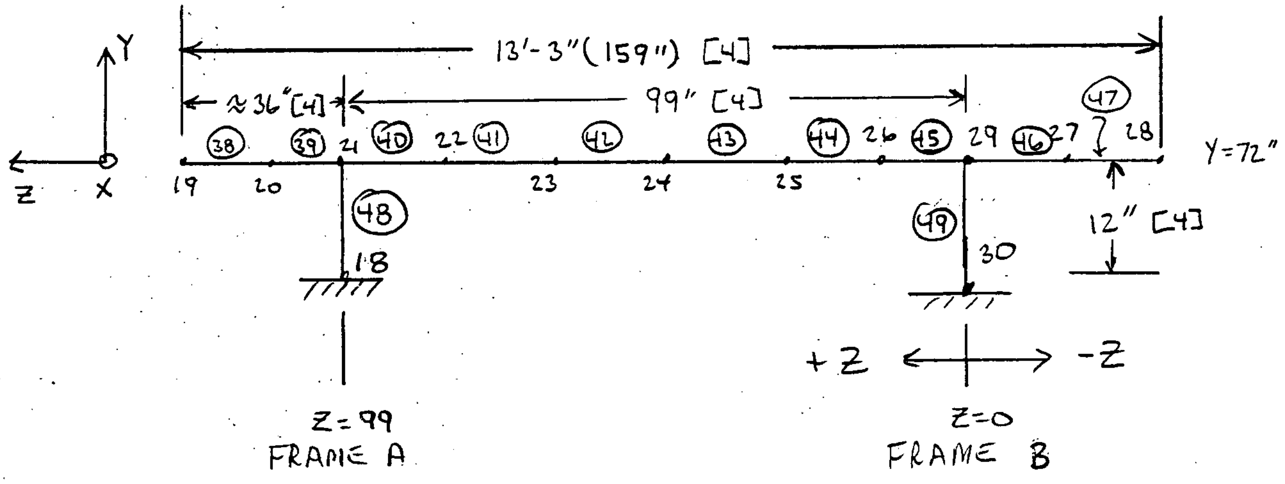
HEAT EXCHANGER SHELL



NODE	X	Y	Z
19	17."	72."	135.
20	↓	↓	117.
21			99.
22			82.5
23			66.
24			49.5
25			33.
26			16.5
29			0.
27			-12.
28	17."	72"	-24.

X = NODE NUMBERS
Ⓧ = ELEMENT NUMBERS

NOTE: DISTANCES FROM 19-21 AND 29⇒28 ARE REVERSED, NO AFFECT ON RESULTS

					SCE E-34 HX
0	WI	6/5/84	GRL	7-20-84	IMPELL CORPORATION
REV	BY	DATE	CHECKED	DATE	

JOB NO 0210-036
CALC NO EQ-06
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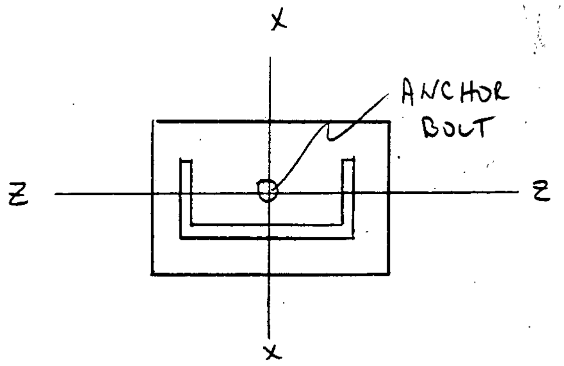
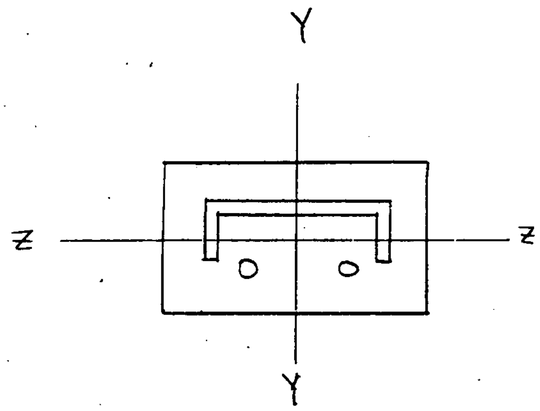
BOUNDARY CONDITIONS

ALL CONNECTIONS ARE ASSUMED FIXED WITH THE FOLLOWING EXCEPTIONS.

- THE CONNECTIONS AT NODES 1 (FRAME A) AND NODE 49 (FRAME B) ARE NOT ASSUMED TO RESIST ANY MOMENTS. THESE CONNECTIONS ARE ASSUMED TO RESIST FORCES ONLY.
- THE CONNECTIONS AT NODES 14 (FRAME A) AND NODE 32 (FRAME B) ARE ASSUMED TO ALLOW ROTATION ABOUT THE GLOBAL Z AXIS.



BASE PLT @ NODES 1,49



BASE PLT @ NODES 14,32

SCE E-34 HX

REV	BY	DATE	CHECKED	DATE
0	WI	6/6/84	SXC	7.18.84

IMPELL CORPORATION

JOB NO 0310.036

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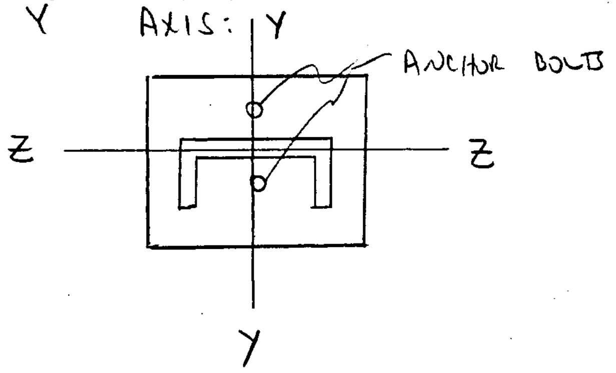
BOUNDARY CONDITIONS CONT.

- THE CONNECTION AT NODE 45 IS ASSUMED TO ALLOW FREE ROTATION ABOUT THE GLOBAL Y AXIS:



- THE CONNECTIONS BETWEEN THE SADDLE SUPPORTS AND THE SUPPORT FRAMES ARE ASSUMED TO BE RIGID.

SCE HX E-34

REV	BY	DATE	CHECKED	DATE
0	WI	6/6/84	SM	7.18.84

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-06

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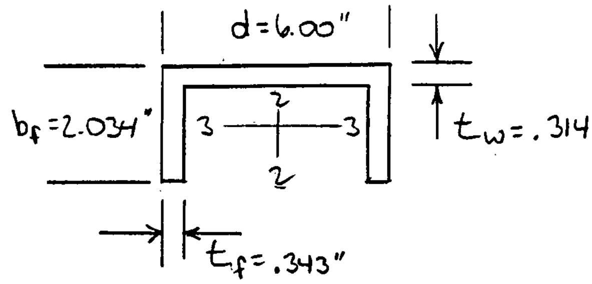
ELEMENT TYPE 1, C6×10.5 ([3], p. 1-36)



$A = 3.09\ in^2$

$A_{22} = 2b_f t_f = 2(2.034)(.343) = 1.395\ in^2$

$A_{33} = t_w d = (.314\ in)(6.00\ in) = 1.884\ in^2$

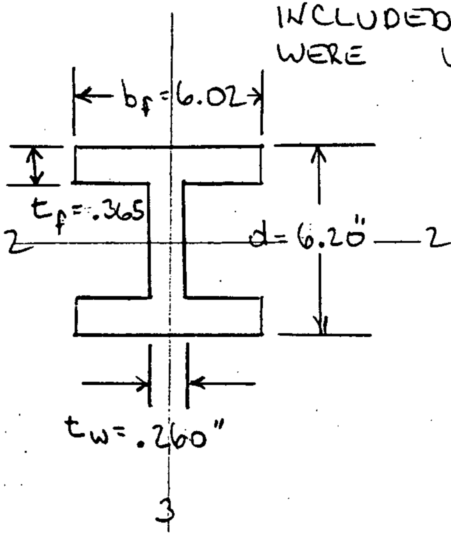
$I_{22} = 15.2\ in^4$ $S_{22} = 5.06\ in^3$

$I_{33} = .866\ in^4$ $S_{33} = .564\ in^3$

ASSUME $J = .01\ in^4$ $r = .529$

ELEMENT TYPE 2,

FROM [2], $d \approx 6.25"$, $b_f \approx 6.00"$; FROM [1], MEMBER IS SPECIFIED AS W6×15.5, W6×15.5 IS NOT INCLUDED IN [3], ∴ ASSUME CURRENT MEMBERS WERE USED, W6×20



$A = 5.87\ in^2$

$A_{22} = 2t_f b_f = 4.39\ in^2$

$A_{33} = t_w \cdot d = (.260\ in)(6.20\ in) = 1.61\ in^2$

$I_{22} = 41.4\ in^4$ $S_{22} = 13.4\ in^3$

$I_{33} = 13.4\ in^4$ $S_{33} = 4.41\ in^3$

$r_{MIN} = 1.50\ in$

$J = .24\ in^4$ [3], p. 1-114

CCE E-34 HX

REV	BY	DATE	CHECKED	DATE
0	WI	5/19/84	SBC	7-18-84

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-06

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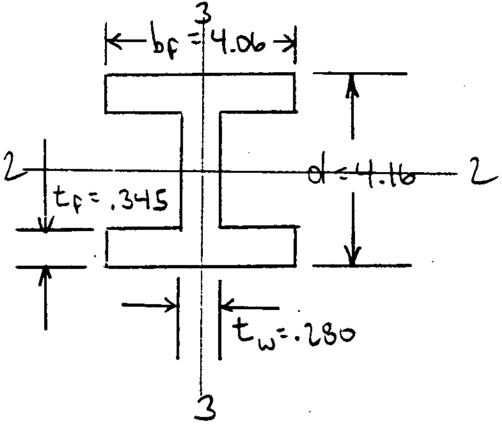
ELEMENT TYPE 3, W4×13



$A = 3.83\ in^2$

$A_{22} = 2 b_f t_f = 2(4.06)(.345) = 2.80\ in^2$

$A_{33} = d\, t_w = (4.16)(.280) = 1.16\ in^2$

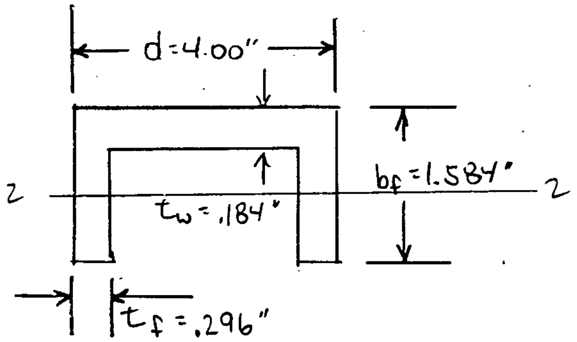
$I_{22} = 11.3\ in^4$ $S_{22} = 5.46\ in^3$

$I_{33} = 3.86\ in^4$ $S_{33} = 1.90\ in^3$

$J \approx .15\ in^4$ [3] p. 1-114

$r = 1.00\ in$

ELEMENT TYPE 4, ASSUME C4×5.4



$A = 1.59\ in^2$

$A_{22} = t_w d = (4.00 in)(.184 in) = .736\ in^2$

$A_{33} = 2 t_f b_f = 2(.296 in)(1.584 in) = .938$

$I_{22} = .319\ in^4$ $S_{22} = .283\ in^3$

$I_{33} = 3.85\ in^4$ $S_{33} = 1.93\ in^3$

ASSUME $J = .01\ in^4$

$r = .449\ in$

ELEMENT TYPE 5, HEAT EXCHANGER SHELL

TOTAL WT. = 3705 lb (ASSUMED, [9], p. 14)

TOTAL LENGTH ≅ 159"

SHELL OD = 18"

$t_{SHELL} \approx .312''$ (ASSUMED, [ ], p. 8)

$\therefore ID = OD - 2t$

$= 18'' - 2(.312'') = 17.376 in$

SCE E-34 HX

0	WI	6/5/84	SL	7-18-84
REV	BY	DATE	CHECKED	DATE

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-06

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$$A = \pi/4\,(OD^2 - ID^2) = \frac{\pi}{4}\left[(18.\,in)^2 - (17.376\,in)^2\right]$$
$$= 17.34\,in^2$$

$$A_{22} = A_{33} = A/2 = 8.67\,in^2$$

$$I = \frac{\pi}{64}(OD^4 - ID^4)$$
$$= \frac{\pi}{64}\left[(18.\,in)^4 - (17.376\,in)^4\right] = 678.2\,in^4$$

$$J = 2I = 1356.\,in^4$$

SLE E-24 HX

REV	BY	DATE	CHECKED	DATE
0	WI	6/5/84	SXC	7-18-84

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-06

MATERIAL TYPE 1 - SA-36 CARBON STEEL

$E \approx 29.0 \times 10^6$ psi

$\nu = .3$

$$\rho_m = \frac{.284 \ \text{lb/in}^3}{386.4 \ \text{in/s}^2} = 7.35 \times 10^{-4} \ \frac{\text{lb}\cdot\text{s}^2}{\text{in}\cdot\text{in}^3}$$

MATERIAL TYPE 2 - EXCHANGER SHELL

$$w = \frac{3705 \ \text{lb}}{159 \ \text{in}} = 23.3 \ \text{lb/in}$$

$A = 17.34 \ \text{in}^2$

$\gamma A = w$ where $\gamma = \rho g$

$\rho g A = w$

$$\rho = \frac{w}{Ag} = \frac{23.3 \ \text{lb/in}}{(17.34 \ \text{in}^2)(386.4 \ \text{in/s}^2)}$$

$$= 3.48 \times 10^{-3} \ \frac{\text{lb}\cdot\text{s}^2}{\text{in}\cdot\text{in}^3}$$

					SCE E-34-HX	
0	WI	6/5/84	SSL	7-18-84	IMPELL CORPORATION	JOB NO 0210-036 CALC NO EQ-06
REV	BY	DATE	CHECKED	DATE		PAGE 8 OF 87

FREQUENCY ANALYSIS

AS DESCRIBED IN THE INTRODUCTION, AN EDSGAP MODEL (DESCRIBED IN THE PREVIOUS SECTION) WAS USED TO CALCULATE THE FUNDAMENTAL FREQUENCY OF THE STRUCTURE. THE INPUT FOR THIS ANALYSIS IS SHOWN ON THE FOLLOWING PAGES.

THE FREQUENCY ANALYSIS [7], SHOWS THAT THE FUNDAMENTAL FREQUENCY IS GREATER THAN 33 Hz IN ALL DIRECTIONS. THEREFORE THE ZPA ACCELERATIONS WILL BE APPLIED TO THE STRUCTURE ($f_1 = 49$ Hz):

HORIZONTAL DIRECTIONS

$$a_x = a_z = .67g$$

VERTICAL DIRECTION

$$a_y = 2/3(.67g)$$

$$= \pm .45g$$

$$a_{DW} = 1.00g \downarrow$$

SCE E-34 HX

0	WI	6/6/84	SSR	7-18-84	IMPELL CORPORATION	JOB NO 0310-036 CALC NO EQ-06	PAGE 19 OF 87
REV	BY	DATE	CHECKED	DATE			

FREQUENCY ANALYSIS INPUT DATA

```
SCE SONGS-1 SEAL WATER HEAT EXCHANGER - E-34
  52    1    0    3    1              10000    0
   1    1    1    1    0    0    0    31.      5.       99.
   2                                  31.      24.0     99.
   3                                  31.      43.      99.
   4    1    1    1    1    1    1    67.      0.       99.
   5                                  49.0     21.5     99.
   6    1    1    1    1    1    1    31.      13.      130.
   7                                  31.      28.0     114.5
   8    1    1    1    1    1    1    31.      43.      130.
   9                                  31.      43.      114.5
  10                                  31.      51.5     99.
  11                                  31.      60.      99.
  12                                  24.0     60.      99.
  13                                  24.0     51.5     99.
  14    1    1    1    1    1    0     0.      60.      99.
  15                                   8.5     60.      99.
  16    1    1    1    1    1    1     0.      48.      99.
  17                                   8.5     54.0     99.
  18                                  17.      60.      99.
  19                                  17.      72.      135.
  20                                  17.      72.      117.
  21                                  17.      72.      99.
  22                                  17.      72.      82.5
  23                                  17.      72.      66.
  24                                  17.      72.      49.5
  25                                  17.      72.      33.
  26                                  17.      72.      16.5
  29                                  17.      72.       0.
  27                                  17.      72.      -12.
  28                                  17.      72.      -24.
  30                                  17.      60.
  31                                   8.5     60.
  32    1    1    1    1    1    0     0.      60.
  33                                   8.5     54.0
  34    1    1    1    1    1    1     0.      48.
  35                                  21.7     60.
  36                                  24.0     51.5
  37                                  26.5     60.
  38                                  31.      60.
  39    1    1    1    1    1    1     0.       0.
  40    1    1    1    1    1    1     0.       0.
  41    1    1    1    1    1    1     0.       0.
  42                                  31.0     30.0     -17.0
  43    1    1    1    1    1    1    31.       0.      -34.
  44                                  13.3     60.       15.6
  45    1    1    1    1    0    1     0.      60.       31.3
  46                                  31.      51.5
  47                                  31.      43.
  48                                  31.      24.
  49    1    1    1    0    0    0    31.       5.
  50                                  49.0     21.5
  51    1    1    1    1    1    1    67.       0.
  52    1    1    1    1    1    1     0.      43.      99.
   2   49    5    0    2
   1   30.0E06          .3   7.35E-04    SA-36 CARBON STEEL
   2   30.0E06          .3   3.48E-03    EXCHANGER W/FLUID
   1      3.09     1.395     1.884      .01      15.2       .866     C6x10.5
   2      5.87     4.39      1.61       .24      41.4      13.4      W6x20
   3      3.83     2.80      1.16       .15      11.3       3.86     W4x13
   4      1.59      .736      .935      .01       .319      3.85     C4x5.4
   5     17.34     8.67      8.67    1356.      678.2     678.2      EXCHANGER SHELL
```

SCE HX E-34

IMPELL CORPORATION

0	WL	6/1d/84	SXL	7-18-84	JOB NO 0310-036	PAGE 20
REV	BY	DATE	CHECKED	DATE	CALC NO EQ-06	OF 87

FREQUENCY ANALYSIS INPUT, CONT

1	1	2	16	1	1	C6x10.5	SUPPORT FRAME 'A'
2	2	3	16	1	1		
3	3	10	16	1	1		
4	10	11	16	1	1		
5	11	12	16	1	1		
6	12	18	16	1	1		
7	18	15	16	1	1		
8	15	14	16	1	1		
9	4	5	8	1	2	W6x20	
10	5	3	8	1	2		
11	3	13	8	1	3	W4x13	
12	13	18	8	1	3		
13	16	17	34	1	3		
14	17	18	34	1	3		
15	6	7	52	1	3		
16	7	3	52	1	3		
17	8	9	52	1	3		
18	9	3	52	1	3		
19	49	48	34	1	1	C6x10.5	SUPPORT FRAME 'B'
20	48	47	34	1	1		
21	47	46	34	1	1		
22	46	38	34	1	1		
23	38	37	34	1	1		
24	37	35	34	1	1		
25	35	30	34	1	1		
26	30	31	34	1	1		
27	31	32	34	1	1		
28	51	50	3	1	2	W6x20	
29	50	47	3	1	2		
30	47	36	3	1	3	W4x13	
31	36	30	3	1	3		
32	30	33	16	1	3		
33	33	34	16	1	3		
34	38	42	4	1	2	W6x20	
35	42	43	4	1	2		
36	37	44	32	1	4	C4x5.4	
37	44	45	32	1	4		
38	19	20	18	2	5	SHELL	HEAT EXCHANGER
39	20	21	18	2	5		
40	21	22	18	2	5		
41	22	23	18	2	5		
42	23	24	18	2	5		
43	24	25	18	2	5		
44	25	26	18	2	5		
45	26	29	18	2	5		
46	29	27	18	2	5		
47	27	28	18	2	5		
48	18	21	30	2	5	SADDLES	
49	30	29	18	2	5		

SCE HX E-34

REV	BY	DATE	CHECKED	DATE
0	WI	6/1/84	SSL	7-14-84

IMPELL CORPORATION

JOB NO 0312-036

CALC NO EQ-06

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NOZZLE LOADS

BASED ON A REVIEW OF [[illegible]], THE NOZZLE LOADS FROM [13] ARE APPLICABLE TO THE SEAL WATER HEAT EXCHANGER. THESE LOADS ARE APPLIED TO THE TUBE SIDE INLET AND OUTLET.

THE LOADS APPLIED TO THE SHELL SIDE NOZZLES ARE ASSUMED EQUAL TO THOSE LISTED IN [9].

THE EDSGAP MODEL USED TO CALCULATE MEMBER FORCES RESULTING FROM THE NOZZLE LOADS IS SHOWN ON THE FOLLOWING PAGE, THE LOADS WERE APPLIED TO THE MODEL AS DESCRIBED BELOW:

1). SHELL SIDE INLET LOADS	NODE 20
2) SHELL SIDE OUTLET LOADS	NODE 27
3) TUBE SIDE INLET AND OUTLET LOADS	NODE 28

ALL LOADS WERE APPLIED SIMULTANEOUSLY IN THE POSITIVE DIRECTION(S) TO THE CENTERLINE OF THE VESSEL.

REV	BY	DATE	CHECKED	DATE
0	WI	7/25/84	SL	7.26.84

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-06

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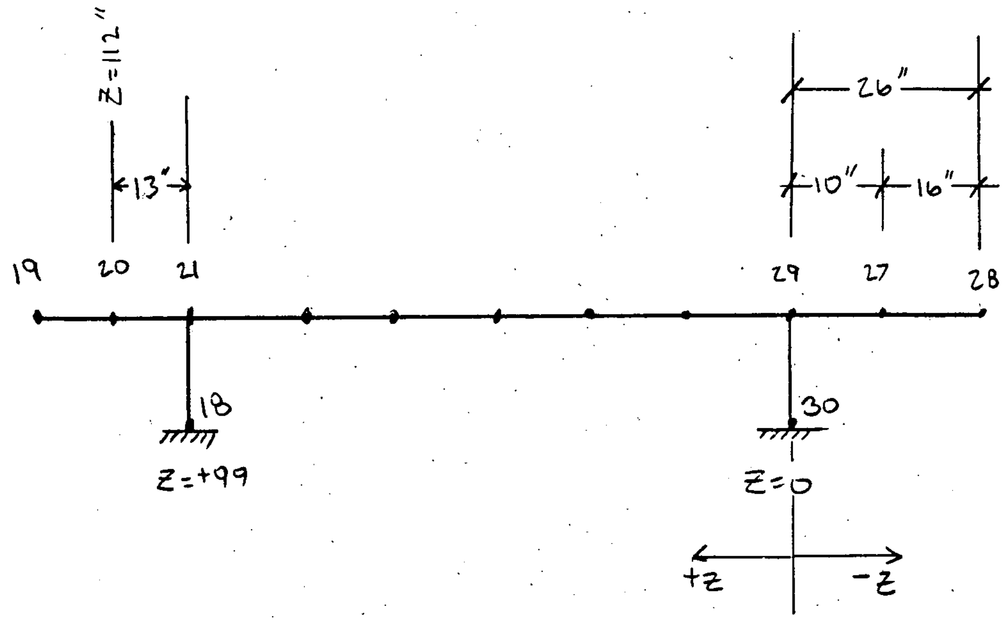

SHELL SIDE INLET LOADS APPLIED TO NODE 20.

SHELL SIDE OUTLET LOADS APPLIED TO NODE 27

TUBE SIDE LOADS APPLIED TO NODE 28

- ALL NOZZLE LOADS ARE ASSUMED TO ACT ON THE CENTER LINE OF THE SHELL.

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REV	BY	DATE	CHECKED	DATE

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-06

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ASSUMED NOZZLE LOADS ([9], p. 52)

NODE 120, 4" WATER OUTLET (SHELL SIDE)

Fx	476	lb	
Fy	1810	lb	
Fz	71	lb	
Mx	30	ft-lb	(360. in-lb)
My	197	ft-lb	(2364. in-lb)
Mz	1501	ft-lb	(18012. in-lb)

MAXIMUM LOADS COMBINED USING ASUM

NODE 175, 4" WATER INLET (SHELL SIDE)

Fx	210	lb	
Fy	708	lb	
Fz	607	lb	
Mx	304	ft-lb	(3648 in-lb)
My	738	ft-lb	(8856 in-lb)
Mz	697	ft-lb	(8364 in-lb)

MAXIMUM LOADS OBTAINED USING ALGEBRAIC SUM

REV	BY	DATE	CHECKED	DATE
0	WI	7/25/84		[illegible]

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-06

NOZZLE LOADS [13]

NODE 260, 3" WATER INLET (TUBE SIDE)

	THERMAL	SAM	DW	SSE	ASUM
Fx	-4	0	-3	±43	50.
Fy	+26	0	-38	±28	92.
Fz	+69	0	-1	±109	179.
Mx	+76	0	-11	±50	137.
My	+4	0	+5	±23	32.
Mz	-10	0	-1	±14	25

NODE 650, 3" WATER OUTLET (TUBE SIDE)

	THERMAL	SAM	DW	SSE	ASUM
Fx	+22	0	-32	±127	181
Fy	+23	0	-228	±102	353
Fz	+40	0	42	±149	231
Mx	+17	0	-30	±36	83
My	-45	0	-58	±157	260
Mz	+38	0	-206	±96	340

NOTE: FORCES IN LBS.
MOMENTS IN FT-LBS.

REV	BY	DATE	CHECKED	DATE
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IMPELL CORPORATION

JOB NO 0310-036
CALC NO EQ-06

COMBINED TUBE SIDE LOADS

$F_x = 50 + 181 = 231.$ lb
$F_y = 92 + 353 = 445.$ lb
$F_z = 179 + 231 = 410.$ lb

$M_x = 137 + 83 = 220$ ft·lb $= 2640$ in·lb
$M_y = 32 + 260 = 292$ ft·lb $= 3504$ in·lb
$M_z = 25 + 340 = 365$ ft·lb $= 4380$ in·lb

0	WI	7/25/84	SSL	7-26-84	**IMPELL** CORPORATION	JOB NO 0310-036 CALC NO EQ-06
REV	**BY**	**DATE**	**CHECKED**	**DATE**		PAGE [illegible] OF 87

EDSGAP INPUT, NOZZLE LOAD ANALYSIS

```
  SCE SONGS-1 SEAL WATER HEAT EXCHANGER - E-34  (NOZZLE LOADS)
    52   1    1    0    0              10000    0
     1   1    1    1    0    0    0          31.        5.         99.
     2                                       31.       24.0        99.
     3                                       31.       43.         99.
     4   1    1    1    1    1    1          67.        0.         99.
     5                                       49.0      21.5        99.
     6   1    1    1    1    1    1          31.       13.        130.
     7                                       31.       28.0       114.5
     8   1    1    1    1    1    1          31.       43.        130.
     9                                       31.       43.        114.5
    10                                       31.       51.5        99.
    11                                       31.       60.         99.
    12                                       24.0      60.         99.
    13                                       24.0      51.5        99.
    14   1    1    1    1    1    0           0.       60.         99.
    15                                        8.5      60.         99.
    16   1    1    1    1    1    1           0.       48.         99.
    17                                        8.5      54.0        99.
    18                                       17.       60.         99.
    19                                       17.       72.        123.
    20                                       17.       72.        112.
    21                                       17.       72.        99.
    22                                       17.       72.        82.5
    23                                       17.       72.        66.
    24                                       17.       72.        49.5
    25                                       17.       72.        33.
    26                                       17.       72.        16.5
    29                                       17.       72.         0.
    27                                       17.       72.       -10.
    28                                       17.       72.       -26.
    30                                       17.       60.
    31                                        8.5      60.
    32   1    1    1    1    1    0           0.       60.
    33                                        8.5      54.0
    34   1    1    1    1    1    1           0.       48.
    35                                       21.7      60.
    36                                       24.0      51.5
    37                                       26.5      60.
    38                                       31.       60.
    39   1    1    1    1    1    1           0.        0.
    40   1    1    1    1    1    1           0.        0.
    41   1    1    1    1    1    1           0.        0.
    42                                       31.0      30.0       -17.0
    43   1    1    1    1    1    1          31.        0.        -34.
    44                                       13.3      60.         15.6
    45   1    1    1    1    0    1           0.       60.         31.3
    46                                       31.       51.5
    47                                       31.       43.
    48                                       31.       24.
    49   1    1    1    0    0    0          31.        5.
    50                                       49.0      21.5
    51   1    1    1    1    1    1          67.        0.
    52   1    1    1    1    1    1           0.       43.         99.
     2  49    5    0    2
     1  30.0E06            .3  7.35E-04
     2  30.0E06            .3  3.48E-03
     1      3.09      1.395      1.884      .01     15.2          .866
     2      5.87       4.39       1.61      .24       41.4        13.4
     3      3.83       2.80       1.16      .15       11.3        3.86
     4      1.59       .736       .938     .01        .319        3.85
     5     17.34       8.67       8.67    1356.      678.2       678.2
   386.4
```

REV	BY	DATE	CHECKED	DATE
0	WI	7/25/84	SL	7-26-84

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-06

EDSGAP INPUT, CONT.

```
               386.4
                         386.4
    1    1    2   16    1    1
    2    2    3   16    1    1
    3    3   10   16    1    1
    4   10   11   16    1    1
    5   11   12   16    1    1
    6   12   18   16    1    1
    7   18   15   16    1    1
    8   15   14   16    1    1
    9    4    5    8    1    2
   10    5    3    8    1    2
   11    3   13    8    1    3
   12   13   18    8    1    3
   13   16   17   34    1    3
   14   17   18   34    1    3
   15    6    7   52    1    3
   16    7    3   52    1    3
   17    8    9   52    1    3
   18    9    3   52    1    3
   19   49   48   34    1    1
   20   48   47   34    1    1
   21   47   46   34    1    1
   22   46   38   34    1    1
   23   38   37   34    1    1
   24   37   35   34    1    1
   25   35   30   34    1    1
   26   30   31   34    1    1
   27   31   32   34    1    1
   28   51   50    3    1    2
   29   50   47    3    1    2
   30   47   36    3    1    3
   31   36   30    3    1    3
   32   30   33   16    1    3
   33   33   34   16    1    3
   34   38   42    4    1    2
   35   42   43    4    1    2
   36   37   44   32    1    4
   37   44   45   32    1    4
   38   19   20   18    2    5
   39   20   21   18    2    5
   40   21   22   18    2    5
   41   22   23   18    2    5
   42   23   24   18    2    5
   43   24   25   18    2    5
   44   25   26   18    2    5
   45   26   29   18    2    5
   46   29   27   18    2    5
   47   27   28   18    2    5
   48   18   21   30    2    5
   49   30   29   18    2    5
   20    1      210.      708.      607.     3648.     8856.     8364.
   27    1      476.     1810.       71.      360.     2364.    18012.
   28    1      231.      445.      410.     2640.     3504.     4380.
```

0	WI	7/25/84		7-26-84	IMPELL CORPORATION	JOB NO 0310-036 CALC NO EQ-06	PAGE 28 OF 37
REV	BY	DATE	CHECKED	DATE			

7.0 STRUCTURAL ANALYSIS

THE LOADS IN THE STRUCTURE ARE DETERMINED BY APPLYING SEISMIC LOAD FACTORS EQUAL TO THE ZPA'S. IN THE THREE GLOBAL DIRECTIONS.

WORST CASE LOADS ARE DETERMINED FOR EACH TYPE OF STRUCTURAL ELEMENT (i.e. W4x13, W6x20, C6x10.5 + SO ON). MAXIMUM LOADS ARE COMBINED REGARDLESS OF THE LOCATION WHERE THEY OCCUR. THIS RESULTS IN A WORST CASE LOAD FOR EACH ELEMENT TYPE. SEISMIC LOADS IN EACH DIRECTION ARE COMBINED USING SRSS, THE RESULT IS THEN COMBINED WITH THE DEAD WEIGHT LOAD USING ASUM:

$$\text{LOAD} = \left[(X_{\text{SEISMIC}})^2 + (Y_{\text{SEISMIC}})^2 + (Z_{\text{SEISMIC}})^2\right]^{\frac{1}{2}} + \text{D.W.}$$

THIS COMBINATION IS USED FOR EACH OF THE FOLLOWING 6 LOADS.

R1 = AXIAL LOAD
R2 = SHEAR IN LOCAL 2 DIRECTION
R3 = " " " 3 "
M1 = TORSIONAL MOMENT
M2 = BENDING ABOUT LOCAL 2 AXIS
M3 = " " " 3 "

ALLOWABLE STRESSES

ASSUME: $F_y = 36$ Ksi, $F_u = 58$ Ksi } SA-36 CARBON STEEL

FROM ASME CODE, SUBSECTION NF

$$\left.\begin{array}{l} F_b = .6F_y = 21.6 \text{ Ksi} \\ F_v = .4F_y = 14.4 \text{ Ksi} \\ F_t = .6F_y = 21.6 \text{ Ksi} \end{array}\right\} \text{LEVEL A}$$

FOR RETURN TO SERVICE, LEVEL D ALLOWABLES MAY BE USED. (APPENDIX F, F-1370)

$$F_t = F_a = \min(1.2F_y, .7F_u)$$

$$\left.\begin{array}{l} 1.2F_y = 1.2(36) = 43.2 \\ .7F_u = .7(58) = 40.6 \end{array}\right\} \underline{40.6 \text{ ksi}}$$

$$F_v = \min(.8F_y, .42F_u)$$

$$\left.\begin{array}{l} .8(36) = 28.8 \text{ ksi} \\ .42(58) = 24.4 \text{ ksi} \end{array}\right\} \underline{24.4 \text{ ksi}}$$

SCE HX-E-34

REV	BY	DATE	CHECKED	DATE
0	WI	6/9/84		7.20.84

IMPELL CORPORATION

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CALC NO EQ-06

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THE INPUT FOR THE STRUCTURAL EVALUATION IS SHOWN ON THE FOLLOWING PAGES. THE INPUT SHOWS THE FOUR LOAD CASES:

1: $a_x = .67g$

2: $a_y = .45g$

3: $a_y = 1.00g$. (DEAD WT)

4: $a_z = .67g$

0	WI	6/10/84	SK	1-18-84	IMPELL CORPORATION	JOB NO 0310-036 CALC NO EQ-06	PAGE 31 OF 87
REV	BY	DATE	CHECKED	DATE			

STATIC ANALYSIS, INPUT DATA

```
SCE SONGS-1 SEAL WATER HEAT EXCHANGER - E-34  (STATIC ANALYSIS)
   52    1    4    0    0          10000    0
    1    1    1    1    0    0    0          31.       5.        99.
    2                                        31.      24.0       99.
    3                                        31.      43.        99.
    4    1    1    1    1    1    1          67.       0.        99.
    5                                        49.0     21.5       99.
    6    1    1    1    1    1    1          31.      13.       130.
    7                                        31.      28.0      114.5
    8    1    1    1    1    1    1          31.      43.       130.
    9                                        31.      43.       114.5
   10                                        31.      51.5       88.
   11                                        31.      60.        99.
   12                                        24.0     60.        99.
   13                                        24.0     51.5       99.
   14    1    1    1    1    1    0           0.      60.        99.
   15                                         8.5     60.        99.
   16    1    1    1    1    1    1           0.      48.        88.
   17                                         8.5     54.0       99.
   18                                        17.      60.        99.
   19                                        17.      72.       135.
   20                                        17.      72.       117.
   21                                        17.      72.        99.
   22                                        17.      72.        82.5
   23                                        17.      72.        66.
   24                                        17.      72.        49.5
   25                                        17.      72.        33.
   26                                        17.      72.        16.5
   29                                        17.      72.         0.
   27                                        17.      72.       -12.
   28                                        17.      72.       -24.
   30                                        17.      60.
   31                                         8.5     60.
   32    1    1    1    1    1    0           0.      60.
   33                                         8.5     54.0
   34    1    1    1    1    1    1           0.      48.
   35                                        21.7     60.
   36                                        24.0     51.5
   37                                        26.5     60.
   38                                        31.      60.
   39    1    1    1    1    1    1           0.       0.
   40    1    1    1    1    1    1           0.       0.
   41    1    1    1    1    1    1           0.       0.
   42                                        31.0     30.0      -17.0
   43    1    1    1    1    1    1          31.       0.       -34.
   44                                        13.3     60.        15.6
   45    1    1    1    1    0    1           0.      60.        31.3
   46                                        31.      51.5
   47                                        31.      43.
   48                                        31.      24.
   49    1    1    1    0    0    0          31.       5.
   50                                        49.0     21.5
   51    1    1    1    1    1    1          67.       0.
   52    1    1    1    1    1    1           0.      43.        99.
    2   49    5    0    2
    1   30.0E06        .3   7.35E-04
    2   30.0E06        .3   3.48E-03
    1      3.09     1.395     1.884         .01      15.2       .866
    2      5.87     4.39      1.61          .24      41.4      13.4
    3      3.83     2.88      1.16          .15      11.3       3.86
```

SCE HX-E-34

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STATIC ANALYSIS, INPUT DATA, CONT.

```
    4       1.59        .736       .938      .01       .319      3.85
    5      17.34        8.67       8.67     1356.      678.2     678.2
  386.4
                   386.4
                               386.4
    1    1    2   16    1    1
    2    2    3   16    1    1
    3    3   10   16    1    1
    4   10   11   16    1    1
    5   11   12   16    1    1
    6   12   13   16    1    1
    7   13   15   16    1    1
    8   15   14   16    1    1
    9    4    5    8    1    2
   10    5    3    8    1    2
   11    5   13    8    1    3
   12   13   16    8    1    3
   13   16   17   34    1    3
   14   17   18   34    1    3
   15    6    7   52    1    3
   16    7    3   52    1    3
   17    8    9   52    1    3
   18    9    3   52    1    3
   19   49   48   34    1    1
   20   48   47   34    1    1
   21   47   46   34    1    1
   22   46   38   34    1    1
   23   38   37   34    1    1
   24   37   35   34    1    1
   25   35   30   34    1    1
   26   30   31   34    1    1
   27   31   32   34    1    1
   28   51   50    3    1    2
   29   50   47    3    1    2
   30   47   36    3    1    3
   31   36   30    3    1    3
   32   30   33   16    1    3
   33   33   34   16    1    3
   34   38   42    4    1    2
   35   42   43    4    1    2
   36   37   44   32    1    4
   37   44   45   32    1    4
   38   19   20   18    2    5
   39   20   21   18    2    5
   40   21   22   18    2    5
   41   22   23   18    2    5
   42   23   24   18    2    5
   43   24   25   18    2    5
   44   25   26   18    2    5
   45   26   29   18    2    5
   46   29   27   18    2    5
   47   27   28   18    2    5
   48   18   21   30    2    5
   49   30   29   18    2    5
    0.67
                   0.45
                  1.00
                               0.67
```

} GRAVITATIONAL ACCELERATION 386.4 in/s²

LOAD CASE 1, $a_x = .67g$

LOAD CASE 2, $a_y = .45g$

LOAD CASE 3, DEAD WT, $a_y = 1.0g$

LOAD CASE 4, $a_z = .67g$

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ALLOWABLE COMPRESSIVE STRESSES

C6x10.5

MAX $l \cong 60"$ (FRAME HEIGHT) - CONSERVATIVE
$r = .529$ in

ASSUME $K = 1.0$ (PINNED - PINNED, [3], P. 5-124)

$$\frac{Kl}{r} = \frac{(1.0)\,60\text{ in}}{.529\text{ in}} = 114$$

$\therefore F_a = 11.13$ Ksi [3] p. 574 (level A)

W4x13

$l_{MAX} \approx 43"$ (ELEMENTS 15, 16)

$r = 1.00$ in

ASSUME $K = 1.00$

$$\frac{Kl}{r} = \frac{1.00\,(43\text{ in})}{1.00\text{ in}} = 43.0$$

$\therefore F_a = 18.95$ ksi level A, ([3], p. 5-74)

SCE HX E-34

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C4x5.4

$l \approx 41''$ ([2])

$r = .449 \text{ in}$

ASSUME $K = 1.0$

$$\frac{Kl}{r} = \frac{41 \text{in}}{.449 \text{in}} = 91.3$$

$\therefore F_a = 13.97$ ksi, level A, (p. 5-74 [3])

W6x20

l_{MAX} (ELEMENTS 34, 35)
NODE 38 (31.0, 60.0, 0)
NODE 43 (31.0, 0, -34.0)
} $l \approx 69''$

let $l = 70''$, $r = 1.50 \text{ in}$

ASSUME $K = 1.00$

$$\frac{Kl}{r} = \frac{(1.00)(70 \text{in})}{1.50 \text{in}} = 46.7$$

$\therefore F_a = 18.61$ ksi level A, ([3], p 5-74)

SCE HX E-34

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MAXIMUM LOADS, C6X10.5 (ELEMENT TYPE 1)

FRAME A

	R1	R2	R3	M1	M2	M3
a_x	1176. ⑧	100.7 ⑤	20.3 ⑤	NEGLIGIBLE	345.6 ③	1088. ⑥
a_y	270.0 ⑦	14.6 ⑤	40.9 ⑦	.	358.1 ⑧	127.9 ⑥
a_z	70.8 ①	4.6 ⑤	855.0 ⑧	.	7600. ⑧	48.6 ⑥
SRSS	1209.	102.	856.	.	7616.	1097.
DW	600.0 ⑦	32.5 ⑤	90.9 ⑦	.	795.7 ⑧	284.2 ⑥
TOTAL	1809.	134.	947.	.	8412.	1381.

FRAME B

	R1	R2	R3	M1	M2	M3
a_z	1001. ㉗	111.3 ㉔	116.2 ㉔	NEGLIGIBLE	1282. ㉕	1104. ㉕
a_y	217.7 ㉗	25.8 ㉓	38.1 ㉔	.	344.8 ㉕	157.4 ㉓
a_z	405.9 ㉔	31.2 ㉔	808.2 ㉗	.	6960. ㉗	266.6 ㉓
SRSS	1102.	118.	817.	.	7085.	1147.
DW	483.7 ㉗	57.2 ㉓	84.7 ㉔	.	766.2 ㉕	349.9 ㉓
TOTAL	1586.	176.	902.	.	7851.	1496.

NOZZLE LOADS, C6x10.5

	FRAME A		FRAME B	
R1	288.2	①	523.4	⑲
R2	54.0	⑤	138.0	㉔
R3	584.7	⑦	205.5	㉔
M1	0.		0	
M2	5284.	⑨	2104.	㉕
M3	584.0	⑥	1191.	㉕

MAXIMUM COMBINED LOADS (SEISMIC + NOZZLE)

R1 = 1809 Ⓐ + 523.4 Ⓑ = 2332. lb
R2 = 176 Ⓑ + 138.0 Ⓑ = 314. lb
R3 = 947 Ⓐ + 584.7 Ⓐ = 1532. lb
M1 = 0 + 0 = 0
M2 = 8412 Ⓐ + 5284. Ⓐ = 13696. in-lb
M3 = 1496 Ⓑ + 1191. Ⓑ = 2687. in-lb

0	WI	7/25/84		7-26-84
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STRESS CHECK

C6x10.5

$$f_a = \frac{R1_{MAX}}{A} = \frac{2332 \text{ lb}}{3.09 \text{ in}^2} = .75 \text{ ksi}$$

$$f_{b2} = \frac{M2_{MAX}}{S_{22}} = \frac{13696 \text{ in} \cdot \text{lb}}{5.06 \text{ in}^3} = 2.71 \text{ ksi}$$

$$f_{b33} = \frac{M3_{MAX}}{S_{33}} = \frac{2687 \text{ in} \cdot \text{lb}}{.564 \text{ in}^3} = 4.76 \text{ ksi}$$

$$f_{v2} = \frac{R2}{A_{22}} = \frac{314. \text{ lb}}{1.395 \text{ in}^2} = .23 \text{ ksi}$$

$$f_{v3} = \frac{R3}{A_{33}} = \frac{1532 \text{ lb}}{1.884 \text{ in}^2} = .81 \text{ ksi}$$

INTERACTION:

$$\frac{.75}{11.13} + \frac{2.71}{21.6} + \frac{4.76}{21.6} = .41 < 1$$

SHEAR:

$$f_{v2} < 14.4$$

$$f_{v3} < 14.4$$

∴ QUALIFIED USING LEVEL A LIMITS.

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BY WI
DATE 6/9/84
CHECKED SKL
DATE 7.20.84

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MAXIMUM LOADS, W6×20 (ELEMENT TYPE 2)

FRAME A

	R1	R2	R3	M1	M2	M3
a_x	343.4 ⑨	2.1 ⑨	32.1 ⑨	NEGLIGIBLE	734.6 ⑩ ↓	69.9 ⑩ ↓
a_y	530.9 ⑨	.7 ⑨	20.4 ⑩	.	549.5	28.1
a_z	129.0 ⑨	34.0 ⑩	8.5	.	264.0	932.8
SRSS	630.	34.	39.	.	955.	936.
DW	1180. ⑨	1.5 ⑨	45.4 ⑩	.	1221. ⑩	62.3 ⑩
TOTAL	1810.	36.	84.	.	2176.	998.

FRAME B

	R1	R2	R3	M1	M2	M3
a_z	235.1 ㉘	8.8 ㉟ ↓	32.7 ㉟	NEGLIGIBLE	676.4 ㉟	210.1 ㉟
a_y	431.7 ㉘	7.5	17.7 ㉙	.	467.2 ㉙	148.1 ㉟
a_z	401.9 ㉟	27.0	20.5 ㉟	.	613.5 ㉙	621.6 ㉟
SRSS	635.	29.	42.	.	1026.	673.
DW	959.4 ㉘	16.7 ㉟	39.3 ㉙	.	1038. ㉞	329.2 ㉟
TOTAL	1594.	46.	82.	.	2064.	1002.

NOZZLE LOADS, W6×20

	FRAME A	FRAME B
R1	64.0	1061. ㉘
R2	10.5	6.5 ㉞
R3	6.8	45.5 ㉘
M1	0	0
M2	396.0	1754. ㉙
M3	411.2	265.9 ㉞

MAXIMUM COMBINED LOADS (SEISMIC + NOZZLE)

R1 = 1810 Ⓐ + 1061 Ⓑ = 2871. lb
R2 = 46 Ⓑ + 10.5 Ⓐ = 57. lb
R3 = 84 Ⓐ + 45.5 Ⓑ = 130. lb
M1 = 0 + 0 = 0
M2 = 2176 Ⓐ + 1754 Ⓑ = 3930. in.lb
M3 = 1002 Ⓑ + 411.2 Ⓐ = 1413. in.lb

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STRESS CHECK

W6x20

$$f_a = \frac{R1_{MAX}}{A} = \frac{2871 \text{ lb}}{5.87 \text{ in}^2} = .49 \text{ Ksi}$$

$$f_{b2} = \frac{M2_{MAX}}{S_{22}} = \frac{3930 \text{ in.lb}}{13.4 \text{ in}^3} = .29 \text{ Ksi}$$

$$f_{b3} = \frac{M3_{MAX}}{S_{33}} = \frac{1413 \text{ in.lb}}{4.41 \text{ in}^3} = .32 \text{ Ksi}$$

$$f_{v2} = \frac{R2_{MAX}}{A_{22}} = \frac{57 \text{ lb}}{4.39 \text{ in}^2} = .01 \text{ Ksi}$$

$$f_{v3} = \frac{R3_{MAX}}{A_{33}} = \frac{130 \text{ lb}}{1.61 \text{ in}^2} = .08 \text{ Ksi}$$

INTERACTION

$$\frac{.49}{18.61} + \frac{.29 + .32}{21.6} = .05 < 1$$

$$f_{v2} + f_{v3} < 14.4 \text{ Ksi}$$

∴ QUALIFIED USING LEVEL A LIMITS

SCE HX E-34

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MAXIMUM LOADS, W4 x 13, ELEMENT TYPE 3

FRAME A

	R1	R2	R3	m1	m2	m3
a_x a_y a_z	667.7 ⑬ 826.3 ⑬ 348.3 ⑰	11.9 ⑮ 14.4 ⑪ 186.1 ⑬	441.6 ⑭ 79.4 ⑬ 47.2 ⑱	NEGLIGIBLE . . .	7495. ⑭ 824.5 ⑬ 1073. ⑱	137.6 ⑮ 164.0 ⑫ 2046. ⑬
SRSS	1118.	187.	451.	.	7616.	2057.
DW	1836. ⑬	31.9 ⑪	176.4 ⑬	.	1832. ⑬	364.3 ⑫
TOTAL	2954.	219.	628.	.	9448.	2421.

FRAME B

	R1	R2	R3	m1	m2	m3
a_z a_y a_z	591.9 ㉝ 668.2 ↓ 376.1	20.2 ㉝ 10.6 ↓ 169.7	428.8 ㉜ 63.6 ㉝ 27.1 ㉝	NEGLIGIBLE . . .	7229. ㉜ 664.1 ㉝ 343.5 ㉚	256.7 ㉜ 143.7 ㉛ 1854. ㉝
SRSS	969.	171.	434.	.	7268.	1877.
DW	1485. ㉝	23.5 ㉝	141.4 ㉝	.	1476. ㉝	319.3 ㉛
TOTAL	2454.	195.	576.	.	8744.	2196.

REV	BY	DATE	CHECKED	DATE
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IMPELL CORPORATION

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NOZZLE LOADS, W4 x 13

	FRAME A		FRAME B	
R1	265.1	⑪	2133.	㉝
R2	140.1	⑬	34.0	㉝
R3	244.2	⑬	358.8	㉚
M1	0		4.	㉜
M2	4101.	⑭	6049.	㉛
M3	1520.	⑭	585.2	㉜

COMBINED LOADS (SEISMIC + NOZZLE)

R1 = 2954. Ⓐ + 2133 Ⓑ = 5087.
R2 = 219. Ⓐ + 140.1 Ⓐ = 359.
R3 = 628. Ⓐ + 358.8 Ⓑ = 987.
M1 = 0 + 4 Ⓑ = NEGLIGIBLE
M2 = 9448. Ⓐ + 6049 Ⓑ = 15497.
M3 = 2421. Ⓐ + 1520 Ⓐ = 3941.

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W4 x 13

$$f_a = \frac{R1_{MAX}}{A} = \frac{5087\ \text{lb}}{3.83\ \text{in}^2} = 1.33\ \text{Ksi}$$

$$f_{b2} = \frac{M2_{MAX}}{S_{22}} = \frac{15497\ \text{in.lb}}{5.46\ \text{in}^3} = 2.84\ \text{Ksi}$$

$$f_{b3} = \frac{M3_{MAX}}{S_{33}} = \frac{3941\ \text{in.lb}}{1.90\ \text{in}^3} = 2.07\ \text{Ksi}$$

$$f_{v2} = \frac{R2_{MAX}}{A_{22}} = \frac{359\ \text{lb}}{2.80\ \text{in}^2} = .13\ \text{Ksi}$$

$$f_{v3} = \frac{R3_{MAX}}{A_{33}} = \frac{987\ \text{lb}}{1.16\ \text{in}^2} = .85\ \text{Ksi}$$

INTERACTION

$$\frac{1.33}{18.95} + \frac{2.84 + 2.07}{21.6} = .30 < 1$$

$$f_{v2} + f_{v3} < F_v = 14.4\ \text{Ksi}$$

∴ QUALIFIES USING LEVEL A ALLOWABLES

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REV	BY	DATE	CHECKED	DATE
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MAXIMUM LOADS, C4x5.4 FRAME B

	R1	R2	R3	M1	M2	M3
a_x a_y a_z	48.7 16.2 658.0	3.3 .5 14.3	.2 2.9 0.0	NEGLIGIBLE	6.7 33.8 2.3	36.8 22.0 495.2
SRSS	660.	15.	3.	.	35.	497.
DW	35.9	1.2	6.4	.	75.0	48.9
TOTAL	696.	16.	9.	.	110.	546.

	R1	R2	R3	M1	M2	M3
a_z a_y a_z	. . .	. . .	. . .	. . .	. . .	. . .
SRSS	.	.	.	.	.	.
DW	.	.	.	.	.	.
TOTAL	.	.	.	.	.	.

NOZZLE LOADS, C4 x 5.4

R1	60.0
R2	3.3
R3	0
M1	0
M2	9.7
M3	135.8

COMBINED LOADS

R1	696	+	60.0	=	756 lb
R2	16	+	3.3	=	19 lb
R3	9	+	0	=	9 lb
M1	0	+	0	=	0
M2	110	+	9.7	=	120 lb.in
M3	546	+	135.8	=	682 · in.lb

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C4 x 5.4

$$f_a = \frac{R1\ \text{max}}{A} = \frac{756\ \text{lb}}{1.59\ \text{in}^2} = .48\ \text{ksi}$$

$$f_{b2} = \frac{M2\ \text{max}}{S_{22}} = \frac{120\ \text{in-lb}}{.283\ \text{in}^3} = .42\ \text{ksi}$$

$$f_{b3} = \frac{M3\ \text{max}}{S_{33}} = \frac{682\ \text{in-lb}}{1.93\ \text{in}^3} = .35\ \text{ksi}$$

$$f_{v2} = \frac{R2\ \text{max}}{A_{22}} = \frac{19\ \text{lb}}{.736\ \text{in}^2} = .03\ \text{ksi}$$

$$f_{v3} = \frac{R3\ \text{max}}{A_{33}} = \frac{9\ \text{lb}}{.938\ \text{in}^2} = .01\ \text{ksi}$$

INTERACTION

$$\frac{.48}{13.97} + \frac{.42 + .35}{21.6} = .07$$

QUALIFIED USING LEVEL A ALLOWABLES

					SCE HX - E-34		
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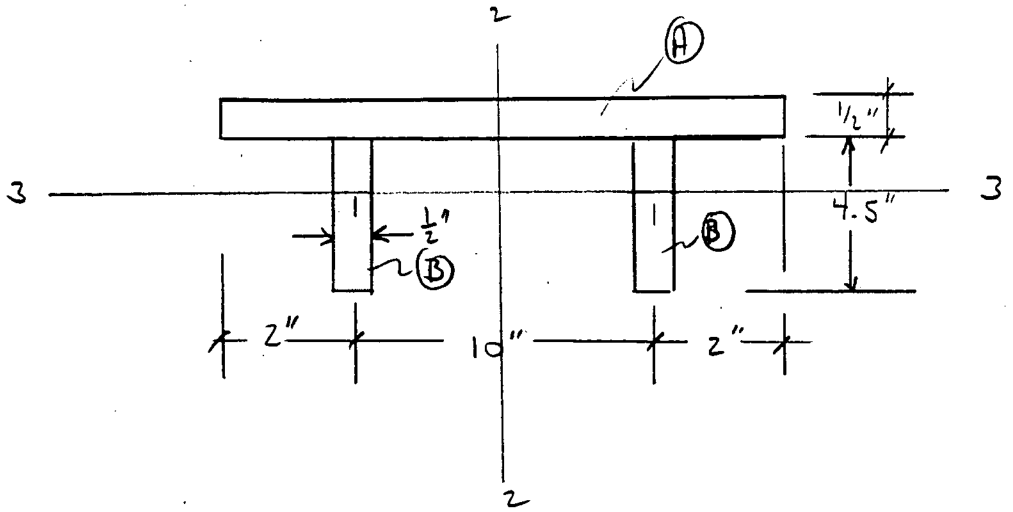
SUPPORT SADDLES

DIMENSIONS FROM [1]



$$I_{22} = I_A + 2(I_B + A_B d_B^2)$$

$$I_A = \frac{(.50in)(14in)^3}{12} = 114.3 in^4$$

$$I_B = \frac{(4.5in)(.5in)^3}{12} = .047 in^4$$

$$A_B = (4.5in)(.5in) = 2.25 in^2$$

$$d_B = 5''$$

$$I_{22} = 114.3 in^4 + 2\left[(.047 in^4) + (2.25 in^2)(5 in)^2\right] = 227. in^4$$

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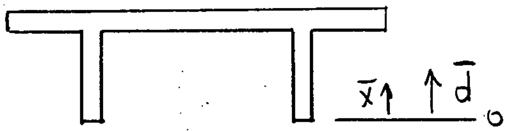
$$I_{33} = \left(I_A + A_A \bar{d}_A^2\right) + 2\left(I_B + A_B \bar{d}_B^2\right)$$

$$I_A = \frac{(14in)(.5in)^3}{12} = .146 in^4 \qquad I_B = \frac{(.5in)(4.5in)^3}{12} = 3.80 in^4$$

$$A_A = (14in)(.5in) = 7.0 in^2 \qquad A_B = (.5in)(4.5in) = 2.25 in^2$$



$$\bar{X}_A = 4.5'' + .5''/2 = 4.75''$$

$$\bar{X}_B = 4.5''/2 = 2.25''$$

$$\bar{d} = \frac{\bar{X}_A A_A + 2(\bar{X}_B A_B)}{A_A + 2A_B}$$

$$= \frac{(4.75in)(7.0in^2) + 2(2.25in)(2.25in^2)}{(7.0 + 2(2.25))in^2} = 3.77in$$

$$\therefore \quad \bar{d}_A = \bar{X}_A - \bar{d} = 4.75 - 3.77 = .98in \qquad \bar{d}_B = |\bar{X}_B - \bar{d}| = 3.77in - 2.25in = 1.52in$$

$$I_{33} = \left[.146in^4 + (7.0in^2)(.98in)^2\right] + 2\left[(3.80in^4) + (2.25in^2)(1.52in)^2\right]$$

$$= 24.87 in^4$$

$$C_{33} = MAX\left[(3.77), \ |5 - 3.77|\right] = \underline{3.77in}$$

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$$A = A_A + 2A_B = (7.0\,in^2) + 2(2.25\,in^2) = 11.50\,in^2$$

$$A_{22} = 2(5.0\,in)(.5\,in) = 5\,in^2$$

$$A_{33} = (14.0\,in)(.5\,in) = 7.00\,in$$

LOADS (EL 48 + 49)

	R1	R2	R3	M1	M2	M3
ax	1.1	21.0	1466.		16390.	313.
ay	998.3	74.7	4.2	NOTE 1	31.0	1098.
az	356.4	1480.	78.3		997.6	18860.
SRSS	1060.	1482.	1468		16420.	18895.
DW	2129.	165.9	9.2		68.9	2441.
NOZZ	2669.	850.3	674.3		18970.	11720.
TOTAL	5858.	2498.	2152		35459.	33056

NOTE 1: THE ACTUAL TORSIONAL STIFFNESS OF THE SADDLES IS LOW, THUS THE TORSIONAL LOADS WILL ALSO BE VERY LOW. ∴ TORSIONAL LOADS WILL CAUSE INSIGNIFICANT STRESSES AND ARE NEGLECTED

STRESSES

AXIAL

$$f_a = \frac{R1}{A} = \frac{5858 \text{ lb}}{11.50 \text{ in}^2} = .51 \text{ Ksi}$$

BENDING

$$f_{b2} = \frac{M2 \cdot C2}{I_{22}} = \frac{(35459 \text{ in.lb})(7.0 \text{ in})}{227. \text{ in}^4} = 1.09 \text{ Ksi}$$

$$f_{b3} = \frac{M3\,C}{I_{33}} = \frac{(33056 \text{ in.lb})(3.77 \text{ in})}{24.87 \text{ in}^4} = 5.01 \text{ Ksi}$$

SHEAR

$$f_{v2} = \frac{R2}{A2} = \frac{2498 \text{ lb}}{5.0 \text{ in}^2} = .50 \text{ Ksi}$$

$$f_{v3} = \frac{R3}{A3} = \frac{2152 \text{ lb}}{7.0 \text{ in}^2} = .31 \text{ Ksi}$$

ALLOWABLES

$$\left.\begin{matrix} F_b = 21.6 \text{ Ksi} \\ F_v = 14.4 \text{ Ksi} \end{matrix}\right\} \text{LEVEL A}$$

Fa :

$$r = \left[\frac{I}{A}\right]^{\frac{1}{2}} = \left[\frac{24.87 \text{ in}^4}{11.50 \text{ in}^2}\right]^{\frac{1}{2}} = 1.47$$

ASSUME $K = 1.0$

$l \approx$ 12" - SHELL OD/2 (SEE [4])

$= 12'' - 18''/2$

$\hat{=}$ 3in

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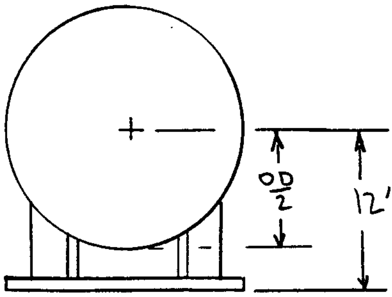

$$\frac{Kl}{r} = \frac{(1.0)(3.0)}{1.47} = 2.0$$

$\therefore F_a = 21.5$ ksi (AISC, p. 5-74, LEVEL A)

INTERACTION

$$\frac{.51}{21.5} + \frac{1.09 + 5.01}{21.6} = .31 < 1$$

$\therefore$ SADDLES QUALIFIED

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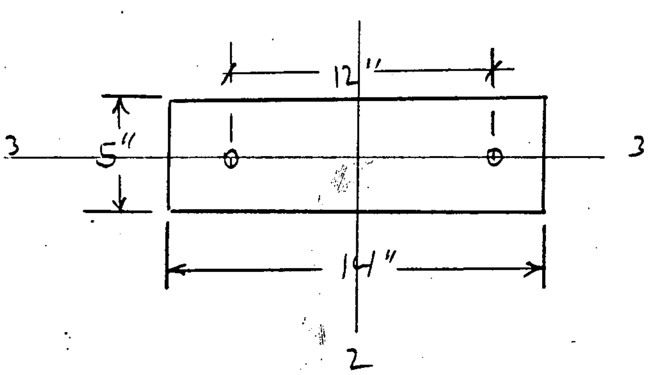
SADDLE BOLTS

BASED ON 13/16" DIA HOLES ([4]), ASSUME 3/4" BOLTS

$A_{ROOT} = .302 \text{ in}^2$
$A_{TENSILE} = .334 \text{ in}^2$ } [3], p. 4-141



LOADS AT THE SADDLE BASES ARE TABULATED ON THE FOLLOWING PAGE. DESIGN LOADS ARE SELECTED AS

R1 = 1772 lb
R2 = 2211 lb
R3 = 1891 lb

M2 = 26592. in.lb
M3 = 4100 in.lb

BOLT LOADS

48I

	R1	R2	R3	M1	M2	M3
a_x a_y a_z	1.1 998.3 356.4	21.0 74.7 1192.	1466. 4.2 78.3	NOTE 1 p.50	16390. 18.9 57.6	61.0 202.3 2125.
SRSS	1060	1195.	1468		16390.	2135.
DW NOZZ	-2129. 293.8	165.9 850.3	9.2 242.7		42.0 8877.	449.7 1515.
TOTAL	-775.	2211	1720.		25309	4100.

49I

	R1	R2	R3	M1	M2	M3
a_x a_y a_z	1.1 795.9 356.4	21.0 74.7 1480.0	1205. 4.2 78.3		15670. 18.9 57.6	44.9 190.1 1103.
SRSS	872.	1482.	1208		15670	1120
DW NOZZ	-1769. 2669	165.9 237.7	9.2 674.3	NOTE 1 p. 50	42.0 10880.	422.4 674.4
TOTAL	1772	1886.	1891		26592.	2217.

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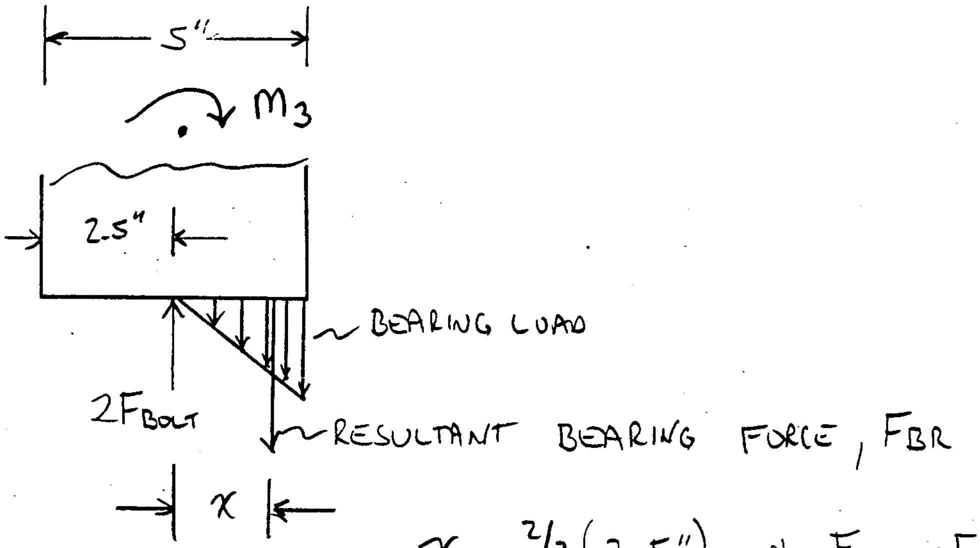
M2 IS ASSUMED TO BE RESISTED BY A FORCE COUPLE IN THE BOLTS.

M3 IS ASSUMED RESISTED BY A LOAD DISTRIBUTION AS SHOWN BELOW.



$$x = \tfrac{2}{3}(2.5") = 1.67\text{in} \qquad \& \quad F_{BOLT} = F_{BR}$$

$$\therefore\ 2F_{BOLT}\,x = M3$$

$$F = \frac{M3}{2(1.67\text{in})}$$

TOTAL TENSILE BOLT FORCE:

$$T = \frac{R1}{2} + \frac{M2}{12\text{in}} + \frac{M3}{(1.67\text{in})2}$$

$$= \frac{1772\text{ lb}}{2} + \frac{26592\text{ in}\cdot\text{lb}}{12\text{ in}} + \frac{4100\text{ in}\cdot\text{lb}}{(1.67\text{in})2}$$

$$= 4330\ \text{lb}/\text{bolt}$$

SHEAR BOLT FORCE

$$V = \frac{\left[(R2)^2 + (R3)^2\right]^{\frac{1}{2}}}{2 \text{ bolts}}$$

$$= \frac{\left[(2211.\text{lb})^2 + (1891.\text{lb})^2\right]^{\frac{1}{2}}}{2 \text{ bolts}} = 1455 \text{ lb/bolt}$$

BOLT STRESS:

$$f_{bt} = \frac{T}{A_{TEN}} = \frac{4330 \text{ lb}}{.334 \text{ in}^2} = 13.0 \text{ ksi}$$

$$f_{bv} = \frac{V}{A_{ROOT}} = \frac{1455 \text{ lb}}{.302 \text{ in}^2} = 4.82 \text{ ksi}$$

ALLOWABLES (ASSUME A 307 BOLTS, Su = 60 ksi)

$$F_{bT} = \frac{Su}{2} = \frac{60 \text{ ksi}}{2} = 30 \text{ ksi}$$

$$F_{vb} = \frac{.62\, Su}{3} = \frac{.62(60 \text{ ksi})}{3} = 12.4 \text{ ksi}$$

LEVEL A
NF-3324.6

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INTERACTION:

$$\frac{13.0}{30.0} + \frac{4.82}{12.4} = .82 < 1$$

∴ QUALIFIED USING LEVEL A ALLOWABLES.

8.0 BASE PLATE EVALUATION

BASE PLATES (INCLUDING ANCHOR BOLTS) ARE DIVIDED INTO FOUR GROUPS. EACH GROUP IS EVALUATED SEPERATLY.

GROUP 1. – BASE PLATES WITH FOUR ANCHORS AND ATTACHED TO A WF MEMBER. INCLUDES PLATES AT ELEMENT NOS. 13I, 33J, 9I, 28I, 15I, 17I, 35J.

GROUP 2 – MAIN CHANNEL CONNECTIONS TO WALL, ELEMENTS 8J, 27J

GROUP 3 - CONNECTION OF VERTICAL CHANNEL TO FLOOR, ELEMENTS 1I, 19I

GROUP 4 - CONNECTION OF MEMBER 37J TO WALL.

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B.1 GROUP 1

BASE PLATES (13I, 33J, 9I, 28I, 15I, 17I, 35J)

A CONSERVATIVE EVALUATION WILL BE PERFORMED USING THE FOLLOWING ASSUMPTIONS:

- BENDING IS ASSUMED ABOUT THE ℄ OF THE BASE PLATE
- BEARING LOADS AND ANCHOR BOLT LOADS WILL BE CALCULATED ASSUMING A 14" SQUARE BASE PLATE.
- BEARING LOADS WILL BE APPLIED TO A 16" SQUARE PLATE (MAXIMUM SIZE). LOADING WILL BE ASSUMED UNIFORM AND REQUIRED THICKNESS CALCULATED USING [3], p. 3-99
- BASED ON THE LOADS CALCULATED ON THE FOLLOWING PAGES THE FOLLOWING LOADS ARE SELECTED TO CHECK BASE PLATE ADEQUACY:

AXIAL = 4647
SHEAR 1 = 3616
SHEAR 2 = 1918
TORSION = 2125
BENDING 1 = 3035
BENDING 2 = 4673

} WORST CASE RESULTANT LOADS, SEE TABLE ON p. 67

THESE LOADS ARE SELECTED FROM THE LOADS FOR 13I, 33J, 9I, 28I. THEY ENVELOPE THE LOADS FOR 15I, 17I, 35J BY OBSERVATION.

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SEISMIC LOADS @ BASE PLATES
BASE PLATE LOADS (LOCAL COORDINATES)

		X	Y	Z	SRSS	DW	TOTAL
R1	15I	229.5	87.7	128.8	277.	194.9	472.
	17I	129.9	34.4	348.3	373.	76.5	450.
	35J	179.1	82.6	401.9	448	183.5	631.
R2	15I	11.9	3.0	3.6	13.	6.6	19.
	17I	6.1	5.7	8.7	12.	12.6	25.
	35J	8.8	7.5	27.0	29.	16.7	46.
R3	15I	5.4	7.6	20.2	22.	17.1	39.
	17I	15.5	12.7	47.2	51.	28.2	79.
	35J	32.7	2.8	20.5	39.	6.3	45.
m1	15I	.4	.2	.1		.5	NEGLIGIBLE
	17I	.9	.2	.1		.4	
	35J	.1	.1	2.1		.2	
m2	15I	122.2	108.9	248.4	297.	242.0	539.
	17I	247.6	145.7	390.1	484.	323.9	808.
	35J	676.4	77.3	458.7	821.	171.8	993.
m3	15I	137.6	66.1	63.1	165.	146.9	312.
	17I	38.5	103.8	111.3	157.	230.6	388
	35J	210.1	148.1	621.6	673.	329.2	1002.

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SEISMIC LOADS @ BASEPLATES

		X	Y	Z	SRSS	D W	TOTAL
R1	13I	667.7	826.3	278.0	1098.	1836.	2934.
	33J	591.9	668.2	376.1	969.	1485	2454
	9I	313.4	530.9	129.0	630.	1180.	1810
	28I	235.1	431.7	8.7	492.	959.4	1451.
R2	13I	2.2	11.9	186.1	186.	26.4	213.
	33J	20.2	10.6	169.7	171.	23.5	195
	9I	2.1	.7	2.6	3.	1.5	5.
	28I	2.1	1.6	19.6	20.	3.6	23.
R3	13I	437.3	79.4	25.1	445.	176.4	622.
	33J	424.5	63.6	22.2	430.	141.4	571.
	9I	32.1	6.9	8.5	34.	15.4	49.
	28I	28.7	4.1	14.5	32.	9.2	42.
M1	13I	.2	.2	.9	1.	.4	NEGLIGIBLE
	33J	.5	.5	1.7	2.	1.2	
	9I	.2	.2	.8	1.	.5	
	28I	.3	.2	1.4	1.	.5	
M2	13I	1650.	824.5	240.7	1860.	1832.	3692.
	33J	1649.	664.1	138.0	1783.	1476.	3259.
	9I	389.4	218.0	213.3	495.	484.4	979.
	28I	299.0	145.0	346.7	480.	322.2	802.
M3	13I	1.5	116.9	2046.	2049.	259.8	2309.
	33J	162.6	83.8	1854.	1863.	186.2	2049
	9I	47.5	10.1	93.9	106.	22.6	128.
	28I	56.8	32.0	482.5	487.	71.1	558.

NOZZLE LOADS @ BASEPLATES

	R1	R2	R3	M1	M2	M3
13I	231.7	140.1	244.2	0	980.6	1396.
33J	2133.	34.0	139.6	4.	416.1	122.3
9I	64.0	10.5	6.8	0	15.5	177.6
28I	1061.	2.6	45.8	0	796.5	86.5
15I	101.2	1.2	9.2	0	74.6	31.2
17I	227.8	9.5	13.0	0	29.4	122.2
35J	301.9	6.5	17.0	0	361.6	179.0

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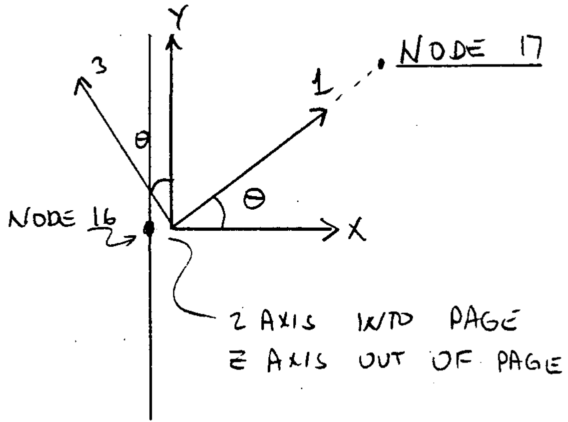
BASE PLATES @ 13I, 33J



$(X, Y)_{16} = (0, 48.0)$

$(X, Y)_{17} = (8.5, 54.0)$

$$\Theta = \text{ARCTAN}\left(\frac{\Delta Y}{\Delta X}\right)$$

$$\Theta = \text{ARCTAN}\left(\frac{54.0 - 48.0}{8.5 - 0.0}\right) = 35^\circ$$

SELECT MAXIMUM LOADS (SEISMIC + NOZZLE)

R1 = 2934 lb (13I) + 2133 lb (33J) = 5067. lb
R2 = 213 lb (13I) + 140 lb (13I) = 353. lb
R3 = 622 lb (13I) + 244.2 (13I) = 866. lb
M1 = NEGLIGIBLE
M2 = 3692 in-lb (13I) + 980.6 (13I) = 4673 in-lb
M3 = 2309 in-lb (13I) + 1396 (13I) = 3705 in-lb

$F_x = R_1 \cos\Theta + R_3 \sin\Theta$ (NOTE 1)
$= 5067 \cos 35^\circ + 866 \sin 35^\circ$
$= 4647.$ lb (INTO WALL)

$F_y = R_3 \cos\Theta + R_1 \sin\Theta$
$= 866 \cos 35^\circ + 5067 \sin 35^\circ$
$= 3616.$ lb

NOTE 1 : NEGLECT DIRECTIONAL EFFECTS. (CONSERVATIVE)

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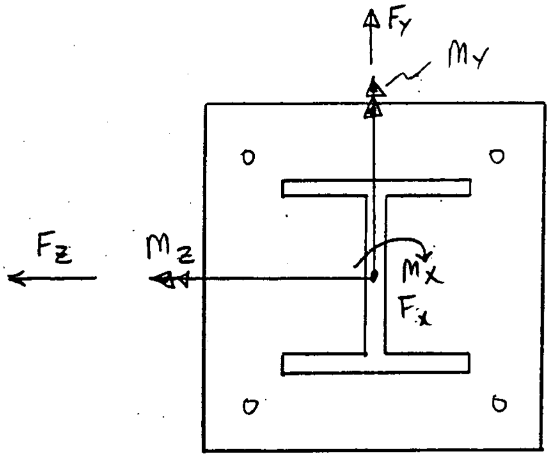
$F_Z = R_Z = 353 .\ \text{lb}$

$$M_X = M_1 \overset{0}{\cancel{\cos}}\ \theta + M_3 \sin\theta$$
$$= (3705\ \text{in}\cdot\text{lb}) \sin 35^\circ$$
$$= 2125\ \text{in}\cdot\text{lb} \qquad \text{(TORSION)}$$

$$M_Y = M_1 \overset{0}{\cancel{\sin}}\ \theta + M_3 \cos\theta$$
$$= (3705\ \text{in}\cdot\text{lb}) \cos 35^0$$
$$= 3035.\ \text{in}\cdot\text{lb}$$

$$M_Z = M_2 = 4673\ \text{in}\cdot\text{lb}$$



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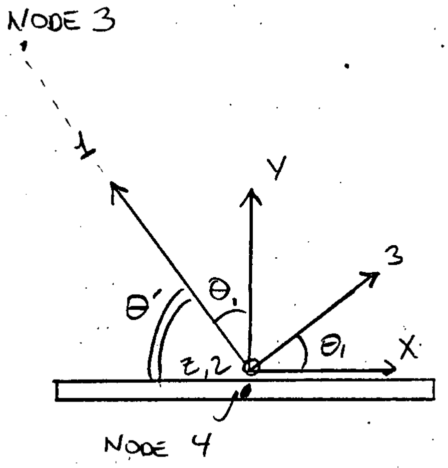
BASE PLATES @ 9I, 28I



$(X,Y)_3 = (31.0 \quad 43.0)$

$(X,Y)_4 = (67.0, 0)$

$$\theta' = \text{ARCTAN}\left(\frac{\Delta Y}{\Delta X}\right) = \text{ARCTAN}\left(\frac{43.0 - 0}{31.0 - 67}\right)$$

$\theta' = 50°$

$$\theta_1 = 180° - 90° - \theta'$$
$$= 180° - 90° - 50°$$
$$= 40°$$

$F_X = R_3 \cos\theta_1 + R_1 \sin\theta_1$

$M_X = M_3 \cos\theta_1 + M_1 \sin\theta_1$

$F_Y = R_3 \sin\theta_1 + R_1 \cos\theta_1$

$M_Y = M_3 \sin\theta_1 + M_1 \cos\theta_1$

NEGLECT DIRECTIONAL EFFECTS, CONSIDER ALL OPERATIONS AS ABSOLUTE SUMS

$M_2 = M_Z$

$F_2 = F_Z$

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USE MAXIMUM LOADS (SEISMIC + NOZZLE)

$R_1 = 1810 \text{ lb } (9I) + 1061. \ (28I) = 2871. \text{ lb}$
$R_2 = 23 \text{ lb } (28I) + 10.5 \ (9I) = 34. \text{ lb}$
$R_3 = 49 \text{ lb } (9I) + 45.8 \ (28I) = 95. \text{ lb}$

$M_1 =$ NEGLIGIBLE
$M_2 = 979 \text{ lb·in } (9I) + 796.5 \ (28I) = 1776 \text{ lb·in}$
$M_3 = 558 \text{ in·lb } (28I) + 177.6 \ (9I) = 736 \text{ lb·in}$

$F_x = R_3 \cos\theta_1 + R_1 \sin\theta_1$
$95 \cos 40 \ \ 2871 \sin 40 = 1918. \text{ lb}$

$F_y = R_3 \sin\theta_1 + R_1 \cos\theta_1$
$95 \sin 40 + 2871 \cos 40 = 2260 \text{ lb}$ (AXIAL)

$F_z = R_2 = 34. \text{ lb}$

$M_x = M_3 \cos\theta_1 + \overset{0}{\cancel{M_1 \sin\theta_1}}$
$= 736 \cos 40 + 0 = 564. \text{ lb·in}$

$M_y = M_3 \sin\theta_1 + \overset{0}{\cancel{M_1 \cos\theta_1}}$
$= 736 \sin 40° = 473. \text{ in·lb}$

$M_z = M_2 = 1776 \text{ in·lb}$

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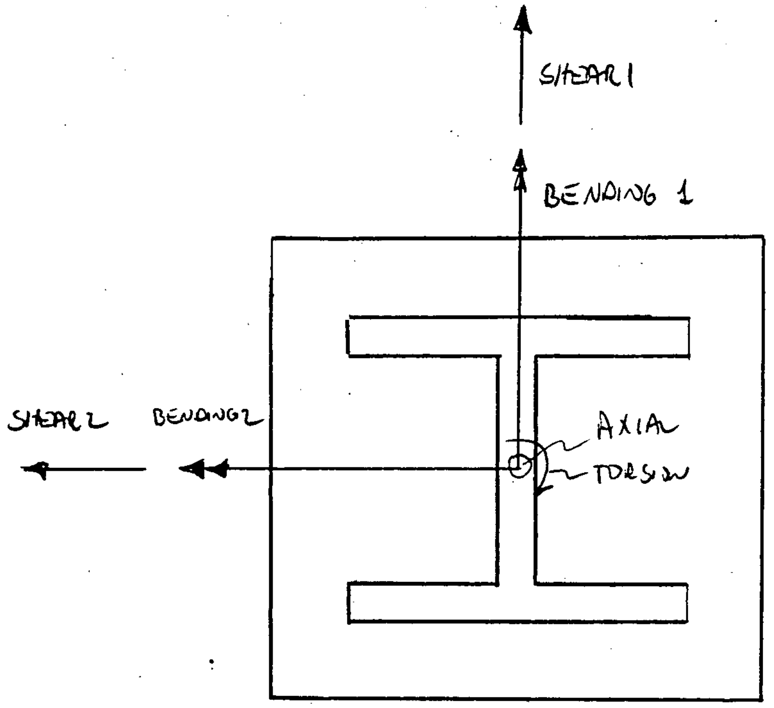
SUMMARY of BASEPLATE (GROUP 1) LOADS

	AXIAL	SHEAR 1	SHEAR 2	TORSION	BEND 1	BEND 2
13I/33J	4647.*	3616 *	353	2125 *	3035 *	4673 *
9I/28I	2260	1918 *	34	473	564	1776



*NOTE: MAXIMUM LOADS SELECTED TO EVALUATE BASEPLATE & ANCHOR BOLTS.

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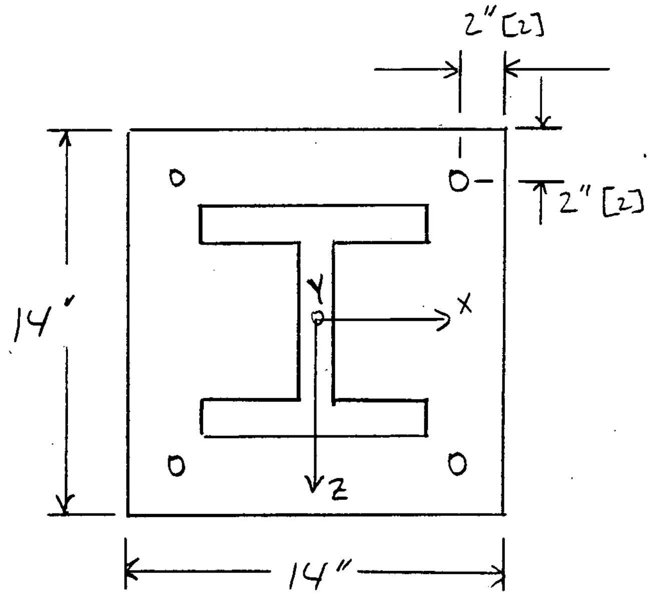
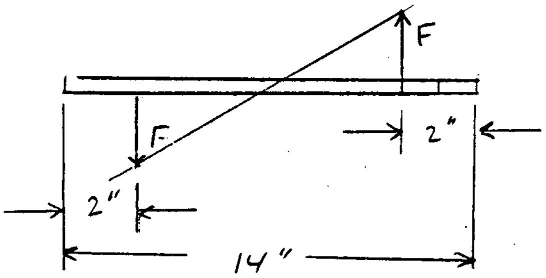


ANCHOR BOLTS

ASSUMING 14" SQUARE PLATE W/BOLTS 2" FROM EACH EDGE, ROTATION ABOUT ℄ OF PLATE



TENSILE BOLT LOAD

$$f_t = \frac{\text{AXIAL}}{4 \text{ bolts}} + \frac{\text{BENDING 1} + \text{BENDING 2}}{2(10")}$$

SCE HX E-34

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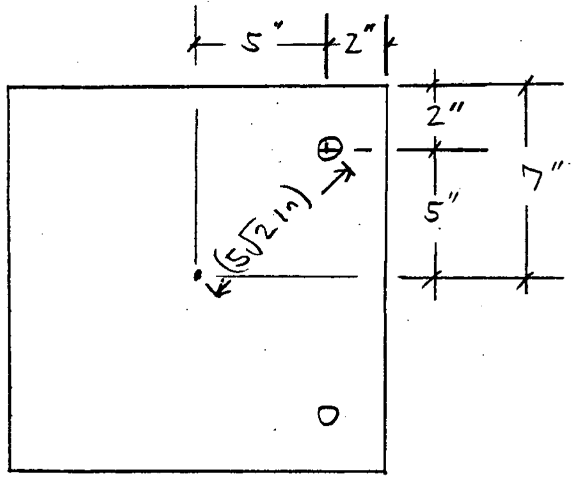
$$f_t = \frac{4647\ lb}{4} + \frac{3035\ lb_{in} + 4673\ lb_{in}}{2(10\ in)}$$

$$= 1547\ lb/bolt$$

SHEAR BOLT LOAD



$$V_1 = \frac{SHEAR\ 1}{4} + \cos 45° \frac{TORSION}{4(5\sqrt{2})}$$

$$V_2 = \frac{SHEAR\ 2}{4} + \sin 45° \frac{TORSION}{4(5\sqrt{2})}$$

$$f_v = \sqrt{V_1^2 + V_2^2}$$

$$V_1 = \frac{3616\ lb}{4} + \frac{2125\ in \cdot lb}{4(5\sqrt{2}\ in)} \cos 45° = 957.\ lb$$

$$V_2 = \frac{1918\ lb}{4} + \frac{2125\ in \cdot lb}{4(5\sqrt{2}\ in)} \sin 45° = 533\ lb$$

$$f_v = \left[(957 lb)^2 + (533.lb)^2\right]^{\frac{1}{2}} = 1095\ lb/bolt$$

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ANCHOR BOLT ALLOWABLES

NUT SIZE $1\frac{1}{2}''$ FLAT - FLAT [2]

∴ ASSUME 1" DIAMETER CONCRETE EXPANSION BOLTS ([3], p. 4-136)

FROM [6] THE MINIMUM ULTIMATE LOADS FOR 1" BOLTS, ASSUMING 2000 psi CONCRETE AND 4 1/2" (MINIMUM) EMBEDMENT

ULT. TENSION = 14,000 lb
ULT. SHEAR = 27,355 lb

APPLYING A SAFETY FACTOR of 4.0

$$F_T = \frac{14{,}000\,\text{lb}}{4} = 3500\,\text{lb}$$

$$F_V = \frac{27{,}355\,\text{lb}}{4} = 6840\,\text{lb}$$

INTERACTION:

$$\frac{1547\,\text{lb}}{3500\,\text{lb}} + \frac{1095\,\text{lb}}{6840\,\text{lb}} = .60 < 1$$

∴ BOLTS QUALIFY (FS = 4.0)

SCE HX-E34

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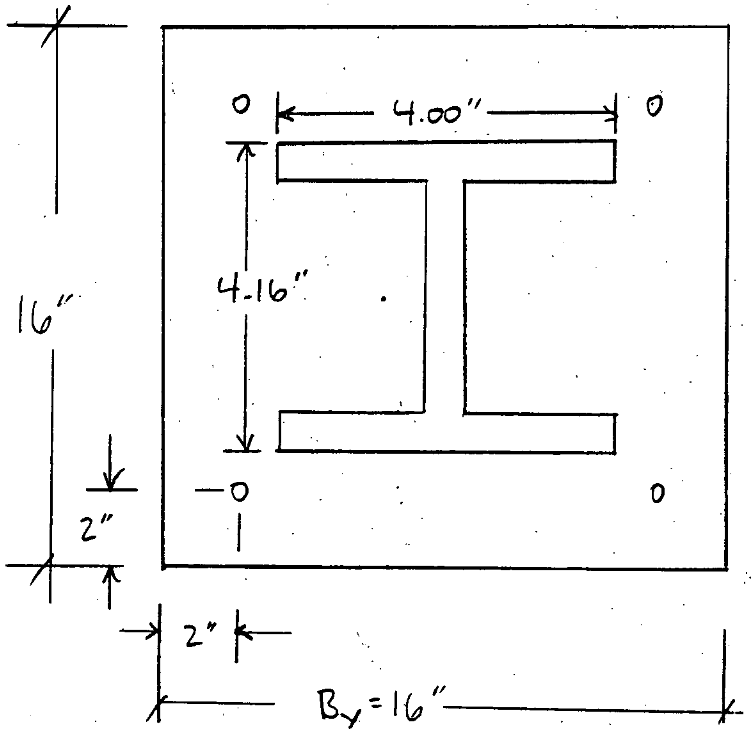
BASEPLATE (USE IMPELL BASEPLATE PROCEDURE [12])



$b_{y\,eff} = .80(4.00\,in) = 3.20\ in$

$b_{x\,eff} = .95(4.16\,in) = 3.95\,in$

} [12], p. D1, fig D2.2

$$t \geq \left[\frac{6T_b}{A_p F_B}\right]^{\frac{1}{2}}$$ [12], p. 4

WHERE, T_b = BOLT LOAD = 1547 lb

$F_B = .6(36) = 21.6$ (Level A)

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$$A_p = \text{MIN}\left[\left(\frac{d_y + \frac{b_y}{2}}{d_x'}\right), \left(\frac{d_x + \frac{b_x}{2}}{d_y'}\right)\right]$$

$$d_y = \frac{16'' - 3.20''}{2} = 6.40''$$

$$d_x = \frac{16'' - 3.95''}{2} = 6.03''$$

$$d_y' = d_y - 2'' = 6.40'' - 2'' = 4.40''$$

$$d_x' = d_x - 2'' = 6.03'' - 2.0'' = 4.03''$$

[12], fig B-1, p. viii

$$\frac{d_y + b_y/2}{d_x'} = \frac{6.40\text{in} + 3.20\text{in}/2}{4.03\text{in}} = 1.99$$

$$\frac{d_x + b_x/2}{d_y'} = \frac{6.03\text{in} + 3.95\text{in}/2}{4.40\text{in}} = 1.82$$

$$\therefore t_{MIN} = \left[\frac{6 \cdot 1547\ \text{lb}}{(1.82)(21.6\ \text{ksi})}\right]^{\frac{1}{2}} = .49\ \text{in}$$

$t_{ACTUAL} = .75''$

∴ BASEPLATE ADEQUATE

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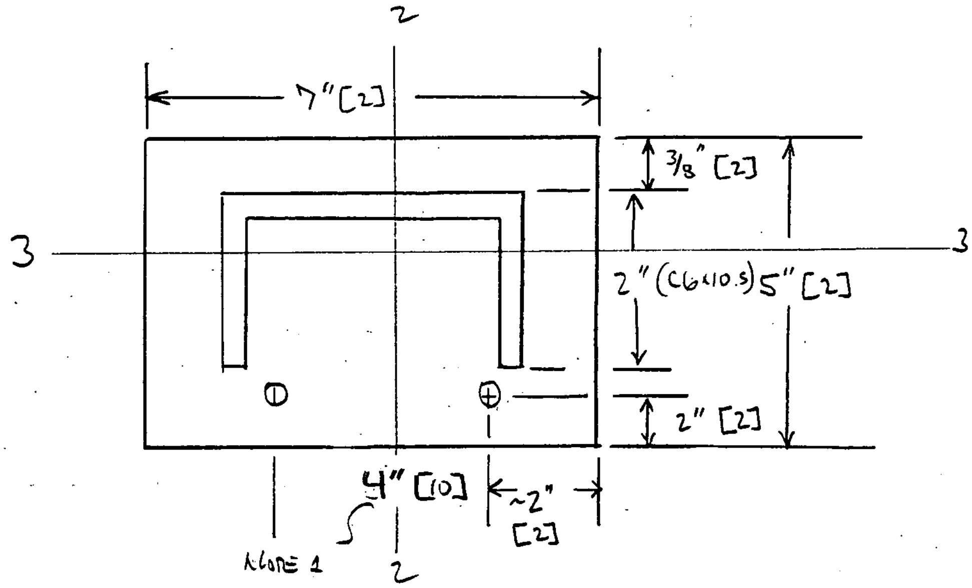
GROUP 2

BASE PLATES @ NODES 14, 32 (ELEMENTS 8J, 27J)



PER [2] THE NUT SIZES ARE 1" FLAT-FLAT. REF [3] DOES NOT LIST 1" NUTS (p. 4-136). SIZES LISTED ARE:

NUT SIZE (FLAT-FLAT)	BOLT SIZE
15/16"	5/8"
1 1/8"	3/4"

BASED ON [9] (p. 29) THE BOLT SIZE IS 3/4"

∴ ASSUME 3/4" DIA. HILTI QUIK BOLTS

NOTE (1): REF [9] LISTS THIS DIMENSION AS 5"
USING 4" WILL RESULT IN HIGHER BOLT FORCES. (CONSERVATIVE)

SCE HX E-34

REV	BY	DATE	CHECKED	DATE
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SEISMIC LOADS

		X	Y	Z	SRSS	DW	TOTAL
R1	8J	1176.	270.0	32.6	1207.	600.	1807.
	27J	1001.	217.7	227.0	1049	483.7	1533.
R2	8J	45.9	6.0	1.8	46.	13.4	60.
	27J	44.1	5.0	2.4	44.	11.1	56.
R3	8J	5.8	40.9	855.0	856.	90.9	947.
	27J	84.1	16.7	808.2	813.	37.1	850.
M1	8J	0	0	0	NEGLI-GIBLE	0	NEGLIGIBLE
	27J	0	0	0		0	
M2	8J	76.7	358.1	7600.	7609.	795.7	8405.
	27J	444.3	136.2	6960.	6975.	302.6	7278.
M3	8J	0	0	0	0	0	0
	27J	0	0	0		0	

NOZZLE LOADS

	8J	27J
R1	51.5	377.0
R2	24.1	18.5
R3	584.7	82.7
M1	0	0
M2	4657.	865.1
M3	0	0

SCE HX E-34

IMPELL CORPORATION

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BASE PLT @ 14,32, CONT

LOADS @ 8J (LOADS @ 8J ENVELOPE LOADS @ 32J)

AXIAL LOAD, $R1 = 1807 + 52 = 1859.$ lb

SHEAR LOAD

$R2 = 60 + 24 = 84.$ lb
$R3 = 947 + 585 = 1532.$ lb

$$R = [(R2)^2 + (R3)^2]^{\frac{1}{2}}$$

$$= [(84\,lb)^2 + (1532.\,lb)^2]^{\frac{1}{2}}$$

$$= 1534.\ lb$$

MOMENT (OVERTURNING)

$M2 = 8405$ in.lb + 4657 in.lb
$= 13062.$ in.lb

BOLT LOADS

TOTAL AXIAL BOLT LOAD IS CALCULATED BY ASSUMING THE MOMENT IS RESISTED BY A FORCE COUPLE IN THE BOLTS.

$$P = \frac{1859.\ lb}{2\ bolts} + \frac{13062\ in.lb}{4''}$$

$$= 4195\ lb$$

ASSUME 3/4" EXPANSION BOLTS W/MINIMUM EMBEDMENT & 4000psi CONCRETE STRENGTH (4000 psi + 3 1/4"). AVERAGE ULTIMATE CAPACITIES ARE:

PULLOUT	10150 lb
SHEAR	17133 lb

USING A FACTOR OF SAFETY OF 2.0 FOR RTS ALLOWABLES

$$F_T = \frac{10150}{2} = 5075\ \text{lb}$$

$$F_V = \frac{17133\ \text{lb}}{2} = 8567\ \text{lb}$$

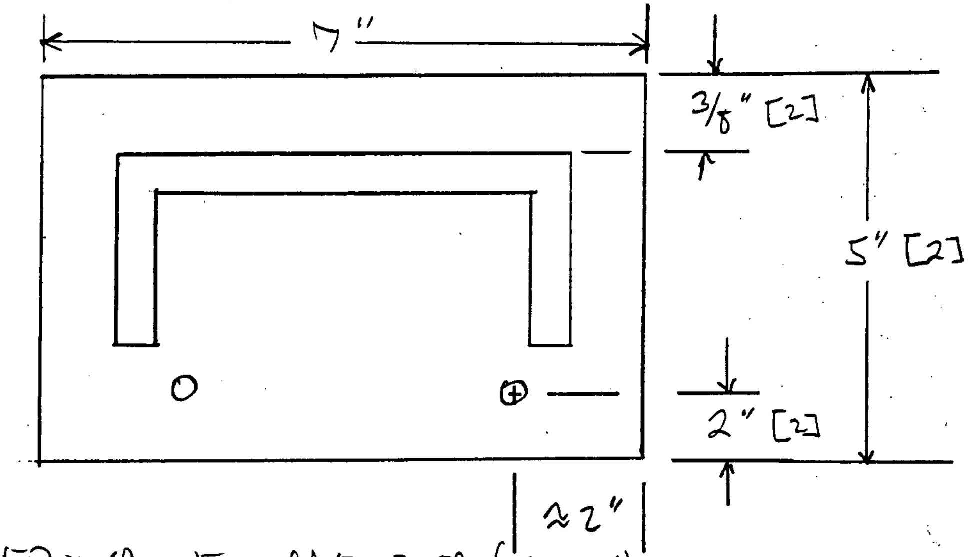
CHECK INTERACTION

$$\frac{4195\ \text{lb}}{5075\ \text{lb}} + \frac{1534\ \text{lb}}{8567\ \text{lb}} = 1.0$$

BOLTS QUALIFY USING RTS ALLOWABLES (FS = 2.0)

BASE PLT @ 14, 32, CONT

STRESS IN THE PLATE ARE EVALUATED ASSUMING THE PLATE IS A WIDE CANTILEVER WITH A POINT LOAD OF 300 lb.



EQUIVALENT CANTILEVER (NOTE 1)

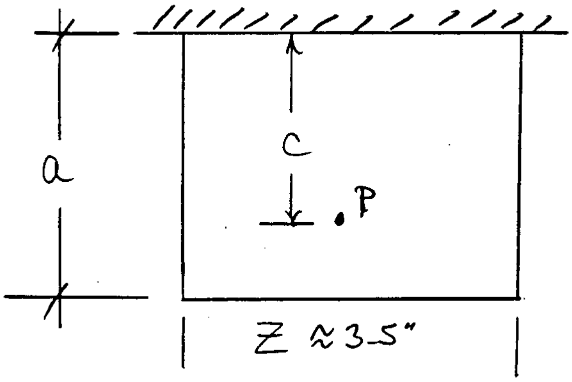


PLATE WIDTH ≈ $7''/2 = 3.5''$
CANTILEVER LENGTH a,

$a \approx 5'' - 3/8'' = 4.625$

DISTANCE TO LOAD, c

$c \approx 5'' - 3/8'' - 2'' = 2.625''$

NOTE 1; SEE [11] (ROARK) ART 7.11, pp. 188-191

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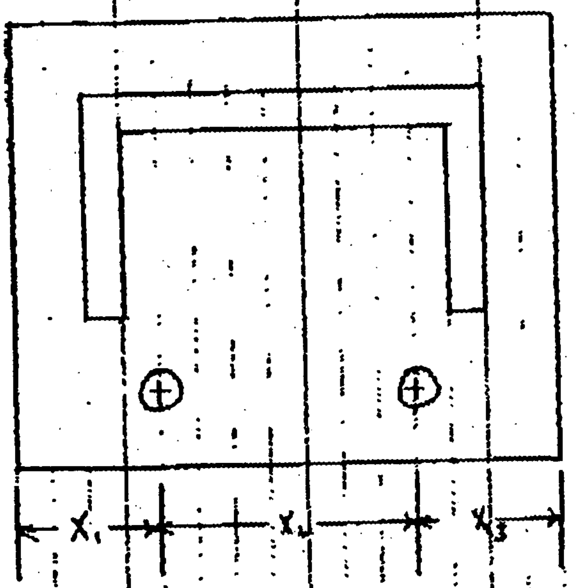
BASE PLATE 1.



X : 1 1/4"

X_2 : 4 1/8"

X_3 : 1 3/4"

PLATE THICKNESS: 1/2"

BASE PLATE 2

SAME DIMENSIONS AS SHOWN ABOVE

X_1 : 1 1/2"

X_2 : 4"

X_3 : 1 1/2"

PLATE THICKNESS: 1/2"

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		5/20/84		5/22/84	IMPELL CORPORATION	CALC NO	OF 4
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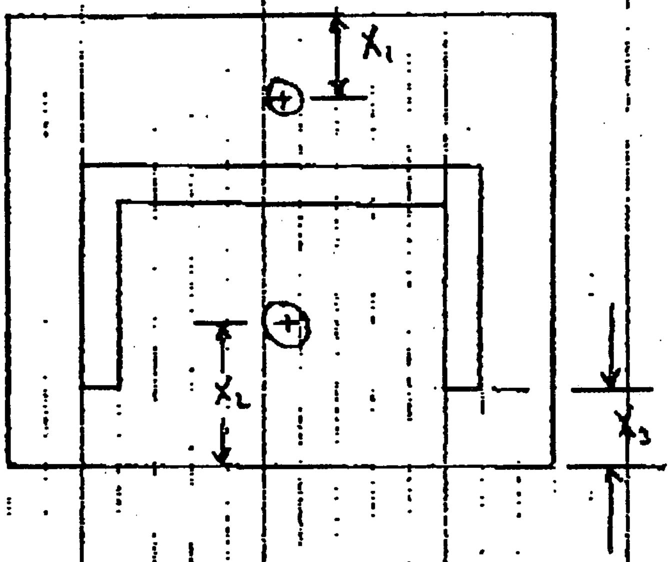
[10], p. 515

BASEPLATE 3



X_1 : 1½"

X_2 : 1½"

X_3 : 2¼"

PLATE THICKNESS: ½"

REV	BY	DATE	CHECKED	DATE
		6/20/84	MJO	6/20/84

IMPELL CORPORATION

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CALCULATION/PROBLEM COVER SHEET

Calculation/Problem No: EQ - 09

Title: QUALIFICATION of CHARGING PUMPS G-8A, B

Client: SCE Project: SONGS - 1 RTS

Job No: 0310 - 036

Design Input/References:

SEE SECTION 1.0

Assumptions:

AS NOTED WITHIN

Method:

Remarks: QUALIFIED, NO MODIFICATIONS REQUIRED

REV. NO.	REVISION	APPROVED	DATE
0	ORIGINAL ANALYSIS		7/18/84

EDS 0008 5/78

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APPENDIX A - REFERENCES (PROVIDED FOR INFORMATION, NOT INCLUDED IN TOTAL PAGES)

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0	WI	6/29/84	AS	7/10/84

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1.0 REFERENCES

1. BECHTEL POWER CORP. LETTER NO. BPC/V-84-156, DATED: MARCH 23, 1984, FROM J.D. DUFFIN TO W. D. GALLO (IMPELL). SUBJECT: SONGS-1 SAFE SHUTDOWN EQUIPMENT DATA, CHARGING PUMPS G-8A/B

2. AISC MANUAL OF STEEL CONSTRUCTION, 8TH EDITION, AMERICAN INSTITUTE OF STEEL CONSTRUCTION, CHICAGO.

3. PACIFIC PUMPS INC FOUNDATION PLAN, DWG NO FC-38771, REV. 4, 11-1-65, FOUNDATION PLAN FOR SONGS-1 CHARGING PUMPS, TRANSMITTED TO IMPELL WITH [1] ABOVE.

4. MEMO FROM CALVIN WONG AND JIM WAGONER (IMPELL) TO WARD INGLES (IMPELL), DATED 6/13/84, SUBJECT: NOZZLE LOADS FOR CHARGING PUMPS G-8A + G-8B.

5. PRELIMINARY CALCULATION, BECHTEL POWER CORP. CALCULATION MC-384-1 FOR CHARGING PUMPS G8A/B. NOT APPROVED - USED FOR INFORMATION ONLY.

6. ASME BOILER + PRESSURE VESSEL CODE, SECTION III, DIVISION 1, 1983 EDITION.

7. ROARK AND YOUNG, "FORMULAS FOR STRESS AND STRAIN," 5TH EDITION, McGRAW-HILL BOOK CO. N.Y. 1975

8. "AVERAGE ULTIMATE TENSILE AND SHEAR LOADS" FOR HILTI-KWIK BOLTS, FROM HILTI CATALOG (INCLUDED IN APPENDIX A)

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0	WI	6/29/84	AS	7/13/84	IMPELL CORPORATION	JOB NO 0310-036 CALC NO EQ-09	PAGE 4 OF 36
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2.0 INTRODUCTION / PROCEDURE

THIS CALCULATION CONTAINS THE EVALUATION OF THE SUPPORTS FOR THE CHARGING PUMPS G-8A + G-8B AT SONGS-1.

THE EVALUATION ADDRESSES THE PUMP AND MOTOR MOUNTING BOLTS, THE FOUNDATION ANCHOR BOLTS, AND THE BASE CHANNEL. ACCEPTANCE CRITERIA ARE BASED ON THE ASME CODE (SECTION III, SUBSECTION NF) AND THE PROJECT TECHNICAL INSTRUCTIONS.

THE EVALUATION IS PERFORMED USING AN EQUIVALENT STATIC ANALYSIS AND THE PEAK OF THE APPROPRIATE FRS. RESULTS ARE SUMMARIZED IN SECTION 10.0.

3.0 SEISMIC LOADS

3.1 SYSTEM FREQUENCY

THE DATA NEEDED TO DETERMINE THE FUNDAMENTAL FREQUENCY OF VIBRATION OF THE PUMP/MOTOR IS NOT CURRENTLY AVAILABLE.

THE PUMP AND MOTOR CAN BE REPRESENTED AS SDOF SYSTEMS BY MODELING EACH COMPONENT AS A RIGID FRAME TYPE STRUCTURE. THE COMMON SUPPORT SKID IS OBVIOUSLY RIGID. AS THE COMPONENTS CAN BE MODELED AS SDOF SYSTEMS, AN EQUIVALENT STATIC ANALYSIS USING A STATIC LOAD EQUAL TO THE PEAK OF THE FLOOR RESPONSE SPECTRUM WILL BE USED.

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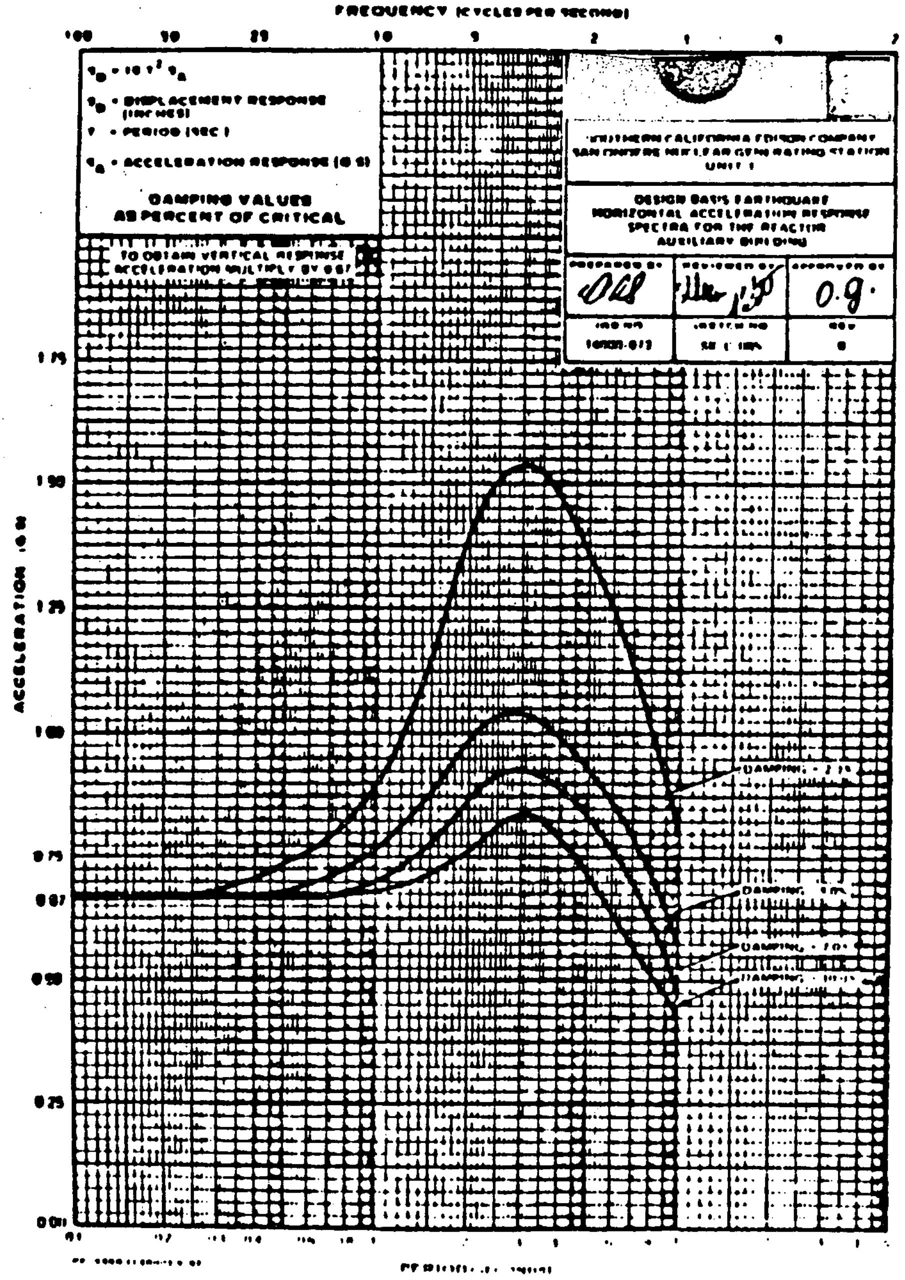
3.2 FLOOR RESPONSE SPECTRUM

BASED ON [5], THE FOLLOWING SPECTRUM IS ASSUMED TO BE APPLICABLE TO THE CHARGING PUMPS.



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3.3 LOADS

SUPPORT CALCULATIONS WILL BE PERFORMED ASSUMING 4% DAMPING (REACTOR AUX. BLDG @ EL +5' + -2', SEE [5]) AND RESPONSE AT THE SPECTRAL PEAK.

$$a_H = 1.05\,g$$

$$a_V = 2/3(1.05g) = t\ .70g$$

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4.0 ALLOWABLE STRESSES

- STRUCTURAL STEEL

ASSUME SA-36 STEEL:

$F_y = 36$ ksi, $F_u = 58$ ksi ([6], TABLE I-7.1)

ALLOWABLE AXIAL/BENDING STRESS, LEVEL D

$F_a = F_b = \min(1.2 F_y, .7 F_u)$ ([6], SUBSECTION NF)

$1.2(36) = 43.2$ ksi

$.7(58) = 40.6$ ksi

$\therefore F_a = F_b = .40.6$ ksi

ALLOWABLE SHEAR

$F_V = \min(.8 F_y, .42 F_u)$

$.8(36) = 28.8$ ksi

$.42(58) = 24.4$ ksi

$\therefore F_V = 24.4$ ksi

- BOLTING (NF-3324.6, TABLE NF-3225.2-1)

ASSUME SA-307 (GR B) BOLTS

$F_u = 60.0$ ksi ([6], TABLE I-7.3)

LEVEL A LIMITS NF-3324.6

$$\begin{cases} F_{vb} = \dfrac{.62 S_u}{3} = \dfrac{.62(60\text{ ksi})}{3} = 12.4\text{ ksi} \\ F_{tb} = \dfrac{S_u}{2} = 30\text{ ksi} \end{cases}$$

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LEVEL D BOLT LOADS (F-1335)
$S_y = 36$ ksi (TABLE I-13.3)

$F_{tb} = \min(.7S_u, S_y)$

$.7S_u = .7(60) = 42.0$ Ksi
$S_y = 36$ ksi

$\therefore F_{tb} = 36$ ksi

$F_{vb} = \min(.42S_u, .6S_y)$

$.42S_u = .42(60) = 25.2$ ksi
$.6S_y = .6(36) = 21.6$ ksi

$\therefore F_{vb} = 21.6$ ksi

- ANCHOR BOLTS

ANCHOR BOLTS ARE ASSUMED TO BE HILTI-KWIK BOLTS [8] (SEE APPENDIX A) THIS IS AN EXTREMELY CONSERVATIVE ASSUMPTION. THE BOLTS ARE PROBABLY EMBEDMENTS WHICH ARE TIED TO THE RE-BAR IN THE CONCRETE FLOOR.

FROM [1], THE ANCHOR BOLTS ARE 5/8" DIA.

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5.0 NOZZLE LOADS

NOZZLE LOADS ARE OBTAINED FROM [4]. LINE NUMBERS ARE ASSUMED BASED ON DATA IN [5]. FROM [3] EACH PUMP HAS THE FOLLOWING CONNECTIONS:

- 3" - SCH 80 - SUCTION ([3] - MARK A)
- 2" - SCH 160 - DISCHARGE ([3] - MARK B)

FROM [5], EACH PUMP HAS A 1" NOZZLE (LINE NOS. 2022-1"-151R (G-8A) AND 2084-1"-151R (G-8B)). LOCATION OF THESE NOZZLES IS NOT CLEAR FROM [3], THEREFORE THESE LOADS WILL BE LUMPED WITH THE LOADS AT THE SUCTION & DISCHARGE NOZZLES.

MAXIMUM LOADS AT THE 1" NOZZLES [4]

GLOBAL COORD.	MAX. LOAD
F_x	15
F_y	9
F_z	27
M_x	11
M_y	18
M_z	2

NOTE: ALL FORCES IN POUNDS, ALL MOMENTS IN FOOT-POUNDS.

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0	WI	6/29/84	a8	7/9/84

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NOZZLE LOADS, 2" DISCHARGE LINES

THERMAL LOADS (REV. 0, BECHTEL, SEE [4])

DIRECTION (GLOBAL)	G-8A	G-8B
Fx	-415 lb	+143 lb
Fy	-21 lb	-95 lb
Fz	423 lb	410 lb
Mx	116 lb-ft	95 ft·lb
My	-109 lb·ft	158 ft·lb
Mz	-9 lb·ft	33 ft·lb

GRAVITY/SSE LOADS (IMPELL, SEE [4])

DIRECTION (GLOBAL)	DIRECTION (LOCAL)	G-8A		G-8B	
		D.W	SSE	D.W	SSE
Fx	Fy	9	±196.	-22	±144
Fy	-Fx	-888	±2073.	-79	±121
Fz	Fz	846	±2490.	-56	±370
Mx	My	187	±6618.	25	±76
My	-Mx	-342	±181.	-27	±157
Mz	Mz	104	±168.	-45	±149

THE LOADS LISTED ABOVE ARE COMBINED ON THE FOLLOWING PAGE

NOTE FORCES IN POUNDS
MOMEENTS IN FOOT-POUNDS

REV	BY	DATE	CHECKED	DATE
0	WI	6/29/84	CB	7/13/84

IMPELL CORPORATION

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NOZZLE LOADS, 2" LINES (CONT.)

G-8A

GLOBAL COORD.	DW	TH	DW + TH	SSE
Fx	9	-415	-406	±196.
Fy	-888	-21	-909	±2073.
Fz	846	423	+1269	±2490
Mx	187	116	+ 303	±6618
My	-342	-109	- 451	±181
Mz	104	-9	+ 95	±168
G-8B				
Fx	-22	+143	+ 121	±144
Fy	-79	-95	- 174	±121
Fz	-56	410	+354	±370
Mx	25	95	+120	±76
My	-27	158	+131	± 157
Mz	-45	33	- 12	±149

FORCES IN POUNDS
MOMENTS IN FOOT- POUNDS

REV	BY	DATE	CHECKED	DATE
0	WI	6/29/84	as	7/13/84

IMPELL CORPORATION

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NOZZLE LOADS, 3" SUCTION LINES

G-8A

GLOBAL COORD.	LOCAL COORD	DW	TH	DW+TH	SSE
Fx	F(S1)	-4	+379	375	±148
Fy	F(AX)	+65	+198	263	±55
Fz	F(S2)	-6	+544	538	±236
Mx	M(B1)	-41	+1	40	±40
My	M(TOR)	-8	-101	109	±151
Mz	M(B2)	+4	-115	111	±54
G-8B					
Fx	F(S1)	18	-87	69	±132
Fy	F(AX)	+181	+95	276	±164
Fz	F(S2)	1	71	72	±205
Mx	M(B1)	-116	-19	135	±134
My	M(TOR)	37	-35	2	±137
Mz	M(B2)	-78	-19	97	±71

NOTE: COORDINATE SYSTEM TRANSFORMATION IS BASED ON STANDARD PIPING PROCEDURES. WHEN THE PIPE AXIS IS VERTICAL (GLOBAL Y), THE LOCAL Y (OR 1) AXIS DEFAULTS TO THE GLOBAL X.

: FORCES IN POUNDS
MOMENTS IN FOOT-POUNDS

0	WI	6/29/84		7/9/84
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TOTAL NOZZLE LOAD @ FOUNDATION

TOTAL LOAD IS SET EQUAL TO THE ABSOLUTE SUM OF THE (DW+TH) LOADS OF THE SUCTION AND DISCHARGE LINES AND THE LOADS ON THE 1" LINES PLUS THE SRSS OF THE SEISMIC LOADS FROM THE SUCTION + DISCHARGE LINES.

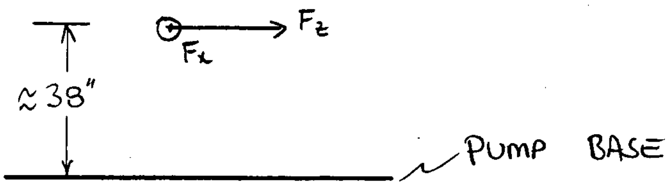
$$\text{TOTAL} = (DW+TH)_{SUC.} + (DW+TH)_{DIS} + (1''\text{ LOADS}) + SRSS(SSE_{SUC.}, SSE_{DIS})$$

ENVELOPING LOADS FROM THE 2 PUMPS WILL BE USED

	$(DW+TH)_S$	$(DW+TH)_D$	1"	SSE_S	SSE_D	TOTAL
Fx	375	406	15	148	196	1042.
Fy	276	909	9	164	2073	3273.
Fz	538	1269	27	236	2490	4335.
Mx'	135	303	11	134	6618	7068.
My'	109	451	18	151	181	814
Mz'	111	95	2	71	168	390

ASSUMING THE LOADS ARE APPLIED AT THE ENDS OF THE NOZZLES (38" ABOVE THE FLOOR) AND AT THE CENTROID OF THE BOLT PATTERN, RESULTS IN THE FOLLOWING MOMENTS

MOMENT DUE TO NOZZLE LOAD



$$M_x = M_x' + F_z \cdot 38''$$
$$= (7068 \text{ ft-lb})(12 \text{ in/ft}) + (4335 \text{ lb})(38 \text{ in}) = 2.50 \times 10^5 \text{ in-lb}$$

$$M_z = M_z' + F_x \cdot 38''$$
$$= (390 \text{ ft-lb})(12 \text{ in/ft}) + (1042 \text{ lb})(38 \text{ in}) = 4.43 \times 10^4 \text{ in-lb}$$

$$M_y = M_y' = (814 \text{ ft-lb})(12. \text{ in/ft}) = 9768 \text{ in-lb}$$

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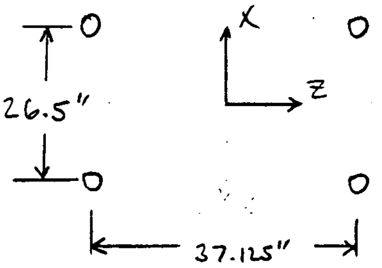
6.0 MOTOR HOLD DOWN BOLTS

4 - 1½" DIAMETER BOLTS (DIMENSIONS FROM [1])



HEIGHT OF CG ABOVE BASE, ASSUME 24" (DIST FROM FLOOR TO PUMP AND MOTOR ℄ [3])

ASSUME BOLTS RESIST OVERTURNING MOMENTS THROUGH FORCE COUPLES. (NOTE 1)

$$T_B = \frac{M_Z}{(2\,\text{bolts})(26.5\,\text{in})} + \frac{M_X}{(2\,\text{bolts})(37.125\,\text{in})} + \frac{F_Y}{4\,\text{bolts}}$$

$F_Y = (a_V\uparrow)\,W_m$
$= (-.30g)(5250\,\text{lb})$
$= -1575\,\text{lb}$

$M_x = M_z = W_m\, a_H\, \bar{Y}$
$= (5250\,\text{lb})(1.05g)(24\,\text{in})$
$= 132,300\,\text{in}\cdot\text{lb}$

$$T_B = \frac{132,300\,\text{in}\cdot\text{lb}}{(2\,\text{bolt})(26.5\,\text{in})} + \frac{132,300\,\text{in}\cdot\text{lb}}{(2\,\text{bolt})(37.125\,\text{in})} + \frac{-1575\,\text{lb}}{4\,\text{bolt}}$$

$$= 3884\,\text{lb/bolt}$$

$$V_B = \frac{(F_x^2 + F_z^2)^{\frac{1}{2}}}{4\,\text{bolt}} = \frac{\left[(W_m a_{H_x})^2 + (W_m a_{H_z})^2\right]^{\frac{1}{2}}}{4\,\text{bolt}}$$

NOTE 1: SEISMIC LOADS ARE ASUMED - CONSERVATIVE

					SCE / SONGS-1
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$$V_B = \frac{W_m}{4\ \text{bolt}} \sqrt{a_H^2 + a_H^2}$$

$$= \frac{5250\ \text{lb}}{4\ \text{bolts}} \left[(1.05g)^2 + (1.05g)^2\right]^{\frac{1}{2}}$$

$$= 1950\ \text{lb}$$

NOTE: BOLT PRELOAD AND FRICTIONAL RESISTANCE WERE CONSERVATIVELY NEGLECTED.

ASSUME A307 BOLTS, FROM [1], BOLTS ARE 1½" DIA.

$A_{ROOT} = 1.29\ \text{in}^2$ ([2], p. 4-141)

$$f_{vb} = \frac{1950\ \text{lb}}{1.29\ \text{in}^2} = 1.51\ \text{ksi}$$

$$f_{tb} = \frac{3884\ \text{lb}}{1.29\ \text{in}^2} = 3.01\ \text{ksi}$$

INTERACTION:

$$\left(\frac{f_{vb}}{F_{vb}}\right)^2 + \left(\frac{f_{tb}}{F_{tb}}\right)^2 = ?$$

$$\left(\frac{1.51\ \text{ksi}}{12.4\ \text{ksi}}\right)^2 + \left(\frac{3.01\ \text{ksi}}{30.0\ \text{ksi}}\right)^2 = .02 < 1$$

∴ QUALIFIED USING LEVEL A LIMITS

SCE/SONGS-1

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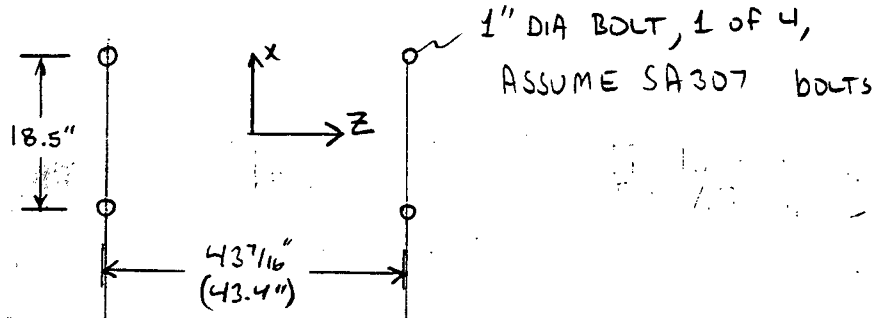
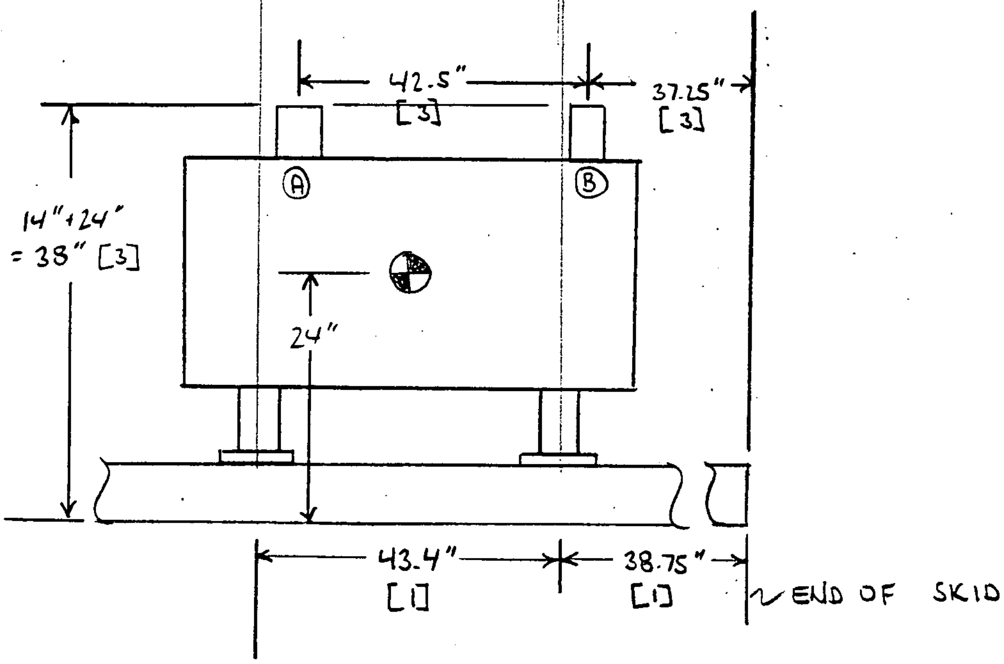
7.0 PUMP HOLD DOWN BOLTS

GEOMETRY (SEE [1])



NOZZLE LOCATIONS



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SEISMIC LOADS

ASSUME ROTATION ABOUT ℄'S OF BOLT PATTERN. BOLTS RESIST OVERTURNING MOMENTS THROUGH FORCE COUPLES. (NOTE 1)

$$T_B = \left[\left(\frac{M_x}{(2\text{ bolts})(43.4\text{ in})}\right)^2 + \left(\frac{M_Z}{(2\text{ bolts})(18.5\text{ in})}\right)^2 + \left(\frac{F_Y}{4}\right)^2\right]^{1/2} - DW/4$$

$$M_x = M_Z = W_P \cdot a_H \cdot \bar{X}$$

W_P = PUMP WT, 9480 lb [1]
a_H = 1.05 g
$\bar{X}$ = 24" (DIST FROM FLOOR TO ℄ OF SHAFT, [3]) ASSUMED CG

$$M_x = M_Z = (9480\text{ lb})(1.05g)(24\text{ in}) = 2.39 \times 10^5\text{ in-lb}$$

$$F_Y = (.7g)(W_P) = (.7g)(9480\text{ lb}) = 6636\text{ lb}$$

$$\therefore T_B = \left[\left(\frac{2.39 \times 10^5\text{ lb}\cdot\text{in}}{2(43.4\text{ in})}\right)^2 + \left(\frac{2.39 \times 10^5\text{ lb}\cdot\text{in}}{2(18.5\text{ in})}\right)^2 + \left(\frac{6636\text{ lb}}{4}\right)^2\right]^{\frac{1}{2}} - \frac{9480}{4}$$

$$= 4845\text{ lb/bolt}$$

SHEAR:

$$V_{BX} = V_{BZ} = \frac{a_H W_P}{4\text{ bolts}} = \frac{(9480\text{ lb})(1.05g)}{4}$$

$$= \frac{9954\text{ lb}}{4\text{ bolts}} = 2489.\text{lb}$$

NOTE 1: SEISMIC LOADS ARE SRSS'ed TO DECOUPLE THE EFFECTS OF THE THREE DIRECTIONAL ACCELERATIONS

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LOADS DUE TO NOZZLE LOADS -
ASSUME ALL LOADS ACT @ CENTROID OF BOLT PATTERN

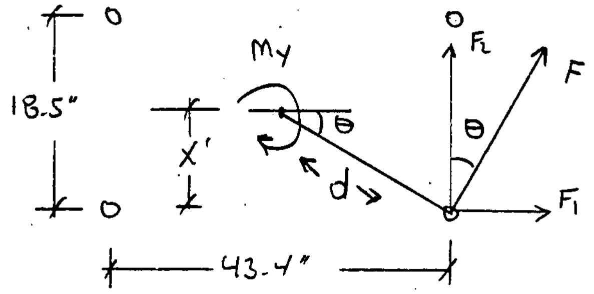
- TENSION

$$T_B = \frac{M_x}{2(43.4\text{ in})} + \frac{M_z}{2(18.5\text{ in})} + \frac{F_y}{4\text{ bolts}}$$

$$= \frac{2.50\times10^5\text{ in}\cdot\text{lb}}{2(43.4\text{ in})} + \frac{4.43\times10^4\text{ in}\cdot\text{lb}}{2(18.5\text{ in})} + \frac{3273}{4}$$

$$= 4896\text{ lb.}/\text{bolt}$$

- SHEAR
  - DUE TO M_y (TORSION)



$$X' = \frac{18.5}{2} = 9.25''$$

$$d = \frac{\left[(18.5'')^2 + (43.4'')^2\right]^{\frac{1}{2}}}{2}$$

$$= 23.6''$$

$$\theta = \text{ARCTAN}\left(\frac{18.5}{43.4}\right) = 23^\circ$$

$$M_y = 4d\cdot F$$

$$F = M_y/4d$$

$$F_1 = \frac{M_y}{4d}\cdot\sin\theta \qquad F_2 = \frac{M_y\cdot\cos\theta}{4d}$$

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$$F_1 = \frac{9768 \text{ in}\cdot\text{lb}) \sin 23^\circ}{4(23.6")} = 40 \text{ lb}$$

$$F_2 = \frac{(9768 \text{ in}\cdot\text{lb}) \cos 23^\circ}{4(23.6")} = 95 \text{ lb}$$

- DUE TO X SHEAR

$$V_{Bx}' = \frac{F_x}{4 \text{ bolts}} = \frac{1042}{4} = 261 \text{ lb}$$

- DUE TO Z SHEAR

$$V_{Bz}' = \frac{F_z}{4} = \frac{4335}{4} = 1084 \text{ lb}$$

Let

$$V_{Bx} = V_{Bx}' + F_1$$
$$= 261 \text{ lb} + 40 \text{ lb} = 301 \text{ lb}$$

$$V_{Bz} = V_{Bz}' + F_2$$
$$= 1084 \text{ lb} + 95 \text{ lb} = 1179 \text{ lb}$$

TOTAL BOLT FORCES (SEISMIC + NOZZLE)

TENSION: 4845 lb + 4896 lb = 9741 lb/BOLT

SHEAR

X: 2489 lb + 261 lb = 2750 lb/BOLT

Z: 2489 lb + 1092 lb = 3581 lb/BOLT

RESULTANT = SRSS(2750, 3581)
= 4515. lb/BOLT

BOLT STRESSES:

FOR 1" DIA BOLTS;

$A_{ROOT} = .551\ in^2$ ([2], p. 4-141)

$\therefore f_{bt} = \frac{9741\ lb}{.551\ in^2} = 17.7\ ksi$

$F_{bt} = 30\ ksi$

} OK

$f_{vb} = \frac{4515\ lb}{.551\ in^2} = 8.2\ ksi$

$F_{vb} = 12.4\ ksi$

} OK

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INTERACTION

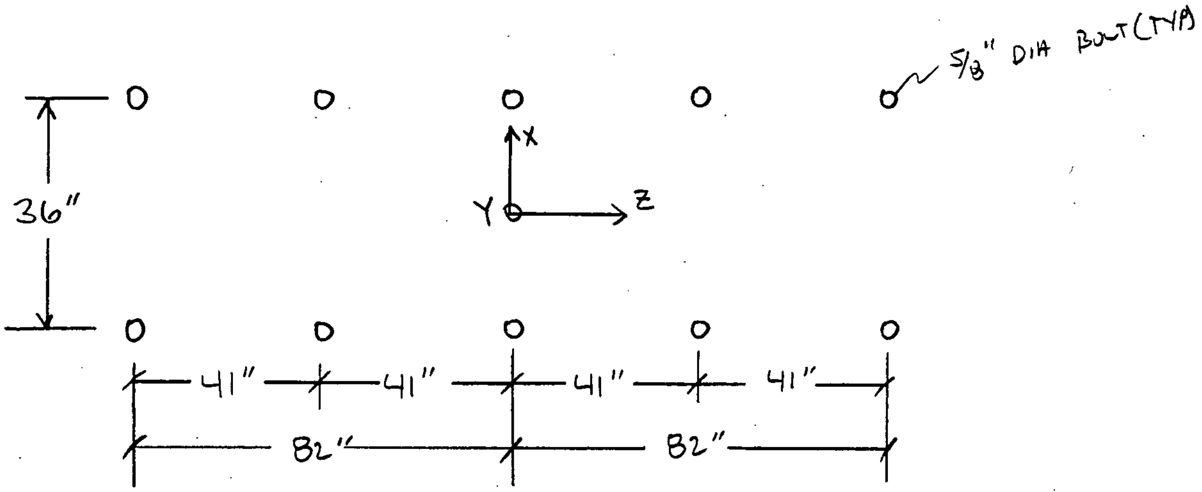
$$\left(\frac{f_{bT}}{F_{bT}}\right)^2 + \left(\frac{f_{vb}}{F_{vb}}\right)^2$$

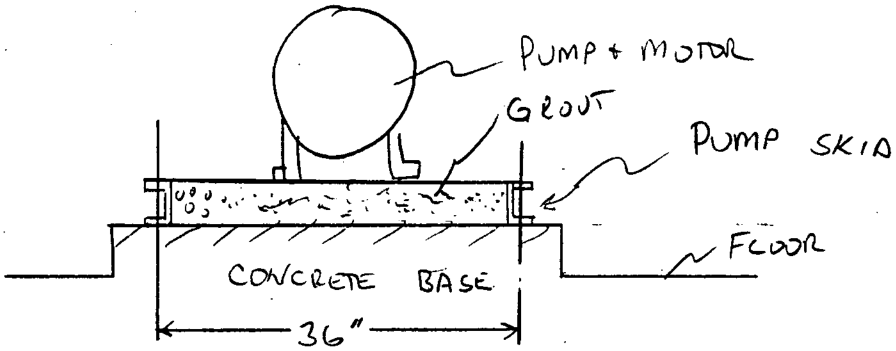
$$= \left(\frac{17.7}{30.0}\right)^2 + \left(\frac{8.2}{12.40}\right)^2 = \underline{.79} < 1$$

∴ PUMP HOLD DOWN BOLTS QUALIFY USING LEVEL A LIMITS + CONSERVATIVE ASSUMPTIONS.

8.0 FOUNDATION ANCHOR BOLTS

10 - 5/8" DIAMETER BOLTS - DIMENSIONS FROM [1] & [3]





FROM THE "ANCHOR BOLT AND FOUNDATION DETAILS" PROVIDED WITH [1], (SEE APPENDIX A, SHEET WAS EXCERPTED FROM " REACTOR AUXILIARY BUILDING SECTIONS & DETAILS, SHEET 6) THE FOUNDATION BOLTS ARE J BOLTS WITH

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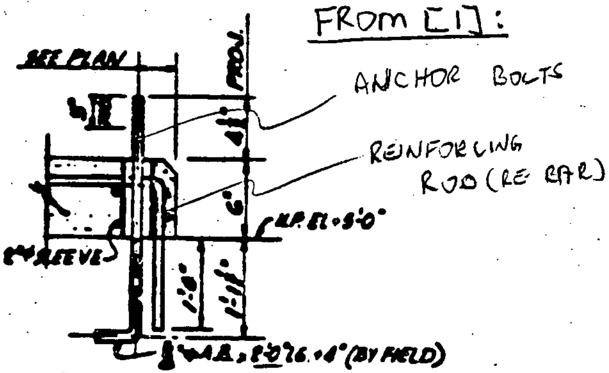
AN EMBEDDED LENGTH EXCEEDING 1 fc. IN ADDITION, THE CONCRETE BASE IS TIED TOGETHER WITH RE-BAR WHICH ALSO EXTENDS 1 fc INTO THE FLOOR.

FIGURE EXCERPTED FROM [1]:



SECTION
SCALE - 1½" = 1'-0"

BASED ON THE CONFIGURATION OF THE PUMP ANCHORAGE, THE FOLLOWING ASSUMPTIONS ARE MADE.

- SHEAR LOADS DUE TO SSE INERTIA AND NOZZLE LOADS APPLIED TO THE PUMP AND/OR MOTOR ARE TRANSFERRED TO THE SKID THROUGH THE MOUNTING BOLTS (EVALUATED IN SECTIONS 6.0 & 7.0). THE SHEAR FORCES ARE THEN TRANSFERED INTO THE FLOOR THROUGH THE GROUT AND CONCRETE. THE FOUNDATION BOLTS DO NOT RESIST THE SHEAR FORCES. (SEE FIGURE ON PRECEEDING PAGE) BASED ON THE FOUNDATION DWG, SHOWN ABOVE, THE FOUNDATION BOLTS

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PASS THROUGH A 2" DIAMETER SLEEVE, THEREFORE THE BOLTS ARE UNABLE TO RESIST SHEAR FORCES. THUS THE ASSUMPTION IS REASONABLE.

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FOUNDATION BOLTS, CONT.

THE LOADS ON THE PUMP/MOTOR/SKID ARE LISTED BELOW.

- MOTOR:

SEISMIC LOADS

$F_x = F_z = (1.05g)W_m = (1.05)(5250\ lb) = 5513\ lb$

$F_y = (.7g)(5250\ lb) = 3675\ lb.$

$M_x = M_z = 132,300\ lb \cdot in$

$M_y = 0$

DEAD LOAD

$F_y = -5250\ lb$

- PUMP

SEISMIC LOADS

$F_x = 9954\ lb$

$F_y = 6636\ lb$

$F_z = 9954\ lb$

$M_x = 2.39 \times 10^5\ in \cdot lb$

$M_y = -0-$

$M_z = 2.39 \times 10^5\ in \cdot lb$

NOZZLE LOADS

$F_x = 1042\ lb$

$F_y = 3273\ lb$

$F_z = 4335\ lb$

$M_x = 2.50 \times 10^5\ in \cdot lb$

$M_y = 9768\ in \cdot lb$

$M_z = 4.43 \times 10^4\ in \cdot lb$

DEAD LOAD

$F_y = -9480\ lb$

0	WI	6/29/84	US	7/13/84
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$$\frac{z}{a} = \frac{3.5''}{4.625''} = .757$$

$$\frac{c}{a} = \frac{2.625''}{4.625''} = .568$$

by INTERPOLATION ([11], p. 190):

z/a	c/a	Km	z/a	c/a	Km
.757	.75 ⇒	.210	.757	.568 ⇒	.155
.757	.50 ⇒	.134			

MAXIMUM BENDING STRESS:

$$f_b = K_m \left(\frac{6P}{t^2} \right)$$

P = MAX BOLT LOAD. = 3005 lb

t = 1/2" ([10])

$$\therefore \quad f_b = .155 \left[\frac{6(4195\ \text{lb})}{(.50\,\text{in})^2} \right] = 15.6\ \text{Ksi}$$

F_b (MW) = .6(36 ksi) = 21.6 ksi (LEVEL A)

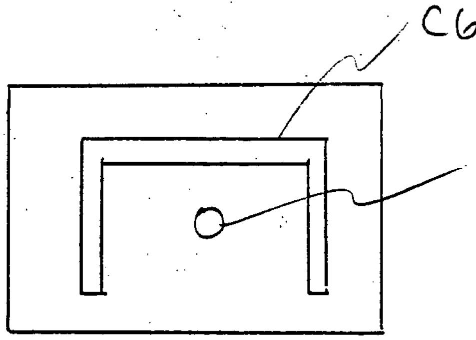
∴ PLATE QUALIFIED

GROUP 3

BASE PLATES @ NODES 1,49 (ELEMENTS 1I , 19I)

SEISMIC LOADS

		a_x	a_y	a_z	RESULTANT SEISMIC	DW
R1	1I 19I	390.6 413.9	137.8 133.9	70.8 212.3	420. 484.	306.3 297.5
R2	1I 19I	4.3 4.2	.5 .4	.2 .3	4. 4.	1.0 .8
R3	1I 19I	0. 1.7	2.0 1.1	22.6 22.7	23. 23.	4.5 2.5



∴ ASSUME 1" DIA. BOLT ([3], p. 4-136)

LOADS ARE INSIGNIFICANT RELATIVE TO THE CAPACITY OF 1" ANCHORS.

∴ QUALIFIED

NOTE: LOADS DUE TO NOZZLE LOADS ARE ALSO SMALL

SCE HX E-34

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0	WI	7/25/84	SAL	7-26-84

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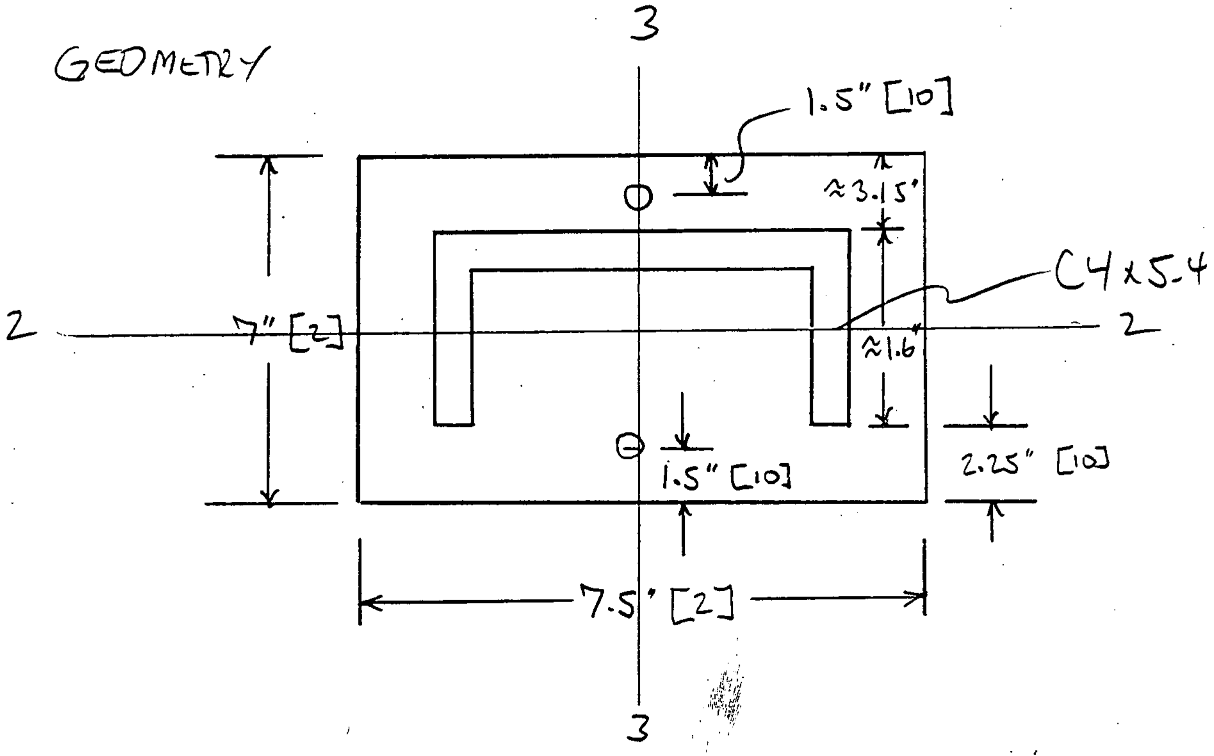
GROUP 4, Baseplate @ 37J (NODE 45)

GEOMETRY



LOADS @ 37J (SEISMIC)

	R1	R2	R3	M1	M2	M3
a_x	48.7	1.5	.2	.2	6.8	0
a_y	16.2	.5	2.9	0	33.8	0
a_z	658.0	14.3	0	0	2.3	0
SRSS	660.0	14.4	2.9	NEGLIGIBLE	34.6	0
DW	35.9	1.2	6.4	0	75.0	0
TOTAL	696.	16.	9.	NEGLIGIBLE	110.	0

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0	WI	7/20/84	SL	7.21.84

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NOZZLE LOADS @ 37J

R1 = 60.0 lb
R2 = 3.3 lb
R3 = 0 lb
M1 = 0
M2 = 9.7 in.lb
M3 = 0

TOTAL LOADS (SEISMIC + NOZZLE)

R1 = 696. + 60. = 756. lb
R2 = 16. + 3.3 = 19. lb
R3 = 9. + 0. = 9. lb
M1 = NEGLIGIBLE
M2 = 110. + 9.7 = 120. in.lb
M3 = 0

0	WI	7/25/84		7.26.84
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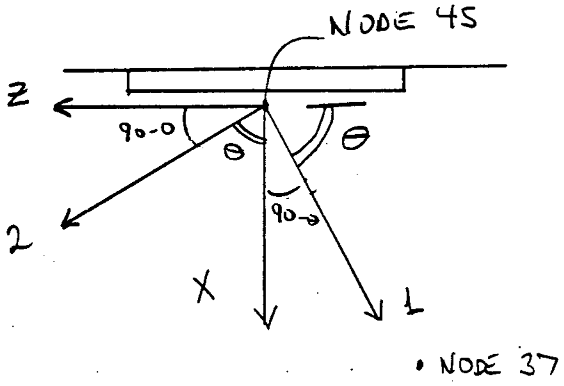
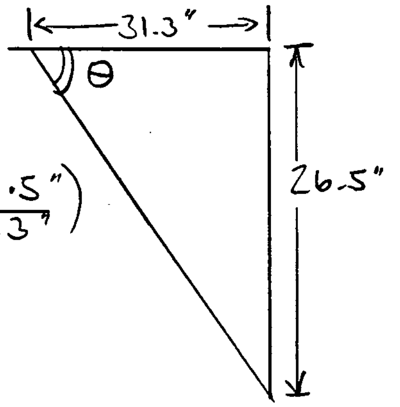
TRANSFORM LOADS TO GLOBAL COORDINATES



$(X,Y,Z)_{37} = (26.5, 60.0, 0.0)$

$(X,Y,Z)_{45} = (0.0, 60.0, 31.3)$



$\theta = \text{ARCTAN}\left(\frac{26.5''}{31.3''}\right)$

$\theta \doteq 40^\circ$

NOTE: NEGLECT DIRECTIONAL EFFECTS IN TRANSFORMATION, CONSERVATIVELY ASSUME ALL COMBINATIONS ARE ASUM.

$RX = R1 \sin\theta + R2 \cos\theta$
$= 756 \sin 40^\circ + 19 \cos 40^\circ$
$= 501 \text{ lb}$

$MX = \cancelto{0}{M1} \sin\theta + M2 \cos\theta$
$= 120 \cos 40^\circ$
$= 92. \text{in-lb}$

$RY = R3 = 9 \text{ lb}$

$MY = M3 = 0$

$RZ = R1 \cos\theta + R2 \sin\theta$
$= 756 \cos 40^\circ + 19 \sin 40^\circ$
$= 591. \text{lb}$

$MZ = \cancelto{0}{M1 \cos\theta} + M2 \sin\theta$
$= 120 \sin 40^\circ$
$= 77 \text{in-lb}$

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0	WE	7/25/84	SJL	7-26-84

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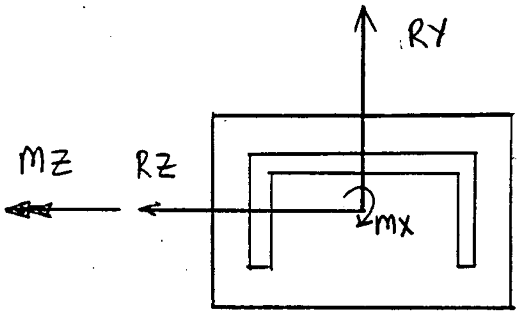

DISTANCE BETWEEN BOLTS:

$$l = 7'' - 1.5'' - 1.5''$$
$$= 4''$$

SHEAR FORCES IN BOLTS

$$V_y = R_Y/2 = \frac{9.\ \text{lb}}{2} = 5.\ \text{lb/bolt}$$

$$V_z = \frac{R_z}{2} + \frac{M_x}{4''}$$

$$= \frac{591\ \text{lb}}{2\ \text{bolts}} + \frac{92\ \text{in·lb}}{4\ \text{in}} = 319\ \text{lb/bolt}$$

$$V_{RESULTANT} = (V_x{}^2 + V_z{}^2)^{1/2}$$

$$= \left[(5.\ \text{lb})^2 + (319.\ \text{lb})^2\right]^{\frac{1}{2}} = 319.\ \text{lb}$$

TENSILE FORCES

$$T = \frac{R_X}{2\ \text{bolts}} + \frac{M_z}{4\ \text{inches}}$$

$$= \frac{501\ \text{lb}}{2} + \frac{77\ \text{in- lb}}{4\ \text{in}} = 270\ \text{lb}/\text{bolt}$$

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ANCHOR BOLT ALLOWABLES

ANCHOR BOLTS - 1" FLAT-FLAT (HEAD SIZE) [2]

- FROM [3], p. 4-136, ASSUME 5/8" DIAMETER BOLTS.
- ASSUME HILTI-KWIK BOLTS, FROM [6], FOR 5/8" BOLTS IN 4000 psi CONCRETE w/ EMBEDDED LENGTH OF 2 3/4" (MINIMUM) THE ULTIMATE CAPACITIES ARE:

TENSILE = 6600 lb

SHEAR = 11562 lb

APPLY A SAFETY FACTOR of 4.0

$$T_A = 6600\text{lb}/4 = 1650.\text{lb}$$

$$V_A = \frac{11562\text{ lb}}{4} = 2891.\text{ lb}$$

INTERACTION:

$$\frac{T}{T_A} + \frac{V}{V_A}$$

$$= \frac{270\text{ lb}}{1650\text{ lb}} + \frac{319\text{ lb}}{2891\text{ lb}} = .27 < 1$$

∴ BOLTS QUALIFY (FS = 4.0)

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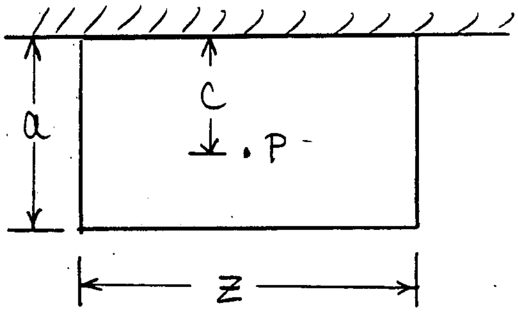
MODEL THE PLATE AS A WIDE CANTILEVER: SEE [11], ART. 7.11, p. 188-191



NOTE: THIS MODEL NEGLECTS THE SUPPORT PROVIDED BY THE CHANNEL WEBS, ∴ CONSERVATIVE.

$a \approx 7'' - 3.15'' = 3.85''$

$c \approx 7 - 3.15'' - 1.5'' = 2.35''$

$z \approx 7.5''$

P = BOLT LOAD = 270 lb (TENSILE)

$\frac{c}{a} = \frac{2.35}{3.85} = .61$

$\frac{z}{a} = \frac{7.5}{3.85} = 1.95$ (let $z/a = 2.00$ for SIMPLICITY)

INTERPOLATE for $c/a = .61$

$z/a = 2.0$

$$\left.\begin{array}{l} c/a = .50,\ K_m = .011 \\ c/a = .75,\ K_m = .023 \end{array}\right\} c/a = .61,\ K_m \approx .016$$

0	WI	7/25/84		7.30.84	IMPELL CORPORATION	JOB NO 0310-036 CALC NO EQ-06	PAGE 55 OF 87
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STRESS, $f_b = \frac{K_m \, 6 \, P}{t^2}$

$t = 1/2"$ [10]

$$f_b = \frac{.016(6.0)(270 \text{ lb})}{(.50 \text{in})^2} = .10 \text{ Ksi}$$

$F_b \, (\text{MIN}) = .6(36) = 21.6 \text{ Ksi}$ (LEVEL A)

∴ PLATE IS QUALIFIED

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0	WI	7/25/84	SXC	7-26-84

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WELDS:

BASED ON THE EXTREMELY LOW STRESSES IN THE STRUCTURAL MEMBERS, MAXIMUM INTERACTION OF .41 WITH NEGLIGIBLE SHEAR, THE WELDS WILL NOT BE EVALUATED.

* WELDS ARE QUALIFIED BY INSPECTION.

0	WT	7/25/84	SL	7-26-84
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APPENDIX - REFERENCE MATERIAL.

REV	BY	DATE	CHECKED	DATE
0	WI			

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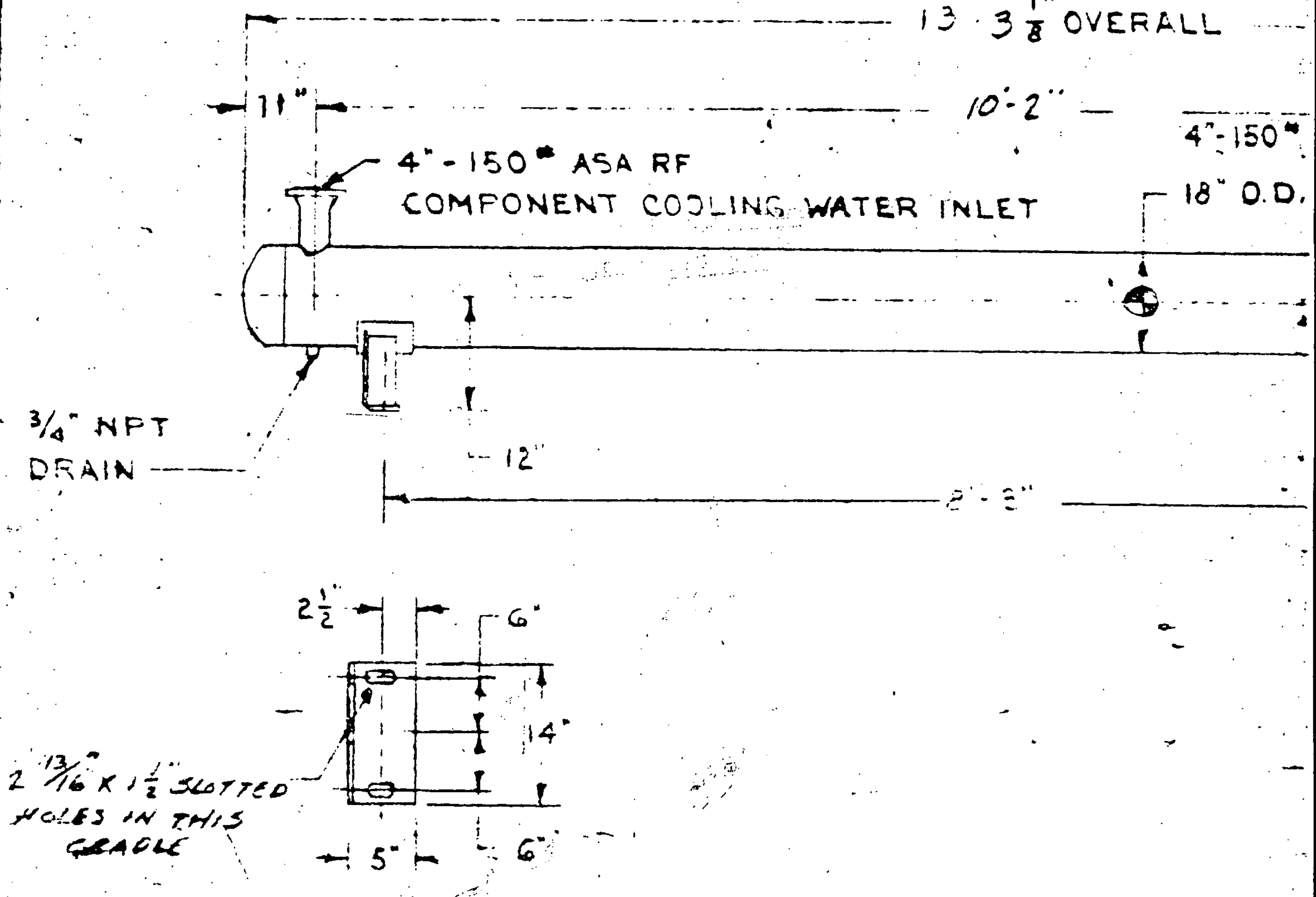


NOTE
1. ALL BOLT HOLES TO STRADDLE ℄s.

DIMENSIONS & DATA
CERTIFIED FOR
CUST. ORDER 54-P-91432
OUR ORDER 406-64-1580
BY Am DATE 3-29-65
BASCO, INC.

UNITS REQ
P.O. 54-P-
DESIGN PR
TEST PRES
DESIGN TE
SURFACE

Bechtel Power Corporation
Engineers – Constructors
12400 East Imperial Highway
Norwalk, California 90650
MAIL ADDRESS
P.O. BOX 60860 - TERMINAL ANNEX, LOS ANGELES, CALIFORNIA 90060
TELEPHONE (213) 807-2000

March 30, 1984
BPC/V-84-160

Mr. W. D. Gallo
Project Manager
Advanced Engineering
Impell Corporation
350 Lennon Lane
Walnut Creek, CA 94598

Subject: San Onofre Nuclear Generating Station, Unit 1
Bechtel Job No. 15691-384
Safe Shutdown Equipment Data For:
- a) Seal Water Supply Filter G2A and G2C
- b) Seal Water Supply Filter G2B
- [redacted]
- d) Charging Pump Oil Coolers - Water Cooled
- e) Charging Pump Oil Coolers - Air Cooled

Dear Mr. Gallo:

The enclosed information is forwarded for your use in performing calculations to determine seismic capability of the subject equipment. Should you require further information, please contact Rick Gold at (213) 807-2466.

Very truly yours,

BECHTEL POWER CORPORATION

John

J. D. Duffin
Project Engineering Manager

RKG:jem/1925L

Enclosure: 1. Summary of Equipment Data Transmittal to Impell
2. Equipment Data

Ref [1]

cc: A. R. Guerrero
W. L. Nelson
G. W. Gartland
All with Enclosure 1 only

ENCLOSURE 1

SUMMARY OF EQUIPMENT
DATA TRAMSMITTAL TO IMPELL

Equipment No.	Description	Type of Data Provided
G-2A/2C	Seal Water Supply Filter	1. Component weight, material, nozzle and vessel thickness and foundation information. 2. Filter support information. 3. Filter assembly dwg. 4. Manufacturers' filter data.
G-2B	Seal Water Supply Filter	1. Component weight, material, nozzle and vessel thickness and foundation information. 2. Filter support information. 3. Filter assembly dwg. 4. Manufacturers' filter data.
E-34 ✓	Seal Water Heat Exchanger	1. Component weight, material and nozzle and vessel thickness. 2. Heat exchanger outline dwg. 3. Heat exchanger support structure detail and pictorial (2 sheets). 4. Structural support assembly (3 sheets). 5. Manufacturers' equipment data.
N.A. ✓	Charging Pump Oil Coolers - (water cooled) for G8A and G8B	1. Component weight, material, nozzle and vessel thickness, oil cooler outline dimensions and mounting and foundation details.
N.A	Charging Pump Oil Coolers - (air cooled) for G8A and G8B	Information not available.

SEAL WATER HEAT EXCHANGER E-34

1. WEIGHT

HX - DRY WT. 2515 #
HX - FLOODED WT. 3705 #

2. MATERIAL

HX - CARBON STEEL
BOLTS (ALL) - SA193 GR. 38
HX SADDLE - A36

3. NOZZLE AND VESSEL THICKNESS

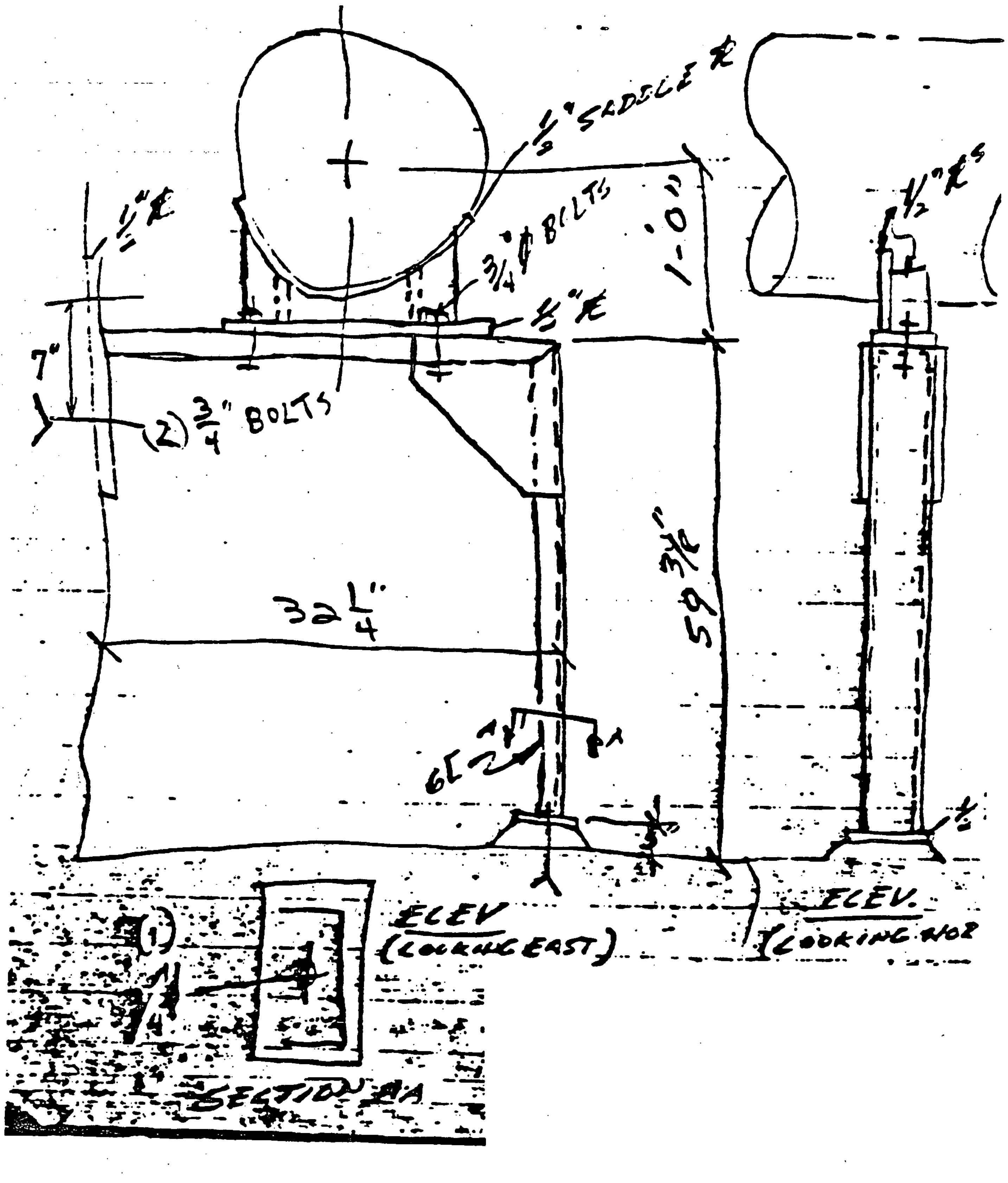
	NOZZLE THICK.	VESSEL THICK.
3" NOZZLES	.12"	.375"
4" NOZZLES	.237"	.375"

ATTACHMENTS TO BECHTEL POWER CORP. LETTER BPC/V-84-160, MARCH 30, 1984, FROM J.D. DUFFIN TO W. D. GALLO (IMPELL), SUBJECT: SONGS-1, BECHTEL JOB NO.: 15691-384 (INCLUDED IN JOB FILE)

WI 5/1/84

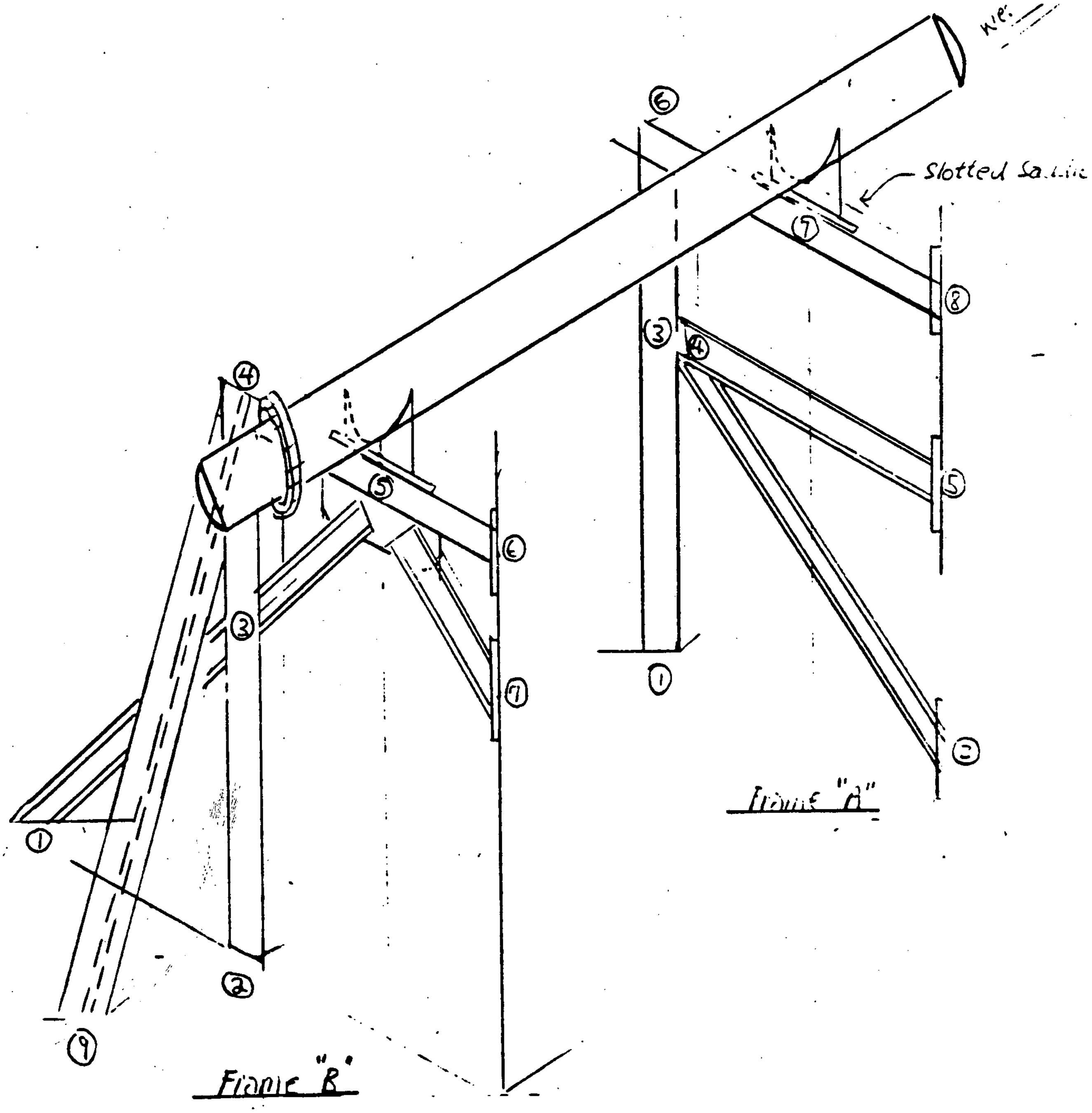
SEAL WATER HEAT EXCHANGER E-34

SUPPORT STRUCTURE (ELEVATION VIEW)

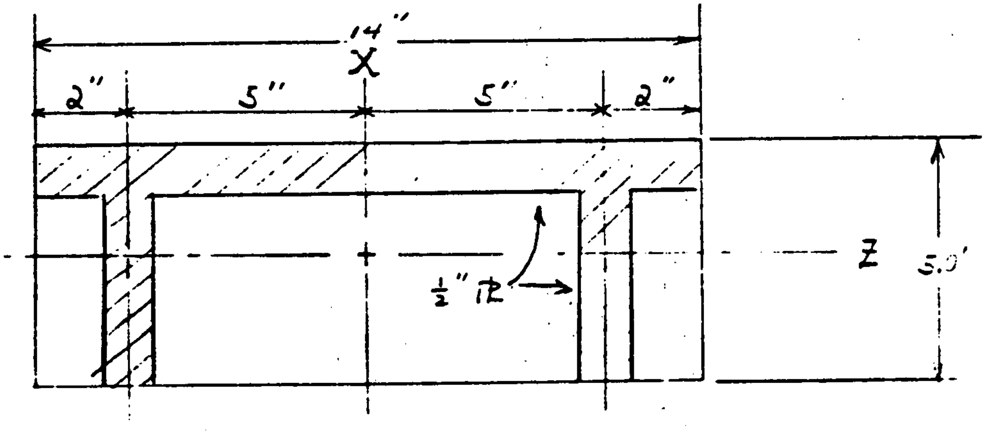


SEAL WATER HEAT EXCHANGER E-34

HX SUPPORT STRUCTURE (PICTORIAL)



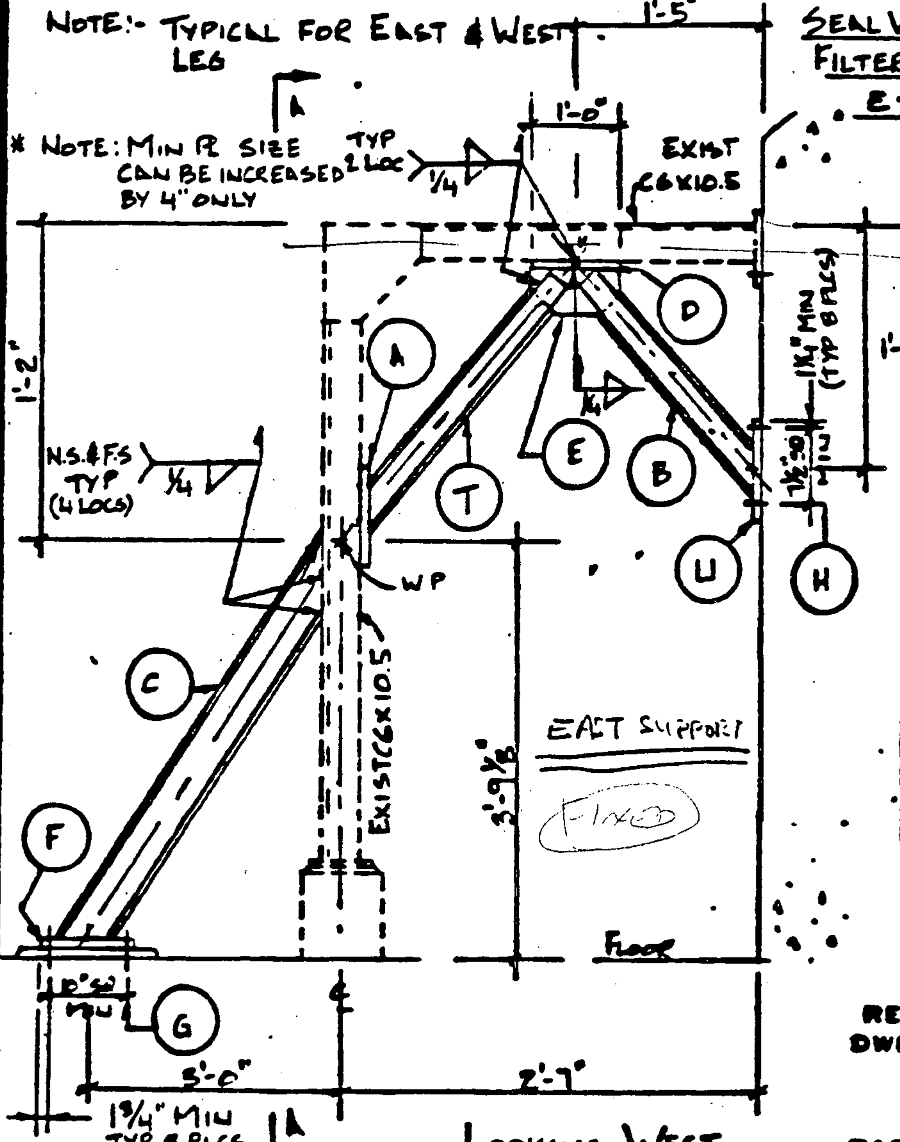
HX SADDLE X-SECTION



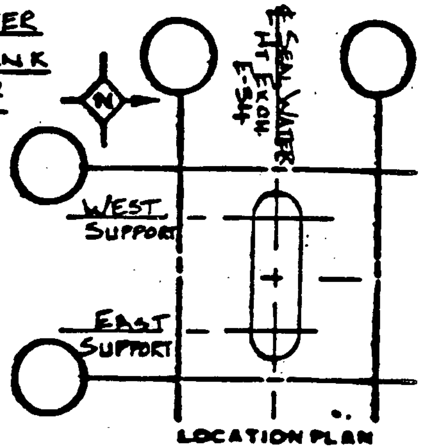
ITEM NO.	NO REQ'D	PART NO	SIZE DESCRIPTION	INF	ASBC	NOTES
A	2		℞ ½ x 7 x 0'-7" (SA-36)		X	
B	2		W4X13 X 2'-0" (CUT TO SUIT) (SA-36)		X	
C	2		W6X15.5 x 5'-2" (CUT TO SUIT) (SA-36)		X	
D	2		℞ ½ x 7 x 1'-0" (SA-36)		X	
E	2		℞ ½ x 7 x 1'-0" (SA-36)		X	
F	2		℞ 3/4 x 13½ x 1'-1½" * (SA-36)		X	
G	8		1" ɸ CONC. EXP BOLTS MIN EMBED = 4½"			
H	8		3/4" ɸ CONC EXP. BOLTS MIN EMBED = 3¼"			
J	1		W6X15.5 X 5'-10" (SA-36) (CUT TO SUIT)		X	
K	1		℞ ½ x 7 x 0'-8" (SA-36)		X	
L	1		℞ 3/4 X 13½" x 1'-1½" * (SA-36)		X	
M	4		1" ɸ CONC. EXP. BOLTS MIN EMBED = 4½"			

NOTE:- TYPICAL FOR EAST & WEST LEG

* NOTE: MIN ℞ SIZE CAN BE INCREASED BY 4" ONLY



LOOKING WEST



LOCATION PLAN

AREA NO. 6

DESIGN CODE		TYPE		
PROJ CL	PIPE			MAX. TEMP °F
QUAL CL	STEEL S.R			
DESIGN		X	Y	Z
	M (FT-LBS)			
	P (LBS)			

☐ PROD. NO.________ PT. NO.________

SPOOL NO.________

REF. DWGS. NO.________

PIPE________

STEEL________

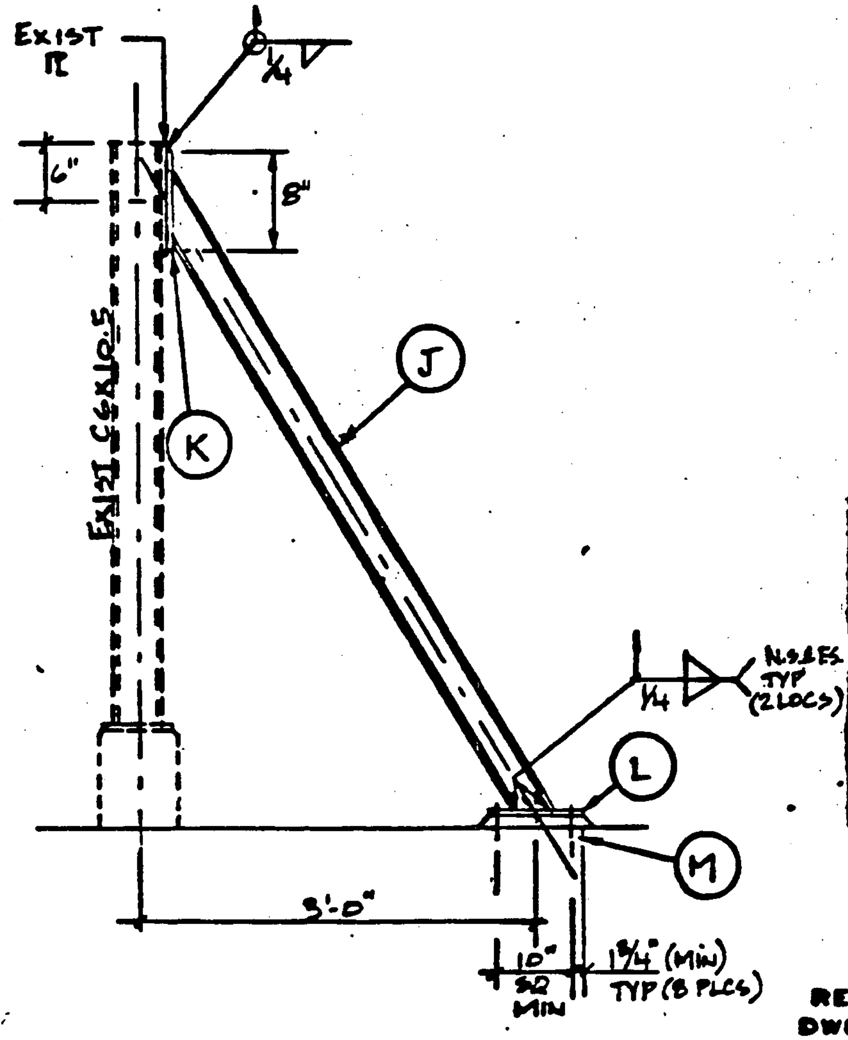
TAG NO.

SH. 1 OF 3

NO.	REVISIONS	DATE	DR.	CHK	E.G.S.		P.E.	Q.A.E.
0	ISSUE FOR CONSTRUCTION	5/13/92	FSM	[illegible]	BG for CM		[illegible]	RSG

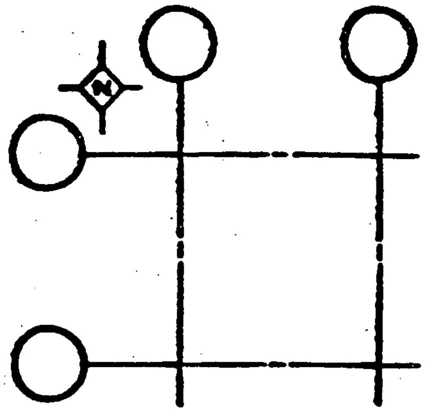
BECHTEL POWER CORPORATION NORWALK, CALIFORNIA	J.O. NO.	SAN ONOFRE NUCLEAR GENERATING STATION
	FILE	PIPE SUPPORT ASSEMBLY
JOB NO. 14000-300 · DATE NA · APPROVED NA		SOUTHERN CALIFORNIA EDISON COMPANY SCALE: NTS · LOS ANGELES. CALIF.

ITEM NO.	NO REQ'D	PART NO	SIZE DESCRIPTION	MF	AISC	NOTES
N	1		W4X13 X 3'-0" (CUT TO SUIT) (SA-36)		X	
P	1		W4X13X 4'-0" (CUT TO SUIT) (SA-36)		X	
Q	1		⅊ 3/4 X 16 X 1'-4" * (SA-36)		X	
R	8		1" ⌀ CONC EXP. BOLTS MIN EMBED=4½"			
S	1		⅊ ½ X 5 X 0'-5" (SA-36)		X	
T	2	-	W4X13X 2'-3" (SA-36)		X	
U	2		⅊ 5/8 X 10 X 0'-10" (SA-36) *		X	
			* SEE SHEET 1 FOR NOTE			



SECTION A-A

NOTE:- FOR EAST LEG.



LOCATION PLAN

AREA NO.

DESIGN CODE		TYPE		
PROJ CL	PIPE			MAX. TEMP °F
QUAL CL	STEEL SR			
DESIGN		X	Y	Z
	M +			
	(FT-LBS) −			
	P +			
	(LBS) −			

☐ PROD. NO.________ PT. NO.________

SPOOL NO________

REF. DWGS.
- NO________
- PIPE________
- STEEL________

TAG NO.

SH. 2 OF 3

NO.	REVISIONS	DATE	DR.	CHK.	E.G.S.		P.E.	Q.A.E.

BECHTEL POWER CORPORATION
NORWALK, CALIFORNIA

J.O. NO.

FILE

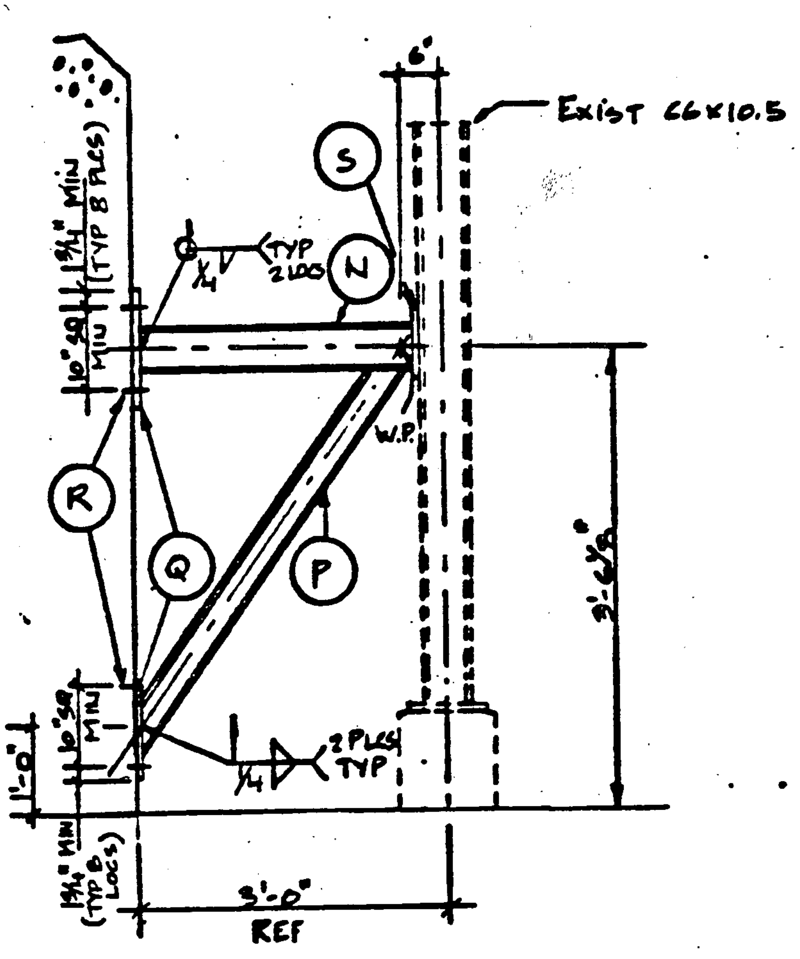
SAN ONOFRE NUCLEAR GENERATING STATION

PIPE SUPPORT ASSEMBLY

SOUTHERN CALIFORNIA EDISON COMPANY
SCALE: NTS
LOS ANGELES, CALIF.

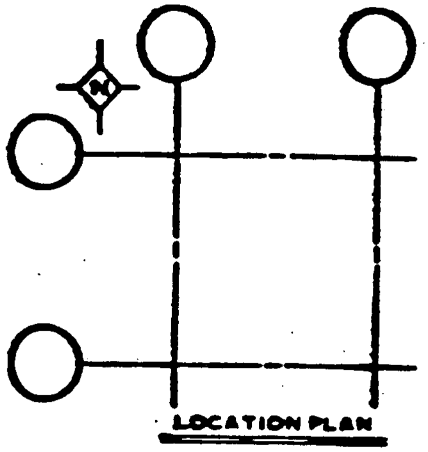
DWG NO.	DATE	APPROVED
800-300	NA	NA

ITEM NO.	NO REQ'D	PART NO	SIZE	DESCRIPTION	WT	AISC	NOTES



SECTION A-A

NOTE:-FOR WEST LEG



LOCATION PLAN

AREA NO.

DESIGN CODE		TYPE	
PROJ CL	PIPE		MAX. TEMP °F
QUAL CL	STEEL SR		

DESIGN		X	Y	Z
	M (FT-LBS)			
	R (LBS)			

☐ PROB. NO.________ PT. NO.________

SPOOL NO.________

REF. DWGS.
- ISO________
- PIPE________
- STEEL________

TAG NO.

SH. 3 of 3

NO.	REVISIONS	DATE	DR.	CHK.	E.G.S.	P.E.	Q.A.E.

BECHTEL POWER CORPORATION
NORWALK, CALIFORNIA

JOB NO.	DATE	APPROVED
14000-300	NA	NA

J.O. NO.

FILE

SAN ONOFRE NUCLEAR GENERATING STATION

PIPE SUPPORT ASSEMBLY

SOUTHERN CALIFORNIA EDISON COMPANY
SCALE: NTS
LOS ANGELES, CALIF.

GP-633 (10079) 9/79

REF [6]

File No. H2189-S1
Report No. 8783R

KWIK-BOLT

AVERAGE ULTIMATE TENSILE & SHEAR LOADS*

CONCRETE STRENGTH		2000 PSI		4000 PSI		6000 PSI	
Diameter	Embedment	Tension	Shear	Tension	Shear	Tension	Shear
1/4"	1 1/8"	975	1653	1455	2612	1755	2389
	1 1/2"	1875	1653	2225	2612	2935	2389
	1 3/4"	2275	1653	2700	2612	3300	2389
	2"	2525	1653	3125	2612	3350	2389
	2 1/4"	2680	1653	3310	2612	3350	2389
	2 1/2"	2800	1653	3350	2612	3350	2389
3/8"	1 5/8"	2245	3748	2355	5107	2810	6266
	2"	2725	3748	3025	5107	3650	6266
	2 1/2"	3075	3748	3900	5107	4450	6266
	3"	3300	3792	4300	5419	5000	6266
	3 1/2"	3425	3792	4600	5419	5275	6266
	4"	3520	3792	4750	5419	5375	6266
	4 1/2"	3580	3792	4800	5419	5400	6266
1/2"	2 1/4"	4545	7444	5510	8316	6845	9341
	2 3/4"	5800	7444	7200	8316	9800	9341
	3 1/2"	7000	7444	9450	8316	13200	9341
	4 1/2"	7275	8897	11225	10232	14550	11522
	5 1/2"	8250	8897	12050	10232	15150	11522
	6"	9000	8897	12300	10232	15300	11522

Actual Concrete Strengths

2178 psi   4027 psi   6119 psi

*See sheet A-3 for notes

File No. H2189-SJ
Report No. 8783R

REF [6]

KWIK-BOLT

AVERAGE ULTIMATE TENSILE & SHEAR LOADS*

CONCRETE STRENGTH		2000 PSI		4000 PSI		6000 PSI	
Diameter	Embedment	Tension	Shear	Tension	Shear	Tension	Shear
5/8"	2 3/4"	5410	11198	6600	11562	7700	13500
	3 1/2"	6250	11198	9100	11562	9560	13500
	4 1/2"	7000	11198	12000	11562	14500	13500
	5 1/2"	7550	13378	14300	15437	20300	15437
	6 1/2"	8025	13378	16000	15437	21000	15437
	7 1/2"	9000	13378	17000	15437	21000	15437
3/4"	3 1/4"	8155	13257	10150	17133	10860	18102
	4"	9700	13257	13400	17133	13700	18102
	5"	11700	13257	16500	17133	17600	18102
	6"	13800	15195	18000	18466	22500	21009
	7"	15800	15195	21000	18466	23600	21009
	8"	16000	15195	23000	18466	23600	21009
	9"	16000	15195	23500	18466	23600	21009
1"	4 1/2"						
	5"						
	6"						
	7"						
	8"						
	9"						
	10"						

Actual Concrete Strengths

2178 psi 4027 psi 6119 psi

*See sheet A-3 for notes

REF [6]

HILTI® INC.
FASTENING SYSTEMS

CORPORATE HEADQUARTERS
P.O. BOX 45400, TULSA, OK 74145, (918) 627-9711

REVISED

1″ DIAMETER HILTI KWIK-BOLT AVERAGE ULTIMATE TENSILE AND SHEAR LOADS

ANCHOR EMBEDMENT DEPTH (INCHES)	CONCRETE STRENGTH					
	2000 PSI		4000 PSI		6000 PSI	
	ULTIMATE TENSION	ULTIMATE SHEAR	ULTIMATE TENSION	ULTIMATE SHEAR	ULTIMATE TENSION	ULTIMATE SHEAR
4½	14000	27355	16000	26879	20500	32112
5	15500	27355	18900	26879	23441	32112
6	17600	27355	23441	26879	23441	32112
7	18200	27355	23441	26879	23441	32112
8	18200	27355	23441	34491	23441	36394
9	18200	27355	23441	34491	23441	36394
10	18200	27355	23441	34491	23441	36394

NOTE: The maximum working loads should not exceed ¼ of the average ultimate values listed. Actual factor of safety to be used depends on the application.

```
        ACTIONS ON SUPPORTS AND ANCHORS                         ME101/J5                   DATE 031684        PAGE   105
  TITLE           : CHEM VOL CONTROL SYSTEM
  PROJECT NUMBER  : 15691-308
  PROBLEM NUMBER  : CVCS-11
  USER            : KHCIGANI
  LOAD CASE       : THRM1


                                          GLOBAL FORCES (LB)                    GLOBAL MOMENTS (FT-LB)
   DATA  TYPE     TITLE                    FX         FY         FZ          MX          MY          MZ
    PT

     5   ANC   PENETR.E-8                  81.        72.         8.       -253.        153.         84.
    47   RAD                              -40.         0.         0.          0.          0.          0.
    47   RAD                                0.         0.        -3.          0.          0.          0.
    60   RAD                                0.       -68.         0.          0.          0.          0.
    60   RAD                                0.         0.      -184.          0.          0.          0.

    75   RAD                              -31.         0.         0.          0.          0.          0.
    75   RAD                                8.       -17.         0.          0.          0.          0.
    78   RAD                              -12.         0.         0.          0.          0.          0.
    78   RAD                                0.        16.         0.          0.          0.          0.
    80   RAD                                3.         0.         0.          0.          0.          0.

    80   RAD                                0.        -4.         0.          0.          0.          0.
    81   RAD                                0.         1.         0.          0.          0.          0.
    81   RAD                                1.         0.         0.          0.          0.          0.
    83   RAD                               -9.         0.         0.          0.          0.          0.
    83   RAD                                0.        -1.         0.          0.          0.          0.

    85   RAD                               52.         0.         0.          0.          0.          0.
    85   RAD                                0.         3.         0.          0.          0.          0.
    86   RAD                             -131.         0.         0.          0.          0.          0.
    86   RAD                                0.       -15.         0.          0.          0.          0.
    88   RAD                      a,    -3739.         0.         0.          0.          0.          0.

    88   RAD                                0.         1.         0.          0.          0.          0.
    90   RAD                      a,     3790.         0.         0.          0.          0.          0.
    90   RAD                                0.        43.         0.          0.          0.          0.
    97   RAD                               26.         0.         0.          0.          0.          0.
    97   RAD                                0.         0.        65.          0.          0.          0.

   105   RAD                              -64.         0.         0.          0.          0.          0.
   105   RAD                                0.       -17.         0.          0.          0.          0.
   137   RAD                              112.         0.         0.          0.          0.          0.
   137   RAD                                0.         0.        41.          0.          0.          0.
   154   RAD                                0.         0.        -2.          0.          0.          0.

   175   ANC                               64.       -22.       -19.         -0.         -2.          8.
   237   RAD                              -10.         0.         0.          0.          0.          0.
   [redacted]
   290   ANC                              116.        41.       -64.        -30.        -10.          7.
   367   RAD                             -106.         0.         0.          0.          0.          0.
```

REF [13]

P. 1 of 8

DATA FT	TYPE	TITLE	GLOBAL FORCES (LB) FX	FY	FZ	GLOBAL MOMENTS (FT-LB) MX	MY	MZ
367	RAC		0.	-275.	0.	0.	0.	0.
610	ANC		39.	4.	38.	14.	53.	12.
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
463	RAD		-17.	0.	0.	0.	0.	0.
463	RAD		0.	0.	4.	0.	0.	0.
470	RAD		-3.	0.	0.	0.	0.	0.
470	RAD		0.	-37.	0.	0.	0.	0.
487	RAD		-34.	0.	0.	0.	0.	0.
487	RAD		0.	0.	-484.	0.	0.	0.
505	ANC		-9.	294.	407.	-27.	-17.	-39.
718	RAD		-130.	0.	0.	0.	0.	0.
718	RAD		0.	0.	-57.	0.	0.	0.
740	ANC		124.	68.	39.	11.	80.	-155.
854	ANC		-88.	-120.	22.	-107.	51.	9.

REF [13]
P. 2 of 8

```
      ACTIONS ON SUPPORTS AND ANCHORS                    ME101/J5                DATE 031684        PAGE   138
 TITLE            : CHEM VOL CONTROL SYSTEM
 PROJECT NUMBER   : 15691-300
 PROBLEM NUMBER   : CVCS-11
 USER             : KHCIGANI
 LOAD CASE        : SAP1

                                         GLOBAL FORCES (LB)            GLOBAL MOMENTS (FT-LB)

  DATA   TYPE    TITLE              FX          FY          FZ          MX          MY          MZ
   PT

    5    ANC   PENETR.8-8          122.         59.         19.        147.        299.        206.
   47    RAD                       127.          0.          0.          0.          0.          0.
   47    RAD                         0.          0.         29.          0.          0.          0.
   60    RAD                         0.         66.          0.          0.          0.          0.
   60    RAD                         0.          0.          7.          0.          0.          0.

   75    RAD                        31.          0.          0.          0.          0.          0.
   75    RAD                         0.         19.          0.          0.          0.          0.
   78    RAD                        22.          0.          0.          0.          0.          0.
   78    RAD                         0.         15.          0.          0.          0.          0.
   80    RAD                         5.          0.          0.          0.          0.          0.

   80    RAD                         0.          3.          0.          0.          0.          0.
   81    RAD                         0.          1.          0.          0.          0.          0.
   81    RAD                         1.          0.          0.          0.          0.          0.
   83    RAD                         0.          0.          0.          0.          0.          0.
   83    RAD                         0.          0.          0.          0.          0.          0.

   85    RAD                         1.          0.          0.          0.          0.          0.
   85    RAD                         0.          0.          0.          0.          0.          0.
   86    RAD                         7.          0.          0.          0.          0.          0.
   86    RAD                         0.          0.          0.          0.          0.          0.
   88    RAD                         1.          0.          0.          0.          0.          0.

   88    RAD                         0.          2.          0.          0.          0.          0.
   90    RAD                         0.          0.          0.          0.          0.          0.
   90    RAD                         0.          1.          0.          0.          0.          0.
   97    RAD                         4.          0.          0.          0.          0.          0.
   97    RAD                         0.          0.          0.          0.          0.          0.

  105    RAD                         0.          0.          0.          0.          0.          0.
  105    RAD                         0.          1.          0.          0.          0.          0.
  137    RAD                         0.          0.          0.          0.          0.          0.
  137    RAD                         0.          0.          0.          0.          0.          0.
  154    RAD                         0.          0.          0.          0.          0.          0.

  175    ANC                         0.          0.          0.          0.          0.          0.
  237    RAD                         0.          0.          0.          0.          0.          0.
[redacted]
  290    ANC                         0.          0.          0.          0.          0.          0.
  367    RAD                         0.          0.          0.          0.          0.          0.
```

REF [13]
P. 3 of 8

ACTIONS ON SUPPORTS AND ANCHORS ME101/J5 DATE 031684

			GLOBAL FORCES (LB)			GLOBAL MOMENTS (FT-LB)		
DATA PT	TYPE	TITLE	FX	FY	FZ	MX	MY	MZ
367	RAD		0.	0.	0.	0.	0.	0.
610	ANC		0.	0.	0.	0.	0.	0.
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
463	RAD		0.	0.	0.	0.	0.	0.
463	RAD		0.	0.	0.	0.	0.	0.
470	RAD		0.	0.	0.	0.	0.	0.
470	RAD		0.	0.	0.	0.	0.	0.
487	RAD		0.	0.	0.	0.	0.	0.
487	RAD		0.	0.	0.	0.	0.	0.
505	ANC		0.	0.	0.	0.	0.	0.
718	RAD		0.	0.	0.	0.	0.	0.
718	RAD		0.	0.	0.	0.	0.	0.
740	ANC		0.	0.	0.	0.	0.	0.
854	ANC		0.	0.	0.	0.	0.	0.

REF [13]
P-4 of 8

TITLE : CHEM VOL CONTROL SYSTEM
PROJECT NUMBER : 15491-300
PROBLEM NUMBER : CVCS-11
USER : KHOIGANI
LOAD CASE : WT1

DATA PT	TYPE	TITLE	GLOBAL FORCES (LB) FX	FY	FZ	GLOBAL MOMENTS (FT-LB) MX	MY	MZ
5	ANC	PENETR.1-8	-5.	-425.	4.	567.	-2.	140.
47	RAD		5.	0.	0.	0.	0.	0.
47	RAD		0.	0.	-5.	0.	0.	0.
60	RAD		0.	-164.	0.	0.	0.	0.
60	RAD		0.	0.	-2.	0.	0.	0.
75	RAD		-10.	0.	0.	0.	0.	0.
75	RAD		0.	-97.	0.	0.	0.	0.
78	RAD		7.	0.	0.	0.	0.	0.
78	RAD		0.	-2.	0.	0.	0.	0.
80	RAD		-2.	0.	0.	0.	0.	0.
80	RAD		0.	-45.	0.	0.	0.	0.
81	RAD		0.	-30.	0.	0.	0.	0.
81	RAD		0.	0.	0.	0.	0.	0.
83	RAD		-0.	0.	0.	0.	0.	0.
83	RAD		0.	-34.	0.	0.	0.	0.
85	RAD		1.	0.	0.	0.	0.	0.
85	RAD		0.	-38.	0.	0.	0.	0.
86	RAD		-3.	0.	0.	0.	0.	0.
86	RAD		0.	-34.	0.	0.	0.	0.
88	RAD		1.	0.	0.	0.	0.	0.
88	RAD		0.	-27.	0.	0.	0.	0.
90	RAD		1.	0.	0.	0.	0.	0.
90	RAD		0.	-9.	0.	0.	0.	0.
97	RAD		3.	0.	0.	0.	0.	0.
97	RAD		0.	6.	7.	0.	0.	0.
105	RAD		-2.	0.	0.	0.	0.	0.
105	RAD		0.	-100.	0.	0.	0.	0.
137	RAD		44.	0.	0.	0.	0.	0.
137	RAD		0.	0.	2.	0.	0.	0.
146	RAD		0.	-176.	0.	0.	0.	0.
154	RAD		0.	0.	-12.	0.	0.	0.
175	ANC		-10.	-267.	-5.	3.	2.	-48.
237	RAD		-18.	0.	0.	0.	0.	0.
250	RAD		0.	-50.	0.	0.	0.	0.
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

REF [13]
P.5 of 8

			GLOBAL FORCES (LB)			GLOBAL MOMENTS (FT-LB)		
DATA PT	TYPE	TITLE	FX	FY	FZ	MX	MY	MZ
290	ANC		-31.	-70.	-4.	1.	-2.	1.
367	RAD		0.	0.	0.	0.	0.	0.
367	RAD		0.	-153.	0.	0.	0.	0.
610	ANC		10.	-111.	-46.	-100.	-133.	192.
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
463	RAD		3.	0.	0.	0.	0.	0.
463	RAD		0.	0.	-9.	0.	0.	0.
470	RAD		10.	0.	0.	0.	0.	0.
470	RAD		0.	-189.	0.	0.	0.	0.
487	RAD		3.	0.	0.	0.	0.	0.
487	RAD		0.	0.	19.	0.	0.	0.
505	ANC		5.	-101.	1.	-64.	3.	10.
718	RAD		-0.	0.	0.	0.	0.	0.
718	RAD		0.	0.	2.	0.	0.	0.
740	ANC		-3.	-19.	0.	2.	2.	34.
854	ANC		22.	-166.	2.	-114.	-19.	1.

REF [13]
p. 6 of 8

```
           ACTIONS ON SUPPORTS AND ANCHORS                                  ME101/J5                  DATE 031684        PAGE   384
    TITLE              : CHEM VOL CONTROL SYSTEM
    PROJECT NUMBER : 15691-300
    PROBLEM NUMBER : CVCS-11
    USER               : KHCIGANI
    LOAD CASE          : SEIS1

                                          GLOBAL FORCES (LB)                            GLOBAL MOMENTS (FT-LB)
     DATA   TYPE     TITLE               FX           FY           FZ           MX           MY           MZ
      PT

        5   ANC   PENETR.E-8            253.         187.         278.         320.         309.         213.
       47   RAD                         112.           0.           0.           0.           0.           0.
       47   RAD                           0.           0.          57.           0.           0.           0.
       60   RAD                           0.          91.           0.           0.           0.           0.
       60   RAD                           0.           0.          67.           0.           0.           0.

       75   RAD                         146.           0.           0.           0.           0.           0.
       75   RAD                           0.          53.           0.           0.           0.           0.
       78   RAD                         100.           0.           0.           0.           0.           0.
       78   RAD                           0.          68.           0.           0.           0.           0.
       80   RAD                          42.           0.           0.           0.           0.           0.

       80   RAD                           0.          20.           0.           0.           0.           0.
       81   RAD                           0.          13.           0.           0.           0.           0.
       81   RAD                          17.           0.           0.           0.           0.           0.
       83   RAD                          24.           0.           0.           0.           0.           0.
       83   RAD                           0.          15.           0.           0.           0.           0.

       85   RAD                          37.           0.           0.           0.           0.           0.
       85   RAD                           0.          13.           0.           0.           0.           0.
       86   RAD                         173.           0.           0.           0.           0.           0.
       86   RAD                           0.          16.           0.           0.           0.           0.
       88   RAD                          29.           0.           0.           0.           0.           0.

       88   RAD                           0.          23.           0.           0.           0.           0.
       90   RAD                          18.           0.           0.           0.           0.           0.
       90   RAD                           0.          35.           0.           0.           0.           0.
       97   RAD                         104.           0.           0.           0.           0.           0.
       97   RAD                           0.           0.         259.           0.           0.           0.

      105   RAD                          43.           0.           0.           0.           0.           0.
      105   RAD                           0.          70.           0.           0.           0.           0.
      137   RAD                         125.           0.           0.           0.           0.           0.
      137   RAD                           0.           0.          91.           0.           0.           0.
      154   RAD                           0.           0.         184.           0.           0.           0.

      175   ANC                         237.         206.          71.          13.           9.          74.
      237   RAD                          59.           0.           0.           0.           0.           0.
[redacted]
      290   ANC                          66.          40.          24.           8.           3.           3.
      367   RAD                          99.           0.           0.           0.           0.           0.
```

REF [13]
p. 7 of 8

ACTIONS ON SLPPCRTS AND ANCHORS   ME101/J5   DATE 031684   PAGE 385

			GLOBAL FORCES (LB)			GLOBAL MOMENTS (FT-LB)		
DATA PT	TYPE	TITLE	FX	FY	FZ	MX	MY	MZ
367	RAD		0.	75.	0.	0.	0.	0.
610	ANC		59.	52.	107.	52.	195.	96.
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
463	RAD		172.	0.	0.	0.	0.	0.
463	RAD		0.	0.	128.	0.	0.	0.
470	RAD		23.	0.	0.	0.	0.	0.
470	RAD		0.	184.	0.	0.	0.	0.
487	RAD		37.	0.	0.	0.	0.	0.
487	RAD		0.	0.	261.	0.	0.	0.
505	ANC		31.	47.	157.	35.	12.	51.
718	RAD		8.	0.	0.	0.	0.	0.
718	RAD		0.	0.	18.	0.	0.	0.
740	ANC		18.	9.	10.	4.	15.	17.
854	ANC		26.	82.	88.	57.	18.	4.

REF [13]
p. 8 of 8

IMPELL CORPORATION

Memorandum

File: 0310-036-1356

To: SUSAN CHAO, RAYMOND HOM

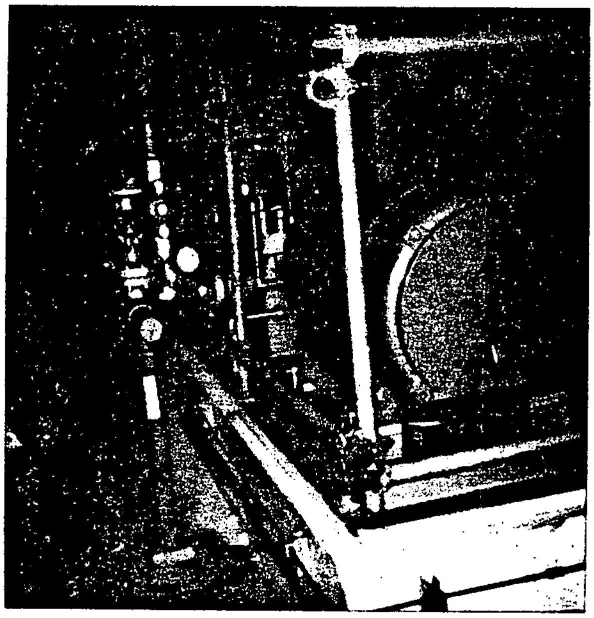
Copy:

From: WARD INGLES

Date: MAY 21, 1984

Subject: SCE EQUIPMENT WALKDOWNS, AUX FW PUMP (G-10S)
SEAL WATER HX (E-34)

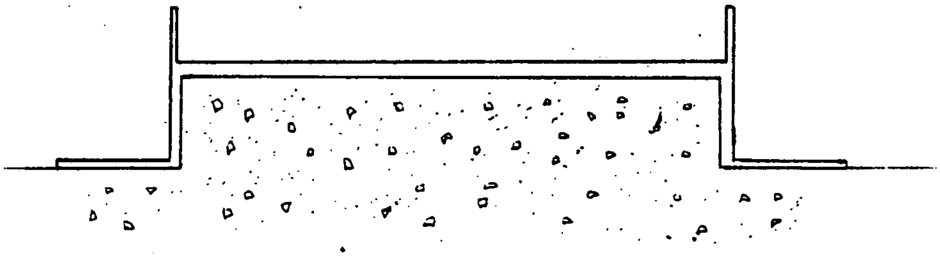
ATTACHED ARE WALKDOWN NOTES + PHOTOS FOR THE SUBJECT EQUIPMENT. PLEASE LET ME KNOW IF ADDITIONAL DATA IS REQUIRED



AUX. FW PUMP
G-105

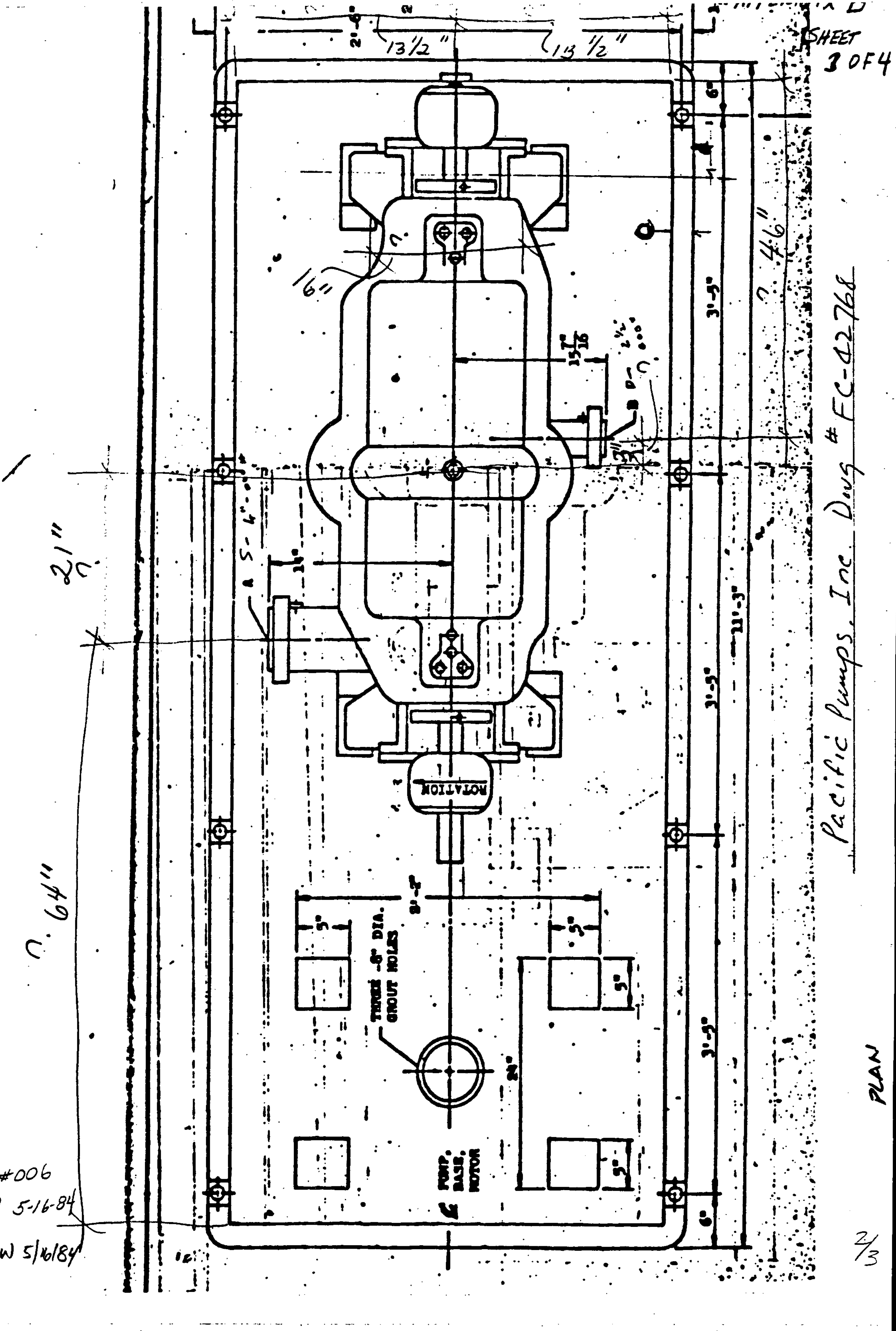
AUX. FW. PUMP
G-105

THE PUMP'S SKID LOOKS LIKE:



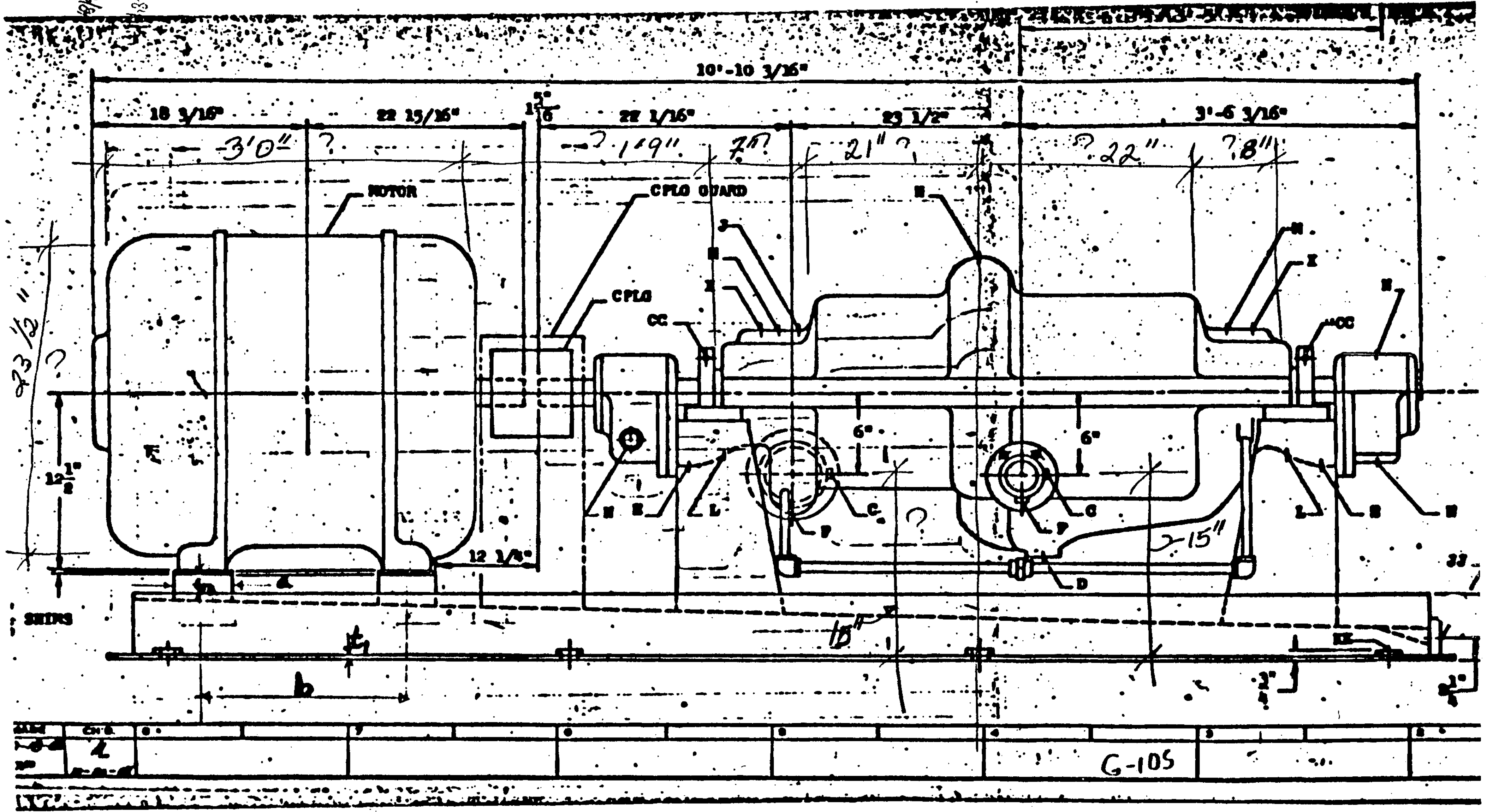
ALSO ATTACHED ARE THE PUMP DRAWINGS WITH THE REQUESTED DIMENSIONS INDICATED 006

					RFI #006		
					AUX FW PUMP G-105		
					IMPELL CORPORATION	JOB NO	PAGE
	DJP	5-16-84	WJW	5/16/84		CALC NO	1 OF 3
REV	BY	DATE	CHECKED	DATE			



RFI #006
BY: DJP 5-16-84
CHK: WJW 5/16/84

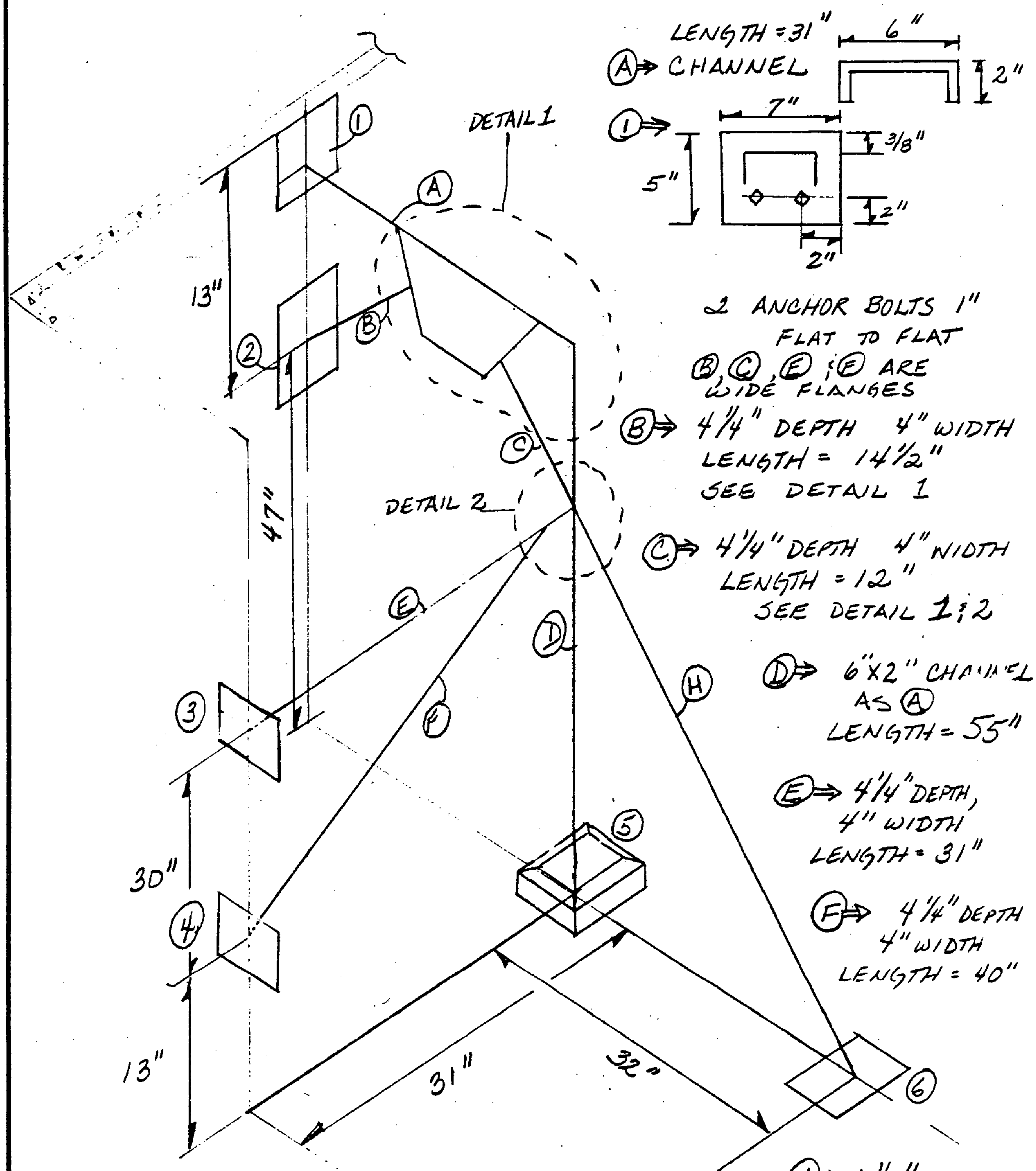
RFI #006
by DQP 5-16-88
CHK: WTW 5/16/88



Pacific Pumps, Inc. Dwg. # FC-42768

ELEVATION

APPENDIX D
SHEET 4 OF



2 ANCHOR BOLTS 1" FLAT TO FLAT

Ⓑ, Ⓒ, Ⓔ & Ⓕ ARE WIDE FLANGES

Ⓑ⇒ 4 1/4" DEPTH 4" WIDTH
LENGTH = 14 1/2"
SEE DETAIL 1

Ⓒ⇒ 4 1/4" DEPTH 4" WIDTH
LENGTH = 12"
SEE DETAIL 1 & 2

Ⓓ⇒ 6"X2" CHANNEL
AS Ⓐ
LENGTH = 55"

Ⓔ⇒ 4 1/4" DEPTH,
4" WIDTH
LENGTH = 31"

Ⓕ⇒ 4 1/4" DEPTH
4" WIDTH
LENGTH = 40"

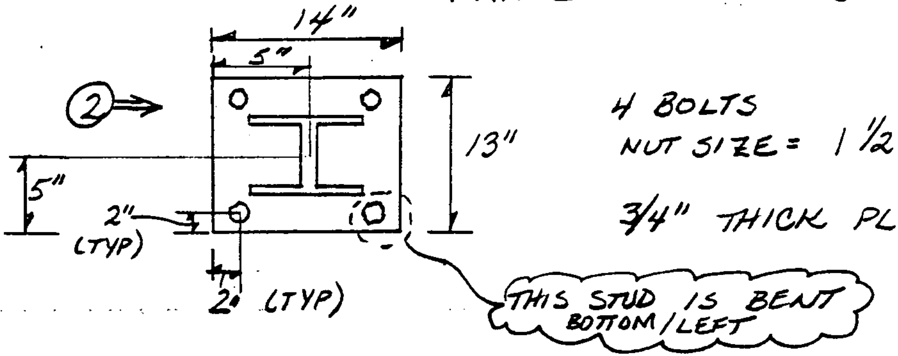
Ⓗ⇒ 6 1/4" DEPTH,
6" WIDTH
LENGTH = 50 1/2"

FRAME A

					RFI #006		
					E-34		
					IMPELL CORPORATION	JOB NO	PAGE 1
	DJP	5-14-84	WJW	5/15/84		CALC NO	OF 8
REV	BY	DATE	CHECKED	DATE			

FRAME A DETAILS

②

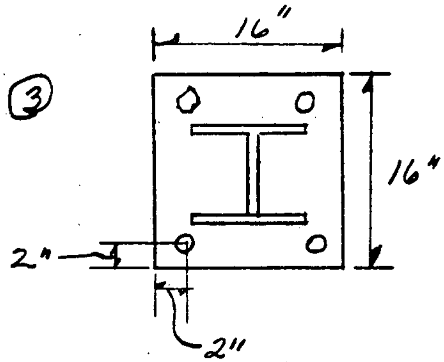


4 BOLTS
NUT SIZE = 1 1/2" FLAT TO FLAT

3/4" THICK PLATE

THIS STUD IS BENT BOTTOM/LEFT

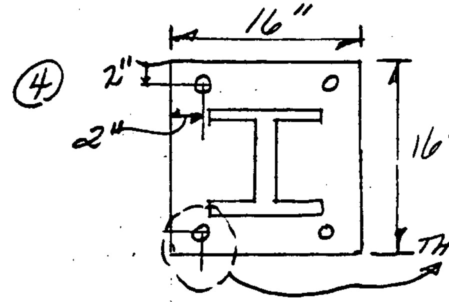
③



4 BOLTS
NUT SIZE = 1 1/2" FLAT TO FLAT

3/4" THICK PLATE

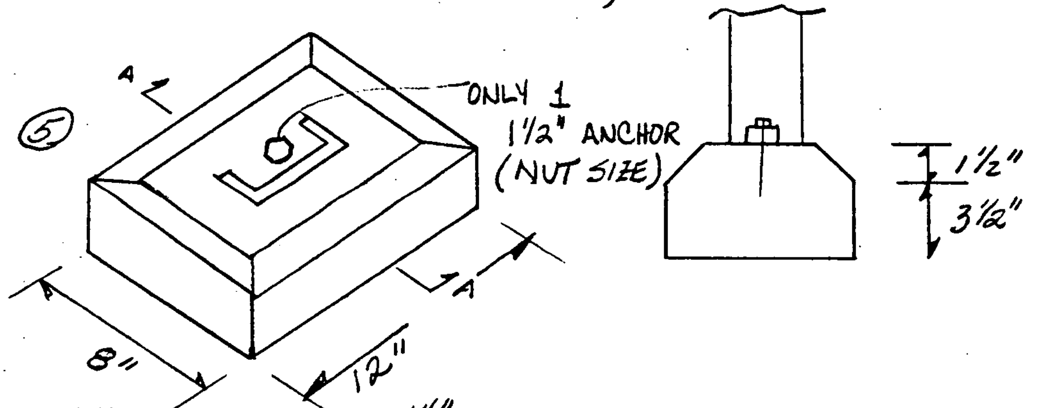
④



4 BOLTS
NUT SIZE = 1 1/2" FLAT TO FLAT
3/4" THICK PLATE

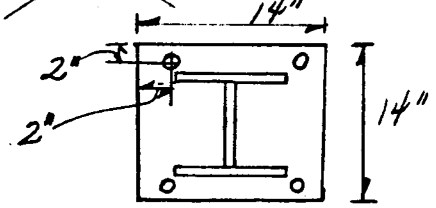
THIS BOLT IS OFF LINE 3 1/2" FROM BOTTOM; 2" FROM SIDE – BOTTOM/RIGHT

⑤



ONLY 1 1 1/2" ANCHOR (NUT SIZE)

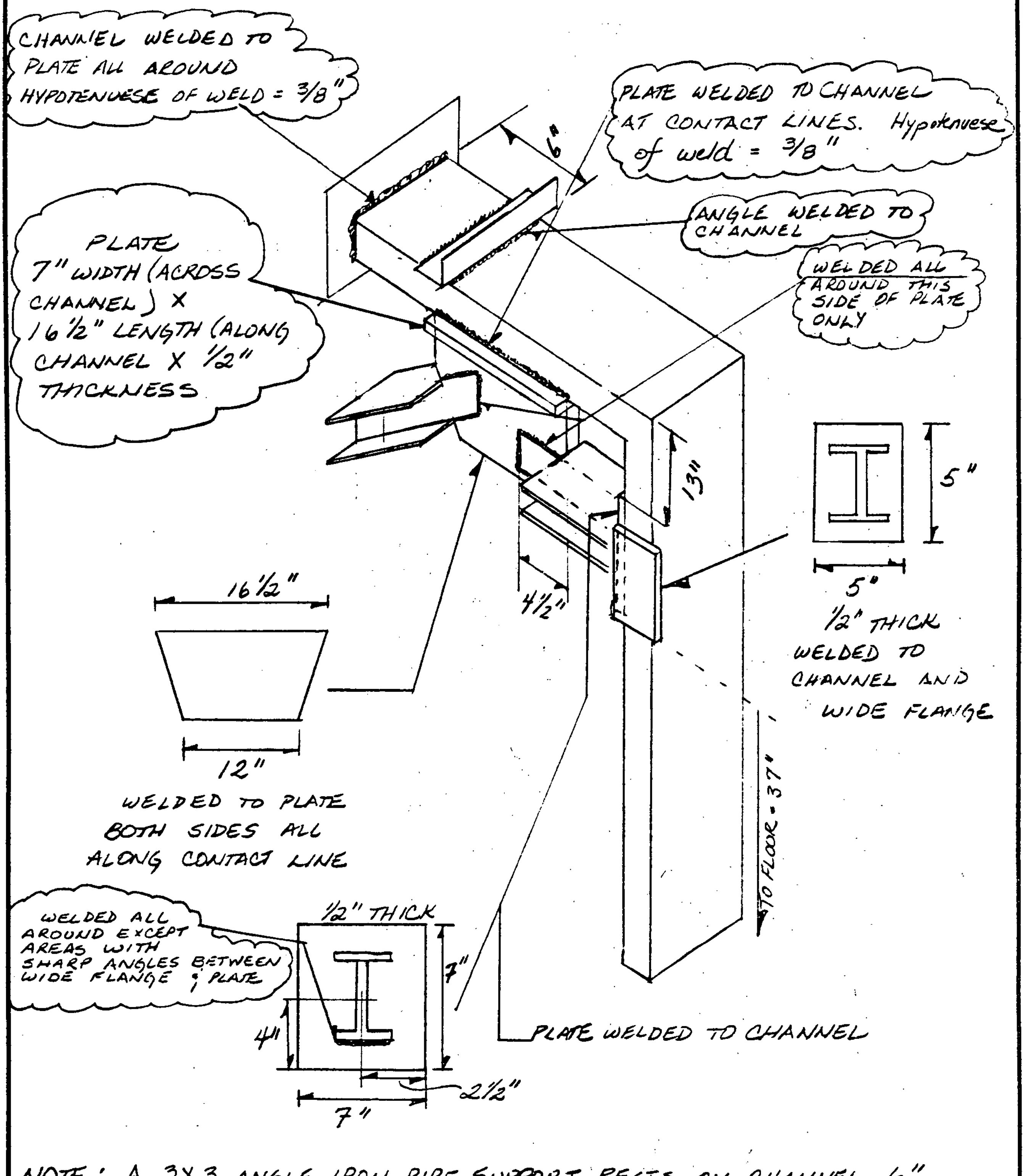
⑥



4 BOLTS
NUT SIZE 1 1/2" FLAT TO FLAT
3/4" THICK PLATE

					RFI #006		
					E-34		
	Djp	5-14-84	WJW	5/15/84	IMPELL CORPORATION	JOB NO CALC NO	PAGE 2 OF 8
REV	BY	DATE	CHECKED	DATE			

FRAME A, DETAIL 1 AND 2



NOTE: A 3X3 ANGLE IRON PIPE SUPPORT RESTS ON CHANNEL 6" OUT FROM WALL 3 GUIDES SUPPORTING 3 PIPES ARE SUPPORTED OFF OF THIS ANGLE (FRAME A ONLY)

RFI #006

E-34

REV	BY	DATE	CHECKED	DATE
	Djp	5-14-84	WJW	5/15/84

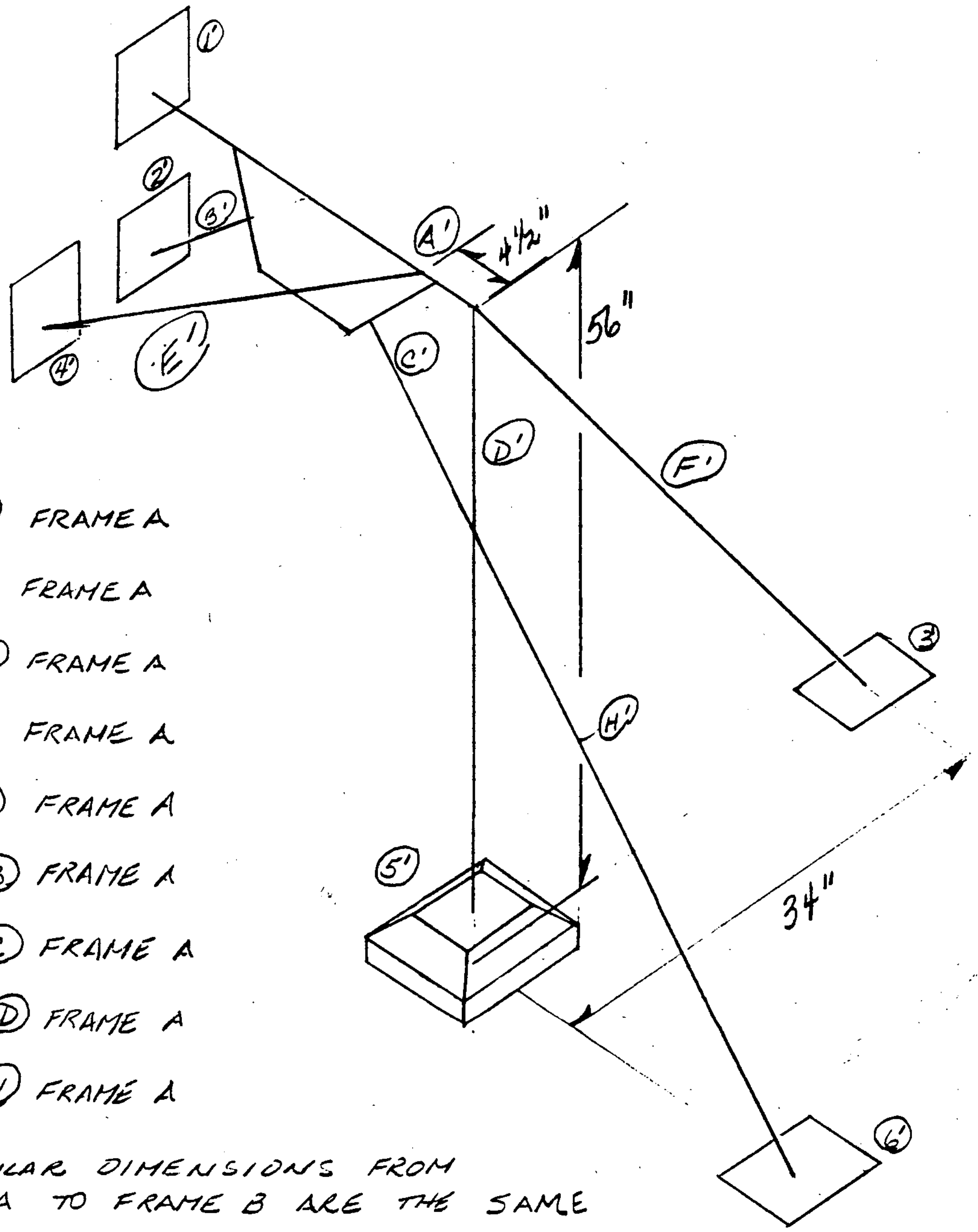
IMPELL CORPORATION

JOB NO

CALC NO

PAGE 3 OF 8

FRAME B



1' = 1 FRAME A

2' = 2 FRAME A

5' = 5 FRAME A

6' = 6 FRAME A

A' = A FRAME A

B' = B FRAME A

C' = C FRAME A

D' = D FRAME A

H' = H FRAME A

ALL SIMILAR DIMENSIONS FROM
FRAME A TO FRAME B ARE THE SAME

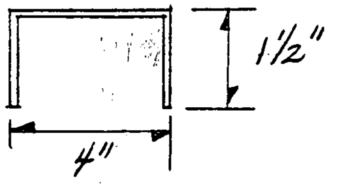
DISTANCE BETWEEN 5 FRAME A ; 5' FRAME B = 100'

FRAME B

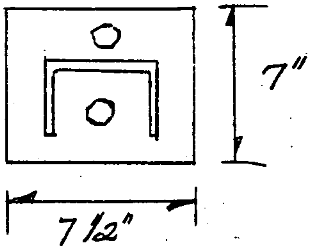
					RFI #006		
					E-34		
						JOB NO	PAGE
0	DJP	5-14-84	WJW	5/15/84	IMPELL CORPORATION	CALC NO	4 OF 8
REV	BY	DATE	CHECKED	DATE			

FRAME B DETAILS

E' = 41" LONG CHANNEL



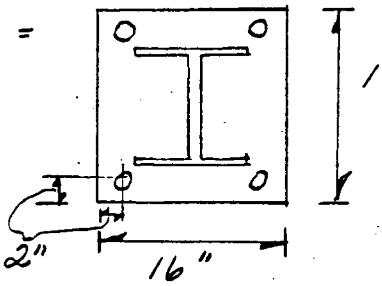
(4') =>



2 ANCHOR BOLTS 1" FROM FLAT TO FLAT (SIZE)
CHANNEL WELDED TO PLATE ALL AROUND.

(F') = 6 X 6¼" WIDE FLANGE AS H'

(3') =



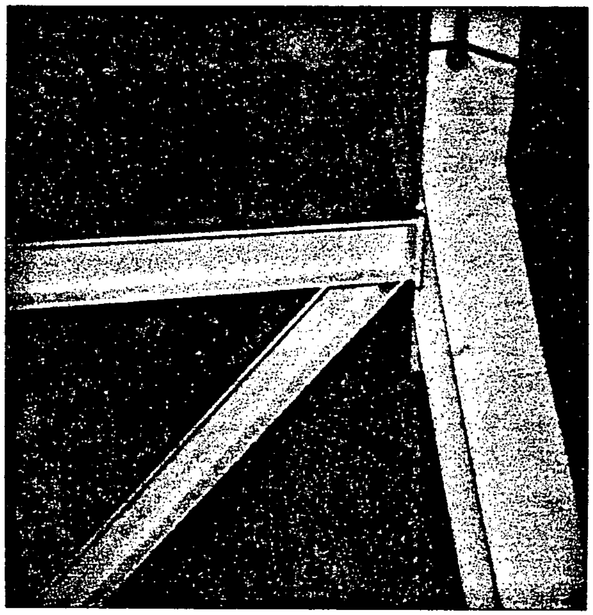
4 BOLTS : NUT SIZE = 1½" FLAT TO FLAT.

MEMBER F' CONNECTS TO CHANNEL A' AT TOP WITH A PLATE BETWEEN. E' IS WELDED TO THE PLATE : THE PLATE IS WELDED TO THE CHANNEL. THIS PLATE IS 13" X 7½" X ½" AND IS OFFSET UP ABOVE THE CHANNEL 2".

NOTE : A 2X2 ANGLE IRON PIPE SUPPORT IS ATTACHED TO MEMBER E'. IT IS LOCATED 11" ALONG E' FROM CHANNEL A'.
THIS PIPE GUIDE SUPPORT IS IDENTIFIED W/ SUPPORT # 51-08-2028-H002

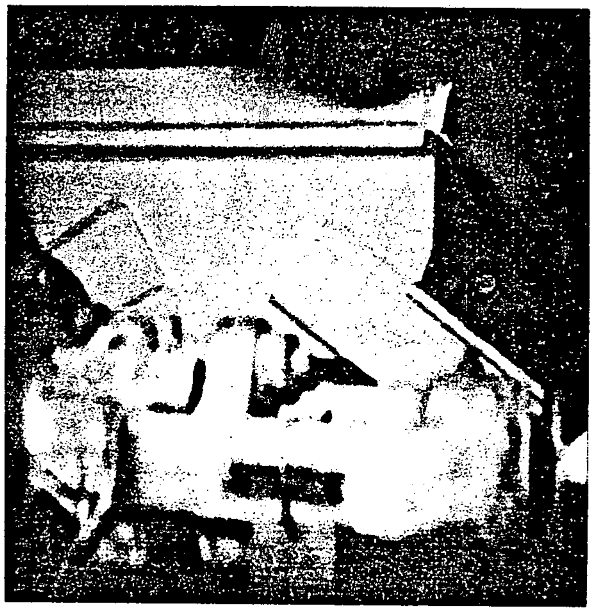
THERE IS ALSO 1 PIPE SUPPORT ATTACHED TO THE CHANNEL A' NEAR BASE PLATE (1')

					RFI * 006		
					E-34		
					IMPELL CORPORATION	JOB NO	PAGE
	Gjp	5-14-84	WJN	5/15/84		CALC NO	5 OF 8
REV	BY	DATE	CHECKED	DATE			

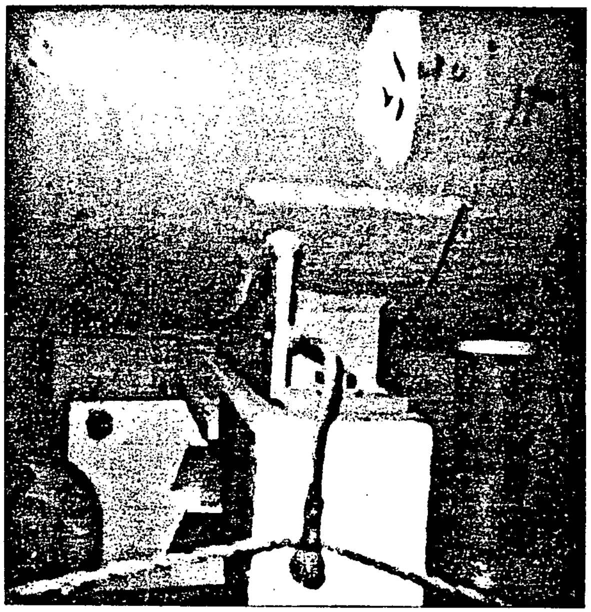


FRAME A : MEMBERS
E, F, D, H (FOREGROUND)

FRAME, A : DETAIL OF
CHANNEL D SUPPORT
AT FLOOR



FRAME A: DETAIL 1 AS
SHOWN IN SKETCH (CONN. OF B & C)



FRAME A: DETAIL
OF SADDLE PLATE
(TYPICAL OF FRAME B)

REV	BY	DATE	CHECKED	DATE
	RJP	5-14-84	WJW	5/15/84

RFI # 006

SEAL WATER HEAT EXCHANGER E-34

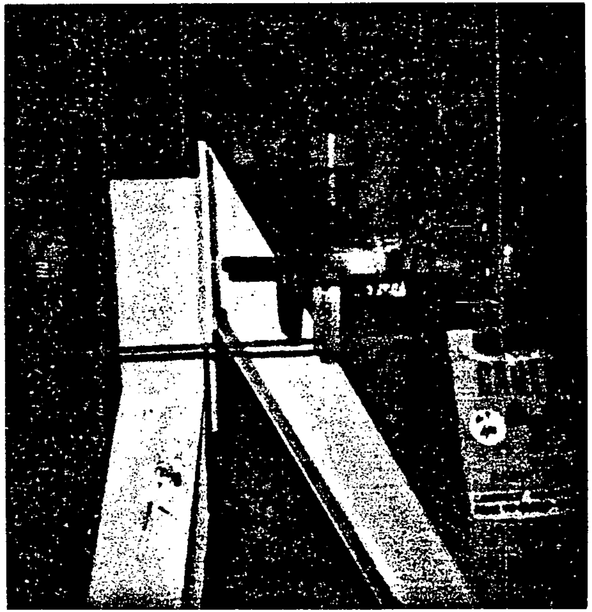
IMPELL CORPORATION

JOB NO

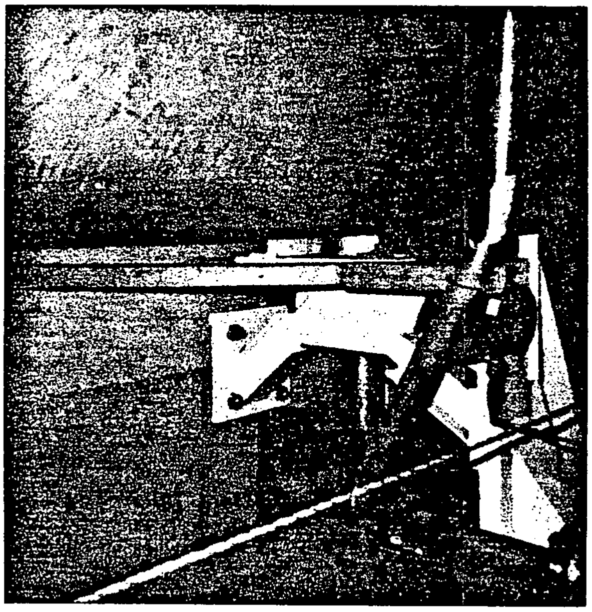
CALC NO

PAGE 6 OF 8

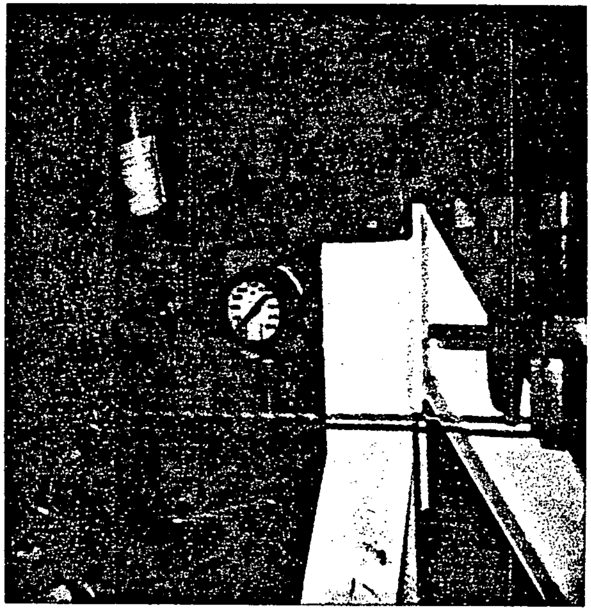
FRAME A: SHOWING CONN OF B ; C FROM BACK. NO WELDS



FRAME B:

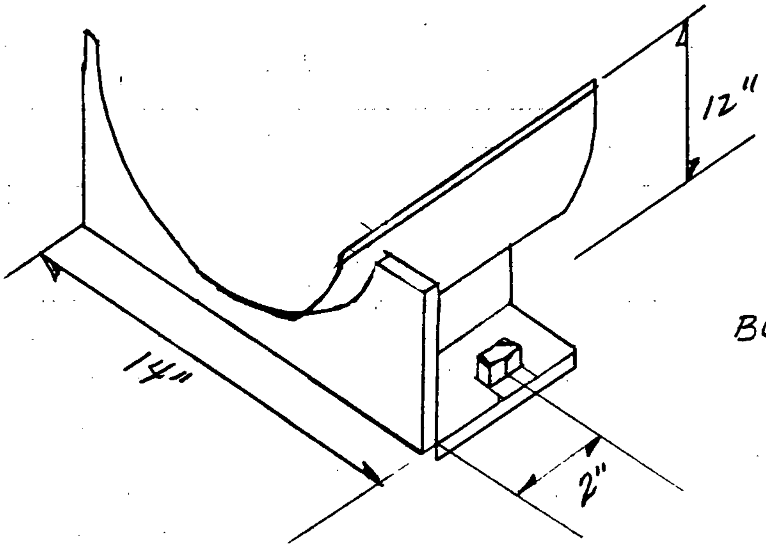


FRAME B



FRAME B

					RFI #006		
					E -34		
					IMPELL CORPORATION	JOB NO	PAGE 7
	Djp	5-14-84	WJW	5/15/84		CALC NO	OF 8
REV	BY	DATE	CHECKED	DATE			



BOLT = 1 1/8" ANCHOR BOLT

SADDLE DETAIL TYPICAL

SEE ALSO PHOTO'S

					RFI #006
					E-34
	DJP	5-14-84	WJW	5/15/84	IMPELL CORPORATION
REV	BY	DATE	CHECKED	DATE	

JOB NO

CALC NO

PAGE 8 OF 8

IMPELL CORPORATION

Memorandum

File: 0310-036-1356

To: JOB FILE 0310-036-1356

Copy: S. J. CHAO (W/O)
W. R. BAK
R. C. HOM

From: WARD INGLES

Date: MAY 7, 1984

Subject: SCE / SONGS-1 EQUIPMENT WALKDOWNS.

ATTACHED ARE WALKDOWN NOTES AND PHOTOS FOR THE FOLLOWING EQUIPMENT ITEMS:

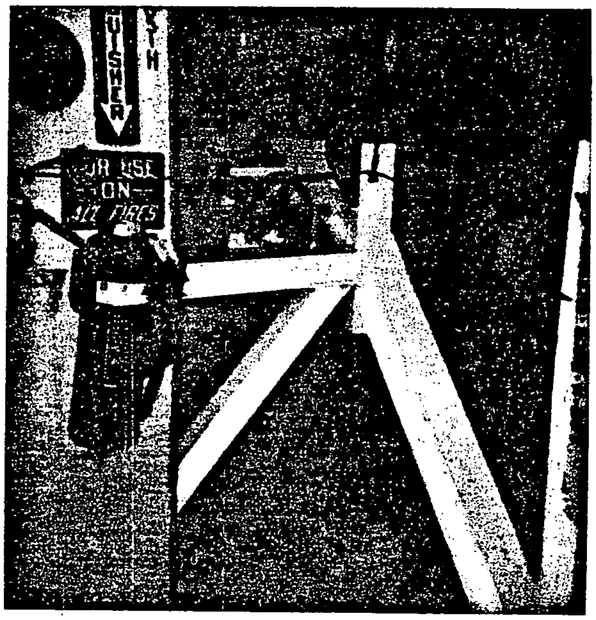
- SEAL WATER HEAT EXCHANGER (E-34)
- CHARGING PUMPS (G8A, B)
- CHARGING PUMP OIL COOLER (WATER COOLED)
- CHARGING PUMP OIL COOLER (AIR COOLED)

THIS INFORMATION WAS OBTAINED BY DONNA POWELL AND JIM WAGONER ON MAY 4, 1984.

Equipment Walkdowns 5/4/84 BY: DJP 5/4/84
CKD: WJW 5/14/8

- Seal Water Heat Exchanger E-34:

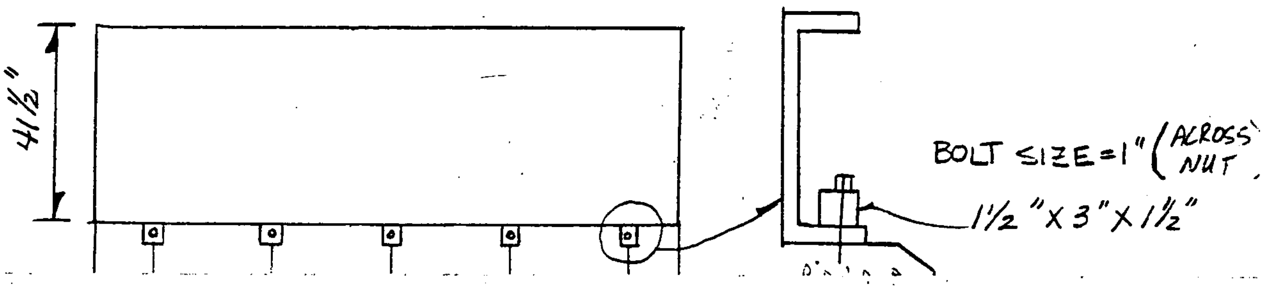
Modifications have been completed see photo below to show bracing



SEAL WATER HEAT EXCHANGER

SEAL WATER HEAT EXCHANGER

- Charging Pumps G8A ; G8B



APPENDIX D

158

CALCULATION SHEET

CALC. NO. AC - 1

URE DATE 6/22/81 CHECKED AK DATE 2/11/82

ECT SONGS-1 JOB NO. 14000-165

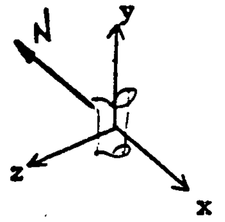
SUBJECT AUX. COOLANT FROM E-34 TO 3037-14"-152N SHEET 1 OF 3 SHEETS

B-1

3.4 SUMMARY OF NOZZLE LOADS

AS-BUILT CONDITION

Orientation of nozzle and component



EQUIPMENT	NODE POINT	DIRE	LOADING CONDITIONS				TOTAL *	RESULTANT	ALLOWABLE*
			DW	T H	SSE	SAM			
Seal Water HT. EXCH. E-34 LINE NO. 3093-4-152N OUTLET)	120	Fx	-3	439	±34		476	1872	
		Fy	-26	1775	±9		1810		
		Fz	0	-11	±60		71		
		Mx	-3	0	±27		30	1514	
		My	-17	4	±176		197		
		Mz	8	-1472	±91		1501		
		Fx							
		Fy							
		Fz							
		Mx							
		My							
		Mz							

*Ref:

EXCERPTED FROM [9]

to, Find out if modified or not.

CALCULATION SHEET

APPENDIX D

CALC. NO. AC 160/02

BY J. Hol DATE 7-1-81 CHECKED Au DATE 2/11/82

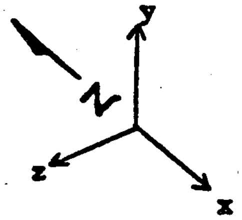
SONGS-1 JOB NO. 14000-165

SUBJECT SHEET 3 OF 3 SHEETS

B-3

3.4 SUMMARY OF NOZZLE LOADS .... AS. BUILT CONDITION

Orientation of nozzle and component



EQUIPMENT	NODE POINT	DIRE	LOADING CONDITIONS				TOTAL	RESULTANT	ALLOWABLE*
			DW	T H	± SSE	SAM			
SEAL WATER HEAT EXCH. (E-34) LINE NO. 303B-4"152N	175 (INLET)	Fx	22.	.69.	119.		210. (LE)	956.	
		Fy	116.	173.	419.		708		
		Fz	-77.	93.	530.		-607		
		Mx	-42.	58.	262.		-304 (FT-LE)	1060.	
		My	-106.	151.	632.		-738		
		Mz	-93.	-212.	392.		-697		
		Fx							
		Fy							
		Fz							
		Mx							
		My							
		Mz							

*Ref: See Calc. on 3.4.1 (pp. 15 & 16).

EXCERPTED FROM [9]

Ref. [10] p. 1 of 5

0310-036-1356

IMPELL CORPORATION

WESTERN REGION TELECOPY

350 LENNON LANE WALNUT CREEK, CA 94598

AUTOMATIC TELECOPY: 415/943-4521
CENTRE POINTE TELECOPY: 415/943-4885
SWITCHBOARD/VERIFICATION: 415/943-4500

TO: COMPANY: SCE
ATTENTION OF: PIUS KAO x59359
SUBJECT(S):

FROM: NAME: WARD INGLES EXT. 720
DATE: 6/13/84
JOB NUMBER: 0310-036-1356
NUMBER OF FOLLOWING PAGES: 4

INSTRUCTIONS/COMMENTS: TELECOPY NO 714-492-7700
X 56157
x 6303

[10], p245

REQUEST FOR FIELD DIMENSIONS FOR SEAL WATER HEAT EXCHANGER, E-34

NOTE: THE EXCHANGER IS LOCATED ON A STEEL FRAME ON THE NORTH WALL OF THE CHARGING PUMP ROOM. THE EXCHANGER IS BEHIND A "HIGH RAD" ROPE.

DIMENSIONAL DATA IS NEEDED FOR THREE BASE PLATES ATTACHED TO THE WALL. THE LOCATIONS OF THE BASE PLATES ARE ON THE NORTH WALL AND ARE SHOWN IN THE SKETCH ON THE FOLLOWING PAGE.

THE INFORMATION NEEDED CAN BE PROVIDED BY FILLING IN THE BLANKS ON THE FOLLOWING PAGE.

REV	BY	DATE	CHECKED	DATE

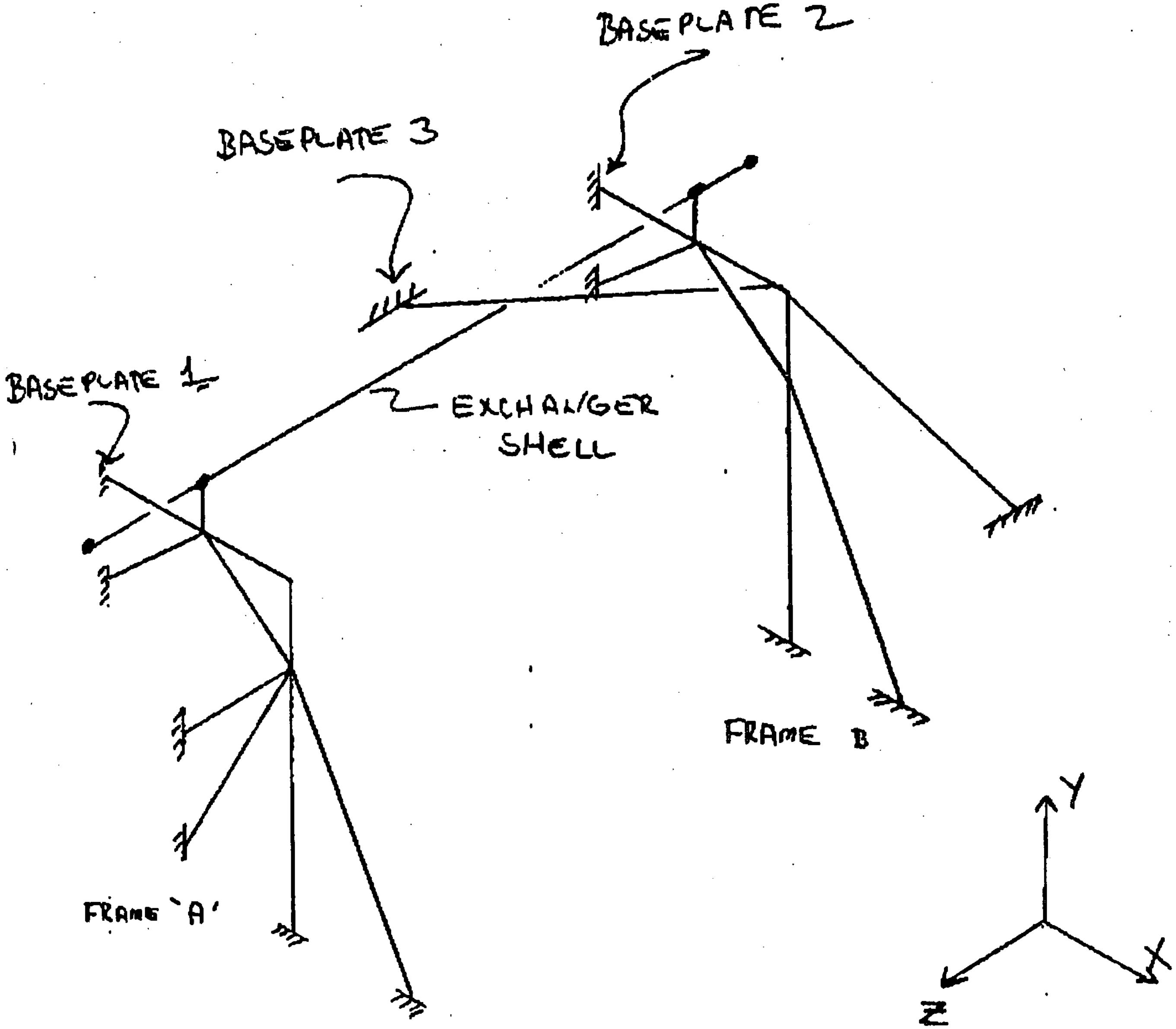
IMPELL CORPORATION

JOB NO 0310-036

CALC NO

PAGE 1 OF 4

EDSGAP MODEL OF SEAL WATER HEAT EXCHANGER - E-34



REV	BY	DATE	CHECKED	DATE
0	WJ	6/5/84		

IMPELL CORPORATION

SCF E-34 HX

JOB NO 0312-026
CALC NO EQ-06
PAGE 2 OF 4

[D] p. 3 of 5

- SKID, WEIGHT = 1700 lb

THE SKID IS OBVIOUSLY RIGID IN THE RANGE OF SEISMIC LOADS,

$$\therefore a_H = .67g$$

$$a_V = \tfrac{2}{3}(.67g) = .45g$$

THE MAXIMUM SHEAR LOADS GENERATED BY THE SKID WILL BE:

$$F_x = F_z = (.67g)(1700\ \text{lb})$$
$$= 1140\ \text{lb}$$

UPLIFT:

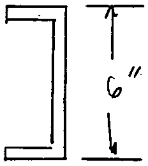
$a_V = \pm.45g$, $\therefore$ UPLIFT WILL NOT OCCUR, THE DOWNWARD VERTICAL LOAD WILL RESIST THE UPLIFT/OVERTURNING LOADS APPLIED TO THE PUMP + MOTOR.

$$F_Y = (1.0 - .45)g \cdot 1700\text{lb} = -935.\text{lb}$$

OVERTURNING MOMENTS

ASSUME THE CG OF THE SKID IS AT ITS GEOMETRIC CENTER.

$\therefore$ THE CG IS 3" (HALF OF THE 6" CHANNEL) ABOVE THE BASE



$$M_x = M_z = 3''(F_x) = 3''(1140\ \text{lb}) = 3420\ \text{in.lb}$$

REV	BY	DATE	CHECKED	DATE
0	WE	6/29/84	CB	7/13/84

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-09

TOTAL LOADS @ FOUNDATION BOLTS

LOAD	MOTOR		PUMP			SKID	TOTAL
	SEISMIC	DEAD	SEISMIC	DEAD	NOZZLE	SEISMIC/DW	
F_x	5513	–	9954	–	1042	1140	17,650.
F_y	3675	-5250	6636	-9480	3273	-935	-2080.
F_z	5513	–	9954	–	4335	1140	20,950
M_x	132,300	–	2.39×10^5	–	2.50×10^5	3420	6.25×10^5
M_y	0	–	0	–	9768	0	9768.
M_z	132,300	–	2.39×10^5	–	4.43×10^4	3420	4.19×10^5

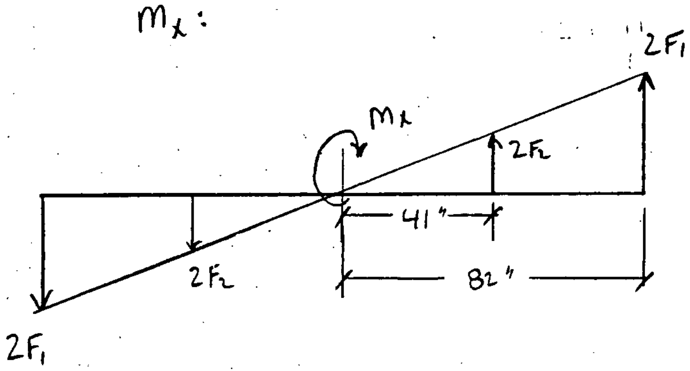
- LOADS ARE COMBINED BY ASUM (EXCEPT FOR DEAD WT.)
- TORSIONAL MOMENT (M_y) IS NEGLIGIBLE
- RESULTANT SHEAR $= [(17650 \text{ lb})^2 + (20,950 \text{ lb})^2]^{1/2}$

  $= 27,400 \text{ lb}$

TENSILE BOLT LOAD:

ASSUME OVERTURNING MOMENTS ABOUT CENTROID OF BOLT GROUP.

M_x:

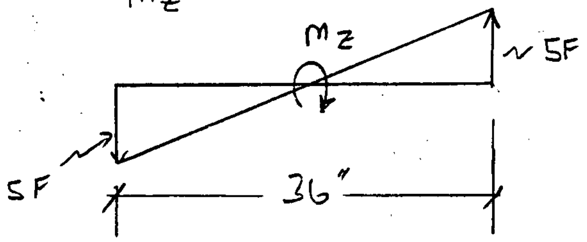


$$M_x = 2(2F_2 \cdot 41'') + 2(2F_1 \cdot 82'')$$
$$= 4F_2 \cdot 41'' + 4F_1\ 82''$$
$$F_2 = F_1/2$$

$$M_x = 4(F_1/2) \cdot 41'' + 328'' \cdot F_1$$
$$= 410'' \cdot F_1$$

$$F = m/410''$$

M_z



$$M_z = 5F(36'')$$
$$= 180'' \cdot F$$

$$F = M_z/180''$$

$$\therefore f_{bt} = \frac{M_x}{410\,in} + \frac{M_z}{180\,in} + \frac{F_y}{4}$$

$$= \frac{6.25 \times 10^5\,in \cdot lb}{410\,in} + \frac{4.19 \times 10^5\,in \cdot lb}{180\,in} - \frac{2080\,lb}{10\,bolts}$$

$$= 3644\ lb/bolt$$

REV	BY	DATE	CHECKED	DATE
0	WI	6/29/84	CAS	7/13/84

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-09

PAGE 31 OF 36

ALLOWABLE BOLT LOAD

TO DETERMINE THE ACTUAL ALLOWABLE ANCHOR BOLT PULLOUT WOULD REQUIRE MORE DETAILS ABOUT THE AS-BUILT CONFIGURATION THAN ARE PRESENTLY AVAILABLE. THEREFORE THE BOLTS WILL BE ASSUMED TO BE HILTI-KWIK-BOLTS [8]

FOR 5/8" DIAMETER BOLTS THE MAXIMUM EMBEDMENT TABULATED IN THE LOAD DATA IS 7½" (COMPARED TO THE ACTUAL 1'-1½"). THE CONCRETE STRENGTH IS ASSUMED TO BE 4000psi. THE AVERAGE ULTIMATE PULLOUT IS: 17000lb, APPLYING A SAFETY FACTOR of 4.0.

$$F_{bt} = \frac{17000 \text{ lb}}{4.0} = 4250 \text{ lb}$$

$$f_{bt} < F_{bt}$$

$$3644 < 4250$$

∴ FOUNDATION BOLTS QUALIFY.

NOTE ON SHEAR

THE RESULTANT SHEAR FORCE IS:

$$FV = 27{,}400 \text{ lb}$$

THE CROSS-SECTIONAL AREA OF THE GROUT / CONCRETE INTERFACE IS:

$$A \approx (3')(14'-8")\left(\frac{144 \text{ in}^2}{1 \text{ ft}^2}\right)$$

$$\approx (3')(14.6')(144 \text{ in}^2/\text{ft}^2) = 6300 \text{ in}^2$$

∴ THE REQUIRED SHEAR STRENGTH OF THE GROUT / CONCRETE INTERFACE (NEGLECTING FRICTIONAL EFFECTS) IS:

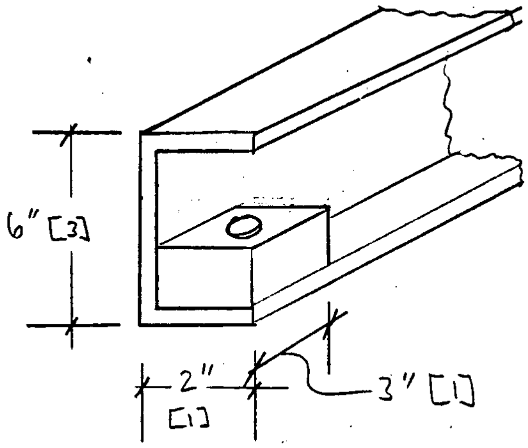
$$F_{V \text{ REQ}} = \frac{27{,}400 \text{ lb}}{6{,}300 \text{ in}^2} = 4.3 \text{ psi}$$

THIS REQUIRED STRENGTH IS VERY LOW, ∴ INTERFACE IS ADEQUATE.

0	WI	6/29/84		7/13/84	IMPELL CORPORATION	JOB NO 0310-036 CALC NO EQ-09	PAGE 33 OF 36
REV	BY	DATE	CHECKED	DATE			

9.0 BASE CHANNEL

THE TENSILE LOAD IN THE ANCHOR BOLTS IS DISTRIBUTED INTO THE BASE CHANNEL BY STEEL BLOCKS. (SEE [1] + [3])



FROM [1], THE BLOCK HAS A DEPTH OF 1 3/4" AND THE CHANNEL A TOTAL DEPTH OF 2". ∴ THE CHANNEL IS ASSUMED 1/4" THICK.

THE BLOCK WILL ELIMINATE BENDING IN THE FLANGE OF THE CHANNEL AND TRANSFER THE LOAD DIRECTLY TO THE WEB, WHERE IT WILL BE CARRIED AS AN AXIAL LOAD.

HOWEVER, AS A CONSERVATIVE CHECK, THE FLANGE WILL BE MODELED AS A WIDE CANTILEVER BEAM WITH A POINT LOAD [7], p. 188-190, ART. 7.11

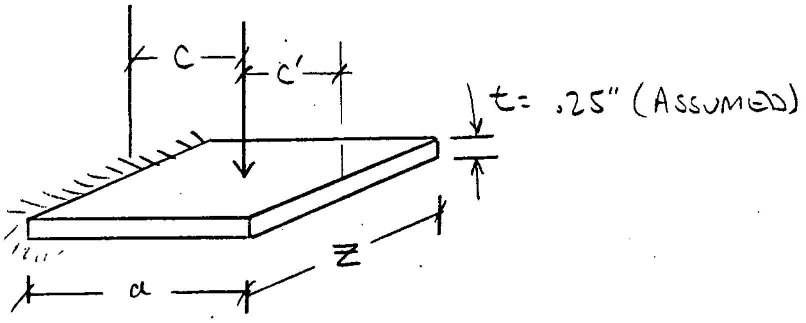
REV	BY	DATE	CHECKED	DATE
0	WE	6/29/84	CB	7/10/84

IMPELL CORPORATION

JOB NO 0310-036

CALC NO EQ-09

PAGE 34 OF 36



a = FLANGE WIDTH - WEB THICKNESS
= 2.00" - .25"
= 1.75"

Z = BLOCK WIDTH = 3.00"

C' = .75" [3]

$C = a - C' = 1.75 - .75 = 1.00"$

$Z/a = 3.00/1.75 = 1.71$
$C/a = 1.00/1.75 = .571$ } $K_m \approx .059$ (MAX)

$$\therefore \sigma_b \cong K_m\left(\frac{6P}{t^2}\right) \qquad P = \text{BOLT LOAD} = 3644\text{ lb}$$

$$= .059\left(\frac{6 \cdot 3644\text{lb}}{(.25\text{in})^2}\right)$$

$$= 20.6\text{Ksi}$$

THIS CONSERVATIVELY CALCULATED STRESS IS LESS THAN THE LEVEL A ALLOWABLE FOR BENDING IN COMPACT SECTIONS (.66·36 = 23.76 ksi)

∴ BASE ANGLE QUALIFIES

0	WT	6/29/84	CS	7/13/84
REV	BY	DATE	CHECKED	DATE

IMPELL CORPORATION

JOB NO 0310-036
CALC NO EQ-09
PAGE 35 OF 36

10.0 SUMMARY.

COMPONENT	CALCULATED STRESS	ALLOWABLE STRESS	REMARKS
MOTOR HOLD DOWN BOLTS	.02 (INTERACTION)	1.0	OK, USING LEVEL A LIMITS
PUMP HOLD DOWN BOLTS	.79 (INTERACTION)	1.0	OK, USING LEVEL A LIMITS
FOUNDATION ANCHOR BOLTS	3694 lb.	4250 lb	OK, F.S. = 4.0 NOTE 1
BASE CHANNEL	20.6 Ksi	23.76 ksi	OK, USING LEVEL A ALLOWABLES

NOTE 1: FOUNDATION BOLTS ARE J-BOLTS WITH AN EMBEDMENT EXCEEDING 12". ALLOWABLE IS BASED ON EXPANSION BOLT WITH 7½" EMBEDMENT IN 4000psi CONCRETE. RESULTS ARE CONSERVATIVE

REV	BY	DATE	CHECKED	DATE
0	WI	6/29/84		7/13/84

IMPELL CORPORATION

JOB NO 0310 · 036

CALC NO EQ-09

APPENDIX A

REFERENCE DOCUMENTS

0	WE			
REV	BY	DATE	CHECKED	DATE

IMPELL CORPORATION

JOB NO 0312 036

CALC NO EQ-09

PAGE

OF

Bechtel Power Corporation
Engineers – Constructors
12400 East Imperial Highway
Norwalk, California 90650
MAIL ADDRESS
P.O. BOX 60860 - TERMINAL ANNEX, LOS ANGELES, CALIFORNIA 90060
TELEPHONE: (213) 807-2000

March 23, 1984
BPC/V-84-156

ROUTE:
WDGALLO
RLGRUBE
ASEIKEN
WRBAK
DGOMEZ

Mr. W. D. Gallo
Project Manager
Advanced Engineering
Impell Corporation
350 Lennon Lane
Walnut Creek, CA 94598

Subject: San Onofre Nuclear Generating Station, Unit 1
Bechtel Job No. 15691-384
Safe Shutdown Equipment Data

Dear Mr. Gallo:

The information indicated on attachment 1 is forwarded for your use in performing calculations to determine seismic capability of the equipment. If you require any additional information, please contact Rick Gold at (213) 807-2466.

Very truly yours,

BECHTEL POWER CORPORATION

John Duffin

J. D. Duffin
Project Engineering Manager

RKG:cwe/1925L

Attachment: 1. Summary of Equipment Data transmitted to Impell
2. Equipment Data

cc: A. R. Guerrero
W. L. Nelson
G. W. Gartland
All with Attachment 1 only

REFERENCE [1] TO
IMPELL CALC NO EQ-09
JOB # 0310-036-1356

MC-384.1

ATTACHMENT 1

SUMMARY OF EQUIPMENT
DATA TRANSMITTAL TO IMPELL

Equipment No.	Description	Type of Data Provided
G-8A/B	Charging Pumps	1. Equipment weights and holddown bolt sizes. 2. Field sketch of holddown bolting pattern (3 sheets). 3. Pump data sheet. 4. Anchorbolt and foundation details. 5. Certified pump outline drawing. 6. Nozzle and vessel thickness.

CHARGING PUMPS G - 8A/B

EQUIPMENT WEIGHTS AND holdDOWN bolt sizes

EQUIPMENT DATA:

PUMP WT. = 9480. lbs.

MOTOR WT. = 5250. lbs.

BASE WT. = 1700. lbs.

TOTAL = 16430. lbs.

FND ANCHOR BOLTS = 10 - 5/8" ϕ BOLTS.

PUMP BOLTS = 4 - 1"* ϕ BOLTS.

MOTOR BOLTS = 4 - $1\frac{1}{2}$"* ϕ BOLTS.

* NOTE:

BOLT DIAMETERS ARE OBTAINED FROM ACTUAL FIELD MEASUREMENTS AND SKETCHES OF THE BOLT HEADS.

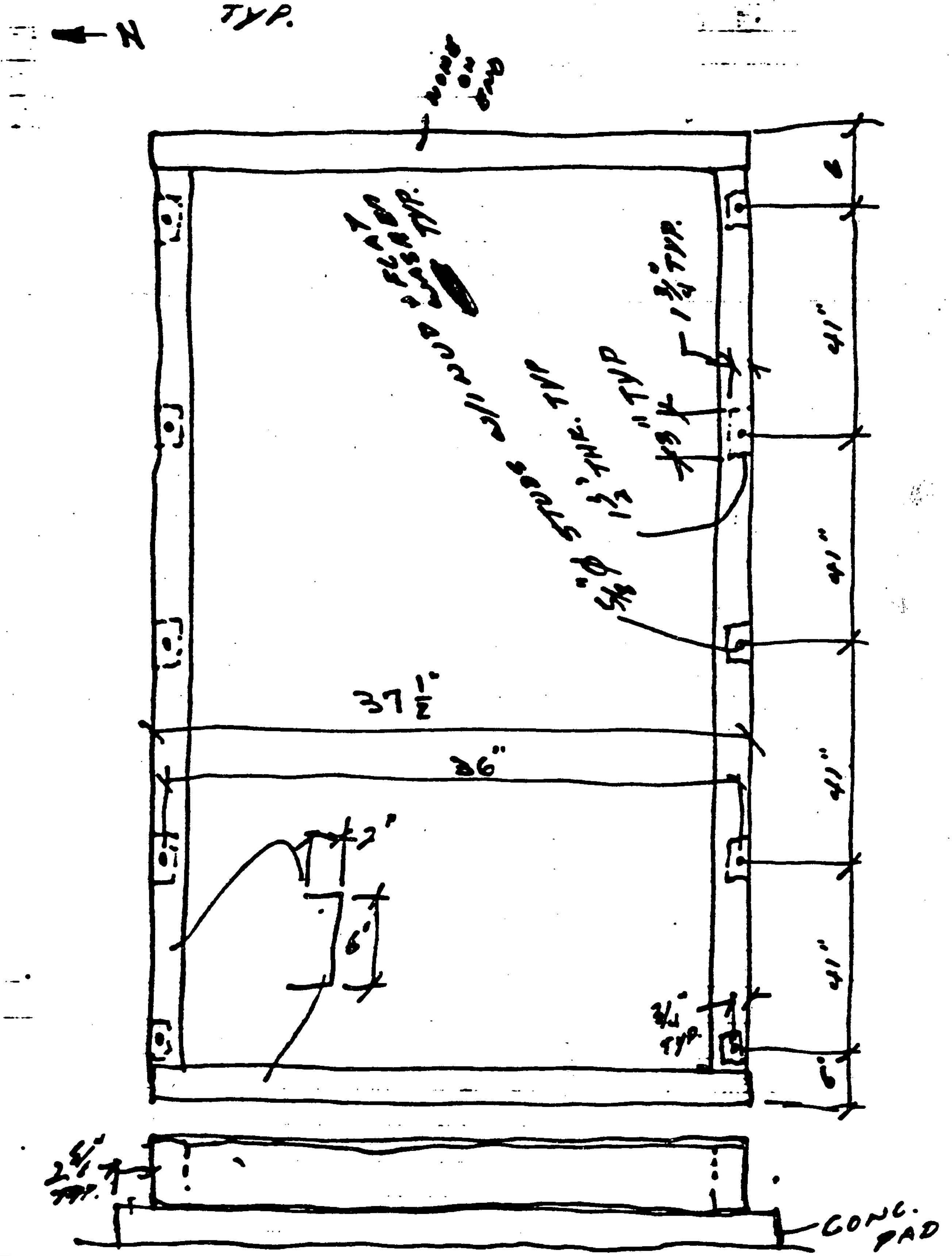
PUMP HOLDDOWN BOLTS

FROM AISC 8th EDITION P 4-136 → BOLT DIAM. = 1"

MOTOR HOLDDOWN BOLTS

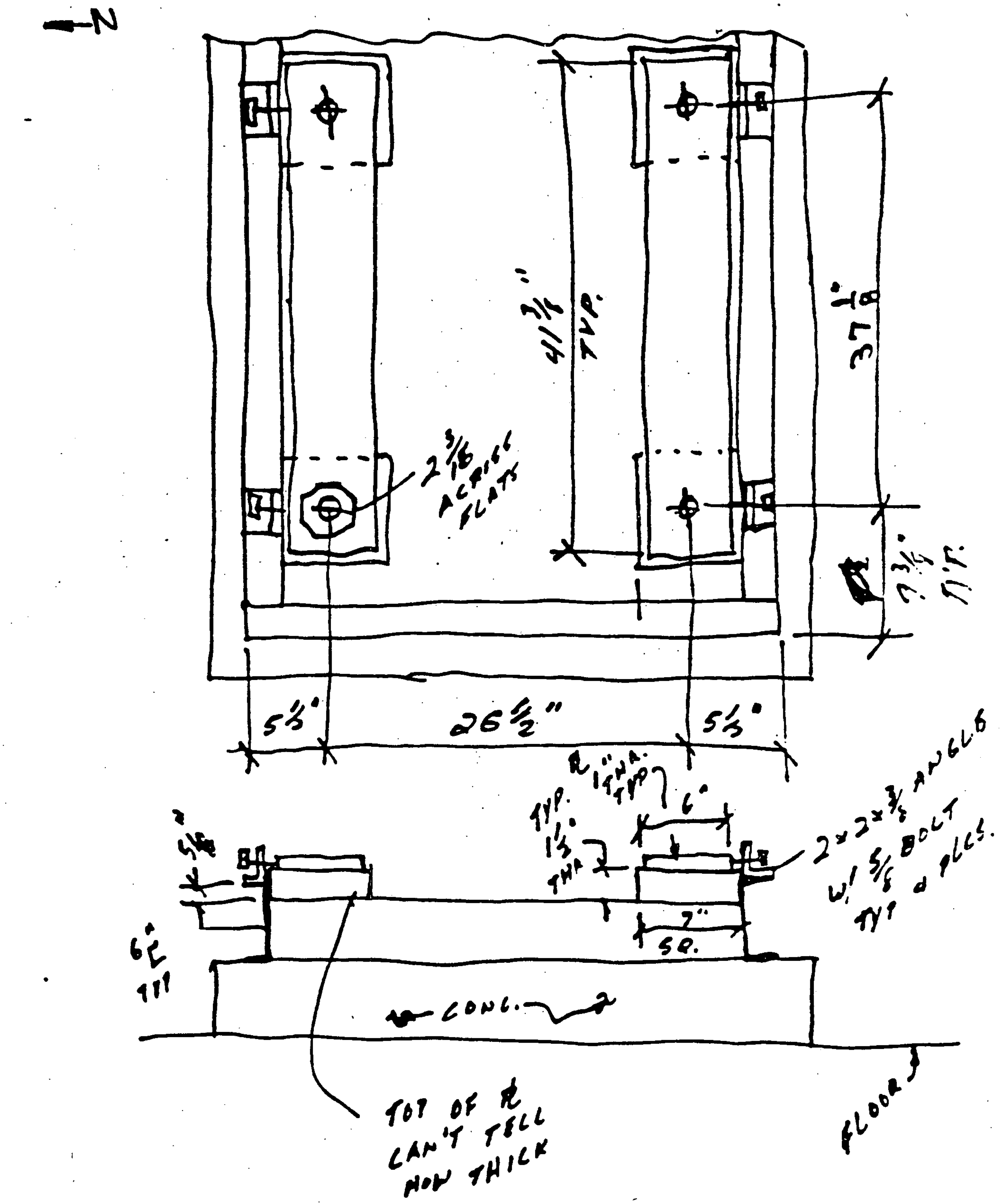
BOLT DIAM. = $1\frac{1}{2}$

FIELD SKETCH OF HOLD DOWN BOLTING PATTERN 1 OF 3



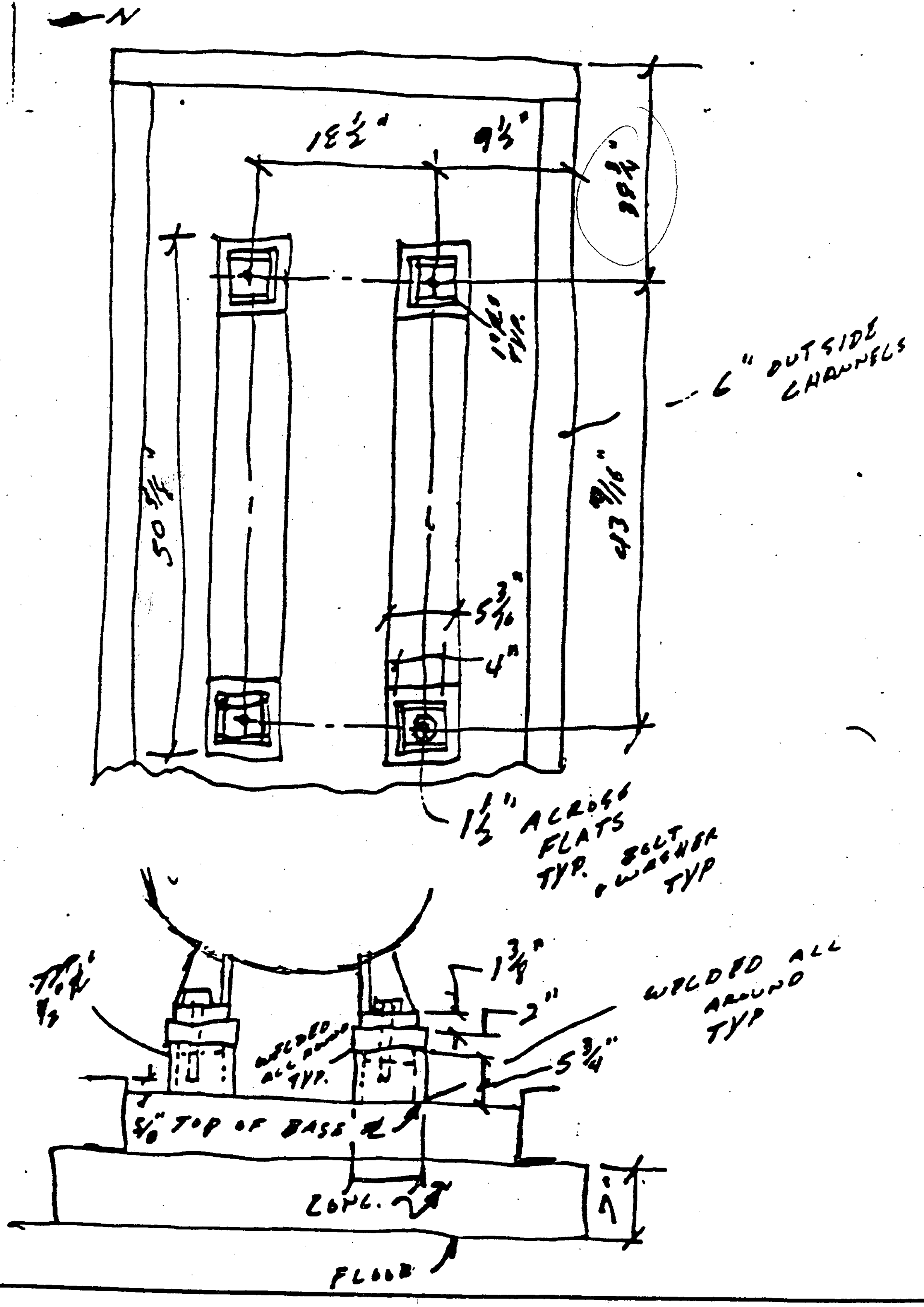
CHARGING PUMPS

FIELD SKETCH OF HOLDDOWN bolting pattern 2 OF 3



Charging Pumps

FIELD SKETCH OF HOLDDOWN BOLTING PATTERN 3OF3



CHARGING PUMPS

APPENDIX A.

LIQUID PUMPED	3% Bor Acid
FLOW: NORMAL/DESIGN (GPM)(XXXXXX)	136/213
FLOW TEMP/SPECIFIC GRAVITY WATER = 1.0	130 F/1.05 max.
VISCOSITY (XXX)/VAPOR PRESS.(PSIA)	0.52 cp/2.3
PRESSURE: SUCTION/DISCHARGE (PSIA)	115 max./2495 max.
DIFFERENTIAL: FEET/PSI	5200/2300
NPSH: AVAILABLE/REQUIRED (FT)	30/11
SERVICE	Charging
SYSTEM	Chemical and Volume Control
BHP/DRIVER HP/EFFICIENCY (AT RATING)	550/600/41 at 136 gpm
IMPELLER DIAMETER: BID/MAX	10-1/8 / 10-1/4
IMPELLER EYE: AREA/ENTRANCE VEL:	12.7 sq. in. / 4.36 ft/sec
RPM/ROTATION (FACING COUPLING)	3570/CCW
MAX. ALLOW WORK PRESS./NO. STAGES	2750#/12
WEAR RING (OR IMPELLER) CLEARANCE	0.016 in. (Diametral)
CASE MATERIAL : INNER/OUTER*	A351, CF8/A266, II, lined w/304 SS
IMPELLER MATERIAL	A351/CF8
WEAR RING MTL: CASE/IMPELLER	A336, F8M/A336, F8M w/Colmonoy #6
SHAFT: MATERIAL/DIAMETER	A336, F8M/2-1/4 in.
SHAFT SLEEVE MTL/EXTEND THRU GLAND?	A336, F8M/Yes
COUPLING: TYPE/MANUFACTURER	Flexible/Thomas DBZ
COUPLING GUARD REQUIRED?	Yes
BASEPLATE: TYPE/MATERIAL	Drain Rim/Fabricated Steel
SHAFT SEAL: TYPE/SEALING CONN?	Teflon Packing/Drain Conn.
BEARINGS: TYPE: THRUST/RADIAL	True Kingsbury/Sleeve
LUBRICATION: THRUST/RADIAL	Forced Feed with Pump, Strainer & Cooler
SUCTION CONNECTION: SIZE/RATING/FACING	3"/Weld End Preparation
(DOUBLE)(SINGLE)/POSITION	Single/Top
DISCHARGE CONNECTION: SIZE/RATING/FACING	2"/Weld End Preparation
POSITION	Top
PUMP MANUFACTURER	Pacific Pumps, Inc.
TYPE & SIZE	2" Type Z 12 Stages
NET WEIGHT (PUMP ONLY)/SERIAL NUMBER	
DRIVER MFG./FURN BY	Westinghouse/Pacific
(MOTOR)(TURB.)/(INTEGRAL)(CPLD.)	Motor/Flexible Coupling
SERIAL NUMBER/DRAWING REFERENCE	
INSPECTION/HYDROSTATIC TEST?	Yes/Yes
PERFORMANCE TEST?/WITNESSED?	Yes/Yes
COST CODE	
(XXXXXXXXXX) (SPEC NO)	E-Spec. No. 675229
*Materials are specified by ASTM Number	
Pump Weight	9480 lbs
Driver Weight	5250 lbs
Base Weight	1700 lbs
Total Weight	16430 lbs

DATE
APPROVALS
MATL
SUPV
CHK
DR
ENG
DESCRIPTION
REV.
0

VPS-E32-12/70

BECHTEL CORPORATION
POWER DIVISION ENGINEERING

HORIZONTAL CENTRIFUGAL PUMP DATA SHEET

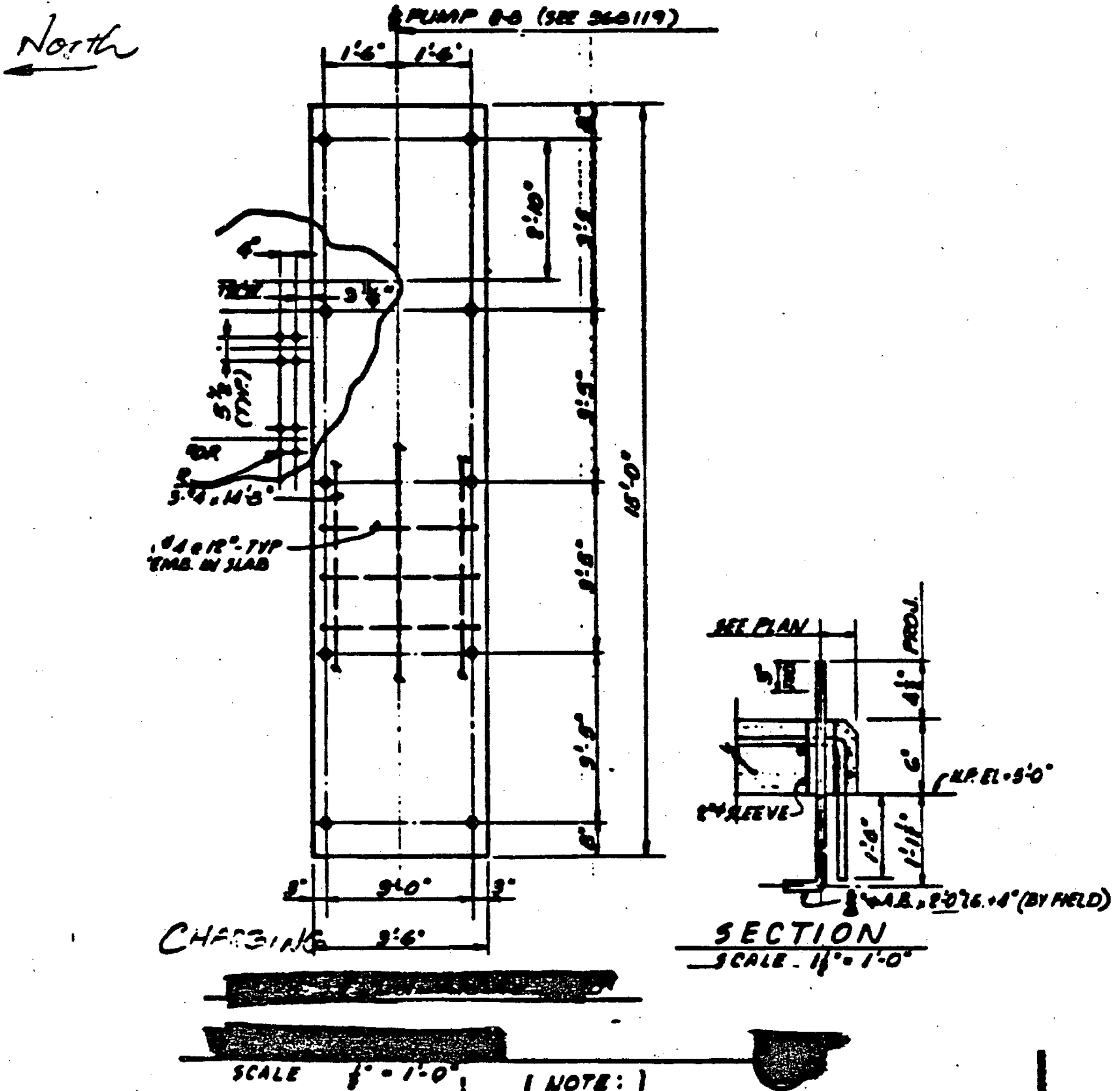
CHARGING PUMPS, G-8A AND B

JOB No 3246

San Onofre Nuclear
Generating Station
Unit No. 1

REV.

Anchor bolt and foundation details APPENDIX C



[redacted]

[redacted]

[redacted]

SECTION
SEAL WATER FILTER SUPPORT
*DETAIL 14/115
SCALE: 1 1/2" = 1'-0"

* NUCLEAR SAFETY RELATED (AS NOTED)

NOTE:
1. FOR GENERAL NOTES SEE 380 567892
2. FOR MISC. NOTES SEE 18-568123
*3. ANCHOR BOLT DIAMETER SPAC., EQUIP. MOUNT. HOLES & CONC. PAD SIZE & HEIGHT HAVE BEEN FIELD VERIFIED PER AS-BUILT CONDITION FOR SECT. B/120, C/120, D/120, E/120 & DET. V/112, 9/112

UNIT 1

EN°1	3-30-7[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	23	1940
REV 6 - REVISED [illegible]	[illegible]	[illegible]	--	[illegible]	[illegible]	A.D	5780
REV. 2	[illegible]	[illegible]	--	[illegible]	[illegible]	TBC	5780
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	GJD	5780
[illegible] CONSTRUCTION	[illegible]	[illegible]		[illegible]	[illegible]	GJB	5780
REVISIONS	DATE	APPROVED	C.E.	S.E.	CHECKED	DRAWN	J.O.No.

LOCATION SAN ONOFRE NUCLEAR GEN. STATION

REACTOR AUXILIARY BUILDING
SECTIONS & DETAILS
SHEET 6

SOUTHERN CALIFORNIA EDISON COMPANY
SCALE AS NOTED LOS ANGELES, CALIF.

33-38 [redacted]

CHARGING PUMP G-8A/B.
NOZZLE AND VESSEL THICKNESS

	NOZZLE THICKNESS	VESSEL THICKNESS
1" NOZZLE	.18"	1.5"
2" NOZZLE	.4"	1.75"
3" NOZZLE	.3"	1.75"

IMPELL
CORPORATION

Memorandum

File: 0310-036-1356

To: Ward Ingles

Copy:

CYW WJW
From: Calvin Wong / Jim Wagoner

Date: 6/13/84

Subject: Nozzle Loads for Charging Pumps G-8A & G-8B

Attached please find the following nozzle loads requested:

Lines 2022-1"-151R & 2084-1"-151R - Analysis CY-307 ✓

Lines 2000-3"-151R & 2001-3"-151R - Analysis CY-12

Lines 2002-2"-2501R & 2003-2"-2501R - Analysis CY-13

Note that for CY-13 data, the thermal loads should be taken from the rev.0 Bechtel load sheet attached. Gravity and seismic loads should be taken from the Impell summary sheet.

Also note that loads for CY-12 are preliminary at this time.

REF [4], CALC NO EQ-09
JOB NO 0310-036-1356

CALC NO. P1-CV-307

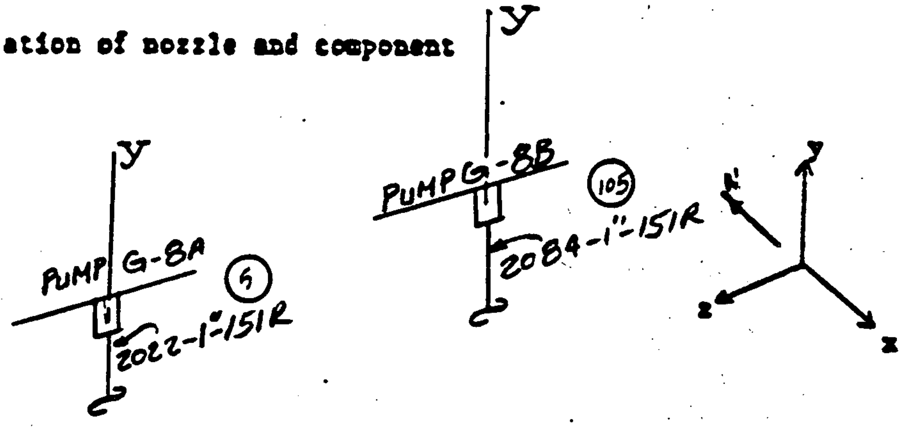
SIGNATURE A. SOLTANI DATE 10-22-82 CHECKED DATE 10-29-82

PROJECT SONGS-1 JOB NO 14000-300

SUBJECT CHEMICAL VOLUME CONTROL SYSTEM SHEET 19 OF 37 SHEETS

3.4 SUMMARY OF NOZZLE LOADS

Orientation of nozzle and component



			LOADING CONDITIONS						
EQUIPMENT	NODE POINT	DIRE	DW	T_H	SSE	SAM	TOTAL	RESULTANT	ALLOWABLE*
PUMP G-8A	5	Fx	1	-10	±5		15		
		Fy	-5	5	±3		8	32.	$F_{r(max)}=65$
		Fz	0.	21	±6		27		
		Mx	2	-9	±2.		11		
		My	0.	-16	±2.		18.	22.	$M_{r(max)}=43$
		Mz	-1.	0.	±1		2		
PUMP G-8B	105	Fx	0	-10.	±5		15		
		Fy	-5.	6.	±3.		9.	32.	$F_{r(max)}=65$
		Fz	0.	19.	±7.		26.		
		Mx	2.	-8.	±2.		10		
		My	0.	-15.	±2.		17	20.	$M_{r(max)}=43$
		Mz	-1.	0.	±1.		2		

*Ref: Bechtel guide lines P-2.6.1.11 & attached calculation pages

$$\frac{Fr}{Fr_{(max)}}+\frac{Mr}{Mr_{(max)}}=\frac{32}{65}+\frac{22}{43}=1.004>1 \quad @5$$

$$\frac{32}{65}+\frac{20}{43}=.96<1 \quad @105$$

Fx, Fy & Fz are in #

Mx, My & Mz are in ft#.

REV	BY	DATE	CHECKED	DATE
0	RCH	11/22/83	GUM	11/28/83

IMPELL CORPORATION

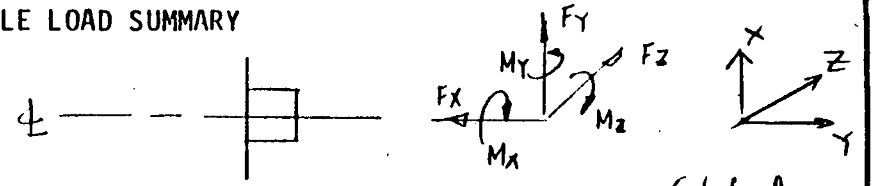
SONGS-1
Safe Shutdown Piping Functionality Assessment

JOB NO 0310-022-1352
CALC NO CV-12

PAGE 23 OF 29

RESULT SUMMARY - B) NOZZLE LOAD SUMMARY

Load direction shown here are positive and act on the nozzle.



Global

Nozzle I.D.	Nominal Pipe Size	Load Force Components	LOADS (lbs./ft.-lbs.)				
			Gravity	SSE Inertia	SSE Resultant		Remarks
Charging Pump G-8A	2"	Fx	89+799=888	85+1988=2073	3246		
		Fy	9	196			
		Fz	26+820= 846	448+2042=2490			
		Mx	10+332=342	181	6623		
		My	25+162=187	101+2131+4386 =6618			
		Mz	70+34=104	168			
Charging Pump G-8B	2"	Fx	79	121	415		
		Fy	-22	144			
		Fz	-56	370			
		Mx	27	157	230		
		My	25	76			
		Mz	-45	149			

Ref P&ID#L See P. 28 ; isometric #__ See P. 28 ; Bechtel/~~I~~ calc. #__ See P 28
NOTE

CALCULATION SHEET

CALC. NO. P1-CV.13

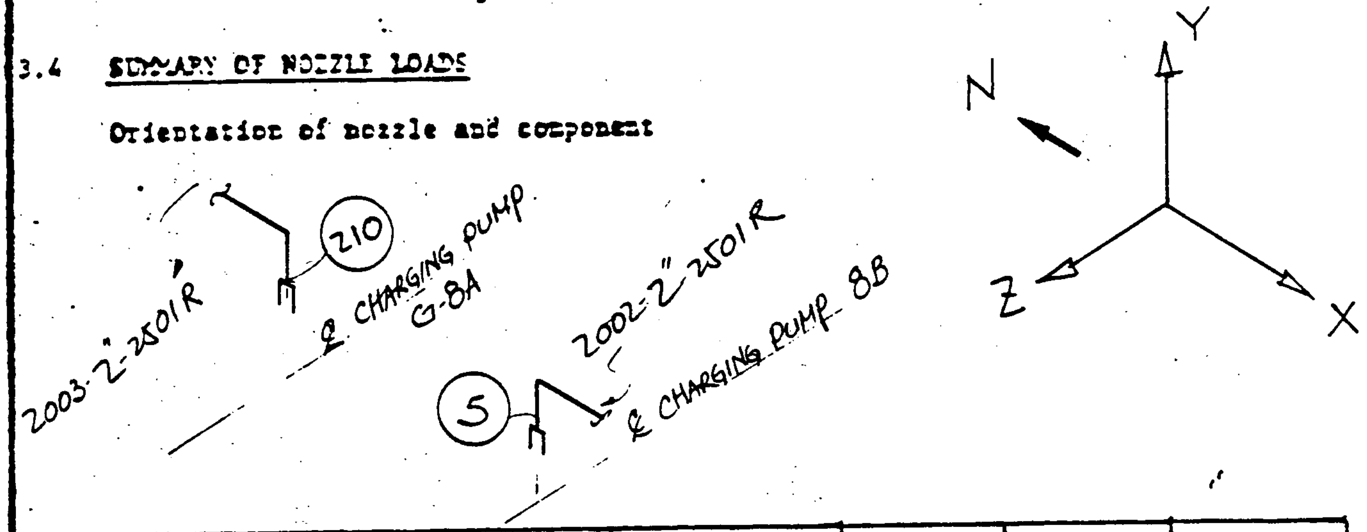
SIGNATURE W. WANG DATE 2/28/83 CHECKED DATE 3/3/83

PROJECT SONGS-1 JOB NO. 14000- 300

SUBJECT CHEMICAL VOLUME & CONTROL SHEET 25 OF 54 SHEETS

3.4 SUMMARY OF NOZZLE LOADS

Orientation of nozzle and component



EQUIPMENT	NODE POINT	DIRE	LOADING CONDITIONS				TOTAL	RESULTANT	ALLOWABLE*
			DW	T p	SSI	SAM			
CHARGING PUMP G-8B	5	F_x	-22	-415	± 144			SEE SHT. 26	
		F_y	-79	-21	± 121				
		F_z	56	423	±370				
		M_x	25	116	± 76				
		M_y	-27	-109	± 157				
		M_z	-45	-9	±149				
CHARGING PUMP G-8A	210	F_x	9	143	±196			SEE SHT. 27	
		F_y	-89	-95	±85				
		F_z	26	410	±448				
		M_x	25	95	±101				
		M_y	10	158	±181				
		M_z	70	33	±168				

~~*Ref. Bechtel guide lines P-2.6.1.11 & attached calculation pages.~~

F_x, F_y & F_z are in #

M_x, M_y & M_z are in ft #.

```
IMPELL CORPORATION                                                              PAGE   19
QUICKPIPE VERS 20  01/03/84,   CYBER 170 - NOS.                     84/06/12   22.29.16

SOUTHERN CALIFORN EDISON, SAN ONOFRE UNIT 1
SAFE SHUTDOWN PIPING FUNCTIONALITY CRITERIA EVALUATION
CALC. NO: CV-12
PROBLEM #  CV12     REV. #     3       SUBMITTED:  12-JUN-84   17:48:58

ANCHOR LOAD SUMMARY.

--------------------------------------------------------------------------------------
--------------------------------------------------------------------------------------

NAME:   AN1              LOCATION:   AN1             AXIS.   LOCAL
-------PUMP G-8A  NOZZLE--------------------------------------------------------------
--------------------------------------------------------------------------------------
                      Y        X          Z
LOAD                        FORCES  (LB)                          MOMENTS  (LBFT)
CONDITION          F(AX)    F(S1)     F(S2)     F(SR)      M(TOR)    M(B1)    M(B2)    M(BR)
--------------------------------------------------------------------------------------

DWGT                 65.      -4.       -6.       7.         -8.      -41.       4.      41.
(+/-)                65.      -4.       -6.       7.         -8.      -41.       4.      41.
--------------------------------------------------------------------------------------

THRM                198.     379.      544.     663.          0.        1.       0.       1.
(+/-)                 0.       0.        0.       0.       -131.        0.    -115.     115.
--------------------------------------------------------------------------------------

SSEI                 55.     148.      236.     279.        151.       40.      54.      67.
(+/-)               -55.    -148.     -236.     279.       -151.      -40.     -54.      67.
--------------------------------------------------------------------------------------

SAMS                  0.       0.        0.       0.          0.        0.       0.       0.
(+/-)                 0.       0.        0.       0.          0.        0.       0.       0.
--------------------------------------------------------------------------------------

DESN                318.     523.      774.     934.        143.        0.      57.      57.
(+/-)                10.    -152.     -242.     286.       -290.      -82.    -164.     183.
--------------------------------------------------------------------------------------
```

Preliminary

```
IMPELL CORPORATION
QUICKPIPE VERS 2C  01/03/84;   CYBER 170 - NOS                          PAGE  199
                                                           84/06/12.  22.29.16.
SOUTHERN CALIFORN EDISON, SAN ONOFRE UNIT 1
SAFE SHUTDOWN PIPING FUNCTIONALITY CRITERIA EVALUATION
CALC. NO: CV-12
PROBLEM #  CV12      REV. #    3      SUBMITTED:  12-JUN-84   17:48:58

ANCHOR LOAD SUMMARY (CONT'D).

-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------

NAME:  AN2               LOCATION:  AN2              AXIS:  LOCAL
---------PUMP G-8B NOZZLE-----------------------------------------------------------
-------------------------------------------------------------------------------------

LOAD                           FORCES (LB)                           MOMENTS (LBFT)
CONDITION       F(AX)    F(S1)    F(S2)    F(SR)     M(TOR)    M(B1)    M(B2)    M(BR)
-------------------------------------------------------------------------------------

DWGT             181      18.       1.      18.        37.    -116.     -78.     140.
(+/-)            181.     18.       1       18.        37.    -116.     -78.     140.
-------------------------------------------------------------------------------------

THRM              95.      0.      71       71.         0.       0        0        0.
(+/-)              0.    -87.       0.      87.       -35.     -19.     -19      27.
-------------------------------------------------------------------------------------

SSEI             164.     132.     205.     244.       137.     134.      71.     152.
(+/-)           -164.    -132     -205.     244.      -137     -134.     -71      152.
-------------------------------------------------------------------------------------

SAMS               0.      0.       0.       0.         0.       0.       0.       0.
(+/-)              0.      0.       0.       0.         0.       0.       0.       0.
-------------------------------------------------------------------------------------

DESN             440.     150.     277.     315.       174.      18.      -7       19.
(+/-)             17.    -201     -204.     286.      -135.    -268.    -168      317.
-------------------------------------------------------------------------------------
```

Preliminary

KWIK-BOLT

AVERAGE ULTIMATE TENSILE & SHEAR LOADS*

CONCRETE STRENGTH		2000 PSI		4000 PSI		6000 PSI	
Diameter	Embedment	Tension	Shear	Tension	Shear	Tension	Shear
1/4"	1 1/8"	975	1653	1455	2612	1755	2389
	1 1/2"	1875	1653	2225	2612	2935	2389
	1 3/4"	2275	1653	2700	2612	3300	2389
	2"	2525	1653	3125	2612	3350	2389
	2 1/4"	2680	1653	3310	2612	3350	2389
	2 1/2"	2800	1653	3350	2612	3350	2389
3/8"	1 5/8"	2245	3748	2355	5107	2810	6266
	2"	2725	3748	3025	5107	3650	6266
	2 1/2"	3075	3748	3900	5107	4450	6266
	3"	3300	3792	4300	5419	5000	6266
	3 1/2"	3425	3792	4600	5419	5275	6266
	4"	3520	3792	4750	5419	5375	6266
	4 1/2"	3580	3792	4800	5419	5400	6266
1/2"	2 1/4"	4545	7444	5510	8316	6845	9341
	2 3/4"	5800	7444	7200	8316	9800	9341
	3 1/2"	7000	7444	9450	8316	13200	9341
	4 1/2"	7275	8897	11225	10232	14550	11522
	5 1/2"	8250	8897	12050	10232	15150	11522
	6"	9000	8897	12300	10232	15300	11522

Actual Concrete Strengths

2178 psi 4027 psi 6119 psi

*See sheet A-3 for notes

REF [8] TO IMPELL
CALC NO EQ-09
JOB NO 0310-036-1356

KWIK-BOLT

AVERAGE ULTIMATE TENSILE & SHEAR LOADS*

CONCRETE STRENGTH		2000 PSI		4000 PSI		6000 PSI	
Diameter	Embedment	Tension	Shear	Tension	Shear	Tension	Shear
5/8"	2 3/4"	5410	11198	6600	11562	7700	13500
	3 1/2"	6250	11198	9100	11562	9560	13500
	4 1/2"	7000	11198	12000	11562	14500	13500
	5 1/2"	7550	13378	14300	15437	20300	15437
	6 1/2"	8025	13378	16000	15437	21000	15437
	7 1/2"	9000	13378	17000	15437	21000	15437
3/4"	3 1/4"	8155	13257	10150	17133	10860	18102
	4"	9700	13257	13400	17133	13700	18102
	5"	11700	13257	16500	17133	17600	18102
	6"	13800	15195	18000	18466	22500	21009
	7"	15800	15195	21000	18466	23600	21009
	8"	16000	15195	23000	18466	23600	21009
	9"	16000	15195	23500	18466	23600	21009
1"	4 1/2"						
	5"						
	6"						
	7"						
	8"						
	9"						
	10"						

Actual Concrete Strengths

2178 psi 4027 psi 6119 psi

*See sheet A-3 for notes

HILTI® INC.
FASTENING SYSTEMS
CORPORATE HEADQUARTERS
P.O. BOX 45400, TULSA, OK 74145, (918) 627-9711

REVISED

1" DIAMETER HILTI KWIK-BOLT AVERAGE ULTIMATE TENSILE AND SHEAR LOADS

ANCHOR EMBEDMENT DEPTH (INCHES)	CONCRETE STRENGTH					
	2000 PSI		4000 PSI		6000 PSI	
	ULTIMATE TENSION	ULTIMATE SHEAR	ULTIMATE TENSION	ULTIMATE SHEAR	ULTIMATE TENSION	ULTIMATE SHEAR
4½	14000	27355	16000	26879	20500	32112
5	15500	27355	18900	26879	23441	32112
6	17600	27355	23441	26879	23441	32112
7	18200	27355	23441	26879	23441	32112
8	18200	27355	23441	34491	23441	36394
9	18200	27355	23441	34491	23441	36394
10	18200	27355	23441	34491	23441	36394

NOTE: The maximum working loads should not exceed ¼ of the average ultimate values listed. Actual factor of safety to be used depends on the application.

KWIK-BOLT

AVERAGE ULTIMATE TENSILE & SHEAR LOADS*

CONCRETE STRENGTH		2000 PSI		4000 PSI		6000 PSI	
Diameter	Embedment	Tension	Shear	Tension	Shear	Tension	Shear
1 1/4"	5 1/2"	19000	36750	23000	35680	31200	45195
	6 1/2"	21600	36750	27100	35680	36500	45195
	7 1/2"	23600	36750	31100	35680	42000	45195
	8 1/2"	25100	39843	34600	35680	44400	47098
	9 1/2"	26200	39843	37800	35680	44400	47098
	10 1/2"	26800	39843	40900	35680	44400	49596

Actual Concrete Strengths

2178 psi   4027 psi   6119 psi

*Tension values obtained from best fit curve through mean values of test data. Curves and test data contained in A. A. Hanks Report No. 8784 (HILTI No. TR-111A).

Shear values are minimum mean values at each embedment based on failure across threaded section of the anchor.