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Plant Specific Seismic Adequacy Evaluation of Turkey Point Units 3 and 4 to Resolve Unresolved Safety Issue (USI) A-46 and Generic Letter (GL) 87-02

Final Report

April 30, 1993

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1.0 INTRODUCTION

Florida Power & Light (FPL) informed the USNRC by letters L-88-333[1] dated August 4, 1988 and L-89-441[2] dated December 12, 1989 that FPL intended to resolve Unresolved Safety Issue (USI) A-46 and Generic Letter (GL) 87-02[3] by the use of a plant specific program, as permitted by GL 87-02.

The FPL plant specific program was developed based upon understandings reached between FPL and the NRC subsequent to technical and economic presentations made by FPL to the NRC on June 2, 1988 at the NRC's White Flint offices. The technical presentation, used plant specific seismic hazard curves developed using the Electric Power Research Institute (EPRI) methodology[4] including source zones in the Caribbean Basin and demonstrated the very low probability of having an earthquake at the Safe Shutdown Earthquake (SSE) level at FPL's plants. The economic presentation used the Calculation of Reactor Accident Consequences, Version 2 (CRAC 2) computer code[5] together with the NRC analytic methodology in NUREG 1211[6] and demonstrated the very low values of potential offsite releases and potential risk reductions given the postulated accident scenarios and seismic hazards. This report documents the implementation of the FPL plant specific program at the Turkey Point Units 3 and 4 facility as it existed in April of 1990 at the time of the walkdown.

This report is organized using the format recommended in Section 8 of EPRI NP-6041 [7]. Some modification of this format was included, as appropriate for GL87-02/USI A-46. Section 1 is this introduction, Section 2 includes the general plant description, and Section 3 is a discussion of the plant's seismic design basis including the design basis demand earthquake used for the walkdown and evaluation. Section 4, the major section of the report, describes the GL87-02/USI A-46 evaluation including a discussion of the overall approach, equipment selection, walkdown criteria, and screening walkdown results. Section 5 describes the resolution of those equipment items that could not be screened out during the walkdown. Section 6 is the discussion of the peer review of the

walkdown, Section 7 the conclusions and results of the GL87-02/USI A-46 effort, and Section 8 references.

There are several appendices that supplement the report which include; the walkdown procedure in Appendix A, the safe shutdown list of equipment in Appendix B, the walkdown checklists and supplementary calculations in Appendix C, the peer review report in Appendix D, and component photographs in Appendix E.

2.0 GENERAL PLANT DESCRIPTION

2.1 SITE LOCATION AND GEOGRAPHY

Turkey Point Units 3 and 4 are located on the west shore of Biscayne Bay in Dade County Florida. The location is approximately 25 miles south of Miami, eight miles east of Florida City and nine miles southeast of Homestead, Florida.

The Turkey Point site lies within the coastal lowlands province on the south Florida shelf. The area is practically flat, with elevations rising from sea level at the site to 10 ft. above mean low water in the Homestead area 9 miles to the west.

2.2 SITE GEOLOGY

The predominant surface feature near the site is the Atlantic Coastal Ridge, which represents an area of bedrock outcrop of the Miami oolite. This formation underlies the site, where it is overlain by organic, mangrove swamp soils which average 4 to 8 ft. in thickness. Pockets of silt and clay are encountered locally, separating the organic soils and the limestone bedrock.

Local depressions, some of which attain depths as great as 16 feet, are occasionally encountered in the surface of the limestone bedrock at the site. Such depressions are not sinkholes associated with collapse above an underground solution channel.

The Miami oolite, a deposit of highly permeable limestone, extends to about 20 ft. below sea level. The rock contains random zones of harder and softer rock and heterogeneously distributed small voids and solution channels, many of which contain secondary deposits. This limestone lies unconformably upon the Ft. Thompson formation, which is a complex sequence of limestones and calcareous sandstones.

At a depth of about 70 ft. below sea level, the Ft. Thompson formation unconformably overlies the Tamiami formation, a predominantly clayey and calcareous marl, locally indurated to limestone. The Tamiami formation also contains beds of silty and shelly sands, and is relatively impermeable. The Tamiami and underlying Hawthorne and Tampa formations, comprise a relatively impermeable hydrogeologic unit called the Floridian aquiclude, which is roughly 500 to 700 ft. thick in southern Florida. The bedrock beneath the site is competent with respect to foundations and is capable of supporting heavy loads.

2.3 Nuclear Steam Supply System and Containment Structure

The nuclear steam supply system (NSSS) is a pressurized water reactor system designed by Westinghouse Electric Corporation. The containment structure consists of a post-tensioned reinforced concrete cylinder, with an inside diameter of 116 feet and an inside height of 170 feet between the base mat and the top of the dome. The cylinder is capped by a shallow dome and has a flat slab base mat. The walls and dome are 3 ft. 9 in. and 3 ft. 3 in. thick, respectively. The base slab is reinforced concrete 10 ft. 6 in. thick. The containment structure was designed by Bechtel Power Corporation.

The rated NSSS thermal core power level is 2200 Mwt. This is the basis for the design of the balance of plant and related facilities, including the major systems and components, the engineered safety features and for evaluation of postulated accidents. The corresponding net electrical output for the rated power level is approximately 666 Mwe.

2.4 MAJOR STRUCTURES AND EQUIPMENT ARRANGEMENT

The nuclear plant installations consist of a containment structure, an auxiliary building, a turbine building, a control building, an intake structure, a radwaste building, an emergency diesel generator building, and switchgear buildings.

The containment structure houses the NSSS, consisting of the reactor, steam generators, reactor coolant pumps, pressurizer, and some of the other reactor auxiliaries. The containment structure is served by circular bridge crane supported on the upper portion of the containment wall.

The auxiliary building houses the chemical and volume control equipment, the waste management facilities, engineered safety features components, heating and ventilating system components, laboratories, offices, and laundry.

The control building houses the control room, the reactor control rod drive equipment, motor control center 3B and 4B, both units reactor trip breakers, the cable spreading room, the battery and inverter rooms, the 125 v DC busses and on the ground floor the plant data computer and display system.

The fuel handling building contains the spent fuel pool and new fuel storage facilities, as well as the cooling and purification equipment for the fuel pool. The fuel is transferred from the reactor containment to the fuel handling building through the fuel transfer tube.

The turbine building houses the turbine generator, condensers, feedwater heaters, condensate and feedwater pumps, turbine auxiliaries and certain

switchgear equipment. Administrative offices, health physics facilities, maintenance shops and warehouses are all located in separate buildings away from the power generation equipment and structures.

2.5 PRINCIPAL DESIGN CRITERIA

2.5.1 Containment Design Criteria

Appendix 5-B of Turkey Point's FSAR[8] describes the loading criteria for the containment. The following constituted the design bases including seismic input for the reactor containment:

1. The containment has the capability of withstanding the peak transient pressure and temperature which could occur due to the postulated loss-of-coolant from a double-ended circumferential rupture of a reactor coolant pipe coincident with the design basis and maximum hypothetical earthquake.

2. The containment will maintain its integrity during the hypothetical earthquake with simultaneous zero period ground accelerations of .15g horizontal and .10g vertical.

3. The containment is designed to meet the shielding requirements of 10CFR20 during normal operation, as well as the suggested guidelines of 10CFR100 during the unlikely hypothetical incident.

4. The foundation and supports for piping and equipment in the containment are designed to prevent a primary system rupture from propagating a secondary system rupture. The reverse is also true.

The containment structure is designed by both working stress and ultimate strength methods. ACI 318-63 limits were used for the working stress design except that the allowable tensile stress in non-prestressed reinforcing was limited to 0.5 f_y.

2.5.2 Design Criteria for Other Class I Structures

Class I structures outside of containment are designed for loads resulting from normal operation and hypothetical accident, wind and earthquake conditions. Loading conditions for these structures are defined in Appendix 5A of Turkey Points FSAR.[8] The normal operation loads are those encountered during normal operation. Class I structures are designed in accordance with design methods of accepted standards and codes as they are applicable. For hypothetical accident, wind and earthquake conditions the Class 1 Structures are proportioned to maintain elastic behavior when subjected to various combinations of dead loads, thermal loads, and wind or seismic loads. The upper limit of elastic behavior is considered to be the yield strength of the effective load-carrying structural materials.

The yield strength for steel (including reinforcing steel) is considered to be the minimum as given in the appropriate ASTM Specification. Concrete structures are designed for ductile behavior whenever possible; that is, with steel stress controlling the design. The ultimate strength values for concrete are used in determining the required yield strength of the structure. Limited yielding is allowable in steel provided the deflection is checked to ensure that the affected Class I systems and equipment are not stressed beyond specified limits.

2.5.3 Design Criteria for Class I Systems and Equipment

The reactor vessel, steam generators, pressurizer and pressurizer relief tank were designed and fabricated according to the requirements of the ASME Boiler and Pressure Vessel Code, Section III, 1964 Edition, October 1965 Addenda. Reactor coolant loop piping and fittings were designed and fabricated in accordance with the requirements of B31.1-1955 Power Piping Code.

3.0 SEISMIC DESIGN BASIS

3.1 Site Seismicity

The earthquake history of the Southeastern United States and the nearby West Indies has been reviewed in detail. The southern part of the peninsula has never experienced earthquake damage.

Florida is far removed from active plate boundaries and other zones of crustal weakness with accompanying earthquakes. The peninsula is characterized by a paucity of seismic events: only six minor tremors that cannot be attributed to blasting or military activities have been identified in the past two centuries. None of the events was recorded on seismographs, and the only reliable estimates of size yield a maximum magnitude of 3.5 Mn and intensity of MM V associated with a 1973 event near Sanford. A similar intensity, generated by the 1886 Charleston, South Carolina, earthquake, was probably experienced in north Florida.

Five of the six events were distributed throughout north Florida, and although most locations are vague, no spacial pattern indicative of subsurface structural control can be identified. No models or reconstructions of the Florida basement include structural features with any potential for significant seismic activity. There is no evidence in the Turkey Point area for basement structures associated with possible earthquakes.

The uniform building code designates the vicinity of the site as Zone 0 on the map entitled, "Map of the United States Showing Zones of Approximate Equal Seismic Probability". The U. S. Coast and Geodetic Survey indicates Zone 0 as an area of no earthquake damage. Furthermore, an examination of historical earthquake epicenter locations show that a broad segment of south and central Florida are entirely absent of earthquake epicenters. The Turkey Point site is in this region.

The Turkey Point site ranks 67th out of the 69 U.S. nuclear power plant sites in regard to seismic hazards in the Lawrence Livermore National Laboratory study of the seismic hazard characterization of nuclear sites east of the Rocky Mountains.[9]

3.2 Seismic Input to Structures and Equipment

The seismic design was based on the acceleration ground response spectrum curves shown in Figure 3.2.1 for the Design Basis Earthquake, DBE, and Figure 3.2.2 for the Maximum Hypothetical Earthquake, MHE. The curves were derived from the "Housner Spectrum" normalized to 0.05g for the DBE and 0.15g for the MHE. The FSAR commitment for an MHE of 0.15g was determined at a time when probabilistic definition of seismic input had not been developed with any degree of consistency or confidence. Therefore, the 0.15g PGA was conservatively estimated based on very limited data available at the time. The basis for this appears to be a letter report from the U.S. Coast and Geodetic Survey.[10]

Earthquake stresses were based on the worse case of a single horizontal ground acceleration acting either in a nominal N-S or E-W direction and a vertical ground acceleration component of two-thirds of the horizontal resultant, with the two acting simultaneously.

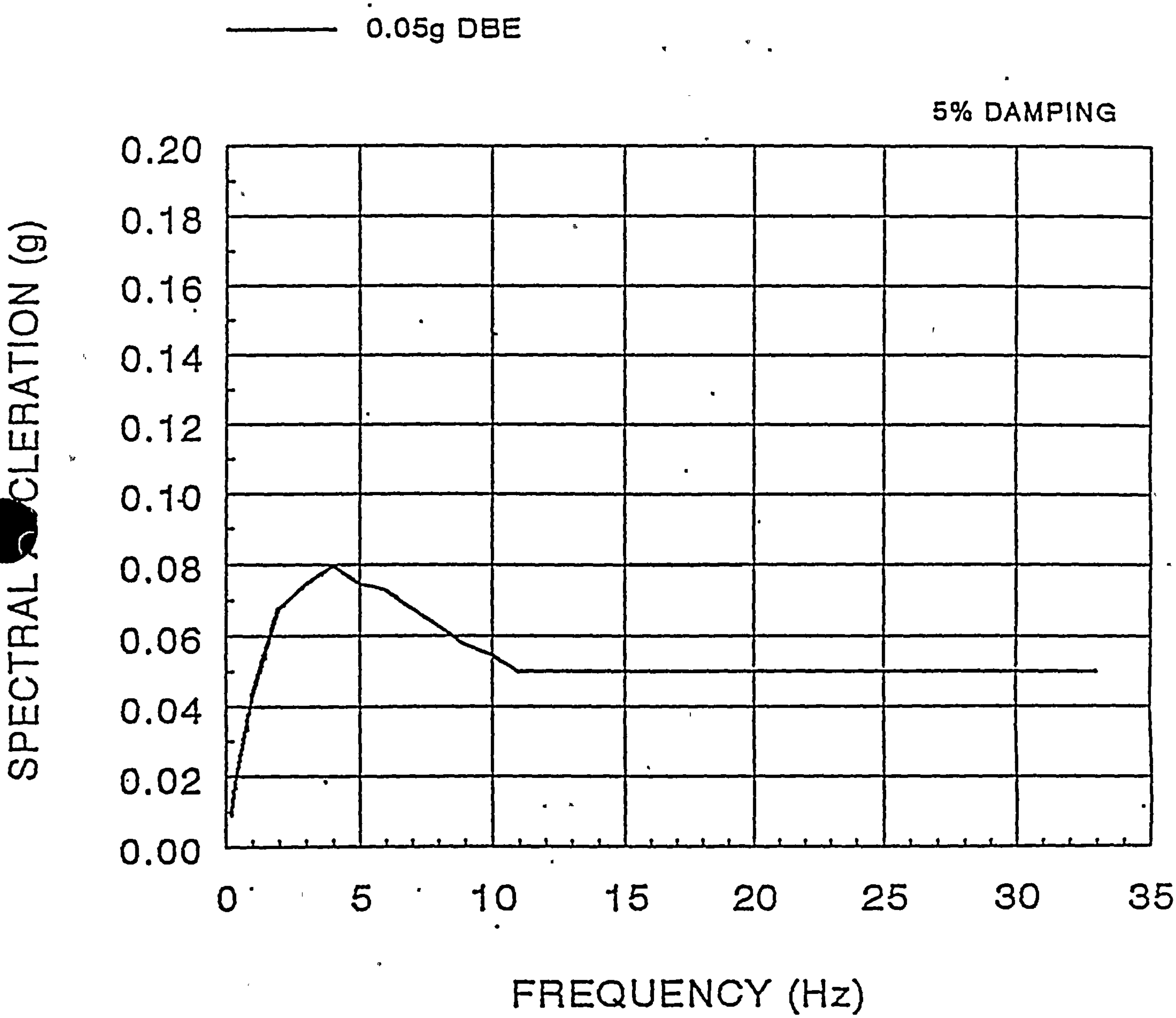

Figure 3.2.1 Turkey Point Units 3 & 4 Ground DBE, 5% Damping

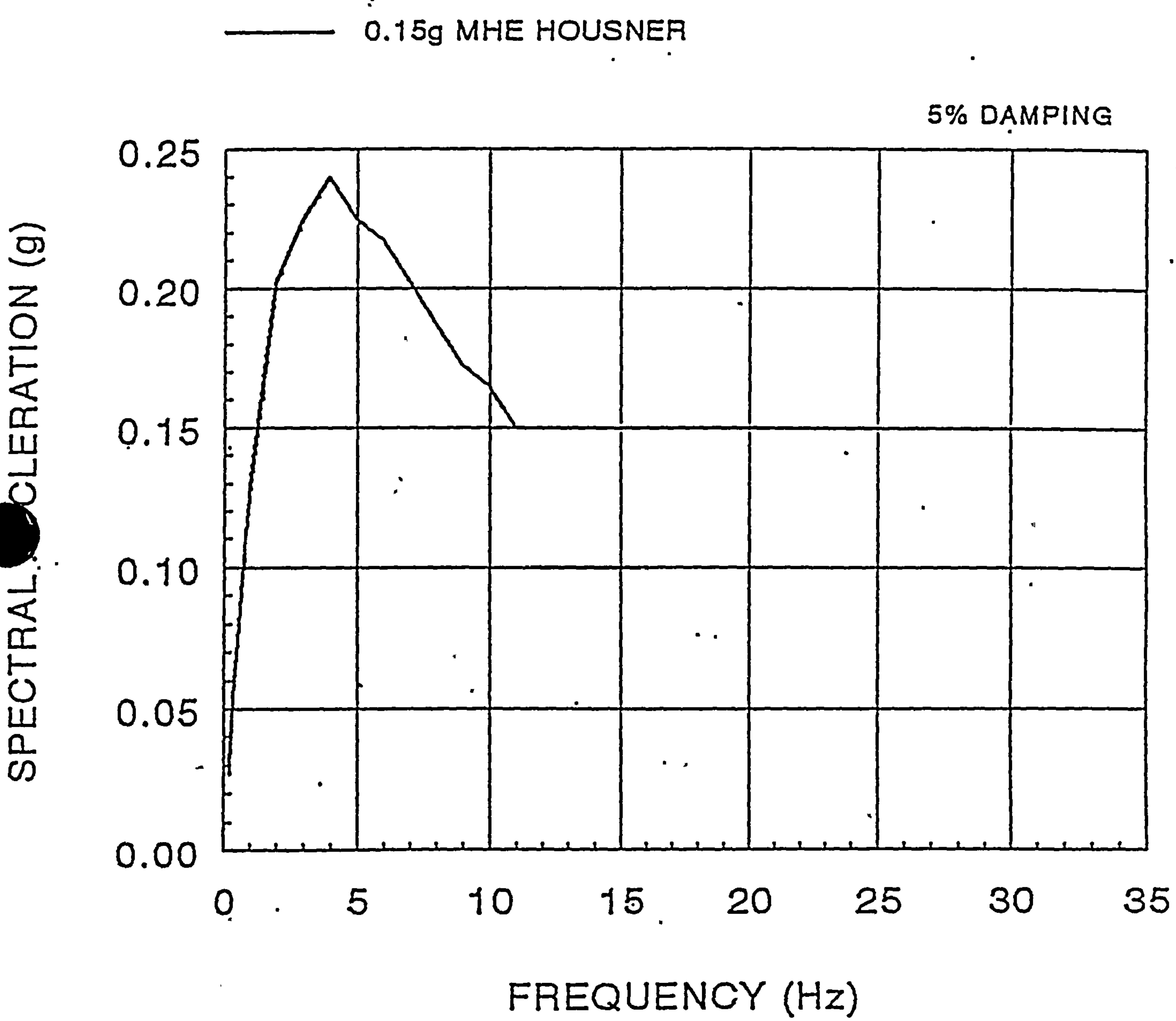

Figure 3.2.2 Turkey Point Units 3 & 4 Ground MHE, 5% Damping

The safety related nuclear Class I equipment originally supplied for Turkey Point Station was evaluated for an equivalent static seismic load that was calculated in accordance with Reference 11. The procedure used accounted for the amplifications associated with potential resonance between the building and the equipment. The procedure was as follows:

1. $S = (S_b + S_g) \times W$

   Where:

   (i) W = Equipment weight
   (ii) S_b = Equipment acceleration due to building harmonic motion
   (iii) S_g = Equipment acceleration due to ground motion
   (iv) S = Equivalent static seismic load

2. $S_b = A_b \times C_{f1}$

   Where:

   (i) A_b = Building acceleration at the elevation of the equipment support due to harmonic motion
   (ii) C_{f1} = A coefficient depending on the equipment and buildings natural frequency

3. $S_g = \frac{(H-h_g)}{H} \times C_{f2}$

   Where:

   (i) H = Total height of building
   (ii) h_g = height of equipment from ground
   (iii) C_{f2} = A coefficient for either the OBE (.05g) or MHE (.15g) for amplifications associated with a damping factor of 0.5%

The acceleration coefficients S_b and S_g are applied in the horizontal direction. The vertical seismic acceleration coefficient are 2/3 of the S_b and S_g coefficients.

After the initial plant design, FPL developed floor response spectra for additional areas of the plant. FPL used these spectra in the re-evaluation or new design of selected Class I equipment, piping, and so forth. When available, the SRT used available floor response spectra. When they were not available, the SRT developed seismic input to the equipment as described in Section 4.2.3.

3.3 Seismic Analysis of Nuclear Class I Structures

Dynamic models were developed and analysis of the structures were made to determine the natural periods for vibration of each structure using lump mass or distributed mass systems as considered appropriate. In these analyses, periods and mode shapes were determined for each mode. These data were used to define participation factors for each structure. These participation factors were used with the spectral acceleration masses and relative displacement to define resultant seismic forces in each mode. These forces were applied to Nuclear Class I Structures to determine resultant shears and moments for design purposes.

3.4 Seismic Design of Mechanical and Electrical Equipment

The equipment furnished for installation at Turkey Point according to the original design basis contained in a 1968 Bechtel Memorandum[11] was designed for earthquake loads. The specified ground acceleration in the horizontal direction were a) .05 g with an allowable stress increase of 33%, over normal allowable and b) .15 g with an allowable stress of 90% of minimum yield stress, with the further condition that the equipment retain the ability to perform its safety function. The vertical ground acceleration specified was 2/3 the horizontal and acts simultaneously with one horizontal earthquake

component. Appendix 5A of Turkey Point's FSAR also states that the mechanical and electrical equipment has been purchased under specifications that include a description of the seismic design criteria for the plant.

In the initial plant design, a methodology was developed to consider building amplifications as a function of the equipment and building natural frequency. This methodology was explained in Section 3.2 of this report.

The mechanical and electrical equipment were purchased under specifications that include a description of the seismic design criteria for the plant. Motor control centers, switchgear and load centers have been shaketable tested to demonstrate no-loss-of-function capacity under the maximum hypothetical earthquake. There were no specific commitments with regard to equipment anchorage in the FSAR.

3.5 Seismic Design of Tanks

According to Appendix 5A Section II-c of Turkey Point's FSAR, Class I equipment is to be designed for both the DBE and MHE in accordance with AEC Publication TID 7024.[12] The percent of critical damping for welded steel plate assemblies that is applicable to tanks is given as 1 percent for both the DBE and MHE. Tanks included in the GL87-02/USI-A46 effort are the Condensate Storage Tanks, Emergency Generator Diesel Day Tanks, Diesel Oil Storage Tanks, Refueling Water Storage Tanks, Component Cooling Surge Tanks, Accumulator Tanks, and Boric Acid Storage Tanks. Specific mention is included in FSAR Appendix 5A that a hydrodynamic analysis of the Refueling Water Storage Tank has been performed using the methods of Chapter 6 of USAEC TID 7024. The anchorage design requirements for tanks were not specified in the FSAR. It should also be noted that the TID 7024 methodology did not consider the amplified frequency response of the impulsive fluid mass. For this reason the seismic reevaluation of large tanks was included in Unresolved Safety Issue A-40.[13] This issue was addressed in the GL87-02/USI A-46 evaluation performed and therefore USI A-40 has also been resolved at Turkey Point.

3.6 Seismic Spatial Interaction

Seismic interaction with non-seismic equipment is not addressed in Turkey Point's FSAR. FPL has conducted a review of the safety related equipment at Turkey Point Unit Nos. 3 and 4 to assess its susceptibility to loss of function from flooding or release of chemicals caused by the failure of non-seismic category I systems.

As a result of this evaluation some relatively minor modifications as to plant configuration were made. The results of this evaluation are described in Reference 14.

Seismic interaction with block walls was also evaluated by FPL in response to IE Bulletin 80-11.[15] The evaluation is documented in Reference 16. A test program was also initiated to support the assumptions made with regard to material properties in this evaluation.

Seismic spatial interactions were addressed in the GL 87-02/USI A-46 evaluation performed as discussed in Section 4.2.4 of this report. Seismic spatial interactions were also the subject of USI A-17 and therefore USI A-17 has also been resolved at Turkey Point.

3.7 Structural Damping

The damping factors used in the analyses of the various structures, equipment and distribution systems at the Turkey Point Plants are as follows:

	PERCENT DAMPING FOR DBE[1]	PERCENT DAMPING FOR MHE[1]
Soil	5.0	10.0
Reinforced Concrete Frames, and Buildings	3.0	5.0
Concrete Equipment Supports on Another Structure	2.0	2.0
Bolted Steel Framed Structures	2.0	2.0
Welded Steel Framed Structures	2.0	2.0
Welded Steel Plate Assemblies	1.0	1.0
Steel Piping Systems	.5	.5

4.0 USI A-46 EVALUATION

4.1 OVERALL APPROACH TAKEN

Florida Power & Light Company (FPL), decided to resolve GL 87-02/USI A-46 by use of a plant specific program. The proprietary procedure developed and implemented at FPL's Turkey Point Units 3 and 4 to provide final resolution of GL 87-02/USI A-46 is included as Appendix A.

Section 3.0 of this report, describes the original seismic design basis for the mechanical and electrical equipment, and tanks and heat exchangers for the plants. The basic requirement is that this equipment will be able to withstand the design basis MHE at the plant and still provide their safe shutdown function. The procedure used for the walkdown relied on the judgment of an expert seismic review team (SRT) to verify that this basic requirement be met. Substantial benefit was obtained by using experts in the field of seismic engineering and seismic capacity of equipment as seismic review team members.

[1]Reference 8 Section 5A page 12.

FPL selected a success path of equipment using safety, and non-safety equipment for achieving hot shutdown for the plants for a period of 8 hours. The relationship drawing, that shows the functions necessary to shutdown the reactor and equipment that supports those are shown in Figure 4.1.1.

FPL did not include relay evaluations based on the low seismic ground motion, low seismic risk, industry experience and taking credit for operator action should a relay actuate as has been done to date in seismic PRAs. A review of the effects of the Leroy earthquake on the Perry Nuclear Plant indicated that for this earthquake which exceeded Perry Plant's operating earthquake design basis, relays would not present a safety risk since only five non-safety related relays actuated of which three relays were in a de-energized state. Diablo Canyon, Limerick and Hatch plants have performed relay evaluations involving over 2,600 relays without any of the relays requiring replacement. When credit is taken for operator action to identify the relay actuation and when following plant operating procedures to address the actuation, relays would not pose a safety risk for FPL sites. In addition, FPL estimated the engineering cost to investigate relays at several hundred thousand dollars, which could not be justified by any reduction in off site risk of radiation exposure to the general public. Also, the NRC exempted Maine Yankee a plant in a much higher seismic area, from GL87-02/A-46 based on the satisfactory completion of a Seismic Margin Assessment using the NRC methodology in NUREG/CR-4826[17] which did not require relay evaluations.

Equipment data sheets were developed and used for each equipment item evaluated. The references documenting the criteria and procedures used for this walkdown, were the most recent at the time of the walkdown (the draft SSRAP report [18], the EPRI margins report [7], and URS anchorage report [19]).

Another aspect of the overall approach taken by FPL was to voluntarily arrange for an independent peer review. The report was reviewed and a plant walkdown performed by an independent seismic expert. The result of the peer review is included in Section 6 and Appendix D.

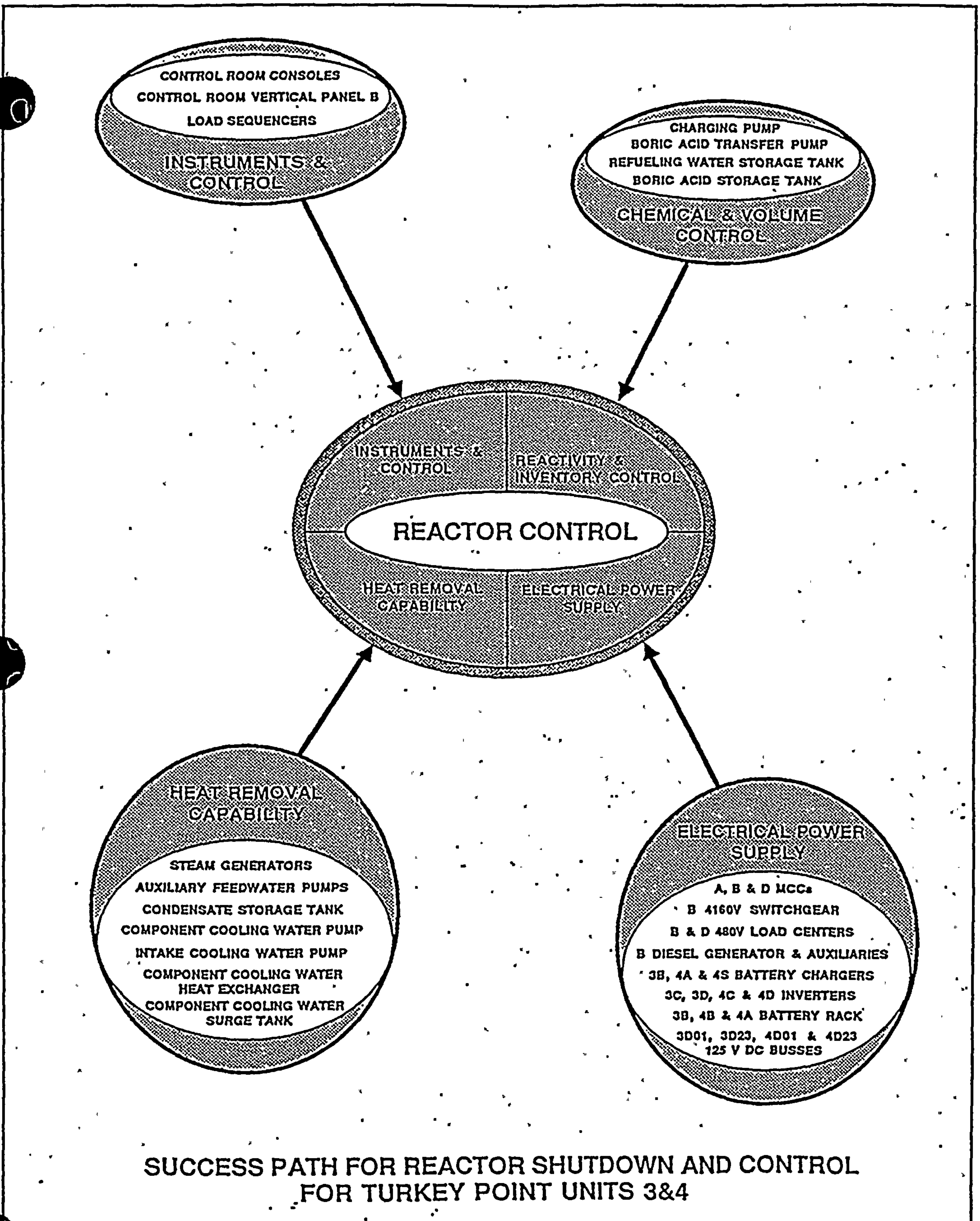

Figure 4.1.1 Relationship Drawing of Functions Necessary to Shut Down Reactor and Equipment Supporting Those Functions

4.2 SCREENING CRITERIA

The four basic requirements for the GL 87-02/USI A-46 review of Turkey Point Units 3 and 4 were addressed in the walkdown. The requirements include; the equipment seismic capacity being greater than demand, the construction adequacy of the equipment, anchorage adequacy and seismic spatial interaction. The specific criteria for satisfying these requirements are discussed in this section of the report.

4.2.1 Seismic Capacity Vs. Demand

Seismic Capacity vs. Demand for the equipment was addressed at the plant level rather than an equipment specific level. As described in the draft SSRAP report(18), well anchored industrial grade equipment have performed well in earthquakes with a magnitude much greater than the MHE defined earthquake at Turkey Point. Figure 4.2.1 shows a comparison of the 5% damped MHE design basis response spectrum and the 5% damped response spectra for the earthquakes used to develop the SSRAP Bounding Spectrum. As demonstrated by this figure equipment in these facilities were subjected to much greater vibration than expected at the Turkey Point site.

The SSRAP Bounding Spectrum recommended for use during GL 87-02/USI A-46 evaluations in Reference 18 envelops the plant MHE ground response spectra over the entire frequency as shown in Figure 4.2.2. SSRAP recommended the use of the Bounding Spectra for equipment whose natural frequency is greater than 8 hz and that are located below about 40 ft. above grade. For equipment that do not meet these qualifiers, the floor response spectra may be compared to 1.5 times the Bounding Spectrum. These limitations did not effect the Turkey Point plant equipment.

The 40′ limitation did not effect the evaluation since there is only one item of equipment located significantly above about 40′ above grade. The Component Cooling Water Surge Tank is located at elevation 71′ which is 53′ above grade.

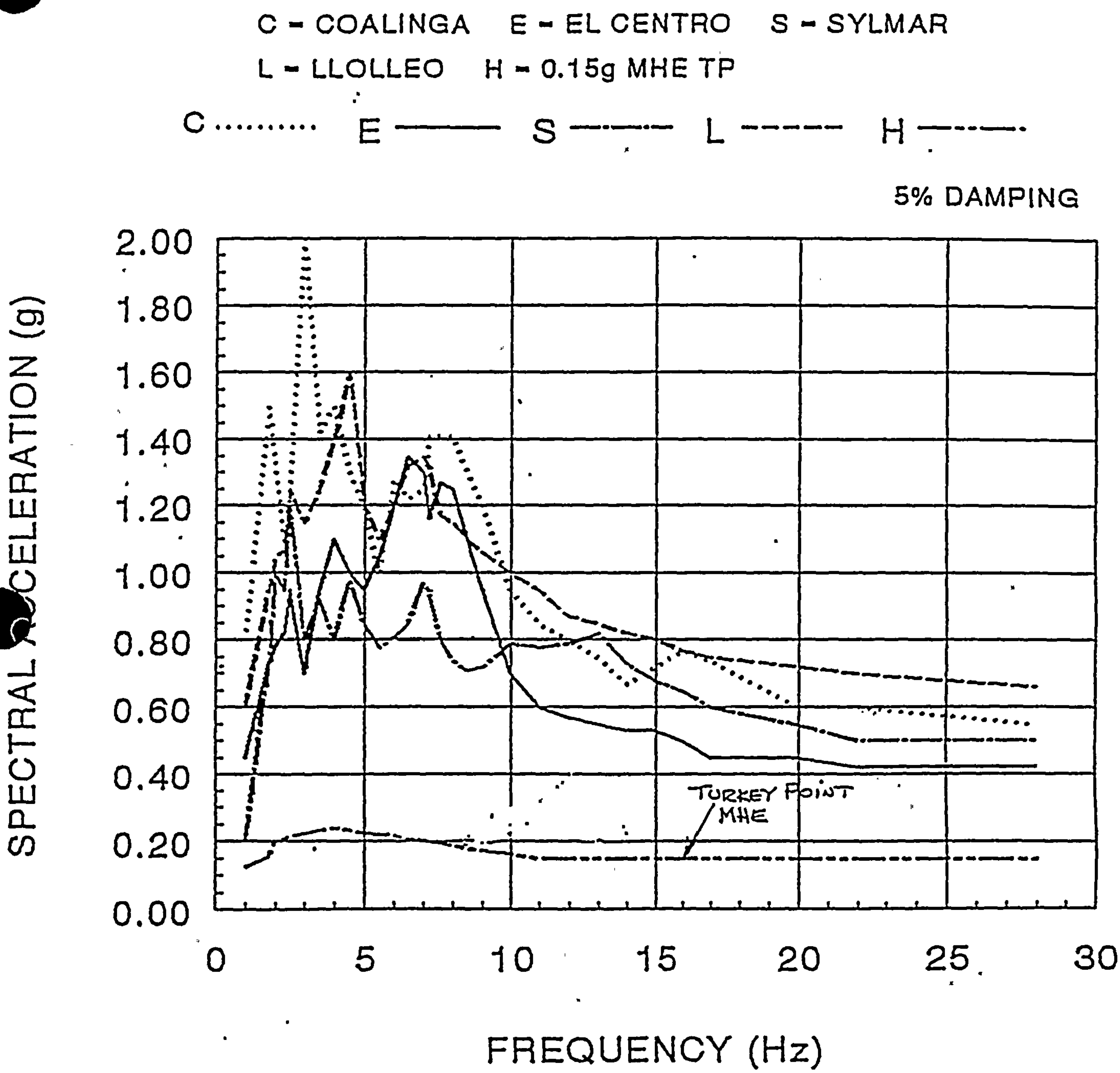

Figure 4.2.1 Comparison Between 5% Damped Ground Response Spectra Of Data Base Earthquakes and Turkey Point Units 3 & 4 MHE

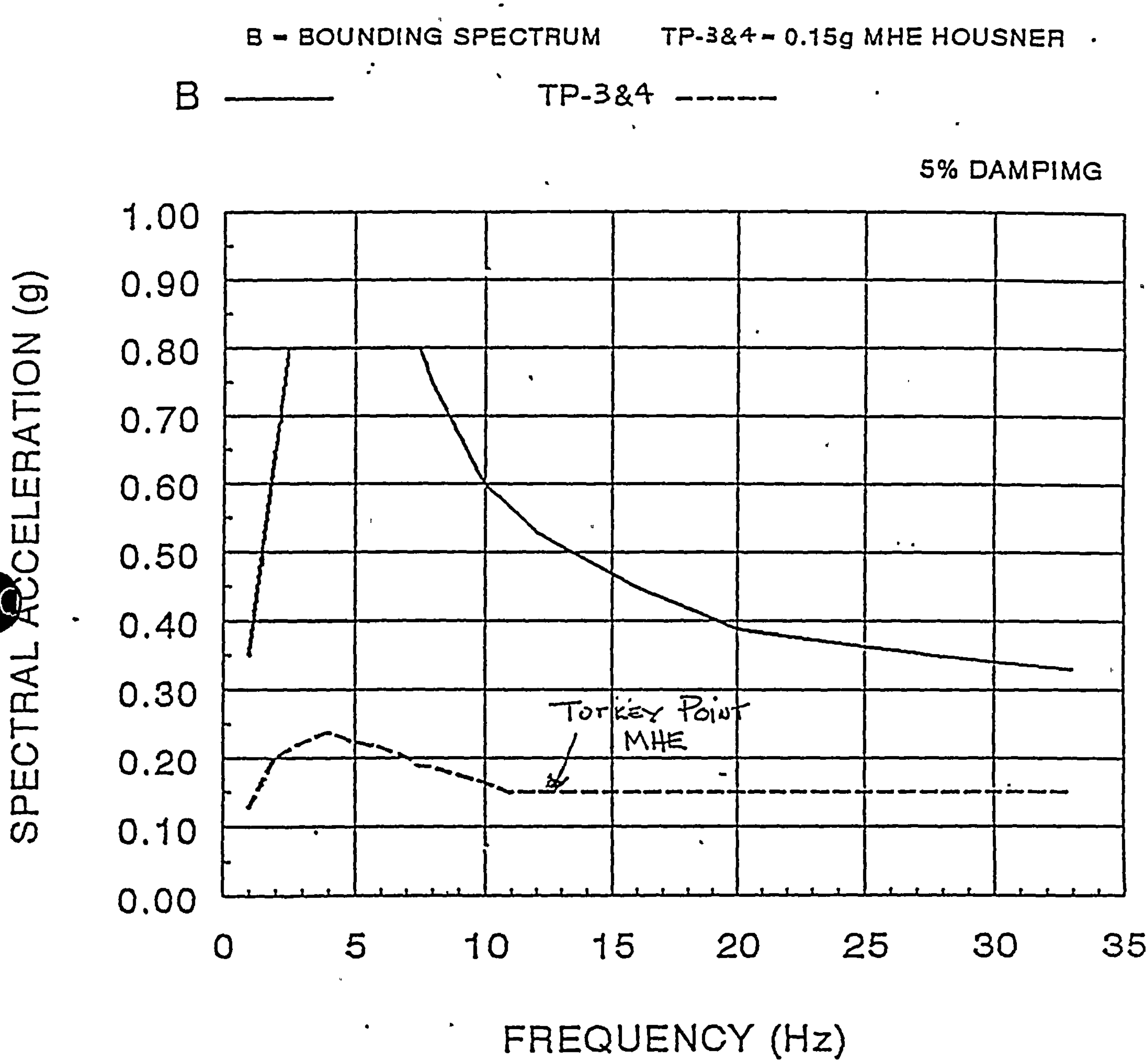

Figure 4.2.2 Comparison Between 5% Damped Bounding Spectra to Turkey Point Units 3 & 4 Ground MHE

The seismically vulnerable components of this item were evaluated using a conservative estimate of the floor response.

The 8 hz criteria is not limiting at Turkey Point since all other equipment was located at 24' above grade and less. At that elevation the floor response spectra available is enveloped by 1.5 times the bounding spectrum, that is recommended in Reference 18 to be used when comparing to the floor spectra.

The question of seismic capacity vs. demand for equipment was therefore judged to be acceptable on a generic basis, and this requirement was not included as an item on the equipment lists or check lists.

4.2.2 Equipment Construction Adequacy

Reference 18 contains criteria for equipment construction adequacy for various equipment categories in the form of caveats. Because of the low seismicity at the site, construction adequacy was not addressed by specific caveats for each type of equipment. Instead, the walkdown emphasized the two issues that have caused the most damage in earthquakes; anchorage adequacy and seismic spatial interaction.

However, the three SRT engineers are experts in the area of seismic adequacy of equipment and equipment performance during earthquakes. They are very familiar with the issues in regard to equipment adequacy from their experience which will be discussed in Section 4.5. The SRT engineers inspected each equipment item, and any detail they felt was seismically vulnerable was addressed.

4.2.3 Anchorage Criteria

An assessment of the anchorage adequacy was performed on each equipment item included on the safe shutdown list. This included an assessment of the seismic demand on the equipment anchorage (forces and stresses on the

anchorage), the seismic capacity of the anchorage components (attachment of the equipment to the anchorage, the anchorage itself, and the development of the anchorage to the foundation), and whether the capacity of the weak link of the anchorage system exceeded the demand.

To perform the anchorage assessment, the guidance contained in Section 7 (Equipment Anchorage) of the draft SSRAP report [18], and the URS anchorage report [19] was used. Other sources for performing the evaluation were knowledge of the design basis ground response spectra, and elevation of the equipment. The main guidance documents referred to above were supplemented when appropriate with references 20 to 23. SRT judgment based on their experience was also used as will be discussed further.

The discussion contained in Reference 19 was primarily used to estimate the seismic demand on the anchorage of mechanical and electrical equipment. The damping used met or was more conservative than the Reference 19 recommendations.

When floor spectra did not exist, an estimate of the demand for mechanical and electrical equipment was made from the ground response spectra. For example, equipment items less than 40' above grade used the peak of the 5% ground spectra times 1.5 for building amplification and 1.25 for conservatism in accordance with Reference 18 [which is 0.45g (.24g x 1.5 x 1.25)].

The anchorage demand for tanks was estimated for the impulsive loads by using the applicable 5% damped spectra. The large flat bottom tanks located at grade and screened during the walkdown included the Diesel Oil Storage Tank, Condensate Storage Tanks and Refueling Water Storage Tanks. The peak of the 5% damped MHE ground response spectra of .24g was used for these evaluations.

Equipment weight was either estimated using the drawing weight or the guidance given in Reference 19. Estimates of equipment fundamental frequency were also made during the course of estimating the seismic demand for some items. In general this estimate was very rough and could be made based on the experience of the SRT members. The judgments were made after the construction of the

equipment was examined during the walkdown. When more refined estimates of fundamental frequency were required, a calculation was performed.

The primary source for estimating the seismic capacity of the anchorage is Reference 19. The details with regard to anchorage allowable loads and cracked concrete considerations are contained in this reference. The safety factor for all expansion bolts used in this evaluation was 3.0 instead of the safety factors of 2.0 and 4.0 contained in Reference 19. The new safety factor was used, because the SRT had knowledge that 3.0 would be included in the updated version of the source reference.

The load path from the center of gravity, c.g., of the equipment was analyzed (by judgment and/or calculation) to the anchorage and ultimately to the supporting structure. Only structural components that could either be seen or verified were relied upon for this assessment. Anchorage components above the foundation were seen and verified, the embedded or buried components were verified using plant specific documentation (drawings). When drawings did not exist, ultrasonic testing was performed to determine anchorage length or the equipment item was identified as an outlier.

The supplemental references 20 to 23 were primarily used in performing evaluations of the capacities of potential weak links in the load path and anchorage system, where Reference 19 was primarily used for the anchorage itself.

An anchorage calculation was not performed for several equipment items. When the anchorage was obviously rugged, SRT judgment was used to assess anchorage adequacy. This judgment was performed in the context of the above criteria.

4.2.4 Seismic Spatial Interaction Criteria

A seismic spatial interaction assessment was performed on each equipment item included on the safe shutdown list. The following seismic spatial interaction issues were evaluated: 1) heavy objects falling (sometimes referred to as II

ver I interactions), 2) heavy objects sliding, swinging, vibrating or tipping (proximity interactions) and 3) inadequate flexibility of lines to accommodate seismic-induced relative movements between utility support points. An assessment was made as to whether a possible interaction existed, and if it did, could the interaction preclude the equipment item from performing it's safe shutdown function. Those interactions identified as possibly precluding the equipment item's safe shutdown function were identified as outliers.

To perform the interaction assessment for the three above mentioned issues the guidance contained in Section 6 (Seismic Walkdown) of the draft SSRAP report[18] and Appendix I of the EPRI NP-6041 seismic margins report[7] was used. Other sources for performing the evaluation was knowledge of the plant's design basis ground response spectra, elevation of the potential interactions source, when available the floor response spectra, and SRT judgment.

Reference 7 provides a very detailed discussion with regard to proximity and II/I issues. The guidance contained and methods described in this discussion were used during the walkdown for evaluating these issues. To evaluate the potential for an adverse consequence of differential support motion, the displacement at each end of the line in question (air line, conduit etc.) was estimated. With this estimate the potential for the line pulling out or rupturing and this effect on the component being evaluated was made by the SRT. Attachments of lines to equipment items in the safe shutdown list were evaluated at least to the first anchor point of the line away from the equipment.

Plant specific documentation was relied on by the SRT during the interaction assessment. For example if a block wall was noted adjacent to the equipment, the SRT would either determine that documentation existed with regard to how the wall was reinforced and that a seismic evaluation had been performed per IE Bulletin 80-11[15], or note on the walkdown data sheets that the block wall evaluation should be verified by FPL. The SRT in any case did not check the details of the evaluations performed, and FPL was responsible for block wall adequacy.

In addition to the evaluation described above, the SRT sought examples of poor seismic housekeeping. Cases of unlatched latches, unsecured drawers, unsecured emergency lighting, unsecured gas bottles, unanchored temporary equipment, and unsecured ceilings and lights were to be noted on the data sheets.

4.3 EQUIPMENT NECESSARY TO ACHIEVE AND MAINTAIN HOT SHUTDOWN

Table 4.3-1 is the complete walkdown list by system and function for Turkey Point Units 3 and 4 including the location, elevation, and height above grade for each component.

The equipment list generated for Turkey Point Units 3 and 4 to achieve and maintain hot shutdown for 8 hours was based on the requirements to:

1. Supervise and control the power plant.
2. Remove decay heat.
3. Provide emergency electrical power assuming a loss-of-offsite power.
4. Provide for chemistry and volume control.
5. Provide a heat sink for the reactor auxiliaries.

Supervisory and control functions included vertical panels "B" and the sequencer panels. Items 49, 50, 51, 52, 55 and 56 in Table 4.3-1 of the walkdown list reviewed this portion of the shutdown requirement which is housed in the main control building or the 4160V Bus Rooms.

Decay heat removal is accomplished by the auxiliary feedwater to the steam generators. The auxiliary feedwater system was previously reviewed for seismic adequacy as part of Generic Letter 81-14[24] and was therefore exempt from further review. The Condensate Storage Tanks were reviewed on the walkdown as items 12 and 13. The Condensate Storage Tanks provide the water source for the Auxiliary Feedwater Pumps.

TABLE 4.3-1
Equipment Walkdown Component List

ITEM #	COMPONENT DESCRIPTION	BUILDING/LOC	ELEV	ELEV ABOVE GRADE
Supervisory and Control Equipment:				
49.	3C23A Sequencer 3A	LC-SWGR	18′	0′
50.	3C23B Sequencer 3B	LC-SWGR	18′	0′
51.	4C23A Sequencer 4A	LC-SWGR	18′	0′
52.	4C23B Sequencer 4B	LC-SWGR	18′	0′
55.	3C05, 3C06, Vertical Panel 3B	Control	42′	24′
56.	4C05, 4C06 Vertical Panel 4B	Control	42′	24′
Decay Heat Removal Equipment:				
12.	Unit 3 Condensate Storage Tank	Outdoors, (Adjacent EDG)	18′	0′
13.	Unit 4 Condensate Storage Tank	Outdoors, S.W. of RCB	18′	0′
Electrical Equipment:				
1.	B Diesel Oil Transfer Pump	Outdoors, (Adjacent EDG)	18′	0′
10.	Diesel Oil Storage Tank	Outdoors, (Adjacent EDG)	18′	0
16.	B EDG Day Tank	EDG	34′	16′
19.	B Emergency Diesel Generator Skid	EDG	18′	0′
20.	B EDG Air Start Tanks	EDG	18′	0′
21.	B EDG Fan Assemblies	EDG	18′	0′
22.	4C12 EDG Local Control Panel B	EDG	18′	0′
23.	3B06 480V Motor Control Center 3B	Control	18′	0′

TABLE 4.3-1
Equipment Walkdown Component List

ITEM #	COMPONENT DESCRIPTION	BUILDING/LOC	ELEV	ELEV ABOVE GRADE
24.	4B06 480V Motor Control Center 4B	Control	18′	0′
25.	B08 480V Motor Control Center D	RAB	18′	0′
26.	3AB 4.16V Switchgear 3B	LC - SWGR	18′	0′
27.	4AB 4.16 V Switchgear 4B	LC - SWGR	30′	12′
28.	3B02 480V HVPDS Load Center 3B (Includes Transformer)	LC - SWGR	30′	12′
29.	3B04 480V HVPDS Load Center 3D (Includes Transformer)	LC-SWGR	30′	12′
30.	4B02 480V HVPDS Load Center 4B (Includes Transformer)	LC-SWGR	30′	12′
31.	4B04 480V HVPDS Load Center 4D (Includes Transformer)	LC-SWGR	30′	12′
32.	3B11 480V Load Center (PZR Heater)	LC - SWGR	30′	12′
33.	4B11 480V Load Center (PZR Heater)	LC - SWGR	30′	12′
34.	3D25 Battery Charger 3B	Control	42′	24′
35.	4D25 Battery Charger 4A	Control	42′	24′
36.	D26 Battery Charger 4S	Control	42′	24′
37.	3D03 Battery Rack 3A	Control	30′	12′
38.	3D24 Battery Rack 3B	Control	42′	24′

TABLE 4.3-1 Equipment Walkdown Component List				
ITEM #	COMPONENT DESCRIPTION	BUILDING/LOC	ELEV	ELEV ABOVE GRADE
39.	3D03 Battery Rack 4B	Control	30'	12'
40.	4D24 Battery Rack 4A	Control	42'	24'
41.	3D01 Distribution Panels/Bus	Control	30'	12'
42.	3D23 Distribution Panels/Bus	Control	30'	12'
43.	4D01 Distribution Panels/Bus	Control	30'	12'
44.	4D23 Distribution Panels/Bus	Control	30'	12'
45.	3Y05 Inverter 3C	Control	42'	24'
46.	3Y07 Inverter 3D	Control	42'	24'
47.	4Y05 Inverter 4C	Control	42'	24'
48.	4Y07 Inverter 4D	Control	42'	24'
57.	B Diesel Generator Exciter Cabinet	EDG	18'	0'
Chemical and Volume Control Equipment:				
2.	3B Charging Pump	RAB	18'	0
3.	4B Charging Pump	RAB	18'	0'
8.	3B Boric Acid Transfer Pump	RAB	18'	0'
9.	4B Boric Acid Transfer Pump	RAB	18'	0'
11.	B Boric Acid Storage Tank	RAB	27'	9'
14.	Unit 3 Refueling Water Storage Tank	Outdoors	18'	0'
15.	Unit 4 Refueling Water Storage Tank	Outdoors	18'	0'

TABLE 4.3-1
Equipment Walkdown Component List

ITEM #	COMPONENT DESCRIPTION	BUILDING/LOC	ELEV	ELEV ABOVE GRADE
Heat Removal Equipment:				
4.	3B Component Cooling Water Pump	RAB	18'	0'
5.	4B Component Cooling Water Pump	RAB	18'	0'
6.	3B Intake Cooling Water Pump	Intake Struct.	18'	0'
7.	4B Intake Cooling Water Pump	Intake Struct.	18'	0'
17.	Unit 3 Component Cooling Water Surge Tank	RAB	71'	53'
18.	Unit 4 Component Cooling Water Surge Tank	RAB	71'	53'
53.	3B CCW Heat exchanger	RAB	18'	0'
54.	4B CCW Heat Exchanger	RAB	18'	0'

The electrical power requirements for obtaining hot shutdown included the assumption that the switchyard would be out-of-service placing Units 3 and 4 in a loss-of-offsite-power condition which is covered by existing procedures. In addition, the pressurizer heaters were included to maintain sub-cooling of the Reactor Coolant System (RCS). Items 1, 10, 16 and 19 through 48 and 57 of the walkdown list addresses the electrical requirements for achieving hot shutdown without offsite power.

Chemistry and volume control to achieve hot shutdown adds equipment necessary to charge the RCS with a boric acid solution to meet hot shutdown reactivity requirements. A charging pump with suction from the Refueling Water Storage Tank will meet the volume change requirements. One train of boric acid solution addition capability was added to achieve the reactivity change requirements. The chemistry and volume control equipment walkdown items 2, 3, 8, 9, 11, 14 and 15 address this requirement.

Reactor auxiliary components and heat exchangers require cooling water to maintain the functionality of this equipment for items like seal cooling, lube oil cooling and heat removal. This requires one train of component cooling water and intake cooling water for each unit to be operable. These are items 4 through 7, 17, 18, 53 and 54 of the walkdown list.

4.4 Operating Procedures Necessary to Achieve and Maintain Hot Shutdown

A review of operating procedures for Turkey Point Units 3 and 4 was performed to verify the equipment list and to identify any additional Equipment which might be required to bring the reactor from 100% power to hot shutdown. The design basis earthquake is not expected to trip the reactor so equipment to reduce power was also reviewed. Operating procedures to shut down the reactor, take the reactor to hot shutdown, reactor trip response and loss of offsite power were reviewed. This review identified that the non-safety pressurizer heaters would be required to maintain sub-cooling during the period. To cope with the loss of offsite power, the Emergency Diesel

generators would be required. Since the train "B" was selected as the success path for obtaining hot shutdown, the "B" Emergency Diesel Generator and its auxiliary equipment would be included in the program. A review of the equipment list for the "B" Emergency Diesel Generator indicated that the Generator Exciter Cabinet would need to be added to the walkdown component list. The function of the exciter cabinet is to use the 125V DC battery power supply to energize and control the generator field for the Emergency Diesel Generator. All other components necessary to bring the Unit 3 and 4 reactors to hot shutdown have been included.

4.5 SEISMIC REVIEW TEAM

There was substantial benefit with regard to walkdown quality derived from using walkdown team members who included Drs. J.D. Stevenson, R. P. Kennedy and J.W. Reed. Their resumes are included as part of this procedure. The foregoing team members are intimately familiar with seismic walkdown criteria having either authored or reviewed the source references for this technology.

Four FPL engineers with mechanical, civil and operating backgrounds completed the walkdown team. These engineers provided the operating, construction and maintenance details which were used by the SRT in their evaluation. The FPL engineers reviewed the operating procedures and the Appendix "R" Safe Shutdown list to develop the equipment list for the walkdown. Corrective actions identified by the SRT were discussed with these engineers which in turn entered the corrective actions into FPL's corrective action system for evaluation and disposition. Using this process, the FPL engineers accepted responsibility for the corrective actions. An additional benefit derived from this process was that the FPL engineers gained seismic design knowledge from the SRT experts.

4.6 WALKDOWN PREPARATION

Prior to the walkdown, FPL licensing prepared the complete walkdown list of equipment to be reviewed by the SRT. A one day pre-walkdown of the plant was

performed, where a video tape was made of the equipment and anchorages. The pre-walkdown aided in determining what information and assistance would be required during the walkdown. A pre-walkdown meeting was held prior to the walkdown with the SRT and cognizant FPL staff. The logistics of the walkdown, and the documentation required for the walkdown were discussed in addition to reviewing the pre-walkdown video tapes.

FPL engineering gathered generic and equipment specific documentation, that was available for review by the SRT during the walkdown. This documentation included the following:

1) Definition of the plant ground response spectra.

2) Seismic design basis for buildings and equipment as defined in the FSAR (damping and stress limits).

3) Site soil conditions and grade elevation.

4) Floor response spectra.

5) Drawings showing standard details for anchorages, and foundation drawings.

6) Equipment drawings.

Equipment specific documentation were placed in an individual file folder for each equipment item. Generic documentation (floor response spectra, standard anchorages, etc.) was gathered and available for use during the walkdown.

Part A, Equipment Description, were filled out on Equipment Data Sheets for each equipment item on the equipment list. Computer sketches of each equipment item including type and description of anchorage were also developed. The final complete data sheets and sketches are included in Appendix C.

4.7 SCREENING WALKDOWN

4.7.1 Overall Walkdown Conduct

Each morning of the walkdown, the SRT reviewed the equipment included in that day's work. Anchorage and foundation drawings were reviewed as required. The equipment data sheets and computer sketches were taken into the field by the SRT. The equipment data sheets were filled out as much as possible in the field with notes and corrections made as required to the computer sketches. There was also a video tape made of the walkdown, that included SRT immediate observations.

Normally, at mid-day and at the end of each day the SRT would confer with the cognizant FPL engineer of what additional information would be helpful, or consult with support engineering about calculations to be performed. At the end of each day, the data sheets where a final judgment could be made with regard to seismic adequacy, were put in final form and signed by the SRT. The calculations performed were also attached to the data sheets. Appendix C include the final signed walkdown sheets and computer sketches for each equipment item. The calculations in Appendix C were developed from the computations done the week of the walkdown, however, they were performed again after the walkdown and put into the FPL Quality Program Format at the request of FPL.

4.7.2 Walkdown Results

The overall walkdown results are included on the Summary Data Sheets in Appendix B. The summary sheets, are a condensed version of the Equipment Data Sheets contained in Appendix C. Photographs of components included in the walkdown are in Appendix E.

4.7.2.1 Outlier Identification

The walkdown resulted in the identification of thirty-five outlier equipment

items. A broad definition for outlier was used in this evaluation. Every equipment item where a concern or recommendation to improve the seismic capacity of the equipment item was made by the SRT was noted as an outlier. This way each issue noted in the walkdown could be tracked until final resolution. The identified outliers, the reason for the outlier and the proposed resolution of the outlier recommended by the SRT are given in Table 5.0.

FPL prudently inspected the anchorage of the similar equipment items in the other plant trains, where anchorage concerns were identified. This resulted in the upgrade of several additional anchorages in the plants.

4.7.2.2 Equipment Anchorage

The equipment included in the Turkey Point Units 3 and 4 walkdown may be put in three major categories; pumps and rotating equipment, tanks and heat exchangers, and electrical equipment. The pumps and rotating equipment included robust anchorage consisting of cast in place bolts, embedded deep in their foundations. The anchorage for the majority of this equipment were judged acceptable without additional calculations after a review of the foundations drawings and the walkdown inspection.

Using the beyond design basis criteria in A-40 (13), high confidence low probability of failure (HCLPF) calculations were performed for Item 10, the Diesel Oil Storage Tank, Items 12 and 13, the Condensate Storage Tanks, and Items 14 and 15, the Refueling Water Storage Tanks. The bolt chair capacity limited the HCLPF calculated capacity of the tanks. Modifying the bolt chairs provided a limiting HCLPF, based on anchor bolt bonding of 0.11g for the Condensate Storage Tanks and the Refueling Water Storage Tanks. Modifying the bolt chairs on the Diesel Oil Storage Tank provided a limiting HCLPF of 0.207g based on the overturning moment. The Component Cooling Water Surge Tank platforms and Boric Acid Storage Tank platforms could not be screened by the SRT during the walkdown and were referred to FPL for resolution.

The anchorage of electrical equipment included in the walkdown was not uniform, as typical for this type equipment in Nuclear Power facilities of Turkey Point Units 3 and 4 vintage. This is due to the installation of this equipment by several different vendors with different anchorage schemes. Electrical equipment anchorage ranged from newly installed expansion anchors, and fillet welds to embedded angle to seal welds and no anchorage at all. When the anchorage was suspect, the SRT either designated the equipment item an outlier or recommended a fix.

When the SRT had a doubt about the anchorage capacity, a calculation was performed. In some instances, the SRT reviewed existing anchorage calculations to judge the anchorage acceptable.

4.7.2.3 Seismic Spatial Interaction

Section 4.2.4 discusses the interaction evaluations performed during the Turkey Point Units 3 and 4 walkdown. There were interaction concerns noted by the walkdown team on equipment items as indicated on the Equipment Data Sheets contained in Appendix C. Outliers were identified because of glass sight tubes for Items 16 and 19, the EDG Day Tank and the Emergency Diesel Generator skid. There was an additional concerns identified for FPL to reconcile with regard to the fossil unit stacks. It was also recommended that FPL should verify that the block wall adjacent to the Items 37 to 40 have been evaluated in the IE Bulletin 80-11 program, that the metal egg crate ceiling should be clipped in, and the lights above the batteries should have tie wires added. There were instances where overhead cranes were noted adjacent to equipment items. In these cases it was verified that during operation the cranes are parked away from the equipment.

As discussed in Section 4.2.4 the SRT sought examples of poor seismic housekeeping. The plant for the most part was free from housekeeping seismic interaction concerns. There was a concerted effort to secure fans, miscellaneous gages and gas bottles. These housekeeping seismic supports were overdesigned for their function.

4.7.2.4 Other Concerns

Section 4.2.2 discusses equipment construction adequacy and identification of potentially vulnerable details during the Turkey Point Units 3 and 4 Walkdown. Examples of these details resulting in outliers are as indicated in the Appendix C documentation. It is noted for Items 6 and 7 that the pump shaft length and cast iron fittings for the Intake Cooling Water Pumps should be evaluated. Spacers are recommended to be added on the east ends of the Battery Racks (Items 37 to 40).

5.0 RESOLUTION OF CONCERNS

FPL addressed all outlier issues listed and the actions taken are listed in Table 5.0. In many cases, FPL engineering generated Plant Change/Modification (PC/M) Packages which provided for physical modification to plant equipment resulting in additional seismic "hardening" of the equipment. These PC/M packages are available in FPL's Juno Beach offices should the NRC desire to review them.

Operability evaluations were performed by FPL and none of the concerns identified as a result of the walkdown were determined as potential unit operability concerns.

6.0 INDEPENDENT PEER REVIEW

Dr. Paul Smith of the Readiness Operation performed the peer review of the USI A-46 evaluation at Turkey Point Units 3 and 4. The review included a detailed review of the draft report, a visit to the plant site to conduct a sample walkdown and a review of the documentation. Dr. Smith concluded that there were no significant deficiencies in the A-46 review effort that was performed on Turkey Points Units 3 and 4. Dr. Smith's review is included as Appendix D.

TABLE 5.0
OUTLIER ISSUES AND RESOLUTIONS
TURKEY POINT UNITS 3 AND 4

ITEM	I.D.	EQUIPMENT DESCRIPTION	OUTLIER ISSUES	SRT RECOMMENDED RESOLUTION	ACTION TAKEN
6.	3B	Intake Cooling Water Pump	1) Pump shaft length longer than can be screened by SSRAP report. 2) Cast iron fittings on pump. 3) Anchorage needs verification. 4) Interaction Fossil Unit Stack may fail.	1) Evaluate Shaft for adequate length and clearances. 2) Check stresses on fittings from loads of attached piping. 3) Verify anchorage with calculation. 4) Check adequacy of fossil stack.	1) TBA
7.	4B	Intake Cooling Water Pump	1) Pump length longer than can be screened by SSRAP report. 2) Cast iron fittings on pump. 3) Anchorage needs verification. 4) Interaction Fossil Unit Stack may fail.	1) Evaluate Shaft for adequate length and clearances. 2) Check stresses on fittings from loads of attached piping. 3) Verify anchorage with calculation. 4) Check adequacy of fossil stack.	1) TBA
10.	N/A	Diesel Oil Storage Tank	1) Anchorage adequacy. 2) Interaction-fossil unit stack may fail.	1) Replace chair plates with 1 1/4" thick plates and evaluate further. 2) Check adequacy of fossil stack.	1) Chair Plates upgraded per PCM 91-169. 2) Fossil Stack adequate per FPL Safety Evaluation,TBA.
11.	B	Boric Acid Storage Tank	1) Platform adequacy for torsional loads.	1) Check platform adequacy for torsion, and upgrade if require.	1) Platform upgraded per PCMS 90-440 and 90-441.
12.	3	Unit 3 Condensate Storage Tank	1) Anchorage adequacy.	1) Replace chair plates with 1 3/4" thick plates, and evaluate further.	1) Chair Plates upgraded per PCM 91-170.
13.	4	Unit 4 Condensate Storage Tank	1) Anchorage adequacy.	1) Replace chair plates with 1 3/4" thick plates, and evaluate further.	1) Chair Plates upgraded per PCM 91-171.
14.	3	Unit 3 Refueling Water Storage Tank	1) Anchorage adequacy.	1) Replace chair plates with 1 3/4" thick plates, and evaluate further.	1) Chair Plates upgraded per PCM 91-172.

TABLE 5.0 OUTLIER ISSUES AND RESOLUTIONS TURKEY POINT UNITS 3 AND 4					
ITEM	I.D.	EQUIPMENT DESCRIPTION	OUTLIER ISSUES	SRT RECOMMENDED RESOLUTION	ACTION TAKEN
15.	4	Unit 4 Refueling Water Storage Tank	1) Anchorage adequacy.	1) Replace chair plates with 1 3/4" thick plates, and evaluate further.	1) Chair Plates upgraded per PCM 91-173.
16.	B	EDG Day Tank	1) Glass sight tube.	1) Replace glass sight tube with non-breakable material.	1) TBA
17.	3	Unit 3 Component Cooling Water Surge Tank	1) Platform adequacy.	1) Check platform adequacy, and upgrade if required.	1) Platform to be upgraded per PCM 90-471.
18.	4	Unit 4 Component Cooling Water Surge Tank	1) Platform adequacy.	1) Check platform adequacy, and upgrade if required.	1) Platform to be upgraded per PCM 90-472.
19.	B	Emergency Diesel Generator Skid	1) Glass sight tube.	1) Replace glass sight tube with non-breakable material.	1) TBA
20.	B	EDG Air Start Tanks	1) Seismic interaction - threaded pipe for air supply not rigidly supported.	1) Complete plant work order (PWO) already written for the support.	1) Air supply and supports replaced per PCMs 86-155 and 86-190.
23.	3B06	480V Motor Control Center 3B	1) Seal welded anchorage, inadequate in tension.	1) Upgrade anchorage.	1) Anchorage upgraded per PCM 91-178.
24.	4B06	480V Motor Control Center 4B	1) No anchorage.	1) Add anchorage.	1) Anchorage upgraded per PCM 91-179.
25.	B08	480V Motor Control Center D	1) Inadequate anchorage for overturning.	1) Brace top of MCC to concrete wall.	1) Anchorage upgraded per PCM 91-178.
26.	3AB	4.16kv Switchgear 3B	1) No anchorage.	1) Add anchorage.	1) Anchorage upgraded per PCM 91-174.

TABLE 5.0
OUTLIER ISSUES AND RESOLUTIONS
TURKEY POINT UNITS 3 AND 4

ITEM	I.D.	EQUIPMENT DESCRIPTION	OUTLIER ISSUES	SRT RECOMMENDED RESOLUTION	ACTION TAKEN
27.	4AB	4.16kv Switchgear 4B	1) No anchorage.	1) Add anchorage.	1) Anchorage upgraded per PCM 91-175.
28.	3B02	480V HVPDS Load Center 3B (Includes Transformer)	1) Cannot determine anchorage.	1) Add anchorage.	1) New load center installed per PCM 89-532 and new anchorage installed per PCM 91-176.
29.	3B04	480V HVPDS Load Center 3D (Includes Transformer)	1) Cannot determine anchorage.	1) Verify anchorage and upgrade if required.	1) New load center installed per PCM 89-532 and new anchorage installed per PCM 91-176.
30.	4B02	480V HVPDS Load Center 4B (Includes Transformer)	1) No anchorage.	1) Add anchorage.	1) New load center installed per PCM 89-533 and new anchorage installed per PCM 91-177.
31.	4B04	480V HVPDS Load Center 4D (Includes Transformer)	1) No anchorage.	1) Add anchorage.	1) New load center installed per PCM 89-533 and new anchorage installed per PCM 91-177.
37.	3D03	Battery Rack 3A	1) No spacers on east end of battery rack. 2) Shade on lights may fail and fall on batteries. 3) Block walls not evaluated by SRT.	1) Add spacers on east end of battery rack. 2) Add tie wire to lights. 3) Verify block wall included in FPL IE 80-11 program.	1) Spacers added per FPL letters JPN-PTN-92-5261 and 5707. 2) Tie wires added per PCM 91-182. 3) FPL verified wall included in IE 80-11 program as block walls C30-1, C30-2, C30-4.
38.	3D24	Battery Rack 3B	1) No spacers on east end of battery rack. 2) Shade on lights may fail and fall on batteries. 3) Block walls not evaluated by SRT.	1) Add spacers on east end of battery rack. 2) Add tie wire to lights. 3) Verify block wall included in FPL IE 80-11 program.	1) Spacers added per FPL letters JPN-PTN-92-5261 and 5707. 2) Tie wires added per PCM 91-182. 3) FPL verified wall included in IE 80-11 program as block walls A42-2, C42-16, C42-17, C42-18.

TABLE 5.0
OUTLIER ISSUES AND RESOLUTIONS
TURKEY POINT UNITS 3 AND 4

ITEM	I.D.	EQUIPMENT DESCRIPTION	OUTLIER ISSUES	SRT RECOMMENDED RESOLUTION	ACTION TAKEN
39.	4D03	Battery Rack 4B	1) No spacers on east end of battery rack. 2) Shade on lights may fail and fall on batteries. 3) Block walls not evaluated by SRT.	1) Add spacers on east end of battery rack. 2) Add tie wire to lights. 3) Verify block wall included in FPL IE 80-11 program.	1) Spacers added per FPL letters JPN-PTN-92-5261 and 5707. 2) Tie wires added per PCM 91-183. 3) FPL verified wall included in IE 80-11 program as block walls C30-2, C30-3, C30-4.
40.	4D24	Battery Rack 4A	1) No spacers on east end of battery rack. 2) Shade on lights may fail and fall on batteries. 3) Block walls not evaluated by SRT.	1) Add spacers on east end of battery rack. 2) Add tie wire to lights. 3) Verify block wall included in FPL IE 80-11 program.	1) Spacers added per FPL letters JPN-PTN-92-5261 and 5707. 2) Tie wires added per PCM 91-183. 3) FPL verified wall included in IE 80-11 program as block walls A42-2, C42-15, C42-16, C42-18.
41.	3D01	Distribution Panels/Bus	1) One loose anchor bolt.	1) Tighten loose bolt.	1) Bolt disposition per PWO 93-010843.
43.	4D01	Distribution Panels/Bus	1) Three loose anchor bolts.	1) Tighten loose bolts.	1) Bolt disposition per PWO 93-010844.
50.	3C23B	Sequencer 3B	1) Additional top bracket as found for sequencer 3A (Item 49) would provide added assurance and strength. - This item had only one bracket.	1) Add top bracket as found for sequencer 3A (Item 49).	1) Bracket added per PCM 91-180.
51.	4C23A	Sequencer 4A	1) Additional top brackets as found for sequencer 3A (Item 49) would provide added assurance and strength. This item had no brackets.	1) Add two top brackets as found for sequencer 3A (Item 49).	1) Bracket added per PCM 91-181.
52.	4C23B	Sequencer 4B	1) Additional top brackets as found for sequencer 3A (Item 49) would provide added assurance and strength. This item had no brackets.	1) Add two top brackets as found for sequencer 3A (Item 49).	1) Bracket added per PCM 91-181.

TABLE 5.0
OUTLIER ISSUES AND RESOLUTIONS
TURKEY POINT UNITS 3 AND 4

ITEM	I.D.	EQUIPMENT DESCRIPTION	OUTLIER ISSUES	SRT RECOMMENDED RESOLUTION	ACTION TAKEN
53.	3B	CCW Heat Exchanger	1) SRT could not verify reinforcement steel design of pedestal.	1) Verify adequacy of pedestal design.	1) FPL verified pedestal adequacy by calculations C-SJ511-01 and 02.
54.	4B	CCW Heat Exchanger	1) SRT could not verify reinforcement steel design of pedestal.	1) Verify adequacy of pedestal design.	1) FPL verified pedestal adequacy by similarity with Item 53.
55.	3C05, 3C06	Vertical Panel 3B	1) Interaction metal egg crate ceiling may fall on operators.	1) Clip in metal egg crate sections of ceiling.	1) TBA
56.	4C05, 4C06	Vertical Panel 4B	1) Interaction metal egg crate ceiling may fall on operators.	1) Clip in metal egg crate sections of ceiling.	1) TBA

7.0 CONCLUSIONS AND RESULTS

FPL developed and implemented a plant specific program to satisfy requirements of GL87-02/USI A-46 as agreed between FPL and the USNRC. The program consisted of developing a walkdown procedure, contained in Appendix A, that concentrated on anchorage concerns of USI-A46, the seismic spatial interaction concerns of USI-A17 and the design concerns for large tanks in USI-A40. The program was developed by FPL to be appropriate and cost effective for addressing GL87-02 concerns at its low seismic sites. The basic requirement for the walkdown is that the equipment will be able to withstand the design basis SSE at the plant and still provide its safe shutdown function. The procedure used was not overly prescriptive but relied on the judgment of an expert team to meet the basic requirement.

A success path of equipment using safety and non-safety equipment was selected for achieving and maintaining hot shutdown of the plant for a period of 8 hours. The final equipment list is included in Appendix B.

Documentation for the walkdown was gathered by FPL, and was available during the walkdown. Equipment specific documentation was placed in individual file folders for each equipment item. Generic documentation (floor response spectra, anchorage details, etc.) was available for review during the walkdown.

Equipment Data Sheets for each equipment item on the equipment list were developed and completed during the walkdown. The data sheets consisted of general descriptions of the equipment, and walkdown observations. Computer sketches of each equipment item including type and description of anchorage were also developed. The final complete data sheets and sketches are included in Appendix C. Photographs of equipment included in the review are in Appendix E. There was also a video tape made of the walkdown, that included SRT immediate observations.

The overall walkdown results are included on the Summary Data Sheets in Appendix B. The Summary Data Sheets, are a condensed version of the Equipment Data Sheets contained in Appendix C.

The walkdown resulted in the identification of thirty-five outlier equipment items with the majority of the outliers being lack of anchorage for electrical cabinets which were not previously required to be anchored and were shaker table tested prior to installation. The outliers identified are summarized in Table 4.7.1.

FPL prudently inspected the anchorage of the similar equipment items in the other plant trains, where anchorage concerns were identified.

A peer review was performed of the walkdown report including a sample walkdown. The peer review report is included as Appendix D.

8.0 REFERENCES

1. FPL Letter L-88-333, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Plant," Letter to USNRC, Aug. 4, 1988.

2. FPL Letter L-89-441, "Unresolved Safety Issue A-46, Generic Letter 87-02," Letter to USNRC, December 12, 1989.

3. Generic Letter 87-02, "Verification of Seismic Adequacy of Mechanical and Electrical equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46," U.S. Nuclear Regulatory Commission, Washington, D.C., February 19, 1987.

4. EBASCO Report, "Probabilistic Seismic Hazard Evaluation and Uniform Hazard Spectra, St. Lucie and Turkey Point Nuclear Power Plant Sites," prepared by EBASCO Services Inc. For FPL, December 1989.

5. CRAC2 Computer Code, "Calculation of Reactor Accident Consequences," Version 2.

6. NUREG-1211, "Regulatory Analysis for Resolution of Unresolved Safety Issue A-46, Seismic Qualification of Equipment in Operating Plants," U.S. Nuclear Regulatory Commission, Washington, D.C., February 1987.

7. EPRI NP-6041, "A Methodology for Assessment of Nuclear Power Plant Seismic Margin," NTS Engineering et. al., October 1988.

8. "Final Safety Analysis Report," (FSAR) Volumes I, II, III, IV and V, Turkey Point Units 3 and 4, Rev. 5, 7/87.

9. NUREG/CR-5250, "Seismic Hazard Characterization of 69 Nuclear Plant Sites East of the Rocky Mountains," Lawrence Livermore National Laboratory, Prepared for USNRC, January 1989.

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12. United States Atomic Energy Commission, TID-7024, "Nuclear Reactors and Earthquakes," August 1963.

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15. I E Bulletin 80-11, "Masonry Wall Design," U.S. Nuclear Regulatory Commission, Washington, D.C., 1980

16. Letter to S.G. Brain (FPL) from G.T. Nutwell (Bechtel), RE: Block Wall Evaluation and Repair Program, March 16, 1984.

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18. SSRAP Report, "Use of Seismic Experience Data to Show Ruggedness of Equipment in Nuclear Power Plants," Senior Seismic Review and Advisory Panel, January 17, 1990, Draft.

19. EPRI NP-5228, "Seismic Verification of Nuclear Plant Anchorage, Volume 1: Development of Anchorage Guidelines; Vol. 2: Anchorage Inspection Workbook, URS Corp./John A. Blume & Assoc., Prepared for Electric Power Research Institute, Palo Alto, CA, May 1987.

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21. Holmes and Martin, Analysis and Design of Structural Connections For Reinforced Concrete & Steel," 1983 Edition.

22. AISC, "Manual of Steel Construction Allowable Stress Design, Ninth Edition," 1989.

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APPENDIX B

Safe Shutdown Summary Data Sheets

TURKEY POINT UNITS 3 & 4
SUMMARY DATA SHEET

Item (1)	I.D. (2)	Equipment Description (3)	Bldg. (4)	Approx. Elev. (5)	Approx. Height Above Grade* (6)	Anchorage Adequacy[1] (7)	Basis for Anchorage Assessment[2] (8)	Seismic Interaction Adequacy[1] (9)	Status[3] (10)	Remarks (11)
1.	B	Diesel Oil Transfer Pump	Outdoors (Adjacent EDG)	18′	0′	Y	R/J	Y	Y	
2.	3B	Charging Pump	RAB	18′	0′	Y	R/J	Y	Y	
3.	4B	Charging Pump	RAB	18′	0′	Y	R/J	Y	Y	
4.	3B	Component Cooling Water Pump	RAB	18′	0′	Y	R/J	Y	Y	
5.	4B	Component Cooling Water Pump	RAB	18′	0′	Y	R/J	Y	Y	
6.	3B	Intake Cooling Water Pump	Intake Structure	18′ (Motor Deepwell Pump)	0′	U	C/J	U	O	1) Check Pump Length. 2) Check Cast Iron Fittings. 3) FPL should verify anchorage with calculation. 4) Confirm Fossil Stack Adequacy.

TURKEY POINT UNITS 3 & 4
SUMMARY DATA SHEET (Cont.)

Item	I.D.	Equipment Description	Bldg.	Approx. Elev.	Approx. Height Above Grade*	Anchorage Adequacy[1]	Basis for Anchorage Assessment[2]	Seismic Interaction Adequacy[1]	Status[3]	Remarks
7.	4B	Intake Cooling Water Pump	Intake Structure	18' (Motor Deepwell Pump)	0'	U	C/J	U	O	1) Check Pump Length. 2) Check Cast Iron Fittings. 3) FPL should verify anchorage with calculation. 4) Confirm Fossil Stack Adequacy.
8.	3B	Boric Acid Transfer Pump	RAB	18'	0'	Y	R/J	Y	Y	
9.	4B	Boric Acid Transfer Pump	RAB	18'	0'	Y	R/J	Y	Y	
10.	N/A	Diesel Oil Storage Tank	Outdoors (Adjacent EDG)	18'	0'	N	C	Y	O	1) Replace Chair Plates with 1-1/4" thick Plates. Will increase HCLPF to 0.20g. 2) Check Fossil Stacks.
11.	B	Boric Acid Storage Tank	RAB	27'	9'	U	C	Y	O	1) FPL should check platform for torsion.
12.	3	Unit 3 Condensate Storage Tank	Outdoors (Adjacent EDG)	18'	0'	N	C	Y	O	1) Replace Chair Plates with 1-1/4" thick plates. Will increase HCLPF for tank to .11g.
13.	4	Unit 4 Condensate Storage Tank	Outdoors (S.W. of RCB)	18'	0'	N	C	Y	O	1) Replace Chair Plates with 1-1/4" thick plates. Will increase HCLPF for tank to .11g.

TURKEY POINT UNITS 3 & 4 SUMMARY DATA SHEET (Cont.)										
Item	I.D.	Equipment Description	Bldg.	Approx. Elev.	Approx. Height Above Grade*	Anchorage Adequacy[1]	Basis for Anchorage Assessment[2]	Seismic Interaction Adequacy[1]	Status[3]	Remarks
14.	3	Unit 3 Refueling Water Storage Tank	Outdoors	18'	0'	N	C	Y	O	1) Replace Chair Plates with 1-1-1/4" thick plates. Will increase HCLPF for tank to .11g.
15.	4	Unit 4 Refueling Water Storage Tank	Outdoors	18'	0'	N	C	Y	O	1) Replace Chair Plates with 1-1/4" thick plates. Will increase HCLPF for tank to .11g.
16.	B	EDG Day Tank	EDG	34'	16'	Y	C	N	O	1) Glass Site Tube.
17.	3	Unit 3 Component Cooling Water Surge Tank	RAB	71'	53'**	U	C	Y	O	1) FPL should check platform adequacy.
18.	4	Unit 4 Component Cooling Water Surge Tank	RAB	71'	53'**	U	C	Y	O	1) FPL should check platform adequacy.
19.	B	Emergency Diesel Generator Skid	EDG	18'	0'	Y	J	N	O	1) Glass Site Tube
20.	B	EDG Air Start Tanks	EDG	18'	0'	Y	R	Y	O	1) Air supply threaded pipe to be fixed by PWO.
21.	B	EDG Fan Assemblies	EDG	18'	0'	Y	J	Y	Y	
22.	4C12	EDG Local Control Panel B	EDG	18'	0'	Y	C	Y	Y	

TURKEY POINT UNITS 3 & 4 SUMMARY DATA SHEET (Cont.)										
Item	I.D.	Equipment Description	Bldg.	Approx. Elev.	Approx. Height Above Grade*	Anchorage Adequacy[1]	Basis for Anchorage Assessment[2]	Seismic Interaction Adequacy[1]	Status[3]	Remarks
23.	3B06	480V Motor Control Center 3B	Control	18'	0'	N	J	Y	0	1) Seal welded anchorage, needs to upgraded.
24.	4B06	480V Motor Control Center 4B	Control	18'	0'	N	J	Y	0	1) No anchorage.
25.	B08	480V Motor Control Center D	RAB	18'	0'	N	C/J	Y	0	1) Brace top of MCC to concrete wall.
26.	3AB	4.16kv Switchgear 3B	LC-Swgr	18'	0'	N	J	Y	0	1) No anchorage.
27.	4AB	4.16kv Switchgear 4B	LC-Swgr	18'	0'	N	J	Y	0	1) No anchorage.
28.	3B02	480 HVPDS Load Center 3B (Includes Transformer)	LC-Swgr	30'	12'	N	J	Y	0	1) Cannot determine anchorage. 2) Block wall included in IE 80-11 program.
29.	3B04	480V HVPDS Load Center 3D (Includes Transformer)	LC-SWGR	30'	12'	N	J	Y	0	1) Cannot determine anchorage. 2) Block wall included in IE 80-11 program.
30.	4B02	480V HVPDS Load Center 4B (Includes Transformer)	LC-Swgr	30'	12'	N	J	Y	0	1) No anchorage. 2) Block wall included in IE 80-11 program.
31.	4B04	480V HVPDS Load Center 4D (Includes Transformer)	LC-Swgr	30'	12'	N	J	Y	0	1) Cannot determine anchorage. 2) Block wall included in IE 80-11 program.
32.	3B11	480V Load Center (PZR Htr.)	LC-Swgr	30'	12'	Y	J	Y	Y	

TURKEY POINT UNITS 3 & 4
SUMMARY DATA SHEET (Cont.)

Item	I.D.	Equipment Description	Bldg.	Approx. Elev.	Approx. Height Above Grade*	Anchorage Adequacy[1]	Basis for Anchorage Assessment[2]	Seismic Interaction Adequacy[1]	Status[3]	Remarks
33.	4B11	480V Load Center (PZR Htr.)	LC-Swgr	30′	12′	Y	J	Y	Y	
34.	3D25	Battery Charger 3B	Control	42′	24′	Y	J	Y	Y	
35.	4D25	Battery Charger 4A	Control	42′	24′	Y	C	Y	Y	
36.	D26	Battery Charger 4S	Control	42′	24′	Y	C	Y	Y	
37.	3D03	Battery Rack	Control	30′	12′	Y	R	N	0	1) Spacers needed on east end of battery rack. 2) Lights need tie wire. 3) FPL should verify block wall in IE 80-11.
38.	3D24	Battery Rack 3B	Control	42′	24′	Y	R	N	0	1) Spacers needed on east end of battery rack. 2) Lights need tie wire. 3) FPL should verify block wall in IE 80-11.
39.	4D03	Battery Rack 4B	Control	30′	12′	Y	R	N	0	1) Spacers needed on east end of battery rack. 2) Lights need tie wire. 3) FPL should verify block wall in IE 80-11.

TURKEY POINT UNITS 3 & 4
SUMMARY DATA SHEET (Cont.)

Item	I.D.	Equipment Description	Bldg.	Approx. Elev.	Approx. Height Above Grade*	Anchorage Adequacy[1]	Basis for Anchorage Assessment[2]	Seismic Interaction Adequacy[1]	Status[3]	Remarks
40.	4D24	Battery Rack 4A	Control	42′	24′	Y	R	O	O	1) Spacers needed on east end of battery rack. 2) Lights need tie wire. 3) FPL should verify block wall in IE 80-11.
41.	3D01	Distribution Panels/Bus	Control	30′	12′	Y	C	Y	Y	1) FPL should tighten one loose bolt.
42.	3D23	Distribution Panels/Bus	Control	30′	12′	Y	C	Y	Y	
43.	4D01	Distribution Panels/Bus	Control	30′	12′	Y	C	Y	Y	1) FPL should tighten 3 loose bolts.
44.	4D23	Distribution Panels/Bus	Control	30′	12′	Y	C	Y	Y	
45.	3Y05	Inverter 3C	Control	42′	24′	Y	J	Y	Y	
46.	3Y07	Inverter 3D	Control	42′	24′	Y	J	Y	Y	
47.	4Y05	Inverter 4C	Control	42′	24′	Y	J	Y	Y	
48.	4Y07	Inverter 4D	Control	42′	24′	Y	J	Y	Y	
49.	3C23A	Sequencer 3A	LC-Swgr	18′	0′	Y	C	Y	Y	
50.	3C23B	Sequencer 3B	LC-Swgr	18′	0′	Y	C/J	Y	Y	1) Add one more top bracket.
51.	4C23A	Sequencer 4A	LC-Swgr	18′	0′	Y	C/J	Y	Y	1) Add two top brackets.
52.	4C23B	Sequencer 4B	LC-Swgr	18′	0′	Y	C/J	Y	Y	1) Add two top brackets.

TURKEY POINT UNITS 3 & 4
SUMMARY DATA SHEET (Cont.)

Item	I.D.	Equipment Description	Bldg.	Approx. Elev.	Approx. Height Above Grade*	Anchorage Adequacy[1]	Basis for Anchorage Assessment[2]	Seismic Interaction Adequacy[1]	Status[3]	Remarks
53.	3B	CCW Heat Exchanger	RAB	18′	0′	Y	R	Y	Y	1) FPL should verify pedestal design.
54.	4B	CCW Heat Exchanger	RAB	18′	0′	Y	R	Y	Y	1) FPL should verify pedestal design.
55.	3C05, 3C06	Vertical Panel 3B	Control	42′	24′	Y	C	N	O	1) Interaction Concern, metal egg crate ceiling.
56.	4C05, 4C06	Vertical Panel 4B	Control	42′	24′	Y	C	N	O	1) Interaction Concern, metal egg crate ceiling.

(1) Key for Anchorage and Interaction Adequacy "Y" Yes (Adequate)
"N" No (Not Adequate)

(2) Key for Basis for Anchorage Assessment "R" (Drawing and/or Calculation Review)
"J" (Judgment)
"C" (Calculation)
"U" (Unknown at time of walkdown)

(3) Status "Y" (Seismically Adequate)
"O" (Outlier)

* "Grade" refers to "Plant Grade" as identified in the plant Safety Analysis Report.

** Equipment with anchorage location higher than 40ft. above grade.

APPENDIX C

Walkdown Checklists and Supplementary Calculations

4

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 1 - Diesel Oil Transfer Pump

PART A. EQUIPMENT DESCRIPTION

I.D. Number B

Building Outdoors (Adjacent EDG)

Manufacturer

Elevation 18'

Model Number

Other

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 1/2" ϕ 4 Bolts
5. Are nuts present and apparently tight on all bolts? YES

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? Yes
   a. SRT Judgment ✓
   b. URS Tables
   c. ANCHOR Program
   d. Other (explain) ~~Review rebar & Bolt depth in Drawings~~
2. Concerns (if any) Coeff of friction of .4

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE for this area.

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/4/90

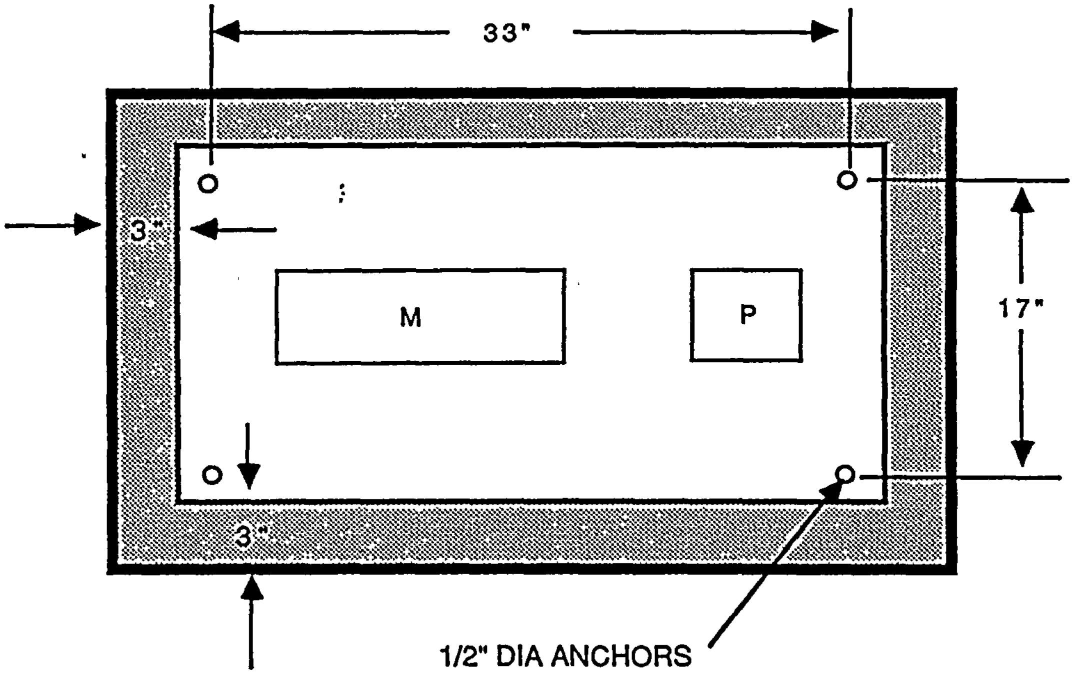
NAME John W Reed DATE 4/5/90

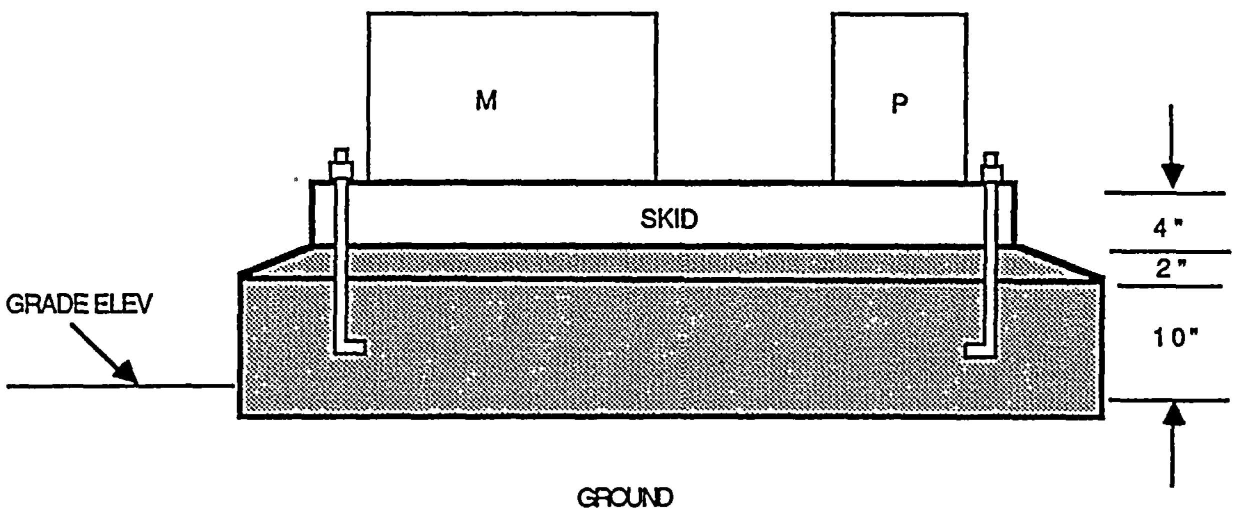
NAME John D. Stevenson DATE 4/5/90

ITEM 1 DIESEL OIL TRANSFER PUMP - B

SRT JUDGEMENT WAS THAT THE ANCHORAGE EXCEEDED DEMAND. IF CALCULATIONS WERE TO BE PERFORMED A COEFFICIENT OF FRICTION OF .4 WAS TO BE USED.

AS-FOUND FIELD CONDITION





DIESEL FUEL OIL TRANSFER PUMP
SEISMIC MOUNTING WORKSHEET

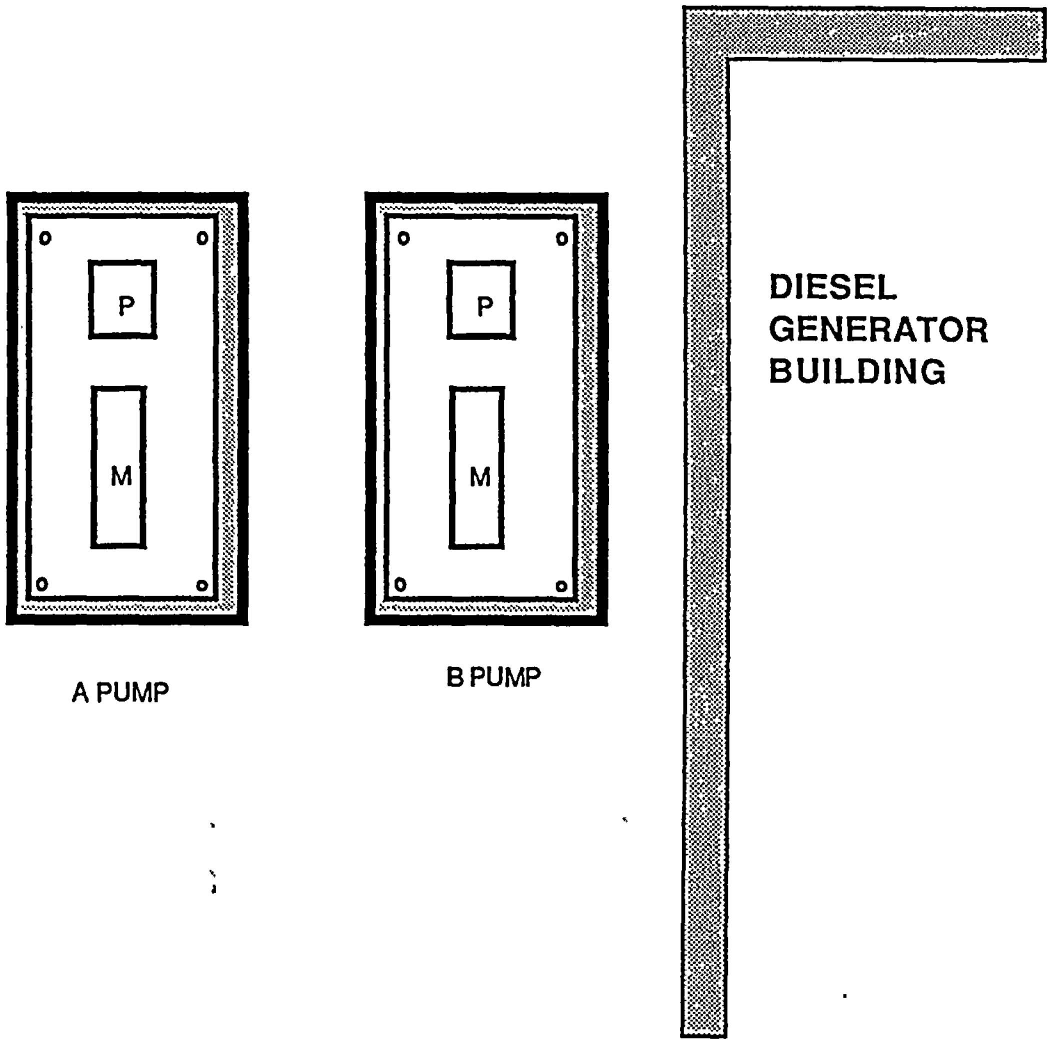
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: DIESEL FUEL OIL TRANS PUMP
DATE: MAR 27, 1990 DWG BY: R GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT HAVE ANY
SEISMIC INTERACTIONS CONCERNS



DIESEL FUEL OIL TRANSFER PUMP
SKID MOUNTED PUMP
SEISMIC INTERACTION WORK SHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: DIESEL FUEL OIL TRANS PUMP
DATE: APR 14, 1990 DWG BY: R. GOULDY

(51)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 2 - Charging Pump

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3B — Building RAB

Manufacturer ______ — Elevation 18'

Model Number ______ — Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number 4 3/4"φ Bolts
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   - a. SRT Judgment ✓
   - b. URS Tables ____
   - c. ANCHOR Program ____
   - d. Other (explain) ____ Reviewed Design drawings
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

______

APPROVED BY SRT

NAME John D. Stevenson DATE 4/4/90

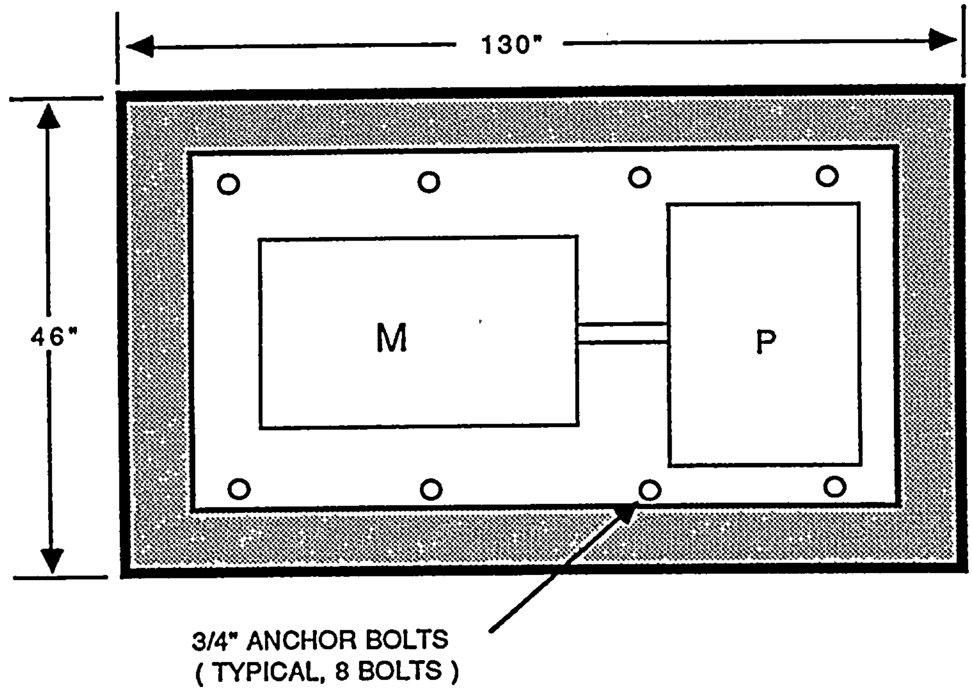
NAME Robert P. Kennedy DATE 4/4/90

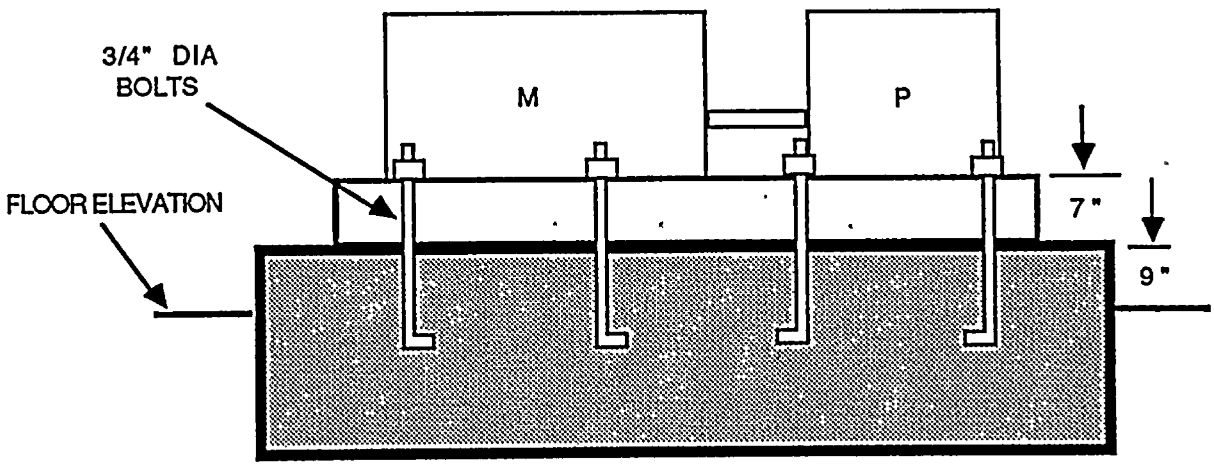
NAME John W. Reed DATE 4/5/90

ITEM 2 CHARGING PUMP 3B

NO CONCERNS, DESIGN DRAWINGS WERE REVIEWED BY SRT

AS-FOUND FIELD CONDITION





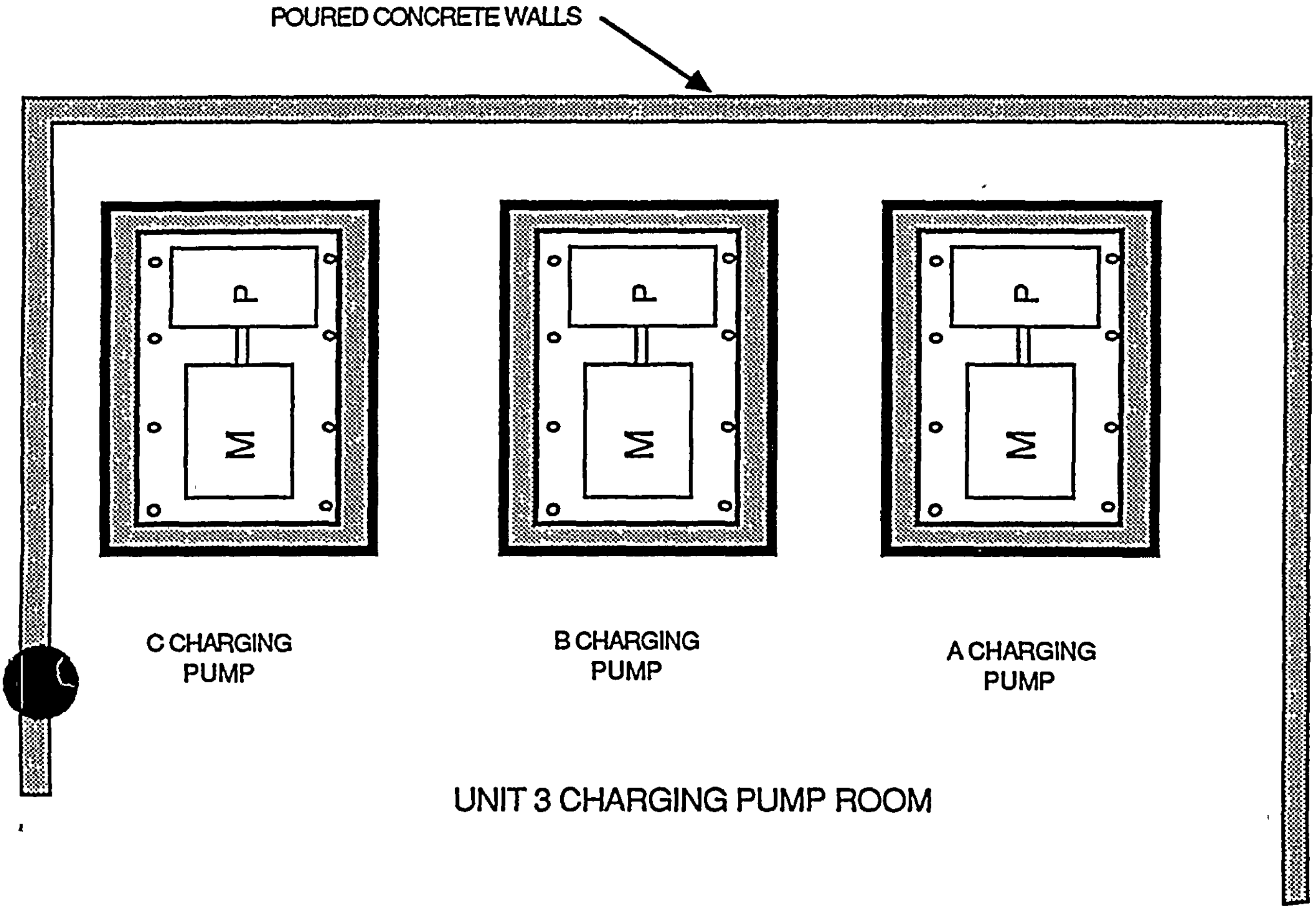
3B CHARGING PUMP
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B CHARGING PUMP
DATE: APR 15, 1990 DWG BY: R.GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT HAVE ANY SEISMIC INTERACTIONS CONCERNS FOR THIS PUMP ARRANGEMENT.

3B CHARGING PUMP
SEISMIC INTERACTIONS WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B CHARGING PUMP
DATE: APR 14, 1990 DWG BY: R. GOULDY

52

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 3 - Charging Pump

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4B Building RAB

Manufacturer ______ Elevation 18'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number 4 3/4" Dia bolts each side
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ✓
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Reviewed Design Drawings
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

______

APPROVED BY SRT

NAME John D. Stevenson DATE 4/4/90

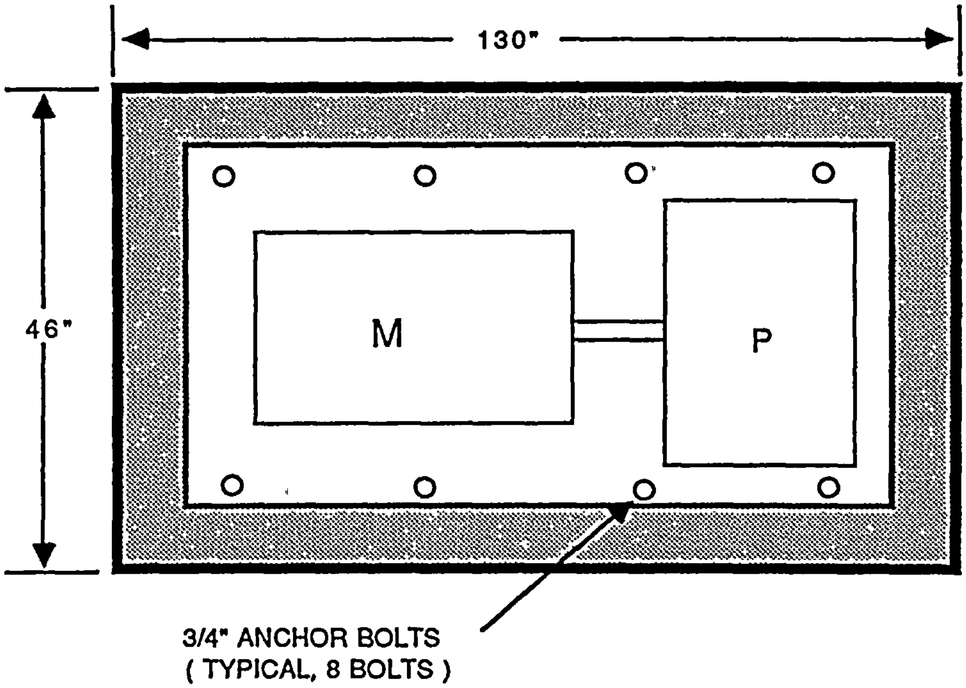
NAME Robert P. Kennedy DATE 4/4/90

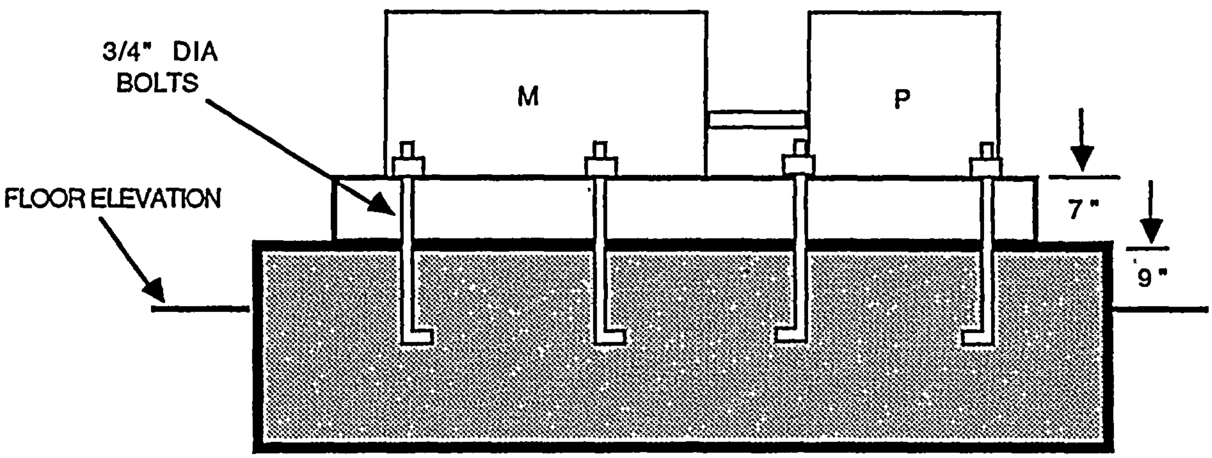
NAME John W. Reed DATE 4/5/90

ITEM 3 CHARGING PUMP 4B

NO CONCERNS, DESIGN DRAWINGS WERE REVIEWED BY SRT

AS-FOUND FIELD CONDITION





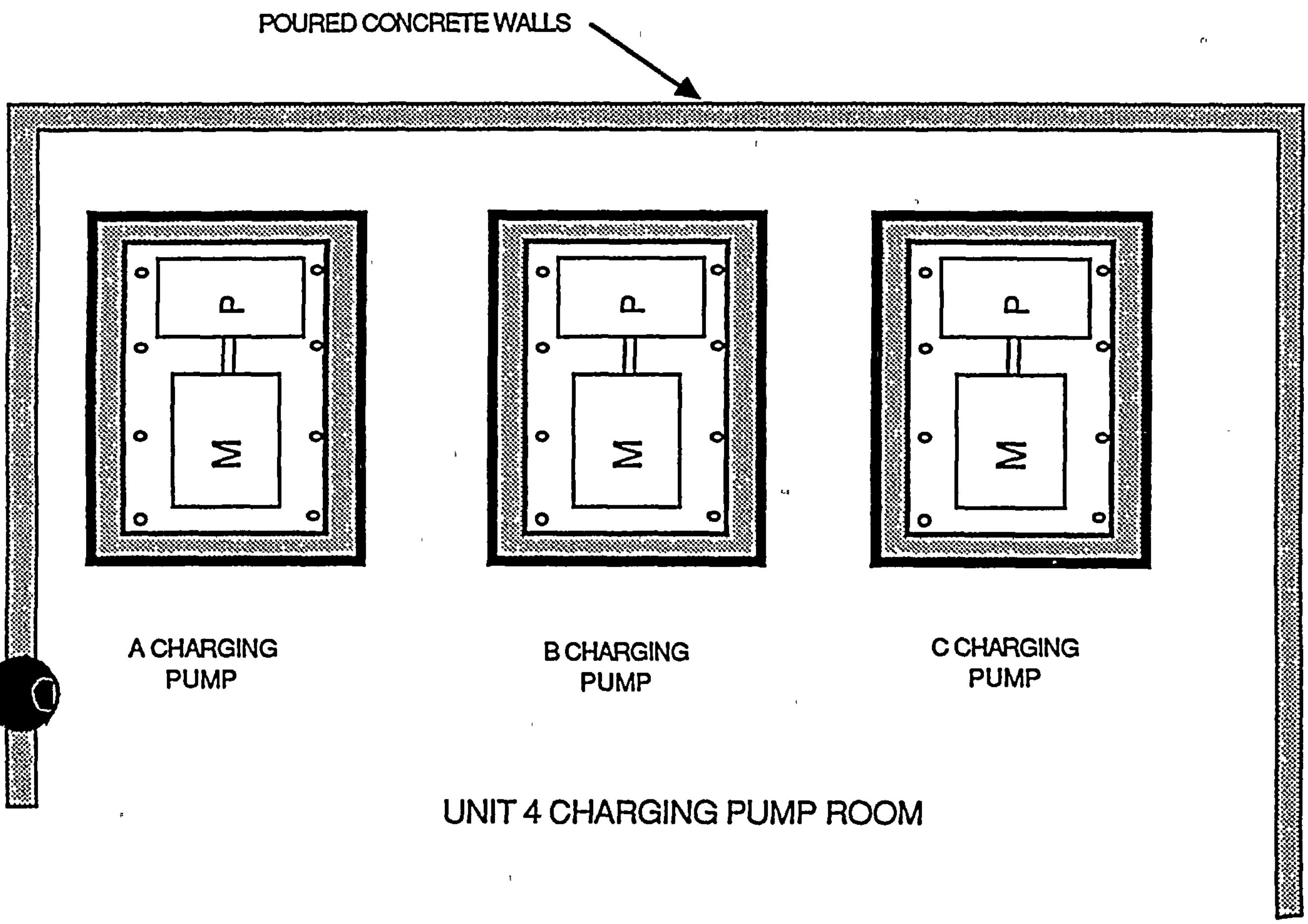
4B CHARGING PUMP
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: 4B CHARGING PUMP	
DATE: APR 15, 1990	DWG BY: R GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT HAVE ANY SEISMIC INTERACTIONS CONCERNS FOR THIS PUMP ARRANGEMENT.

4B CHARGING PUMP
SEISMIC INTERACTIONS WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B CHARGING PUMP
DATE: APR 14, 1990 DWG BY: R. GOULDY

(46)

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 4 - Component Cooling Water pump

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3B — Building RAB

Manufacturer ______ — Elevation 18'

Model Number ______ — Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number 5- 7/8"ϕ EACH SIDE
5. Are nuts present and apparently tight on all bolts? yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ✓
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Reviewed detail & Calculation. Review of calculation performed found it was acceptable, CALC. C-SJ183-11 (SEE ATTACHED NOTES)
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

______

APPROVED BY SRT

NAME Robert P. Kennedy — DATE 4/5/90

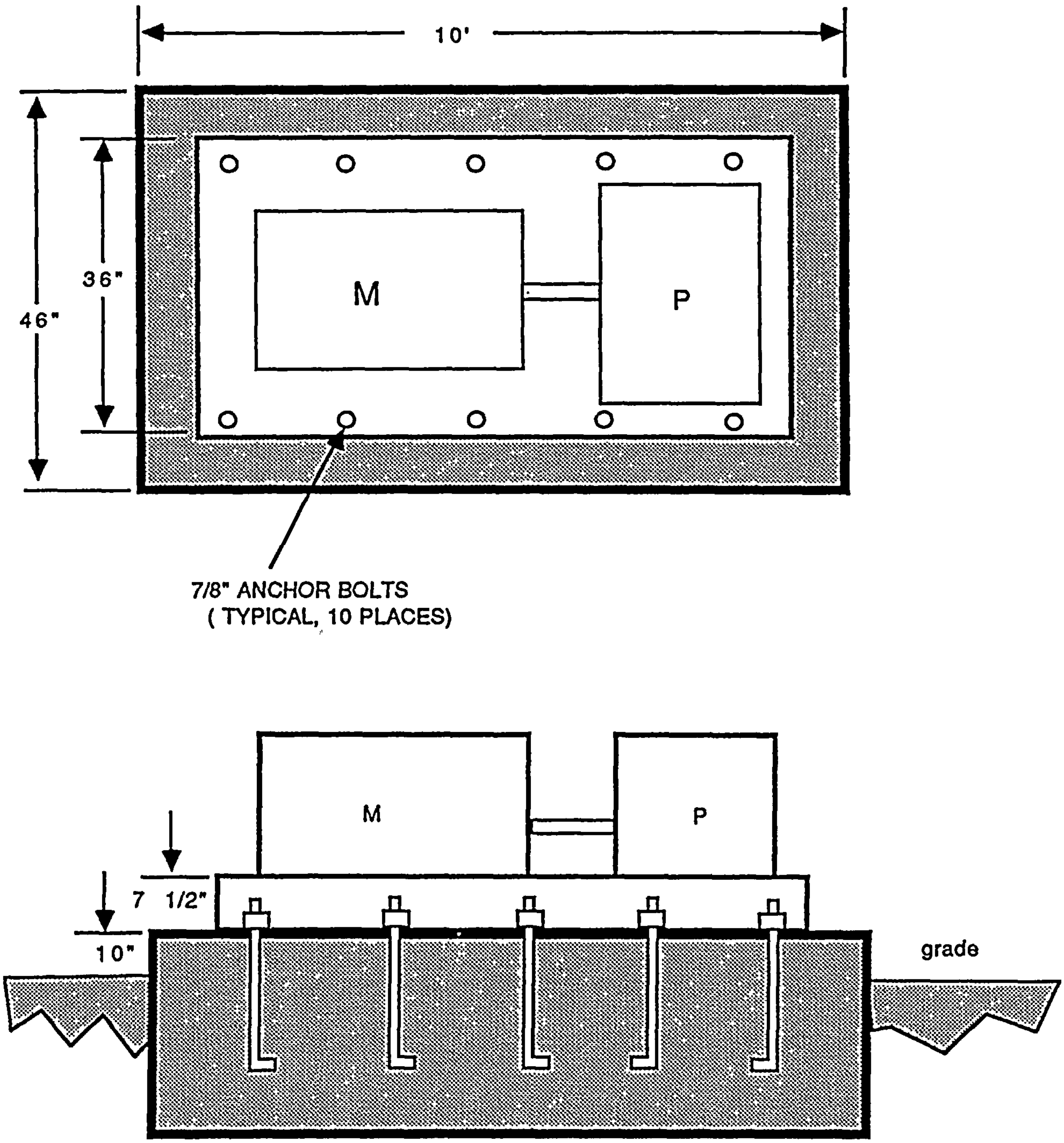
NAME John W Reed — DATE 4/5/90

NAME John D. Stevenson — DATE 4/5/90

ITEM 4 COMPONENT COOLING WATER PUMP - 3B

NO CONCERNS, DESIGN DRAWINGS AND CALCULATIONS REVIEWED BY SRT.

AS-FOUND FIELD CONDITION

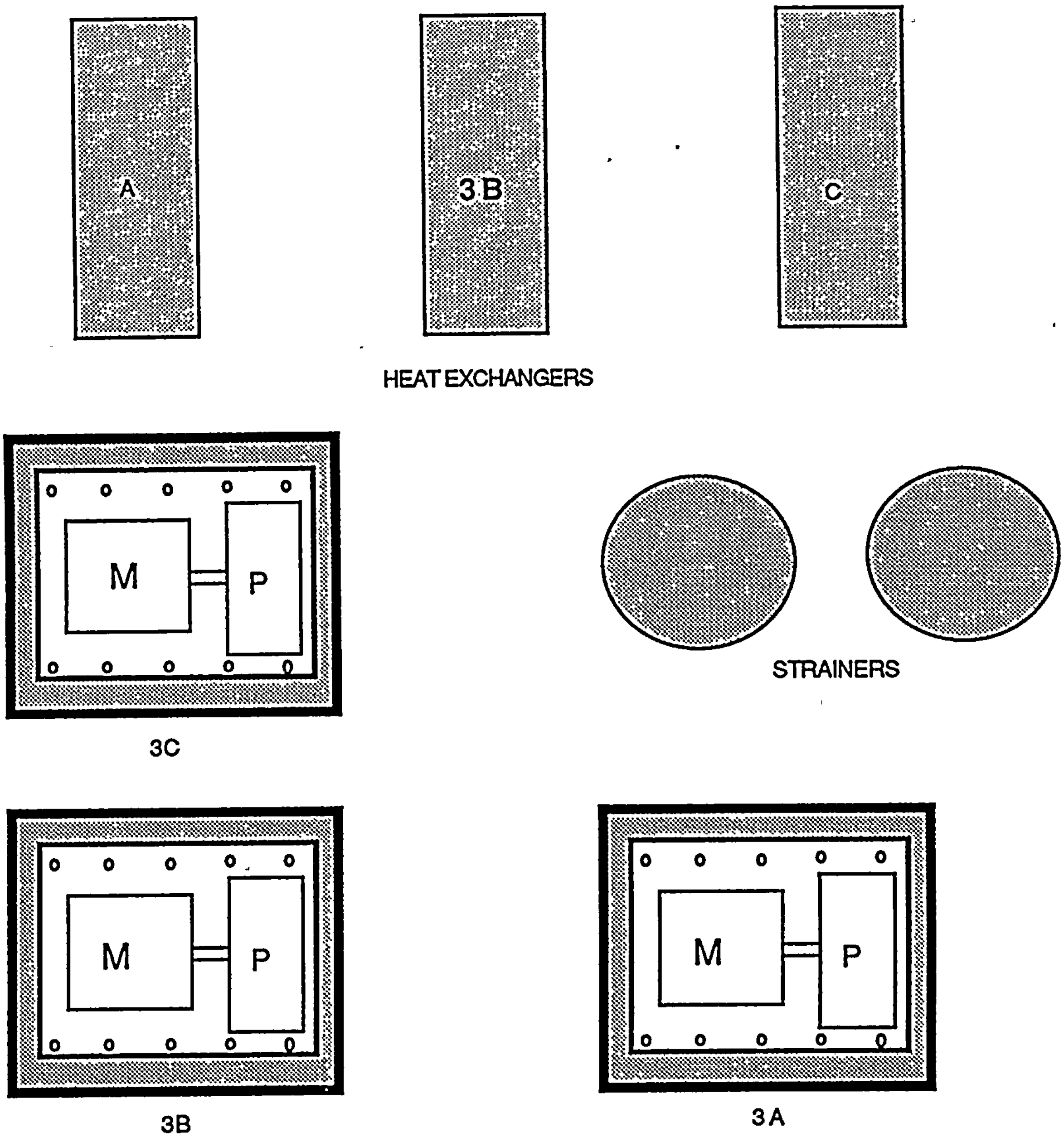


3B CCW PUMP
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B CCW PUMP
DATE: MAR 22, 1990 DWG BY: R GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT HAVE ANY SEISMIC INTERACTIONS CONCERNS WITH THIS PUMP ARRANGEMENT. THE STEEL GRATING ABOVE WAS REVIEWED AND FOUND TO BE BOLTED TO THE STEEL I-BEAMS

3B CCW PUMP
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B CCW PUMP
DATE: MAR 22, 1990 DWG BY: R. GOULDY

FIN ITEMS 4,5

STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

SUBJECT: Turkey Point JOB No. 90C1585 SHEET 1 OF 1

CCW Pump
Items 4 & 5

REVISIONS: WD 4/6/90

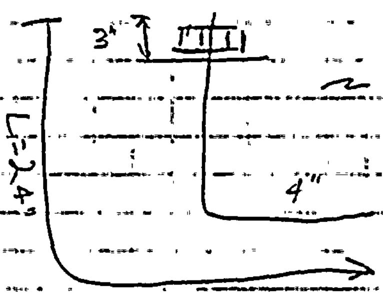
Reviewed Calc # C-SJ183-11

Wt Pump + motor = 13350 #

El 18' H = 0.15g V = 0.10g

Calculated Bolt Loads – used circular interaction

Anchor Bolt Typ AB63 L = 24" B = 4"
T = 3"



~ 7/8" Ø Rept Used T_u = 15.0^k
V_u = 7.8^k

Equivalent L = 24 − 3 − 9.75 + 4(7/8) = 14.75"

Grout Pad = 9½"

$$T_u = 14.75 \pi \left(\frac{7}{8}\right)(1.2)\frac{25.4^2}{4.45} = 11.8^k$$
(+ 9¾)

P26 + 28

T_{Demand} = 9.14 < 11.8^k

V_{Demand} = 3.93 < 0.4 T_u Shear Friction OK

48

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT: Item 5 - Component Cooling Water Pump

PART A. EQUIPMENT DESCRIPTION

I.D. Number	4B	Building	RAB
Manufacturer		Elevation	18'
Model Number		Other	

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments ____
3. Length, size, number, and soundness of welds ~~10 - 7/8" ϕ~~
4. Anchor bolt type, size and number 10 - 7/8" ϕ Bolts
5. Are nuts present and apparently tight on all bolts? ____

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ✓
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Perform pull out bonding calculation. CALC. C-SJ183-11 (SEE ATTACHED NOTES) Review of Calculation performed and was accepted
2. Concerns (if any) ____

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

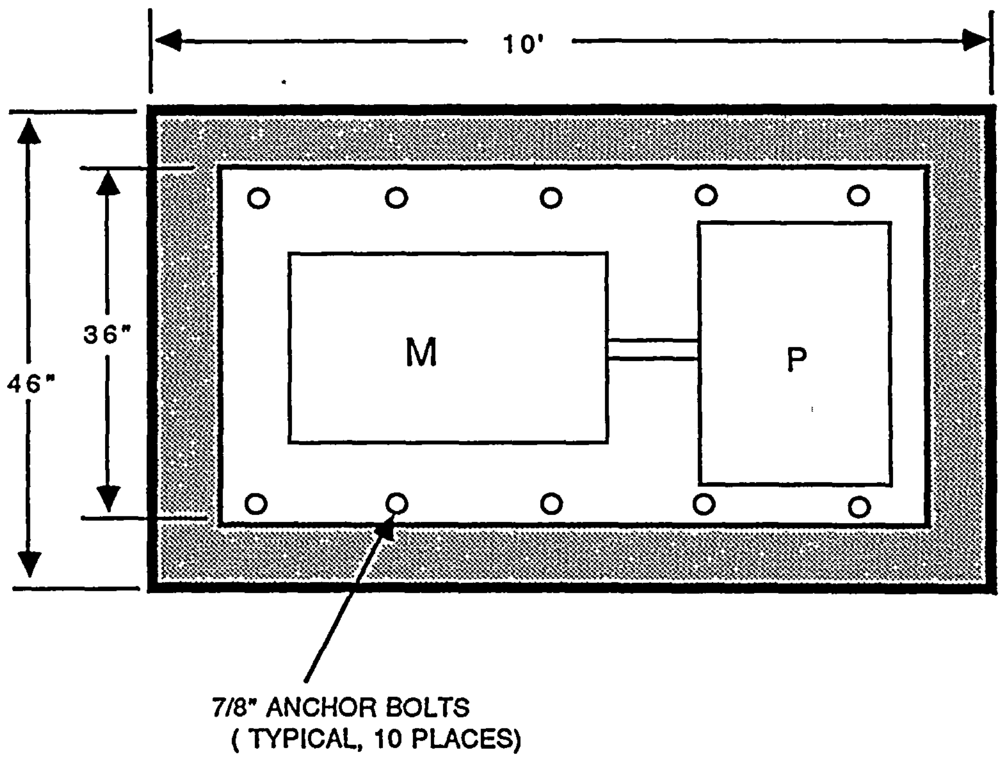
APPROVED BY SRT

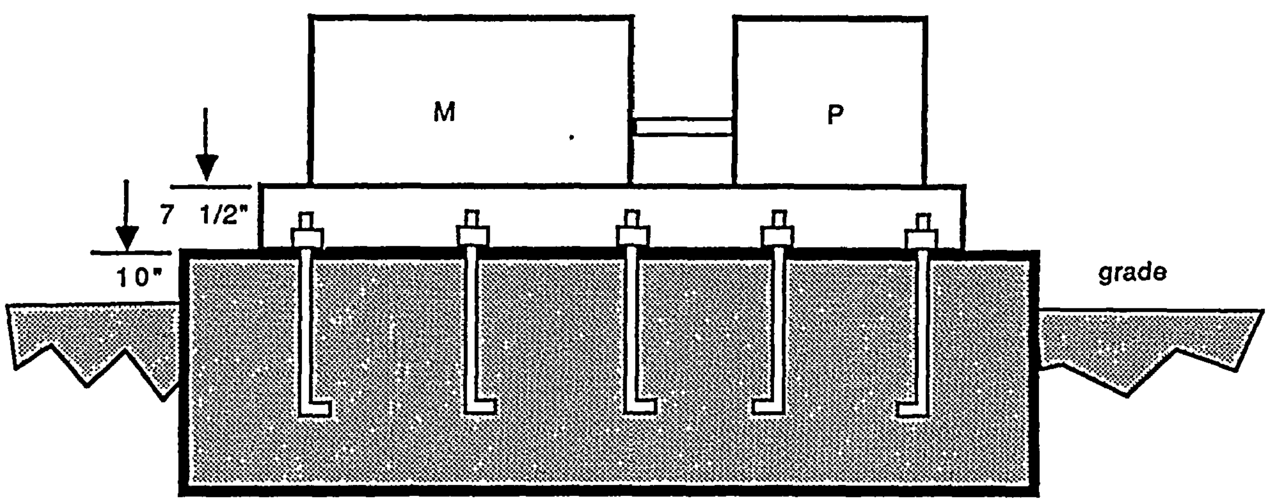
NAME	Robert P. Kennedy	DATE	4/5/90
NAME	John W. Reed	DATE	4/5/90
NAME	John D. Stevenson	DATE	4/5/90

ITEM 5 COMPONENT COOLING WATER PUMP-4B

NO CONCERNS, DESIGN DRAWINGS AND CALCULATIONS WERE REVIEWED BY THE SRT. PULL-OUT CALCULATION PERFORMED AT THE SITE AND WAS FOUND to be acceptable FOR THIS PUMP ANCHOR.

AS-FOUND FIELD CONDITION



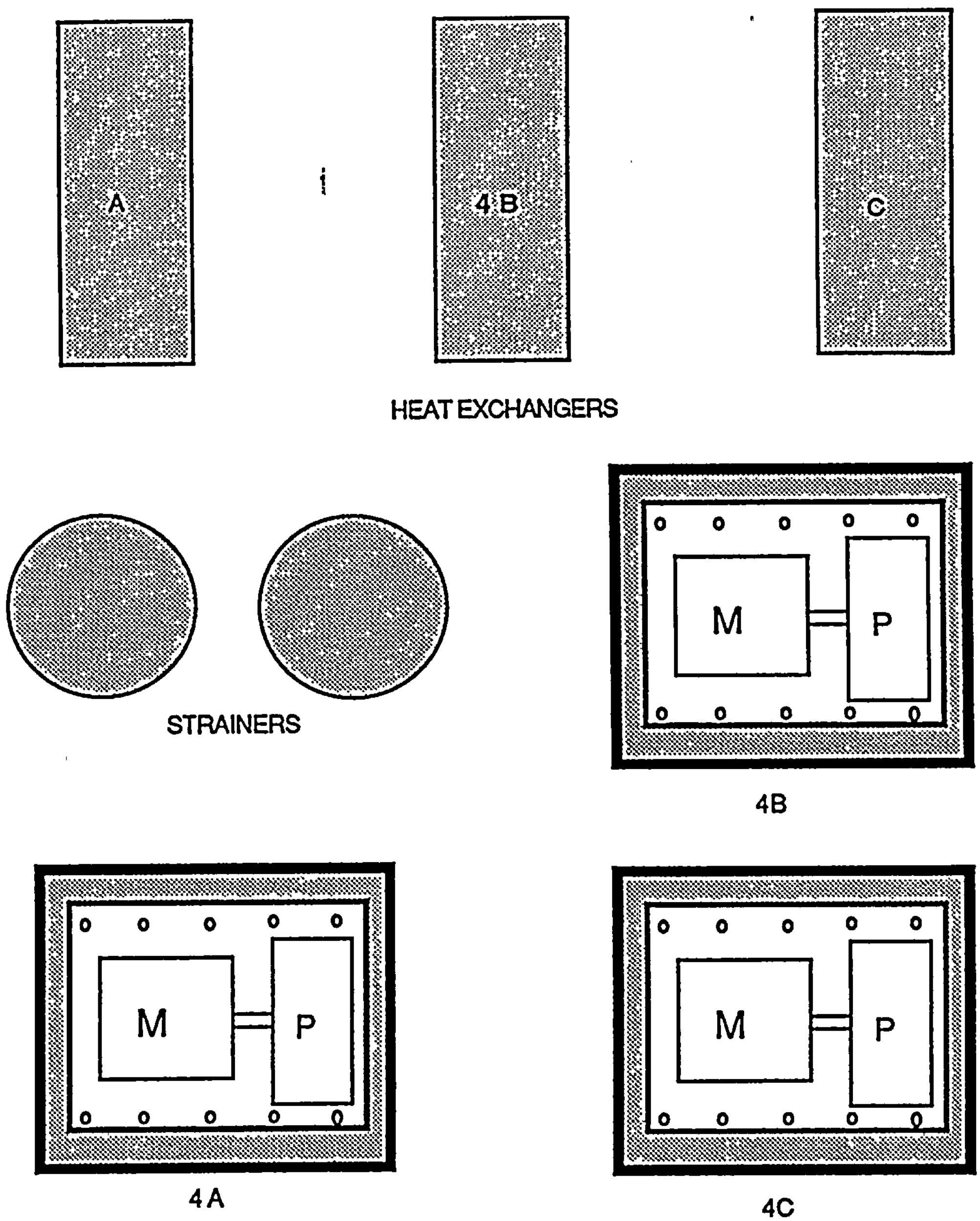


4B CCW PUMP
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B CCW PUMP
DATE: MAR 22, 1990 DWG BY: R GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT HAVE ANY SEISMIC INTERACTIONS CONCERNS WITH THIS PUMP ARRANGEMENT. THE STEEL GRATING ABOVE WAS REVIEWED AND FOUND TO BE BOLTED TO THE STEEL I-BEAMS

4B CCW PUMP
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B CCW PUMP
DATE: MAR 22, 1990 DWG BY: R. GOULDY

(1)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT: Item 6 - Intake Cooling Water Pump

PART A. EQUIPMENT DESCRIPTION

I.D. Number: 3B
Building: Intake Structure
Manufacturer: Louis Allis
Elevation: 18' (Motor deepwell pump)
Model Number: ____
Other: ____

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments: good.
3. Length, size, number, and soundness of welds: N/A Bolted
4. Anchor bolt type, size and number: 1 1/4" 4 TGMC 54"OC
5. Are nuts present and apparently tight on all bolts? TIGHT

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) ~~Acceptance~~ UPON Review of DRAWINGS for embedment length.
2. Concerns (if any)
   - CHECK SHAFT LENGTH (27')
   - SHEAR calculation.
   - SHAFT CASING ANALYSIS

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) OVERHEAD Crane LOCKED

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

ITEM 6 CONSIDERED OUTLIER BECAUSE OF CONCERNS NOTED ON ATTACHED PAGE.

APPROVED BY SRT

NAME: Robert P. Kennedy DATE: 9/2/91
NAME: John W Reed DATE: 9/2/91
NAME: John D. Stevenson DATE: 9/2/91

ITEM 6   INTAKE COOLING WATER PUMP - 3B

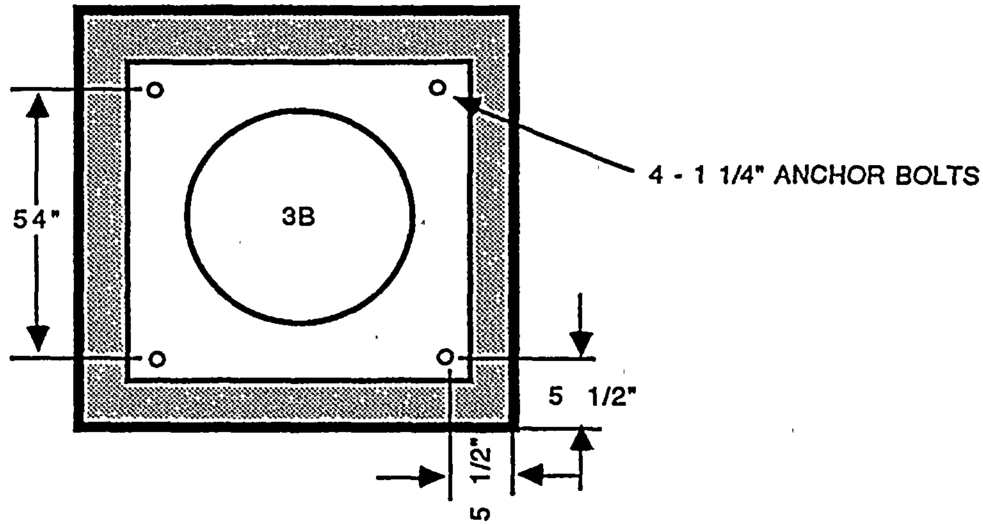
THE SRT WANTED TO REVIEW THE ANCHORAGE DRAWINGS & CHECK EMBEDMENT LENGTH.

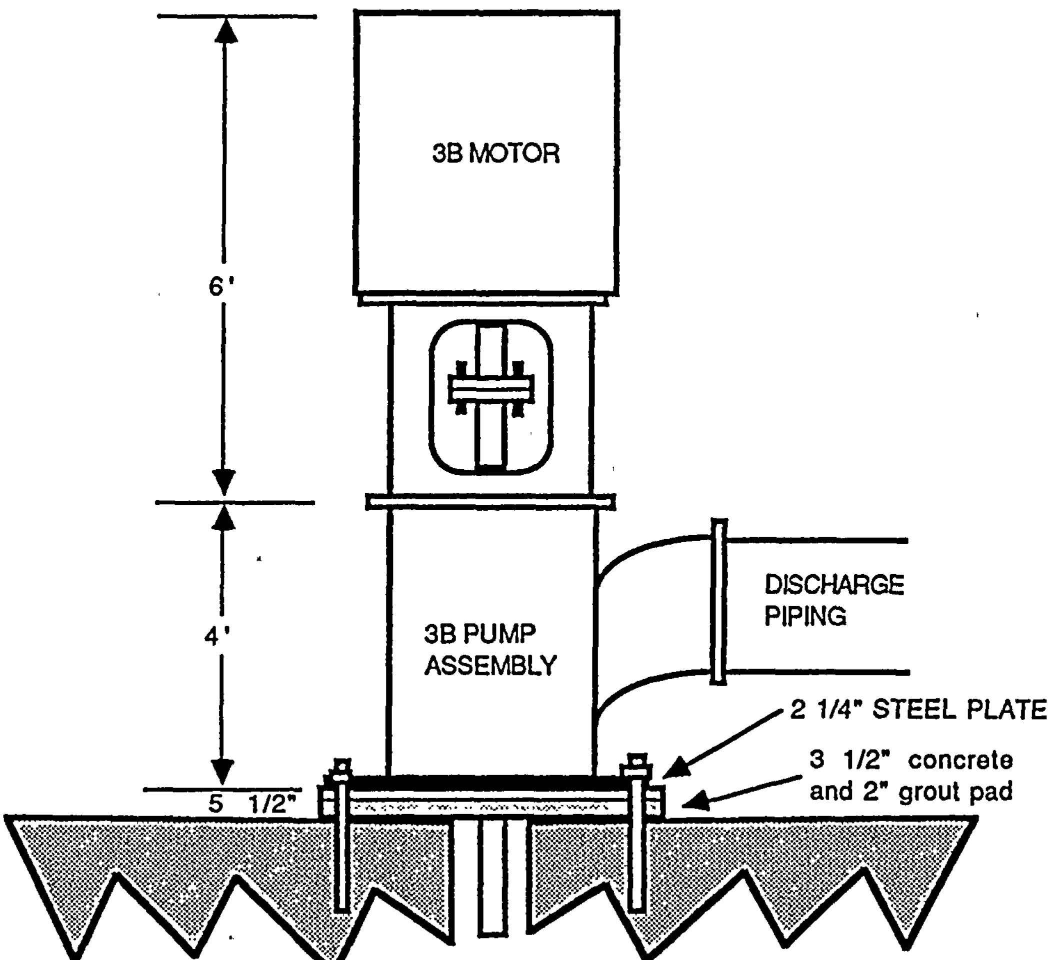
CONCERNS: • CHECK PUMP SHAFT LENGTH & DETERMINE IF SHAFT HAS SUPPORTS OR BEARINGS - SHAFT LENGTH = 27'

- PERFORM SHEAR ANCHORAGE (BURSTING) CALCULATION FOR PUMP
- CHECK STRESSES FOR CAST IRON FITTINGS ON PUMP
- CONFIRM ADEQUACY OF WESTINGHOUSE CALCULATION FOR THE FOSSIL UNITS STACK TO INSURE IT WON'T FALL ON PUMPS DURING AN EARTHQUAKE.

THE SRT NOTED THE SEISMIC INTERACTION CONCERN FOR THE OVERHEAD CRANE. THE CONCERN WAS RESOLVED BY REVIEWING WHERE THE CRANE IS PARKED AND STORED WHEN NOT IN USE. THIS AREA IS WELL CLEAR OF ALL THE PUMPS.

AS-FOUND FIELD CONDITION





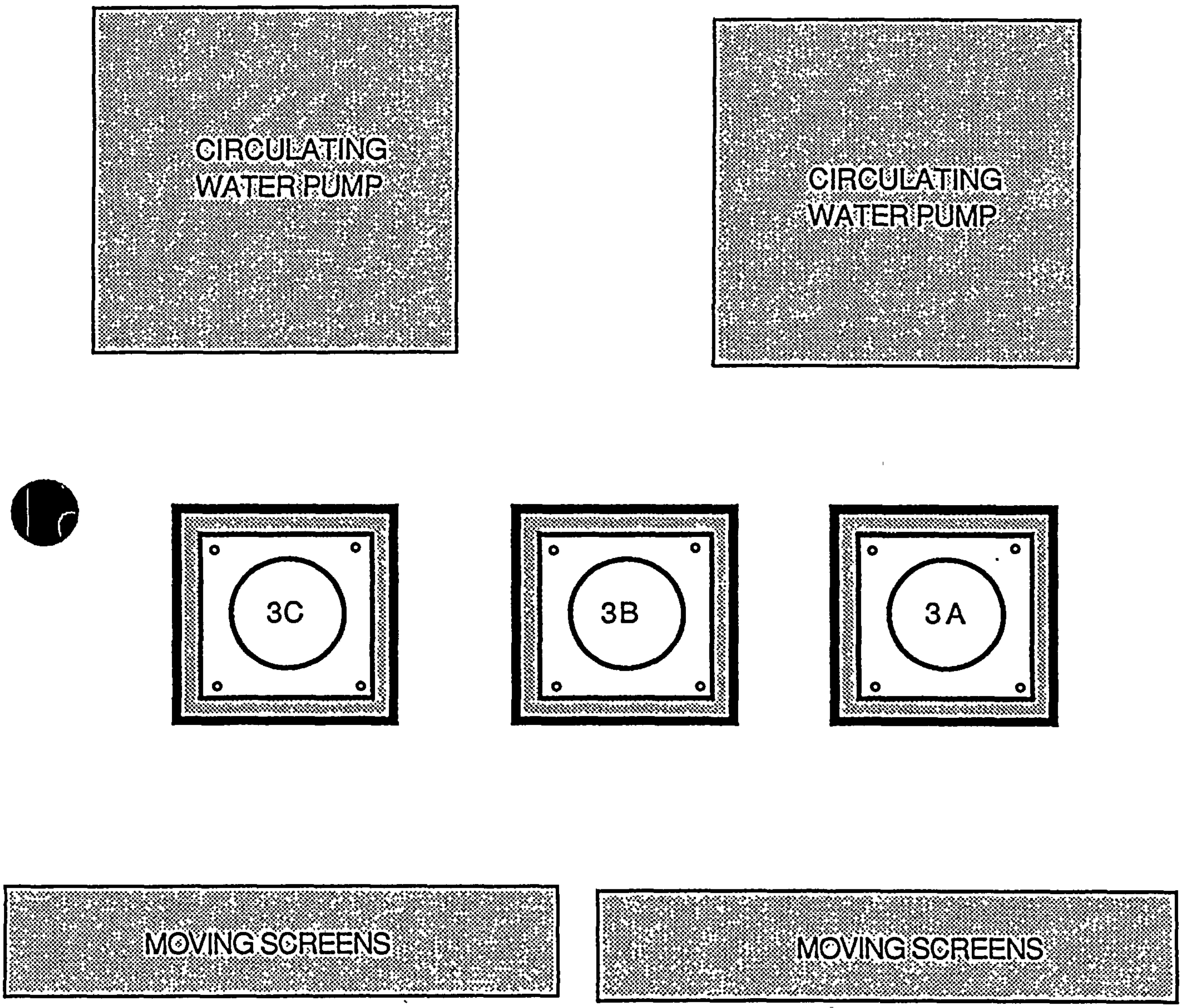
3B ICW PUMP SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B INTAKE COOLING WATER PUMP
DATE: MAR 22, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD NOTES



3B ICW PUMP SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B INTAKE COOLING WATER PUMP
DATE: MAR 22, 1990 DWG BY: R. GOULDY

(2)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 7 - Intake Cooling Water Pump

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4B
Building Intake Structure
Manufacturer Louis Allis
Elevation 18' (Motor Deepwell Pump)
Model Number ______
Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments CRACKS IN GROUT LAYER
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 1¼" 4 Places
5. Are nuts present and apparently tight on all bolts? YES

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) CHECK ANCHOR BOLT EMBEDMENT, SHAFT LENGTH. CHECK BOLT CAPACITY thru grout Layer of raised pad. CHECK fitting for material (CAST STEEL). ANCHOR BOLT EMBEDMENT CHECKED AND ACCEPTED.
2. Concerns (if any)

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) OVERHEAD CRANE IS Parked Away from Pumps

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

ITEM 7 CONSIDERED OUTLIER BECAUSE OF CONCERNS NOTED ON ATTACHED PAGE.

APPROVED BY SRT

NAME Robert P. Kennedy DATE 9/2/91
NAME John W. Reed DATE 9/2/91
NAME Jalen D. Stevenson DATE 9/2/91

ITEM 7: INTAKE COOLING WATER PUMP -4B

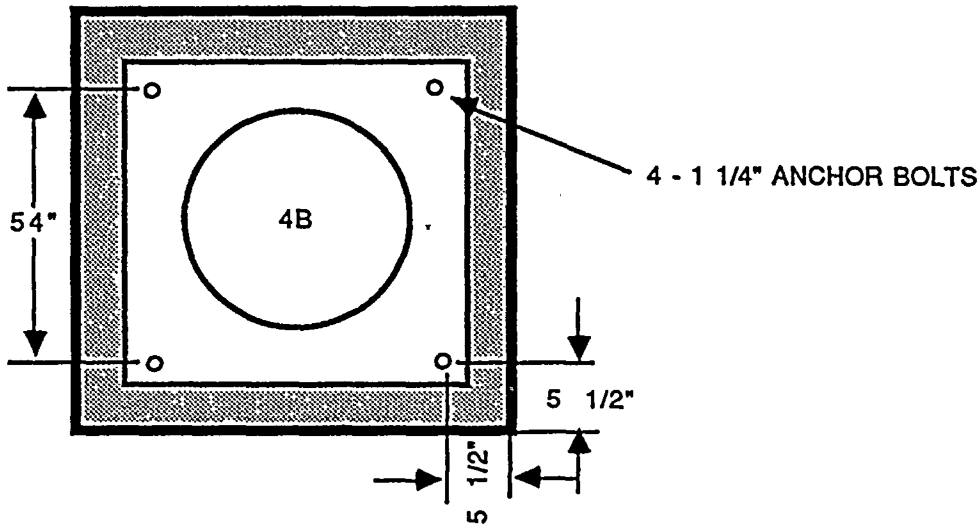
THE SRT WANTED TO REVIEW THE ANCHORAGE DRAWINGS & CHECK EMBEDMENT LENGTH.

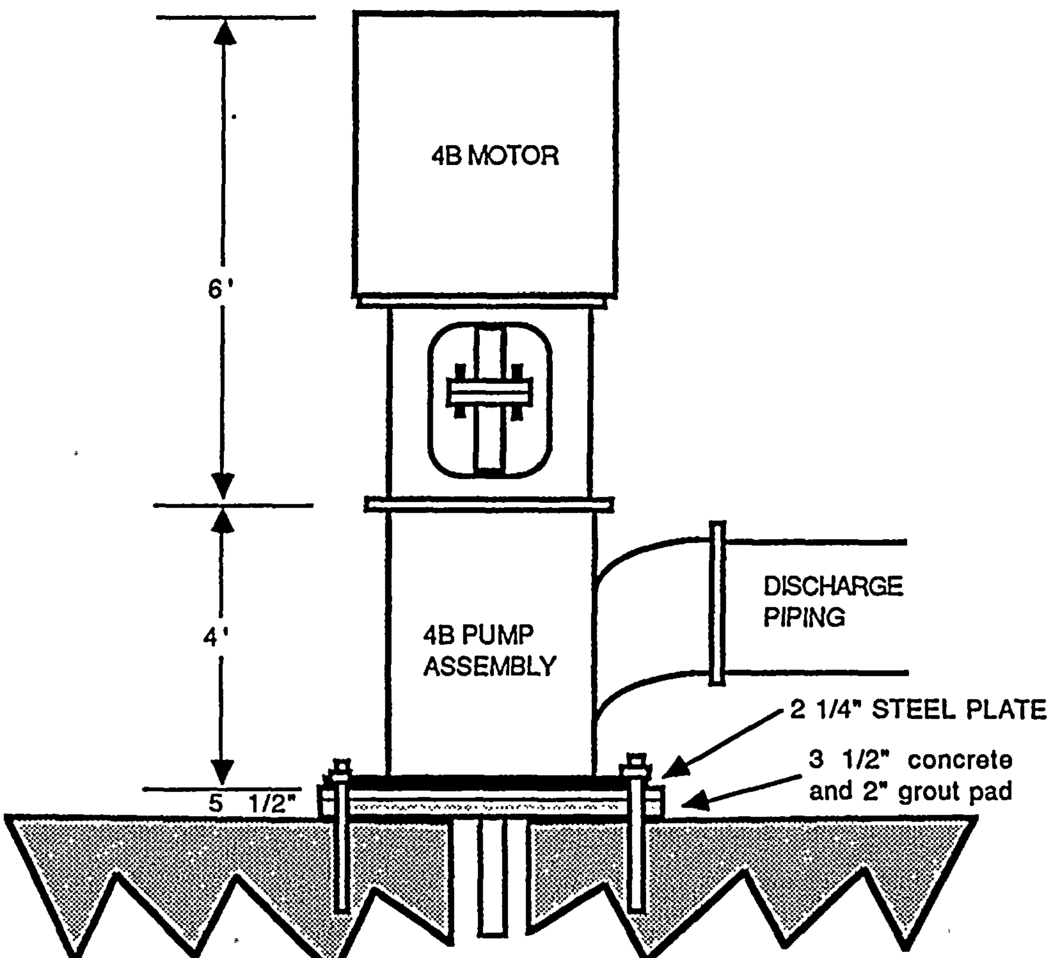
CONCERNS: • CHECK PUMP SHAFT LENGTH & DETERMINE IF SHAFT HAS SUPPORTS OR BEARINGS – SHAFT LENGTH = 27

- PERFORM SHEAR ANCHORAGE (BURSTING) CALCULATION FOR PUMP
- CHECK STRESSES FOR CAST IRON FITTINGS ON PUMP
- CONFIRM ADEQUACY OF WESTINGHOUSE CALCULATION FOR THE FOSSIL UNITS STACK TO INSURE IT WON'T FALL ON PUMPS DURING AN EARTHQUAKE.

THE SRT NOTED THE SEISMIC INTERACTION CONCERN FOR THE OVERHEAD CRANE. THE CONCERN WAS RESOLVED BY REVIEWING WHERE THE CRANE IS PARKED AND STORED WHEN NOT IN USE. THIS AREA IS WELL CLEAR OF ALL THE PUMPS.

AS-FOUND FIELD CONDITION





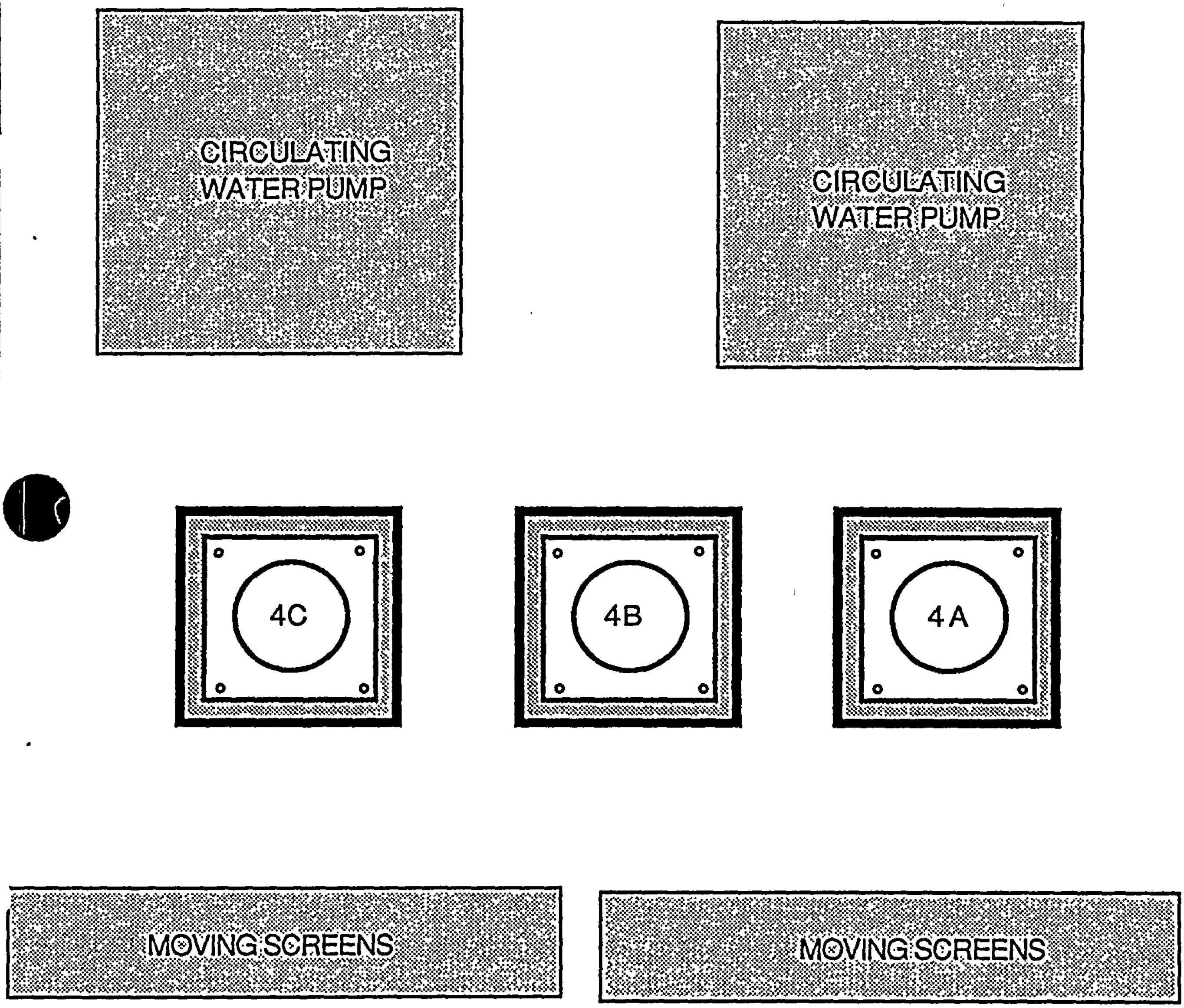
4B ICW PUMP SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B INTAKE COOLING WATER PUMP
DATE: MAR 22, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD NOTES



4B ICW PUMP SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B INTAKE COOLING WATER PUMP
DATE: MAR 22, 1990 DWG BY: R. GOULDY

(53)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 8 - Boric Acid Transfer Pump

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3B

Building RAB

Manufacturer ______

Elevation 18'

Model Number ______

Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments ______
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number 6 1/2" Φ Anchor Bolts
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Drawings for installation Reviewed
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME John D. Stevenson DATE 4/4/90

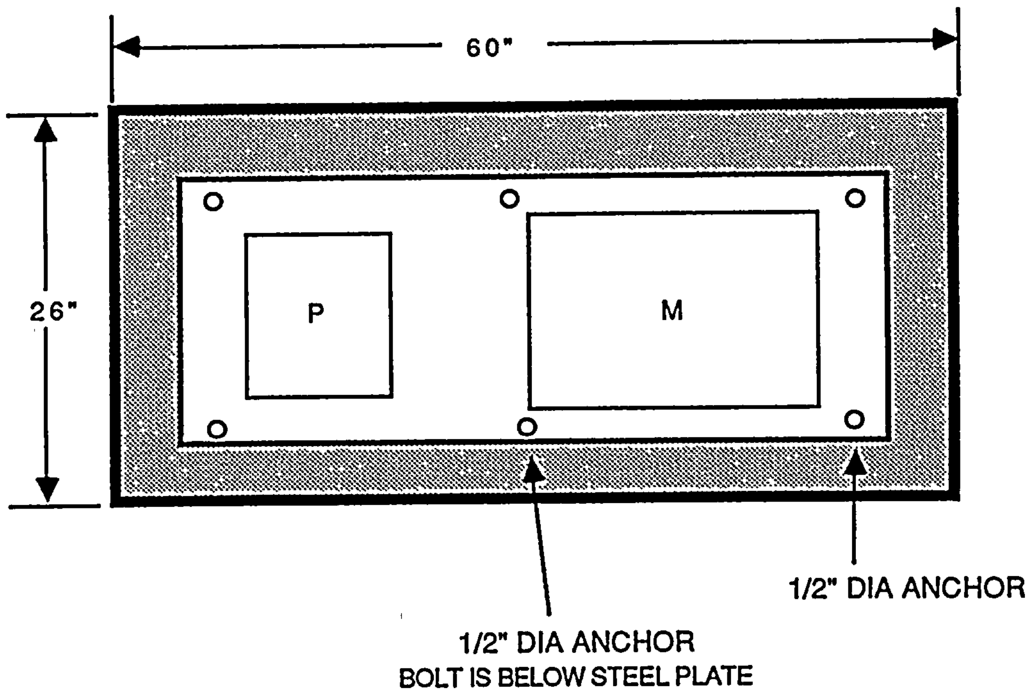
NAME Robert J. Kennedy DATE 4/4/90

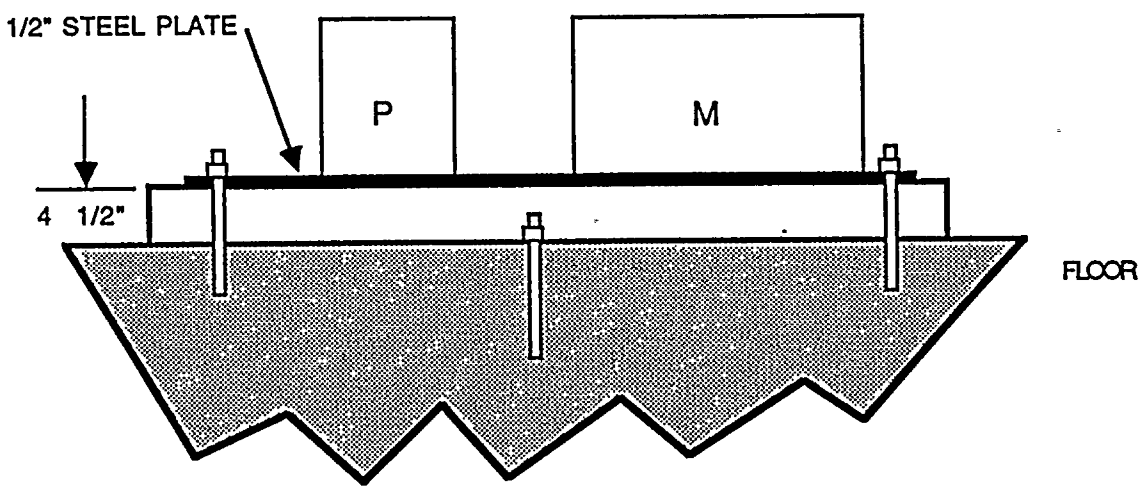
NAME John W. Reed DATE 4/5/90

ITEM 8 BORIC ACID TRANSFER PUMP 3B

NO CONCERNS, DESIGN DRAWINGS REVIEWED. IN THE FIELD DURING THE WALKDOWN.

AS-FOUND FIELD CONDITION





3B BORIC ACID TRANSFER PUMP
SEISMIC MOUNTING WORKSHEET

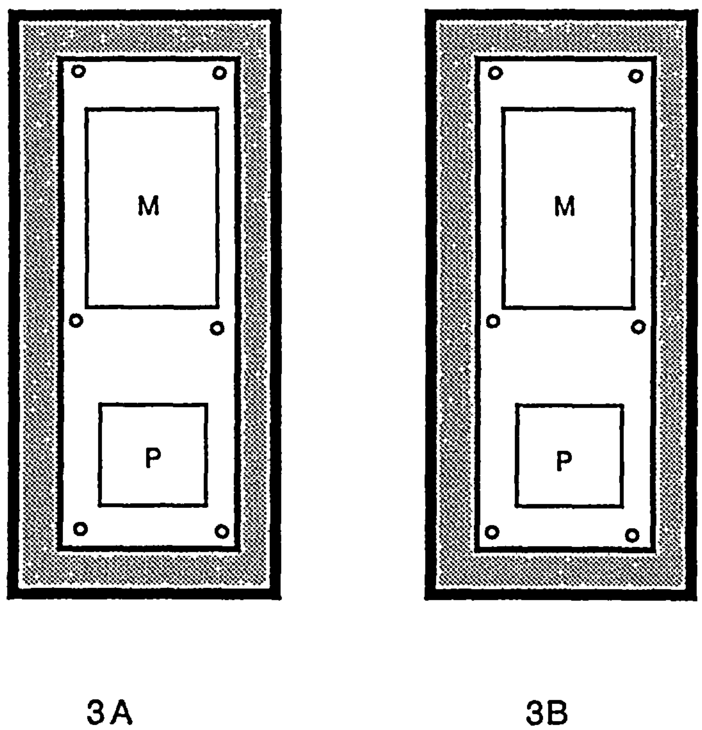
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B BORIC ACID TRANS PUMP
DATE: MAR 22, 1990 DWG BY: R GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT HAVE ANY SEISMIC INTERACTIONS CONCERNS WITH THIS PUMP ARRANGEMENT. THE BORIC ACID STORAGE TANKS ARE LOCATED ABOVE THESE PUMPS AND WILL BE ADDRESSED ON THEIR WALKDOWN ITEM CHECK SHEET. DUE TO LOCAL CONTAMINATION, THESE PUMPS WERE REVIEWED FROM A DISTANCE.



3B BORIC ACID TRANSFER PUMP
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B BORIC ACID TRANS PUMP
DATE: MAR 22, 1990 DWG BY: R. GOULDY

54

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 9 - Boric Acid Transfer Pump

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4B | Building RAB

Manufacturer ______ | Elevation 18'

Model Number ______ | Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments ______
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number 6 1/2"ϕ Anchors
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Drawings reviewed
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

______

APPROVED BY SRT

NAME John D. Stevenson DATE 4/4/90

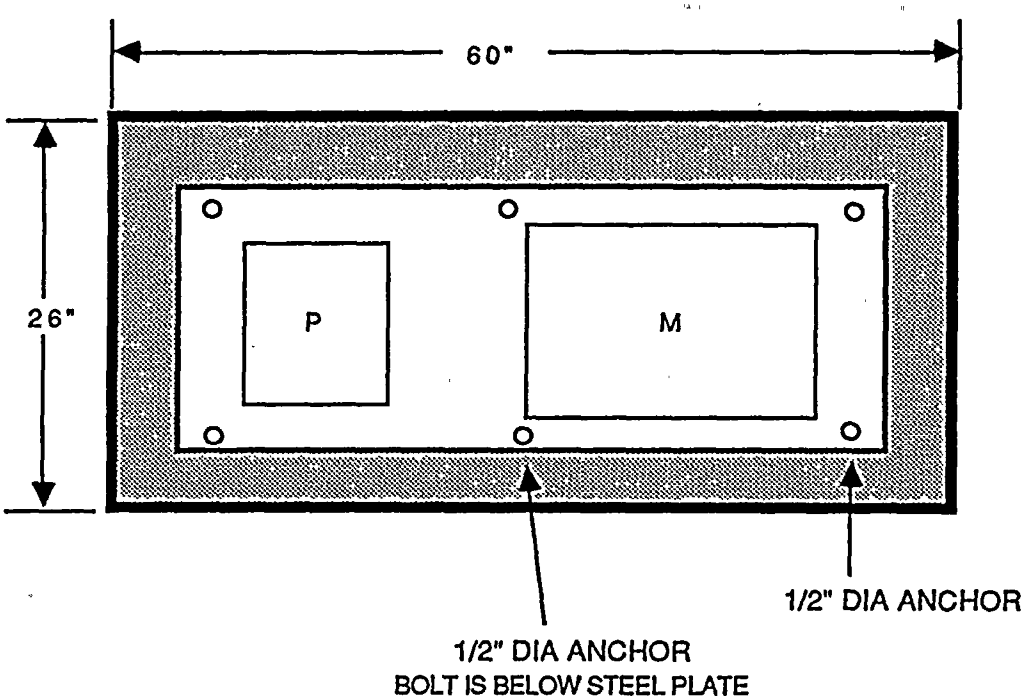
NAME Robert P. Kennedy DATE 4/4/90

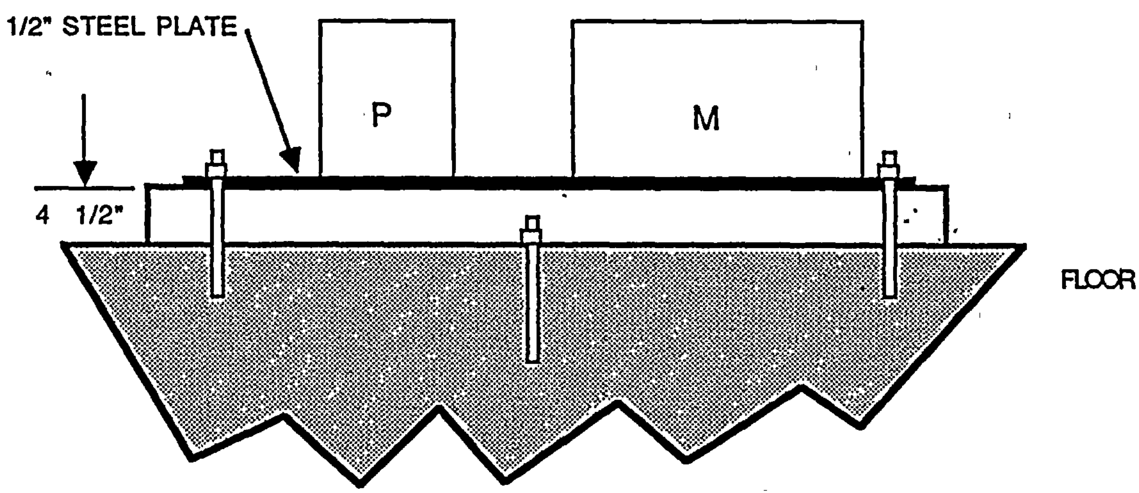
NAME John W Reed DATE 4/5/90

ITEM 9 BORIC ACID TRANSFER PUMP - 4B

NO CONCERNS.

AS-FOUND FIELD CONDITION





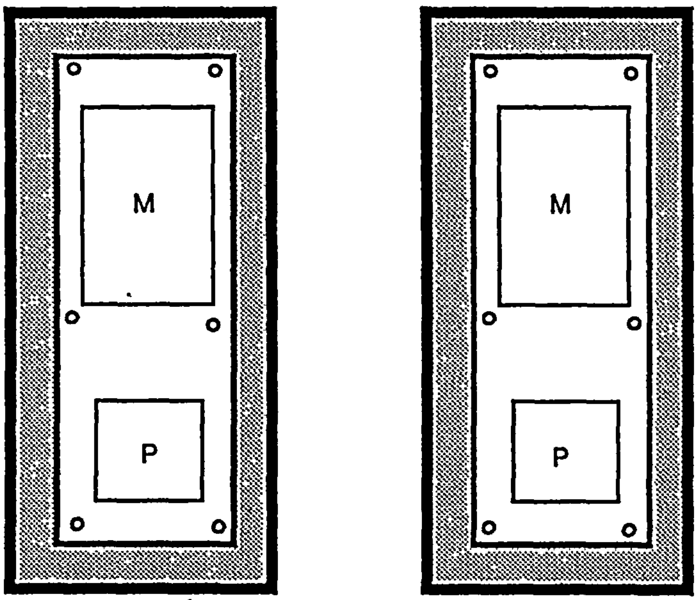
4B BORIC ACID TRANSFER PUMP
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B BORIC ACID TRANS PUMP
DATE: MAR 22, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT HAVE ANY SEISMIC INTERACTIONS CONCERNS WITH THIS PUMP ARRANGEMENT. THE BORIC ACID STORAGE TANKS ARE LOCATED ABOVE THESE PUMPS AND WILL BE ADDRESSED ON THEIR WALKDOWN ITEM CHECK SHEET. DUE TO LOCAL CONTAMINATION, THESE PUMPS WERE REVIEWED FROM A DISTANCE. THESE PUMPS HAVE THE SAME ARRANGEMENT AS THE 3A & 3B BORIC ACID TRANSFER PUMPS



4A 4B

4B BORIC ACID TRANSFER PUMP
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B BORIC ACID TRANS PUMP
DATE: MAR 22, 1990 DWG BY: R GOULDY

3

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 10 - Diesel Oil Storage Tank

PART A. EQUIPMENT DESCRIPTION

I.D. Number N/A
Building Outdoors (Adjacent EDG)
Manufacturer ______
Elevation 18'
Model Number ______
Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes x No ____
2. Condition of nearby concrete and embedments Acceptable
3. Length, size, number, and soundness of welds ~~1/4" Fillet welds~~ some top plate welds to tank are marginal good gusset welds
4. Anchor bolt type, size and number 6 - 1 1/4"
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? No.
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) ____ Review EMBED DRAWINGS
   Based on current tank anchorage calculations. Anchorage capacity controlled by top plate of chair
2. Concerns (if any) ______

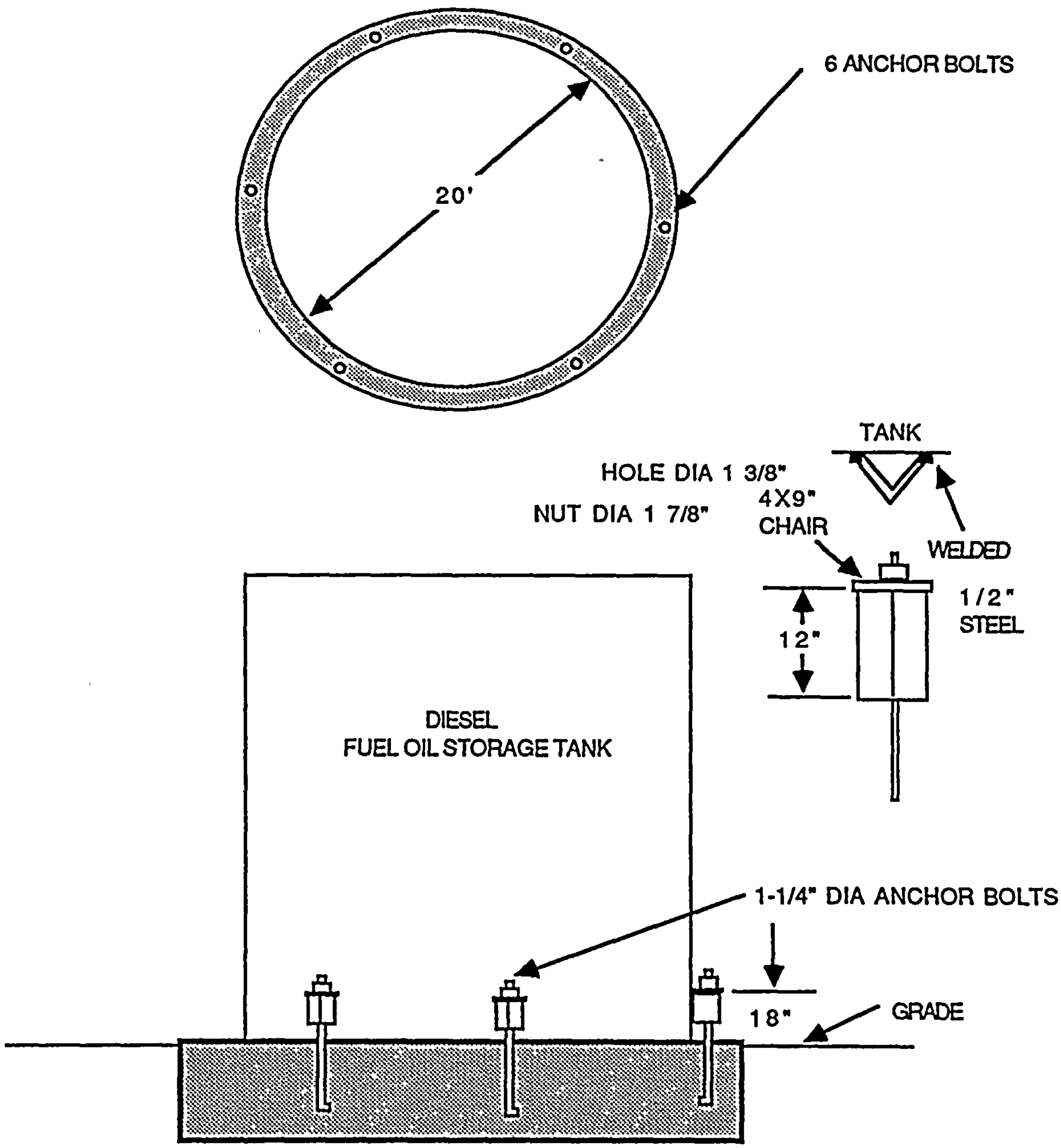
PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any)
Review STACKS on Fossil plants. Addressed in report summary.

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

______

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90
NAME John W. Reed DATE 4/5/90
NAME John D. Stevenson DATE 4/5/90



SEISMIC MOUNTING WORKSHEET

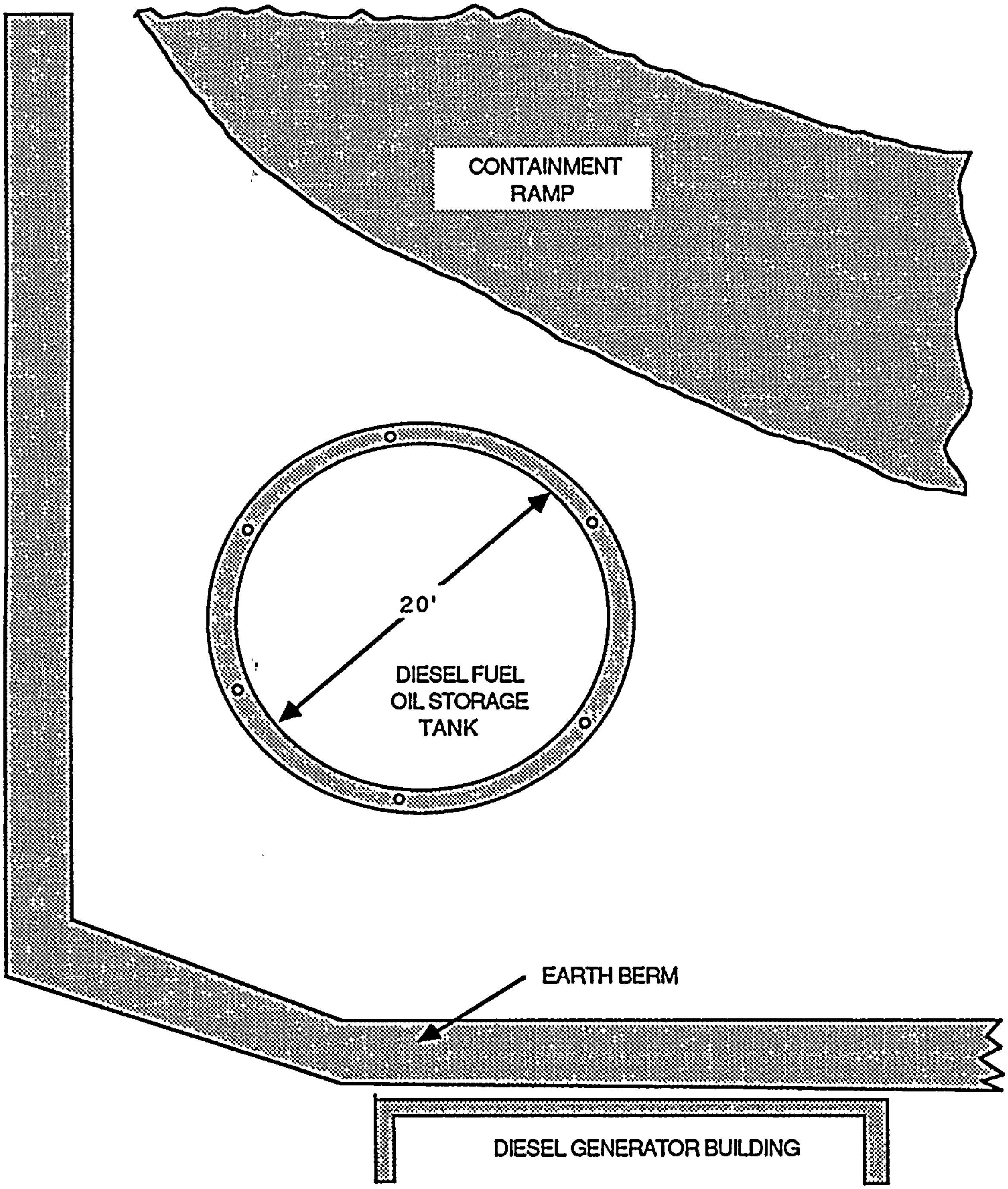
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: DIESEL FUEL OIL STORAGE TANK
DATE: MAR 27, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT HAVE ANY SEISMIC INTERACTIONS CONCERNS



DIESEL FUEL OIL STORAGE TANK SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: DIESEL FUEL OIL STORAGE TANK
DATE: APR 14, 1990 DWG BY: R. GOULDY

ITEM 10 DIESEL OIL STORAGE TANK

SRT REVIEWED TANK INSTALLATION, AND FOUNDATION DRAWINGS.

1) WANTED CALCULATIONS FOR BOLTING AND BOLT CHAIRS

2) UNIT 1 & 2 SMOKE STACKS COULD CAUSE SEISMIC INTERACTION AND WANTED THE STACKS ADDRESSED IN THE REPORT SUMMARY.

CALCULATION PERFORMED & CONCLUDED TANK SUFFICIENT FOR TURKEY POINT MHE IF CHAIR PLATES REPLACED WITH 1-1/4" THICK CHAIR PLATES.

CALCULATION COVER SHEET

Calculation No: TPN-1SJC-90-007

Title: SME (SEISMIC MARGIN EVALUATION) CAPACITY OF THE DIESEL FUEL STORAGE TANK WITH INCREASED CHAIR PLATE

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SUBJECT Turkey Point JOB No. 90C1585 SHEET 1 OF 31

CALC # TPN-SSJC-90-007

SME Capacity of the Diesel Fuel Storage Tank

With Increased Chair Plate

Turkey Point Units 3&4

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1. PURPOSE/SCOPE

The purpose of this calculation is to perform an evaluation of the Diesel Fuel Storage Tank of the TURKEY Point units 3&4 to estimate the tanks seismic capacity after the top chair plate is increased to 1 1/4". This calculation is intended to be conservative and gives the High Confidence Low Probability of Failure (HCLPF) seismic capacity of the tank.

2) REFERENCES

/1/ Kennedy, R.P. et al., "Assessment of Seismic Margin Calculation Methods" NUREG/CR-5270, UCID-21572, Lawrence Livermore National Laboratory, Livermore, 1988.

/2/ Veletsos, A.S., "Seismic Response and Design of Liquid Storage Tanks" In: Guidelines for the Seismic Design of Oil and Gas Pipeline Systems, ASCE, New York, 1984.

/3/ Veletsos, A.S. and Yang, J.Y., "Dynamics of Fixed-Base, Liquid-Storage Tanks", Proceedings of the U.S.-Japan Seminar for Earthquake Engineering Research with Emphasis on Life Line Systems, Tokyo, Japan, Nov. 1976.

/4/ Veletsos, A.S. and Tang, Yu, "Dynamic of Vertically Excited Liquid Storage Tanks", Journal of Structural Engineering, Vol. 112, No. 6, ASCE, June 1986, pp. 1228-1246.

/5/ Haroun, M.A. - Housner, G.W.; "Seismic Design of Liquid Storage Tanks". Journal of the Technical Councils of ASCE, Vol. 107, No. TC1, 1981, pp. 191÷207.

/6/ ASCE Standard and Commentary "Seismic Analysis of Safety Related Nuclear Structures", ASCE-4-86, September 1986.

/7/ Niwa, A. - Clough, R.W. Buckling of Cylindrical Liquid Storage Tanks under Earthquake Loading. Earthquake Engineering and Structural Dynamics, Vol. 10, 1982, pp. 107-122.

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SUBJECT Turkey Point JOB No. 90C1585 SHEET 2 OF 21

CALC # TPN-ISUC-90-007

SME Capacity of the Diesel Fuel Storage Tank

Turkey Point Units 3 & 4

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/8/ Buckling of Thin-Walled Circular Cylinders, NASA SP-8007, August, 1968.

/9/ Manual of Steel Construction, 8th edition, AISC, Chicago 1980.

/10/ Holmes, M., Martin, L.H., "Analysis and Design of Structural Connections: Reinforced Concrete and Steel", 1983.

/11/ Drawing 5610-C-18-592, Turkey Point Units 3 & 4, Condensate and Diesel Fuel Storage Tanks.

/12/ Turkey Point - Ground Response Spectra 15% Acceleration, Fig. 5A-2.

3. METHODOLOGY

The seismic evaluation of the diesel fuel storage tank consists of two main parts: (1) a seismic response analysis presented in the chapter 5 and (2) a seismic capacity assessment given in the chapter 6. The seismic response analysis is based here on the works of Veletsos /2,3,4/, while the approach and formulas given in Ref. /1/ are mostly used in the seismic capacity assessment.

The actual SME capacity of the tank is estimated from

/1/ $$SME = \frac{Capacity - Static}{k \cdot Seismic_e} (SME_e)$$

where Capacity is the HCLPF capacity of the tank, Static is the portion of this capacity used up by static loads, $Seismic_e$ is the computed seismic response, k is the inelastic energy absorption factor and SME_e is .15g in this case.

The horizontal and vertical seismic ground motions are defined for the maximum hypothetical earthquake of .15g ZPGA by response spectrum curves (the vertical motion is specified as two-thirds of the horizontal motion).

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SUBJECT: Turkey Point   JOB No. 90C1585   SHEET 3 OF 31

CALC# TPN-15JC-90-027

SME Capacity of the Diesel Fuel Storage Tank

Turkey Point Units 3&4

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4. BASIC ASSUMPTIONS

/1/ a) The tank is considered in accordance with Ref. /1/ to be vertical of circular cross section, fixed by the anchorage bolts at the concrete foundation, and to have a free liquid surface.

/1/ /2/ /3/ /4/ b) Solutions are based upon the theory of small displacements of the tank shell and tank bottom and small displacement of the incompressible liquid inside the tank.

/6/ c) Any effects of soil-tank foundation interaction are not considered. The tank foundation is assumed to be sufficiently rigid. Only higher damping ratio is introduced when the vertical seismic response is determined to partially compensate the effects of soil flexibility and energy radiation below the foundation.

d) As the anchorage bolt hold-down capacity is governed by the bolt pullout capacity and not by its tensile capacity only very limited inelastic elongation of the outermost bolt is taken into account.

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SUBJECT: Turkey Point JOB No. 90C1585 SHEET 4 OF 31

CALC # TPN-ISJL-90-007

SME Capacity of the Diesel Fuel Storage Tank

Turkey Point Units 3&4

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5. CALCULATION - RESPONSE EVALUATION

5.1. Basic Input Data

/11/

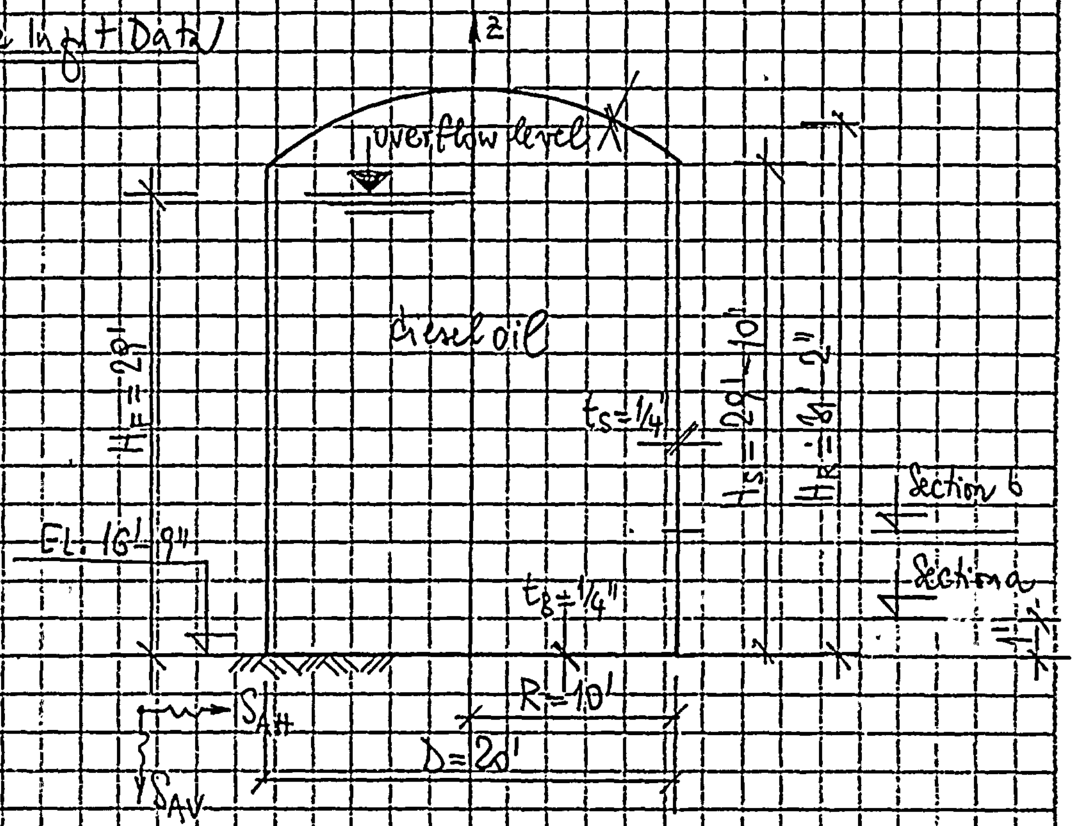

Fig. 1 Diesel Fuel Storage Tank

a) Elastic properties:

- tank steel $E_{ST} = 29 \times 10^6$ psi (Young's modulus of elasticity)

$\nu = 0.3$ (Poisson's ratio)

- fluid none

b) Specific weights and masses:

- tank steel $w_{ST} = 490\ lb/ft^3$, $\rho_{ST} = w_{ST}/g = 490/32.185 = 15.225\ lb\text{-}s^2/ft^4$

- fluid $w_F = 47.5\ lb/ft^3$, $\rho_F = w_F/g = 47.5/32.185 = 1.476\ lb\text{-}s^2/ft^4$

($g = 32.185\ ft/s^2$ - gravity acceleration)

c) Weights and masses:

– roof $W_R = 1.1\pi R^2 t_R w_{ST} = 1.1\pi (10)^2 \frac{.25}{12} 490 = 3,527.75$ lb;

$m_R = W_R / g = 3,527.75 / 32.185 = 109.608$ lb-s²/ft;

– shell $W_S = \pi D H_S t_S w_{ST} = \pi (20)(29.833) \frac{.25}{12} 490 = 19,135.14$ lb;

$m_S = W_S / g = 19,135.14 / 32.185 = 594.536$ lb-s²/ft;

$\mu_S = M_S / H_S = 594.536 / 29.833 = 19.929$ lb-s²/ft²;
(mass per unit of height)

– bottom $W_B = \pi R^2 t_B w_{ST} = \pi (10)^2 \frac{.25}{12} 490 = 3,207.04$ lb;

$m_B = W_B / g = 3,207.04 / 32.185 = 99.644$ lb-s²/ft;

– fluid $W_F = \pi R^2 H_F w_F = \pi (10)^2 (28)(47.5) = 432,754.39$ lb;

$m_F = W_F / g = 432,754.39 / 32.185 = 13,445.84$ lb-s²/ft

$\mu_F = M_F / H_F = 13,445.84 / 29 = 463.65$ lb-s²/ft²;
(mass per unit of height)

5.2. Free Vibration Analysis

/2/ /3/ a) Fundamental horizontal natural frequency of the tank-liquid system

– the frequency coefficient for the tank filled with water:

$C_W = .113$ for $H_F / R = 29/10 = 2.9$ and $t_S / R = .25/120 = .00208$
(dimensionless)

– the frequency coefficient for the tank filled with liquid under consideration:

$C_F = C_W \sqrt{\frac{\rho_W}{\rho_F}} = .113 \sqrt{\frac{1.939}{1.476}} = .1295$ (dimensionless)

($\rho_W = 62.4 / 32.185 = 1.939$ lb-s²/ft⁴ – specific mass of water)

– fundamental horizontal natural frequency without effects of the roof mass:

$$f'_H = \frac{C_F}{2\pi H_F}\sqrt{\frac{E_{ST}}{\rho_{ST}}} = \frac{.1295}{2\pi(29)}\sqrt{\frac{29\times10^6(12)^2}{15.225}} = 11.77\ Hz,$$

– flexural and shear stiffness of the tank computed as a cantilever beam:

$$k_F = 3\pi\left(\frac{R}{H_S}\right)^3 E_{ST}\, t_S = 3\pi\left(\frac{10}{29.833}\right)^3 (29\times10^6)(12)(.25) = 3.088\times10^7\ lb/ft;$$

$$k_S = \frac{\pi}{2(1+\nu)}\frac{R}{H_S}E_{ST}\, t_S = \frac{\pi}{2(1+.3)}\left(\frac{10}{29.833}\right)(29\times10^6)(12)(.25) = 3.52\times10^7\ lb/ft;$$

– corresponding natural frequencies for an empty tank of the same proportions as an actual tank but for which the only structural mass is the roof mass M_R:

$$f'_{HF} = \frac{1}{2\pi}\sqrt{\frac{k_F}{m_R}} = \frac{1}{2\pi}\sqrt{\frac{3.088\times10^7}{109.608}} = 84.477\ Hz;$$

$$f'_{HS} = \frac{1}{2\pi}\sqrt{\frac{k_S}{m_R}} = \frac{1}{2\pi}\sqrt{\frac{3.52\times10^7}{109.608}} = 90.19\ Hz;$$

– the fundamental horizontal natural frequency including effects of the roof mass (using the approximate expression of the Dunkerley type):

$$\frac{1}{f_H^2} = \frac{1}{(f'_H)^2} + \frac{1}{(f'_{HF})^2} + \frac{1}{(f'_{HS})^2} = \frac{1}{11.77^2} + \frac{1}{84.477^2} + \frac{1}{90.19^2} = .0074816$$

and, therefore,

$$f_H = \sqrt{1/.0074816} = 11.56\ Hz;$$

12/14/ b) Fundamental vertical natural frequency of the tank–liquid system

– the frequency coefficient:

$$C_V = .087 \quad \text{for } H_F/R = 2.9 \text{ and } t_S/R = .00208;$$

– fundamental vertical natural frequency without effects of tank inertia (based on a theory that considers the tank to act as a membrane – axisymmetric cylinder):

$$f_V' = \frac{C_V}{2\pi H_F}\sqrt{\frac{E_{ST}}{\rho_{ST}}} = \frac{.097}{2\pi(29)}\sqrt{\frac{28\times10^6(12)^2}{15.225}} = 8.817\ Hz$$

– natural frequency of axial vibration of the tank incl. effects of the roof mass:

$$f_a = \frac{.275}{H_S\sqrt{1+3\,m_R/m_S}}\sqrt{\frac{E_{ST}}{\rho_{ST}}} = \frac{.275}{29.833\sqrt{1+3\frac{109.608}{594.536}}}\sqrt{\frac{29\times10^6(12)^2}{15.225}} =$$

$$= 122.5\ Hz;$$

– the fundamental vertical natural frequency incl. effects of tank inertia (using the approximate expression of the Dunkerley type):

$$\frac{1}{f_V^2} = \frac{1}{(f_V')^2} + \frac{1}{(f_a)^2} = \frac{1}{8.817^2} + \frac{1}{122.5^2} = .01293$$

and, therefore,

$$f_V = \sqrt{1/.01293} = 8.795\ Hz;$$

Remarks:

(1) It is concluded from relations given above, effects of tank inertia in vertical direction as well as effects of roof inertia in horizontal direction are both negligible.

(2) Rigid foundation of the tank is assumed and no effects of soil-tank interaction are taken into account here.

/2/ /3/ c) Three fundamental sloshing frequencies

$$f_{S1} = \frac{1.043}{\sqrt{R}} = .329\ Hz,\quad f_{S2} = \frac{2.075}{\sqrt{R}} = .656\ Hz \text{ and } f_{S3} = \frac{2.638}{\sqrt{R}} = .834\ Hz;$$

$(R = 10\ ft)$

Both calculated fundamental natural frequencies f_H and f_V of the tank-liquid system may vary ±15% as well as all sloshing frequencies given above (uncertainties in input data, simplified calculations etc.).

5.3. Spectral Accelerations

/12/ The following spectral accelerations have been extracted from the given response spectrum (ZPA = .15g)

S_{AI} (f_H = 11.56 Hz ±15%, damping 5%) = .25g (conservatively) } impulsive horizontal

S_{AV} (f_V = 8.795 Hz ± 15%, damping 5%) = 2/3 × .25 g = .167 g } and vertical effect

S_{AS} (f_{S1} = .329 Hz ± 15%, damping .5%) = .08g — sloshing

5.4. Horizontal Impulsive Mode Response

/2/ /3/ /4/

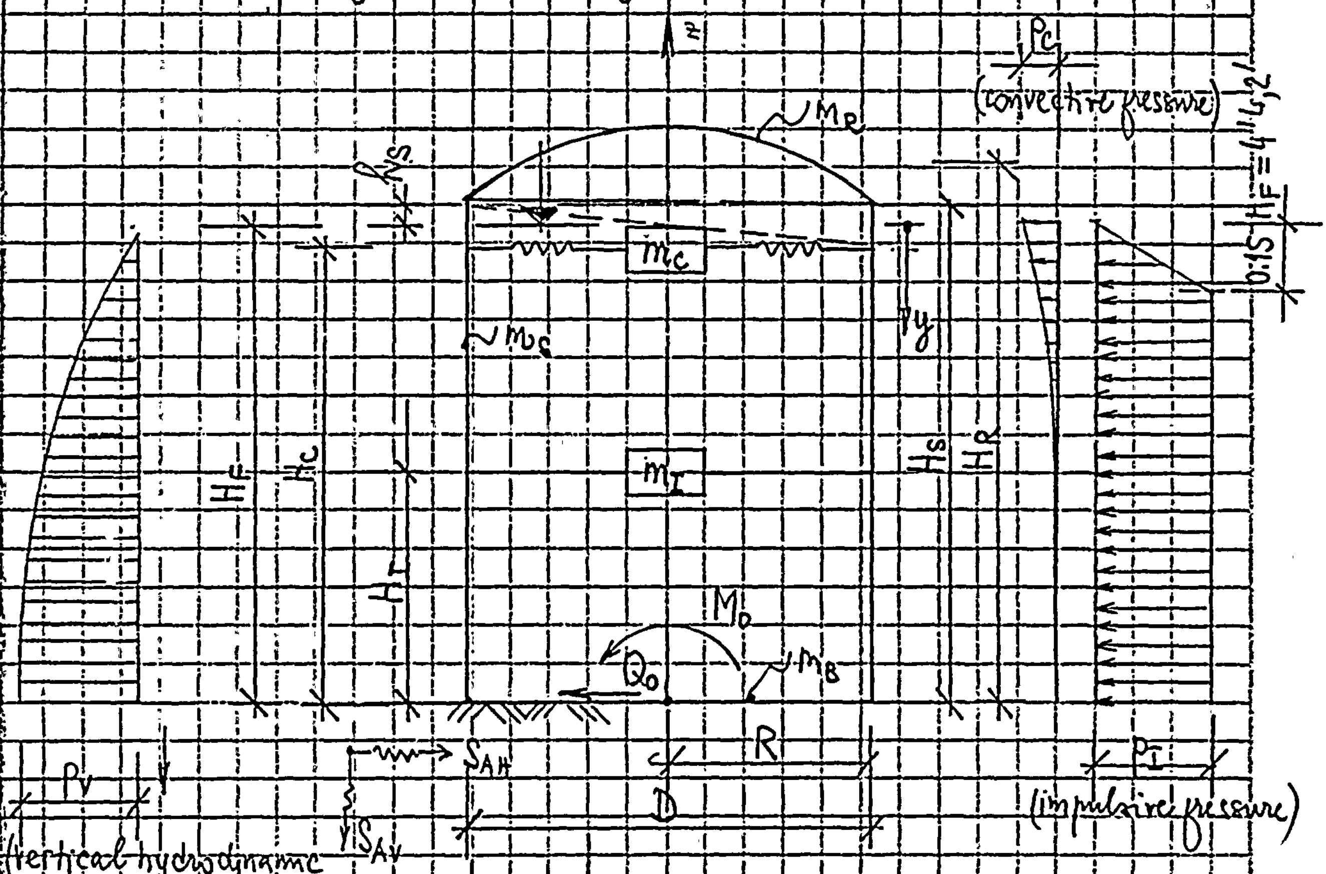

Fig. 2 Components of Tank Earthquake Response

/6/ According to ASCE Standard 4-86, the impulsive mode base shear Q_{0I} and moment M_{0I} at the base of the tank shell are given by:

$$Q_{0I} = (m_R + m_S + m_B + m_I)\, S_{AI} \qquad (1)$$

and

$$M_{0I} = \left(m_R H_R + m_S \frac{H_S}{2} + m_I H_I\right) S_{AI} \qquad (2)$$

For all items see Fig. 2

In this case, when $H_F/R = 29/10 = 2.9 > 1.5$,

$$\frac{m_I}{m_F} = 1.0 - 0.435\frac{R}{H_F} = 0.85 \quad \text{i.e. } m_I = 0.85\, m_F = 0.85\,(13,445.84) = 11,428.96\ lb\text{-}s^2/ft;$$

and

$$\frac{H_I}{H_F} = 0.5 - 0.188\frac{R}{H_F} = 0.435, \quad \text{i.e. } H_I = 0.435\, H_F = 0.435 \times 29 = 12.62\ ft;$$

Thus from eq. (1) and (2), the impulsive mode base shear and moment are:

$$Q_{0I} = (109.608 + 584.536 + 99.644 + 11,428.96) \times 0.25 \times 32.185 = 98,427.4\ lb = 98.43\ kips;$$

and

$$M_{0I} = \left(109.608 \times 31.167 + 594.536 \times \frac{29.833}{2} + 11,428.96 \times 12.62\right) \times 0.25 \times 32.185 = 1259,285.7\ lb\text{-}ft = 1259.29\ kip\text{-}ft;$$

One can easily recognize, that neglecting tank inertia effects in expressions for the impulsive mode base shear and moment would create errors ~~that cannot be neglected~~.

/2/ Veletsos provides a slightly different formulation of Q_{0I} and M_{0I} which leads to a slightly lower base shear and to a practically identical base moment.

/5/ Haroun and Housner provide another different formulation which gives slightly lower base shear, but slightly higher base moment.

/6/ For this case, the results given by eqs. (1) and (2) are used as they are in accordance with ASCE Standard 4-86.

/6/ According to ASCE Standard 4-86, the impulsive mode hydrodynamic pressure p_I should be approximated by:

$$p_I = \frac{m_{FI} H_I S_{AI}}{1.36 R H_F^2} = \frac{11,428.96 \times 12.62 \times .25 \times 32.185}{1.36 \times 10 \times 29^2} = 101.46 \text{ lb/ft}^2 \text{ i.e. } 0.71 \text{ psi}$$

/2/ /5/ Both Veletsos and Haroun & Housner provide alternate formulations for estimating the impulsive pressures which gives slightly different values. The impulsive pressure determined above is used further.

5.5. Horizontal Convective (Sloshing) Mode Response

The convective mode base shear and moment are given by

$$Q_{OC} = m_C S_{AC} \qquad (3)$$

and

$$M_{OC} = m_C H_C S_{AC} \qquad (4)$$

For all items see Fig. 2.

/6/ According to ASCE Standard 4-86 and to all another subjected references

$$\frac{m_C}{m_F} = 0.46 \frac{R}{H_F} \tanh\left(1.835 \frac{H_F}{R}\right) = 0.1586, \text{ i.e. } m_C = .1586 m_F =$$

$$= .1586 \times 13,445.84 = 2,132.5 \text{ lb-s}^2\text{/ft};$$

$$\frac{H_C}{H_F} = 1.0 - \frac{\cosh\left(1.835 \frac{H_F}{R}\right) - 1.0}{1.835 \frac{H_F}{R} \sinh\left(1.835 \frac{H_F}{R}\right)} = 0.8139, \text{ i.e. } H_C = .8139 H_F = .8139 \times 29 =$$

$$= 23.603 \text{ ft};$$

Thus from eq (3) and (4), the convective mode base shear and moment are:

$$Q_{OC} = 2,132.5 \times 0.08 \times 32.185 = 5,490.76 \text{ lb} \doteq 5.49 \text{ kips}$$

and

$$M_{OC} = 2,132.5 \times 23.603 \times 0.08 \times 32.185 \doteq 129,598.43 \text{ lb-ft} \doteq 129.16 \text{ kip-ft}$$

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CALC # TPN-ISU C-90-007
SME Capacity of the Diesel Fuel Storage Tank

Turkey Point Units 3&4

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The hydrodynamic convective pressure can be estimated as follows:

$$p_c = \frac{0.267\, m_F\, S_{AC}}{R H_F} \times \frac{\cosh\left(1.835 \frac{H_F - y}{R}\right)}{\cosh\left(1.835\, H_F/R\right)} \quad (5)$$

where y is a depth from the top of the liquid :

Using eq. (5), if y=0,

$$p_c = \frac{0.267 \times 13{,}445.84 \times 0.08 \times 32.185}{10 \times 29} \times 1.0 = 31.87\ lb/ft^2 = .221\ psi;$$

if y = 10 and 20 ' we obtain

$$p_c = .221\ \frac{\cosh\left(1.835\frac{29-10}{10}\right)}{\cosh\left(1.835\ 29/10\right)} = .0353\ psi \quad \text{and} \quad p_c = .221\ \frac{\cosh\left(1.835\frac{29-20}{10}\right)}{\cosh\left(1.835\ 29/10\right)} = .0058\ psi$$

Such pressures are generally negligible compared to either the hydrodynamic impulsive pressure p_I, or the hydrostatic pressure p_{ST}, except at shallow depths below the fluid surface.

/6/ Lastly, the fundamental mode fluid sloshing height h_s, can be approximated by

$$h_s = 0.84\, R\, (S_{AS}/g) = .84 \times 10\, (.08) = .672\ ft.$$

5.6. Vertical Fluid Mode Response

/2/ /14/ According Veletsos, the hydrodynamic vertical fluid response mode pressure for a tank on a rigid foundation can be estimated as

$$p_v = 0.8\, \rho_F\, H_F (S_{AV}) \cos\left(\frac{\pi}{2}\ \frac{H_F - y}{H_F}\right) \quad (6)$$

which is more accurate than the linear varying pressure defined by eq. 3500-7 of ASCE Standard 4-86.

Even for tanks on a rock site there will be some foundation flexibility. A flexible foundation (may be a flexible floor supporting) greatly reduces the vertical fluid mode hydrodynamic pressures below that computed for a absolute rigid foundation. One way to approximate this influence is through the increased damping (in this case about 5%).

Using eq. (6), when $y = H =$, we obtain

$$p_V = 0.8 \times 1.476 \times 29 \times 0.167 \times 32.185 = 184.05\ lb/ft^2 = 1.278\ psi,$$

and, consequently when $y = 20$ and $10'$, we have

$$p_V = \cos\left(\frac{\pi}{2} \times \frac{29-20}{29}\right) \times 1.278 = 1.129\ psi \quad \text{and} \quad p_V = \cos\left(\frac{\pi}{2} \times \frac{29-10}{29}\right) \times 1.278 = 0.659\ psi$$

respectively.

5.7. Combined Responses

/1/ The combined horizontal responses for base shear Q_0, base moment, M_0,
/2/ and for horizontal hydrodynamic pressures, p_H, can be obtained by the SRSS combination of the horizontal impulsive and convective responses. Thus,

$$Q_0 = \sqrt{Q_{0I}^2 + Q_{0C}^2} = \sqrt{98.43^2 + 5.49^2} = 98.58\ kips,$$

$$M_0 = \sqrt{M_{0I}^2 + M_{0C}^2} = \sqrt{1259.29^2 + 129.6^2} = 1265.94\ kip\text{-}ft,$$

while Table 1 presents the combined horizontal dynamic pressures, p_H.

For the purposes of the membrane hoop stress capacity check, it is necessary to have an estimate of the maximum seismic hydrodynamic pressures p_S, which is obtained by the SRSS combination of the horizontal seismic pressures p_H and the vertical fluid response hydrodynamic pressures, p_V. Table 1 presents these values at two capacity evaluation locations (sections a and b).

For the purposes of estimating the compressive buckling capacity of the tank shell, it is necessary to have an estimate of the expected maximum and minimum fluid pressures acting against the tank shell near the base at the location of maximum axial compression during the time of maximum base moment. Those expected maximum and minimum compression zone pressures can be estimated as

/1/ $$p_{C+} = p_{ST} + p_H + 0.4\,p_V \quad \text{and} \quad p_{C-} = p_{ST} + p_H - 0.4\,p_V \qquad (7)$$

where the factor 0.4 on p_V is to account for the probable vertical mode hydrodynamic vertical pressure at the same time of maximum base moment.

Table 1. Hydrostatic and Hydrodynamic Pressures and SME Capacity at Capacity Evaluation Locations

Section	y [ft]	Wall thickness [in]	Individual pressures [psi] p_{ST}	p_I	p_c	p_V	Combined pressures [psi] p_H	p_S	Capacity*) pressure [psi] p_{ca}	Capacity**) SME_p***) [g]
a	28'	.25	9.24	.71	0.0	1.275	.71	1.459	67.5	7.48
b	21'-6½	.25	7.11	.71	0.005	1.175	.71	1.373	67.5	8.25

Notes: *) $p_{ca} = \frac{0.9\, \sigma_{ye} \times t_s}{R} = \frac{0.9 \times 36{,}000 \times .25}{12 \times 10} = 67.5$ psi (steel A36, $\sigma_{ye} = 36$ ksi)

**) $SME = \frac{\text{Capacity} - \text{Static}}{k \cdot \text{Seismic}}$ (SME_c) ; here $k = .8$ (inelastic energy absorption seismic reduction factor for the hoop membrane failure mode)

$SME_e = .15g$

***) Computed SME_p are many times greater than other SME factors, so that these do not govern!

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SME Capacity of the Diesel Fuel Storage Tanks
Turkey Point Units 3 & 4

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SUBJECT Turkey Point JOB No. 90C1585 SHEET 14 OF 37

CALC # TPN-1532-00-007

SME Capacity of the Diesel Fuel Storage Tank

Turkey Point Units 3 & 4

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Similarly, for the purposes of estimating the expected minimum fluid hold-down forces in the zone of maximum tank wall axial tension, it is needed
1 to have an estimate of the minimum tension zone fluid pressure, p_{T-}, at the same time of maximum moment, as given by

$$p_{T-} = p_{ST} - p_H - 0.4 p_V \qquad (8)$$

For the sliding capacity evaluation one needs the expected minimum average fluid pressure on the base plate, p_a, at the same time of maximum base
1 shear, as given by

$$p_a = p_{ST} - 0.4 p_V \qquad (9)$$

The static fluid pressure is $p_{ST} = W_F \cdot y$, so, when $y = H_F$ (tank base), we obtain a maximum value

$$p_{ST} = W_F H_F = 47.5 \cdot 29 = 1377.5 \text{ lb/ft}^2 = 9.57 \text{ psi}$$

Thus, at the tank base

1

~~$p_{C+} = 9.57 + 0.71 + 0.4 \times 1.278 = 10.79$ psi~~

$p_{C-} = 9.57 + 0.71 - 0.4 \times 1.278 = 8.77$ psi

$p_{T-} = 9.57 - 0.71 - 0.4 \times 1.278 = 8.35$ psi

$p_a = 9.57 - 0.4 \times 1.278 = 9.06$ psi

1 Lastly one needs an estimate of the expected minimum total effective weight W_{Te}, of the tank shell and roof at the time of maximum moment and base shear:

$$W_{Te} = (W_R + W_S)\left(1 - 0.4\,(a_v/g)\right) = (3{,}527.75 + 19{,}135.14)(1 - 0.4 \times 0.1) = 21{,}756.4 \text{ lb}$$

Here $a_v = \frac{2}{3}$ ZPA $= \frac{2}{3}\, 0.15g = 0.1g$.

6. CAPACITY ASSESSMENT

6.1. Compressive Buckling Capacity of the Tank Shell

/1/ – The 'elephant' buckling axial stress, σ_p, of the tank shell will be

$$\sigma_p = \frac{0.6\,E_{ST}}{(R/t_S)}\left[1-\left(\frac{pR}{\sigma_{ye}\,t_S}\right)^2\right]\left[1-\frac{1}{1.12+S_1^{1.5}}\right]\left[\frac{S_1+(\sigma_{ye}/36\,ksi)}{S_1+1}\right] \quad (10)$$

where $S_1 = \frac{R}{400\,t_S} = \frac{120}{400\times 0.25} = 1.2$ $\quad (t_S = 1/4")$

$\sigma_{ye} = 36$ ksi (steel A36)

$p = p_{ct} = 10.79$ psi

$E = 29\times 10^3$ ksi

After substitution into eq. (10), we obtain

$$\sigma_p = \frac{0.6\times 29\times 10^3}{480}\left[1-\left(\frac{10.79\times 480}{36\times 10^3}\right)^2\right]\left[1-\frac{1}{1.12+1.2^{1.5}}\right] = 20.92\ ksi$$

/1/ For HCLPF capacity computations it is suggested that a slight conservatism be introduced by specifying C_m in terms of $0.9\sigma_p$, so that

$$C_m = 0.9\,\sigma_p\,t_S = 0.9\times 20.92\times 0.25 = 4.71\ kip/in$$

/8/ – The classical 'diamond' buckling capacity stress of supported cylindrical shell under combined axial bending and internal pressure, σ_{CB}, for such a case can be conservatively estimated from NASA SP-8007:

$$\sigma_{CB} = (0.6\,\gamma + \Delta\gamma)\frac{E_{ST}}{(R/t_S)} \quad (11)$$

where

$\gamma = 1 - 0.73\,(1-e^{-\varphi})$, $\varphi = \frac{1}{16}\sqrt{R/t_S}$, and $\Delta\gamma$ = an increase factor for internal pressure.

In this case, $\Delta\gamma \doteq 0.15$ (from Fig. 6 – NASA SP-8007), $\varphi = \frac{1}{16}\sqrt{480} = 1.37$

$\gamma = 1 - 0.73\,(1 - e^{-1.37}) = 0.456$ and, therefore

$\sigma'_{CB} = (0.6 \times 0.456 + 0.15)\,\frac{29 \times 10^3}{480} = 25.57$ ksi $< \sigma'_{ye}$

Since σ_{CB} is conservatively estimated, it may be directly used with no reduction for estimating $C_m \doteq \sigma_{CB}\, t_s$. In this case σ_{CB} exceeds $0.9\sigma_p$, so this buckling mode does not govern.

/7/ Another formula to estimate the axial bending induced "diamond" buckling stress σ_{CB} was introduced by Niwa and Clough:

$\sigma'_{CB} = 0.373\, E_{ST}\, t_s / R = 0.373 \times 29 \times 10^3 / 480 = 22.54$ ksi $< \sigma_{ye}$

which gives as well more than $0.9\sigma_p$.

6.2. Bolt Hold-Down Capacity

/10/ a) Bolt bond stress capacity (see Ref. 10)

– calculation of the total equivalent anchorage length:

hook portion: $8\phi + (12 - 2 \times 1\frac{1}{4}) = 19.5'' < 24\phi$

above hook: 12"

total equivalent anchorage length

$l_{eq} = 12 + 19.5 = 31.5''$

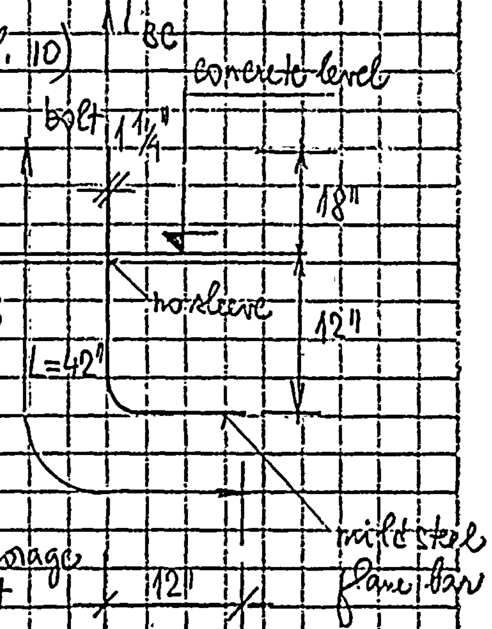

Fig. 3 Anchorage bolt

– ultimate bond stress $\sigma_{bond} = 1.2$ MPa $= 1.2 \times 145 = 174$ psi

– bolt hold-down capacity $T_{BC} = \sigma_{bond}\, l_{eq} = \pi \times 1.25 \times 174 \times 31.5 = 21,523.8$ lb

(concrete $f'_c = 20$ MPa $\doteq 2.9 \times 10^3$ psi, mild steel, plane bar)

b) Bolt tensile capacity (see Ref. 10)

– ultimate tensile stress of the bolt

$\sigma_T' = 1.7 \times 20 = 34$ ksi;

– ultimate bolt tensile capacity

$T_{bc} = A_{nom} \times \sigma_T = \frac{\pi 1.25^2}{4} \times 34 = 41.72$ kips > 21.52 kips (bond stress)

and, therefore, does not govern

c) Capacity of the top plate of the bolt chair

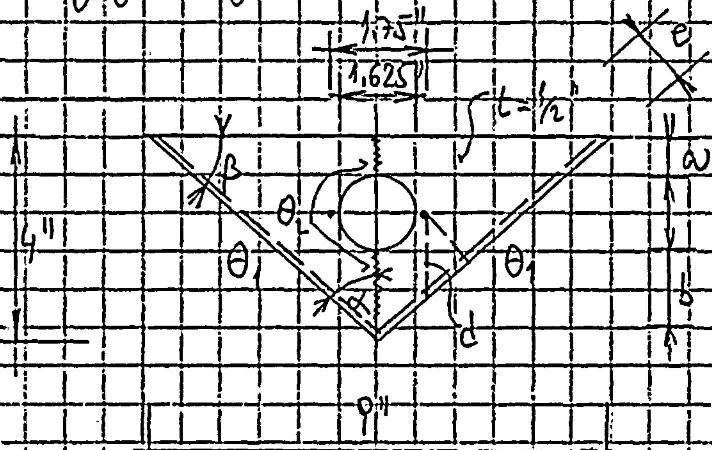

Fig 4. Top plate of the bolt chair – sketch for the yield line analysis

– geometric and plastic properties:

$\alpha = \tan^{-1}(4.5/4) = 48.37°$; $a + b = 4 - 1.625 - \cos(48.37°) \times .5 = 2.043$ in

$d = (4.5 - 1.75/2)\frac{4.0}{4.5} - 1.25 = 1.972$ in ; $e = d \times \cos\alpha = 1.972 \times \cos(48.37°) = 1.31''$

$m = 0.9\frac{\sigma_{yc} t^2}{4} = 0.9\frac{36 \times (0.5)^2}{4} = 2.025$ kip-in/in

(limit plastic bending moment, $\sigma_{yc} = 36$ ksi – steel A36)

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- governing equation of equilibrium

$$m(a+b)\,\theta_2 = e \times F \times \theta_1 \qquad (12)$$

while $\theta_2 = 2\cos\alpha \times \theta_1 = 1.329\,\theta_1$

Now we can obtain from eq. (12)

$$F = 1.329\, m\, \frac{a+b}{e} = 1.329 \times 2.025 \times \frac{2.043}{1.31} = 4.20 \text{ kips} \ll \text{pullout bolt capacity} = 21.52 \text{ kips}$$

It is proposed to reinforce the bolt chairs replacing the existing top plates by another ones with the thickness sufficient to have bolt pullout control the bolt capacity. Using proportionality

$$\bar{m} = m\,\frac{21.52}{4.2} = 10.376 \text{ kip-in/in}$$

and therefore, the necessary thickness will be approximately

$$t_{min} = 1.1\sqrt{\frac{4m}{.9 \times \sigma_{ye}}} = 1.1\sqrt{\frac{4 \times 10.376}{.9 \times 36}} = 1.243 \text{ in}$$, i.e. the 1-1/4" plate shall be applied.

The "pseudo-linear" analysis of such thick triangle plate subjected to the given pullout bolt capacity F = 21.52 kips is given in Appendix A.

d) Weld stress checking of the chair

The same welds were checked for the 16.8 kips load at the similar condensate storage tank. Then, using proportionality, the maximum weld stresses will be

$$\sigma_{w,ten} = 2.8 \times \frac{21.52}{16.8} = 3.59 \text{ ksi}$$

and

$$\sigma_{w,shear} = 1.4 \times \frac{21.52}{16.8} = 1.79 \text{ ksi}$$

} both these values are smaller than the corresponding admissible weld stresses!

e) Finally, if the proposed above reinforcing of the bolt chair top plates is realized, the bolt hold-down capacity is determined by

$F_{BC} = 21.52$ kips (controlled by the bolt pullout capacity, not by the bolt tensile capacity).

A maximum bolt elastic elongation under the load F_{BC} is

$$\delta_B = \frac{F_{BC}\, l_B}{A_{nom}\, E_B} = \frac{21.52 \times 30}{1.227 \times 29 \times 10^3} = .0181 \text{ in} \quad (\sim .06\%)$$

where $l_B = 15 + 12 + 3 = 30''$ (above concrete + below concrete level + hook)

6.3. Fluid Hold-Down Forces

/1/

For tanks with minimum anchorage, hold-down forces resulting from fluid pressure acting on the tank bottom will contribute

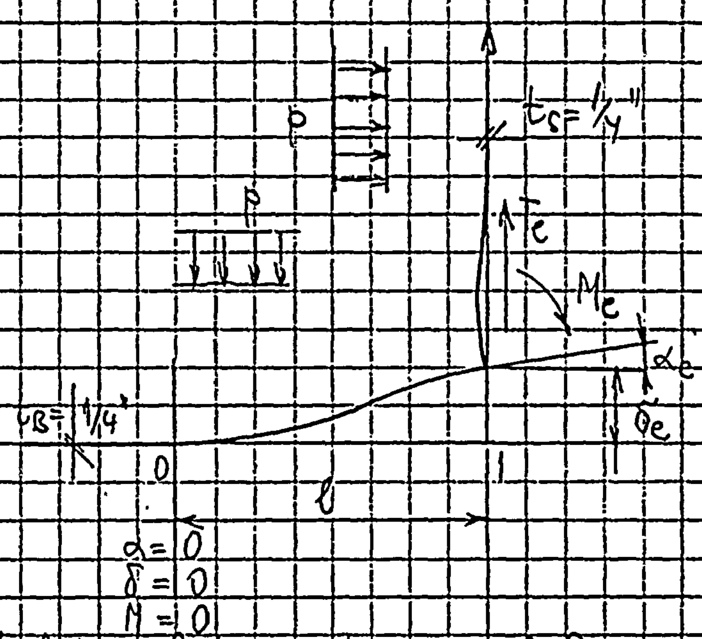

Fig. 5. Tank Bottom Behavior Near Tensile Region of the Tank Shell

to overturning moment capacity, M_{SC} of the tank. The situation in the region of axial tension in the tank shell is sketched in Fig 5 for a small uplift displacement δ_e. This uplift is accompanied by the development of a tension, T_e, and moment, M_e, in the side shell at the intersection with the tank bottom.

(1) The relations are as follows:

$$\frac{E_{ST} I_B \delta_e}{p} = \frac{\ell^4}{24} - \frac{1}{F}\left(\frac{K_S \ell^5}{72 E_{ST} I_B} + \frac{M_F \ell^2}{6p}\right); \quad (13)$$

$$\frac{T_e}{p} = \frac{\ell}{2} + \frac{1}{F}\left(\frac{K_S \ell^2}{12 E_{ST} I_B} + \frac{M_F}{p\ell}\right); \quad (14)$$

$$\frac{M_e}{p} = \frac{1}{F}\left(\frac{K_S \ell^3}{12 E_{ST} I_B} + \frac{M_F}{p}\right); \quad (15)$$

$$\frac{M_F}{p} = \frac{\ell^2}{8} - \frac{M_e}{2p} + \frac{M_e^2}{2p^2\ell^2}; \quad (16)$$

where

$$K_S = \frac{2K\ell}{R} = \frac{2 \times 41.495 \times 28.16}{120} = 19.475 \text{ kips};$$

$$\ell = \left[\frac{R}{t_s}\sqrt{3(1-\nu^2)}\right]^{1/2} = \left[480\sqrt{3(1-.3^2)}\right]^{1/2} = 28.16 \text{ (dimensionless)};$$

$$K = \frac{E_{ST} t_s^3}{12(1-\nu^2)} = \frac{29 \times 10^3 \times (.25)^3}{12(1-.3^2)} = 41.495 \text{ kip-in};$$

$$\frac{M_F}{p} = \frac{R t_s}{\sqrt{12(1-\nu^2)}}\left(1 - \frac{R}{H_F \ell}\right) = \frac{120 \times (.25)}{\sqrt{12(1-.3^2)}}\left(1 - \frac{120}{348 \times 28.16}\right) = 8.967 \text{ in}^2$$

$$I_B = \frac{t_B^3}{12(1-\nu^2)} = \frac{.25^3}{12(1-.3^2)} = .00143 \text{ in}^3, \quad p = p_T - = 8.35 \text{ psi};$$

$$F = 1 + \frac{K_s \ell}{2 E_{ST} I_B} = 1 + \frac{19.475 \times \ell}{2 \times 29 \times 10^6 \times .00143} = 1 + 0.2348 \times \ell;$$

After substitution into eq. (13) we obtain the following relation between the uplift, δ_e, and the uplift length, ℓ, for numerical solution

$$1.1921 \times 10^5 \times \delta_e (1 + .2348 \times \ell) = \ell^4 + .07825 \times \ell^5 - 35.87 \times \ell^2$$

(both values, δ_e and ℓ are in inches). Results of numerical solution are given in Table 2.

(1) Table 2 Fluid Hold-Down Quantities

δ_e [in]	ℓ [in]	T_e [lb/in] *)	M_e [lb-in/in] **)	M_+ [lb-in/in] ***)
0.0	5.07	31.74	53.62	6.72
0.025	9.25	49.98	105.15	44.49
0.05	10.83	57.98	138.30	63.06
0.10	12.78	68.16	189.22	89.03
0.15	14.17	75.54	232.18	109.61
0.20	15.23	81.22	268.65	126.44

(1) *) Calculated from eq. (14) which, after substitution, gives

$$T_e = 8.35\left(\frac{\ell}{2} + \frac{8.967 + .03913 \times \ell^3}{\ell + .2348 \times \ell^2}\right), \ [lb/in], \ (\ell \text{ in inches});$$

**) Calculated from eq. (15) which, after substitution, gives

$$M_e = \frac{.3268 \times \ell^3 + 74.87}{1 + .2348 \times \ell}, \ [lb\text{-}in/in], \ (\ell \text{ in inches});$$

***) Calculated from eq. (16) which, after substitution, gives

$$M_+ = 1.044 \times \ell^2 - \frac{M_e}{2} + \frac{M_e^2}{16.7 \times \ell^2}, \ [lb\text{-}in/in], \ (\ell \text{ in inches});$$

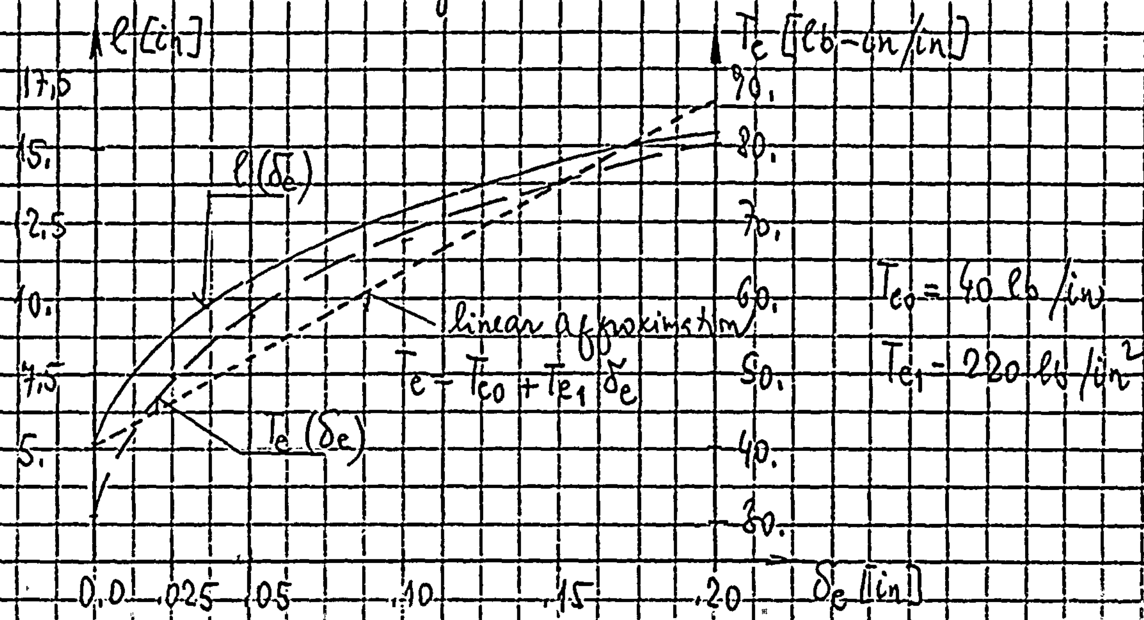

Fig. 6: Fluid Hold-Down Force, F_e, and Uplift Length, ℓ, vs. Uplift Displacement, δ_e

These relationships will be used in overturning moment capacity evaluations.

6.4. Overturning Moment Capacity

(1) a) With an estimate of the compressive capacity of the tank shell, C_m, the anchor bolt hold-down capacity, T_{bc}, and the relationship between fluid hold-down force and uplift displacement, it is possible to estimate the overturning moment capacity, M_{sc}, of the tank. The corresponding theory and assumptions are given in Ref. 4. We will analyze two cases which are schematically illustrated in Fig. 7

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(1)

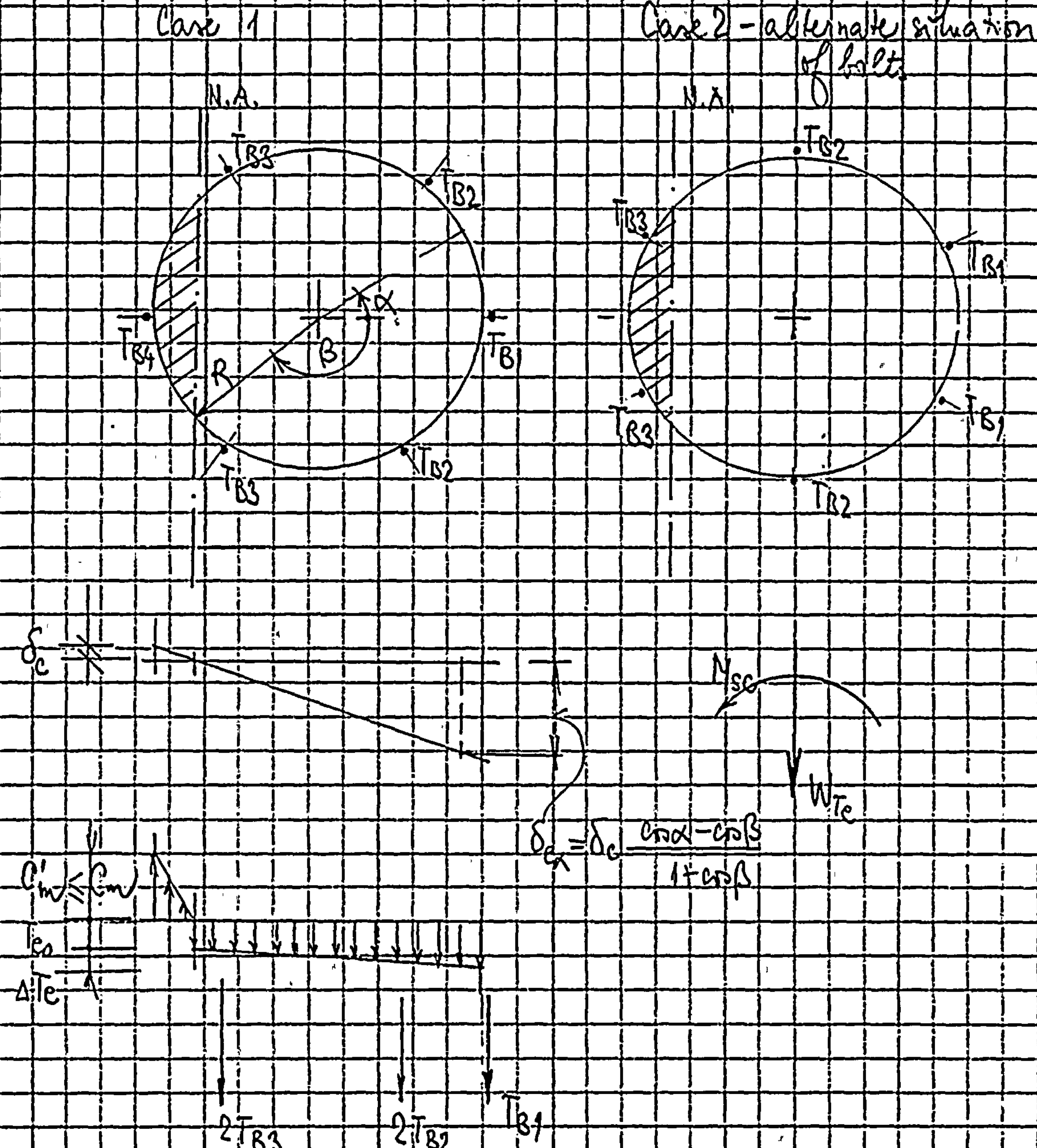

Fig. 7. Vertical loading on the Tank Shell at the Base

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(1) b) The corresponding formulas are as follows:

$$\delta_c = \frac{C_m' h_c}{E_s t_s};\qquad (18)$$

$$\delta_{c\alpha} = \delta_c \left(\frac{\cos\alpha - \cos\beta}{1+\cos\beta}\right) \quad \text{(see Fig 7)}\qquad (19)$$

$$C_1 = \frac{1+\cos\beta}{\sin\beta + (\pi-\beta)\cos\beta};\quad C_2 = \frac{\sin\beta\cos\beta + \pi - \beta}{1+\cos\beta};$$
$$C_3 = \frac{\sin\beta - \beta\cos\beta}{\sin\beta + (\pi-\beta)\cos\beta};\quad C_4 = \frac{\beta - \sin\beta\cos\beta}{1+\cos\beta};\qquad (20)$$

$$C_m'' = \left(\frac{W_{Tc} + \sum_i T_{Bi}}{2R} - T_{co}\,\beta\right) C_1 + T_{e1}\,\delta_c\,C_3;\qquad (21)$$

$$M_{sc} = C_m'' C_2 R^2 + \sum_i \left(F_{Bi} R \cos\alpha_i\right) + T_{eo} R^2 (2\sin\beta) + \Delta T_c C_4 R^2\qquad (22)$$

where

$C_m' \le C_m$ – maximum compressive load of the tank shell (see Fig. 7)

$T_{Bi} = T_{BP} + K_B\left(\frac{\cos\alpha_i - \cos\beta}{1+\cos\beta}\right) \le T_{BC}$ – the anchor bolt tension (limited by T_{BC})

$K_B = \frac{\delta_c A_B E_B}{h_a + h_c}$; T_{BP} bolt pretension, in our case $T_{BP} = 0.0$;

$h_c = 15''$; $h_a = 15''$ (12+3); $E_s = E_B = 29\times10^3$ ksi; $W_{Tc} = 21.76$ kips;

$A_B = 1.227\ in^2$; $T_{eo} = .04$ kips/in; $T_{e1} = .22$ kips/in^2; $\Delta T_c = T_{e1}\cdot\delta_c$

c) All numerical calculations are given in Tables 3 and 4. First, a trial angle β is selected and eq. (21) is used to obtain C_m'' which is compared to the C_m' from eq. (18). The angle β is varied until $C_m'' \doteq C_m'$. Then eq. (22) is used with this β to determine the moment capacity.

The elongation $\delta_{c\alpha=0}$ or $\delta_{c\alpha=\pi/6}$ of the outermost bolt is limited from .02 in (a max. the maximum elastic elongation of the bolt) to .1 in (expected elongation corresponding to the T_{BC}).

Table 3 Overturning Moment Capacity – Case 1

trial β [rad]	1+cosβ	C_1	C_2	C_3	C_4	$C'_m < C_m$ [kip/in]	δ_c [in]	$\delta_{c,\alpha=0}$ [in]	K_B [kips]	$\cos\alpha_1 = 1$: $T_{B1} \le T_{BC}$ [kips]	$\cos\alpha_2 = 0.5$: $2T_{B2} \le 2T_{BC}$ [kips]	$\cos\alpha_3 = -0.5$: $2T_{B3} \le 2T_{BC}$ [kips]	$\sum T_{Bi}$ [kips]	C''_m [kip/in]	M_{sc} [kip-in]
2.8	.0577	4.398	.4494	226.41	53.932	4.71	.00974	.3275	12.836	21.52	43.04	43.04	107.6	3.349	
2.9	.0290	6.2145	.3199	653.77	107.860	4.71	.00974	.6610	12.836	21.52	43.04	43.04	107.6	5.437	
2.85	.0422	5.151	.3850	368.21	74.043	4.71	.00974	.4517	12.836	21.52	43.04	43.04	107.6	4.153	
solution converges but elongation $\delta_{c,\alpha=0}$ of the outermost bolt is too large															
2.85	.0422	5.151	.3850	368.21	74.043	1.0421	.002156	.1	2.8413	21.52	43.04	43.04	107.6	3.5385	
2.80	.0577	4.398	.4494	226.41	53.932	1.4377	.002974	.1	4.0791	21.52	43.04	43.04	107.6	3.0119	
2.70	.0959	3.408	.5755	109.90	32.173	2.4350	.005038	.1	6.9100	21.52	43.04	43.04	107.6	2.3179	
2.72	.0876	3.569	.5506	117.83	35.028	2.2100	.004579	.1	6.2788	21.52	43.04	43.04	107.6	2.4304	
2.71	.0917	3.486	.5621	109.49	33.696	2.3226	.004805	.1	6.5905	21.52	43.04	43.04	107.6	2.3727	
2.708	.0925	3.471	.5656	107.92	33.383	2.3448	.004851	.1	6.6541	21.52	43.04	43.04	107.6	2.3617	22,675.7
solution converges; M_{sc} = 22,675.7/12 = 1,889.6 kip-ft >> 1,265.9 OK															
2.65	.1184	3.065	.6372	72.656	25.892	1.5209	.00315	.05	4.3161	21.52	43.04	27.816	92.376	1.8326	
2.62	.1330	2.889	.6737	60.179	22.953	1.7212	.00356	.05	4.8842	21.52	43.04	26.963	91.523	1.7135	21,003.8
solution converges; M_{sc} = 21,003.8/12 = 1,750.3 kip-ft >> 1,265.9 OK															
2.55	.1699	2.5906	.7542	40.137	17.728	.8977	.00186	.02	2.5475	21.52	39.874	9.895	71.289	1.2655	
2.52	.1877	2.4290	.7922	34.166	16.003	.9973	.00206	.02	2.8310	21.52	39.743	9.473	70.735	1.1965	
2.51	.1929	2.3911	.8038	32.427	15.481	1.0319	.00213	.02	2.9284	21.52	39.683	9.323	70.529	1.1747	
2.50	.1989	2.3544	.8153	30.798	14.983	1.0673	.00221	.02	3.0285	21.52	39.631	9.172	70.323	1.1507	
2.48	.2110	2.2841	.8382	27.836	14.053	1.1400	.00236	.02	3.2352	21.52	39.532	8.866	69.918	1.1135	18,675.2
solution converges; M_{sc} = 18,675.2/12 = 1,556.3 kip-ft >> 1,265.9 OK															
Case 1 – without bolts, T_{BC} = 0.0 (proposed reinforcing does not realized!!!)															
2.8	.0577	4.399	.4494	226.41	53.932	4.71	.00974	.3275	—	—	—	—	—	1.3767	
2.9	.0290	6.215	.3199	653.77	107.860	4.71	.00974	.6610	—	—	—	—	—	2.6852	
3.00	.0100	10.597	.188 y	3294.45	313.75	4.71	.00974	1.9368	—	—	—	—	—	9.2917	
too much uplift, using of the theory is limited, $\delta_{c,max} \le 0.6\,t_p = 0.6 \times 0.25 = 0.15$ in															
2.8	.0577	4.399	.4494	226.41	53.932	2.1567	.004462	.15	—	—	—	—	—	1.1138	
2.9	.0290	6.215	.3199	653.77	107.860	1.0683	.002210	.15	—	—	—	—	—	1.6022	
2.85	.0422	5.152	.3850	368.21	74.043	1.5652	.003214	.15	—	—	—	—	—	1.3163	
2.865	.03801	5.420	.3655	432.76	82.290	1.4045	.002906	.15						1.3912	8,394.7
solution converges; M_{sc} = 8,394.7/12 = 699.56 kip-ft << 1,265.9 not OK.															

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Table 4. Overturning Moment Capacity - Case 2

Trial β [rad]	tan β	C_1	C_2	C_3	C_4	$C_m'' \le C_{m}$ [kip/in]	δ_c [in]	$\delta_{\alpha=\pi/6}$ [in]	K_B [kips]	cos α₁ = .866: $\Sigma T_{B1} \le \Sigma T_{BC}$ [kips]	cos α₂ = 0: $\Sigma T_{B2} \le \Sigma T_{BC}$ [kips]	cos α₃ = -.866: $\Sigma T_{B3} \le \Sigma T_{BC}$ [kips]	ΣT_{Bi} [kips]	C_m'' [kip/in]	M_{SC} [kip-in]
2.7	.09591	3.4080	.5755	101.902	32.173	2.6194	.00542	.1	7.190	43.04	43.04	5.670	91.749	2.1014	
2.65	.11812	3.0646	.6372	72.656	25.892	3.2752	.00628	.1	8.980	43.04	43.04	2.350	88.480	1.8402	
2.72	.08760	3.5686	.5506	117.825	35.328	2.5797	.00492	.1	6.489	43.04	43.04	6.883	92.963	2.2217	
2.73	.08352	3.6550	.5380	126.999	37.077	2.2647	.00469	.1	6.175	43.04	43.04	7.465	93.545	2.2860	23,098.1
solution converges									M_{SC} = 23,098.1 / 12 = 1,924.85 kip-ft >> 1,265.8 OK						
2.65	.11842	3.0646	.6372	72.656	25.892	1.6375	.003388	.05	4.465	43.04	43.04	1.175	87.255	1.7710	
2.66	.11374	3.1269	.6250	77.542	26.995	1.5687	.003246	.05	4.278	43.04	43.04	1.524	87.604	1.8129	
2.64	.12318	3.0081	.6485	68.157	28.550	1.7081	.003534	.05	4.657	43.04	43.04	.818	86.898	1.7297	21,438.02
solution converges									M_{SC} = 21,438.02 / 12 = 1,786.5 kip-ft >> 1,265.9 OK						
2.50	.19886	2.3544	.8153	30.798	14.983	1.1531	.002386	.02	3.1440	43.04	25.332	—	68.372	1.1358	
2.51	.19291	2.3911	.8038	32.427	15.481	1.1145	.002306	.02	3.0391	43.04	25.429	—	68.470	1.1554	
2.505	.19587	2.3726	.8096	31.599	15.229	1.1337	.002346	.02	3.0912	43.04	25.382	—	68.422	1.1455	18,624.6
solution converges									M_{SC} = 18,624.6 / 12 = 1,552.05 kip-ft >> 1,265.9 OK						

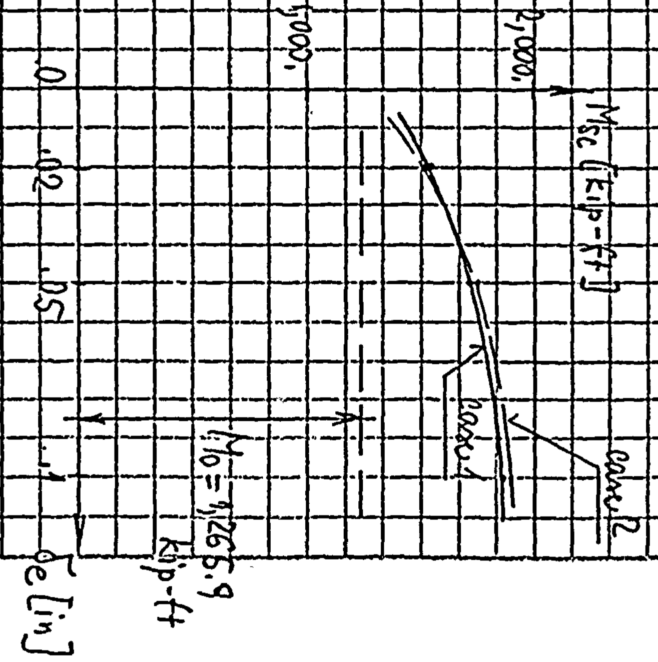

Fig. 8. Overturning Moment Capacity M_{SC} vs δ_c of the Diesel Fuel Tank (case 1 α = 0, case 2 α = π/6)

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CALC # TPN-J, SJC-90-007
SIE Capacity of the Diesel Fuel Storage Tank
Turkey Point Units 3&4

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9SS 1/20/91

In such cases, the compressive buckling capacity stress of the tank shell cannot develop in the compressive zone, and, therefore, the quantities δ_c and $C_m < C_m$ are back calculated using eq. 18 and 19 for the done limit bolt elongation δ_{ex} and for any given final β. These back-calculated δ_c and C_m values are then used to solve the moment capacity M_{sc} in the same manner as described above, i.e. the angle β is varied until $C_m' = C_m'$.

d) Results are presented in Fig. 8 for both analyzed here cases 1 and 2. The calculated overturning moment capacities M_{sc} are plotted in Fig. 8 vs. the given elongation δ_{ex} of the outermost bolt which is limited up to .1 in. One can see from this figure, that in all these cases $M_{sc} >> M_0$, where $M_0 = 1,265.8$ kip-ft is the calculated above seismic base overturning moment response corresponding with the given seismic excitation. Both cases 1 and 2 give practically the same results.

(MO) e) The maximum elongation of the outermost bolt corresponding to its hold-down pullout capacity, T_{BC}, may be estimated as

$$\delta_e^{max} = 2.0\,\delta_B^{el} + 1.5\,\delta_{PL}^{el} = 2.0 \times 0.0181 + 1.5 \times 0.009 = 0.05\ in$$

where $\delta_B^{el} = .0181$ in - is the maximum bolt elastic elongation under the load F_{BC}

$\delta_{PL}^{el} = .009$ in - is the maximum elastic deflection of the top plate of the bolt chair under the load F_{BC}

2.0 ; 1.5 = coefficients implying the inelastic-ductility effects in the concrete near the anchor bolt and in the top plate (see Ref. 10 and Appendix A)

For this value $M_{sc} = 1,750.3$ kip-ft and, therefore

$$SME_M = \frac{M_{sc}}{k \cdot M_0} \times 0.15g = \frac{1,750.3}{1.0 \times 1,265.8} \times 0.15g = 0.207g$$

($k = 1.0$ - the inelastic energy absorption factor taken conservatively as unity for this failure mode).

f) All these results are valid if the bolt hold-down capacity $T_{BC} = 21.52$ kips is assured i.e. by means of the proposed reinforcing of the top triangle plates of the tank bolt chairs. As it is illustrated in Table 3, the overturning seismic moment capacity of the unanchored given tank (when $T_{BC} = 4.2$ kips only, the tank is practically unanchored) reaches only about 55% of the base overturning seismic moment response M_0 (up to the maximum uplift $\delta_c = .15$ in, otherwise the more comprehensive nonlinear analysis would be necessary). So the proposed reinforcing of the top plates of the bolt chairs is required!

6.5. Sliding Capacity

Since the seismic base shear response Q_0 and the base seismic overturning moment response M_0 are primarily due to the horizontal impulsive mode, they both are maximum in the same time. Thus, the sliding shear tank capacity is

$$Q_{SC} = \mathcal{K}\left[W_{ve} + \sum_i T_{Bi}\right] \quad (23)$$

where $W_{ve} = W_{Te} + p_a(\pi R^2)$ and $\mathcal{K}$ is the friction coefficient.

Here: $W_{Te} = 21.76$ kips, $p_a = 9.06$ psi, $\min \sum_i T_{Bi} = 86.898$ (see Table 4), and we assume $\mathcal{K} = 0.7$

Thus $W_{ve} = 21.76 + 0.00906(\pi \times 120^2) = 431.62$ kips

$Q_{sc} = 0.7[431.62 + 86.898] = 362.96$ kips

and $SME_Q = \frac{Q_{sc}}{k\,Q_0} \times 0.15g = \frac{362.96}{1.0 \times 98.58} \times .15g = 0.553g \gg SME_M$

(general formula for SME is $SME = \frac{\text{capacity} - \text{static}}{k \cdot \text{seismic response}}$ (SME$_c$))

k = inelastic energy absorption factor, in this case k = 1.0

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SUBJECT: Turkey Point JOB No. 90C1585 SHEET 30 OF 81

CALC # TPN-ISJC-90-007
SME Capacity of the Diesel Fuel Storage Tank
Turkey Point Units 3&4

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APPENDIX A

Results of static "pseudo-linear" analysis of the top plate of the bolt chair
(Effective stresses are more than σ_ye in several elements as F_{BC} is near the plate ultimate load)

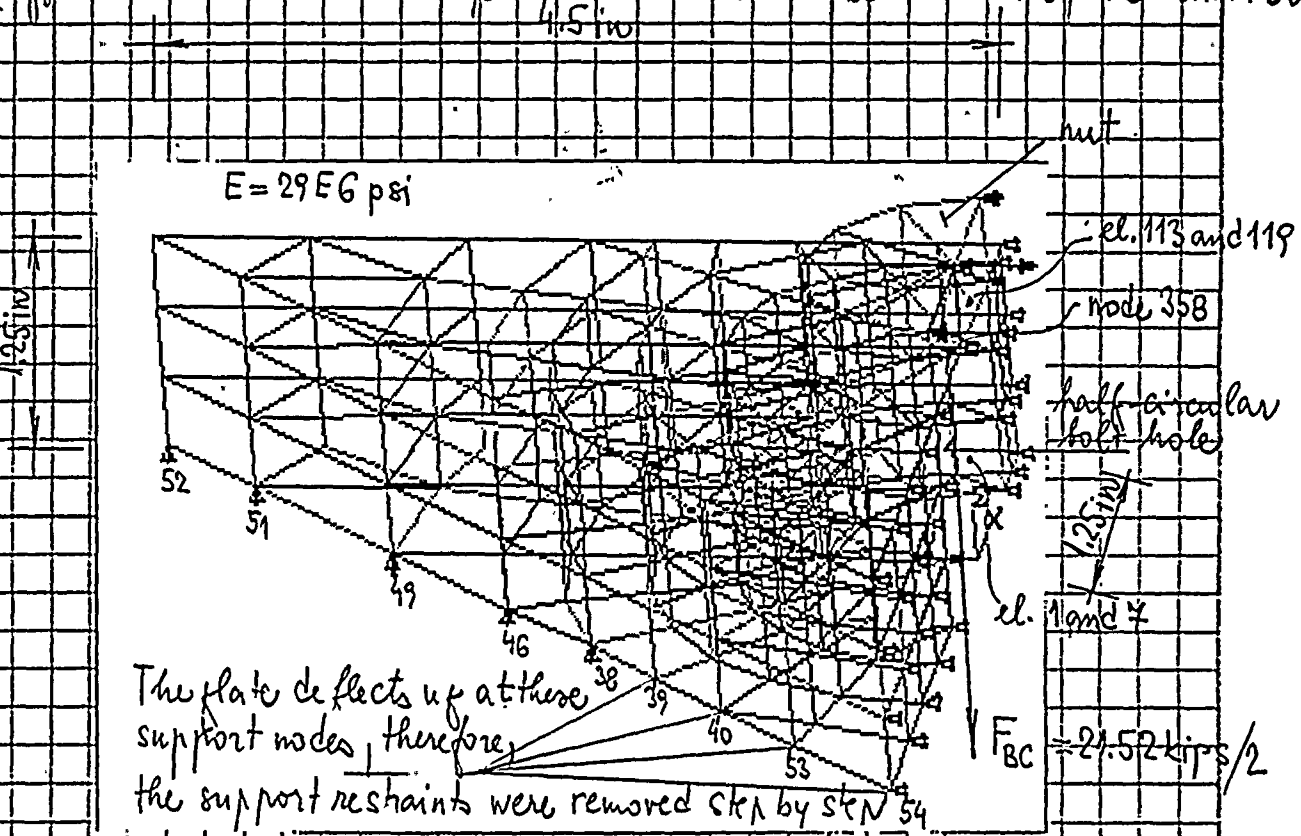

Fig. 9. Finite Element Model of the Top Plate of the Bolt Chair
(only 1/2 of the plate is analysed using symmetry)

THE FOLLOWING X,Y,Z DISPLACEMENTS ARE IN NODAL COORDINATES

NODE	UX	UY	UZ
358	-0.2867E-02	0.0000E+00	-0.8919E-02

Effective stresses in psi at several finite elements with greatest stress concentration (more than σ_ye)

ELEM	SIGI	SIGJ	SIGK	SIGL	SIGM	SIGN	SIGO	SIGP
7	75979.	74948.	76360.	76360.	41339.	40531.	43748.	43748.
119	49199.	8105.6	49779.	49779.	58834.	51055.	55244.	55244.

ELEM	SIGI	SIGJ	SIGK	SIGL	SIGM	SIGN	SIGO	SIGP
1	54525.	52650.	53122.	53122.	28078.	26377.	26674.	26674.
113	47241.	8527.6	3772.6	3772.6	61711.	51319.	53237.	53237.

Such great stresses near the bolt hole justify to use the coefficient 2.0 (see page 27).

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SUBJECT	Turkey Point
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SME Capacity of the Diesel Fuel Storage Tank
Turkey Point Units 3 & 4

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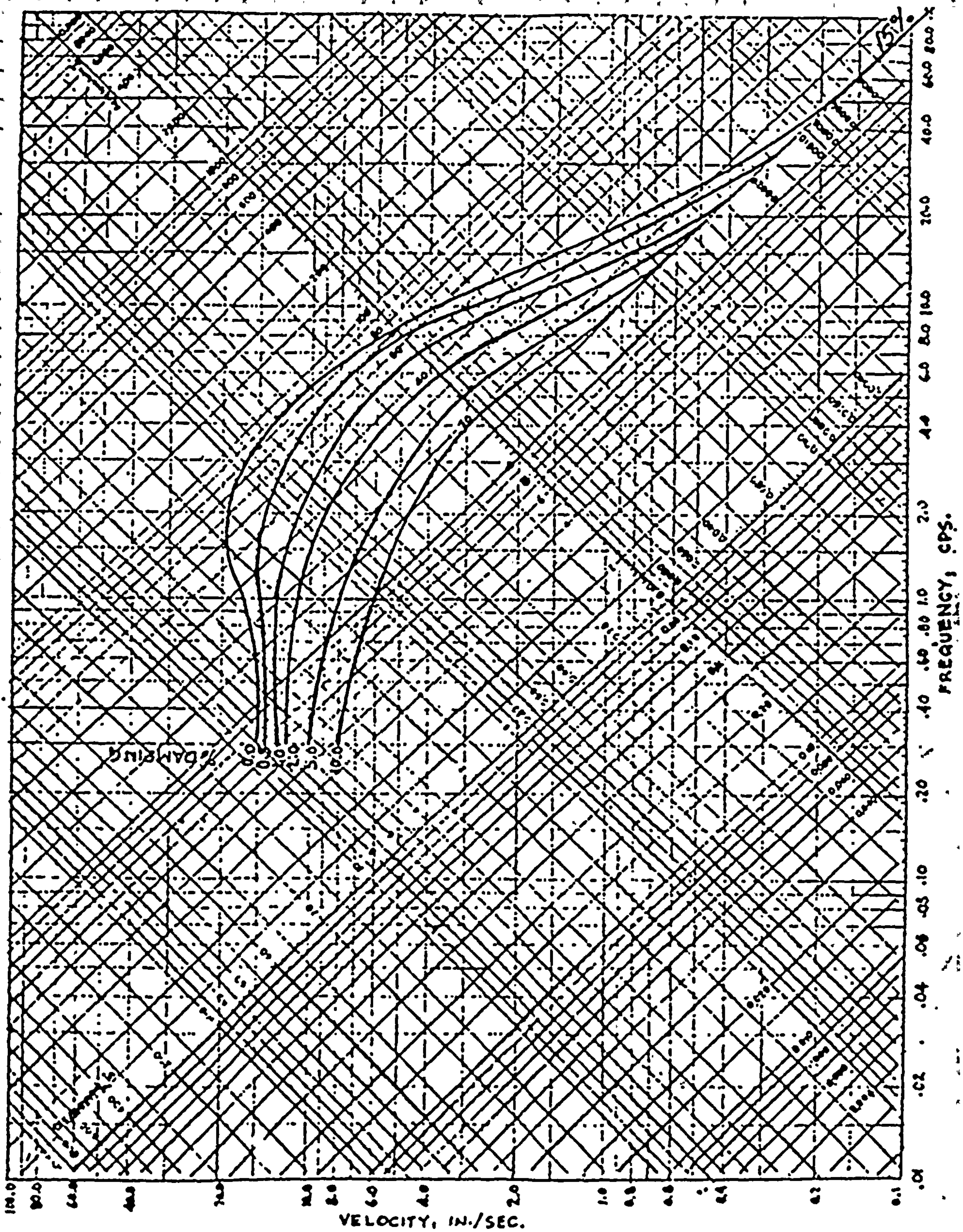
APPENDIX B - Damped Response Spectra, 15% ZPGA



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90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 11 - Boric Acid Storage Tank

PART A. EQUIPMENT DESCRIPTION

I.D. Number B | Building RAB

Manufacturer ______ | Elevation 27'

Model Number ______ | Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments ______
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number 8-7/8" Bolts Total
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) check anchorage of legs, bolts to Flanges, welds. Anchorage is adequate to support beam. However,
2. Concerns (if any) Torsion on support beam is a concern

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

ITEM 11 CONSIDERED OUTLIER BECAUSE OF CONCERNS NOTED ON ATTACHED PAGE

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90

NAME John W. Reed DATE 4/5/90

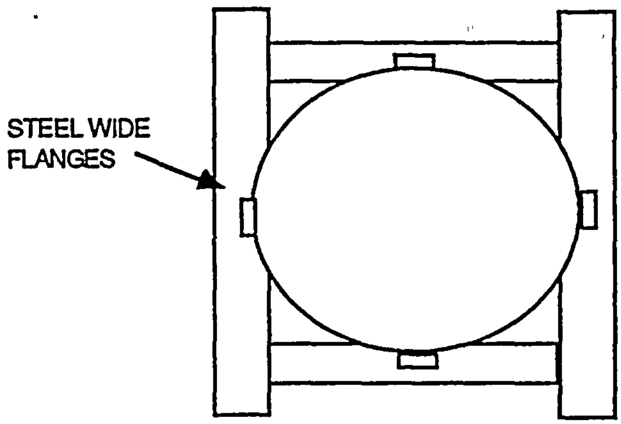
NAME Walter D. Stevens DATE 4/5/90

ITEM 11 BORIC ACID STORAGE TANK B

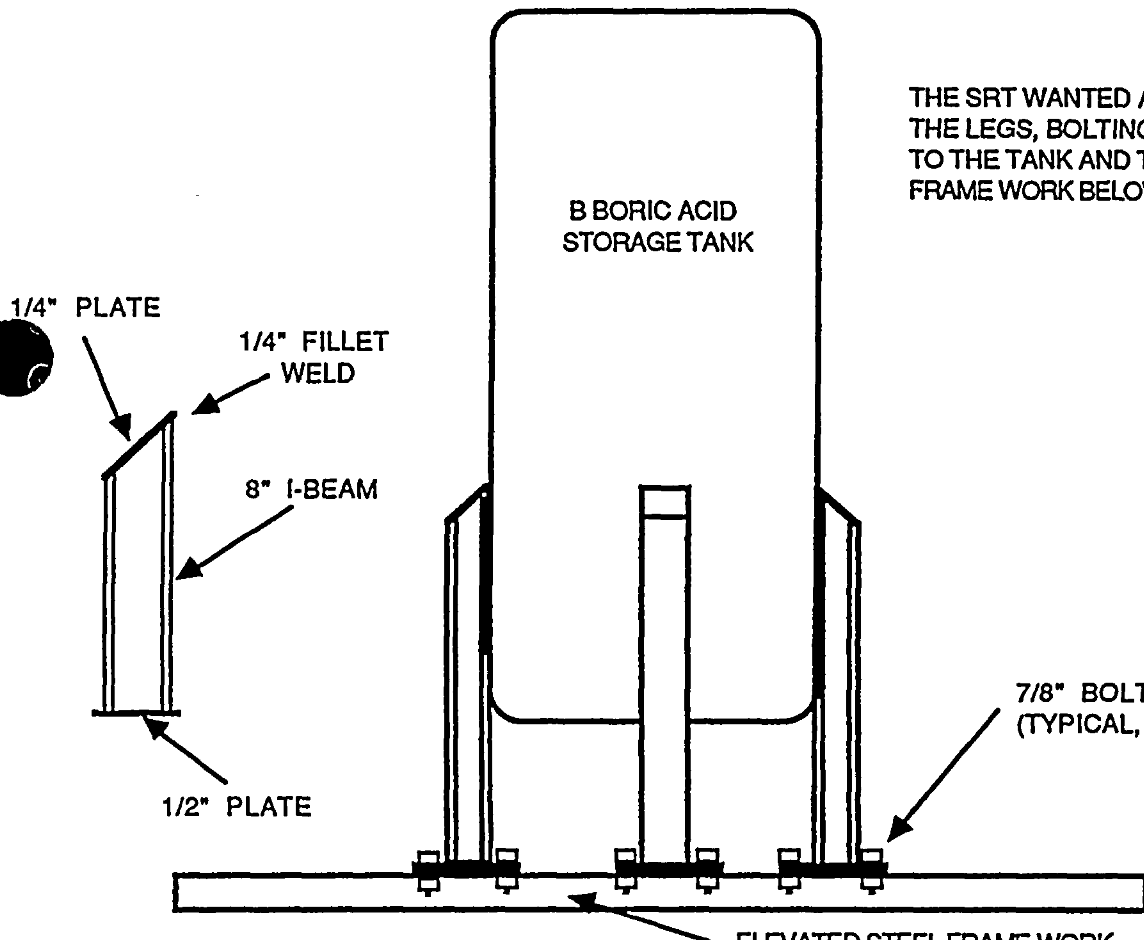
SRT WANTED ANCHORAGE TO PLATFORM, BOLT TO FLANGE, CHECKED. WELD CAPACITY OF LEGS TO TANK ALSO CHECKED.

PLATFORM TO BE CHECKED FOR TORSION, BY FPL.

AS-FOUND FIELD CONDITION



THE SRT WANTED AN ANALYSIS OF THE LEGS, BOLTING, ATTACHMENT TO THE TANK AND TO THE STEEL FRAME WORK BELOW.



ELEVATED TANK ABOVE THE BORIC ACID TRANSFER PUMPS, FILTERS AND VALVES

B BORIC ACID STORAGE TANK SEISMIC MOUNTING WORKSHEET

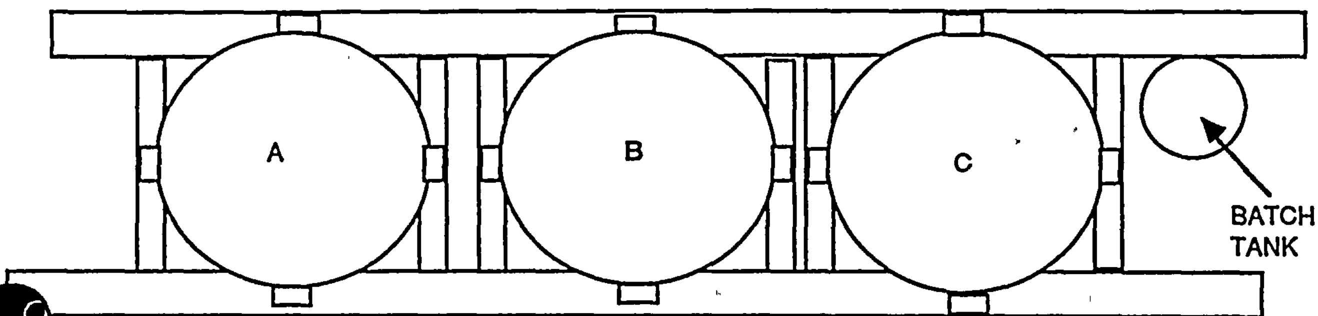
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT:B BORIC ACID STORAGE TANK
DATE: MAR 22, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT HAVE ANY SEISMIC INTERACTIONS CONCERNS



ELEVATED TANK ABOVE THE BORIC ACID TRANSFER PUMPS, FILTERS AND VALVES

B BORIC ACID STORAGE TANK SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT:B BORIC ACID STORAGE TANK
DATE: MAR 22, 1990 DWG BY: R. GOULDY

(11)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 12 - Condensate Storage Tank

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3

Building Outdoors (Adjacent EDG)

Manufacturer

Elevation 18'

Model Number

Other

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No
2. Condition of nearby concrete and embedments Good
3. Length, size, number, and soundness of welds gussets have good 1/2" penetration welds. Poor or broken Chair to tank welds.
4. Anchor bolt type, size and number 16 1 1/4" ϕ Anchors
5. Are nuts present and apparently tight on all bolts? Yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? No
   a. SRT Judgment
   b. URS Tables
   c. ANCHOR Program
   d. Other (explain) Calculations Required
   Based on Tank anchorage calculations Top chair and anchor embedment control bolt capacity.
2. Concerns (if any) TOP CHAIR welds have been broken on several chairs. Some top chairs have been bent assume all are not connected.

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90
NAME John W. Reed DATE 4/5/90
NAME John D. Stevenson DATE 4/5/90

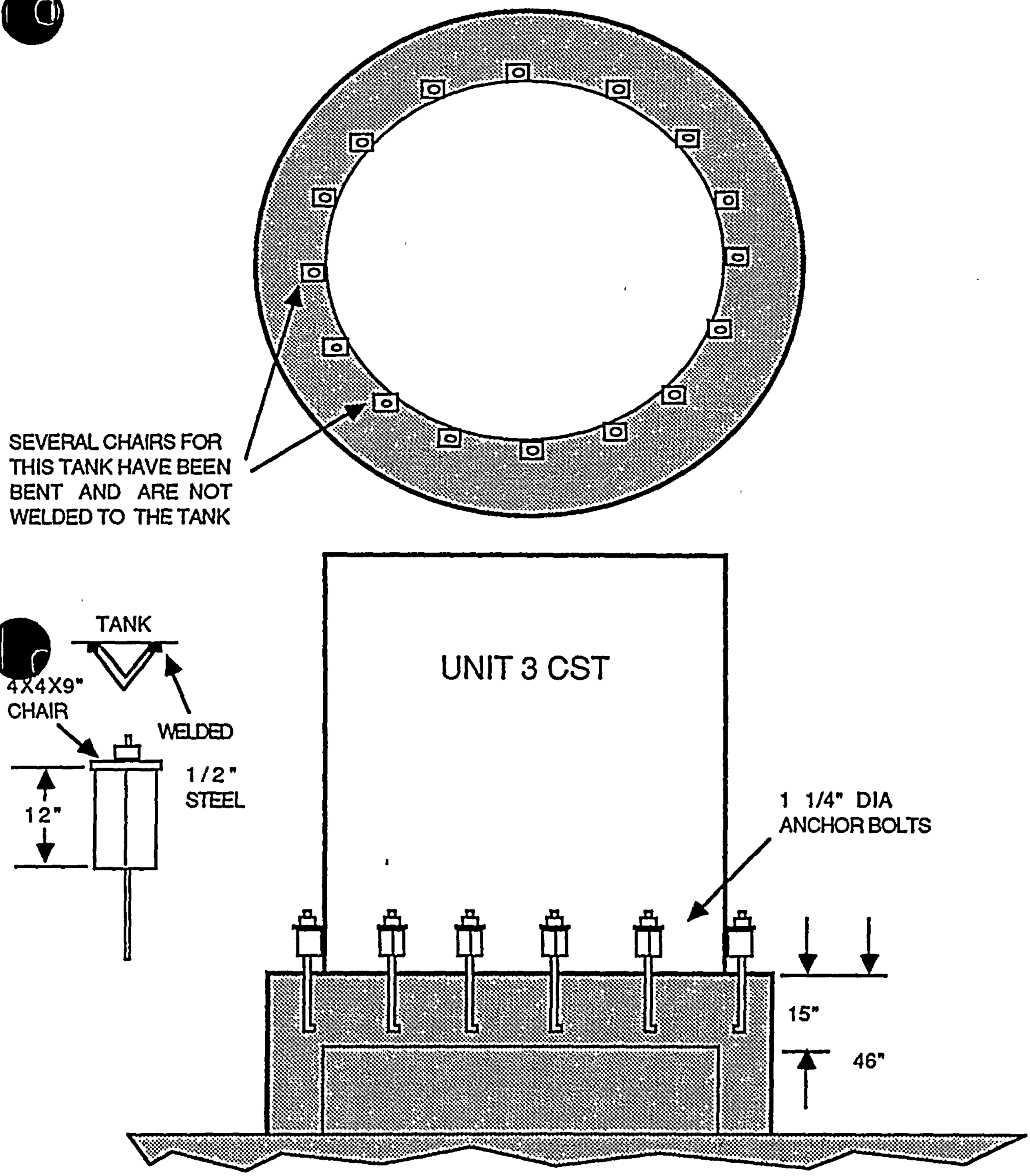
ITEM 12 CONDENSATE STORAGE TANK - Unit 3

SRT WANTED CALCULATIONS FOR:

1) BOLT ANCHORAGE
2) TOP OF CHAIR ADEQUACY
3) NOTED THAT TOP OF SOME CHAIRS ARE NOT WELDED TO TANK & SOME CHAIR PLATES ARE BENT.

HCLPF FOR BOLT BOND FAILURE CALCULATED TO BE .11g WITH THE INCREASED CHAIR PLATE.

AS-FOUND FIELD CONDITION



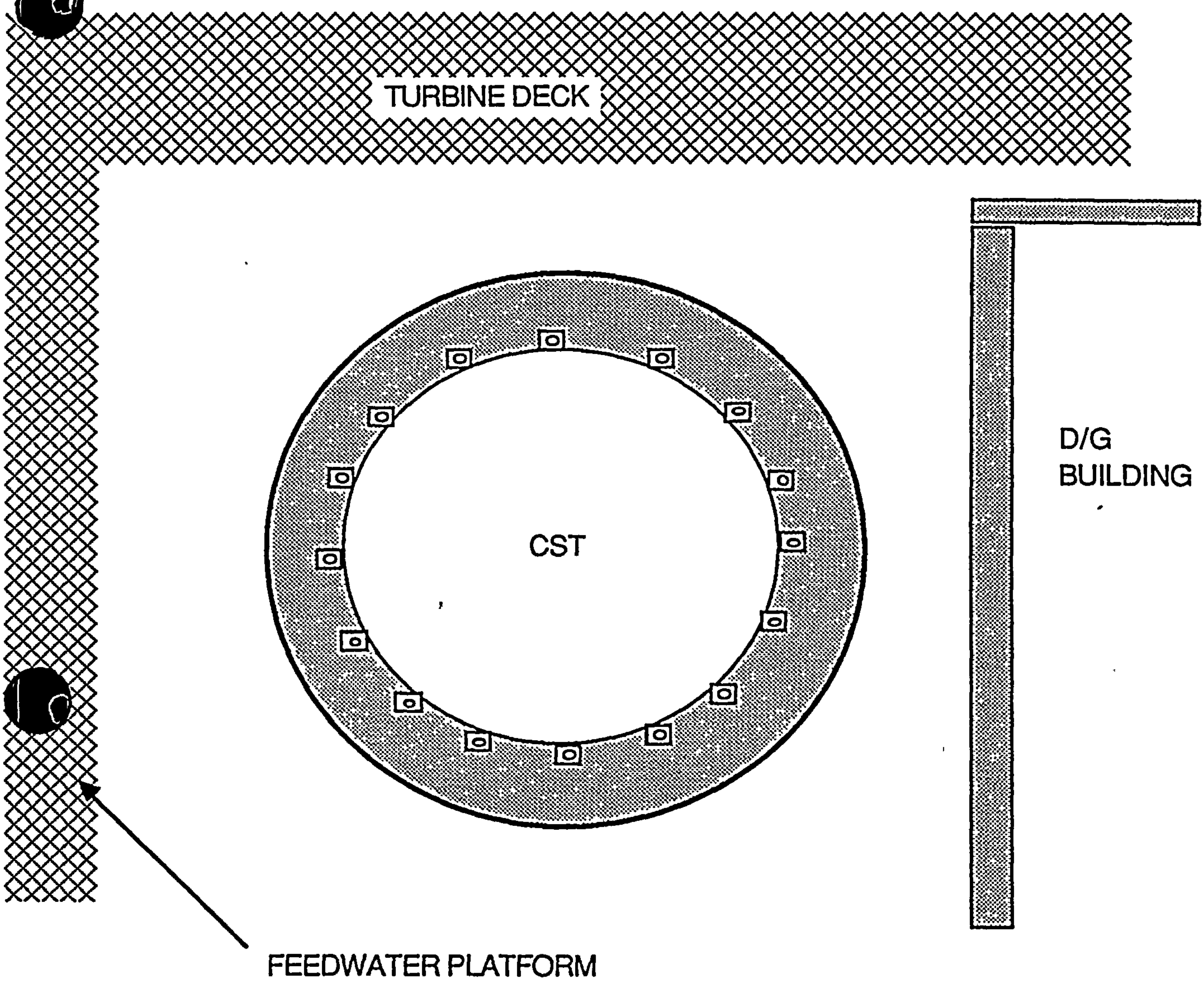
UNIT 3 CST TANK
TANK MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT UNIT 3 CST	
DATE:MAR 22, 1990	DWG BY: R.GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT HAVE ANY SEISMIC INTERACTIONS CONCERNS

UNIT 3 CST TANK
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT UNIT 3 CST	
DATE:MAR 22, 1990	DWG BY: R. GOULDY

CALCULATION COVER SHEET

Calculation No: TPN-15JC-90-008

Title: SME Capacity of the Condensate Storage Tank with Increased Chair Plate

No.	Description	By	Date	Chk/Ver	Date	Appr	Date
0	INITIAL ISSUE	RM	12/12/90	DDJ	1/20/90	DJS	1/20/90

REVISIONS

LIST OF EFFECTIVE PAGES

CALCULATION NUMBER TPN-1SJC-90-008 REV. 0

PAGE	SECTION	REV	PAGE	SECTION	REV	PAGE	SECTION	REV
1	1.0 Purpose/Scope	0	15	6.0 Capacity Assessment	0			
	2.0 References			6.1 Compressive Buckling Capacity of the Tank Shell				
2	"	0						
	3.0 Methodology		16	"	0			
				6.2 Bolt Hold-Down Capacity				
3	4.0 Basic Assumptions	0	17	"	0			
	Calculation		18	6.3 Fluid Hold-Down Forces	0			
4	5.0 Response Evaluation	0	19	"	0			
	5.1 Basic Input Data		20	"	0			
			21	6.4 Overturning Moment Capacity	0			
5	"	0						
	5.2 Free Vibration Analysis		22	"	0			
			23	"	0			
6	"	0	24	"	0			
7	"	0	25	"	0			
8	5.3 Spectral Accelerations	0		6.5 Sliding Capacity				
	5.4 Horizontal Impulsive Mode Response		26	"	0			
				6.6 Other Capacity Checks				
9	"	0		7.0 Results				
10	"	0	27	"	0			
	5.5 Horizontal Convective (Sloshing) Mode Response							
11	"	0						
	5.6 Vertical Fluid Mode Response							
12	"	0						
	5.7 Combined Responses							
13	"	0						
14	"	0						

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CALCULATION NUMBER TPN-ISJC-90-008 REV. 0

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SUBJECT Turkey Point JOB No. 90C1585 SHEET 1 OF 27

CALC # TPN-ISSC-90-008
SME Capacity of the Condensate Storage Tanks
With Increased Chair Plate
Turkey Point, Units 3&4

REVISIONS
0 [initials] 12/15/90
[initials] 1/20/91

1. PURPOSE / SCOPE

The purpose of this calculation is to perform an evaluation of the Condensate Storage Tanks of the TURKEY Point, Units 3&4, to estimate the tanks seismic capacity after the top plates are increased to 1 1/4 inches. This calculation is intended to be conservative and gives the High-Confidence-Low-Probability-of-Failure (HCLPF) seismic capacity of the tank.

2. REFERENCES

/1/ Kennedy, R.P. et al., "Assessment of Seismic Margin Calculation Methods" NUREG/CR-5270, UCID-21572, Lawrence Livermore National Laboratory, Livermore, 1988.

/2/ Veletsos, A.S., "Seismic Response and Design of Liquid Storage Tanks" In: Guidelines for the Seismic Design of Oil and Gas Pipeline Systems, ASCE, New York, 1984.

/3/ Veletsos, A.S. and Yang, J.Y., "Dynamics of Fixed-Base Liquid-Storage Tanks", Proceedings of the U.S.-Japan Seminar for Earthquake Engineering Research with Emphasis on Life Line Systems, Tokyo, Japan, Nov. 1976.

/4/ Veletsos, A.S. and Tang, Yu, "Dynamics of Vertically Excited Liquid Storage Tanks", Journal of Structural Engineering, Vol. 112, No. 6, ASCE, June 1986, pp. 1228-1246.

/5/ Haroun, M.A. - Housner, G.W., "Seismic Design of Liquid Storage Tanks", Journal of the Technical Councils of ASCE, Vol. 107, No. TC1, 1981, pp. 191-207.

/6/ ASCE Standard and Commentary "Seismic Analysis of Safety Related Nuclear Structures", ASCE 4-86, September 1986.

/7/ Niwa, A. - Clough, R.W. Buckling of Cylindrical Liquid Storage Tanks under Earthquake Loading, Earthquake Engineering and Structural Dynamics, Vol. 10, 1982, pp. 107÷122.

/8/ Buckling of Thin-Walled Circular Cylinders, NASA SP-8007, August, 1968

/9/ Manual of Steel Construction, 8th edition, AISC, Chicago, 1980.

/10/ HOLMES M., MARTIN L.H., "ANALYSIS AND DESIGN OF STRUCTURAL CONNECTIONS REINFORCED CONCRETE AND STEEL," 1983

/11/ Drawing 5610-C-18-392, Turkey Point Units 3&4, Condensate and Diesel Fuel Storage Tanks

/12/ Turkey Point - Ground Response Spectra 15% Acceleration, Fig. S.2

3. METHODOLOGY

The seismic evaluation of the condensate storage tank consists of two main parts: (1) a seismic response analysis presented in the chapter 5 and (2) a seismic capacity assessment given in the chapter 6. The first seismic response analysis is based here on the works of Veletsos /2,3,4/, while the approach and formulas given in Ref. /1/ are mostly used in the seismic capacity assessment.

The actual SME capacity of the tank is estimated from

/1/ $$SME = \frac{Capacity - Static}{k \; Seismic_c} (SME_c)$$

where Capacity is the HCLPF capacity of the tank, Static is the portion of this capacity used up by static loads, $Seismic_c$ is the computed seismic response, k is the inelastic energy absorption factor and SME_c is .15g in this case.

Both horizontal and vertical seismic ground motions are defined by response spectrum curves (the vertical motion is specified as two-thirds of the horizontal one) which correspond to the maximum hypothetical earthquake of .15g ZPGA at the power plant site.

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SUBJECT Turkey Point JOB NO. 90C1585 SHEET 3 OF 27

CALC. # TPN-15JC-90-008
SME Capacity of the Condensate Storage Tank
WITH INCREASED CHAIR PLATE
Turkey Point, Units 3&4

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4. BASIC ASSUMPTIONS

/11/ a) The tank is considered in accordance with Ref. 11 to be vertical of circular cross section, fixed by the anchorage bolts at the concrete foundation, and to have a free liquid surface.

/1/ /2/ /3/ /4/ b) Solutions are based upon the theory of small displacements of the tank shell and tank bottom and small displacements of the incompressible liquid inside the tank.

/6/ c) Any effects of soil-tank foundation interaction are not considered. The tank foundation is assumed to be sufficiently rigid. Only higher damping ratio is introduced when the vertical seismic response is determined to partially compensate the effects of soil flexibility and energy radiation below the foundation.

d) As the anchorage bolt hold-down capacity is governed by the bolt pullout capacity and not by its tensile capacity, only very limited inelastic elongation of the outermost bolt is taken into account.

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SUBJECT: Turkey Point JOB No. 90 C1 585 SHEET 4 OF 27

CALC. #TPN-15JC-90-009
SME Capacity of the Condensate Storage Tank
WITH INCREASED CHAIR PLATE
Turkey Point, Units 3&4

REVISIONS: 0 — RM 12/15/90; JJS 1/20/91

Calculations:

5. RESPONSE EVALUATION

5.1. Basic Input Data

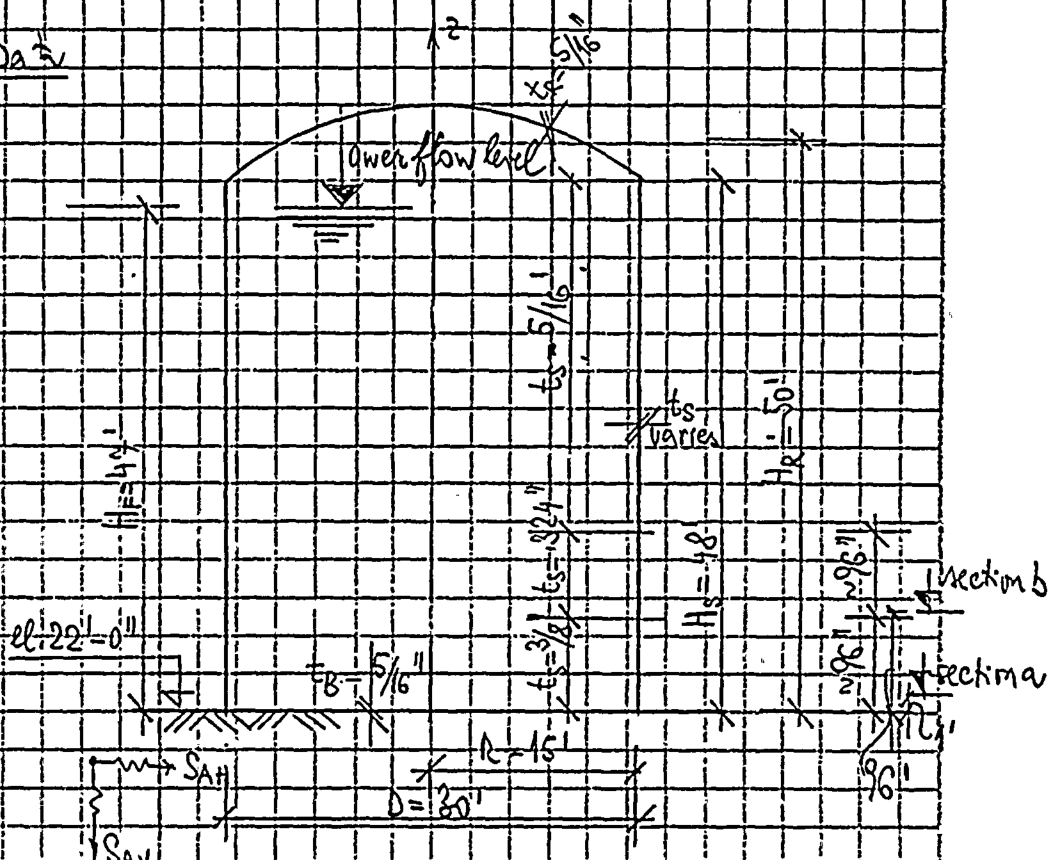

Fig. 1. Condensate Storage Tank

a) Elastic properties:

- tank steel $E_{ST} = 29 \times 10^6$ psi (Young's modulus of elasticity)

$\nu = .3$ (Poisson's ratio)

- fluid none

b) Specific weights and masses:

- tank steel $W_{ST} = 490$ lb/ft³, $\rho_{ST} = W_{ST}/g = 490/32.185 = 15.225$ lb-s²/ft⁴

- fluid (water) $W_F = 62.4$ lb/ft³, $\rho_F = W_F/g = 62.4/32.185 = 1.939$ lb-s²/ft⁴

($g = 32.185$ ft/s² – gravity acceleration)

c) Weights and masses:

- roof $W_R = 1.1 \pi R^2 t_R w_{ST} = 1.1 \pi (15^2) \frac{.3125}{12} \times 490 = 9,821.79$ lb;

$m_R = W_R / g = 9,821.79 / 32.185 = 305.274$ lb-s²/ft

- shell $W_S = \pi D H_S \tilde{t}_S w_{ST} = \pi (30)(48) \frac{.3248}{12} \times 490 = 58,748.91$ lb

$\left(\tilde{t}_S = \frac{4 \times 0.3125'' + .324'' + .375''}{6} = .3248''\right)$ $\tilde{t}_S$ = average thickness of the shell

$m_S = W_S / g = 58,748.91 / 32.185 = 1,825.35$ lb-s²/ft

- bottom $W_B = \pi R^2 t_B w_{ST} = \pi (15^2) \frac{.3125}{12} \times 490 = 9,019.81$ lb;

$m_B = W_B / g = 9,019.81 / 32.185 = 280.249$ lb-s²/ft

- fluid $W_F = \pi R^2 H_F w_F = \pi (15^2)(47) \times 62.4 = 2,073,074.2$ lb;

$m_F = W_F / g = 2,073,074.2 / 32.185 = 64,411.19$ lb-s²/ft

5.2 Free Vibration Analysis

a) Fundamental horizontal natural frequency of the tank - liquid system

- the frequency coefficient for the tank filled with water

$C_W = .108$ for $H_F / R = 47/15 = 3.133$ and $\tilde{t}_S / R = .3248 / (15 \times 12) = .001804$ (dimensionless)

- the tank is filled with water and, therefore,

$C_L = C_W = .108$

- the fundamental horizontal natural frequency without effects of the roof mass will be:

$$f_H' = \frac{C_F}{2\pi H_F}\sqrt{\frac{E_{ST}}{\rho_{ST}}} = \frac{.108}{2\times\pi\times(47)}\sqrt{\frac{29\times10^6(12^2)}{15.225}} = 6.057\ Hz$$

– flexural and shear stiffness of the tank computed as a cantilever beam):

$$k_F = 3\pi\left(\frac{R}{H_S}\right)^3 E_{ST}\,k\,\tilde{t}_S = 3\pi\left(\frac{45}{48}\right)^3(29\times10^6)\times(12)\times(.3248) = 3.251\times10^7\ lb/ft$$

$$k_S = \frac{\pi}{2(1+\nu)}\frac{R}{H_S}E_{ST}\tilde{t}_S = \frac{\pi}{2(1+.3)}\left(\frac{45}{48}\right)(29\times10^6)\times(12)\times(.3248) = 4.268\times10^7\ lb/ft$$

– corresponding natural frequencies for an empty tank of the same proportions as an actual tank but for which the only structural mass is the roof mass m_R:

$$f_{HF}' = \frac{1}{2\pi}\sqrt{\frac{k_F}{m_R}} = \frac{1}{2\pi}\sqrt{\frac{3.251\times10^7}{308.274}} = 51.684\ Hz;$$

$$f_{HS}' = \frac{1}{2\pi}\sqrt{\frac{k_S}{m_R}} = \frac{1}{2\pi}\sqrt{\frac{4.268\times10^7}{308.274}} = 59.219\ Hz;$$

– the fundamental horizontal natural frequency including effect of the roof mass (using the approximate expression of the Dunkerley type):

$$\frac{1}{f_H^2} = \frac{1}{(f_H')^2} + \frac{1}{(f_{HF}')^2} + \frac{1}{(f_{HS}')^2} = \frac{1}{6.057^2} + \frac{1}{51.684^2} + \frac{1}{59.219^2} = .027917;$$

and, therefore,

$$f_H = \sqrt{1/.027917} = 5.985\ Hz;$$

.12/.14/ b) Fundamental vertical natural frequency of the tank – liquid system

– the frequency coefficient

$C_V = .0975$ for $H_F/R = 1.133$ and $\tilde{t}_S/R = .001804$

– fundamental vertical natural frequency without effects of tank inertia (based on a theory that considers the tank to act as a membrane, axisymmetric cylinder):

$$f_V' = \frac{C_V}{2\pi H_E}\sqrt{\frac{E_{ST}}{\rho_{ST}}} = \frac{.0975}{2\pi(47)}\sqrt{\frac{29\times10^6(12)^2}{15.225}} = 5.468\ Hz$$

– natural frequency of axial vibration of the tank incl. effects of the roof mass

$$f_a = \frac{.275}{H_S\sqrt{1+3m_R/m_S}}\sqrt{\frac{E_{ST}}{\rho_{ST}}} = \frac{.275}{47\times\sqrt{1+3\times\frac{308.274}{1,825.35}}}\sqrt{\frac{29\times10^6\times12^2}{15.225}} = 78.946\ Hz$$

– the fundamental vertical natural frequency incl. effects of tank inertia (using the approximate expression of the Dunkerley type):

$$\frac{1}{f_V^2} = \frac{1}{(f_V')^2} + \frac{1}{(f_a)^2} = \frac{1}{5.468^2} + \frac{1}{78.946^2} = .033606;$$

and, therefore,

$$f_V = \sqrt{1/.033606} = 5.455\ Hz$$

Remarks:

(1) It is concluded from relations given above effects of tank inertia in vertical direction as well as effects of roof inertia in horizontal direction are both negligible.

(2) Rigid foundation of the tank is assumed and no effects of soil-tank interaction are taken into account here.

/2/ /3/ c) Three fundamental sloshing frequencies are

$$f_{S1} = \frac{1.043}{\sqrt{R}} = .269\ Hz \quad f_{S2} = \frac{2.075}{\sqrt{R}} = .536\ Hz \text{ and } f_{S3} = \frac{2.638}{\sqrt{R}} = .6811\ Hz$$

$(R = 15\ ft)$

Both calculated fundamental natural frequencies f_H and f_V of the tank-liquid system may vary ± 15% as well as sloshing frequencies (uncertainties in input data, simplified calculations etc.).

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5.3. Spectral Accelerations

/12/ The following spectral accelerations have been extracted from the given response spectrum (ZPA = .15g)

S_{AI} (f_H = 5.985 Hz ± 15%, damping 5%) = .285g (peak value) } impulsive horizontal

S_{AV} (f_V = 5.455 Hz ± 15%, damping 5%) = 2/3 × .285g = .19g } vertical effects

S_{AC} (f_H = .269 Hz ± 15%, damping .5%) = .08g — sloshing, convective effects

5.4. Horizontal Impulsive Mode Response

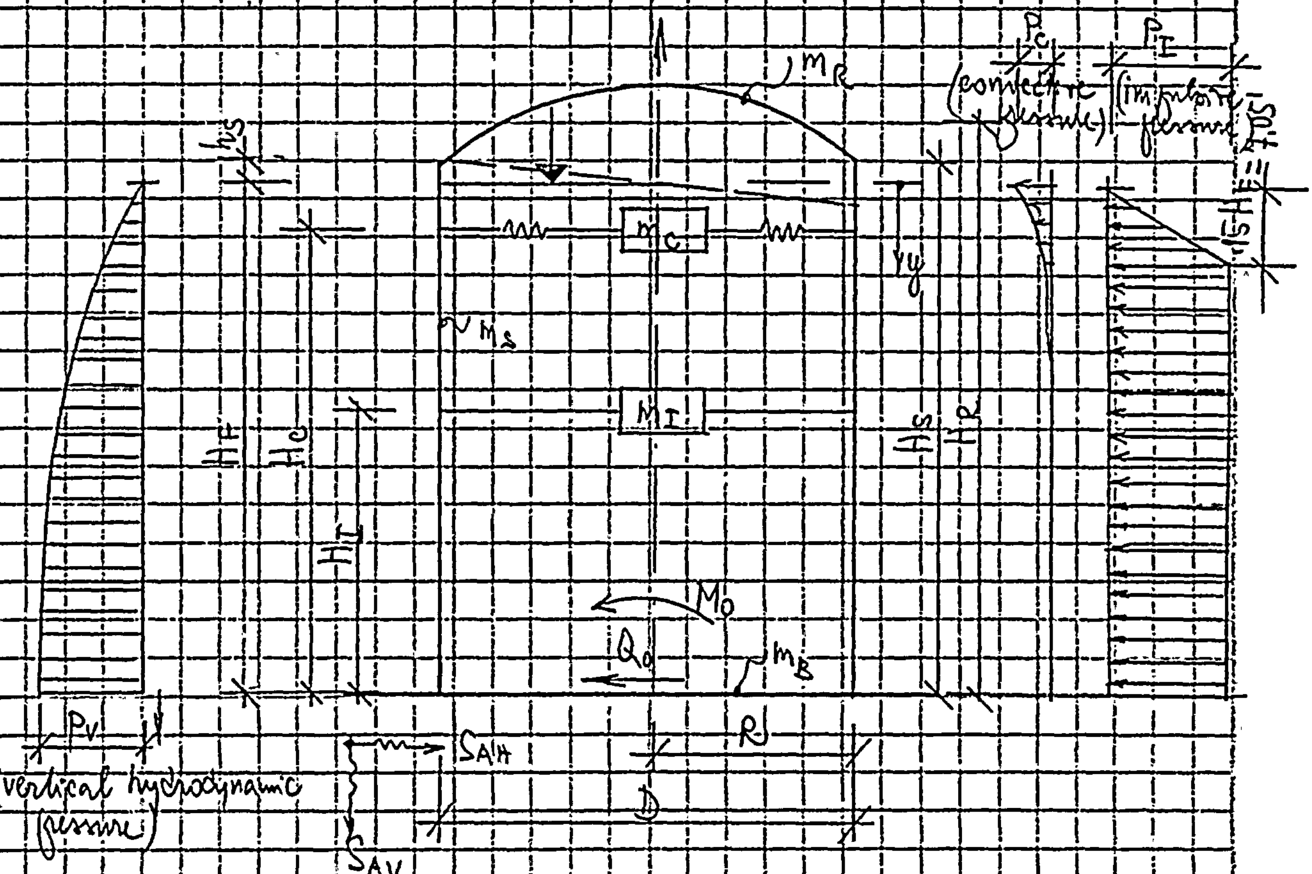

Fig. 2. Components of Tank Earthquake Response

1/ According to the ASCE Standard 4-86, the impulsive mode base shear, Q_{oI} and moment, M_{oI}, at the base of the tank shell are given by

$$Q_{oI} = (m_R + m_S + m_B + m_I) S_{AI} \qquad (1)$$

and

$$M_{oI} = \left(m_R H_R + m_S \frac{H_S}{2} + m_I H_I\right) S_{AI} \qquad (2)$$

For all items see Fig. 2.

In this case, when $H_F/R = 47/15 = 3.133 > 1.5$

$$\frac{m_I}{m_F} = 1.0 - .435\frac{R}{H_F} = .861 \text{, i.e. } m_I = .861 m_F = .861\,(64,411.19) = 55,458.04 \text{ lb-s}^2/\text{ft};$$

and

$$\frac{H_I}{H_F} = .5 - .188\frac{R}{H_F} = .44 \text{, i.e. } H_I = .44 H_F = .44 \times 47 = 20.68 \text{ ft},$$

Thus from eq. (1) and (2), the impulsive mode base shear and moment are:

$$Q_{oI} = (308.274 + 1,825.35 + 280.249 + 55,458.04) \times .285 \times 32.185 = $$
$$= 530,843.14 \text{ lb} = 530.84 \text{ kips}$$

$$M_{oI} = \left(308.274 \times 50 + 1,825.35 \times \frac{48}{2} + 55,458.04 \times 20.68\right) \times .285 \times 32.185 =$$
$$= 11,063,172. \text{ lb-ft} \doteq 11,063.17 \text{ kip-ft}$$

One can easily recognize that neglecting tank inertia effects in expressions for the impulsive mode base shear and moment would create errors that cannot be neglected.

2/ Veletsos provides a slightly different formulation of Q_{oI} and M_{oI} which leads to a slightly lower base shear and to a practically identical base moment.

3/ Haroun and Housner provide another different formulation which gives slightly lower base shear, but slightly higher base moment.

For this case, the results given by eqs. (1) and (2) to be used as they are in accordance with ASCE Standard 4-86.

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/b/ According to the ASCE Standard 4-86, the impulsive mode hydrodynamic pressure p_I should be approximated by:

$$p_I = \frac{m_I H_I}{1.36 R} \frac{S_{AI}}{H_F^2} = \frac{55{,}458.04 \times 20.68 \times .285 \times 32.185}{1.36 \times 15 \times 47^2} = 233.446 \text{ lb/ft}^2 \text{ i.e. } 1.621 \text{ psi}$$

Both Veletsos and Haroun & Housner provide alternate formulations for estimating the impulsive pressure which gives slightly different values. The impulsive pressure determined above will be used below.

5.5. Horizontal Convective (Sloshing) Mode Response

The convective mode base shear and moment are given by

$$Q_{OC} = m_C S_{AC} \quad (3)$$

and

$$M_{OC} = m_C S_{AC} H_C \quad (4)$$

For all items see Fig. 2.

/c/ According to the ASCE Standard 4-86 and another subjected references

$$\frac{m_C}{m_F} = 0.46 \frac{R}{H_F} \tanh\left(1.835 \frac{H_F}{R}\right) = .1468, \text{ i.e. } m_C = .1468\, m_F = .1468 \times 64{,}411.19 = 9{,}455.92 \text{ lb-s}^2/\text{ft}$$

$$\frac{H_C}{H_F} = 1.0 - \frac{\cosh\left(1.835 \frac{H_F}{R}\right) - 1.0}{1.835 \frac{H_F}{R} \sinh\left(1.835 \frac{H_F}{R}\right)} = .8272; \text{ i.e. } H_C = .8272 H_F = .8272 \cdot 47 = 38.88 \text{ ft}$$

Thus from eqs. (3) and (4), the convective mode base shear and moment are

$$Q_{OC} = 9{,}455.92 \times .08 \times 32.185 = 24{,}347.10 \text{ lb} \doteq 24.35 \text{ kips}$$

and

$$M_{OC} = 9{,}455.92 \times 38.88 \times .08 \times 32.185 = 946{,}615.86 \text{ lb-ft} \doteq 946.62 \text{ kip-ft}$$

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The hydrodynamic convective pressure can be estimated as follows:

$$p_c = \frac{.267\, m_F\, S_{AC}}{R\, H_F} \times \frac{\cosh\left(1.835\,\frac{H_F - y}{R}\right)}{\cosh\left(1.835\, H_F/R\right)} \qquad (5)$$

Where y is a depth from the top of the liquid (see Fig. 2).

If y = 0, using eq. (5)

$$p_c = \frac{.267 \times 64,411.19 \times 0.8 \times 32.185}{15 \times 47} \times 1.0 = 62.81\ lb/ft^2 = .436\ psi$$

If y = 10' and 20', we obtain

$$p_c = .436 \times \frac{\cosh\left(1.835\,\frac{47-10}{15}\right)}{\cosh\left(1.835 \times 47/15\right)} = .1283\ psi \text{ and } p_c = .436\,\frac{\cosh\left(1.835\,\frac{47-20}{15}\right)}{\cosh\left(1.835 \times 47/15\right)} = .0378\ psi$$

Such pressures are generally negligible compared to either the hydrodynamic impulsive pressure p_I or hydrodynamic vertical pressure p_v except at shallow depths below the fluid surface.

(6) Lastly, the fundamental mode fluid sloshing height h_s can be approximated as

$$h_s = .84\, R\, (S_{AC}/g) = .84 \times 15 \times 0.08 = 1.008\ ft.$$

5.6 Vertical Fluid Mode Response

(4) According Veletsos, the hydrodynamic vertical fluid response mode pressure for a tank on a rigid foundation can be estimated as

$$p_v = 0.8\, \rho_F\, H_F\, (S_{AV}) \cos\left(\frac{\pi}{2}\,\frac{H_F - y}{H_F}\right) \qquad (6)$$

which is more accurate than the linear varying pressure defined by eq. 3500-7 of the ASCE Standard 4-86.

Even for tanks on a rock site there will be some foundation flexibility. A flexible foundation greatly reduces the vertical fluid mode hydrodynamic pressures below

that computed for a absolute rigid foundation. One way to approximate this influence is through increased damping, in this case about 5%.

Using eq. (6) when $y = H_F$, we obtain

$$p_V = 0.8 \times 1.939 \times 47 \times 0.19 \times 32.185 = 445.83\ lb/ft^2 = 3.096\ psi$$

and, consequently, when $y = 15'$ and $30'$ we have

$$p_V = 3.096 \cos\left(\frac{\pi}{2} \times \frac{47-15}{47}\right) = 1.4879\ psi \quad \text{and} \quad p_V = 3.096 \cos\left(\frac{\pi}{2}\frac{47-30}{47}\right) = 2.6096\ psi,$$

respectively.

5.7. Combined Responses

The combined horizontal responses for base shear, Q_0, base moment M_0, and for horizontal hydrodynamic pressures (p_H) can be obtained by the SRSS combination of the horizontal impulsive and convective responses. Thus,

$$Q_0 = \sqrt{Q_{0I}^2 + Q_{0C}^2} = \sqrt{530.84^2 + 24.35^2} = 531.40\ kips$$

$$M_0 = \sqrt{M_{0I}^2 + M_{0C}^2} = \sqrt{11,063.17^2 + 946.62^2} = 11,103.60\ kip\text{-}ft$$

while Table 1 presents the combined horizontal dynamic pressures, p_H.

For the purposes of the membrane hoop stress capacity check it is necessary to have an estimate of the maximum seismic hydrodynamic pressures, p_S, which is obtained by the SRSS combination of the horizontal seismic pressures, p_H, and the vertical fluid response hydrodynamic pressures p_V. Table 1 presents these values at two capacity evaluation locations (section a and b).

For the purposes of estimating the compressive buckling capacity of the tank shell it is necessary to have an estimate of the expected maximum and minimum fluid pressures acting against the tank shell near the base at the location of maximum axial compression during the time of maximum base moment. Those expected maximum and minimum compression zone pressures can be estimated as

$$p_{C+} = p_{ST} + p_H + 0.4\,p_V \quad \text{and} \quad p_{C-} = p_{ST} + p_H - 0.4\,p_V \qquad (7)$$

where the factor 0.4 on p_v is to account for the probable vertical mode hydrodynamic vertical pressure at the same time of maximum base moment.

/1/ Similarly, for the purposes of estimating the expected minimum fluid hold-down forces in the zone of maximum tank wall axial tension, it is need to have an estimate of the maximum tension zone fluid pressure, p_{T-}, at the same time of maximum moment, as given by

$$p_{T-} = p_{ST} - p_H - 0.4\,p_V \qquad (8)$$

/1/ For the sliding capacity evaluation one needs the expected minimum average fluid pressure on the base plate p_a, at the same time of maximum base shear, as given by

$$p_a = p_{ST} - 0.4\,p_V \qquad (9)$$

The static fluid pressure is $p_{ST} = W_F \cdot y$, so, when $y = H_F$ (tank base), we obtain a maximum value

$$p_{ST} = W_F \times H_F = 62.4 \times 47 = 2{,}932.8 \text{ lb/ft}^2 = 20.37 \text{ psi}$$

/1/ Thus, at the tank base

$$p_{C+} = 20.37 + 1.621 + 0.4 \times 3.096 = 23.229 \text{ psi}$$

$$p_{C-} = 20.37 + 1.621 - 0.4 \times 3.096 = 20.753 \text{ psi}$$

$$p_{T-} = 20.37 - 1.621 - 0.4 \times 3.096 = 17.106 \text{ psi}$$

$$p_a = 20.37 - 0.4 \times 3.096 = 19.132 \text{ psi}$$

/1/ Lastly one needs an estimate of the expected minimum total effective weight W_{TE}, of the tank shell and roof at the time of maximum moment and base shear:

$$W_{TE} = (W_R + W_S)\left(1 - 0.4\,(a_v/g)\right) = (8{,}921.79 + 58{,}748.91)(1 - .4 \times 0.1) = 65{,}923.87 \text{ lb} \doteq 65.92 \text{ kips}$$

Here $a_v = 2/3\,ZPA = 2/3 \times 0.15g = 0.1g$

Table 1 Hydrostatic and Hydrodynamic Pressures and SME Capacity at Capacity Evaluation Locations

Section	Wall thickness [in]	y [ft]	Individual pressures [psi] P_{ST}	P_I	P_C	P_V	Combined pressures [psi] P_H	P_S	Capacity*) pressure P_{ca} [psi]	Capacity**) SME $_P$ ***) [g]
a	.375	46	19.93	1.621	~0.0	3.094	1.621	3.493	67.5	2.553
b	.324	39	16.90	1.621	~0.0	2.986	1.621	3.398	58.32	2.286

Notes: *) $P_{ca} \doteq \frac{0.9\,\sigma_{ye} \times t_s}{R} = \frac{.9 \times 36,000 \times .375}{12 \times 15} = 67.5$ psi (steel A36, $\sigma_{ye} = 36$ ksi) section a

$P_{ca} \doteq \frac{.9 \times 36,000 \times .324}{12 \times 15} = 58.32$ psi section b

**) $SME = \frac{CAPACITY - STATIC}{k \cdot SEISMIC_e} (SME_e)$; here $k = .8$ (inelastic energy absorption seismic reduction factor for the roof membrane failure mode)

$(SME_e) = .15g$

***) Calculated SME_P are many times greater than another SME factors so that they are absolutely not governing

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6. CAPACITY ASSESSMENT

6.1. Compressive Buckling Capacity of the Tank Shell

/1/ – The "elephant" buckling axial stress, σ_p, of the tank shell will be

$$\sigma_p = \frac{0.6\,E_{ST}}{(R/t_s)}\left[1-\left(\frac{pR}{\sigma_{ye}\,t_s}\right)^2\right]\left[1-\frac{1}{1.12+S_1^{1.5}}\right]\left[\frac{S+(\sigma_{ye}/36\,ksi)}{S_1+1}\right] \quad (10)$$

where $S_1 = \frac{R}{400\,t_s} = \frac{12 \times 15}{400 \times .375} = 1.2$ (t_s = the shell thickness near the base)

$\sigma_{ye} = 36$ ksi (steel A36)

$p = p_{CT} = 23.229$ psi

$E_{ST} = 29 \times 10^3$ ksi

After substitution into eq. (10), we obtain

$$\sigma_p = \frac{0.6 \times 29 \times 10^3}{480}\left[1-\left(\frac{23.229 \times 480}{36 \times 10^3}\right)^2\right]\left[1-\frac{1}{1.12+1.2^{1.5}}\right] = 19.311 \text{ ksi}$$

/1/ For HCLPF capacity computations it is suggested that a slight conservatism be introduced by specifying C_m in terms 0.9 σ_p, so that

$C_m = 0.9\,\sigma_p\,t_s = 0.9 \times 19.311 \times .375 = 6.517$ kip/in

/8/ The classical "diamond" buckling capacity stress of supported cylindrical shell under combined axial bending and internal pressure, σ_{CB}, for such a case can be conservatively estimated from NASA SP-8007:

$$\sigma_{CB} = (0.6\,\gamma + \Delta\gamma)\frac{E_{ST}}{(R/t_s)} \quad (11)$$

where

$\gamma = 1 - 0.73(1 - e^{-\varphi})$, $\varphi = \frac{1}{16}\sqrt{R/t_s}$, and $\Delta\gamma$ = an increase factor for internal pressure

In this case $\Delta\gamma = .15$ (from Fig 6 – NASA SP-8007),

$\varphi = 1/16\sqrt{480} = 1.37$, $\gamma = 1. - 0.73(1 - e^{-1.37}) = .456$ and, therefore,

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$\sigma_{CB} = (0.6 \times 0.456 + 0.15)\frac{29\times 10^3}{480} = 25.57 \text{ ksi} < \sigma_{ye}$

Since σ_{CB} is conservatively estimated it may be directly used with no reduction for estimating $C_n = \sigma'_{CB}\, t_s$. In this case σ_{CB} exceeds $0.9\sigma_p$, so this buckling mode does not govern.

(7) Another formula to estimate the axial bending induced "diamond" buckling stress σ_{CB} was introduced by Hiiwas and Clough:

$\sigma_{BC} = 0.373\, E_{st}\, t_s/R = 0.373 \times 29\times10^3/480 = 22.54 \text{ ksi} < \sigma_{ye}$

which gives as well more than $0.9\sigma_p$.

6.2. Bolt Hold-Down Capacity

(10) a) Bolt pullout capacity (see Ref. 10)

- calculation of the total equivalent anchorage length:

hook provides: $8\phi + (12 - 2\times 1.375) = 20.25"$ $< 24\phi$?

above hook 12"

total equivalent anchorage length

$l_{eq} = 12 + 20.25 = 32.25"$

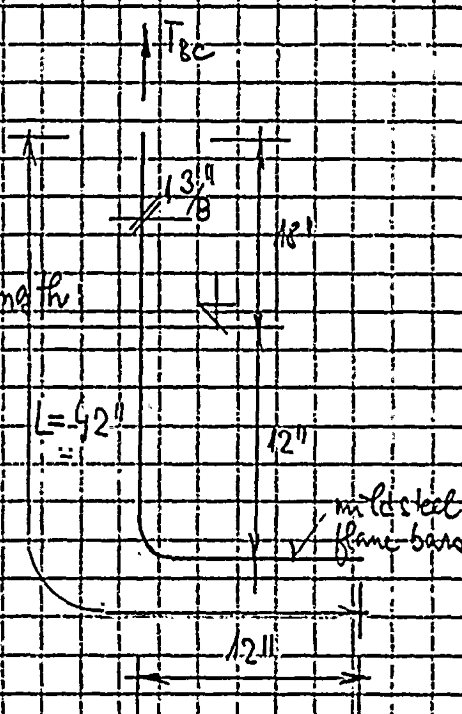

Fig. 8. Anchorage bolt

- ultimate bond stress $\sigma_{BOND} = 1.2 \text{ MPa} = 1.2 \times 145 = 174 \text{ psi}$

- bolt hold-down capacity

$T_{BC} = \pi\phi\,\sigma_{BOND}\, l_{eq} = \pi \times 1.375 \times 174 \times 32.25 = 24{,}239.84 \text{ lb} \approx 24.24 \text{ kips}$

(concrete $f'_c = 20 \text{ MPa} = 2.9\times10^3$ psi, mild steel, plane bar)

b) Bolt tensile capacity

– ultimate tensile stress of the bolt $\sigma_T = 1.7 \times 20 = 34$ ksi

– ultimate bolt tensile capacity

$$T_{BC} = A_B\,\sigma_T = \frac{\pi\, 1.375^2}{4} \times 34 = 54.5 \text{ kips} \gg 24.24 \text{ kips (pullout bolt capacity)}$$

and, therefore, it does not govern.

c) Capacity of the bolt chair

The limit chair capacity was calculated for the diesel fuel storage tank. The chairs are identical for condensate storage tank. It was as well proposed in that calculation to reinforce the bolt chairs replacing their existing top plates by another ones having a thickness sufficient to have bolt pullout control the bolt hold-down capacity. Such necessary thickness was determined by 1.25" which is acceptable as well here, though the pullout bolt capacity is slightly higher. At the same time the nut is slightly larger and, therefore, the real capacity of the top plate should be slightly greater than the computed capacity of the chair top plate of the diesel fuel storage tank.

(margin note: See the diesel fuel storage tank seismic calculation)

d) Finally, if the proposed reinforcing of the bolt chair top plates will be realized, the bolt hold-down capacity may be taken as

$F_{BC} = 24.24$ kips (controlled by the bolt pullout capacity, not by the bolt tensile capacity)

A maximum bolt elastic elongation under the load F_{BC} will be

$$\delta_B^{el} = \frac{F_{BC}\,l_B}{A_B\,E_B} = \frac{24.24 \times 30}{1.485 \times 29 \times 10^3} = 0.0169 \text{ in } (\approx 0.056\%)$$

where $l_B = 15 + 12 + 3 = 30''$ (above concrete + below concrete level + hook)
$l_B = h_a + h_c$ (h_a = below concrete level + hook, h_c = above concrete)

6.3. Fluid Hold-Down Forces

/1/ For tanks with minimum anchorage, hold-down forces resulting from fluid pressure acting on the tank bottom will contribute to overturning moment capacity M_{cc} of the tank. The situation in the region of axial tension in the tank shell is sketched in Fig. 4 for a small uplift displacement δ_e. This uplift is accompanied by the development of a Tension T_e, and moment M_e, in the side shell at the intersection with the tank bottom.

/1/ The relations are as follows:

$$\frac{E_{ST} I_B \delta_e}{p} = \frac{\ell^4}{24} - \frac{1}{F}\left(\frac{K_s \ell^5}{72 E_{ST} I_B} + \frac{M_F \ell^2}{6p}\right), \qquad (12)$$

$$\frac{T_e}{p} = \frac{\ell}{2} + \frac{1}{F}\left(\frac{K_s \ell^2}{12 E_{ST} I_B} + \frac{M_F}{p\ell}\right), \qquad (13)$$

$$\frac{M_e}{p} = \frac{1}{F}\left(\frac{K_s \ell^3}{12 E_{ST} I_B} + \frac{M_F}{p}\right) \qquad (14)$$

$$\frac{M_+}{p} = \frac{\ell^2}{8} - \frac{M_e}{2p} + \frac{M_e^2}{2p^2\ell^2}, \qquad (15)$$

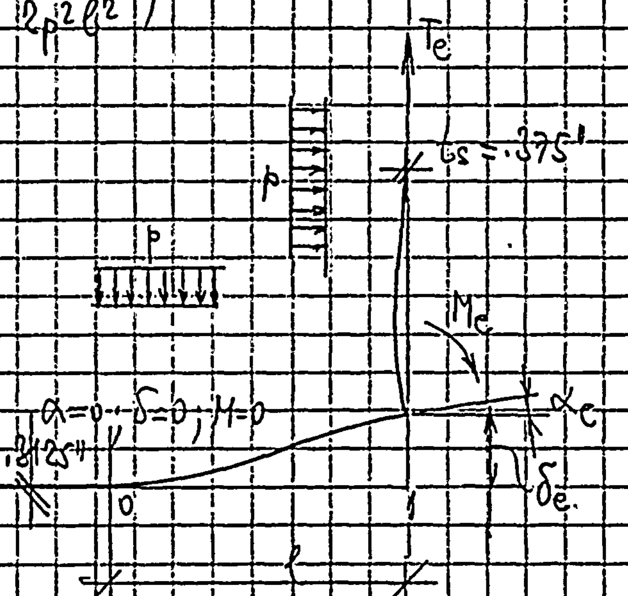

Fig. 4. Tank Bottom Behaviour Near Tensile Region of the Tank Shell

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where)

$$K_S = \frac{2K\ell}{R} = \frac{2\times140.05\times28.46}{15\times12} = 43.82\ \text{kips};$$

$$\ell = \left[R/t_S\sqrt{3(1-\nu^2)}\right]^{1/2} = \left[480\sqrt{3(1-.3^2)}\right]^{1/2} = 28.16;\ (\text{dimensionless});$$

$$K = \frac{E_{ST}\,t_s^3}{12(1-\nu^2)} = \frac{29\times10^3\times(.375)^3}{12(1-.3^2)} = 140.05\ \text{kip-in};$$

$$\frac{M_F}{P} = \frac{R\,t_S}{\sqrt{12(1-\nu^2)}}\left(1-\frac{R}{H_F\,\ell}\right) = \frac{12\times15\times(.375)}{\sqrt{12(1-.3^2)}}\left(1-\frac{12\times15}{564\times28.16}\right) = 20.195\ \text{in}^2;$$

$$I_B = \frac{t_B^3}{12(1-\nu^2)} = \frac{.3125^3}{12(1-.3^2)} = 0.002795\ \text{in}^3;\quad P = P_T = 17.106\ \text{psi}$$

$$F = 1 + \frac{K_S\,\ell}{2E_{ST}\,I_B} = 1 + \frac{43.82\times\ell}{2\times29\times10^3\times.002795} = 1 + 0.2703\,\ell$$

After substitution into eq. (12) we obtain the following relation between the uplift, δ_e, and the uplift length, ℓ, for numerical solution:

$$1.1371\times10^5\times\delta_e(1+.2703\times\ell) = \ell^4 + 0.0901\times\ell^5 - 80.784\times\ell^2$$

(both values, δ_e and ℓ, are in inches). Results of numerical solution are given in Table 2.

Table 2. Fluid Hold-Down Quantities

δ_e [in]	ℓ [in]	T_e [lb/in] *)	M_e [lb-in/in] **)	M_1 [lb-in/in] ***)
0.0	7.03	90.20	211.44	26.38
0.025	9.89	114.62	297.00	86.88
0.05	11.34	128.86	361.43	123.92
0.10	13.74	153.71	497.35	193.25

*) Calculated from eq. (13) which after substitution gives

$$T_e = 17.106\left(\frac{\ell}{2} + \frac{20.195 + 0.04505\,\ell^3}{\ell + 0.2703 \times \ell^2}\right),\ [lb/in];\ (\ell \text{ in inches});$$

**) Calculated from eq. (14) which after substitution gives

$$M_e = \frac{.77065 \times \ell^3 + 345.46}{1 + .2703 \times \ell};\ [lb/in];\ (\ell \text{ in inches});$$

***) Calculated from eq. (15) which after substitution gives

$$M_+ = 2.158 \times \ell^2 - \frac{M_e}{2} + \frac{M_e^2}{34.21 \times \ell^2};\ [lb/in];\ (\ell \text{ in inches});$$

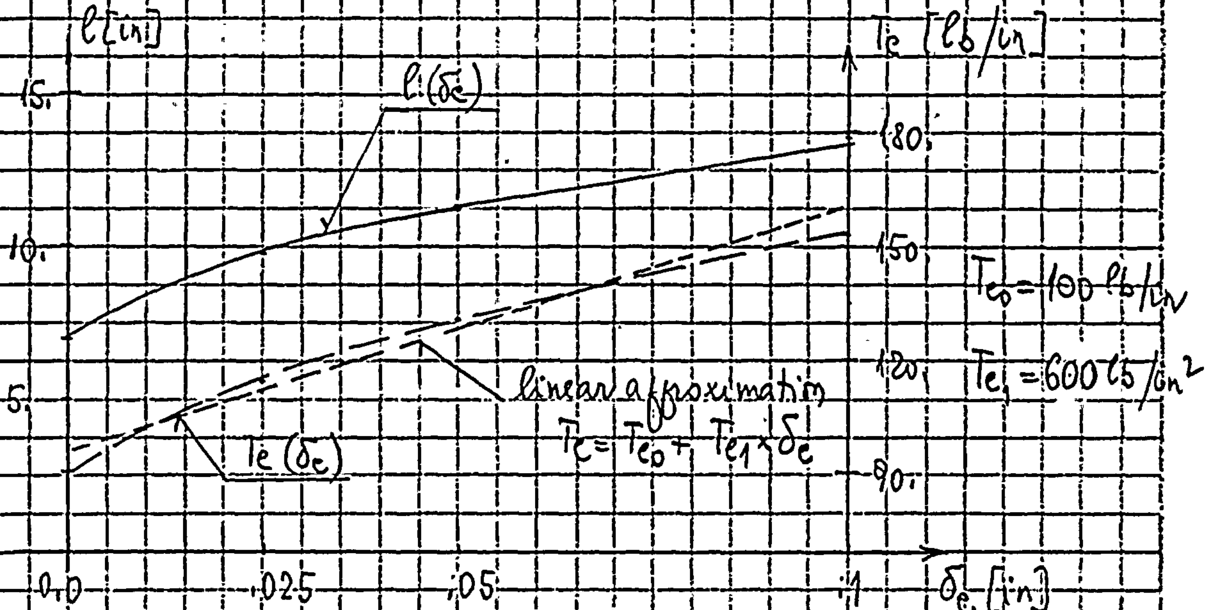


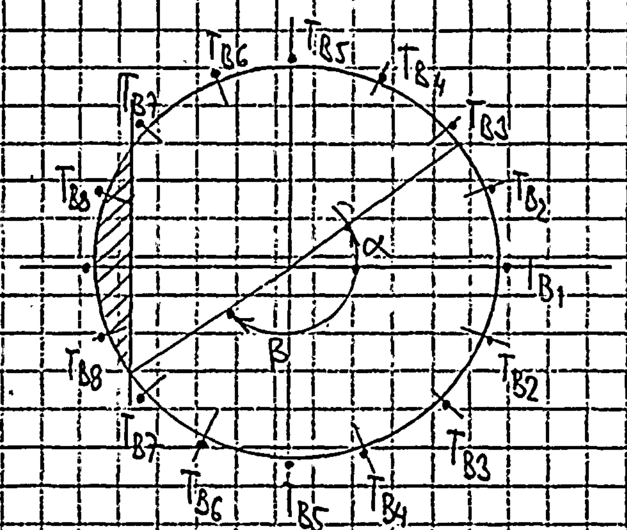
Fig. 5. Fluid Hold-Down Force, F_e, and Uplift Length, ℓ, vs. Uplift Displacement, δ_e.

Note: M_+ = the maximum positive bending moment in the bottom plate; both moments, M_e and M_+, are not necessary for the calculation below, they are given here only for completeness.

(1)

6.4. Overturning Moment Capacity

a) With an estimate of the compressive capacity of the tank shell, C_m, the anchor bolt hold-down capacity T_{BC}, and the relationship between the fluid hold-down force and the uplift displacement, it is possible to estimate the overturning moment capacity, M_{SC}, of the tank. The corresponding theory and assumptions are given in Ref. 1. We will analyze the case sketched in Fig. 6.



	$\cos\alpha$
1	1
2	.9238
3	.7071
4	.3827
5	.0
6	-.3827
7	-.7071
8	-.9238

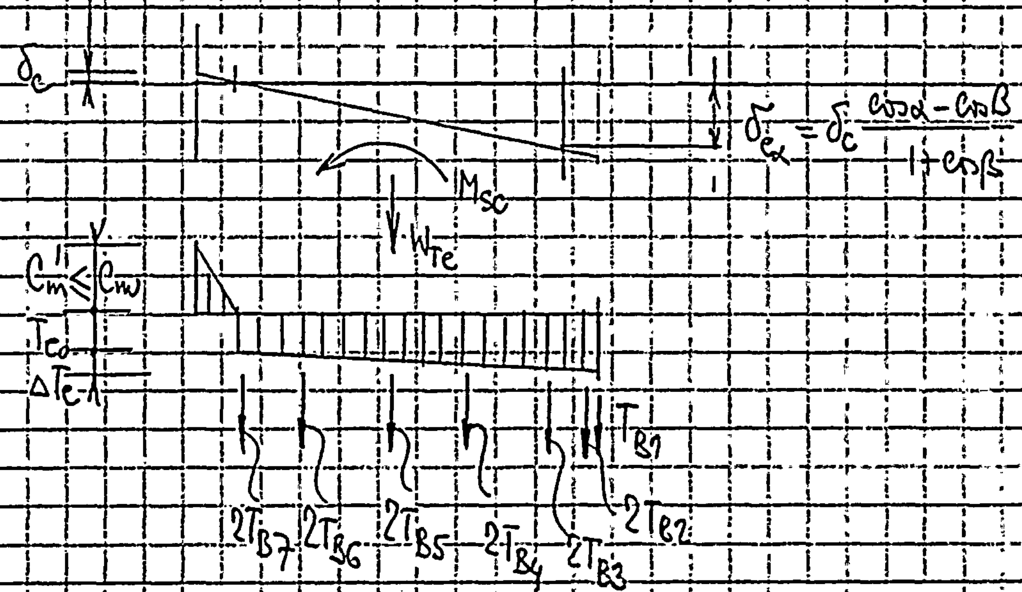


Fig. 6. Vertical loading on the Tank Shell at the Base

b) The corresponding formulas are as follows:

/1/

$$\delta_c = \frac{C_m' h_c}{E_s t_s};\qquad (16)$$

$$\delta_{ex} = \delta_c \frac{\cos\alpha - \cos\beta}{1+\cos\beta} \quad (\text{see Fig. 6})\qquad (17)$$

$$C_1 = \frac{1+\cos\beta}{\sin\beta + (\pi-\beta)\cos\beta};\quad C_2 = \frac{\sin\beta\cos\beta + \pi - \beta}{1+\cos\beta};$$

$$C_3 = \frac{\sin\beta - \beta\cos\beta}{\sin\beta + (\pi-\beta)\cos\beta};\quad C_4 = \frac{\beta - \sin\beta\cos\beta}{1+\cos\beta};\qquad (18)$$

$$C_m'' = \left(\frac{W_{TC} + \sum_i T_{Bi}}{2R} + T_{eo}\beta\right)C_1 + T_{eq}\,\delta_c\, C_3;\qquad (19)$$

$$M_{SC} = C_m'' C_2 R^2 + \sum_i (F_{Bi}\, R\cos\alpha_i) + T_{eo} R^2 (2\sin\beta) + \Delta T_e C_4 R^2 \qquad (20)$$

where

$C_m' \leq C_m$ — maximum compressive load of the tank shell (see Fig. 6)

$T_{Bi} = T_{BP} + K_B\left(\frac{\cos\alpha_i - \cos\beta}{1+\cos\beta}\right) \leq T_{BC}$ — the anchor bolt tension (limited by T_{BC})

$K_B = \frac{\delta_c A_B E_B}{h_a + h_c}$; T_{BP} = bolt pretension, in our case $T_{BP} = 0.0$

$h_c = 15''$; $h_a = 15''$ $(12+3)''$; $E_S = E_B = 29\times10^3$ ksi; $W_{TC} = 65.92$ kips;

$A_B = 1.485\ in^2$; $T_{eo} = 0.1$ kips/in; $T_{eq} = .60$ kips/in²; $\Delta T_e = T_{eq}\times\delta_c$

c) All numerical calculations are given in Table 3. First, a trial angle β is selected and eq. (19) is used to obtain C_m'' which is compared to the C_m' from eq. (16). The angle β is varied until $C_m' \doteq C_m''$. Then eq. (20) is used with this β to determine the moment capacity M_{SC}.

The elongation $\delta_{ex=0}$ of the outermost bolt is limited from ~.02 in (approx. the maximum elastic elongation of the bolt under loading T_{BC}) to .1 in (expected maximum elongation under T_{BC} incl. ductility and plastic effects).

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SUBJECT: Turkey Point — JOB No. 90C1585 — SHEET 23 OF 27

CALC. # TPN-15JC-90-008
SME Capacity of the Condensate Storage Tank
"WITH INCREASED CHAIR PLATE"
Turkey Point Unit 3&4

REVISIONS: D — RH 12/18/90 — DDS 1/20/91

Table 3. Overturning Moment Capacity

Trial θs [rad]	Δ cos β	C_1	C_2	C_3	C_4	$C_w \le C_m$ [kip/in]	δ_c [in]	$\delta_{x=0}$ [in]	K_B [kips]	$T_{B1} \le T_{BC}$ [kips]	$2T_{B2} \le 2T_{BC}$ [kips]	$2T_{B3} \le 2T_{BC}$ [kips]	$2T_{B4} \le 2T_{BC}$ [kips]	$2T_{B5} \le 2T_{BC}$ [kips]	$2T_{B6} \le 2T_{BC}$ [kips]	$2T_{B7} \le 2T_{BC}$ [kips]	$\sum T_{Bi}$ [kips]	C''_m [kips]
2.8	.0577	4.399	.4494	226.41	53.332	1.9865	.002974	.1	4.2692	24.24	48.48	48.48	48.48	48.48	48.48	34.79	301.43	5.788
2.7	.0959	3.408	.5755	109.90	32.173	3.6526	.005038	.1	7.2320	24.24	48.48	48.48	48.48	48.48	48.48	29.71	296.35	4.682
2.68	.1047	3.261	.6001	88.65	29.41	4.0036	.00552	.1	7.924	24.24	48.48	48.48	48.48	48.48	48.48	28.49	295.13	4.438
2.67	.1092	3.193	.6124	82.86	32.61	4.1852	.005773	.1	8.2843	24.24	48.48	48.48	48.48	48.48	48.48	27.88	294.52	4.362
M_{sc} = 104,231.58 kip-in = 8685.9 kip-ft < 11,103.6 not OK !!																		
2.62	.1320	2.889	.6737	60.18	22.95	2.5818	.00356	.05	6.1109	24.24	48.48	48.48	48.48	48.48	37.21	12.29	267.66	3.562
2.6	.1431	2.784	.6978	53.86	24.16	2.7940	.00385	.05	5.5267	24.24	48.48	48.48	48.48	48.48	36.62	11.57	266.35	3.412
2.58	.1536	2.685	.7217	47.49	19.73	3.0154	.00416	.05	5.8705	24.24	48.48	48.48	48.48	48.48	36.04	10.83	265.03	3.280
2.57	.1590	2.639	.7336	44.86	19.03	3.1300	.00432	.05	6.1972	24.24	48.48	48.48	48.48	48.48	35.73	10.44	264.33	3.215
2.56	.1644	2.594	.7455	42.42	18.86	3.2470	.00448	.05	6.4287	24.24	48.48	48.48	48.48	48.48	35.41	10.05	263.62	3.152
M_{sc} = 99,508.14 kip-in = 8,292.43 kip-ft < 11,103.6 not OK !!																		
2.45	.2298	2.187	.8720	24.03	12.80	1.8821	.00259	.02	3.7266	24.24	48.48	48.48	37.40	24.98	12.57	2.05	198.20	2.177
2.43	.2427	2.127	.8943	21.84	12.05	2.0023	.00276	.02	3.9647	24.24	48.48	48.48	37.25	24.75	12.24	1.65	197.08	2.106
2.425	.2460	2.112	.8996	21.34	11.87	2.0320	.00280	.02	4.0251	24.24	48.48	48.48	37.20	24.67	12.15	1.54	196.76	2.089
M_{sc} = 83,347.98 kip-in = 6945.66 kip-ft < 11,103.6 not OK !!																		

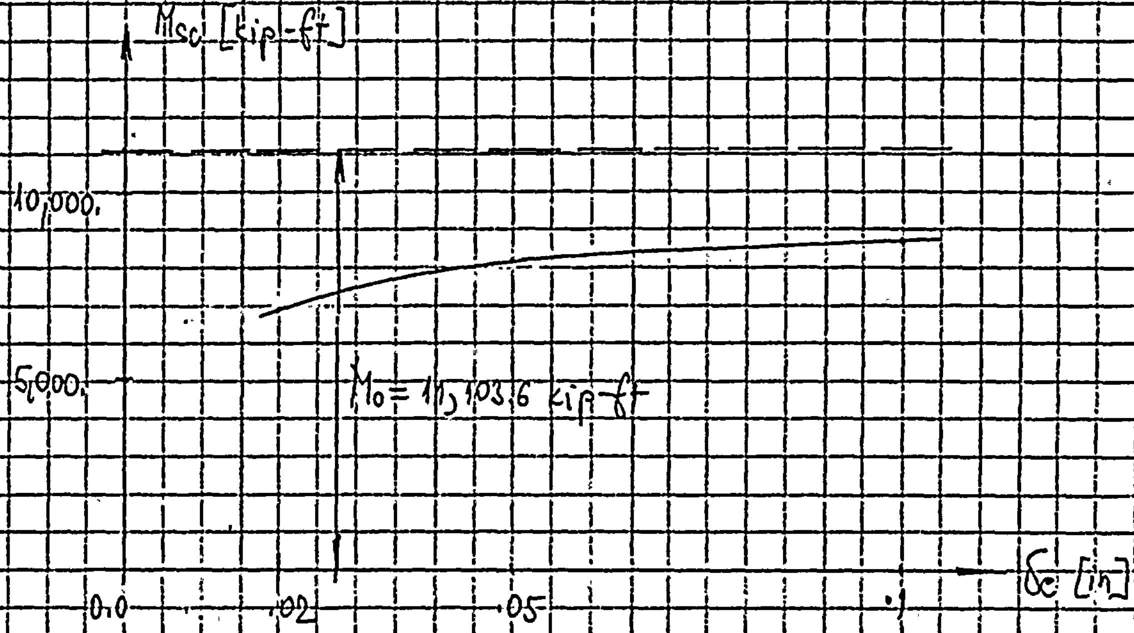

Fig 7. Overturning Moment Capacity vs. elongation δ_c of the outermost bolt ($\alpha = 0$)

When the elongation of the outermost bolt is limited as here, the compressive buckling capacity stress of the tank shell cannot develop in the compressive zone, and, therefore, the quantities δ_c and $C_m' < C_m$ are backcalculated using eq. 16 & 17 for the some limit bolt elongation δ_{c} and for any given trial β. These back calculated δ_c and C_m values are than used to solve the moment capacity M_{sc} in the same manner as described above, i.e. the angle β is varied until $C_m' = C_m$.

d) Results are presented in Fig 7. One can see that in all cases $M_{sc} < M_o$, so the seismic overturning moment capacity is less than 1.5 g

e) The maximum elongation of the outermost bolt corresponding to its hold-down pullout capacity T_{sc}, may be estimated as

$$\delta_c^{max} = 2.0\,\delta_B^{el} + 1.5\,\delta_{Pl}^{el} = 2.0 \times 0.0169 + 1.5 \times 0.009 = .047 \text{ in}$$

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SUBJECT Turkey Point JOB NO. 90C1585 SHEET 25 OF 27

CALC. # TPN-1SJC-90-008
SME Capacity of the Condensate Storage Tank
WITH INCREASED CHAIR PLATE
Turkey Point, Units 3&4

REVISIONS
0 [initials] 12/18/90
[initials] 1/20/91

$\delta_B^{el} = .068$ in = the maximum bolt elastic elongation under the load $F_{BC} = 24.24$ kips

$\delta_P^{el} = .008$ in = the maximum elastic deflection of the top plate of the bolt chair under the same load (see the calculation of the diesel fuel storage tank with the same bolt chairs)

2.0 and 1.5 - the coefficients implying the inelastic - ductility effects in the concrete near the anchor bolt and in the top plate of the bolt chair.

value $M_{SC} = 8{,}200$ kip-ft and, therefore

$$\varepsilon_M = \frac{M_{SC}}{k\,M_0} \times 0.15g = \frac{8{,}200}{1.0 \times 11{,}036} \times 0.15g = 0.11g$$

- the inelastic energy absorption factor taken conservatively as unity failure mode).

Sliding Capacity

The seismic base shear response Q_0, and the base seismic overturning response M_0, are primarily due to the horizontal impulsive mode, are maximum in the same time. Thus, the sliding shear tank capacity

$$= \mathcal{H}\left[W_{ve} + \sum_i T_{Bi}\right] \qquad (21)$$

$W_{ve} = W_{TE} + p_a(\pi R^2)$ and $\mathcal{H}$ = the friction coefficient

$W_{TE} = 65.92$ kips, $p_a = 19.132$ psi and $\sum_i T_{Bi} \doteq 263.6$ kips (for $\delta_{e_{x=0}} = .05$ in see Table 3)

we assume $\mathcal{H}$ to be 0.7.

Thus $W_{ve} = 65.92 + .018132 \times (\pi \times 180^2) = 2,013.32$ kips,

$Q_{sc} = 0.7 [2,013.32 + 263.6] = 1,593.84$ kips

and $SME_Q = \frac{Q_{sc}}{k \cdot Q_0} \times 0.15g = \frac{1,593.84}{1.0 \times 531.40} \times 0.15g = 0.45g >> SME_M$!

(k = inelastic energy absorption factor, in this case = 1.0)

6.6. Other Capacity Checks

The fluid pressure capacity is summarized in Table 1. In this case k = 1.8. Computed SME's are many many times greater than another SME factors, so they do not govern.

The fluid sloshing height h_s was estimated to be about 1 ft. Any significant damage of the roof might not be expected.

The sufficient piping flexibility to accommodate relative seismic movements between places where the piping is supported from the tank shell and where it is independently supported is assumed.

No additional capacity checks have been performed in this calculation.

7. RESULTS

a) With the old top plates at the bolt chairs (their thickness is only 1/2") the tank is practically unanchored to the concrete foundation and its seismic overturning stability is reduced from that calculated above.

b) If these top plates would be replaced by another ones more thick (1.25" as minimum) to reach the pullout bolt capacity $F_{sc} = 24.24$ kips, the governing SME_M capacity is .11g.

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90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 13 - Condensate Storage Tank

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4 Building Outdoors (S.W. of RCB)

Manufacturer ______ Elevation 18'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 16 1 1/4" Dia
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? No
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Based on Tank anchorage calculations. Top chair and anchor embedment control capacity
2. Concerns (if any) ~~Some~~ Top chairs bent
   Gusset welds good Top chair to tank questionable

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) Turbine Gantry Crane. ~~[illegible]~~ Prande analysis demonstrates crane will not fail

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)
~~perform seismic analysis~~

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90

NAME John W. Reed DATE 4/5/90

NAME John D. Stevenson DATE 4/5/90

ITEM 13 CONDENSATE STORAGE TANK . Unit 4

SRT WANTED CALCULATION FOR

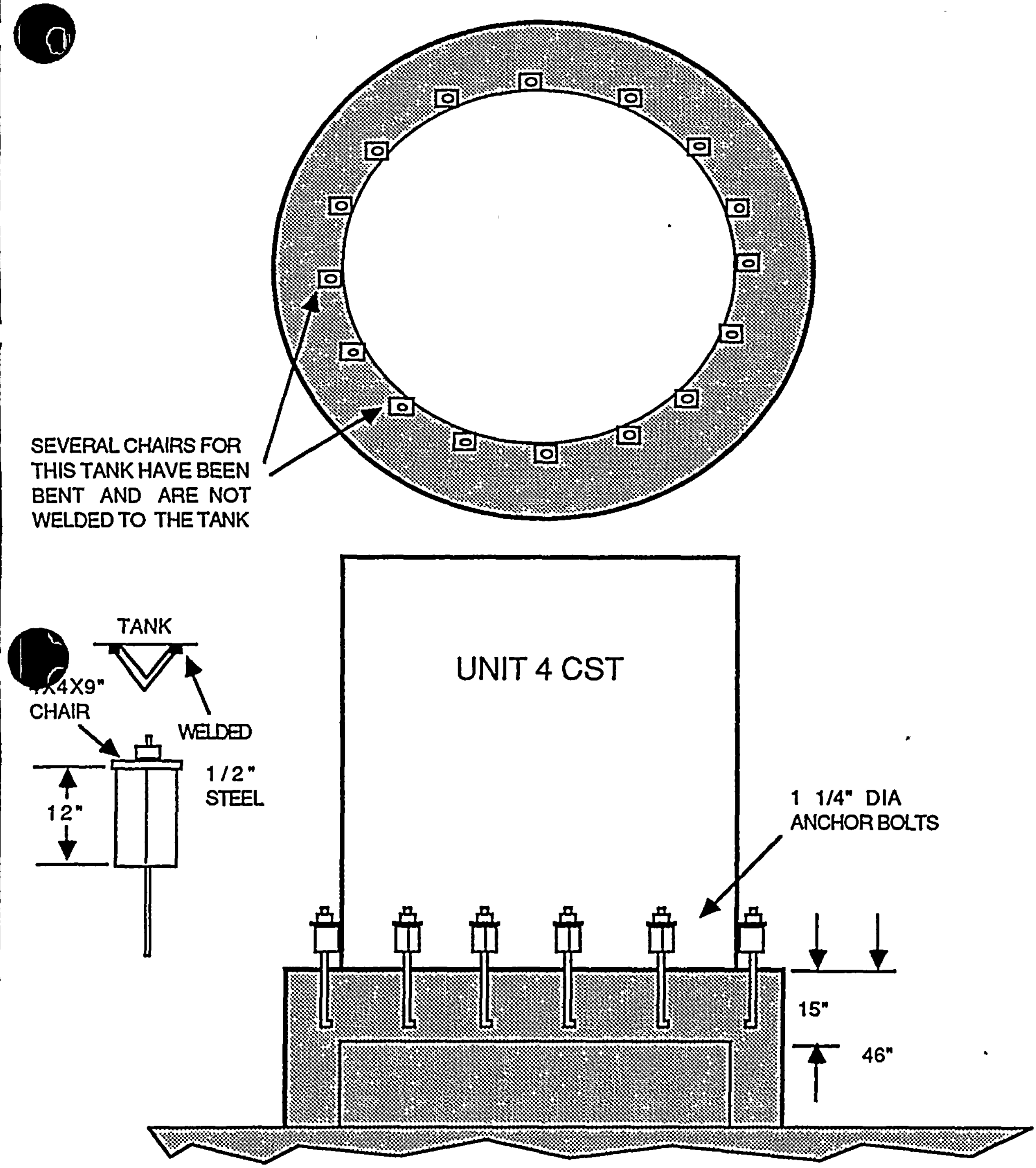
1) BOLT ANCHORAGE
2) TOP OF CHAIRS

} RESULTS OF Unit 3 CAN BE USED

THE SRT HAD A SEISMIC INTERACTION CONCERN WITH THE TURBINE GANTRY CRANE which has it's NORMAL PARKING SPACE BY THIS CST.

HCLPF FOR BOLT BOND FAILURE CALCULATED TO BE .11 g WITH THE INCREASED CHAIR PLATE. CALCULATIONS ATTACHED TO ITEM 12.

AS-FOUND FIELD CONDITION



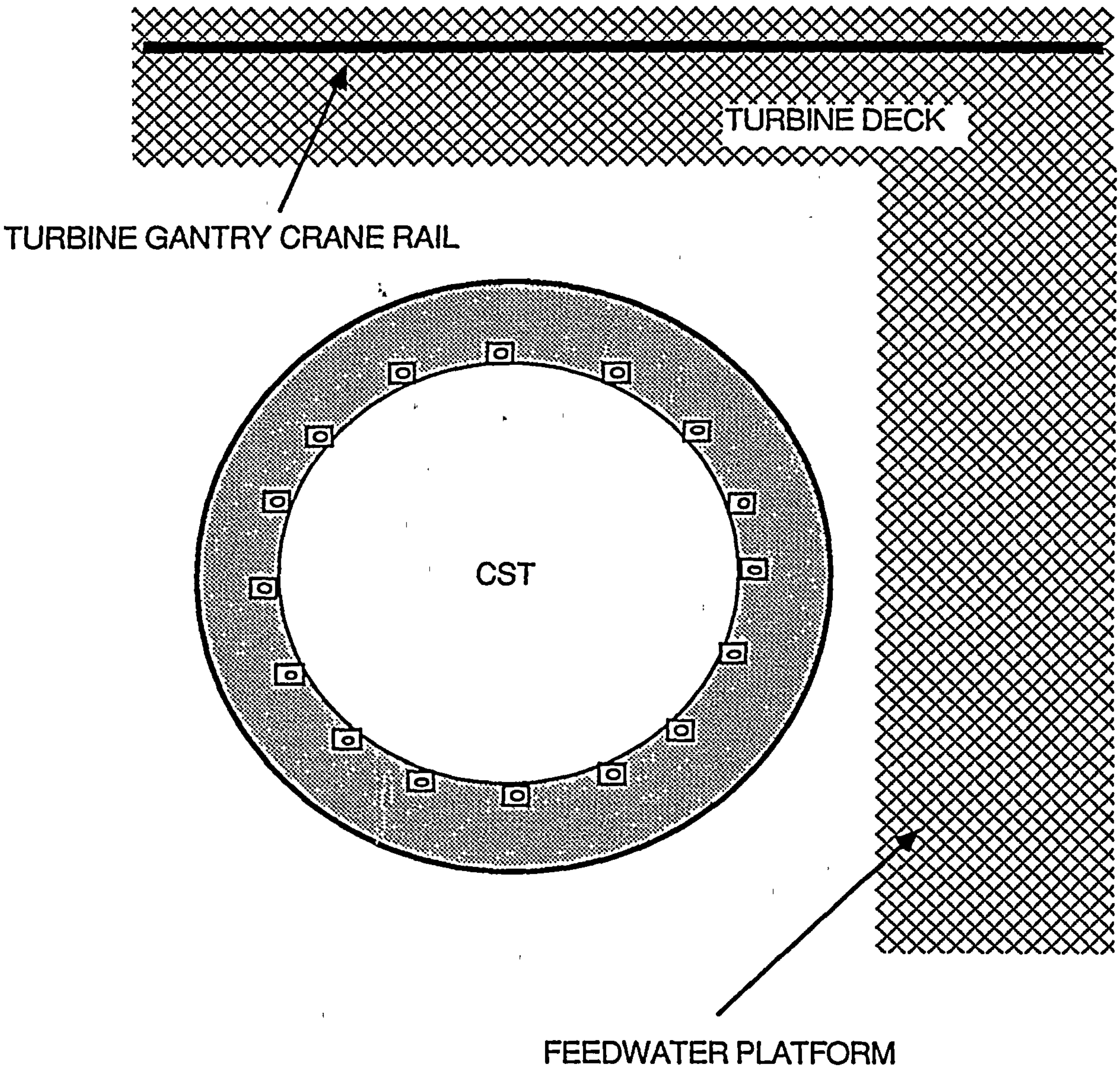
UNIT 4 CST TANK
TANK MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
   SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT UNIT 4 CST	
DATE:MAR 22, 1990	DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT NOTED THAT THE TURBINE GANTRY CRANE IS NORMALLY PARKED AND PINNED INTO POSITION AT THE SOUTH END OF THE TURBINE STRUCTURE WHIC IS LOCATED NEAR THE UNIT 4 CST. THERE WERE NO OTHER SEISMIC INTERACTIONS CONCERNS NOTED WITH THIS TANK

UNIT 4 CST
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT UNIT 4 CST	
DATE: MAR 22, 1990	DWG BY: R. GOULDY

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90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 14 - Refueling Water Storage Tank

PART A. EQUIPMENT DESCRIPTION

I.D. Number	3	Building	Outdoors
Manufacturer		Elevation	18'
Model Number		Other	

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes x No ____
2. Condition of nearby concrete and embedments ____
3. Length, size, number, and soundness of welds ____
4. Anchor bolt type, size and number 1¼" 16 TOTAL
5. Are nuts present and apparently tight on all bolts? ____

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? NO.
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) TOP CHAIRS ARE NOT welded gusset welds ARE good. TANK TO Be analyzed.
2. Concerns (if any) Based on anchorage analysis - not Adequate controlled by top chair plate and bolt embedment

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE SFP CRANES PARKED AWAY FROM TANK

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME	Robert P. Kennedy	DATE	4/5/90
NAME	[signature]	DATE	4/5/90
NAME	Walter D. Stevenson	DATE	4/5/90

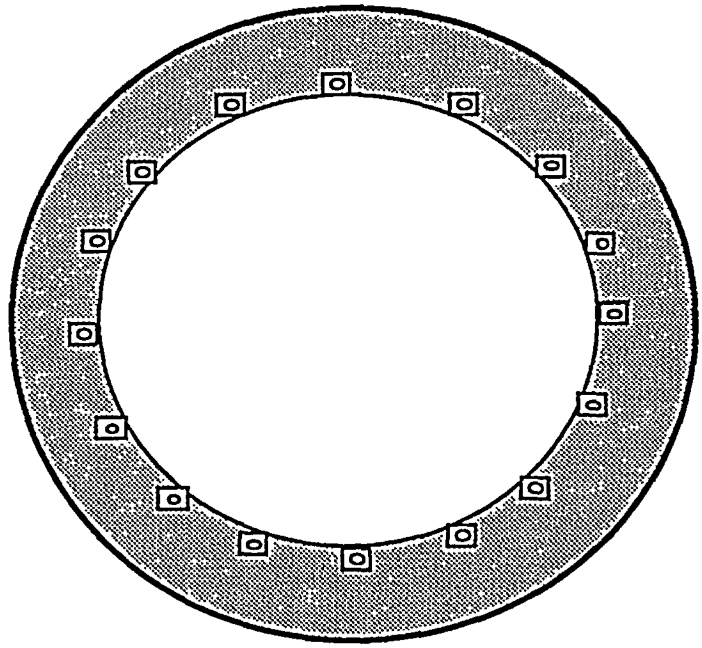
ITEM 14 REFUELING WATER STORAGE TANK 0:A3

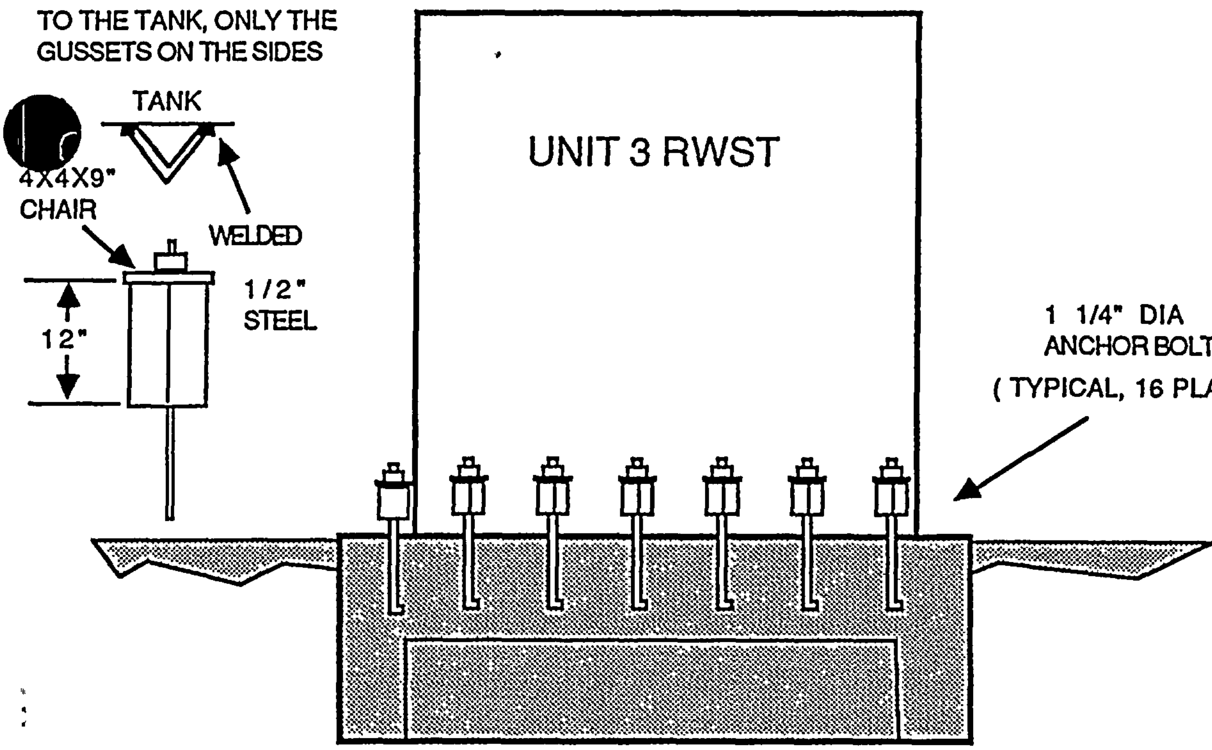
SRT WANTED ANCHORAGE AND CHAIR CALCULATIONS TO BE PERFORMED.

THE SPENT FUEL CASK CRANE WAS NOTED FOR SEISMIC INTERACTION CONCERN BUT WAS SHOWN TO BE PARKED AND STORED AWAY ~~FORM~~ FROM THIS TANK. THIS RESOLVED THIS INTERACTION CONCERN.

HCLPF FOR BOLT BOND FAILURE CALCULATED TO BE .11g WITH THE INCREASED CHAIR PLATE.

AS-FOUND FIELD CONDITION





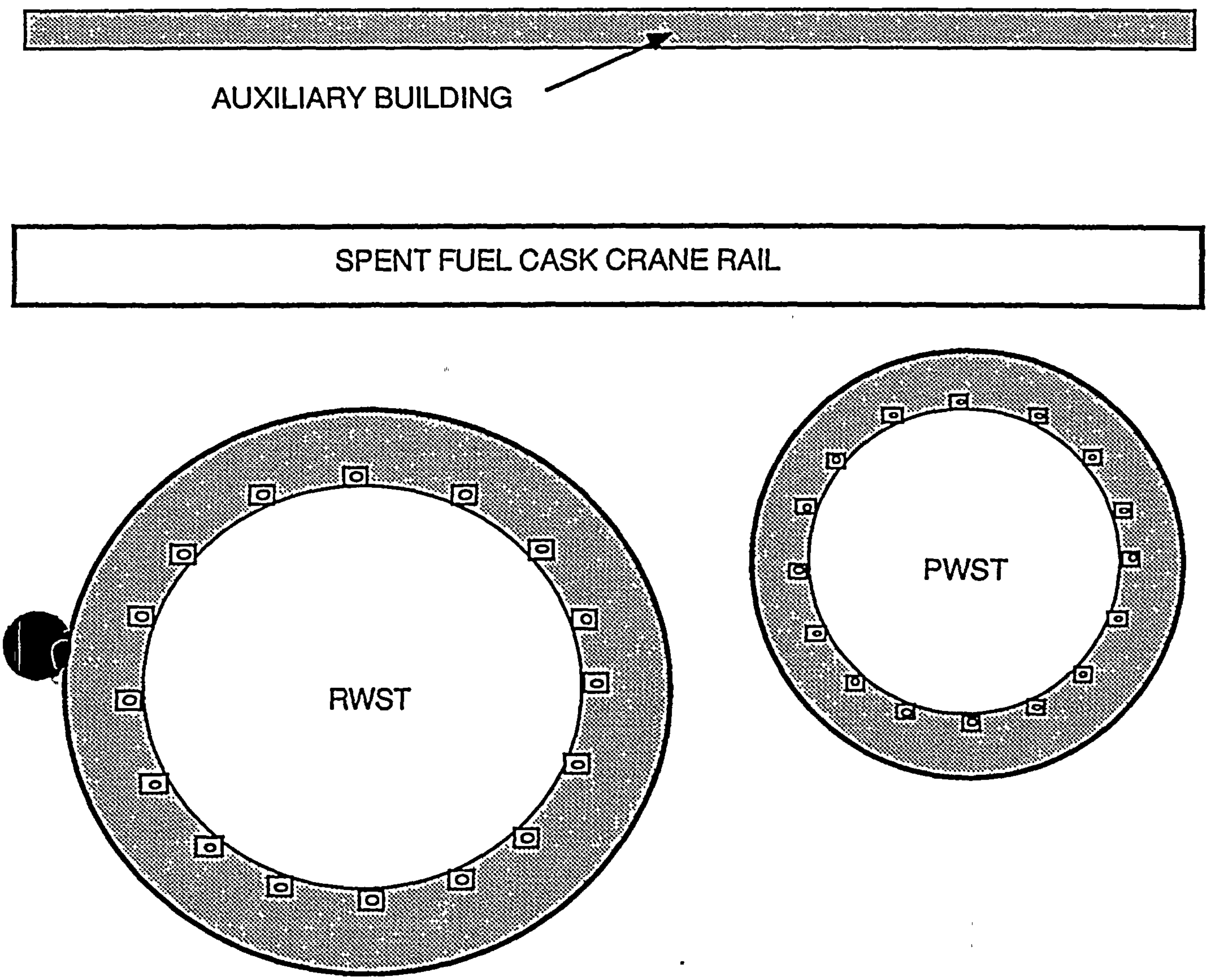
UNIT 3 RWST
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT UNIT 3 RWST
DATE:MAR 22, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT NOTED THE SPENT FUEL CASK CRANE RAIL STRUCTURE NEARBY BUT NOTED THAT THIS CRANE IS STORED AND PINNED AWAY FROM ANY ITEM ON THE WALKDOWN LIST. THERE WERE NO SEISMIC INTERACTIONS CONCERNS.

UNIT 3 RWST
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT UNIT 3 RWST
DATE: MAR 22, 1990 DWG BY: R. GOULDY

CALCULATION COVER SHEET

Calculation No: TPN-1SJC-90-006

Title: SME CAPACITY OF THE REFUELING WATER STORAGE TANK

0	INITIAL ISSUE	RM	12/20/90	[illegible]	1/20/91	[illegible]	1/20/91
No.	Description	By	Date	Chk/Ver	Date	Appr	Date
REVISIONS							

LIST OF EFFECTIVE PAGES

CALCULATION NUMBER TPN-15JC-90-006 REV. 0

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1	1.0 INTRODUCTION 2.0 REFERENCES	0	15	6.0 CAPACITY ASSESSMENT 6.1 COMPRESSIVE BUCKLING CAPACITY OF THE TANK SHELL	0			
2	" 3.0 METHODOLOGY	0	16	" 6.2 BOLT HOLD-DOWN CAPACITY 6.3 FLUID HOLD-DOWN FORCES	0			
3	4.0 BASIC ASSUMPTIONS	0	17	"	0			
4	5.0 CALCULATION RESPONSE EVALUATION 5.1 BASIC INPUT DATA	0	18	"	0			
5	" 5.2 FREE VIBRATION ANALYSIS	0	19	" 6.4 OVERTURNING MOMENT CAPACITY	0			
6	"	0	20	"	0			
7	"	0	21	"	0			
8	5.3 SPECTRAL ACCELERATIONS 5.4 HORIZONTAL IMPULSIVE MODE RESPONSE	0	22	"	0			
9	"	0	23	"	0			
10	" 5.5 HORIZONTAL CONVECTIVE (SLOSHING) MODE RESPONSE	0	24	6.5 SLIDING CAPACITY 6.6 OTHER CAPACITY CHECKS	0			
11	" 5.6 VERTICAL FLUID MODE RESPONSE	0	25	7.0 RESULTS	0			
12	" 5.7 COMBINED RESPONSES	0	26	"	0			
13	"	0						
14	"	0						

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CALCULATION NUMBER TPN-1SJC-90-006 REV. 0

S&A STEVENSON & ASSOCIATES a structural-mechanical consulting engineering firm	SUBJECT Turkey Point JOB No. 90 C1 585 SHEET 1 OF 26 CALC # TPN-15JC-90-006 SME Capacity of the Refueling Water Storage Tank WITH INCREASED CHAIR PLATE Turkey Point, Units 3&4	REVISIONS 0 DH 12/20/90 DDS 1/20/91

1. INTRODUCTION

The purpose of this calculation is to perform an evaluation of the Refueling Water Storage Tank of the TURKEY POINT, Units 3&4, to estimate the tank's seismic capacity after the top bolt plate is increased to 1¼". This calculation is intend to be conservative and gives the High-Confidence-Low-Probability-of-Failure (HCLPF) seismic capacity of the tank.

2. REFERENCES

/1/ Kennedy, R.P. et al., "Assessment of Seismic Margin Calculation Methods" NUREG/CR-5270, UCID-21572, Lawrence Livermore National Laboratory, Livermore, 1988.

/2/ Veletsos, A.S., "Seismic Response and Design of Liquid Storage Tanks" In: Guidelines for the Seismic Design of Oil and Gas Pipeline Systems, ASCE, New York, 1984.

/3/ Veletsos, A.S. and Yang, J.Y., "Dynamics of Fixed-Base Liquid-Storage Tanks", Proceedings of the U.S.-Japan Seminar for Earthquake Engineering Research with Emphasis on Life Line Systems, Tokyo, Japan, Nov. 1976.

/4/ Veletsos, A.S. and Tang, Yu, "Dynamics of Vertically Excited Liquid Storage Tanks", Journal of Structural Engineering, Vol. 112, No. 6, ASCE, June 1986, pp. 1228-1246.

/5/ Haroun, M.A. - Housner, G.W., "Seismic Design of Liquid Storage Tanks", Journal of the Technical Councils of ASCE, Vol. 107, No. TC1, 1981, pp. 191-207.

/6/ ASCE Standard and Commentary, "Seismic Analysis of Safety Related Nuclear Structures", ASCE-4-86, September 1986.

/7/ Niwa, A. - Clough, R.W., Buckling of Cylindrical Liquid Storage Tanks under Earthquake Loading, Earthquake Engineering and Structural Dynamics, Vol. 10, 1982, pp. 107-122.

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SUBJECT Turkey Point JOB No. 90 C1 585 SHEET 2 OF 26

CALC #TPN-15JC-90-006

SME Capacity of the Refueling Water Storage Tank

Turkey Point, Units 3&4

REVISIONS: 0 DM 12/20/90; DJJS 1/20/91

/8/ Buckling of Thin-Walled Circular Cylinders, NASA SP-8007, August, 1968

/9/ Manual of Steel Construction, 8th edition, AISC, Chicago, 1980.

/10/ Anchorage to Concrete, ed. by G. B. Hasselwander, ACI-SP-103, American Concrete Institute, Detroit, 1987.

/11/ Drawing 5610-C-18-392, Turkey Point Units 3&4, Condensate and Diesel Fuel Storage Tanks.

/12/ Turkey Point - Ground Response Spectra 15% Acceleration, Fig. 5.2

B. METHODOLOGY

The seismic evaluation of the condensate storage tank consists of two main parts: (1) a seismic response analysis presented in the Chapter 5 and, (2) a seismic capacity assessment, given in the chapter 6. The first seismic response analysis is based here on the well-known works of Veletsos /2, 3, 4/, while the approach and formulas given in Ref. /1/ are mostly used in the seismic capacity assessment.

The actual SME capacity of the tank is estimated from

$$\text{(1)} \quad SME = \frac{Capacity - Static}{k \cdot Seismic_c} (SME_c)$$

where Capacity is the HCLPF capacity of the tank, Static is the portion of this capacity used up by static loads, Seismic$_c$ is the computed seismic response, k is the inelastic energy absorption factor and SME$_c$ is .15g in this case.

Both horizontal and vertical seismic ground motions are defined by response spectrum curves (the vertical motion is specified as 2/3 of the horizontal one) which correspond to the maximum hypothetical earthquake of .15g ZPGA at the power plant site.

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4. BASIC ASSUMPTIONS

/11/ a) The tank is considered in accordance with Ref. 11 to be vertical of circular cross section, fixed by the anchorage bolts at the concrete foundation, and to have a free liquid surface.

/1/ b) Solutions are based upon the theory of small displacements of the tank
/2/ shell and tank bottom and small displacements of the
/3/
/4/ incompressible liquid inside the tank.

/6/ c) Any effects of soil-tank foundation interaction are not considered. The tank foundation is assumed to be sufficiently rigid. Only higher damping ratio is introduced when the vertical seismic response is determined to partially compensate the effects of soil flexibility and energy radiation below the foundation.

d) As the anchorage bolt hold-down capacity is governed by the bolt pullout capacity and not by its tensile capacity, only very limited inelastic elongation of the outermost bolt is taken into account.

CALCULATION

5. RESPONSE EVALUATION

5.1. Basic Input Data

(1)

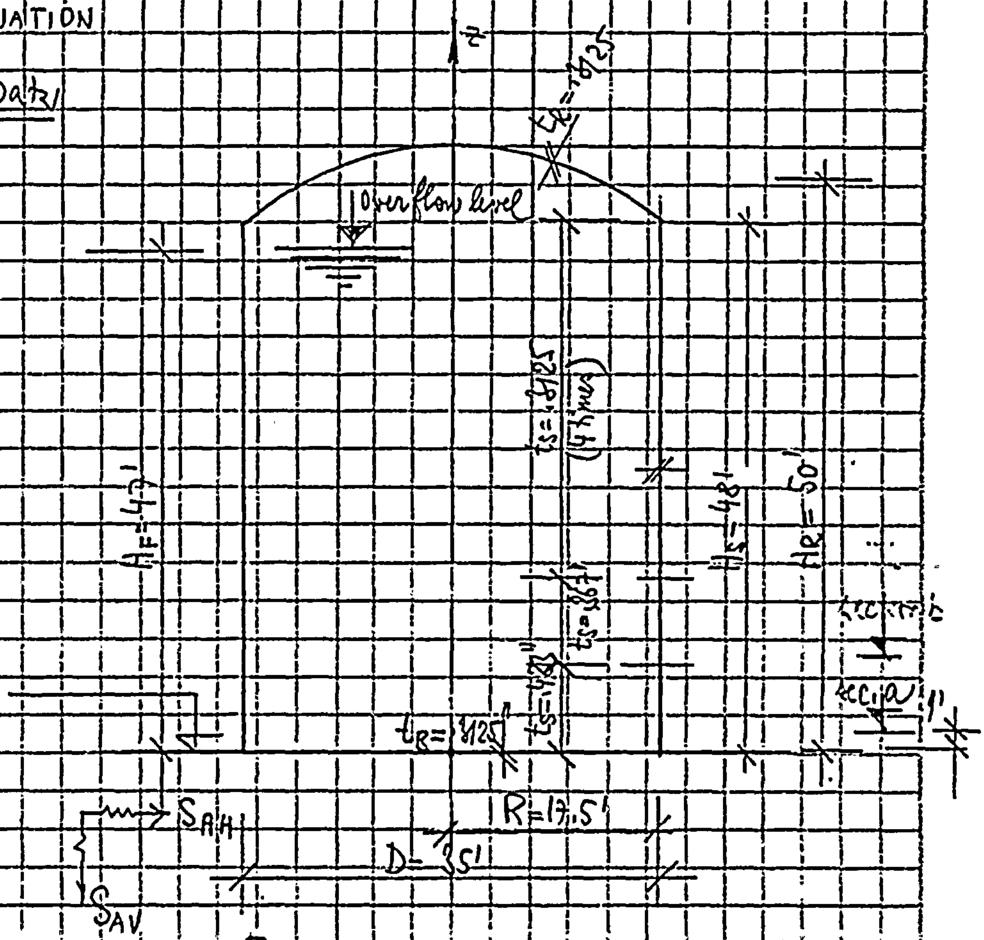

Fig. 1. Refueling Water Storage Tank

a) Elastic properties

- tank steel $E_{ST} = 29 \times 10^6$ psi (Young's modulus of elasticity)
$\nu = .3$ (Poisson's ratio)

- fluid none

b) Specific weights and masses

- tank steel $w_{ST} = 490$ lb/ft³, $\rho_{ST} = w_{ST}/g = 490./32.185 = 15.225$ lb-s²/ft⁴

- fluid (water) $w_F = 62.4$ lb/ft³, $\rho_F = w_F/g = 62.4/32.185 = 1.939$ lb-s²/ft⁴

$g = 32.185$ ft/s² - gravity acceleration

e) Weights and masses:

- roof $W_R = 1.1 \pi R^2 t_R w_{ST} = 1.1\pi (17.5^2) \frac{.3125}{12} \times 490 = 13{,}504.66$ lb

$m_R = W_R/g = 13{,}504.66 / 32.185 = 419.59$ lb-s²/ft

- shell $W_S = \pi D H_S \tilde{t}_S w_{ST} = \pi (35)(48) \frac{.34}{12} \times 490 = 73{,}274.51$ lb

$\left(\tilde{t}_S = \frac{4 \times 0.3125'' + .367'' + .423''}{6} = .34''\right)$ $\tilde{t}_S$ = the average thickness of the shell

$m_S = W_S/g = 73{,}274.51/32.185 = 2{,}276.67$ lb-s²/ft

- bottom $W_B = \pi R^2 t_B w_{ST} = \pi (17.5^2) \frac{.3125}{12} \times 490 = 12{,}276.96$ lb

$m_B = W_B/g = 12{,}276.96 / 32.185 = 381.45$ lb-s²/ft

- fluid $W_F = \pi R^2 H_F w_F = \pi (17.5^2)(47) \times 62.4 = 2{,}821{,}684.3$ lb

$m_F = W_F/g = 2{,}821{,}684.3 / 32.185 = 87{,}670.787$ lb-s²/ft

5.2. Free Vibration Analysis

a) Fundamental horizontal natural frequency of the tank - liquid system

- the frequency coefficient for the tank filled with water

$C_W = .104$ for $H_F/R = 47/17.5 = 2.686$ and $\tilde{t}_S/R = .34/(17.5 \times 12) = 0.00162$ (dimensionless)

- the tank is filled with water and, therefore,

$C_F = C_W = .104$

- the fundamental horizontal natural frequency without effects of the roof mass will be:

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$$f_H' = \frac{C_F}{2\pi H_F}\sqrt{\frac{E_{ST}}{\rho_{ST}}} = \frac{.104}{2\pi \times (47)}\sqrt{\frac{29\times10^6 (12^2)}{15.225}} \doteq 5.832 \text{ Hz}$$

– flexural and shear stiffness of the tank, computed as a cantilever beam:

$$K_F = 3\pi\left(\frac{R}{H_S}\right)^3 E_{ST}\times\tilde{t}_b = 3\pi\left(\frac{17.5}{48}\right)^3 (29\times10^6)\times(12)\times(.34) = 5.404\times10^7 \text{ lb/ft}$$

$$K_S = \frac{\pi}{2(1+\nu)}\frac{R}{H_S}E_{ST}\tilde{t}_s = \frac{\pi}{2(1+.3)}\times\left(\frac{17.5}{48}\right)\times(29\times10^6)\times(12)\times(.34) = 5.21\times10^7 \text{ lb/ft}$$

– corresponding natural frequencies for an empty tank of the same proportions as an actual tank but for which the only structural mass is the roof mass m_R:

$$f_{HF} = \frac{1}{2\pi}\sqrt{\frac{K_F}{m_R}} = \frac{1}{2\pi}\sqrt{\frac{5.404\times10^7}{419.59}} = 57.12 \text{ Hz};$$

$$f_{HS}' = \frac{1}{2\pi}\sqrt{\frac{K_S}{m_R}} = \frac{1}{2\pi}\sqrt{\frac{5.21\times10^7}{419.59}} = 56.08 \text{ Hz};$$

– the fundamental horizontal natural frequency including effects of the roof mass (using the approximate expression of the Dunkerley type):

$$\frac{1}{f_H^2} = \frac{1}{(f_H')^2} + \frac{1}{(f_{HF})^2} + \frac{1}{(f_{HS}')^2} = \frac{1}{5.832^2} + \frac{1}{57.12^2} + \frac{1}{56.08^2} = .03003$$

and, therefore,

$$f_H = \sqrt{1/.03003} = 5.77 \text{ Hz};$$

(2) (4) b) Fundamental vertical natural frequency of the tank – liquid system

– the frequency coefficient

$C_V \doteq .0970$ for $H_F/R = 2.686$ and $\tilde{t}_s/R = .00162$

– fundamental vertical natural frequency without effects of tank inertia (based on a theory that considers the tank to act as a membrane – axisymmetric cylinder):

$$f_V' = \frac{C_V}{2\pi H_F}\sqrt{\frac{E_{ST}}{\rho_{ST}}} = \frac{.0970}{2\pi \cdot 47}\sqrt{\frac{29\times10^6\times(12)^2}{15.225}} = 5.44\ Hz;$$

- natural frequency of axial vibration of the tank incl. effects of the roof mass:

$$f_a = \frac{.275}{H_S\sqrt{1+3\,m_R/m_S}}\sqrt{\frac{E_{ST}}{\rho_{ST}}} = \frac{.275}{47\times\sqrt{1+3\times\frac{419.59}{2,270.6F}}}\sqrt{\frac{29\times10^6\times12^2}{15.225}} = 77.76\ Hz;$$

- the fundamental vertical natural frequency incl. effects of tank inertia (using the approximate expression of the Dunkerley type):

$$\frac{1}{f_V^2} = \frac{1}{(f_{V1})^2} + \frac{1}{(f_a)^2} = \frac{1}{5.44^2} + \frac{1}{77.76^2} = .03396;$$

and therefore,

$$f_V = \sqrt{1/.03396} = 5.427\ Hz$$

Remarks:

(1) It is concluded from relations given above effects of tank inertia in vertical direction as well as effects of roof inertia in horizontal direction are both negligible.

(2) Rigid foundation of the tank is assumed and no effects of soil-tank interaction are taken into account here.

c) Three fundamental sloshing frequencies are:

$$f_{S1} = \frac{1.043}{\sqrt{R}} = .249\ Hz \qquad f_{S2} = \frac{2.075}{\sqrt{R}} = .496\ Hz \quad \text{and} \quad f_{S3} = \frac{2.638}{\sqrt{R}} = .6306$$

$(R = 17.5\ ft)$

Both calculated fundamental natural frequencies f_H and f_V of the tank-liquid system may vary $\pm 15\%$ as well as sloshing frequencies (uncertainties in input data, simplified calculation etc.).

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5.3. Spectral Accelerations

The following spectral accelerations have been extracted from the given response spectrum (ZPA = .15g)

/12/

S_{AI} (f_H = 5.77 Hz ± 15%, damping 5%) = .285g – peak value } impulsive horizontal & vertical effects

S_{AV} (f_V = 5.427 Hz ± 15%, damping 5%) = 2/3 × .285g = .19g }

S_{AC} (f_c = .249 Hz ± 15%, damping .5%) = .08g – sloshing, convective effect

5.4 Horizontal Impulsive Mode Response

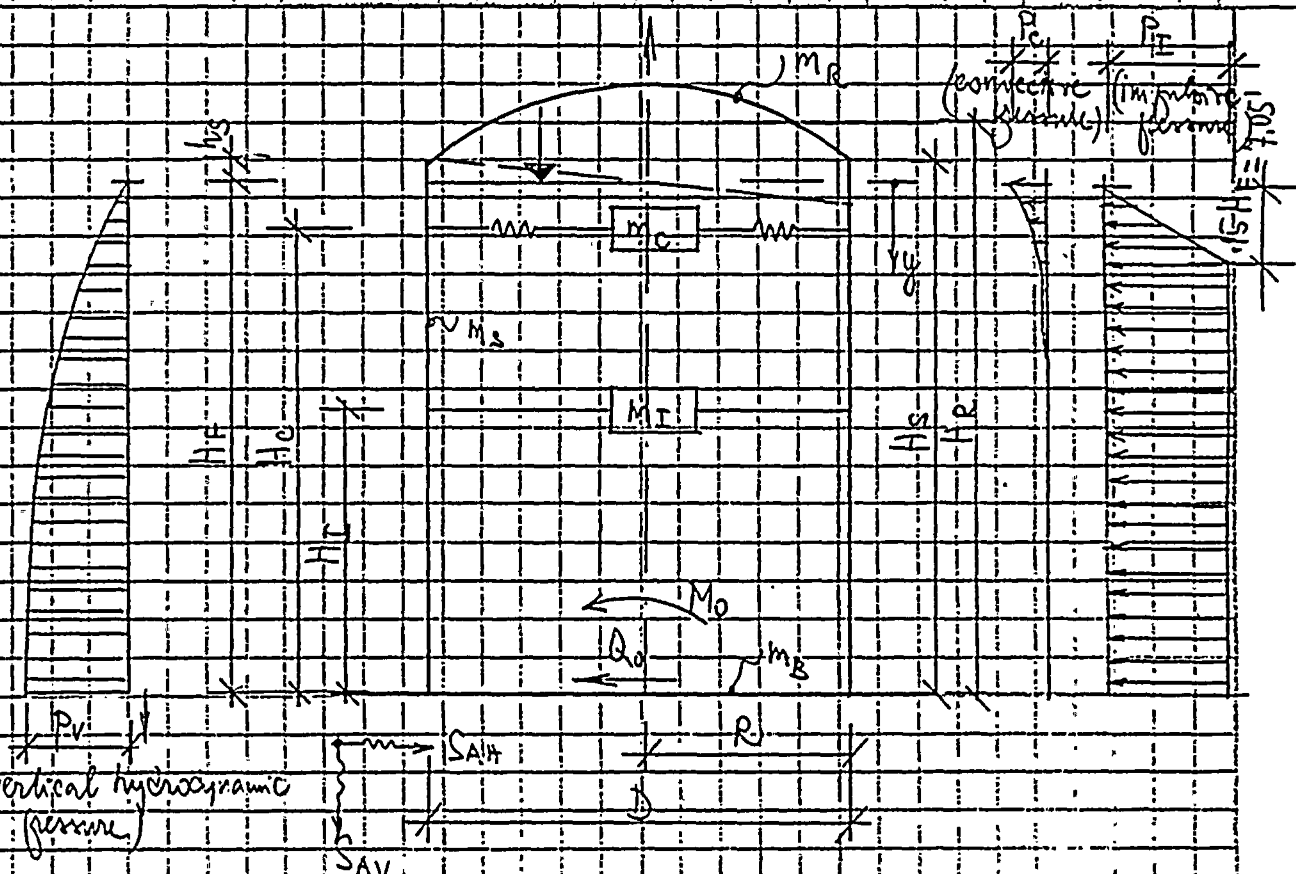

Fig. 2. Components of Tank Earthquake Response

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/6/ According to the ASCE Standard 4-86 the impulsive mode base shear, Q_{OI}, and moment, M_{OI}, at the base of the tank shell are given by

$$Q_{OI} = (m_R + m_S + m_B + m_I)\, S_{AI} \quad (1)$$

and

$$M_{OI} = \left(m_R H_R + m_S \frac{H_S}{2} + m_I H_I\right) S_{AI} \quad (2)$$

For all items see Fig. 2.

In this case, when $H_F / R = 47/17.5 = 2.686 > 1.5$

$$\frac{m_I}{m_F} = 1.0 - .435 \frac{R}{H_F} = .838, \text{ i.e. } m_I = .838\, m_F = .838 \times (87,670.787) = 73,472.48 \ lb\text{-}s^2/ft;$$

and

$$\frac{H_I}{H_F} = .5 - .188 \frac{R}{H_F} = .43, \text{ i.e. } H_I = .43\, H_F = .43 \times 47 = 20.21\ ft$$

Thus from eq. (1) and (2), the impulsive mode base shear and moment are:

$$Q_{OI} = (419.59 + 2,276.67 + 381.45 + 73,472.43) \times .285 \times 32.185 =$$
$$= 702,173.38\ lb \doteq 702.17\ kips;$$

$$M_{OI} = \left(419.59 \times 50 + 2,276.67 \times \frac{48}{2} + 73,472.43 \times 20.21\right) \times .285 \times 32.185 =$$
$$= 14,314,013\ lb = 14,314.01\ kips$$

One can easily recognize that neglecting tank inertia effects in expressions for the implosive mode base shear and moment would create errors that cannot be neglected.

/2/ Veletsos provides a slightly different formulation of Q_{OI} and M_{OI} which leads to a slightly lower base shear and to a practically identical base moment.

/5/ Haroun and Housner provide another different formulation which gives a slightly lower base shear but a slightly higher base moment.

For this case the results given by eq. (1) and (2) to be used as they are in accordance with ASCE Standard 4-86.

/6/ According to the ASCE Standard 4-86 the impulsive mode hydrodynamic pressure p_I should be approximated by:

$$p_I = \frac{m_I \; H_I \; S_{AI}}{1.36 \; R \; H_F^2} = \frac{73,472.43 \times 20.21 \times .285 \times 32.185}{1.36 \times 17.5 \times 47^2} = 259.07 \; lb/ft^2 \text{ i.e. } 1.799 \text{ psi}$$

Both Veletsos and Haroun & Housner provide alternate formulations for estimating the impulsive pressure which give slightly different values. The impulsive pressure determined above will be used below.

5.5. Horizontal Convective (Sloshing) Mode Response

The convective mode base shear and moment are given by

$$Q_{OC} = m_C \; S_{AC} \qquad (3)$$

and

$$M_{OC} = m_C \; S_{AC} \; H_C \qquad (4)$$

For all items see Fig. 2

/6/ According to the ASCE Standard 4-86 and another subjected references

$$\frac{m_C}{m_F} = 0.46 \frac{R}{H_F} \tanh\left(1.836 \frac{H_F}{R}\right) = .1703, \text{ i.e. } m_C = .1713 \, m_F =$$

$$= .1713 \times 87,670.787 = 15,014.39 \; lb\text{-}s^2/ft$$

$$\frac{H_C}{H_F} = 1.0 - \frac{\cosh\left(1.835 \frac{H_F}{R}\right) - 1.0}{1.835 \frac{H_F}{R} \sinh\left(1.835 \frac{H_F}{R}\right)} = .8, \text{ i.e. } H_C = .8 \times H_F = 37.6 \; ft$$

Thus from eqs. (3) and (4), the convective mode base shear and moment are

$$Q_{OC} = 15,014.39 \times .08 \times 32.185 = 38,659.05 \; lb = 38.66 \; kips$$

and

$$M_{OC} = 15,014.39 \times .08 \times 32.185 \times 37.6 = 1,453,580.3 \; lb\text{-}ft = 1,453.58 \; kip\text{-}ft.$$

The hydrodynamic convective pressure can be estimated as follows:

$$p_c = \frac{.267\ m_F S_{AC}}{R\ H_F} \times \frac{\cosh\left(1.835\frac{H_F - y}{R}\right)}{\cosh(1.835\ H_F/R)} \quad (5)$$

Where y is a depth from the top of the liquid.

If y = 0 using eq. (5)

$$p_c = \frac{.267 \times 87,670.787 \times 0.08 \times 32.185}{17.5 \times 47} \times 1.0 = 73.28\ lb/ft^2 = .509\ psi$$

If y = 10' and 20', we obtain

$$p_c = .509 \frac{\cosh\left(1.835\frac{47-10}{17.5}\right)}{\cosh(1.835 \times 47/17.5)} = .1785\ psi \text{ and } p_c = .509 \frac{\cosh\left(1.835\frac{47-20}{17.5}\right)}{\cosh(1.835 \times 47/17.5)} =$$

$= .063$ psi respectively.

Such pressures are, generally, negligible compared to either the hydrodynamic impulsive pressure p_I, or hydrodynamic vertical pressure, p_v, except at shallow depths below the fluid surface.

(6) Lastly, the fundamental mode fluid sloshing height, h_s, can be approximated as

$$h_s = .84\ R\ (S_{AC}/g) = .84 \times 17.5 \times 0.08 = 1.176\ ft.$$

5.6. Vertical Fluid Mode Response

(4) According Veletsos, the hydrodynamic vertical fluid response mode pressure for a tank on a rigid foundation can be estimated as

$$p_v = 0.8\ \rho_F\ H_F\ (S_{AV}) \cos\left(\frac{\pi}{2}\ \frac{H_F - y}{H_F}\right) \quad (6)$$

which is more accurate than the linear varying pressure defined by eq. 3500-7 of the ASCE Standard 4-86.

Even for tanks on a rock site there will be some foundation flexibility.

A flexible foundation greatly reduces the vertical fluid mode hydrodynamic pressures below that computed for an absolute rigid foundation. One way to approximate this influence is through increased damping, in this case about 5%.

Using eq. (6), when $y = H_F$, we obtain

$$p_v = 0.8 \times 1.939 \times 47 \times 0.19 \times 32.185 = 445.83 \text{ lb/ft}^2 = 3.096 \text{ psi}$$

and, consequently, when $y = 15'$ and $30'$ we have

$$p_v = 3.096 \cos\left(\frac{\pi}{2} \times \frac{47-15}{47}\right) = 1.4879 \text{ psi} \quad \text{and} \quad p_v = 3.096\left(\frac{\pi}{2} \times \frac{47-30}{47}\right) = 2.6096 \text{ psi respectively}$$

5.7. Combined Responses

(1) The combined horizontal responses for base shear, Q_0, base moment, M_0,
(2) and for horizontal hydrodynamic pressures, p_H, can be obtained by the SRSS combination of the horizontal impulsive and convective responses. Thus,

$$Q_0 = \sqrt{Q_{0I}^2 + Q_{0C}^2} = \sqrt{702.17^2 + 38.66^2} = 703.23 \text{ kips}$$

$$M_0 = \sqrt{M_{0I}^2 + M_{0C}^2} = \sqrt{14,314.01^2 + 1,453.58^2} = 14,387.63 \text{ kip-ft}$$

while Table 1 presents the combined horizontal dynamic pressures, p_H.

For the purposes of the membrane hoop stress capacity check, it is necessary to have an estimate of the maximum seismic hydrodynamic pressures, p_{ST}, which is obtained by the SRSS combination of the horizontal seismic pressures, p_H, and the vertical fluid response hydrodynamic pressures, p_v. Table 1 presents these values at two capacity evaluation locations (section a and section b).

For the purposes of estimating the compressive buckling capacity of the tank shell, it is necessary to have an estimate of the expected maximum and minimum fluid pressures acting against the tank shell near the base at the location of maximum axial compression during the time of maximum base moment. Those expected maximum and minimum compression zone pressures can be estimated as:

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(1) $p_{C+} = p_{ST} + p_H + 0.4 p_V$ and $p_{C-} = p_{ST} + p_H - 0.4 p_V$ (7)

where the factor 0.4 on p_V is to account for the probable vertical mode hydrodynamic vertical pressure at the same time of maximum base moment.

Similarly, for the purposes of estimating the expected minimum fluid hold-down forces in the zone of maximum tank wall axial tension, it is need to have an estimate of the maximum tension zone fluid pressure, p_{T-}, at the same time of maximum moment, as given by

$p_{T-} = p_{ST} - p_H - 0.4 p_V$ (8)

(1) For the sliding capacity evaluation one needs the expected minimum average fluid pressure on the base plate, p_a, at the same time of maximum base shear, as given by

$p_a = p_{ST} - 0.4 p_V$ (9)

The static fluid pressure is $p_{ST} = W_F \cdot y$, so, when $y = H_F$ (tank base) we obtain the maximum value

$p_{ST} = W_F \times H_F = 62.4 \times 47 = 2,932.8$ lb/ft^2 = 20.37 psi.

Thus, at the tank base

$p_{C+} = 20.37 + 1.8 + .4 \times 3.096 = 23.408$ psi

$p_{C-} = 20.37 + 1.8 - .4 \times 3.096 = 20.932$ psi

$p_{T-} = 20.37 - 1.8 - .4 \times 3.096 = 17.332$ psi

$p_a = 20.37 - .4 \times 3.096 = 19.132$ psi

(1) Lastly, one needs an estimate of the expected minimum total effective weight W_{TE}, of the tank shell and roof at the time of maximum moment and base shear:

$W_{TE} = (W_R + W_S)(1 - 0.4(a_V/g)) = (13,504.66 + 73,274.51)(1 - .4 \times 0.1) =$
$= 83,308.0$ lbs $= 83.308$ kips

where $a_V = 2/3$ ZPA $= 2/3 \times .15 = .1$ g

Table 1. Hydrostatic and Hydrodynamic Pressures and SME Capacity at Capacity Evaluation Locations

Section	Wall thickness [in]	y [ft]	Individual pressures [psi] P_{ST}	P_{I}	P_c	P_V	Combined pressures [psi] P_H	P_S	Capacity *) pressure P_{ca} [psi]	Capacity **) SME_A ***) [g]
a	.423	46	19.93	1.799	~0.	3.094	1.8	3.58	62.26	2.21
b	.367	39	16.90	1.799	~0.	2.986	1.8	3.49	50.96	1.83

Notes: *) $P_{ca} = \frac{0.9\,\sigma_{yc} \times t_s}{R} = \frac{.9 \times 36 \times 10^3 \times .423}{12 \times 17.5} = 62.26$ psi (steel A36, $\sigma_{yc} = 36$ ksi) section a

$P_{ca} = \frac{.9 \times 36 \times 10^3 \times .367}{12 \times 17.5} = 50.96$ psi section b

**) $SME = \frac{CAPACITY - STATIC}{k \cdot SEISMIC_c}(SME_c)$; here $k = .8$ $(SME_c) = .15g$ (2PGA)

***) Calculated SME_A are many times greater than another SME factors, so that these do not govern!

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6. CAPACITY ASSESSMENT

6.1. Compressive Buckling Capacity of the Tank Shell

/1/ – The "elephant" buckling axial stress, σ_p, of the tank shell will be

$$\sigma_p = \frac{0.6\,E_{ST}}{(R/t_s)}\left[1-\left(\frac{pR}{\sigma_{yc}\,t_s}\right)^2\right]\left[1-\frac{1}{1.12+S_1^{1.5}}\right]\left[\frac{S_1+(\sigma_{yc}/36\,ksi)}{S_1+1}\right] \quad (10)$$

where

$$S_1 = \frac{R}{400\,t_s} = \frac{12\times 17.5}{400\times .423} = 1.241 \quad (t_s = \text{the shell thickness near the base})$$

$\sigma_{yc} = 36$ ksi (A 36 steel)

$p = p_{CT} = 23.408$ psi

$E_{ST} = 29\times 10^3$ ksi

After substitution into eq. (10), we obtain

$$\sigma_p = \frac{.6\times 29\times 10^3}{496.45}\left[1-\left(\frac{23.408\times 496.45}{36\times 10^3}\right)^2\right]\left[1-\frac{1}{1.12+1.241^{1.5}}\right] = 18.851 \text{ ksi}$$

/1/ For HCLPF capacity computations it is suggested that a slight conservatism be introduced by specifying C_m in terms $0.9\sigma_p$, so that

$$C_m = .9\,\sigma_p\,t_s = .9\times 18.851\times .423 = 7.176 \text{ kip/in}$$

/8/ The classical "diamond" buckling capacity stress of supported cylindrical shell under combined axial bending and internal pressure, σ_{CB}, for such a case can be conservatively estimated from NASA SP-8007

$$\sigma_{CB} = (0.6\,\gamma + \Delta\gamma)\frac{E_{ST}}{(R/t_s)} \quad (11)$$

where $\gamma = 1 - 0.73\,(1-e^{-\varphi})$, $\varphi = \frac{1}{16}\sqrt{R/t_s}$ and $\Delta\gamma$ – an increase factor for internal pressure

In this case $\Delta\gamma = .15$ (from /8/);

$\varphi = \frac{1}{16}\sqrt{496.45} = 1.392$, $\gamma = 1 - 0.73\,(1-e^{-1.392}) = .451$ and therefore,

$$\sigma_{CB}' = (.6 \times .451 + .15)\frac{29\times10^3}{496.45} = 24.57 \text{ ksi} < \sigma_{ye}$$

Since σ_{CB} is conservatively estimated, it may be directly used with no reduction for estimating $C_m = \sigma_{CB}\, t_s$. In this case σ_{CB} exceeds $0.9\sigma_p'$, so this buckling mode does not govern.

(7) Another formula to estimate the axial bending induced "diamond" buckling stress σ_{CB} was introduced by Niwa and Clough:

$$\sigma_{CB}' \doteq .373\, E_{ST}\, t_s/R = .373 \times 29\times10^3 / 496.45 = 21.79 \text{ ksi} < \sigma_{ye}$$

which gives as well more than $0.9\,\sigma_p'$

6.2. Bolt Hold-Down Capacity

The anchor bolts are the same as for the condensate storage tank. So, if the proposed reinforcing of the bolt chair top plates will be realized (the necessary thickness was determined as 1.25"), the bolt hold-down capacity may be taken as

$F_{BC} = 24.24$ kips (controlled by the bolt pullout capacity, not by the bolt tensile capacity)

A maximum bolt elastic elongation under the load F_{BC} will be

$$\delta_B^{el} = \frac{F_{BC}\, l_B}{A_B\, E_B} = \frac{24.24\times30}{1.485\times29\times10^3} = .0169 \text{ in } (\approx 0.056\%)$$

where: $l_B = h_a + h_c = (12+3)+15 = 30''$. ($h_a = (12+3)''$ below the concrete level, $h_c = 15''$ above concrete)

(See the condensate storage tank seismic calculation)

6.3. Fluid Hold-Down Forces

For tanks with minimum anchorage, hold-down forces resulting from fluid pressure acting on the tank bottom will contribute to overturning moment capacity, M_{SC}, of the tank. The solution in the region of axial tension in the tank shell is sketched in Fig. 3 for a small uplift displacement δ_e. This uplift is accompanied by the development of a tension, T_e, and moment, M_e, in the side shell at the intersection with the tank bottom.

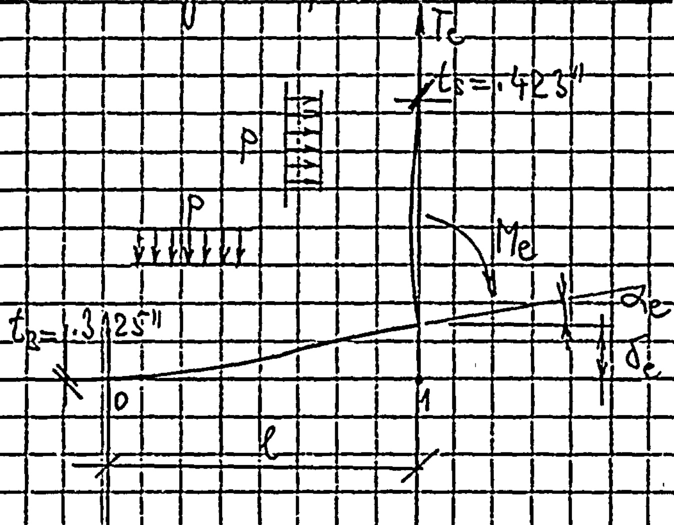

Fig. 3. Tank Bottom Behaviour Near Tensile Region of the Tank Shell

The relations are as follows:

$$\frac{E_{ST} I_B \delta_e}{p} = \frac{\ell^4}{24} - \frac{1}{F}\left(\frac{K_s \ell^5}{72 E_{ST} I_B} + \frac{M_F \ell^2}{6p}\right) \quad (12)$$

$$\frac{T_e}{p} = \frac{\ell}{2} + \frac{1}{F}\left(\frac{K_s \ell^2}{12 E_{ST} I_B} + \frac{M_F}{p\ell}\right) \quad (13)$$

$$\frac{M_e}{p} = \frac{1}{F}\left(\frac{K_s \ell^3}{12 E_{ST} I_B} + \frac{M_F}{p}\right); \quad (14)$$

$$\frac{M_F}{p} = \frac{\ell^2}{8} - \frac{M_e}{2p} + \frac{M_e^2}{2p^2\ell^2} \quad (15)$$

where $K_s = \frac{2Kk}{R} = \frac{2 \times 201.0 \times 28.64}{12 \times 17.5} = 54.825$ kips

$k = \left[R/t_s \sqrt{3(1-\nu^2)}\right]^{1/2} = \left[496.45 \sqrt{3(1-.3^2)}\right]^{1/2} = 28.64$; (dimensionless)

$K = \frac{E_{ST} t_s^3}{12(1-\nu^2)} = \frac{29 \times 10^3 \times (.423)^3}{12(1-.3^2)} = 201.00$ kip-in

$\frac{M_F}{p} = \frac{R t_s}{\sqrt{12(1-\nu^2)}}\left(1 - \frac{R}{H_F k}\right) = \frac{12 \times 17.5 \times (.423)}{\sqrt{12(1-.3^2)}}\left(1 - \frac{12 \times 17.5}{564 \times 28.64}\right) = 26.53 \text{ in}^2$

$I_B = \frac{t_B^3}{12(1-\nu^2)} = \frac{.3125^3}{12(1-.3^2)} = .002795 \text{ in}^3$; $p = p_T = 17.332$ psi;

$$F = 1 + \frac{k_s \ell}{2E_{ST} I_B} = 1 + \frac{54.825 \times \ell}{2 \times 29 \times 10^3 \times .002795} = 1 + 0.3382\ell$$

After substitution in eq. (12) we obtain the following relation between the uplift, δ_e, and the uplift length, ℓ, for numerical solution:

$$1.1224 \times 10^5 \times \delta_e (1 + .3382 \times \ell) = \ell^4 + .1127 \times \ell^5 - 106.121\ell^2$$

(both values, δ_e and ℓ, are in inches). Results of numerical solution are given in Table 2.

Table 2. Fluid Hold-Down Quantities

δ_e [in]	ℓ [in]	T_e [lb/in] *)	M_e [lb-in/in] **)	M_+ [lb-in/in] ***)
0.	7.57	84.741	248.189	31.098
0.025	10.25	121.851	338.479	89.596
0.05	11.61	135.382	403.654	125.143
0.1	13.42	154.253	509.309	177.170

*) Calculated from eq. (13) which after substitution gives

$$T_e = 17.332\left(\frac{\ell}{2} + \frac{26.53 + 0.05637 \times \ell^3}{\ell + .3382 \times \ell^2}\right); \ [lb/in], \ (\ell \text{ in inches})$$

**) Calculated from eq. (14) which after substitution gives

$$M_e = \frac{.9769 \times \ell^3 + 459.818}{1 + .3382 \times \ell}; \ [lb\text{-}in/in], \ (\ell \text{ in inches})$$

***) Calculated from eq. (15) which after substitution gives

$$M_+ = 2.167 \times \ell^2 - \frac{M_e}{2} + \frac{M_e^2}{34.66 \times \ell^2}; \ [lb\text{-}in/in], \ (\ell \text{ in inches})$$

M_+ - maximum positive bending moment in the bottom plate, both moments M_e and M_+ are not explicit necessary for the calculation below, they are given only for completeness of the analysis.

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SUBJECT Turkey Point JOB No. 90C1585 SHEET 19 OF 26

SME Capacity of the Refueling Water Storage Tank

Turkey Point, Units 3&4

REVISIONS: 0 RM 12/20/90; JJDS 1/20/91

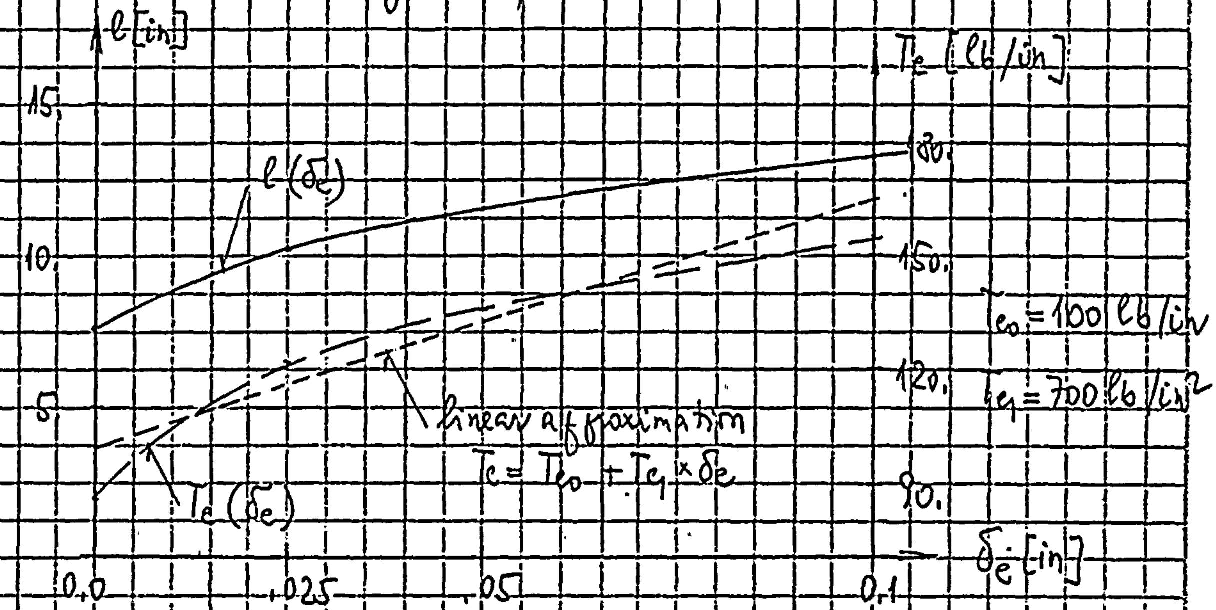

Fig 4 Fluid Hold-Down Force, F_c and Uplift length, l, vs. Uplift Displacement δ_c

6.4. Overturning Moment Capacity

/1/ With an estimate of the compressive capacity of the tank shell, C_m, the anchor bolt hold-down capacity, T_{bc}, and the relationship between the fluid hold-down force and the uplift displacement, it is possible to estimate the overturning moment capacity M_{sc} of the tank. The corresponding theory and assumptions are given in Ref. 1. We will analyze the case sketched in Fig. 5.

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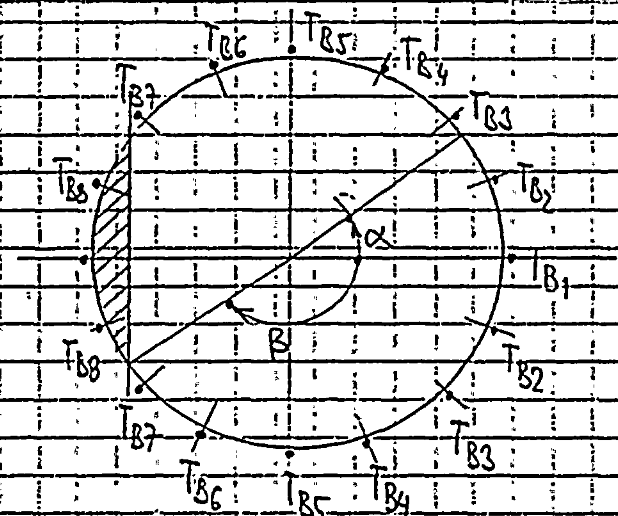
SUBJECT: Turkey Point JOB No. 90C1585 SHEET 20 OF 26

SME Capacity of the Refueling Water Storage Tank

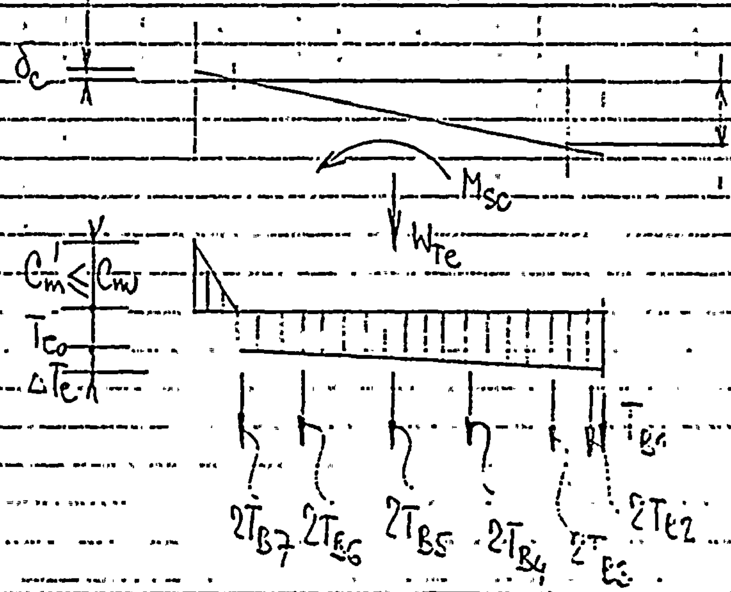
Turkey Point, Units 3&4

REVISIONS: 0 RM 12/20/90; DDS 1/20/91

/1/



	cos α
1	1.
2	.9238
3	.7071
4	.3827
5	0
6	-.3827
7	-.7071
8	-.9238



$$\delta_{c\alpha} = \delta_c \frac{\cos\alpha - \cos\beta}{1 - \cos\beta}$$

Fig. 5 Vertical Loading on the Tank Shell at the Base

11/ b) The corresponding formulas are as follows:

$$\delta_c = \frac{C_m'' h_c}{E_s \cdot t_s}; \qquad (16)$$

$$\delta_{c\alpha} = \delta_c \frac{\cos\alpha - \cos\beta}{1+\cos\beta} \quad \text{(see Fig. 6)} \qquad (17)$$

$$C_1 = \frac{1+\cos\beta}{\sin\beta + (\pi-\beta)\cos\beta}; \quad C_2 = \frac{\sin\beta\cos\beta + \pi - \beta}{1+\cos\beta};$$

$$C_3 = \frac{\sin\beta - \beta\cos\beta}{\sin\beta + (\pi-\beta)\cos\beta}; \quad C_4 = \frac{\beta - \sin\beta\cos\beta}{1+\cos\beta}; \qquad (18)$$

$$C_m'' = \left(\frac{W_{Tc} + \sum_i T_{Bi}}{2R} + T_{c0}\beta\right) C_1 + T_{c1}\delta_c C_3; \qquad (19)$$

$$\therefore M_{sc} = C_m'' C_2 R^2 + \sum_i (F_{Bi} \cdot R\cos\alpha_i) + T_{c0} R^2 (2\sin\beta) + \Delta T_c C_4 R^2 \qquad (20)$$

where

$C_m'' \leq C_m'$ = maximum compressive load of the tank shell (see Fig. 6)

$T_{Bi} = T_{BP} + K_B \left(\frac{\cos\alpha_i - \cos\beta}{1+\cos\beta}\right) \leq T_{BC}$ – the anchor bolt tension (limited by T_{BC})

$K_B = \frac{\delta_c A_B E_B}{h_a \cdot h_c}$, T_{BP} = bolt pretension, in our case $T_{BP} = 0.0$

$h_c = 15"$, $h_a = 12+3 = 15"$, $E_S = E_B = 29\times10^3$ ksi, $W_{Tc} = 83.308$ kips

$A_B = 1.485$ in² (bolt ⌀ 1 3/8"); $T_{c0} = 0.1$ kips/in; $T_{c1} = 70$ kips/in²; $\Delta T_c = T_{c1}\cdot\delta_c$

c) All numerical calculations are given in Table 3. First a trial angle β is selected and eq. (19) is used to obtain C_m'' which is compared to the C_m'' from eq. (16). The angle β is varied until $C_m'' = C_m''$. Then eq. (20) is used with this β to determine the moment capacity M_{sc}.

The elongation $\delta_{c\alpha=0}$ of the outer most bolt is limited from ~.02 in (approx. the maximum elastic elongation of the bolt under loading T_{BC}) to .1 in (expected maximum elongation under T_{BC} incl. ductility and plastic effects).

Table 3. Overturning Moment Capacity

Trial Cβ [rad]	1+cosβ	C_1	C_2	C_3	C_4	$C_m \le C_{mu}$ [kip/in]	δ_c [in]	$\delta_{e\,x=0}$ [in]	K_B [kips]	$T_{B1} \le T_{BC}$ [kips]	$2T_{B2} \le 2T_{BC}$ [kips]	$2T_{B3} \le 2T_{BC}$ [kips]	$2T_{B4} \le 2T_{BC}$ [kips]	$2T_{B5} \le 2T_{BC}$ [kips]	$2T_{B6} \le 2T_{BC}$ [kips]	$2T_{B7} \le 2T_{BC}$ [kips]	$\sum T_{Bi}$ [kips]	C''_m [kips]
2.70	.0959	3.408	.5755	109.90	32.17	4.1200	.005038	.1	7.232	24.24	48.48	48.48	48.48	48.48	48.48	29.71	296.35	4.388
2.68	.1047	3.261	.6601	88.65	29.41	4.5143	.005520	.1	7.924	24.24	48.48	48.48	48.48	48.48	48.48	28.49	295.13	4.156
2.69	.1002	3.333	.5880	94.98	30.75	4.3151	.005276	.1	7.574	24.24	48.48	48.48	48.48	48.48	48.48	29.12	295.76	4.255
M_{sc} = 133,129.03 kip-in = 11,094.09 kip-ft < 14,387.63 not OK																		
2.60	.1481	2.784	.6978	53.36	24.16	3.1485	.003850	.05	5.527	24.24	48.48	48.48	48.48	48.48	36.63	11.57	266.86	3.185
M_{sc} = 126,828.7 kip-in = 10,569.06 kip-ft < M_o = 14,387.63 kip-ft not OK																		
2.45	.2298	2.187	.8720	24.03	12.80	2.1181	.002590	.02	3.718	24.24	48.48	48.48	37.81	24.923	12.54	2.04	198.01	2.044
2.46	.2234	2.218	.8609	26.22	13.20	2.0570	.002510	.02	3.603	24.24	48.48	48.48	37.39	25.05	12.705	2.24	198.59	2.079
M_{sc} = 108,840.9 kip-in = 9,070.07 kip-ft < M_o = 14,387.63 kip-ft not OK																		

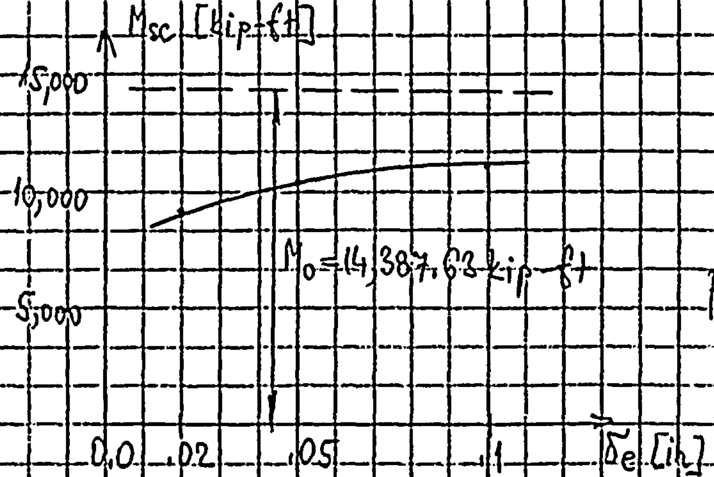


Fig. 6. Overturning Moment Capacity vs. elongation of the outermost bolt (x=0)

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0 DLM 12/20/90
SSS 1/20/91

When the elongation of the outermost bolt is limited as in this case the compressive buckling capacity stress of the tank shell cannot develop in the compressive zone, and therefore, the quantities δ_c and $C_n' < C_m$, are back calculated using eq. 16 and 17 for the limiting bolt elongation $\delta_{\alpha=0}$ and for any trial β.

These back-calculated δ_c and C_n' values are then used to solve the moment capacity M_{SC} in the same manner as described above, i.e. the angle β is varied until $C_m' = C_n'$.

d) Results are presented in Fig. 6. One can see that in all cases $M_{SC} < M_0$, so the seismic overturning moment capacity is less than .15g.

e) The maximum elongation of the outermost bolt corresponding to its hold-down pullout capacity T_{SC}, may be estimated as

$$\delta_c^{max} = 2.0\,\delta_B^{el} + 1.5\,\delta_{PL}^{el} = 2.0 \times 0.0169 + 1.5 \times 0.009 = 0.047 \text{ in},$$

where

$\delta_B^{el} = .0169$ in = the maximum bolt elastic elongation under the load F_{SC}

$\delta_{PL}^{el} = .009$ in = the maximum elastic deflection of the top plate of the bolt chair under the same load (See the calculation of the diesel fuel storage tanks with the same bolt chairs)

2.0 and 1.5 = the coefficients implying the inelastic-ductility effects in the concrete near the anchor bolt and in the top plate of the bolt chair.

For this value $M_{SC} = 10{,}500.$ kip-ft and, therefore,

$$SME_M = \frac{M_{SC}}{k\,M_0} \times .15g = \frac{10{,}500.}{1.0 \times 14{,}327.63} \times .15g = 0.11g$$

($k = 1.0$ - the inelastic energy absorption factor taken conservatively as unity for this failure mode).

6.5 Sliding Capacity

/1/ Since the seismic base shear response Q_0 and the base seismic overturning moment response M_0 are primarily due to the horizontal impulsive mode, they both are maximum in the same time. Thus the sliding shear tank capacity is

$$Q_{sc} = \mathcal{H}\left[W_{ve} + \sum_i T_{Bi}\right] \qquad (21)$$

where $W_{ve} = W_{TE} + p_a(\pi R^2)$ and $\mathcal{H}$ = the friction coefficient

Here: $W_{TE} = 83.308$ kips, $p_a = 19.132$ psi and $\sum_i T_{Bi} \doteq 266.36$ kips (for $\delta_y \doteq 0.05$ in, see Table 3), while we assume $\mathcal{H}$ to be .7.

Thus $W_{ve} = 83.308 + .019132 \times (\pi \times 210^2) = 2{,}733.94$ kips

$$Q_{sc} = .7[2{,}733.94 + 266.36] = 2{,}100.21 \text{ kips}$$

and

$$SME_Q = \frac{Q_{sc}}{k \times Q_0} \times 0.15g = \frac{2{,}100.21}{1.0 \times 703.23} \times 0.15g = 0.448g \gg SME_M\ !$$

($k = 1.0$ - the inelastic energy absorption factor).

6.6. Other Capacity Checks

The fluid pressure capacity is summarized in Table 1. In this case $k = .8$. Computed SME_p are many times greater than another SME factors, so they do not govern.

The fluid sloshing height h_s was estimated to be about 1.18 ft. Any significant damage of the roof might not be expected.

The sufficient piping flexibility to accommodate relative seismic movements between places where the piping is supported from the tank shell and where it is independently supported was verified in the field.

No additional capacity checks have been performed in this calculation.

STEVENSON & ASSOCIATES a structural-mechanical consulting engineering firm	SUBJECT Turkey Point JOB No. 90C1585 SHEET 25 OF 26
	SME Capacity of the Refueling Water Storage Tank
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7. RESULTS

a) With the old top plates at the bolt chairs (their thickness is only 1/2") the tank does not have sufficient anchorage and its seismic overturning moment stability is reduced from that calculated herein.

b) If these top plates would be replaced as proposed by other ones that are more thick (1.20" as minimum) to reach the pullout bolt capacity $F_{BC} = 24.24$ kips, the governing SME_M capacity is .11g.

(44)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 15 - Refueling Water Storage Tank

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4 Building Outdoors

Manufacturer ______ Elevation 18'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments yes
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 1¼" 16 TOTAL
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? No.
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) ____ TOP CHAIRS ARE NOT welded gusset welds good
   TANK to be ANALYZED. Based on anchorage
2. Concerns (if any) analysis - not adequate. Capacity controlled by top chair and embedment of anchorage

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE - SF CASK CRANE IS STORED AWAY FROM THIS TANK.

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90

NAME [signature] DATE 4/5/90

NAME John D. Stevenson DATE 4/5/90

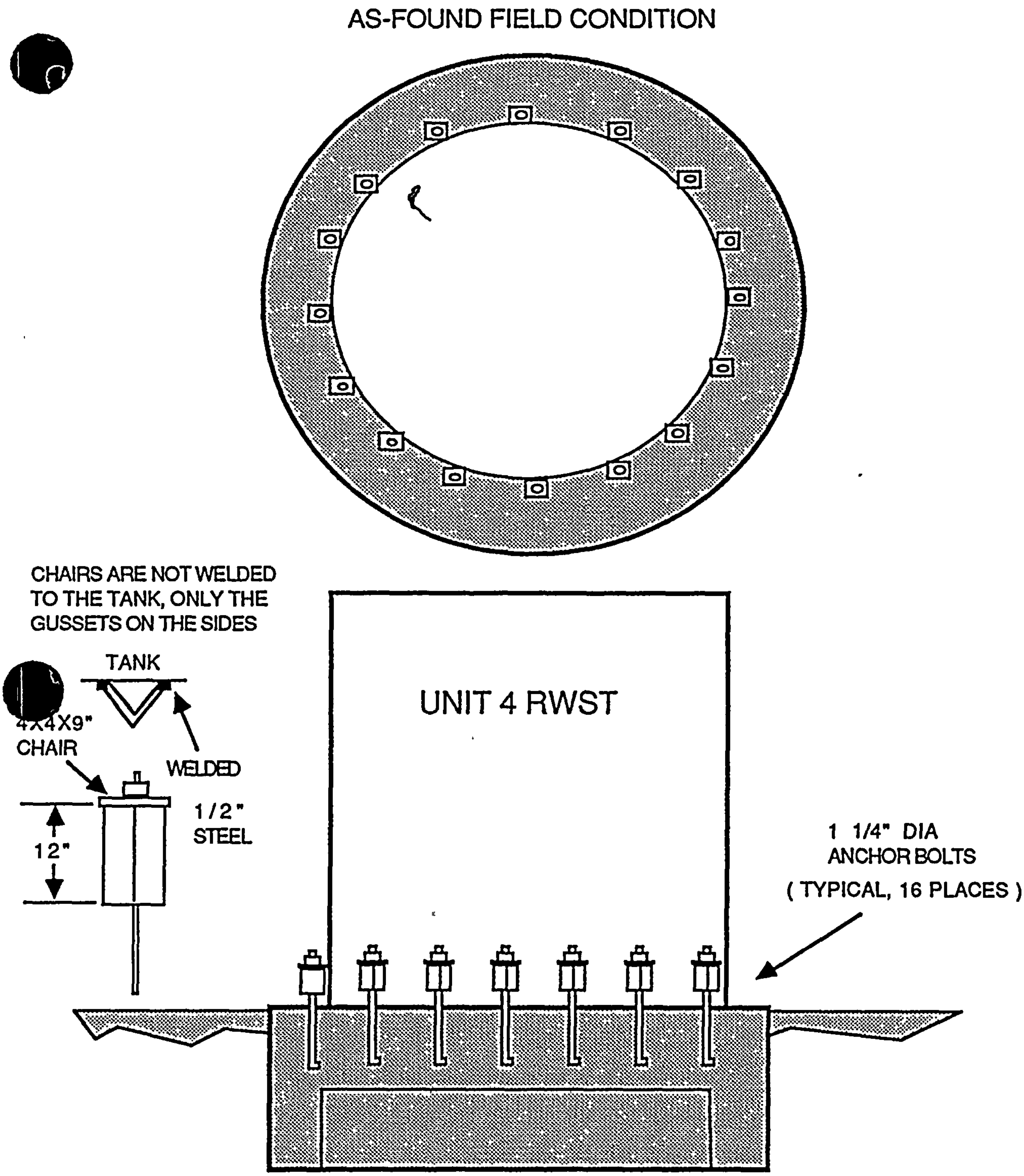
ITEM 15 REFUELING WATER STORAGE TANK - Unit 4

SRT WANTED THE TANK ANCHORAGE AND CHAIR TO BE ANALYZED. (SAME AS Unit 3).

SRT NOTED THE SPENT FUEL CASK CRANE AND it's NORMAL STORAGE AREA TO RESOLVE THE SEISMIC INTERACTION CONERN.

HCLPF FOR BOLT BOND FAILURE CALCULATED TO BE .11g WITH INCREASED CHAIR PLATE.

CALCULATIONS ATTACHED TO ITEM 14.

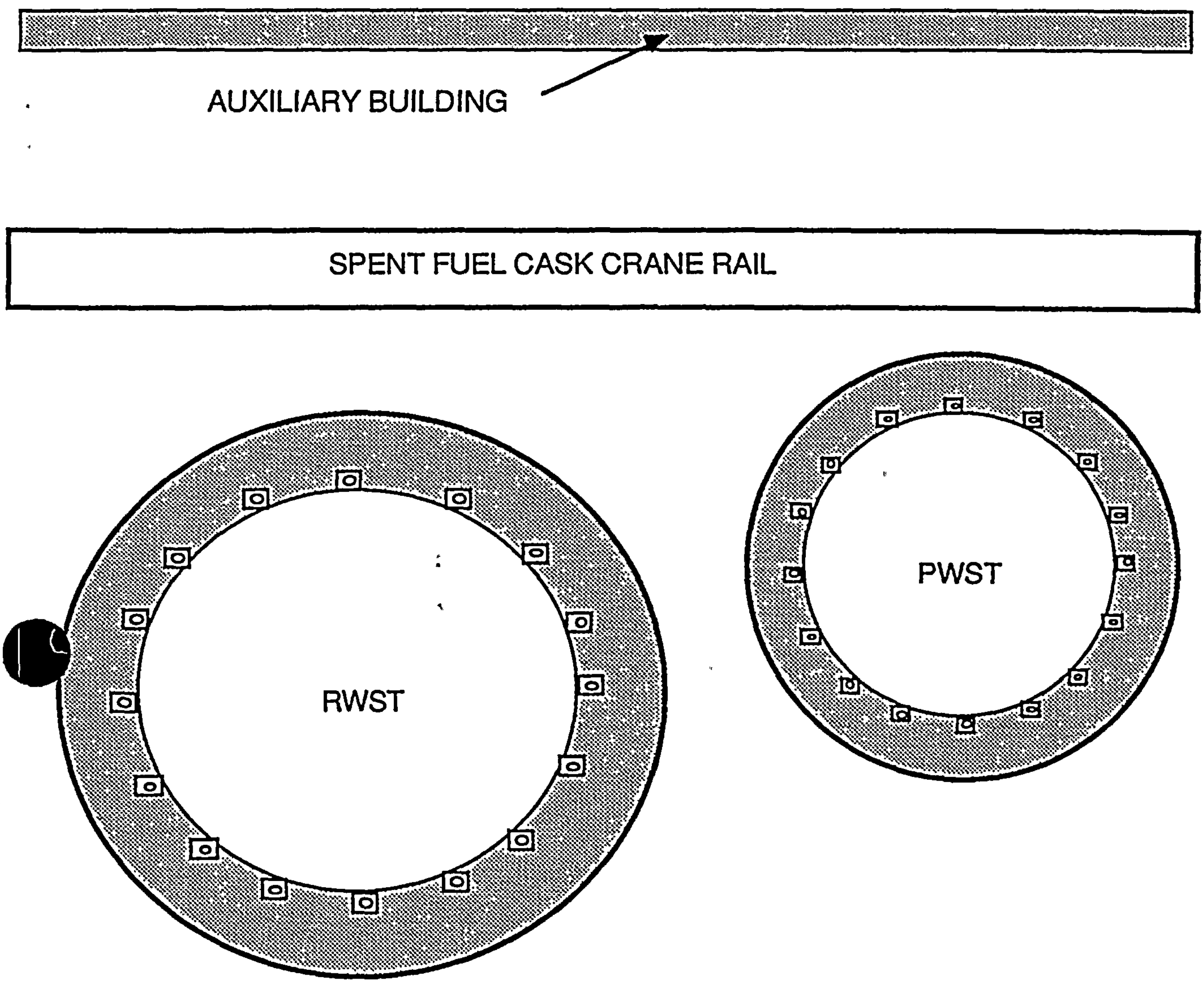


UNIT 4 RWST
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT UNIT 4 RWST
DATE:MAR 22, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT NOTED THE SPENT FUEL CASK CRANE RAIL STRUCTURE NEARBY BUT NOTED THAT THIS CRANE IS STORED AND PINNED AWAY FROM ANY ITEM ON THE WALKDOWN LIST. THERE WERE NO SEISMIC INTERACTIONS CONCERNS.

UNIT 4 RWST
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT UNIT 4 RWST
DATE: MAR 22, 1990 DWG BY: R. GOULDY

(10)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 16 - EDG Day Tank

PART A. EQUIPMENT DESCRIPTION

I.D. Number B
Building EDG
Manufacturer
Elevation 34'
Model Number
Other

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 4 3/4" ϕ Anchors
5. Are nuts present and apparently tight on all bolts? yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment
   b. URS Tables
   c. ANCHOR Program
   d. Other (explain) Edge distance calculation for Anchors & Bolt capacity calculation
2. Concerns (if any) → Reviewed Drawing & Edge distance is NOT a concern a Bolts inside Rebar cage

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) Sight glass on DG Fuel Oil tank. Fill valve on Diesel Day support is poorly designed & Not a concern with the tank. Valve may not function.

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

ITEM 16 CONSIDERED AN OUTLIER BECAUSE OF REASON 2 ON ATTACHED PAGE (GLASS SIGHT GLASS). OTHER CONCERNS HAVE BEEN RECONCILED BY ATTACHED CALCULATIONS.

APPROVED BY SRT

NAME Robert P. Kennedy DATE 9/2/91
NAME John W. Reed DATE 9/3/91
NAME John D. Stevenson DATE 9/2/91

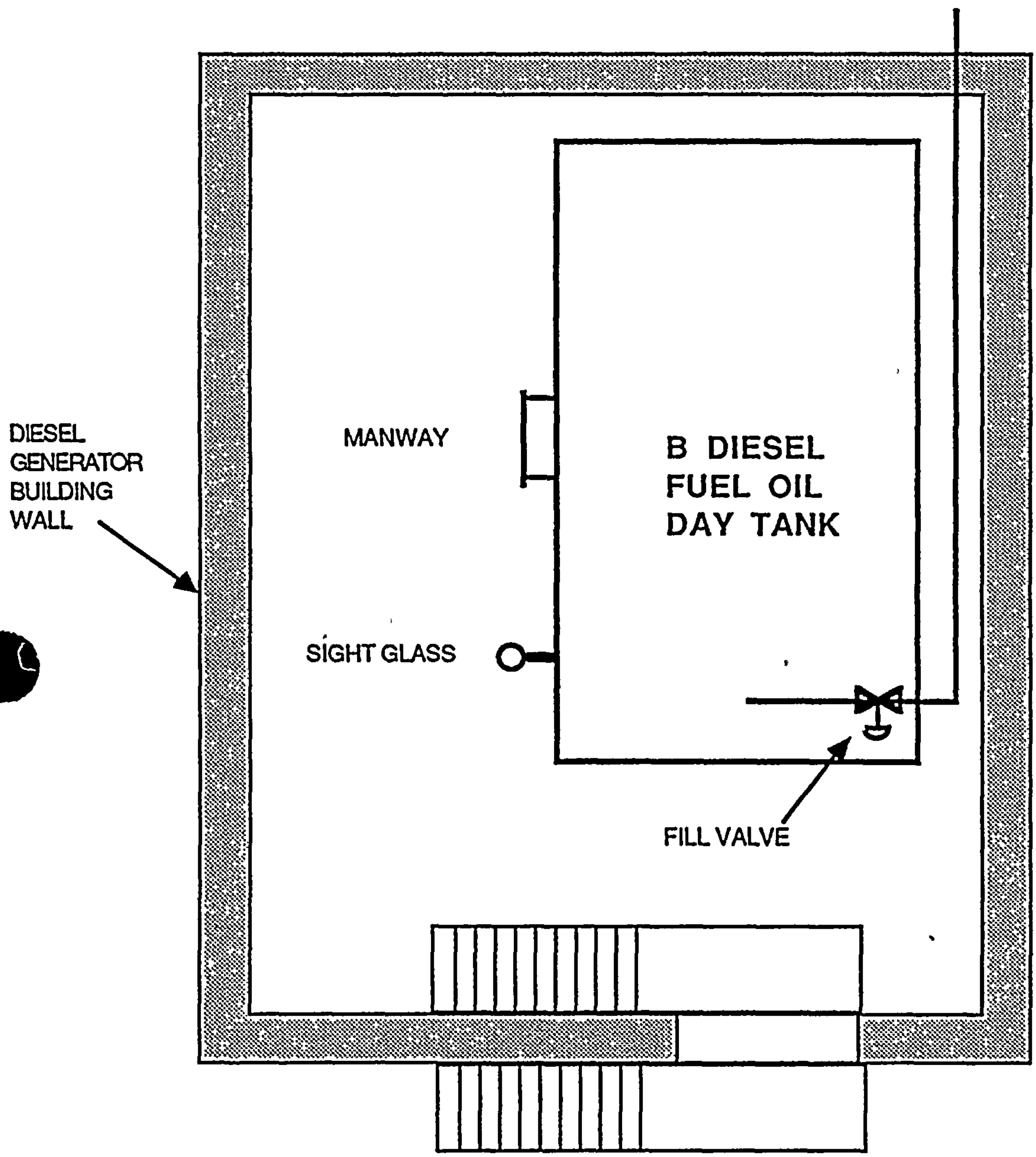
ITEM 16 E D/G DAY TANK - B

1. THE SRT REVIEWED THE TANK INSTALLATION IN IT'S OWN ROOM. A Review of the DRAWINGS SHOWING THE CURB DETAIL with REBAR CAGE & the ANCHOR BOLTS INSIDE the CAGE resolved A CONCERN with bolt edge distance.

2. AN INTERACTION CONCERN WITH THE GLASS SIGHT GLASS WAS IDENTIFIED.

3. The SRT ALSO NOTED A POORLY DESIGNED HANGER FOR AN AIR-OPERATED FILL VALVE. FAILURE of this HANGER OR VALVE WOULD NOT CREATE A CONCERN WITH THE DAY TANK.

AS-FOUND FIELD CONDITION



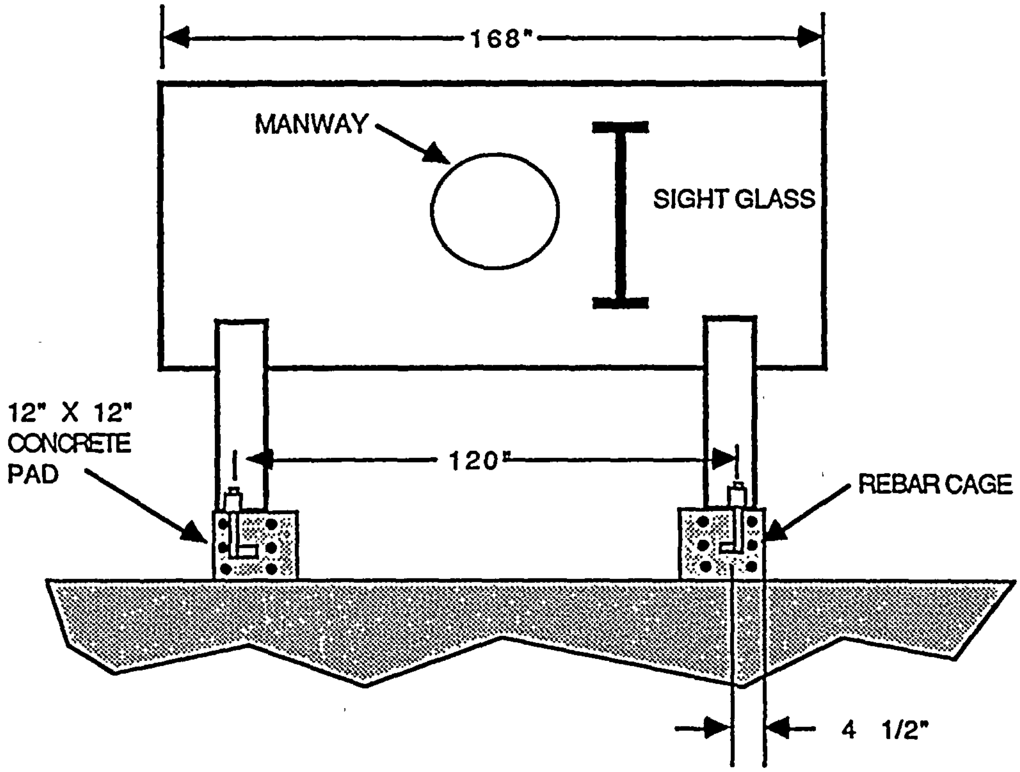
B DAY TANK SEISMIC INTERACTION WORKSHEET

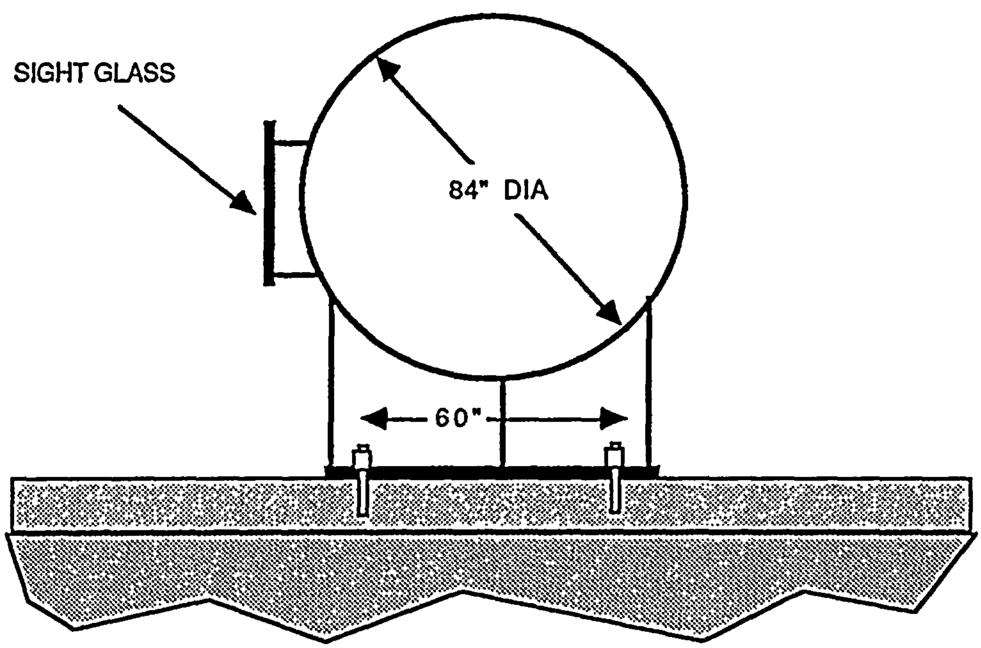
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: D/G DAY TANK
DATE: MAR 22,1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION





D/G DAY TANK SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: D/G DAY TANK
DATE: MAR 22, 1990 DWG BY: R. GOULDY

CALCULATION COVER SHEET

Calculation No: TPN-1SJC-90-001

Title: EDG TANK ANCHORAGE EVALUATION INCLUDING PRYING ACTION - ITEM 16

No.	Description	By	Date	Chk/Ver	Date	Appr	Date
0	INITIAL ISSUE	[illegible]	10/20/90	RHL 8/2/91	8/7/91	PRW	8/12/91

REVISIONS

LIST OF EFFECTIVE PAGES

CALCULATION NUMBER TPN-1SJC-90-001 REV. 0 10/20/90

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	2.0 References	0						
2	3.0 Methodology	0						
	4.0 Assumptions/ Bases	0						
3	5.0 Calculations	0						
4	"	0						
5	"	0						
6	"	0						
	6.0 Results	0						
7	"	0						

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STEVENSON & ASSOCIATES
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SUBJECT Calc. # TPN-1SJC-90-001 - EDG Tank Anchorage Evaluation Including Prying Action - Item 16

Turkey Point - Unit 2 & 3

S&A JOB No. 90C1585 SHEET 1 OF 7

REVISIONS: 0 DDD 10/20/90; RM 8/7/91

Ref.

1.0 Purpose/Scope

During the USI A-46 walkdown of Turkey Point Unit 2 and 3 a concern was expressed that the anchorage may not be of sufficient capacity to withstand the loads from the defined MHE at the Turkey Point Plant. The calculation also includes prying considerations. The purpose of this calculation is to determine the anchorage adequacy. The scope only includes anchorage.

2.0 References

1. Turkey Point - Ground Response Spectra 15% Acceleration, Figure 5A-2, Turkey Point FSAR Appendix A.
2. SSRAP Report "Use of Seismic Experience Data to Show Ruggedness of Equipment in Nuclear Power Plants," Senior Seismic Review and Advisory Panel, April 16, 1990.
3. EPRI NP-5228 "Seismic Verification of Nuclear Plant Equipment Anchorage," URS Corporation/John A. Blume & Associates, Engineers, San Francisco, California, May 1987.
4. Drawing #5610-M-22-1, Turkey Point Unit 3 & 4 Emer. Diesel Generator Fuel Oil Day Tank, Rev. 3, 5-30-79.
5. AISC, Manual of Steel Construction, Allowable Stress Design, Ninth Edition, 1989

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SUBJECT CALC. # TPN-15JC-S1A JOB No. 90C1585 SHEET 2 OF 7

90-001 - EDG TANK ANCHORAGE EVALUATION INCLUDING PRYING ACTION - ITEM 16

TURKEY POINT - UNIT 2 & 3

REVISIONS: 0 — [initials] 10/20/90; RM 8/7/91

REF.

3.0 METHODOLOGY

THE METHODOLOGY EMPLOYED IS TO CALCULATE THE BOLT LOADING FOR EARTHQUAKE LOADS IN THE THREE ORTHOGONAL DIRECTIONS (2 HORIZONTAL, AND 1 VERTICAL). THESE LOADINGS WILL BE COMBINED BY ADDING 100% OF THE LOAD IN THE WORST (MOST LOADED) DIRECTION AND 40% IN THE OTHERS. GRAVITY LOADS WILL THEN BE ADDED. THIS COMBINATION IS A CONSERVATIVE APPROXIMATION OF THE SRSS COMBINATION.

DAMPING TO BE USED IS 4% BY SRT JUDGMENT, APPLICABLE TO HORIZONTAL TANKS. SINCE THE TANK IS LOCATED LESS THAN 40' ABOVE GRADE

1, 2 1.5 x GROUND RESPONSE SPECTRA AS AN ESTIMATE OF THE MEDIAN CENTERED FLOOR RESPONSE SPECTRA.

3 A 1.25 FACTOR FOR CONSERVATISM WILL BE INCLUDED FOR ANCHORAGE LOADING.

4.0 ASSUMPTIONS / BASES

THE FOLLOWING ASSUMPTIONS WERE MADE IN PERFORMING THIS CALCULATION:

4 a) WT. = 33,713 LBS. ✓

S&A STEVENSON & ASSOCIATES a structural-mechanical consulting engineering firm	SUBJECT CALC# TPN-ISJC-90-001 - EDG TANK ANCHORAGE EVALUATION INCLUDING PRYING ACTION - ITEM 16 — TURKEY POINT - UNIT 3 & 4
S&A JOB No. 90C1585	SHEET 3 OF 7
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REF.

b. WILL CONSERVATIVELY USE PEAK OF RESPONSE SPECTRA FOR ESTIMATING LOADS.

3 c. ASSUME A307 BOLTS ~ ALLOWABLE STRESS FOR MHE IS

TENSION $1.7 \times 20^{ksi} = 34^{ksi}$ ✓

SHEAR $1.7 \times 10^{ksi} = 17^{ksi}$ ✓

5.0 CALCULATIONS

A. LOAD CALCULATIONS

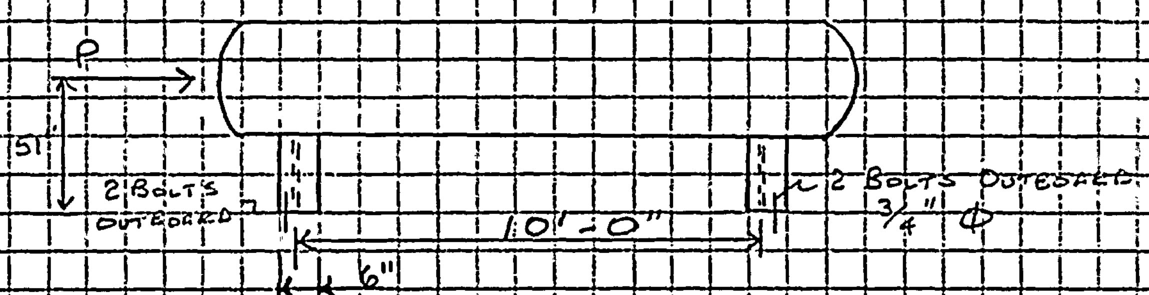
FROM RESPONSE SPECTRA ~ PEAK OF SPECTRA FOR 5% DAMPING ~ .285g ✓

$\therefore$ FOR 4% PEAK $= .285\left(\sqrt{\frac{.05}{.04}}\right) = .319g$ ✓

HORIZONTAL $g_{LOAD} = 1.5 \times 1.25 \times .319g = .598g$ ✓

VERTICAL $g_{LOAD} = \frac{2}{3} \cdot (.598g) = .399g$ ✓

B. BOLT LOAD FOR EARTHQUAKE IN HORIZONTAL LONGITUDINAL DIRECTION.



$P = .598g \cdot 33.713^{k} = 20.16^{k}$ ✓

ASSUME TANK ACTS AS A HINGED - HINGED FRAME.

STEVENSON & ASSOCIATES a structural-mechanical consulting engineering firm	SUBJECT CALC. # TPN-15JC-S&A JOB No. 90C1585 SHEET 4 OF 7
	90-001, EDG TANK ANCHORAGE EVALUATION INCLUDING PRYING ACTION - ITEM 16
	TURKEY POINT - UNIT 2 & 3
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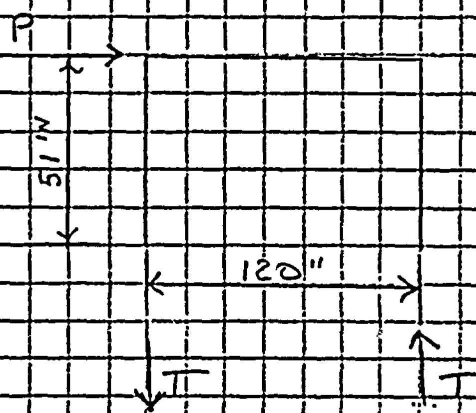
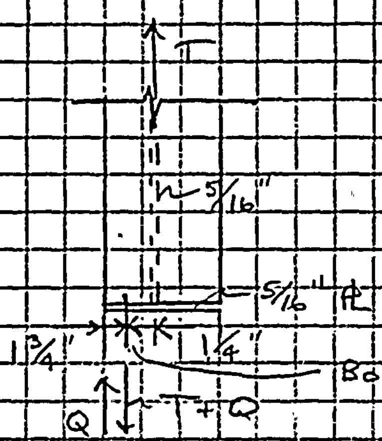
REF.

$$T = \frac{20.16^K \cdot (51)^{IN}}{2\,(120)} = 4.28^K \text{ PER BOLT}$$
(2 BOLTS)



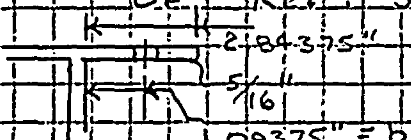


BOLT 3/4" Φ IN 1 1/8" Φ HOLE

$$V = \frac{20.16^K}{4 \text{ BOLTS}} = 5.04^K/\text{BOLT}$$

4

5 PRYING CALCULATION BASED ON Pg 4-90 TO 4-92 OF REF. 5.



ASSUME EFFECTIVE WIDTH ~ 2 × EDGE DISTANCE OF 6" OR 2 × 6" = 12" = p

5 FOLLOWING REF. 5

T = APPLIED TENSION = 4.28^K, t = THICKNESS OF FLANGE = .3125^{IN}

B = ALLOWABLE TENSION = $34^{KSI} \cdot \frac{\pi (.75)^2}{4} = 15.0^K$

d = BOLT Φ = .75^{IN} F_y = (YIELD ST. FLANGE MATERIAL) = 36^{KSI}

b = 1.09375^{IN} d' = WIDTH OF BOLT HOLE = 1.125^{IN}

a = 2.84375 - 1.09375 = 1.75^{IN}

b' = b - d/2 = 1.09375 - (.75/2) = .71875^{IN}

a' = a + d/2 = 1.75" + .75/2 = 2.125^{IN}

p = LENGTH OF FLANGE ASSUME 12^{IN}

$$t_c = \sqrt{\frac{8 B b'}{p F_y}} = \sqrt{\frac{8\,(15^{KIPS})(.71875^{IN})}{12^{IN}\;36^{K/IN^2}}} = .4468^{IN}$$

$$\rho = b'/a' = \frac{.71875''}{2.125''} = .3382 \checkmark$$

$$\delta = 1 - d'/p = 1 - \frac{1.125}{12} = .90625 \checkmark$$

REF.

$$\alpha = \frac{1}{\delta}\left[\frac{T/B}{(t/t_c)^2} - 1\right]$$ (TO GET UPPER BOUND Q FORCE SET T = B = 4.28^K)

$$\therefore \alpha = \frac{1}{.90625}\left[\frac{4.28/4.28}{\left(\frac{.3125}{.4468}\right)^2} - 1\right] = 1.1522 \checkmark$$

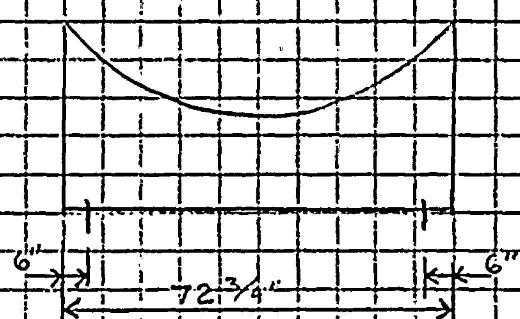
$$Q = B\delta\alpha\rho\left(\frac{t}{t_c}\right)^2 = 4.28^K \cdot (.90625)(1.1522)(.3382)\left(\frac{.3125}{.4468}\right)^2$$
$$= .74^K \checkmark$$

$\therefore$ TOTAL BOLT TENSION $= T + Q = 4.28 + .74 = 5.02^K$

PRYING ACTION ADDS $\left(\frac{.74}{4.28}\right) \times 100\% = 17.29\%$ TO THE BOLT LOAD ✓

C. BOLT LOAD FOR EARTHQUAKE IN THE HORIZONTAL LATERAL DIRECTION

4 FROM REF. 4 (SADDLE DIMENSIONS)



DISTANCE FROM EDGE OF SADDLE TO BOLT = 72 3/4" − 6" = 66 3/4"

ASSUME SADDLE ACTS AS HINGED-HINGED FRAME

$$T = \frac{(20.16^K \cdot 51^{IN})}{2_2 \cdot (66.75^{IN})} = 7.702^K/\text{BOLT} + \text{PRYING} \checkmark$$

(20.16^K ⋅ 51^IN FROM PAGE 4; 2 = TWO SADDLES)

$$V = \frac{20.16^K}{4_{\text{BOLTS}}} = 5.04^K/\text{BOLT} \checkmark$$

REF.	
11	D. Bolt Load for Vertical Response
1	Use 2/3 of peak of 4% damped horizontal spectrum.
	∴ $P_{VERT} = .399_g \cdot (33.713^K) = 13.451^{KIP}$ ✓ (Page 3)
	$T_{BOLT} = \frac{13.451}{4_{BOLTS}} = 3.363^{KIPS}/_{BOLT}$ ✓
	E. Total Load
	Will use a conservative approximation of SRSS as described on Page 2.
	∴ $T_{TOTAL} = 7.702^K + .4(4.28^K) + .4(3.363)^K - \left(\frac{33.713^K}{4}\right)$ (Dead weight)
	$= 2.331^K/_{BOLT}$
	$T+Q = 2.331^K \cdot (1.1729) = 2.734^K/_{BOLT}$ (Page 5)
	$V_{TOT} = \sqrt{2} \cdot 5.04^K = 7.13^K/_{BOLT}$ (V same in both directions)
5	$\sigma_{TEN\ BOLT} = \frac{2.734^K}{.4418\ IN^2} = 6.19^{KSI} < 1.7 \times 20^{KSI} = 34^{KSI}$ OK ✓ (Area of 3/4 ⌀ bolt (5))
	$\sigma_{SHEAR\ BOLT} = \frac{7.13^K}{1.4418} = 16.14^{KSI} < 1.7 \times 10^{KSI} = 17^{KSI}$ OK ✓
	Check bolt interaction
	$\left(\frac{6.19}{1.7(20)}\right)^2 + \left(\frac{16.14}{1.7(10)}\right)^2 = .93 < 1.0$ OK ✓
	6.0 Results
	Bolt loadings including prying effects were evaluated for loads from the MHE defined

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SUBJECT CALC # TPN-153C-90-001-EDG TANK ANCHORAGE EVALUATION INCLUDING PRYING ACTION - ITEM 16

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TURKEY POINT - UNIT 2 & 3

REVISIONS		
0	[illegible]	10/20/90
	RM	08/07/91

REF.

(2) TURKEY POINT, PLUS DEAD LOAD. THE RESULTING BOLT LOADS WERE BELOW THE ACCEPTANCE CRITERIA. A VERY CONSERVATIVE LOAD DEFINITION WAS ASSUMED (PEAK OF RESPONSE SPECTRA).

56

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 17 - Component Cooling Water Surge Tank

PART A. EQUIPMENT DESCRIPTION

I.D. Number	3	Building	RAB
Manufacturer		Elevation	71'
Model Number		Other	

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes x No ____
2. Condition of nearby concrete and embedments N/A
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 4 - 7/8" BOLTS TOTAL
5. Are nuts present and apparently tight on all bolts? Yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Check bolts per saddle support - Anchorage
2. Concerns (if any) THE SRT DID NOT EVALUATE THE STEEL PLATFORM AND HOW IT IS CONNECTED TO THE BUILDING IN THIS REVIEW

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)
ITEM 17 CONSIDERED AN OUTLIER BECAUSE OF REASON 2 ON ATTACHED PAGE (PLATFORM ADEQUACY). CONCERN 1 HAS BEEN RECONCILED WITH THE ATTACHED CALCULATION.

APPROVED BY SRT

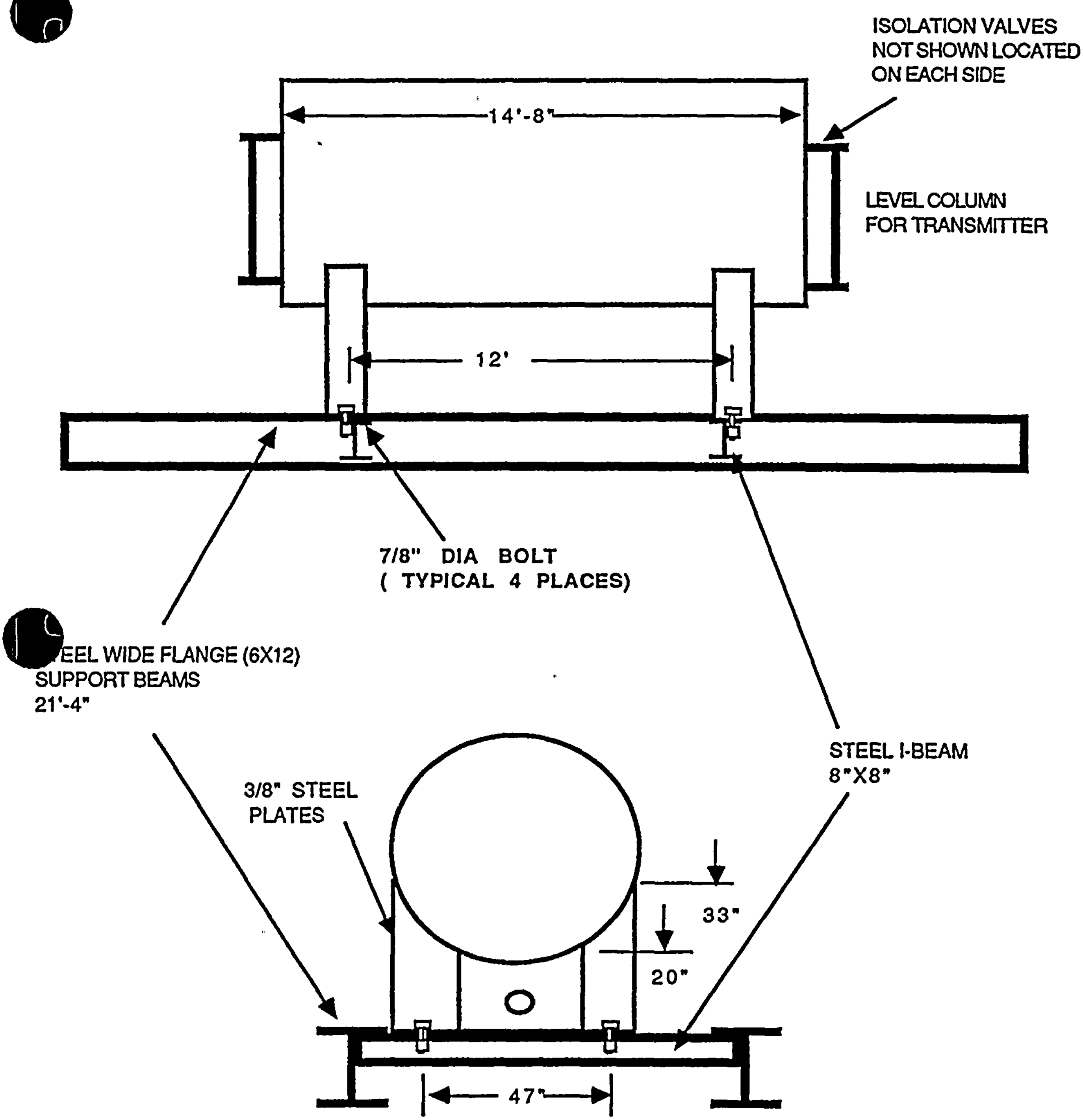
NAME Robert P. Kennedy	DATE 9/2/91
NAME John W. Reed	DATE 9/2/91
NAME John D. Stevenson	DATE 9/2/91

ITEM 17 COMPONENT COOLING WATER SURGE TANK - UNIT 3

1. The SRT WANTED A CALCULATION PERFORMED TO VERIFY ADEQUACY OF THE ANCHOR BOLTS ON THE SADDLE SUPPORTS.

2. THE SRT DID NOT EVALUATE THE STEEL PLATFORM ITSELF AND HOW this Platform IS TIED INTO THE SPENT Fuel BUILDING.

AS-FOUND FIELD CONDITION



UNIT 3 CCW SURGE TANK SEISMIC MOUNTING WORKSHEET

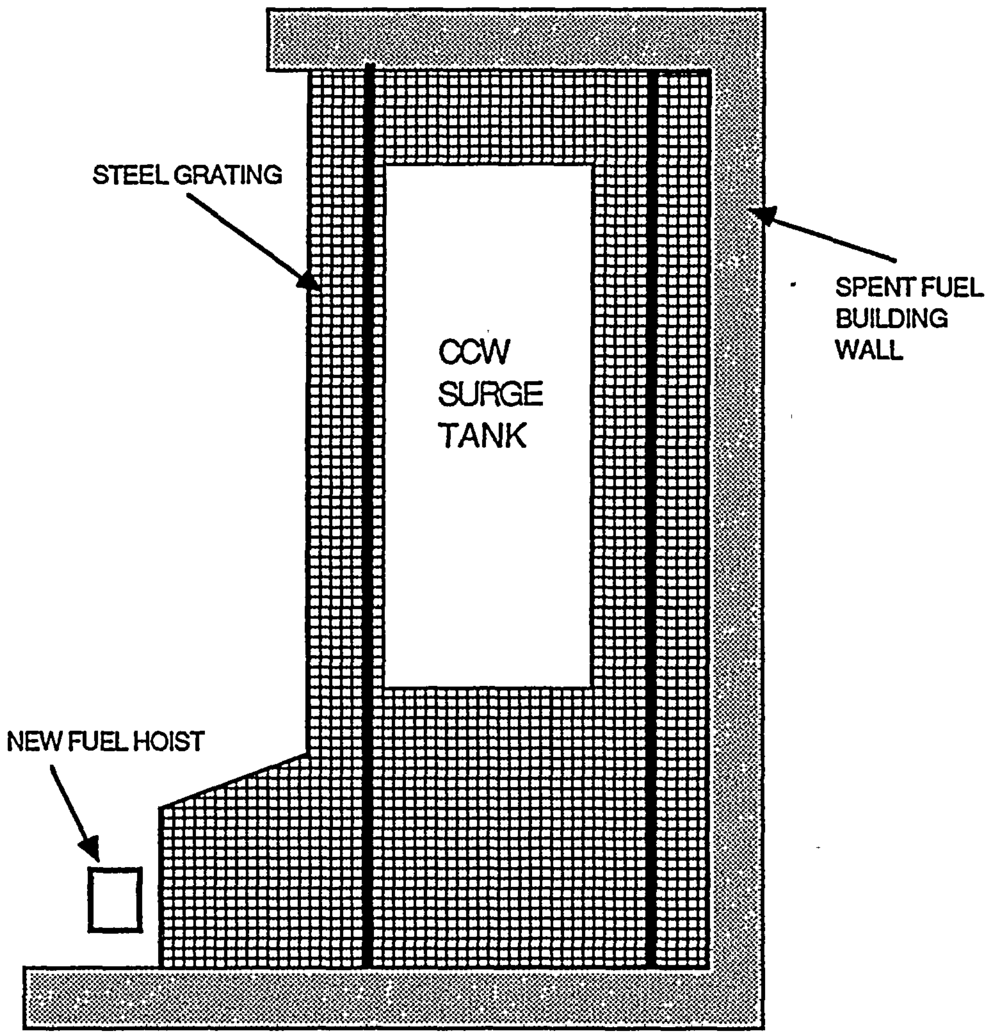
GENERAL NOTES

DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.

SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: CCW SURGE TANK
DATE: APRIL 14, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



UNIT 3 CCW SURGE TANK SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: CCW SURGE TANK	
DATE: APR 14,1990	DWG BY: R. GOULDY

STR JOB # 90L1323

CALCULATION COVER SHEET

Calculation No: TPN-ISJC-90-002

Title: CCW TANK ANCHORAGE EVALUATION INCLUDING PRYING ACTION - ITEM 17 & 18

No.	Description	By	Date	Chk/Ver	Date	Appr	Date
0	INITIAL ISSUE	JJJS	10/20/90	RhA 1/3/91	8/4/91	PRW	5/2/91

REVISIONS

LIST OF EFFECTIVE PAGES

CALCULATION NUMBER TPN-1S)C-90-002 REV. 0 10/20/90

PAGE	SECTION	REV	PAGE	SECTION	REV	PAGE	SECTION	REV
1	1.0 PURPOSE/SCOPE	0						
2	2.0 REFERENCES	0						
3	3.0 METHODOLOGY	0						
4	4.0 ASSUMPTIONS	0						
	5.0 CALCULATIONS	0						
5	"	0						
6	"	0						
7	"	0						
	6.0 RESULTS	0						

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CALCULATION NUMBER TPN-ISJC-90-002 REV. 0 /10/20/90

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SUBJECT CALC TPN-1SUC- S&A JOB No. 90C1585 SHEET 1 OF 7

90-002- CCW TANK ANCHORAGE EVALUATION INCLUDING PRYING ACTION - ITEM 17 AND 18

REVISIONS: 0 [initials] 10/20/90; RM 2/7/91

REF.

1.0 PURPOSE/SCOPE

DURING THE USI A-46 WALKDOWN OF TURKEY POINT UNIT 2 AND 3 A CONCERN WAS EXPRESSED THAT THE ANCHORAGE MAY NOT BE OF SUFFICIENT CAPACITY TO WITHSTAND THE LOADS FROM THE DEFINED MHE AT THE TURKEY POINT PLANT. THE CALCULATION ALSO INCLUDES PRYING CONSIDERATIONS. THE PURPOSE OF THIS CALCULATION IS TO DETERMINE THE ANCHORAGE ADEQUACY. THE SCOPE ONLY INCLUDES ANCHORAGE.

THE PLATFORM EVALUATION WAS DEFINED BY FP&L TO BE OUTSIDE THE SCOPE OF THE WALKDOWN. THIS ISSUE IS BEING ADDRESSED BY OTHERS. THE COMPONENT HAS BEEN DEFINED AS AN OUTLIER BECAUSE OF THE PLATFORM ISSUE. HOWEVER POSSIBLE AMPLIFICATION THROUGH THE PLATFORM IS ADDRESSED.

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SUBJECT CALC # TPN-ISJC- JOB No. 90C1585 SHEET 2 OF 7

90-002 - CCW TANK ANCHORAGE EVALUATION INCLUDING PEYING ACTION - ITEM 17 & 18

REVISIONS		
0	[illegible]	10/20/90
	RM	8/7/91

REF.

2.0 REFERENCES

1. BECHTEL CALCULATION # C-5J183-10, JOB # 5J183-0, PROJECT - TURKEY PT UNITS 3 & 4, SUBJECT - CCW SURGE TANK PLATFORM ANALYSIS, REV 2, 1/26/90.

2. SPEC 5177-C-00 REV. 1 "SEISMIC RESPONSE SPECTRA".

3. TURKEY POINT - GROUND RESPONSE SPECTRA 15% ACCELERATION, FIGURE 5A-2, TURKEY POINT FSAR APPENDIX A.

4. EPRI NP-5228, "SEISMIC VERIFICATION OF NUCLEAR PLANT EQUIPMENT ANCHORAGE" URS CORPORATION / JOHN A. BLUME & ASSOCIATES, ENGINEERS, SAN FRANCISCO, CALIFORNIA, MAY 1987.

5. AISC, MANUAL OF STEEL CONSTRUCTION, ALLOWABLE STRESS DESIGN, NINTH EDITION, 1989.

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SUBJECT CALC LTPN-15JC-90-002 - CCW TANK ANCHORAGE EVALUATION INCLUDING PRYING ACTION - ITEM 17 & 18

S&A JOB No. 90C1585 SHEET 3 OF 7

REVISIONS		
0	DDS	10/20/90
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3.0 METHODOLOGY

THE METHODOLOGY EMPLOYED IS TO CALCULATE THE BOLT LOADING FOR EARTHQUAKE LOADS IN THE THREE ORTHOGANAL DIRECTIONS (2 HORIZONTAL AND 1 VERTICAL). THESE LOADINGS WILL BE COMBINED BY ADDING 100% OF THE LOAD IN THE WORST (MOST LOADED) DIRECTION AND 40% IN THE OTHERS. GRAVITY LOADS WILL THEN BE ADDED. THIS COMBINATION IS A CONSERVATIVE APPROXIMATION OF THE SRSS COMBINATION.

THE APPLICABLE RESPONSE SPECTRA FOR THE AUXILIARY BUILDING ACCORDING TO TURKEY POINTS FSAR IS THE GROUND RESPONSE SPECTRA. THERE ARE NO FLOOR RESPONSE SPECTRA FOR THE AUXILIARY BUILDING. THE PLATFORM IS LOCATED ABOVE ABOUT 40' (@ 54'). IN ORDER TO FOLLOW

1.2 THE INTENT OF THE SSRAP GUIDANCE: A FACTOR OF $\left(\frac{54}{40}\right) \cdot 1.5 = 2.025$ ✓ WILL BE USED AS AN ESTIMATE OF THE MEDIAN CENTERED FLOOR RESPONSE SPECTRA. A 1.25 FACTOR ✓ FOR CONSERVATISM WILL BE INCLUDED FOR ANCHORAGE LOADING. DAMPING TO BE USED IS 4% BY SRT JUDGMENT APPLICABLE TO HORIZONTAL TANKS.

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SUBJECT Calc. # TPN-15JC-90-002 - CCW Tank Anchorage Evaluation Including Prying Action - Item 17&18

S&A JOB No. 90C1585 SHEET 4 OF 7

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0	JDS	10/20/90
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REF

4.0 ASSUMPTIONS

THE FOLLOWING ASSUMPTIONS WERE MADE IN PERFORMING THIS CALCULATION:

a. WT = 2,300 LB

b. WILL CONSERVATIVELY USE PEAK OF RESPONSE SPECTRA FOR ESTIMATING LOADS.

c. ASSUME A307 BOLTS ALLOWABLE STRESS FOR MHE IS
TENSION 1.7 × 20 KSI = 34 KSI ✓
SHEAR 1.7 × 10 KSI = 17 KSI ✓

5.0 CALCULATIONS

A. LOAD CALCULATIONS

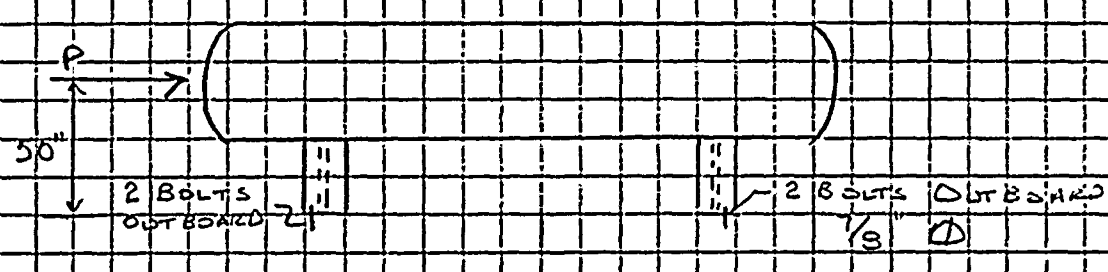
FROM RESPONSE SPECTRA ~ PEAK OF SPECTRA FOR 5% DAMPING ~ .285 g ✓

∴ FOR 4% PEAK = .285 $\left(\sqrt{\frac{.05}{.04}}\right)$ = .319 g

2 HORIZONTAL g_{LOAD} = 2.025 (1.25) (.319 g) = .8075 g ✓

2 VERTICAL g_{LOAD} = 2/3 (.8075 g) = .5383 g ✓

B. BOLT LOAD FOR EARTHQUAKE IN HORIZONTAL LONGITUDINAL DIRECTION



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SUBJECT: CALC # TPN-ISJC-S&A-90-002 - CCW TANK ANCHORAGE EVALUATION INCLUDING PRYING ACTION - ITEM 17 & 18
JOB No. 90C1585 SHEET 5 OF 7

REVISIONS:

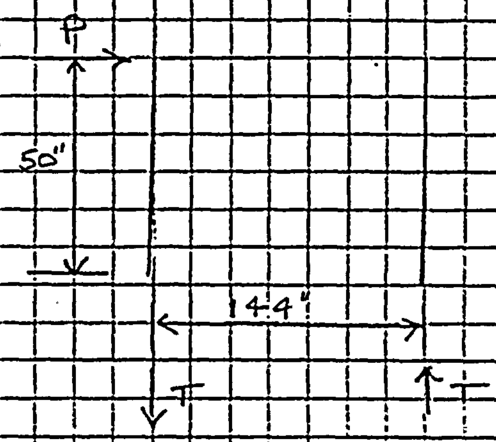
Rev.	By	Date
0	BDS	10/20/90
	RM	8/7/91

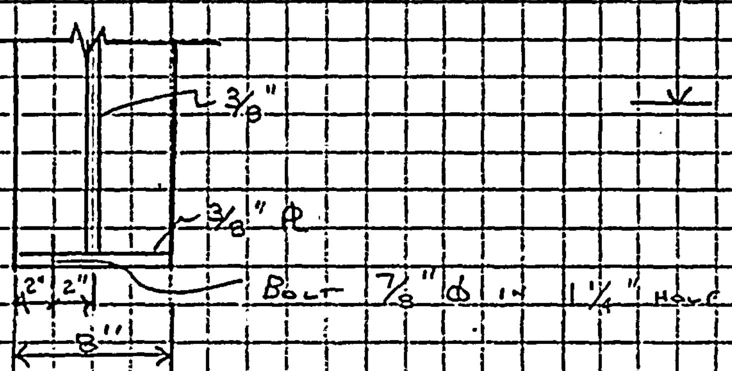
REF.

$P = .8075 g \cdot 21.8^k = 17.604^k$

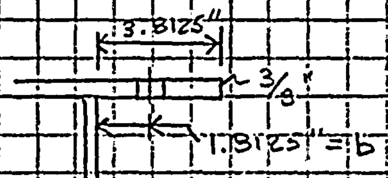
TANK ACTS AS A HINGED-HINGED FRAME.

$T = \frac{17.604^k \; 50''}{2(144)} = 3.06^{kip}/\text{BOLT}$





5 PRYING CALCULATION BASED ON PG. 4-90 TO 4-92 OF REF. 5.



ASSUME EFFECTIVE WIDTH 2 × EDGE DISTANCE OF 6" OR 2×6 = 12" ✓

T = APPLIED TENSION = 3.06^k, t = THICKNESS OF FLANGE = .375"

$B = \text{ALLOWABLE TENSION} = 34^{ksi} \cdot \frac{\pi(.875)^2}{4} = 20.44^k$

$d = \text{BOLT } \phi = .875''$ $F_y = 36^{ksi}$

$a = 3.8125 - 1.8125 = 2''$ $b = 1.8125$ $d' = \text{WIDTH OF BOLT HOLE} = 1.25^{in}$

$b' = b - d/2 = 1.8125 - (.875/2) = 1.375^{in}$ ✓

$a' = a + d/2 = 2 + \frac{.875}{2} = 2.4375^{in}$ ✓

p = LENGTH OF FLANGE = 12"

$t_c = \sqrt{\frac{8Bb'}{pF_y}} = \sqrt{\frac{8(20.44)(1.375)}{12(36)}} = .7214''$ ✓ $\rho = b'/a' = \frac{1.375}{2.4375} = .5641$ ✓

$\delta = 1 - d'/p = 1 - \frac{1.25}{12} = .89583$ ✓

REF.

$\alpha = \frac{1}{\delta}\left[\frac{T/B}{(t/t_c)^2} - 1\right]$ (TO GET UPPER BOUND Q FORCE SET T = B = 3.56 kip/BOLT)

$\therefore \alpha = \frac{1}{.89583}\left[\frac{3.56/3.56}{\left(\frac{.375}{.7214}\right)^2} - 1\right] = 3.015$ ✓

$Q = B\,\delta\,\alpha\,\rho\left(\frac{t}{t_c}\right)^2 = 3.06^k (.89583)\,3.015\,(.564)\left(\frac{.375}{.7214}\right)^2$

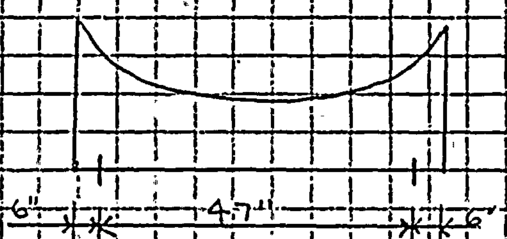
$= 1.26^k$ ✓

$\therefore$ TOTAL BOLT TENSION = $3.06^k + 1.26^k = 4.32^k$ ✓

PRYING ACTION ADDS $\frac{1.26}{3.06} \times 100\% = 41.18\%$ ✓

C. BOLT LOAD FOR EARTHQUAKE IN THE HORIZONTAL LATERAL DIRECTION

FROM REFERENCE (SADDLE DIMENSIONS)



DISTANCE FROM EDGE OF SADDLE TO BOLT = 47' + 6" = 53" ✓

ASSUME SADDLE ACTS AS HINGED-HINGED FRAME

$T = \frac{(17.604)\cdot 50^{IN}}{2\,(53^{IN})} = 8.304^k/_{BOLT}$ + PRYING

$V = \frac{17.604}{4_{BOLTS}} = 4.401^k/_{BOLT}$ ✓

D. BOLT LOAD FOR VERTICAL RESPONSE

USE 2/3 OF PEAK OF 4% DAMPED HORIZONTAL SPECTRUM.

$\therefore P_{VERT} = .5333\,(21.9^k) = 11.735^k$ ✓

$T_{BOLT} = \frac{11.735^k}{4_{BOLTS}} = 2.934$ KIPS/BOLT ✓

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SUBJECT CALC # TPN-15JC-S&A-90-002 - CCW TANK ANCHORAGE EVALUATION INCLUDING PRYING ACTION - ITEM 17 & 18

JOB No. 90C1585 SHEET 7 OF 7

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REF.

E. TOTAL LOAD

WILL USE A CONSERVATIVE APPROXIMATION OF SRSS AS DESCRIBED ON PAGE 3

$T_{TOTAL} = 8.304 + .4(3.06) + .4(2.934) - \frac{21.8^K}{4} = 5.25^K$

$T + Q = 5.25^K \cdot (1.4118)$ ^PAGE 6 $= 7.412$ KIPS

$V_{TOT} = \sqrt{2} \cdot 4.401$ K/BOLT $= 6.224$ K/BOLT

$\sigma_{TEN\ BOLT} = \frac{7.412^K}{.6013} = 12.33^{KSI} < 1.7 \times 20^{KSI} = 34^{KSI}$

(.6013 = AREA OF 7/8" BOLT)

$\sigma_{SHEAR\ BOLT} = \frac{6.224}{.6013} = 10.35^{KSI} < 1.7 \times 10^{KSI} = 17^{KSI}$

CHECK BOLT INTERACTION

4 $\left(\frac{12.33}{1.7(20)}\right)^2 + \left(\frac{10.35}{1.7(10)}\right)^2 = .502 < 1.0$ OK

6.0 RESULTS

BOLT LOADING INCLUDING PRYING EFFECTS WERE EVALUATED FOR LOADS FROM THE MHE DEFINED @ TURKEY POINT, PLUS DEAD LOAD. THE RESULTING BOLT LOADS WERE BELOW THE ACCEPTANCE CRITERIA. A VERY CONSERVATIVE LOAD DEFINITION WAS ASSUMED (PEAK OF RESPONSE SPECTRA).

57

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 18 - Component Cooling Water Surge Tank

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4 Building RAB

Manufacturer ______ Elevation 71'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments N/A
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 4 7/8" DIA TOTAL
5. Are nuts present and apparently tight on all bolts? Yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) CHECK ~~anchorage~~ to bolts and saddle to support beam
2. Concerns (if any) THE SRT DID NOT EVALUATE THE STEEL PLATFORM OR HOW IT IS CONNECTED TO THE BUILDING

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

ITEM 18 CONSIDERED AN OUTLIER BECAUSE OF REASON 2 ON ATTACHED PAGE (PLATFORM ADEQUACY). CONCERN 1 HAS BEEN RECONCILED WITH THE ATTACHED CALCULATION TO ITEM 17.

APPROVED BY SRT

NAME Robert P. Kennedy DATE 9/2/91

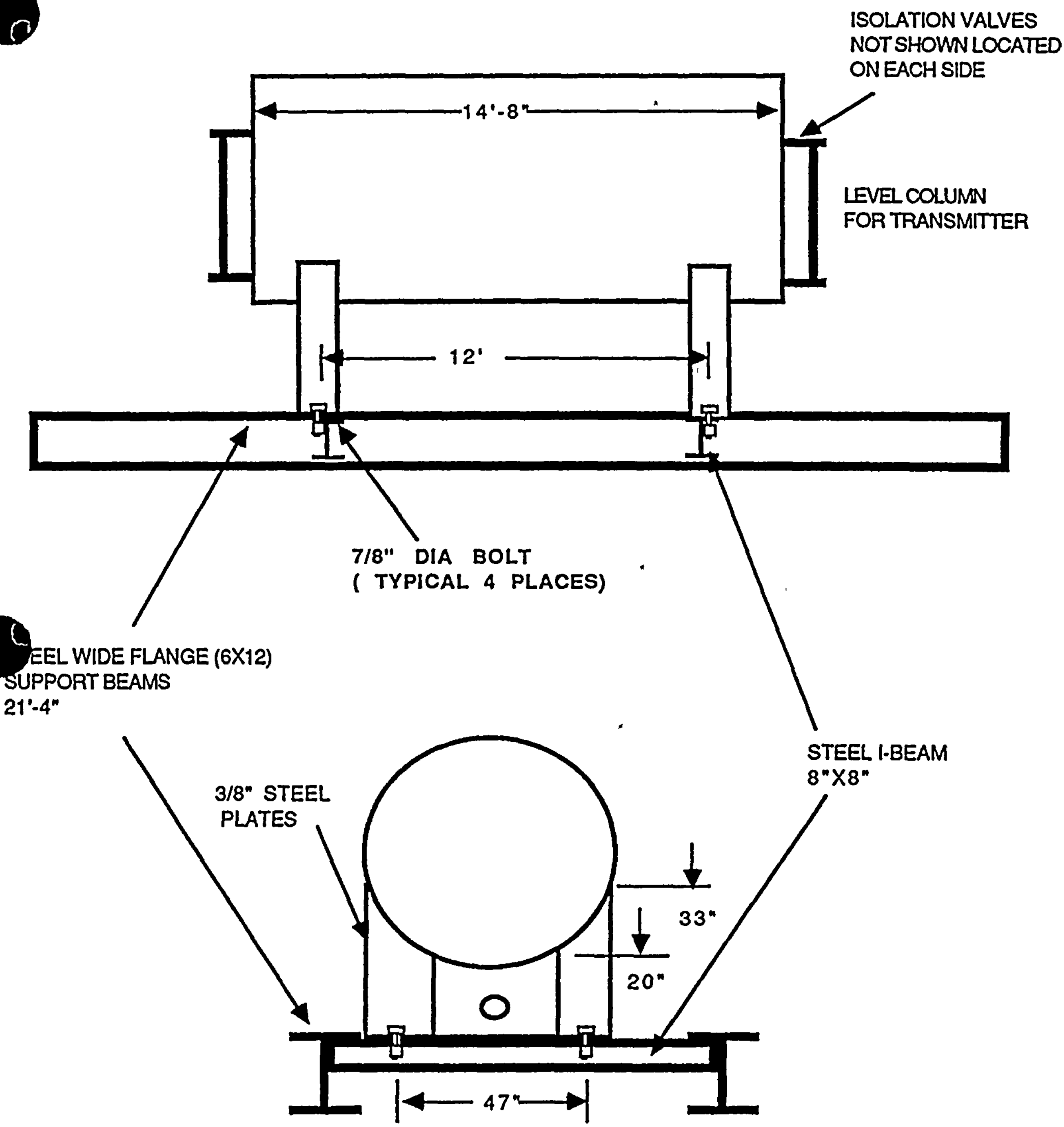
NAME John W. Reed DATE 9/2/91

NAME John D. Stevenson DATE 9/2/91

ITEM 18 — COMPONENT COOLING WATER SURGE TANK - UNIT 4

- The SRT WANTED A CALCULATION PERFORMED TO VERIFY ADEQUACY OF THE ANCHOR BOLTS ON THE SADDLE SUPPORTS. (SEE CALCULATION FOR ITEM 17)
- THE SRT DID NOT EVALUATE THE STEEL PLATFORM ITSELF AND How this Platform IS TIED INTO THE SPENT Fuel BUILDING

AS-FOUND FIELD CONDITION



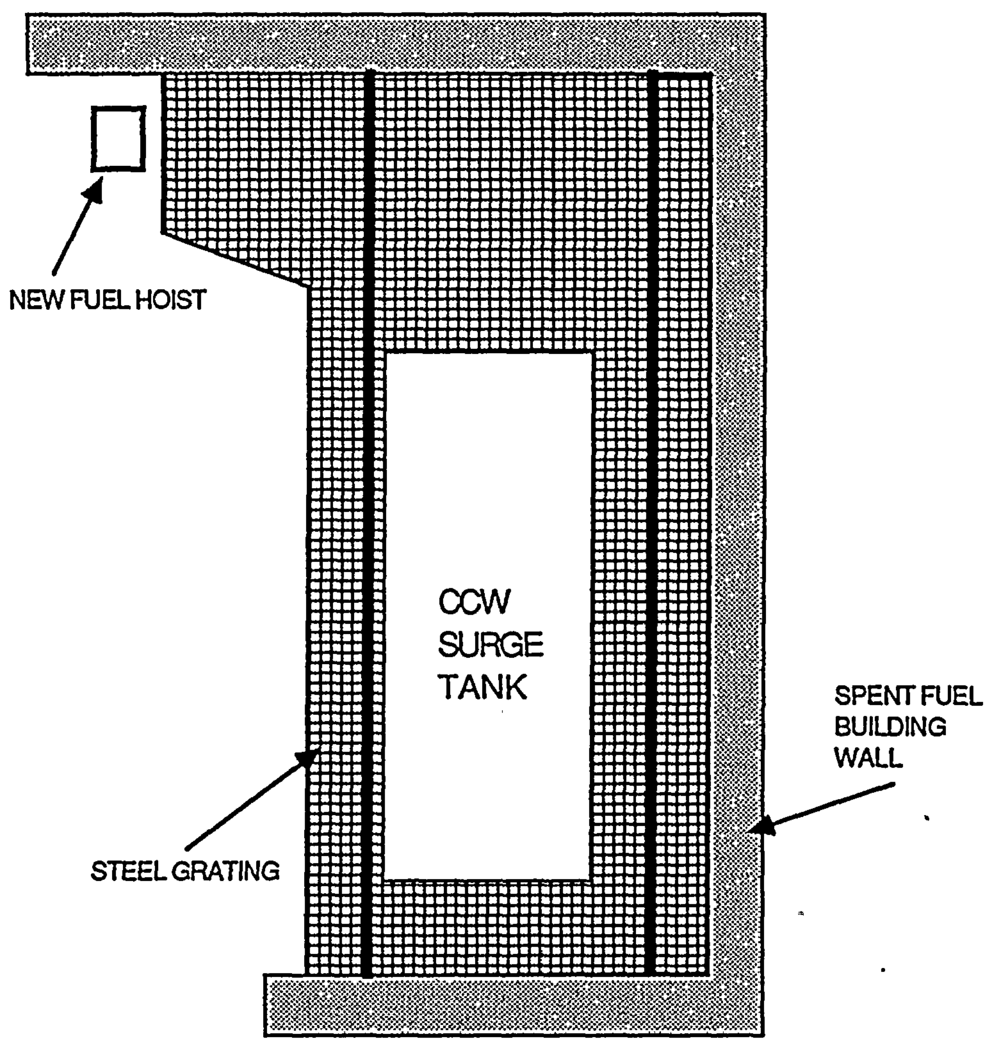
UNIT 4 CCW SURGE TANK SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: UNIT 4 CCW SURGE TANK
DATE: APR 14, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



UNIT 4 CCW SURGE TANK SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: CCW SURGE TANK	
DATE: APR 14,1990	DWG BY: R. GOULDY

(5)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 19 - Emergency Diesel Generator Skid

PART A. EQUIPMENT DESCRIPTION

I.D. Number	B	Building	EDG
Manufacturer		Elevation	18'
Model Number		Other	

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments 1" ϕ Bolts 7 per Side - good concrete floor
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 1"ϕ 5' o.c.
5. Are nuts present and apparently tight on all bolts? Yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Ref. to operating loads verify adequate anchorage
2. Concerns (if any)

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) Sight glass on cooling water surge tank. Well supported fire protection

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any) Recommends replacement of cooling water sight glass with a plastic or shatter proof material.

APPROVED BY SRT

NAME	[signature] D. Stevenson	DATE	4/4/90
NAME	[signature] P. Kennedy	DATE	4/4/90
NAME	[signature]	DATE	4/5/90

ITEM 19 EMERGENCY DIESEL GENERATOR SKID - B

SRT ACCEPTED ANCHORAGE BASED ON THE NORMAL OPERATION LOADS BEING MUCH GREATER THAN THE SEISMIC LOADS.

SEISMIC INTERACTION CONCERNS

1) COOLING WATER SURGE TANK SIGHT GLASS
2) RECOMMENDS REPLACEMENT WITH A PLASTIC OR OTHER flexible MATERIAL.

FPL

Inter-Office Correspondence

To: K. Greene

From: R. Gouldy

Date: February 17, 1992

Department: JNL -92-35

Subject: 3A & 3B Diesel Generator Cooling Water Sight Glass Review

Per the request of Nuclear Engineering, a review of the A-46 Seismic Review Team's recommendation to replace the 3A & 3B glass sight glass on the skid mounted diesel engine cooling water surge tank with sight glasses made from a plastic material has been completed. A site inspection was performed on February 10, 1992 to review these sight glasses. Mr. G. G. Thomas of Stevenson and Associates was with me to help evaluate any spatial interactions or other problems associated with these sight glasses. During the St. Lucie Unit 1, A-46 walkdown, the same concern of the glass sight glasses was raised by the SRT. However, during the discussions concerning the ruggedness of glass, it was noted that the diesel engine starting loads imposed by the diesel engine fast starts are much greater than the .1g earthquake loads. Therefore, at St. Lucie, the SRT did not recommend the replacement of the glass sight glasses considering the number of times this diesel had fast started since their installation. At Turkey Point the 3A ED/G has fast started over 700 times and the 3B ED/G over 1000 times without failure of these sight glasses. Therefore, they are rugged enough for continued use.

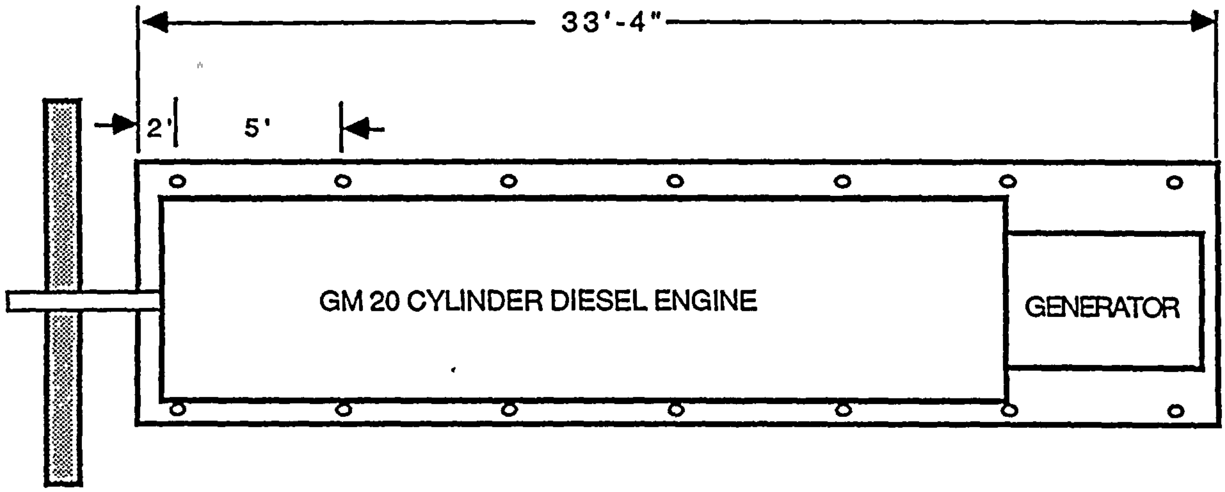
The next area to be addressed was that of spatial interactions with near by equipment. During the Dual Unit Outage, both emergency diesels received numerous upgrades. These upgrades along with equipment near by were examined to determine if impact could occur during a beyond-the-design-basis earthquake. We did not find any piping, cabinets or equipment that could come in contact with or was located over head that would create a seismic interaction. Photographs of the diesel area are provided on the attached.

Conclusion: The replacement of the sight glasses with a plastic material should not be a requirement since the existing sight glasses have demonstrated their ruggedness and there were no spatial interaction concerns identified on the February 10 site inspection following the 3A and 3B diesel upgrade.

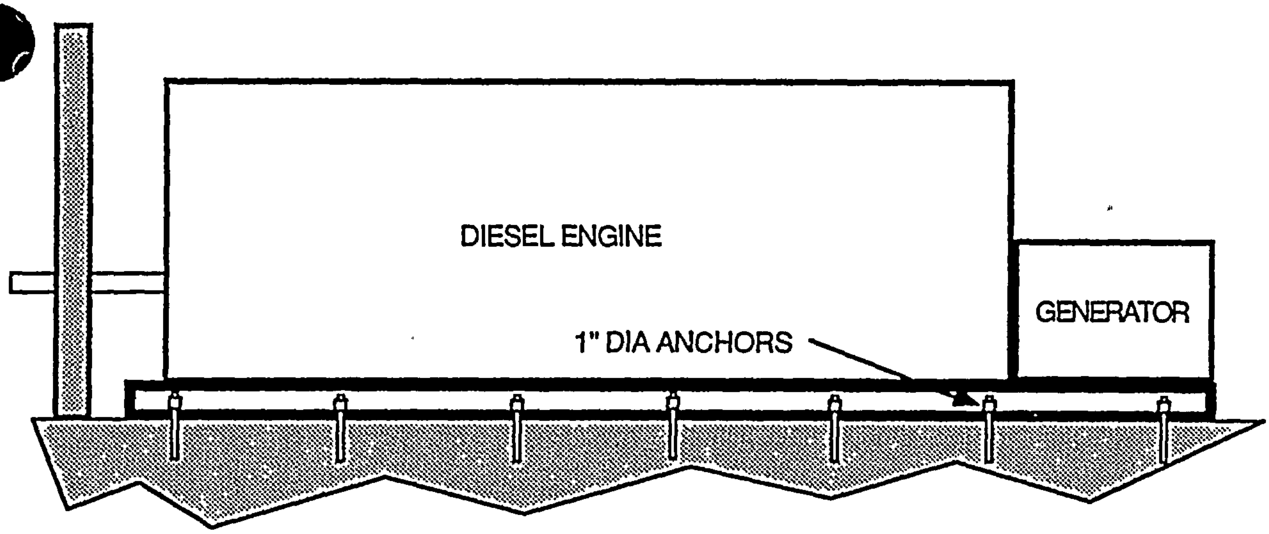
Should there be any questions regarding this inspection and evaluation, please contact me.

Russell Gouldy, PE
Member, Seismic Review Team

AS-FOUND FIELD CONDITION



THE SRT NOTED THAT OPERATING LOADS VERIFY ADEQUATE ANCHORAGE



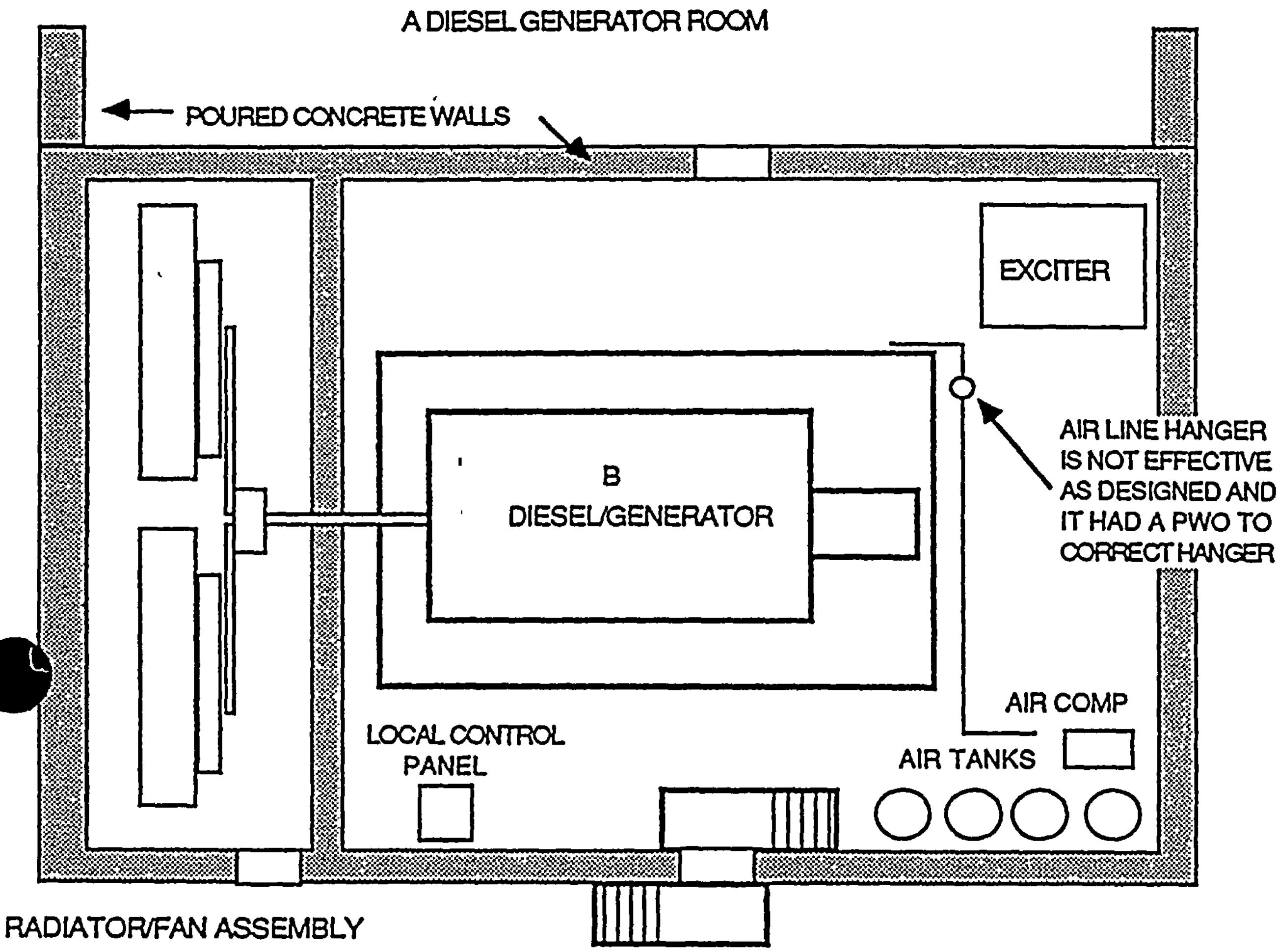
B DIESEL GENERATOR SKID
DIESEL GENERATOR SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: B DIESEL GENERATOR SKID
DATE: MAR 22, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT NOTED THE MOVEMENT OF THE AIR START LINE AND THE PWO ON THE HANGER TO CORRECT THE PROBLEM. THE AIR LINE WAS TESTED BY SHAKING AND DID NOT PRESENT A PROBLEM. THE WERE NO OTHER SEISMIC CONCERNS NOTED BY THE SRT.

B DIESEL GENERATOR SKID
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: B DIESEL GENERATOR ROOM
DATE: MAR 22, 1990 DWG BY: R. GOULDY

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90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 20 - EDG Air Start ~~Skid~~ FG TANKS

PART A. EQUIPMENT DESCRIPTION

I.D. Number	B	Building	EDG
Manufacturer		Elevation	18'
Model Number		Other	

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good.
3. Length, size, number, and soundness of welds 2 3" FILLETS ON EACH SIDE OF 2" ANGLES are good.
4. Anchor bolt type, size and number 1/2" Dia anchor bolts 4 per Tank
5. Are nuts present and apparently tight on all bolts? yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ✓
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) REVIEWED ANCHOR BOLT DRAWINGS AND CALCULATION
2. Concerns (if any) ____

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) ~~NONE~~ RG Threaded pipe for air is not Rigidly supported. PWO already on hanger

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

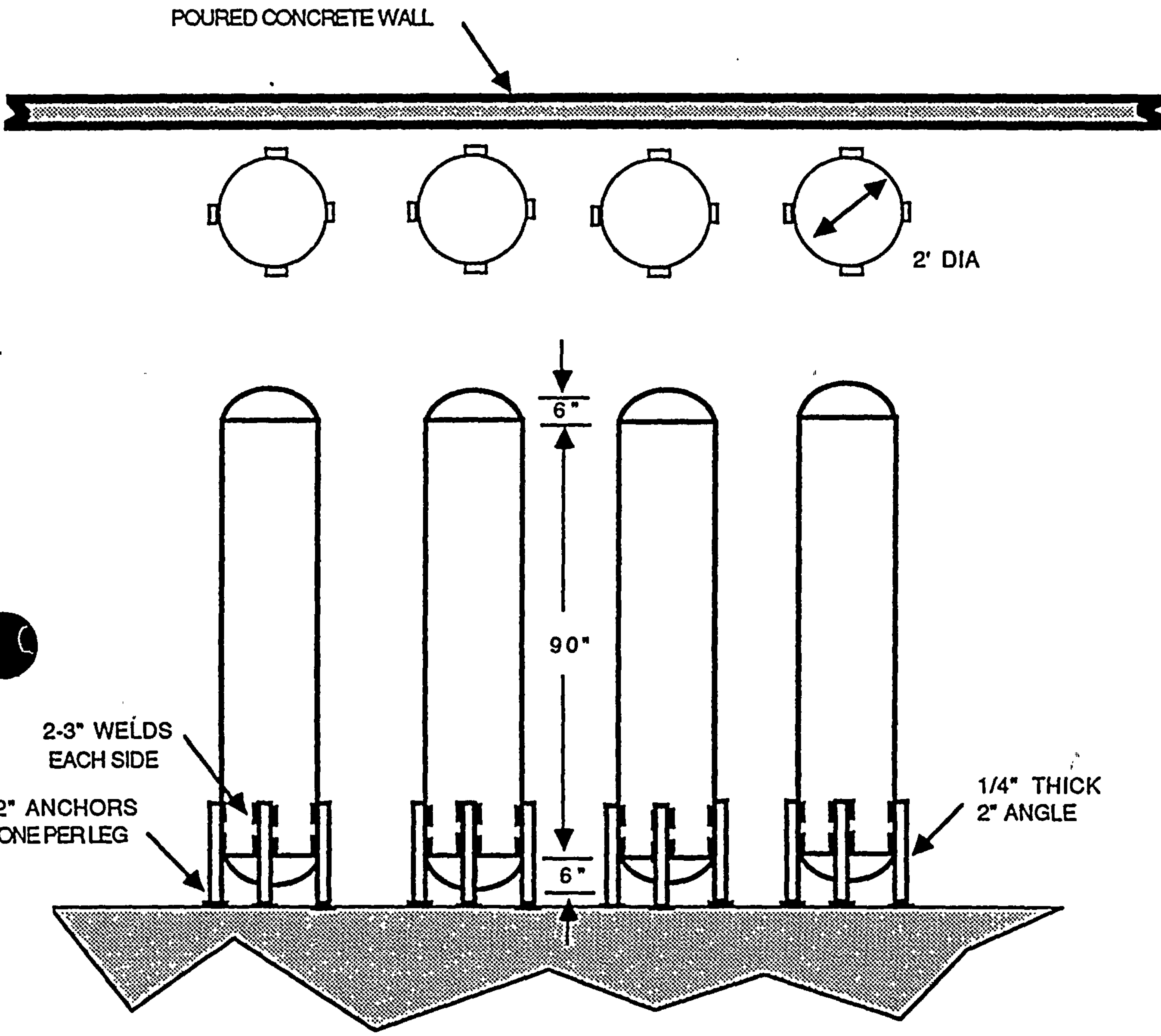
NAME	[signature]	DATE	4/4/90
NAME	[signature]	DATE	4/4/90
NAME	[signature]	DATE	4/5/90

ITEM 20 EDG AIR START TANKS - B

SRT REVIEWED THE ANCHOR BOLT DRAWINGS AND CALCULATION. DID NOT HAVE ANY ANCHORAGE CONCERNS.

SRT HAD A SEISMIC INTERACTION CONCERN WITH THE THREADED PIPE FOR AIR SUPPLY THAT WAS NOT RIGIDLY SUPPORTED. IT IS NOTED THAT A PLANT WORK ORDER (PWO) WAS ALREADY WRITTEN AND HUNG ON the hANGER TO FIX THIS CONCERN.

AS-FOUND FIELD CONDITION



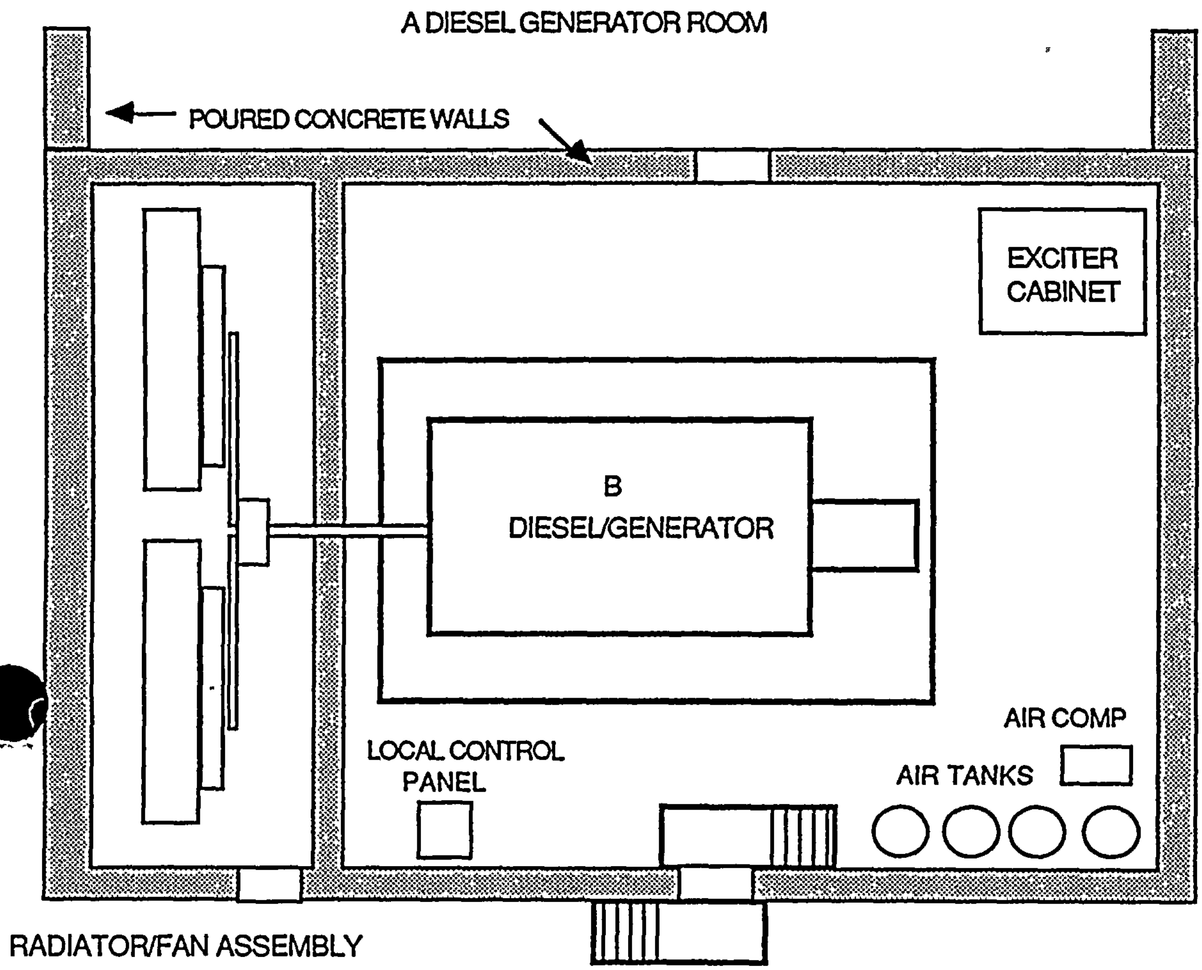
DIESEL GENERATOR AIR START TANKS
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
   SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: DIESEL AIR START TANKS	
DATE: MAR 22, 1990	DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THERE WERE NO SEISMIC INTERACTION CONCERNS NOTED BY THE SRT.

B DIESEL GENERATOR SKID
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: B DIESEL GENERATOR ROOM
DATE: MAR 22, 1990 DWG BY: R. GOULDY

(9)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 21 - EDG Fan Assemblies

PART A. EQUIPMENT DESCRIPTION

I.D. Number B — Building EDG

Manufacturer ______ — Elevation 18'

Model Number ______ — Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 3/4" 2 each side radiator 4 anchors on Bearing housing 2 - Bolts & 2 Anchors
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) OK
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) ~~None~~ RG No problems even considering the ductwork above

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

______

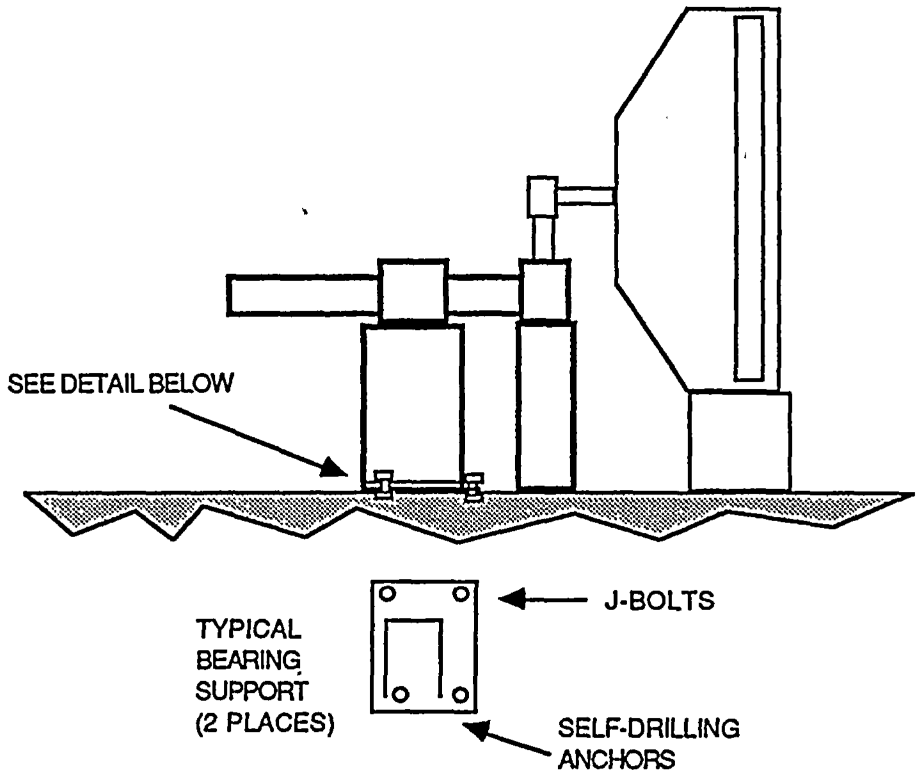
APPROVED BY SRT

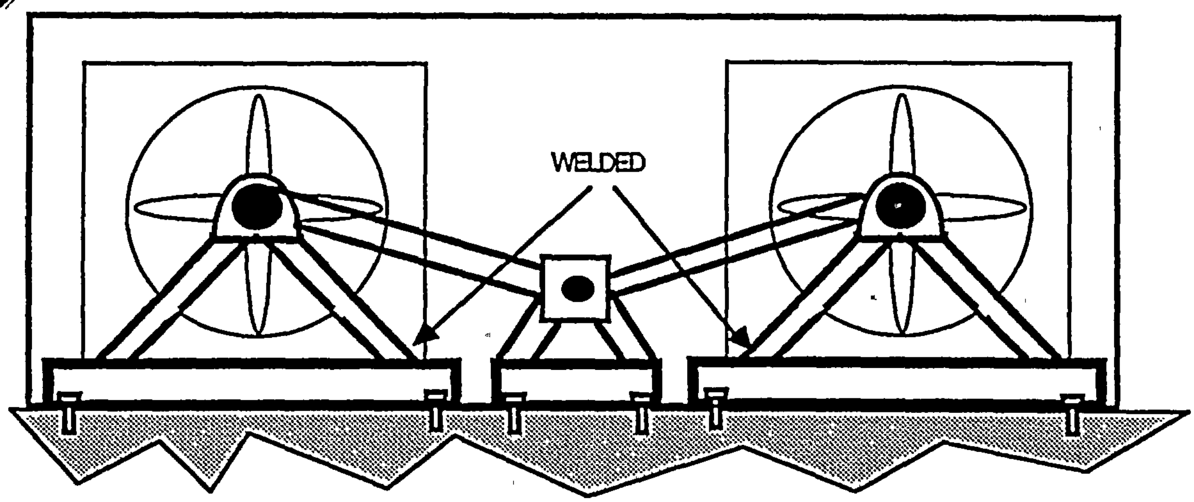
NAME John D. Stevenson DATE 4/4/90

NAME Robert P. Kennedy DATE 4/4/90

NAME John W. Reed DATE 4/5/90

AS-FOUND FIELD CONDITION





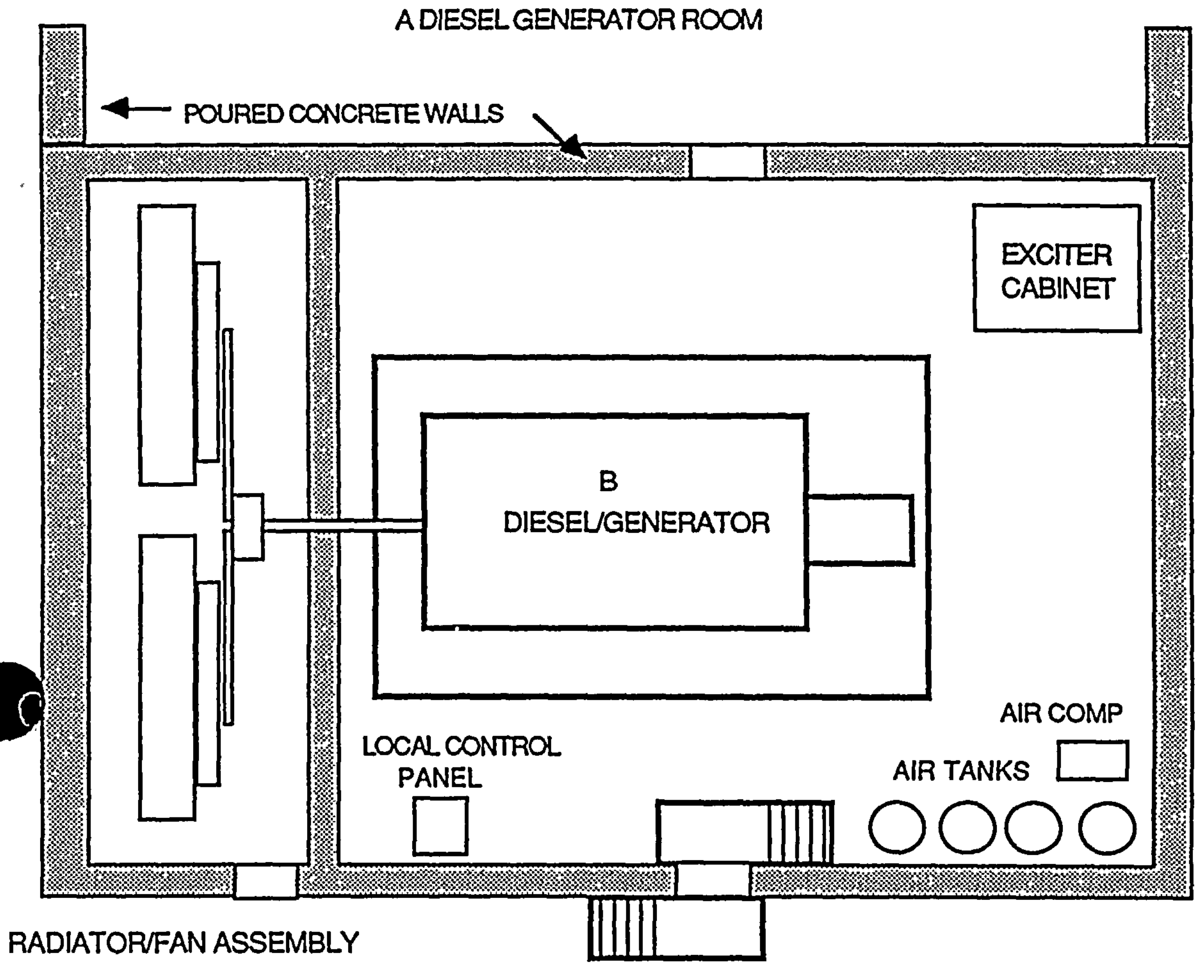
DIESEL GENERATOR FAN ASSEMBLY
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: D/G FAN ASSEMBLY
DATE: MAR 22, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THERE WERE NO SEISMIC INTERACTION CONCERNS NOTED BY THE SRT.

B DIESEL GENERATOR SKID
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: B DIESEL GENERATOR ROOM
DATE: MAR 22, 1990 DWG BY: R. GOULDY

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TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 22 - EDG Local Control Panel B

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4C12 Building EDG

Manufacturer ______ Elevation 18'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments Good
3. Length, size, number, and soundness of welds 2 - 1½" EACH SIDE ¼" Fillet
4. Anchor bolt type, size and number N/A
5. Are nuts present and apparently tight on all bolts? N/A

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ✓
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) ____ Calculation for welds → Calculation performed & is acceptable
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME [signature] DATE 4/4/90

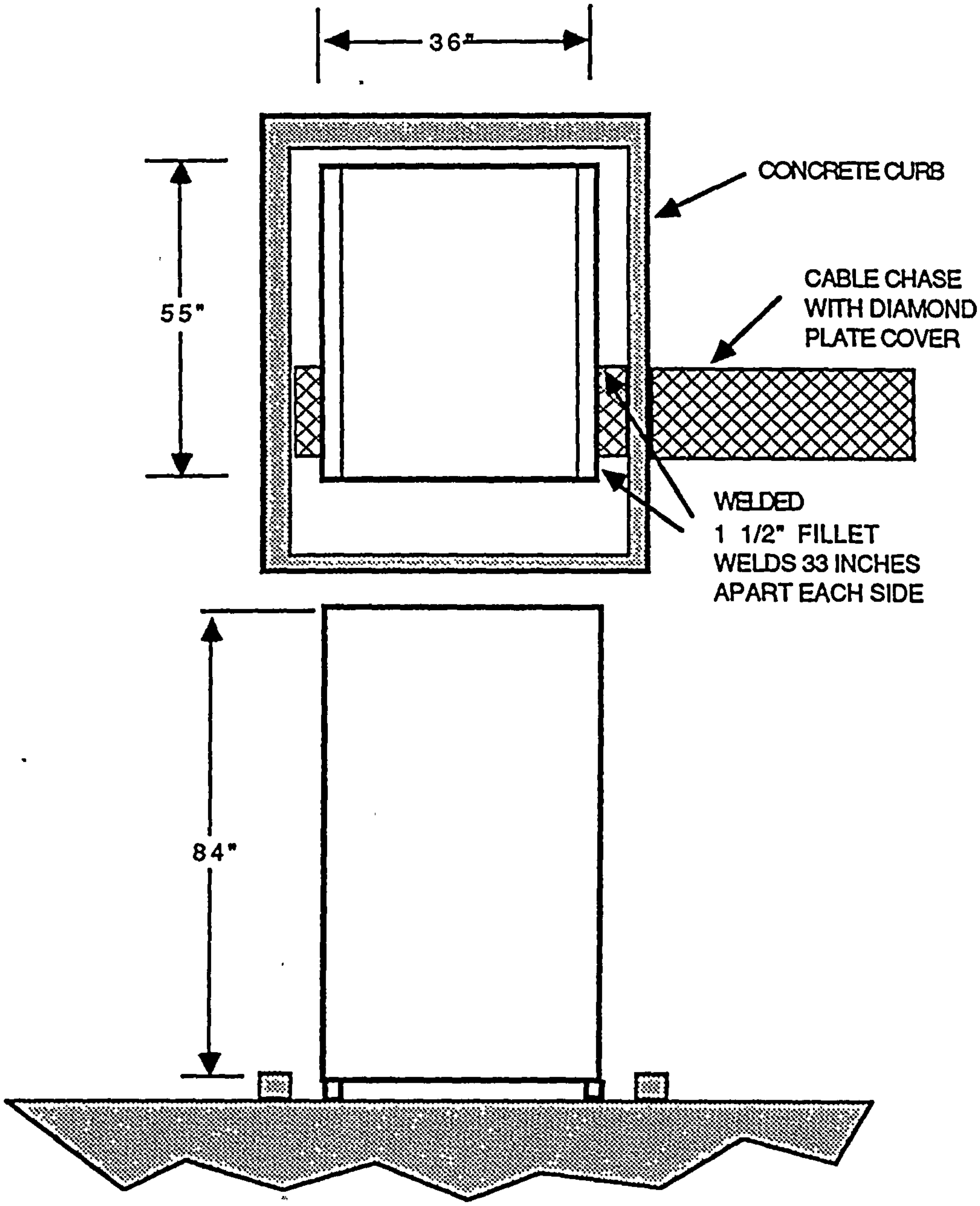
NAME [signature] DATE 4/4/90

NAME [signature] DATE 4/5/90

ITEM 22 EDG LOCAL CONTROL Panel B

SRT REQUESTED A CALCULATION EVALUATING THE WELD CAPACITY. THE CALCULATION SHOWED ADEQUATE WELD CAPACITY.

AS-FOUND FIELD CONDITION



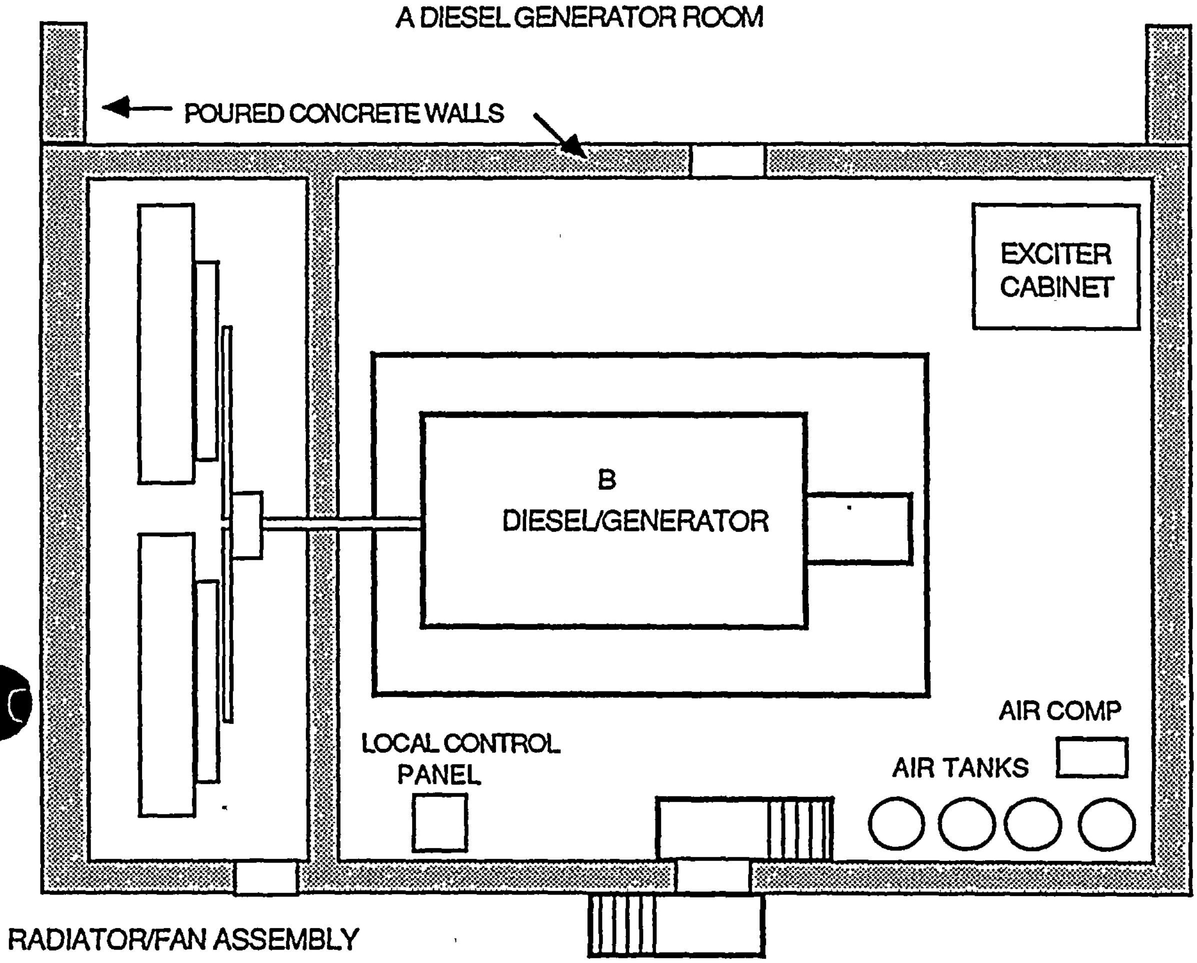
B DIESEL GENERATOR LOCAL CONTROL PANEL
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: LOCAL CONTROL PANEL B D/G
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THERE WERE NO SEISMIC INTERACTION CONCERNS NOTED BY THE SRT.

B DIESEL GENERATOR SKID
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

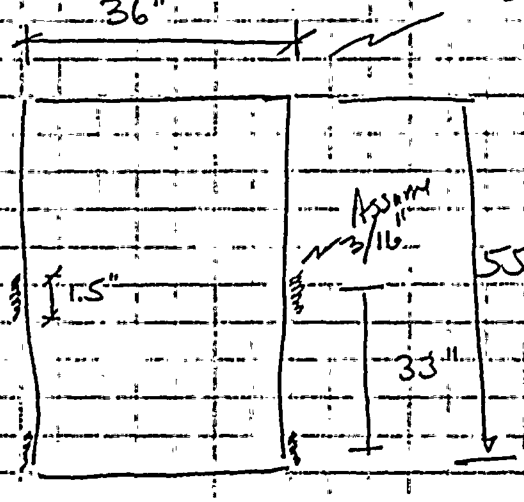
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: B DIESEL GENERATOR ROOM
DATE: MAR 22, 1990 DWG BY: R. GOULDY

S&A STEVENSON & ASSOCIATES a structural-mechanical consulting engineering firm

SUBJECT: BDG Local Control Panel   JOB No. ____   SHEET 1 OF ____

REVISIONS: WD 4/2/91



Dimensions given by Walk-down Team

$\rho = 35\#/ft^3$

$Volume = \frac{90'' \times 55 \times 36}{1728} = 103\ ft^3$

$W = 103 \times 35\#/ft^3 = 3.6^K$

$OTM = W \cdot 45'' \cdot 0.33g = 14.85\ W\ in\text{-}k$

$RM = 18\ (W) = 18W > OTM$ OK

Reduce RM by Vertical EQ (i.e. reduce by 10% (Vert ZPA))

$RM = 16.2W\ in\text{-}k > 14.85$ OK

No tension in weld

Shear Force in Welds

$M_T = \frac{55}{2}(W)(0.33g)$

$R_{weld} = 18\,ksi\,(1.5)\ 0.707\left(\frac{3}{16}\right) = 3.6\ ^K/weld$

$M_T = 32.7\ in\text{-}k$

Item 22 Pg 2

S&A

STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

SUBJECT: EDG Local Control Panel JOB No. ______ SHEET 2 OF ______

REVISIONS: WD 4/3/98

$$F_w = \frac{32.7\sqrt{2}}{33(2)} = 0.71^K << 3.6^K$$

OK

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90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 23 - 480V Motor Control Center 3B

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3B06 Building Control

Manufacturer ______ Elevation 18'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No X** INAdequate
2. Condition of nearby concrete and embedments ______
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number ______
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? No
   a. SRT Judgment ______
   b. URS Tables ______
   c. ANCHOR Program ______
   d. Other (explain) 2" SEAL welds 20" o.c.
2. Concerns (if any) NEEDS upgrade

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE - NO problems

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

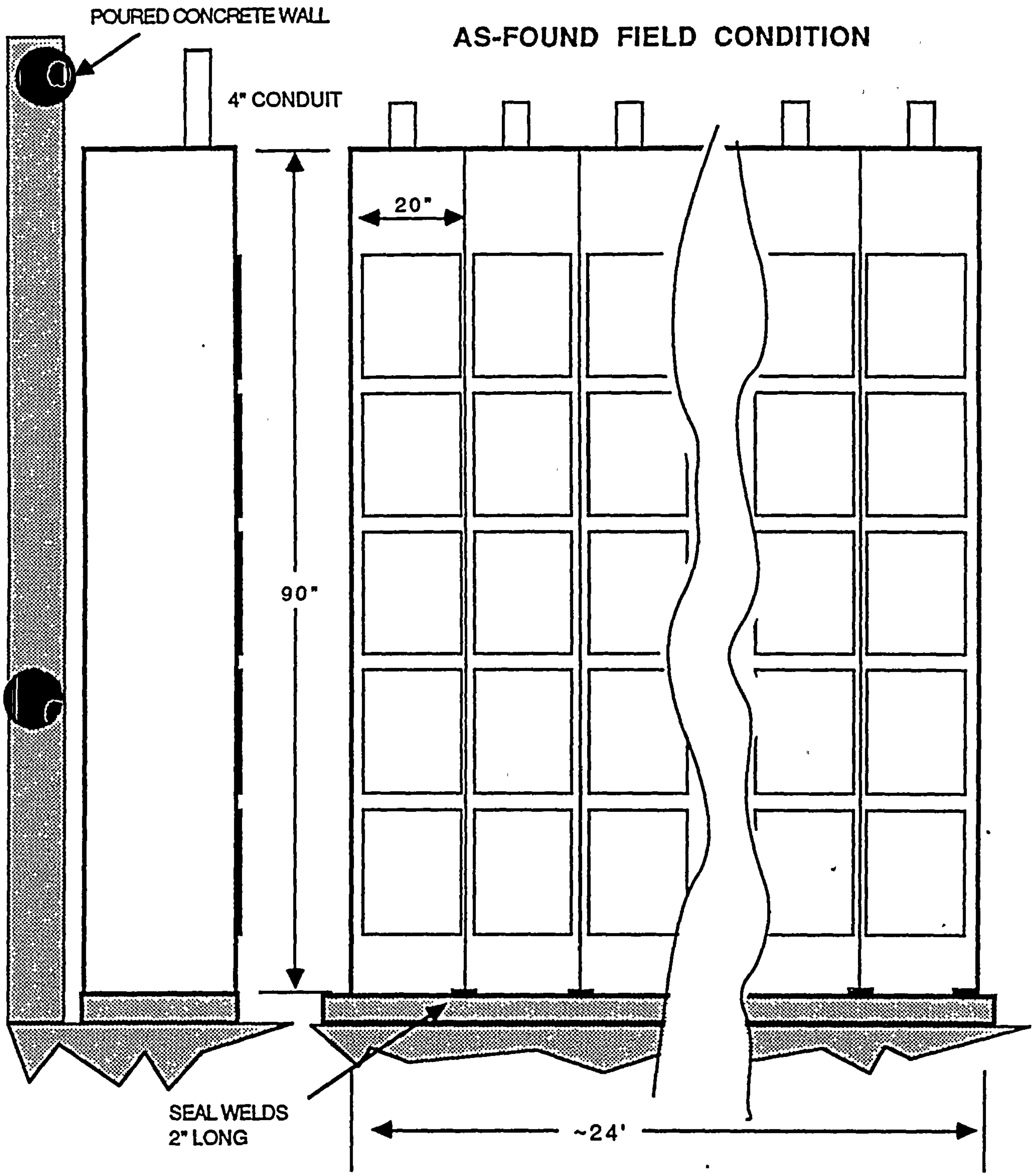
APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90
NAME John W. Reed DATE 4/5/90
NAME John D. Stevenson DATE 4/5/90

ITEM 23 480V MOTOR CONTROL CENTER - 3B

SRT NOTED THAT SEAL WELDS ARE USED FOR ANCHORAGE. SEAL WELDS ARE NON-STRUCTURAL AND THEREFORE NO CREDIT CAN BE TAKEN FOR THESE WELDS IN THE USI A-46 PROGRAM.

AS-FOUND FIELD CONDITION



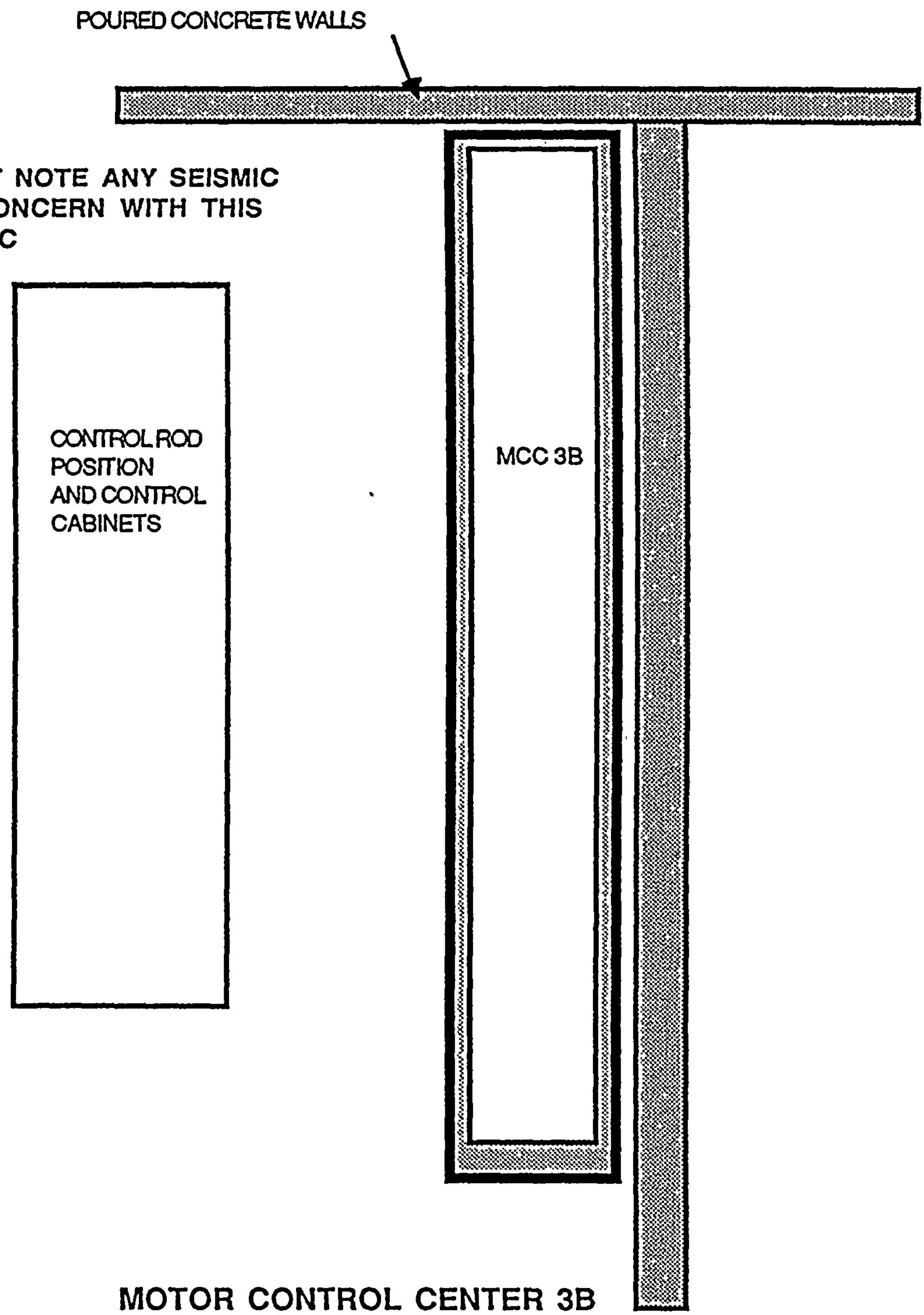
MOTOR CONTROL CENTER 3B
ELECTRICAL EQUIPMENT MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B MCC
DATE: MAR 22, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERN WITH THIS ROOM OR THE MCC



MOTOR CONTROL CENTER 3B
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: 3B MCC	
DATE: MAR 23, 1990	DWG BY: R. GOULDY

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90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 24 - 480V Motor Control Center 4B

PART A. EQUIPMENT DESCRIPTION

I.D. Number	4B06	Building	Control
Manufacturer		Elevation	18'
Model Number		Other	

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes ____ No X
2. Condition of nearby concrete and embedments
3. Length, size, number, and soundness of welds
4. Anchor bolt type, size and number
5. Are nuts present and apparently tight on all bolts?

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? No
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Fix it NO Anchorage
2. Concerns (if any)

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

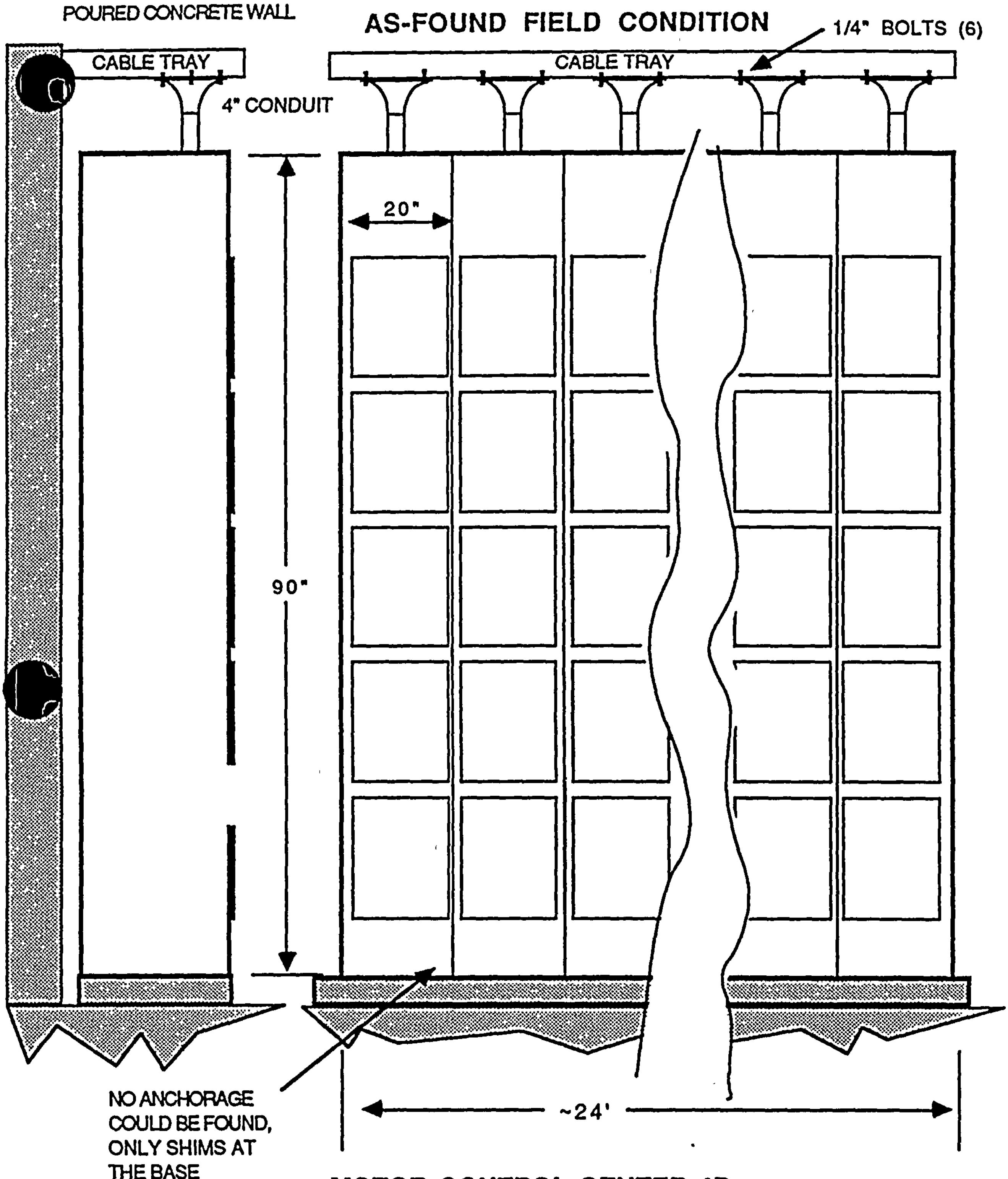
PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME	Robert P. Kennedy	DATE	4/5/90
NAME	John W Reed	DATE	4/5/90
NAME	Walter D. Stevenson	DATE	4/5/90

ITEM 24. 480V MOTOR CONTROL CENTER -4B

NO ANCHORAGE FOUND. USI-A-46 will REQUIRE ANCHORAGE.

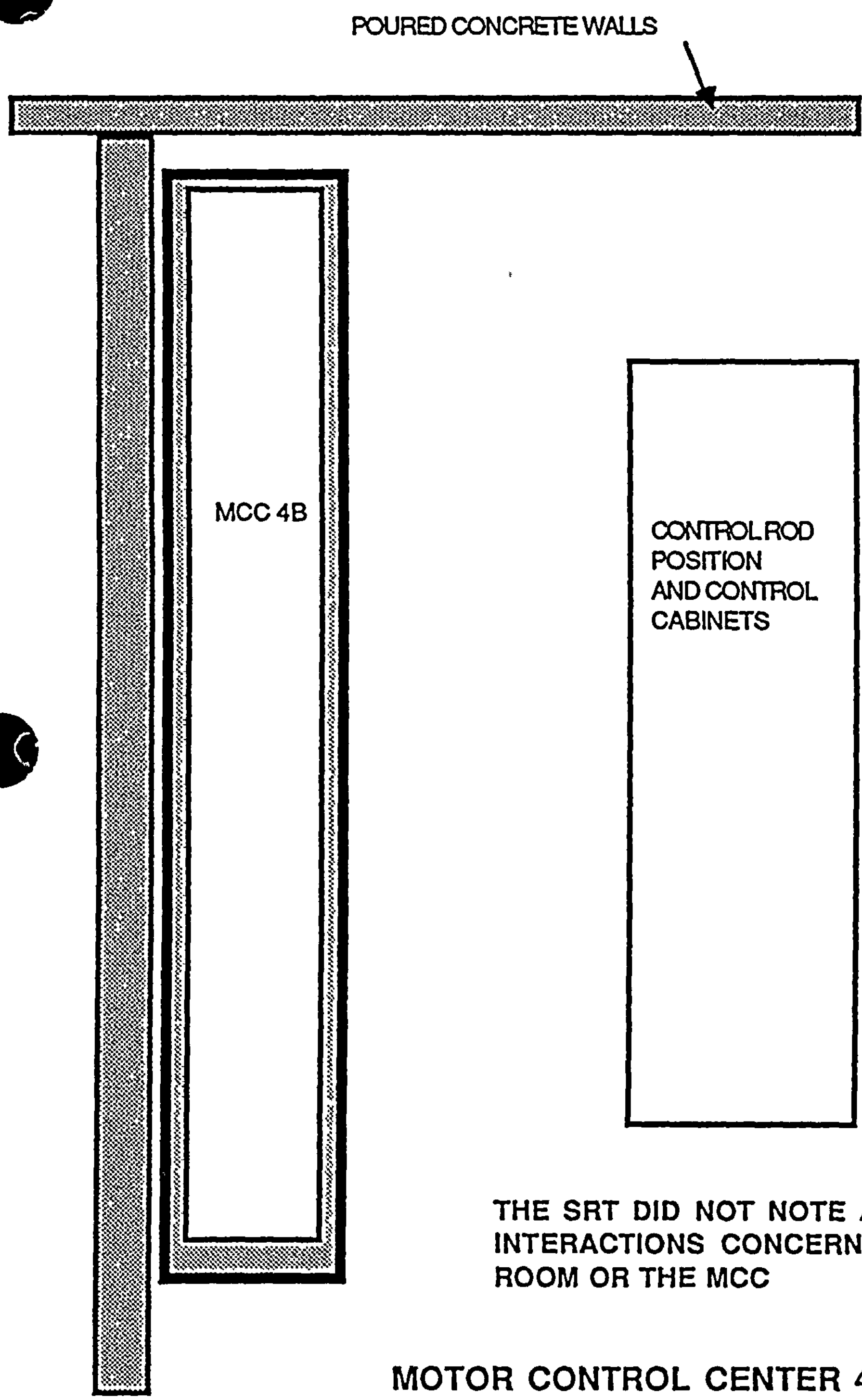


MOTOR CONTROL CENTER 4B
ELECTRICAL EQUIPMENT MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B MCC
DATE: MAR 22, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERN WITH THIS ROOM OR THE MCC

MOTOR CONTROL CENTER 4B
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: 4B MCC	
DATE: MAR 23, 1990	DWG BY: R. GOULDY

50

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 25 - 480V Motor Control Center D

PART A. EQUIPMENT DESCRIPTION

I.D. Number B08 Building RAB

Manufacturer ______ Elevation 18'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments ______
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number ~~SELF TAPPING~~ DRILLING ANCHORS with 2 sets of washers spaced as shown on attached pages.
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? No.
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) perform shear calculation
2. Concerns (if any) TOP NEEDS TO BE TIED BACK TO WALL

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

TIE TOP of MCC TO concrete wall behind the MCC D. If done, shear capacity of bolts at base will be adequate

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90

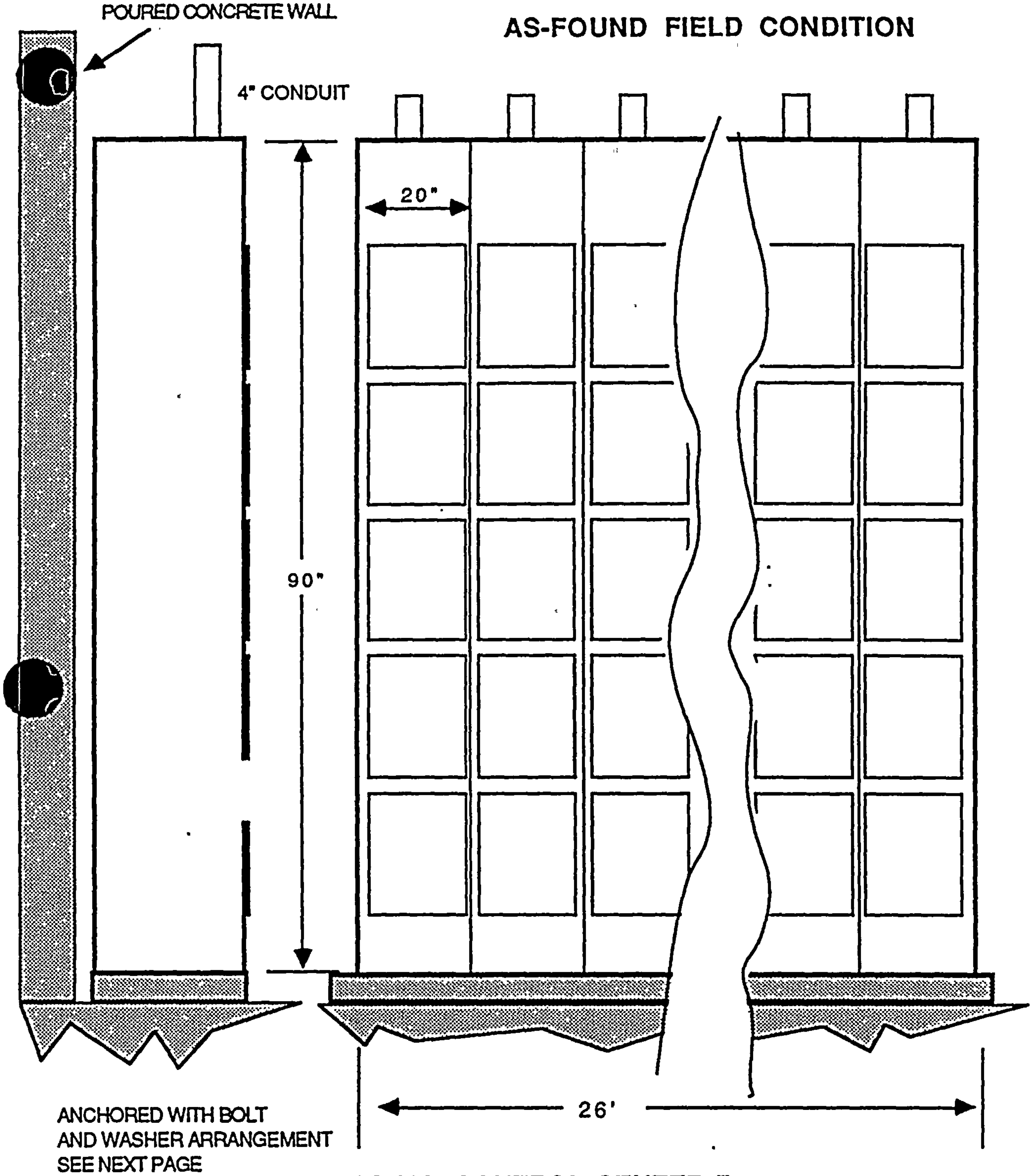
NAME [signature] DATE 4/5/90

NAME [signature] DATE 4/5/90

ITEM 25 480 VOLT MOTOR CONTROL CENTER - D

THE SRT WANTED A SHEAR CALCULATION TO BE PERFOKMED FOR THE SELF-DRILLING ANCHORS USED. RECOMMONDED THAT A TIE-BACK TO THE CONCRETE WALL BE INSTALLED ON THE TOP OF THE MCC.

AS-FOUND FIELD CONDITION



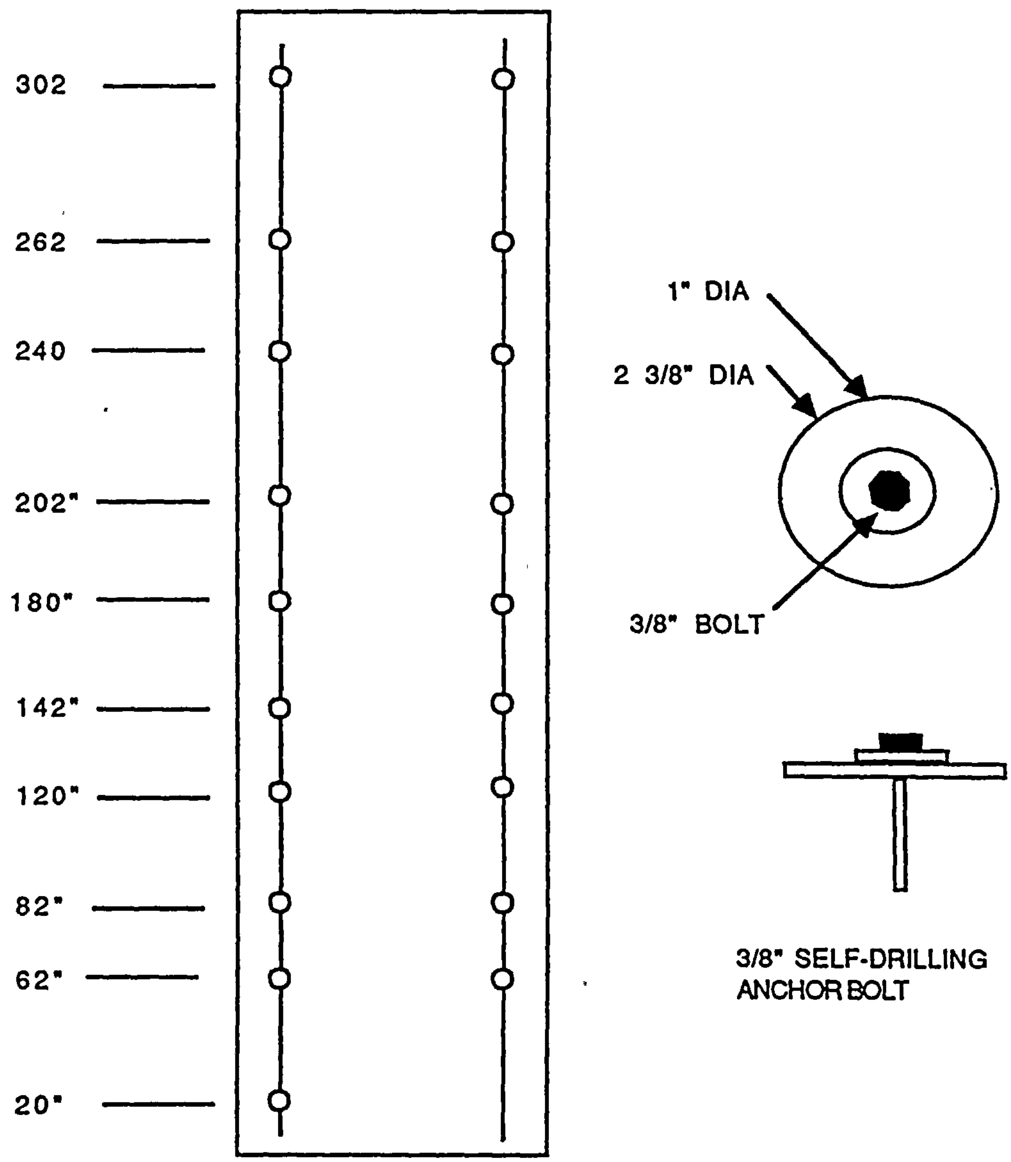
MOTOR CONTROL CENTER D
ELECTRICAL EQUIPMENT MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: D MCC
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



MOTOR CONTROL CENTER D
ELECTRICAL EQUIPMENT MOUNTING WORKSHEET

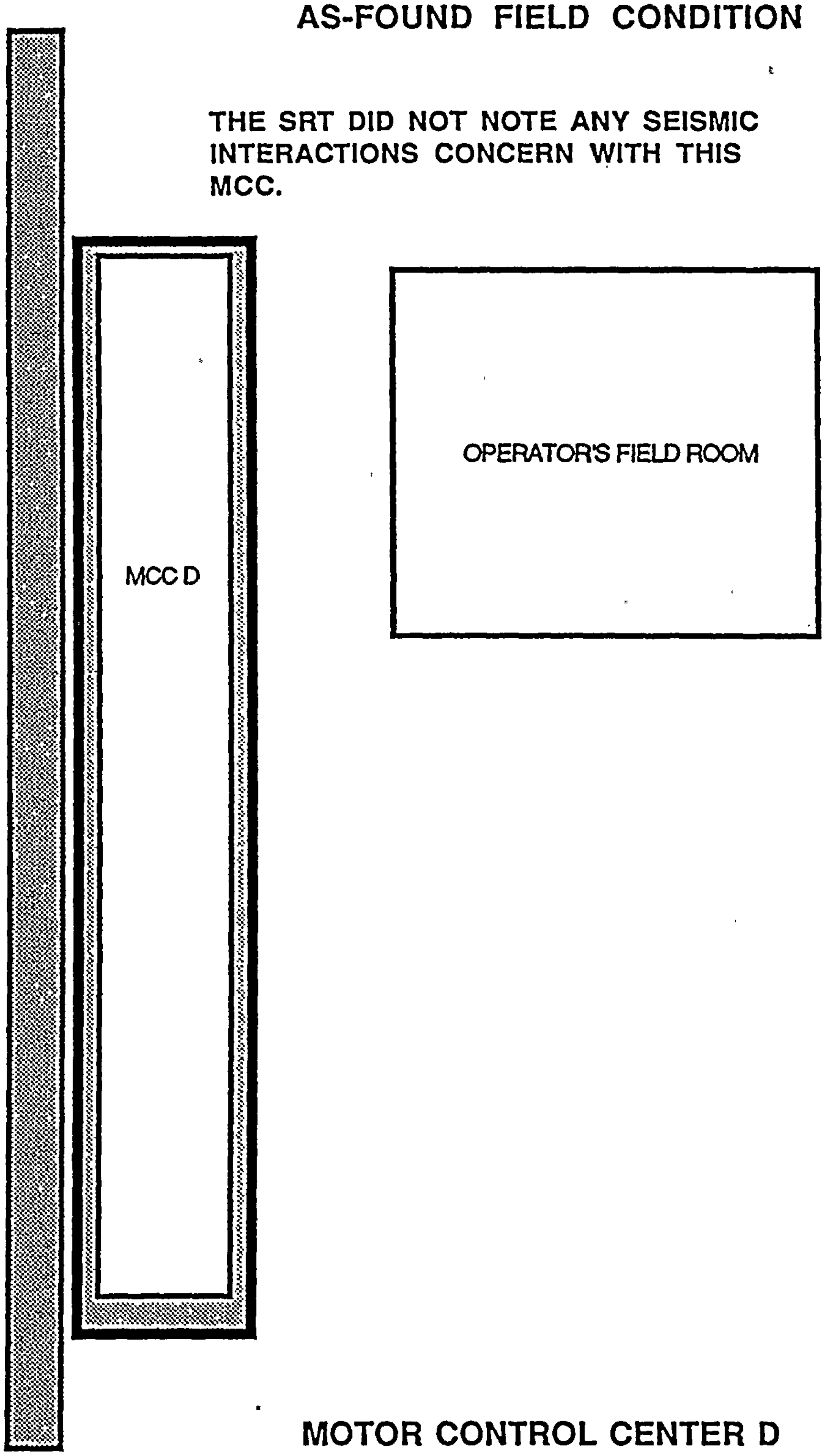
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: D MCC
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERN WITH THIS MCC.



MOTOR CONTROL CENTER D
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: D MCC
DATE: MAR 23, 1990 DWG BY: R. GOULDY

PJN 117M ...

STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

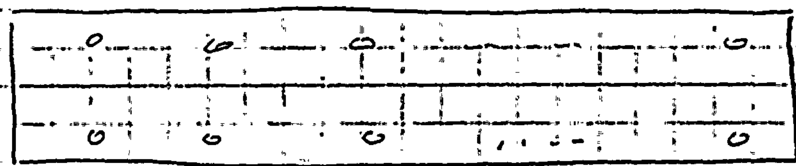
SUBJECT: MCC D — Anchorage Evaluation   JOB No. ____   SHEET ____ OF ____

REVISIONS: WD 9/5/90

El 18

Use 30 pcf

3/8" ϕ Self-Drilling Anchors
Use 10 bolts/side



20"   90" Tall

> 322" → say 350"

See Equipment Sketch D MCC 3/23/90 per Walkdown

$$W = \frac{350 \times 20 \times 90}{1728} \times 30 = 11^K$$

$$OTM = \sqrt{0.33^2 + 0.4(.33)^2} \times 45 \times 11 = 176$$

$$RM = 10 \times 11 \times 0.95g = 105$$

$$T_{bolt} = \frac{176 - 105}{20\,(10)} = 358\#/bolt > T_u = 300\#$$

$$S_{bolt} = \frac{11\,(0.35)}{20} = 200\#/bolt < T_u = 700\#$$

Note: Will have no tension as it will be tied back to the wall and therefore tension ≅ 0.

(12)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 26 - 4.16 kv Switchgear 3B

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3AB — Building LC-Swgr

Manufacturer GE — Elevation 18'

Model Number ______ — Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes ____ No X
2. Condition of nearby concrete and embedments ______
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number ______
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) ______
2. Concerns (if any) No anchorage

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE.

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90

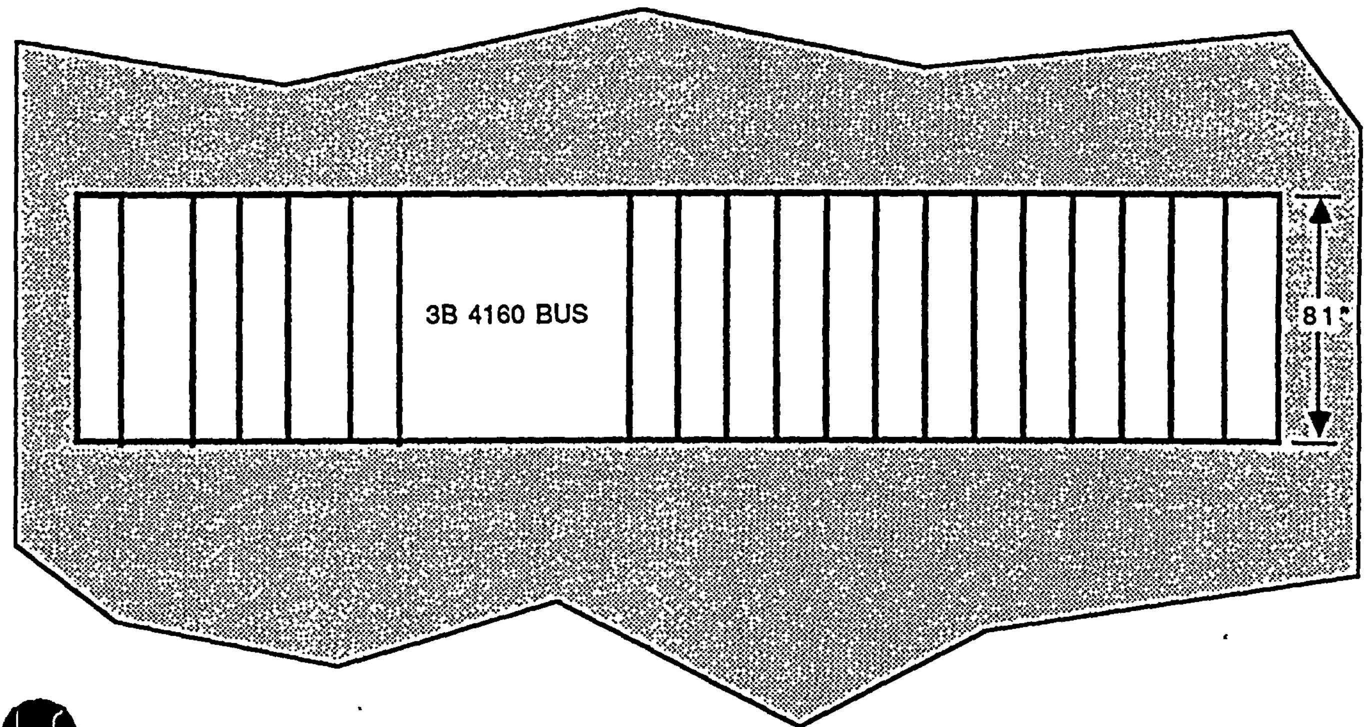
NAME John W. Reed DATE 4/5/90

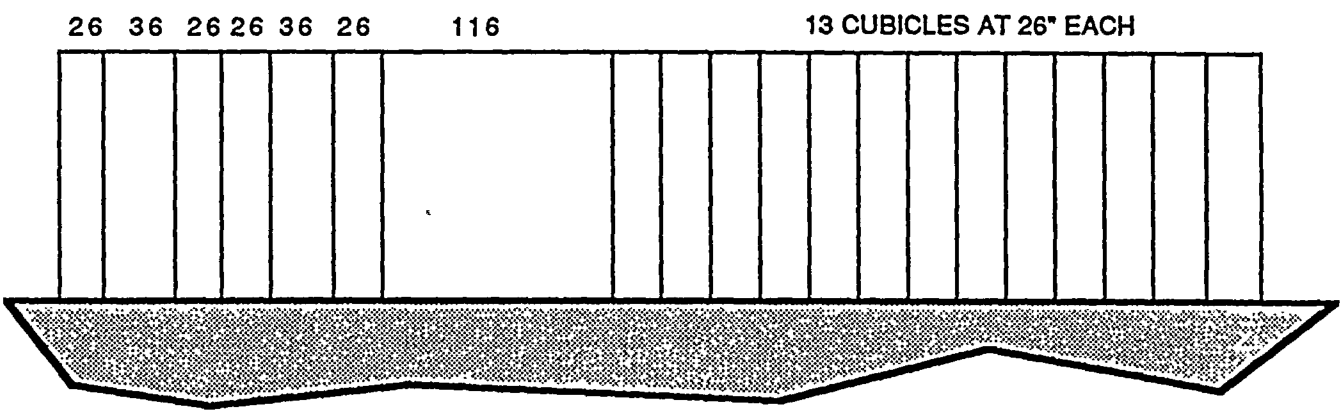
NAME John D. Stevenson DATE 4/5/90

ITEM 26 4.160 KV SWITCHGEAR 3B

THE SRT REVIEWED THE SWITCHGEAR ARRANGEMENT. NO ANCHORS ARE USED AND THEREFORE, WILL BE REQUIRED TO HAVE ANCHORS INSTALLED TO MEET USI-A-46 PROGRAM REQUIREMENTS

AS-FOUND FIELD CONDITION





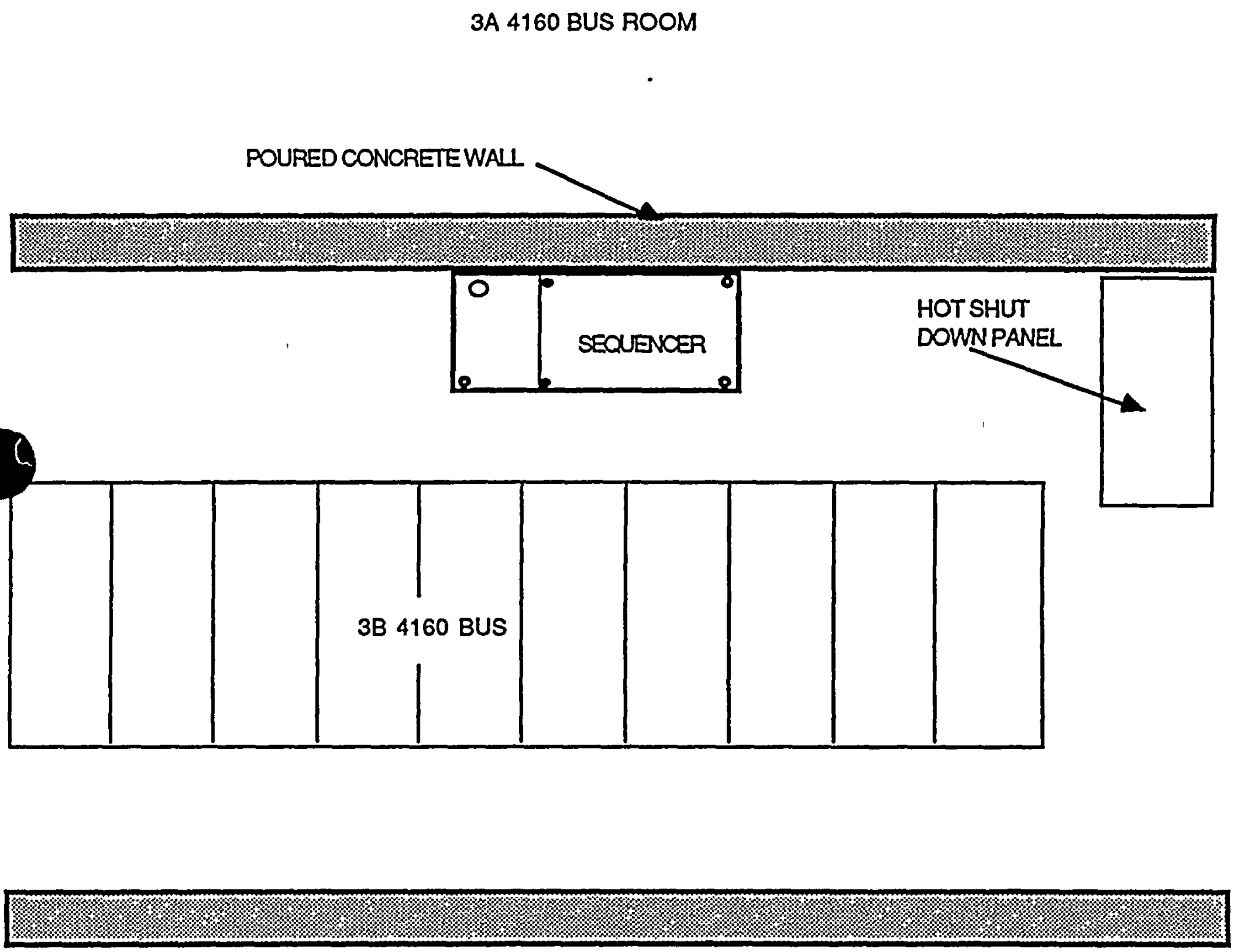
3B 4160 v SWITCHGEAR
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B 4160 SWITCHGEAR
DATE: MAR 28, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT NOTE ANY SEISMIC INTERACTION CONCERNS WITH THIS ROOM OR THE SEQUENCER



3B 4160 v SWITCHGEAR ROOM
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B SEQUENCER
DATE: MAR 28, 1990 DWG BY: R. GOULDY

40

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 27 - 4.16kv Switchgear 4B

PART A. EQUIPMENT DESCRIPTION

I.D. Number	4AB	Building	LC-Swgr
Manufacturer		Elevation	18'
Model Number		Other	

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes ____ No X
2. Condition of nearby concrete and embedments ____
3. Length, size, number, and soundness of welds ____
4. Anchor bolt type, size and number ____
5. Are nuts present and apparently tight on all bolts? ____

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? NO.
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) NO Anchorage
2. Concerns (if any) ____

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

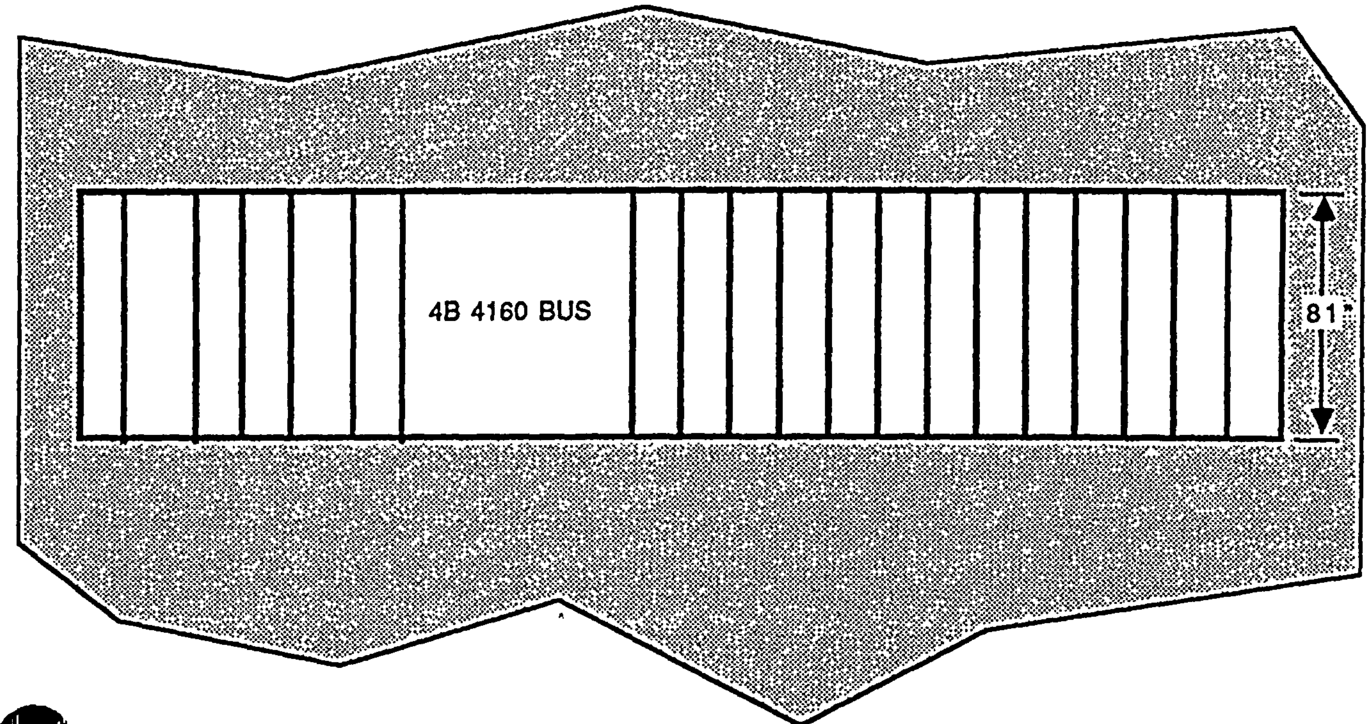
APPROVED BY SRT

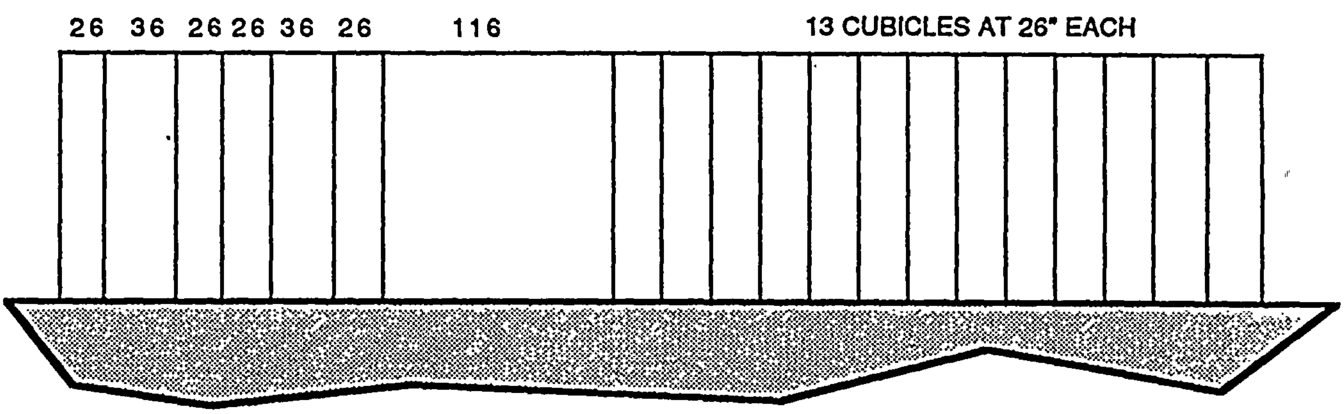
NAME	Robert P. Kennedy	DATE	4/5/90
NAME	John W Reed	DATE	4/5/90
NAME	John D. Stevenson	DATE	4/5/90

ITEM 27 4.160 KV SWITCHGEAR - 4B

THE SRT REVIEWED THE SWITCHGEAR ARRANGEMENT. NO ANCHORS ARE USED for this installation. To meet USI-A-46 REQUIREMENTS THIS SWITCHGEAR WILL HAVE TO BE ANCHORED.

AS-FOUND FIELD CONDITION





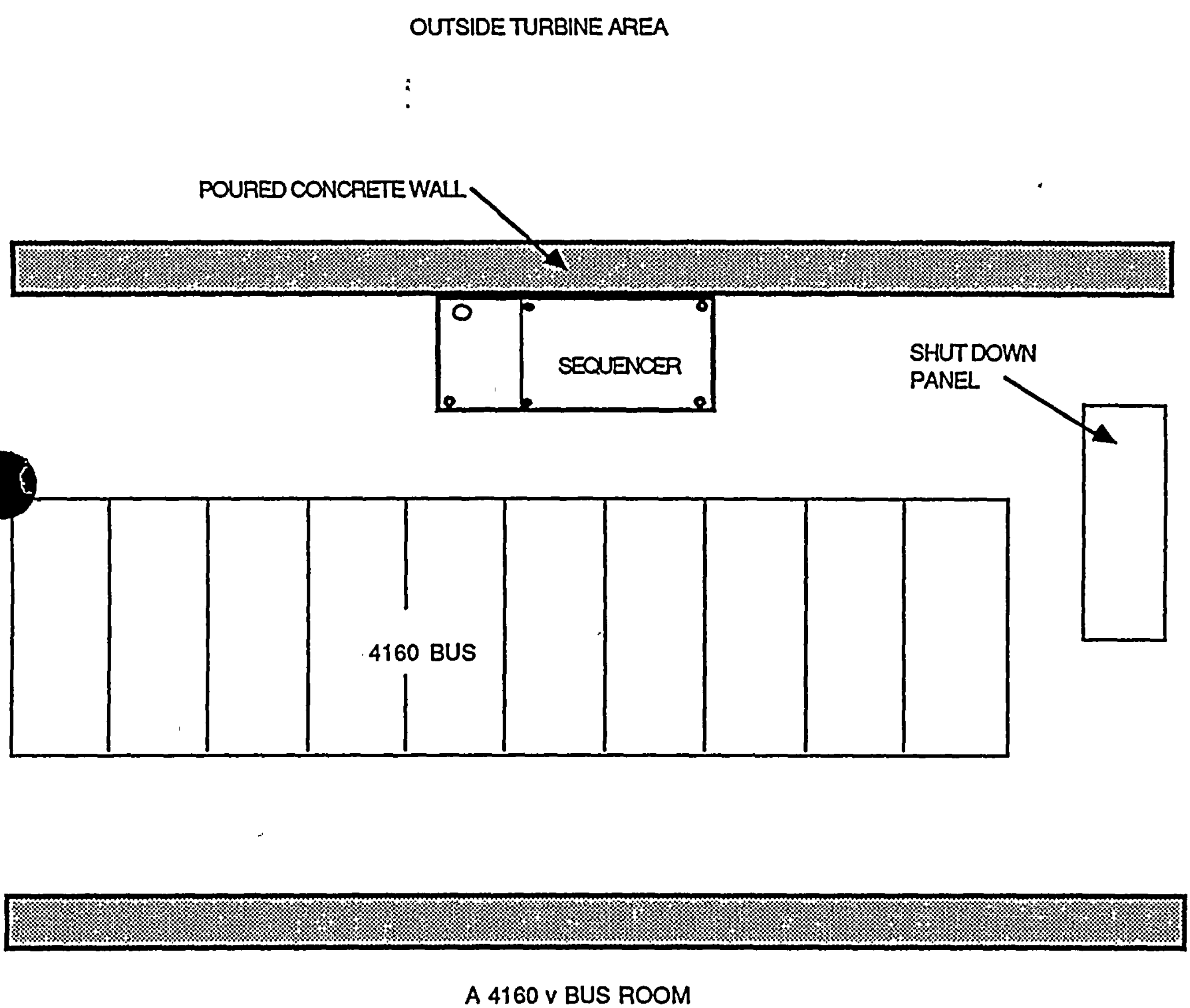
4B 4160 v SWITCHGEAR
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B 4160 SWITCHGEAR
DATE: MAR 28, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



4B 4160 v SWITCHGEAR SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: 4B 4160 SWITCHGEAR	
DATE: MAR 28,1990	DWG BY: R. GOULDY

(15)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 28 - 480V HVPDS Load Center 3B (Includes Transformer)

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3B02 Building LC-Swgr

Manufacturer ______ Elevation 30'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes ____ No X
2. Condition of nearby concrete and embedments ______
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number ______
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Can not determine anchorage - if any.
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None Block walls STRENgthened

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

______

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90

NAME John W. Reed DATE 4/5/90

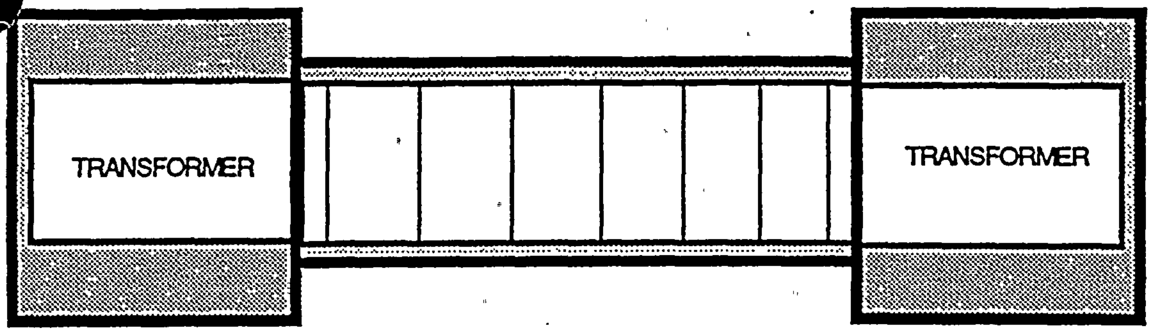
NAME John D. Stevenson DATE 4/5/90

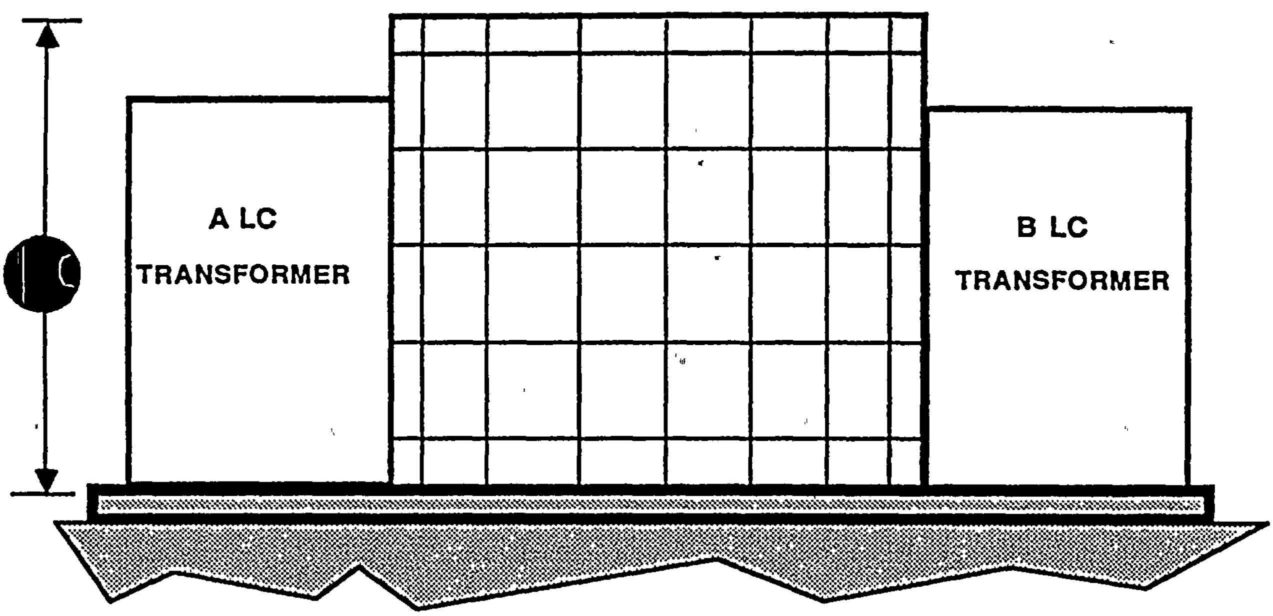
ITEM 28 480v HVPDS Load Center - 3B

THE SRT WALKDOWN TEAM COULD NOT FIND ANY ANCHORAGE FOR THIS INSTALLATION. IT WAS NOTED THAT THIS L.C. & TRANSFORMER ARE GOING TO BE MODIFIED/REPLACED DURING THE UP-COMMING EMERGENCY POWER UPGRADE OUTAGE.

SEISMIC INTERACTION CONCERNS WERE NOTED IN THAT BLOCK WALLS ARE PRESENT IN THE ROOM but the CONCERN Was RESOLVED because THE block walls WERE HALF HEIGHT & WERE PART OF THE GENERIC Letter block Wall program. (WALL NUMBERS T-31-1A AND T-31-3A)

AS-FOUND FIELD CONDITION





NO ANCHORAGE CAN BE DETERMINED FROM THE FIELD INSPECTION

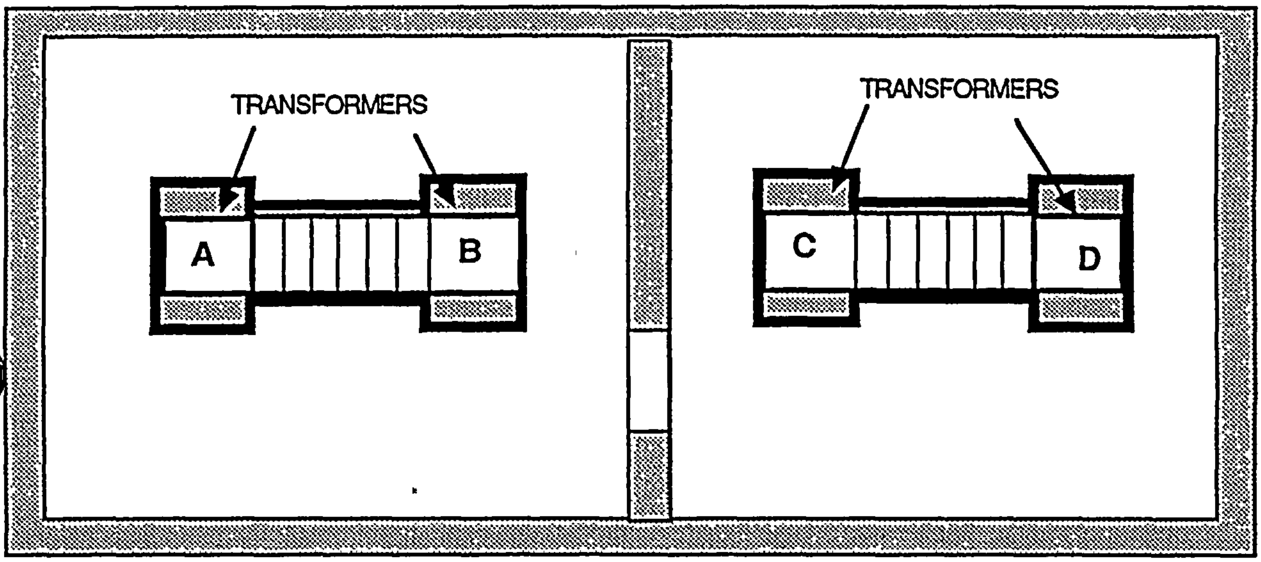
480 VOLT LOAD CENTER 3B
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 480 V LOAD CENTER 3B
DATE: MAR 28, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERN WITH THE LOAD CENTERS OR THE ROOM. CONCRETE BLOCK WALLS WERE FOUND BUT WERE LOW IN THE ROOM AND WERE COVERED BY THE BLOCK WALL GENERIC LETTER IMPROVEMENTS



480 VOLT LOAD CENTER 3B
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 480 V LOAD CENTERS
DATE: MAR 28, 1990 DWG BY: R. GOULDY

(10)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item - 29-480V HVPDS Load Center 3D (Includes Transformer)

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3B04 Building LC-Swgr

Manufacturer ______ Elevation 30'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes ____ No X
2. Condition of nearby concrete and embedments ______
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number ______
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   - a. SRT Judgment ____
   - b. URS Tables ____
   - c. ANCHOR Program ____
   - d. Other (explain) Can not determine if anchored
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE Block Walls are Seismic ~~Qualified~~ STRENgthened (Not reviewed by SRT)

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90

NAME [signature] DATE 4/5/90

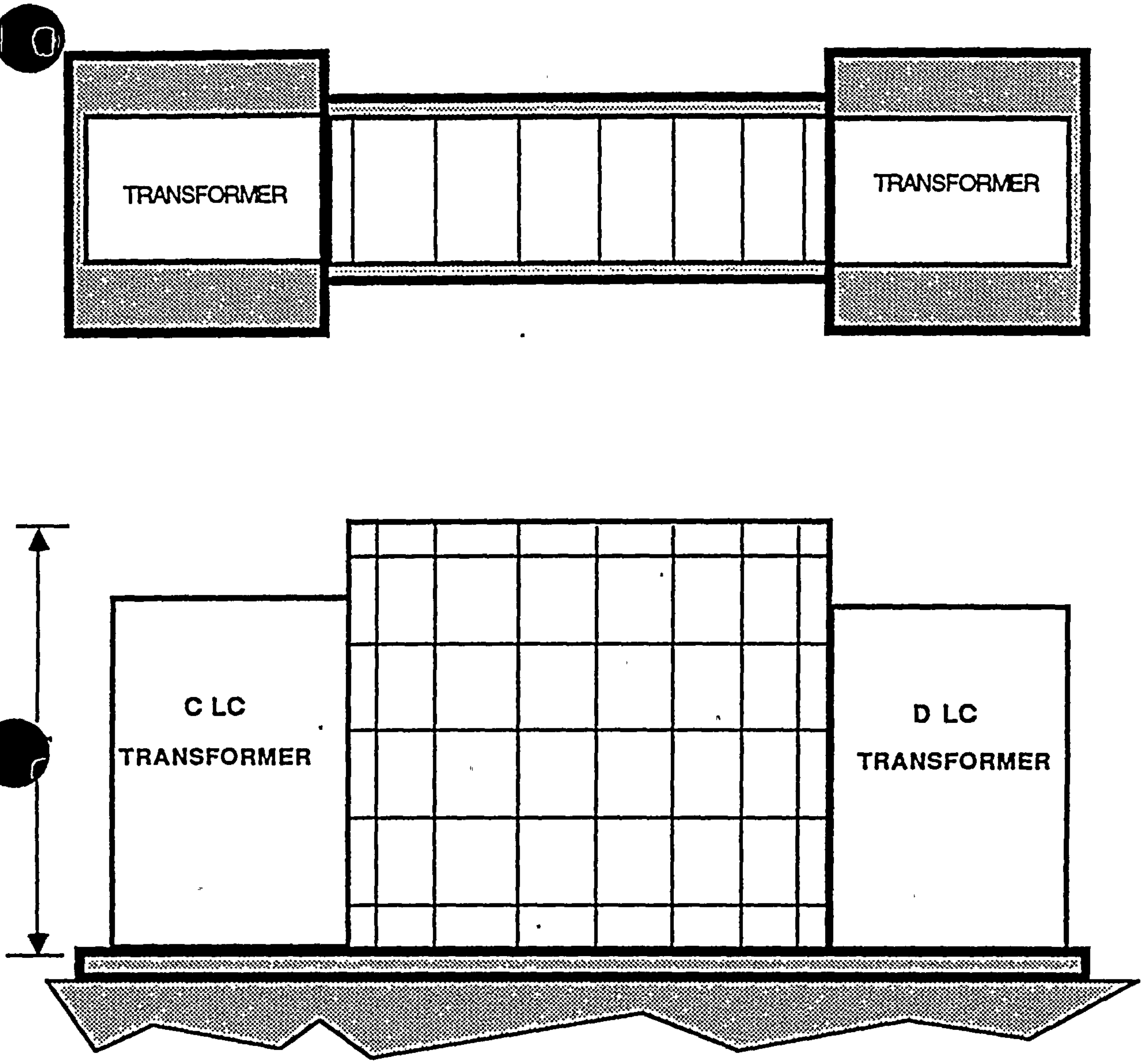
NAME [signature] DATE 4/5/90

ITEM 29 480V HVPDS Load Center - 3D

THE SRT WALKDOWN TEAM COULD NOT FIND ANY ANCHORAGE FOR THIS INSTALLATION. IT WAS NOTED THAT THIS LC & TRANSFORMER ARE GOING TO BE MODIFIED/REPLACED DURING THE UP.COMMING EMERGENCY POWER UPGRADE OUTAGE.

SEISMIC INTERACTION CONCERNS WERE NOTED IN THAT BLOCK WALLS ARE PRESENT IN THE Room but the CONCERN was resolved because THE block walls WERE HALF HEIGHT & WERE PART OF THE GENERIC Letter block Wall Program. (WALL NUMBERS T-31-1A AND T-31-2A)

AS-FOUND FIELD CONDITION



NO ANCHORAGE CAN BE DETERMINED FROM THE FIELD INSPECTION

480 VOLT LOAD CENTER 3D
SEISMIC MOUNTING WORKSHEET

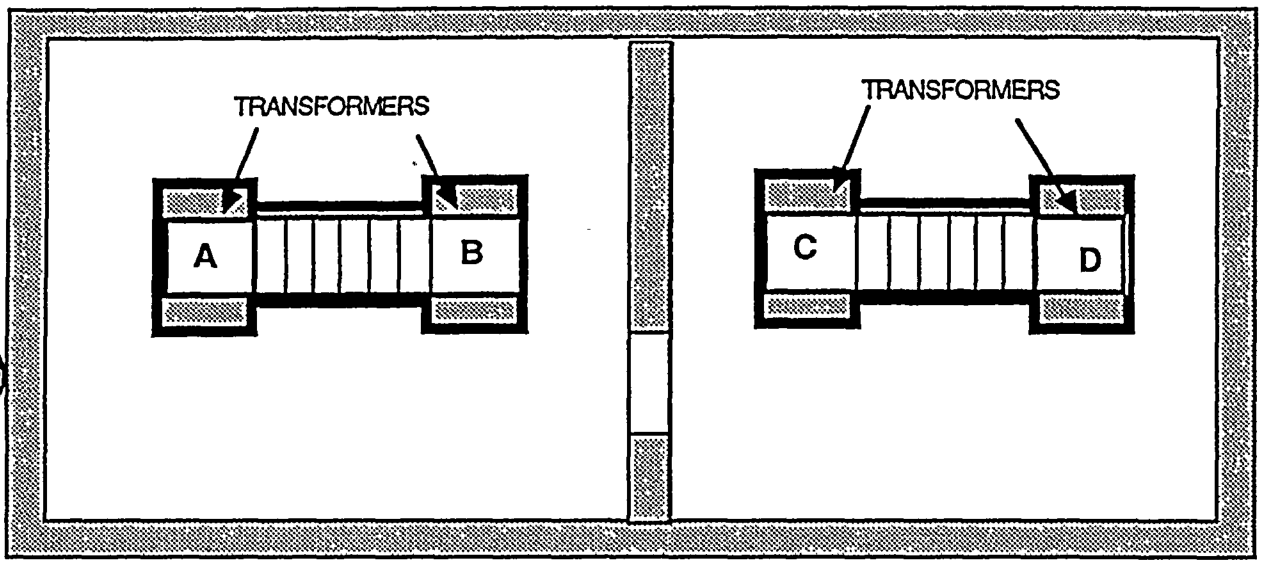
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 480 V LOAD CENTER 3D
DATE: MAR 28, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERN WITH THE LOAD CENTERS OR THE ROOM. CONCRETE BLOCK WALLS WERE FOUND BUT WERE LOW IN THE ROOM AND WERE COVERED BY THE BLOCK WALL GENERIC LETTER IMPROVEMENTS



480 VOLT LOAD CENTER 3D
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 480 V LOAD CENTERS
DATE: MAR 28, 1990 DWG BY: R. GOULDY

(34)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 30 - 480V HVPDS Load Center 4B (Includes Transformers)

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4B02 Building LC-Swgr

Manufacturer ______ Elevation 30'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes ____ No X
2. Condition of nearby concrete and embedments ______
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number ______
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? No
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) ______
2. Concerns (if any) No anchorage

PART D. **SPATIAL SEISMIC INTERACTION CONCERNS** (if any) None considering seismic block walls

PART E. **RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS** (if any)

______

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90

NAME John W. Reed DATE 4/5/90

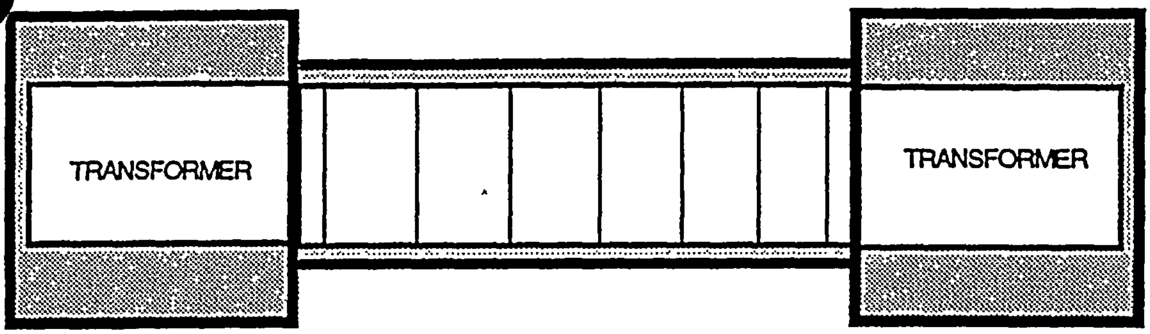
NAME John D. Stevenson DATE 4/5/90

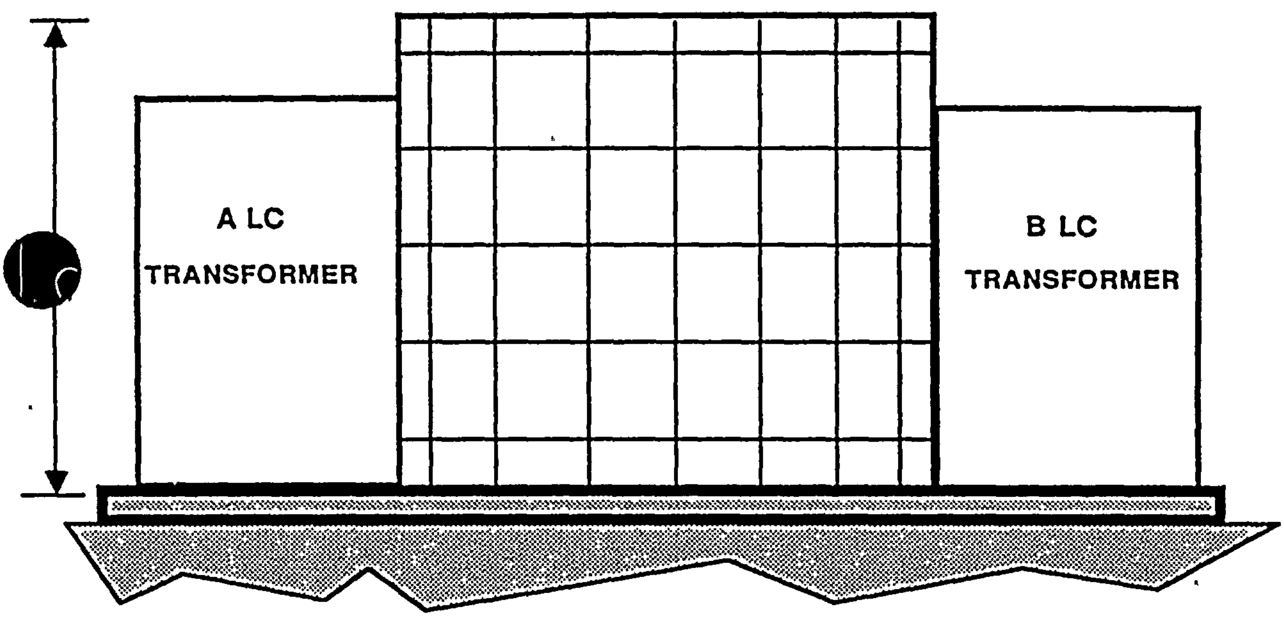
ITEM 30 480v HVPDS Load Center - 4B

THE SRT WALKDOWN TEAM COULD NOT FIND ANY ANCHORAGE FOR THIS INSTALLATION. IT WAS NOTED THAT THIS LC. & TRANSFORMER ARE GOING TO BE MODIFIED/REPLACED DURING THE UP.COMMING EMERGENCY POWER UPGRADE OUTAGE.

SEISMIC INTERACTION CONCERNS WERE NOTED IN THAT BLOCK WALLS ARE PRESENT IN THE Room but the CONCERN was RESOLVED because THE block walls WERE HALF HEIGHT & WERE PART OF THE GENERIC Letter block wall Program. (WALL NUMBERS T-31-1B AND T-31-3B)

AS-FOUND FIELD CONDITION





NO ANCHORAGE CAN BE DETERMINED FROM THE FIELD INSPECTION

480 VOLT LOAD CENTER 4B
SEISMIC MOUNTING WORKSHEET

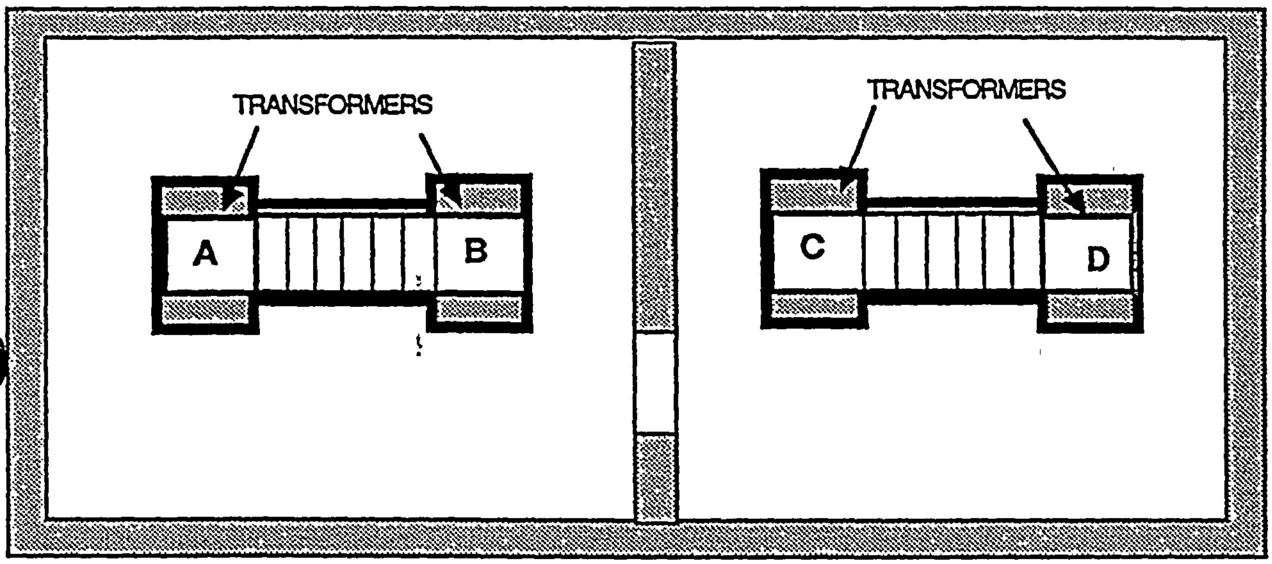
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 480 V LOAD CENTER 4B
DATE: MAR 28, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERN WITH THE LOAD CENTERS OR THE ROOM. CONCRETE BLOCK WALLS WERE FOUND BUT WERE LOW IN THE ROOM AND WERE COVERED BY THE BLOCK WALL GENERIC LETTER IMPROVEMENTS



480 VOLT LOAD CENTER 4B
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 480 V LOAD CENTERS
DATE: MAR 28, 1990 DWG BY: R GOULDY

35

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item - 31 480V HVPDS Load Center 4D (Includes Transformer)

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4B04 Building LC-Swgr

Manufacturer ____ Elevation 30'

Model Number ____ Other ____

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes ____ No X
2. Condition of nearby concrete and embedments ____
3. Length, size, number, and soundness of welds ____
4. Anchor bolt type, size and number ____
5. Are nuts present and apparently tight on all bolts? ____

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? NO
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) No Anchorage
2. Concerns (if any) ____

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE CONSIDERING SEISMIC BLOCK WALLS

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

____

APPROVED BY SRT

4/5/90

NAME Robert P. Kennedy DATE 4/5/90

NAME John W. Reed DATE 4/5/90

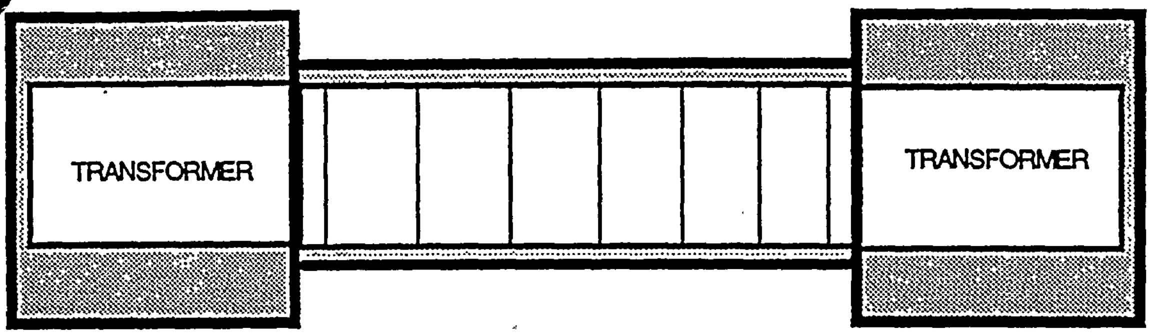
NAME Julen D. Stevenson DATE 4/5/90

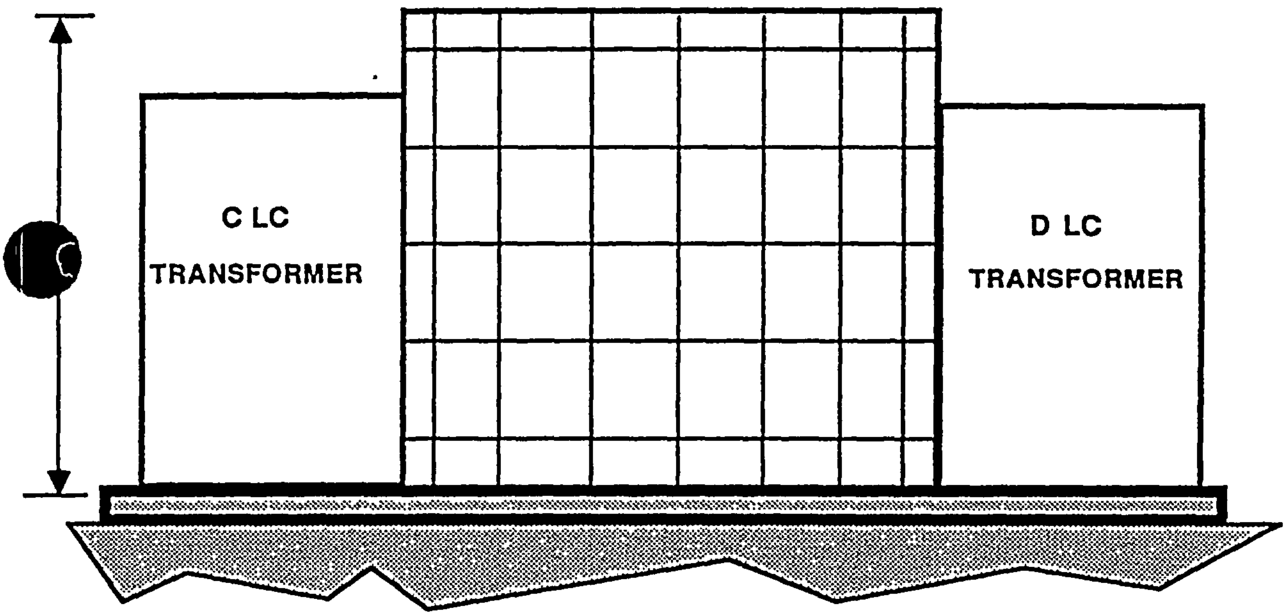
ITEM 31 480V HVPDS Load Center - 4D

THE SRT WALKDOWN TEAM COULD NOT FIND ANY ANCHORAGE FOR THIS INSTALLATION. IT WAS NOTED THAT THIS LC & TRANSFORMER ARE GOING TO BE MODIFIED/REPLACED DURING THE UP.COMMING EMERGENCY POWER UPGRADE OUTAGE.

SEISMIC INTERACTION CONCERNS WERE NOTED IN THAT BLOCK WALLS ARE PRESENT IN THE Room but the CONCERN Was RESOLVED because THE blockwalls WERE HALF HEIGHT & WERE PART OF THE GENERIC Letter block Wall Program. (WALL NUMBERS T-31-1B AND T-31-2B)

AS-FOUND FIELD CONDITION





NO ANCHORAGE CAN BE DETERMINED FROM THE FIELD INSPECTION

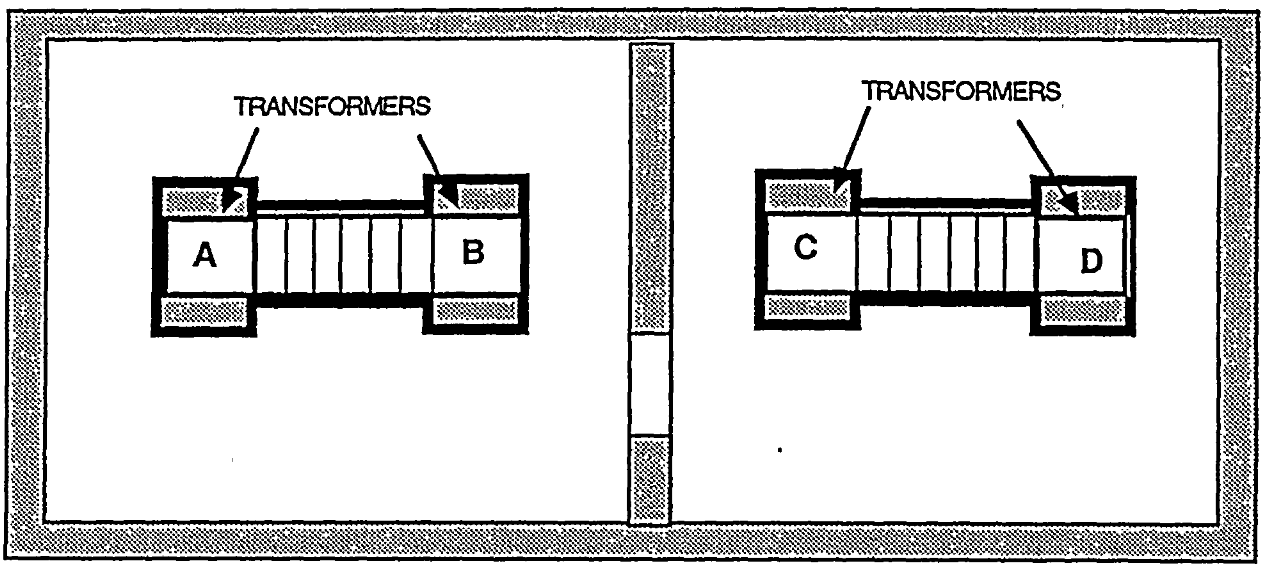
480 VOLT LOAD CENTER 4D
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 480 V LOAD CENTER 4D
DATE: MAR 28, 1990 DWG BY: R.GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERN WITH THE LOAD CENTERS OR THE ROOM. CONCRETE BLOCK WALLS WERE FOUND BUT WERE LOW IN THE ROOM AND WERE COVERED BY THE BLOCK WALL GENERIC LETTER IMPROVEMENTS



480 VOLT LOAD CENTER 4D
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 480 V LOAD CENTERS
DATE: MAR 28, 1990 DWG BY: R.GOULDY

36

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 32 - 480VLoad Center (PZR Htr.)

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3B11 Building LC-Swgr

Manufacturer ______ Elevation 30'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 4 3/8" DIA Anchors
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) ~~Load tested~~ RG.
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

______

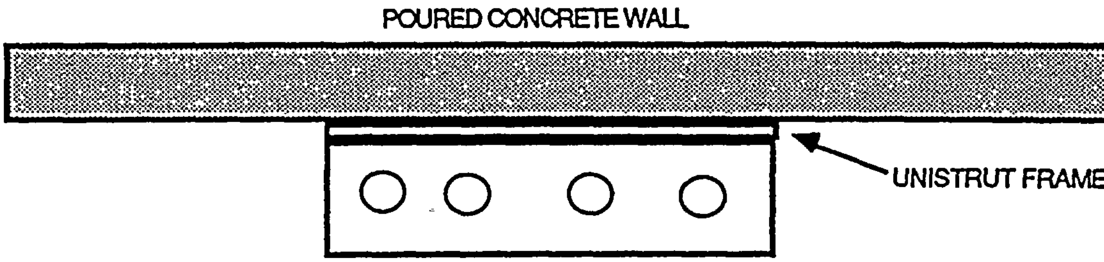
APPROVED BY SRT

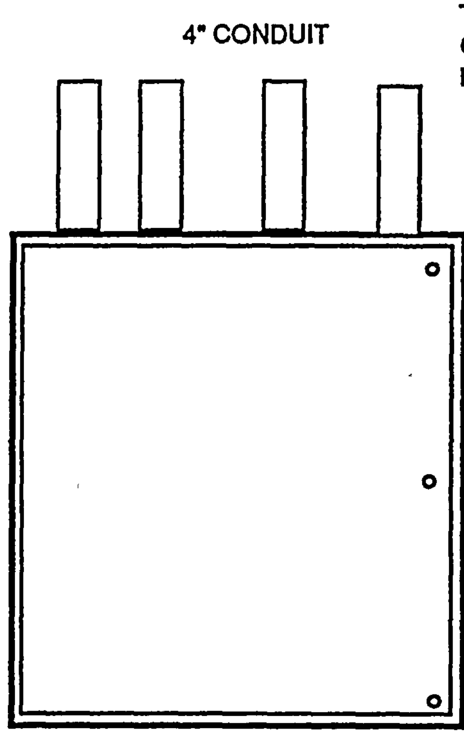
NAME John D. Stevenson DATE 4/4/90

NAME Robert P. Kennedy DATE 4/4/90

NAME [signature] DATE 4/5/90

AS-FOUND FIELD CONDITION





THE SRT APPLIED FORCES TO THIS CABINET AND DETERMINED THAT IT WAS VERY WELL ANCHORED

UNIT 3 PRESSURIZER HEATER LOAD CENTER SEISMIC MOUNTING WORKSHEET

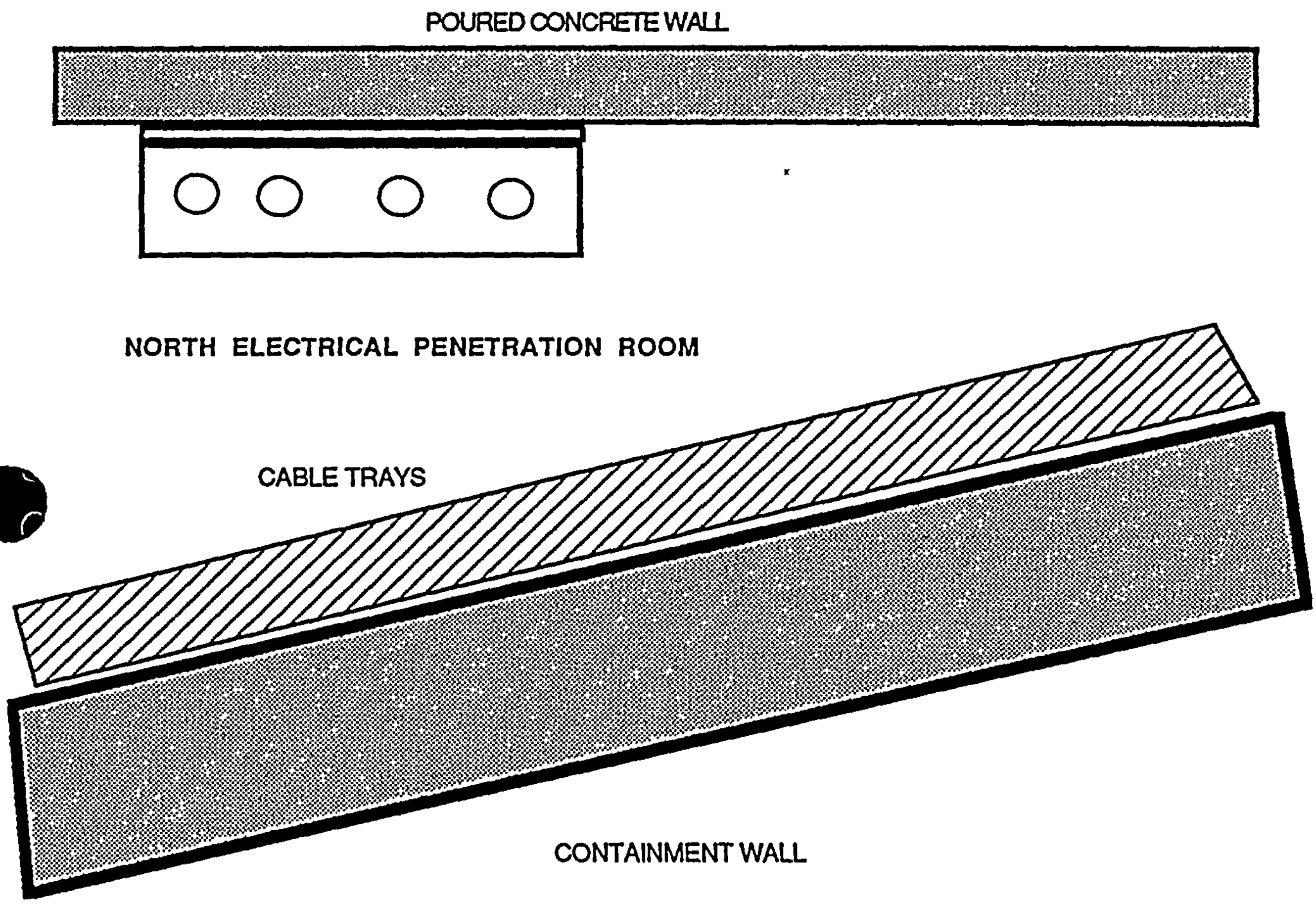
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT:UNIT 3 PRZ HEATER LOAD CENTER
DATE: MAR 28,1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERNS FOR THIS ROOM



UNIT 3 PRESSURIZER HEATER LOAD CENTER
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.

2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: UNIT 3 PRZ HEATER LOAD CENTER
DATE: MAR 28,1990 DWG BY: R. GOULDY

37

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 33 - 480 V Load Center)PZR Htr.)

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4B11 Building LC-Swgr

Manufacturer ______ Elevation 30'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ______
2. Condition of nearby concrete and embedments ______
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number UNI STRUT Frame
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ______
   c. ANCHOR Program ______
   d. Other (explain) ______
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

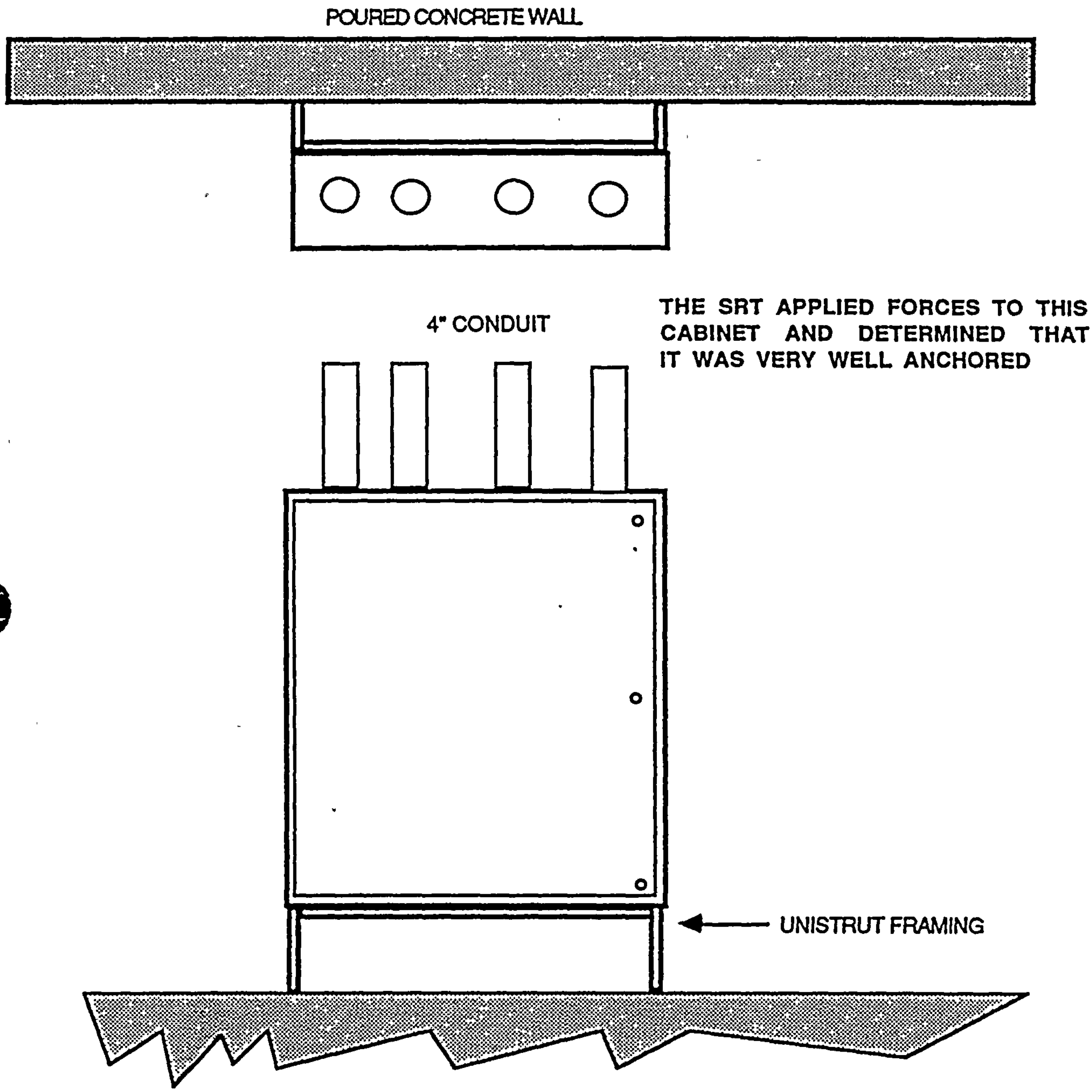
APPROVED BY SRT

NAME John D. Stevenson DATE 4/4/90

NAME Robert P. Kennedy DATE 4/4/90

NAME John W. Reed DATE 4/5/90

AS-FOUND FIELD CONDITION



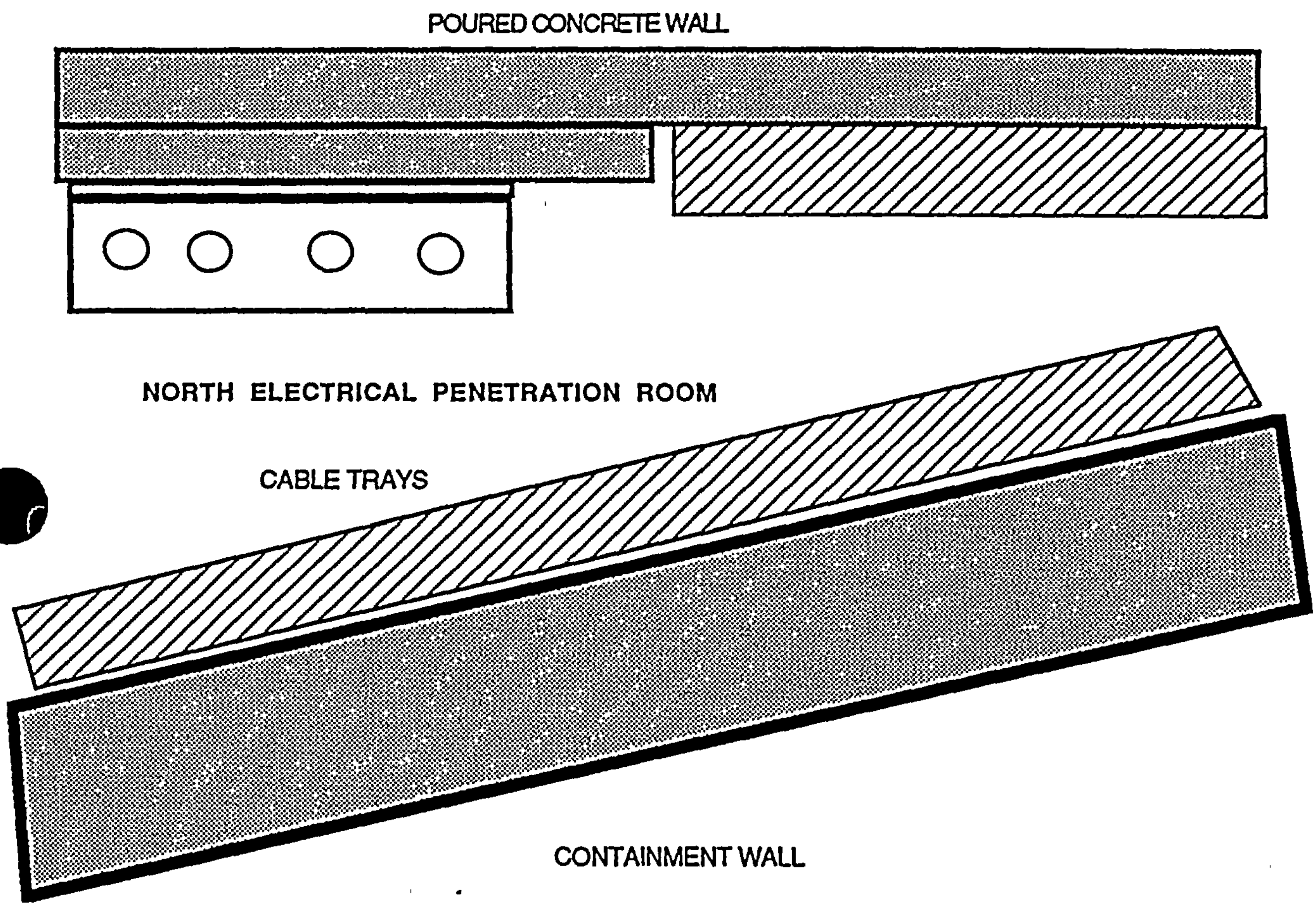
UNIT 4 PRESSURIZER HEATER LOAD CENTER
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT:UNIT 4 PRZ HEATER LOAD CENTER
DATE: MAR 28,1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERNS FOR THIS ROOM



UNIT 4 PRESSURIZER HEATER LOAD CENTER SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: UNIT 4 PRZ HEATER LOAD CENTER
DATE: MAR 28,1990 DWG BY: R. GOULDY

29

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 34 - Battery Charger 3B

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3D25 Building Control

Manufacturer ____ Elevation 42'

Model Number ____ Other ____

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments ____
3. Length, size, number, and soundness of welds ____
4. Anchor bolt type, size and number ____
5. Are nuts present and apparently tight on all bolts? ____

PART C. ANCHORAGE ADEQUACY

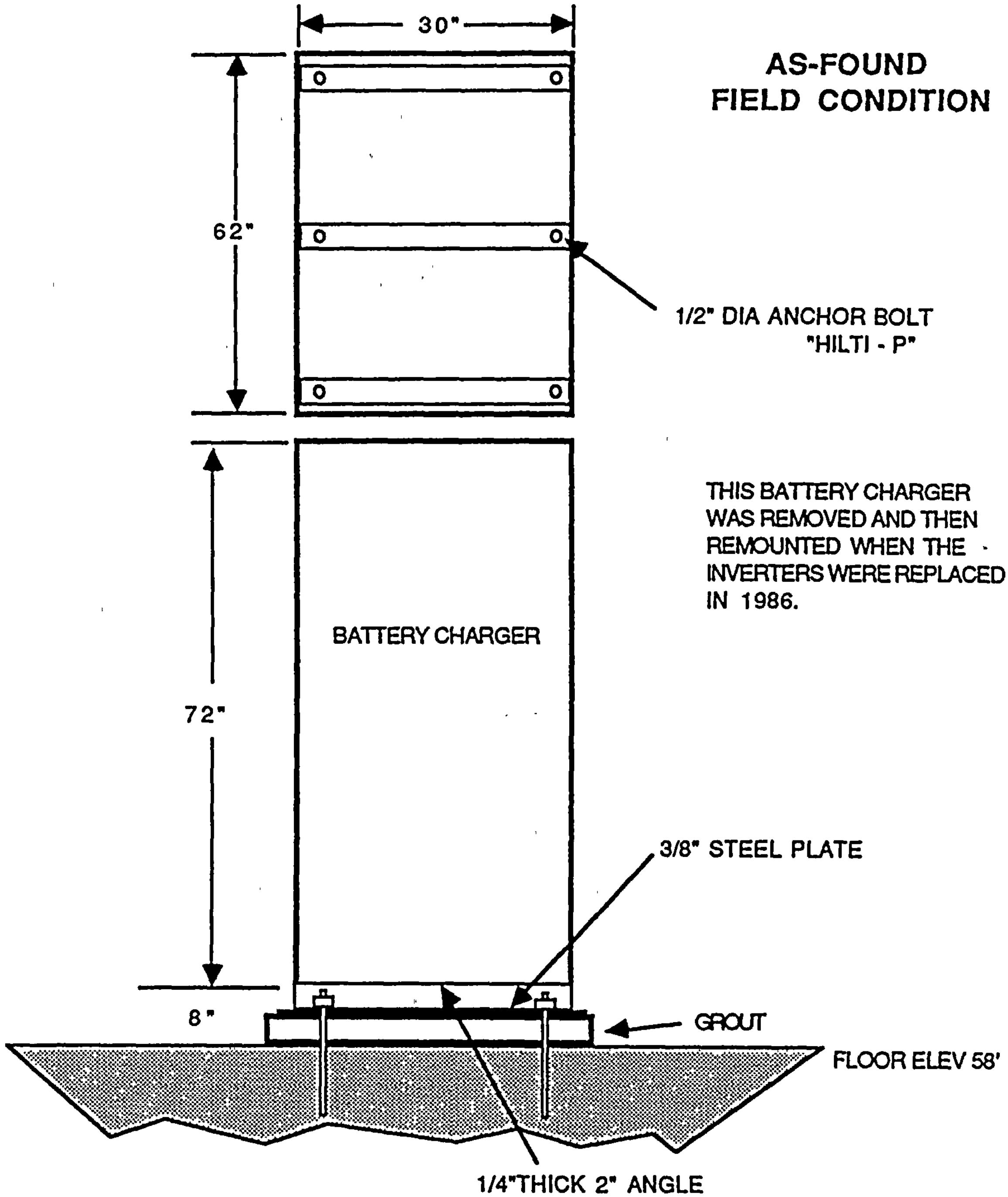
1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Battery Charger was remounted
2. Concerns (if any) NONE

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME John D. Stevenson DATE 4/4/90
NAME Robert P. Kennedy DATE 4/4/90
NAME John W. Reed DATE 4/5/90

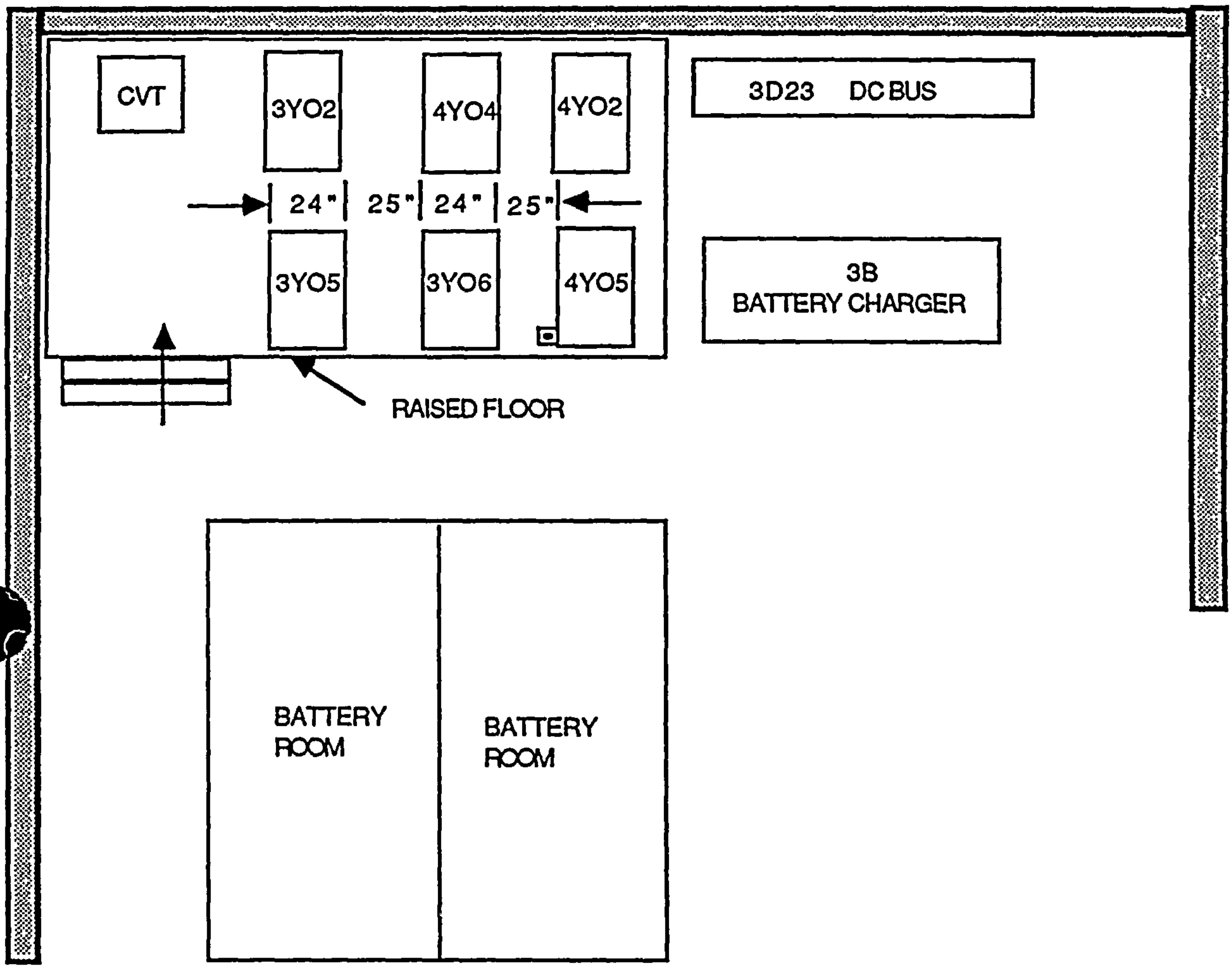


3B BATTERY CHARGER
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B BATTERY CHARGER
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT NOTE ANY SEISMIC INTERACTION CONCERNS WITH THIS ROOM OR THE ASSOCIATED EQUIPMENT.

3B BATTERY CHARGER
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B BATTERY CHARGER
DATE: MAR 23, 1990 DWG BY: R. GOULDY

28

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 35 - Battery Charger 4A

PART A. EQUIPMENT DESCRIPTION

I.D. Number	4D25	Building	Control
Manufacturer	EXIDE	Elevation	42'
Model Number		Other	

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes ____ No ____
2. Condition of nearby concrete and embedments CRACKED Flooring
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 6 - 1/2"ϕ RODD ANchor
5. Are nuts present and apparently tight on all bolts?

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Bounding calculation performed and is adequate as anchored.
2. Concerns (if any) Cracks in floor - Not problem because loads very low

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

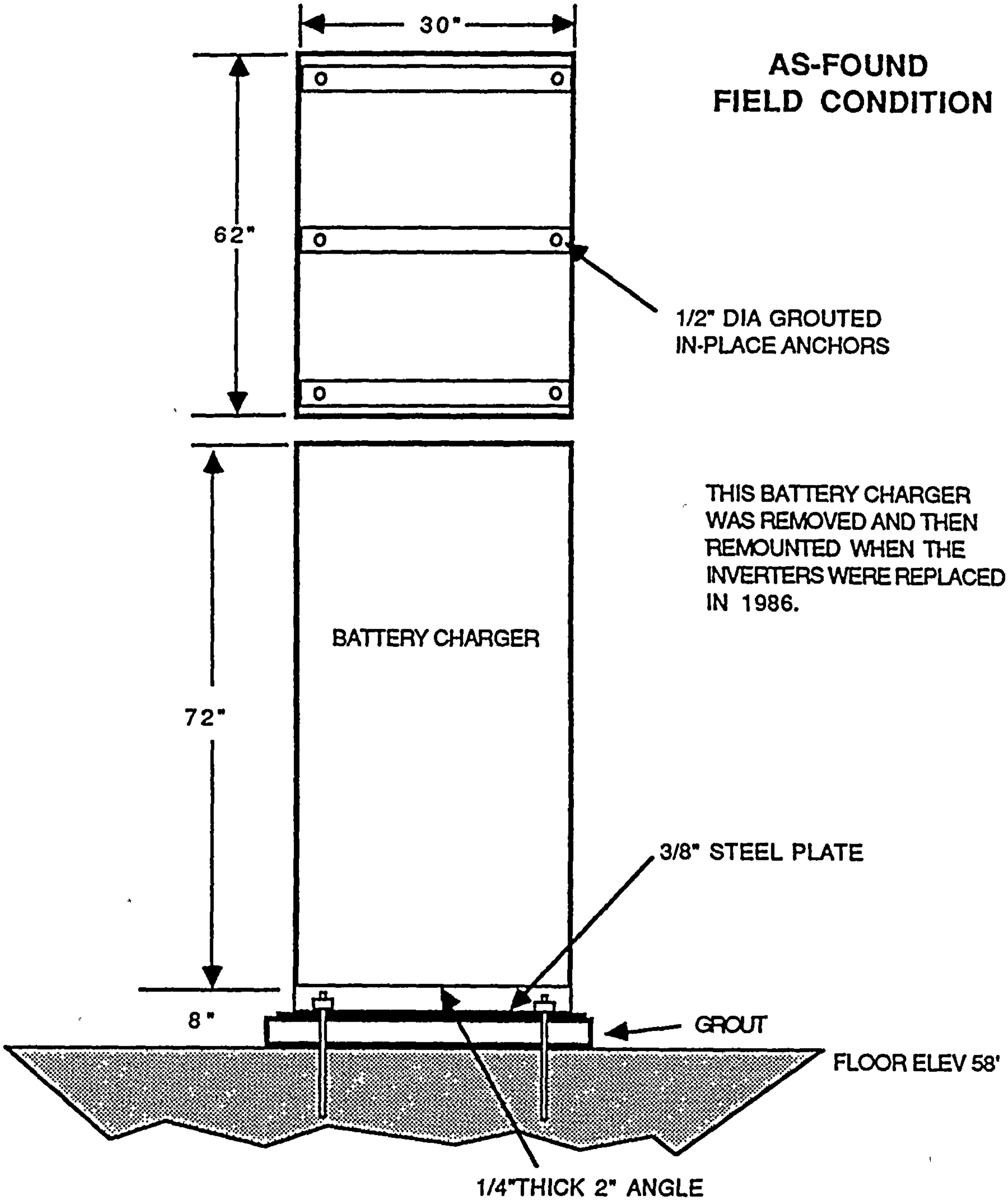
PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME	John D. Stevenson	DATE	4/4/90
NAME	Robert P. Kennedy	DATE	4/4/90
NAME	John W. Reed	DATE	4/5/90

ITEM 35 BATTERY CHARGE - 4A

SRT REQUESTED A BOUNDING Calculation
AND REVIEW OF THE BOUNDING Calculation
INDICATED ADEQUATE ANCHORAGE.

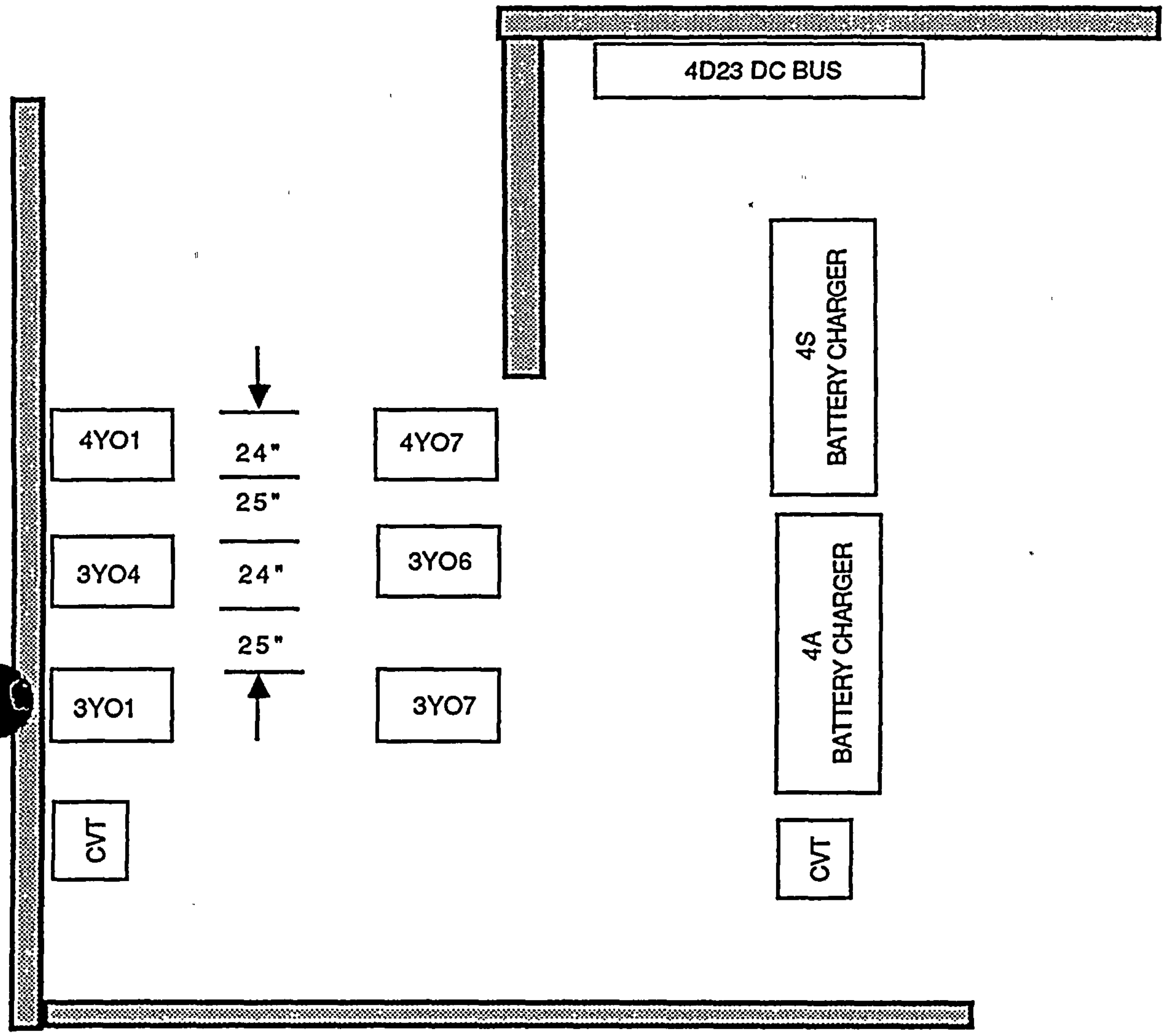


4B BATTERY CHARGER
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B BATTERY CHARGER
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



CONTROL ROOM

THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERNS WITH THIS ROOM OR THE ASSOCIATED EQUIPMENT.

INVERTERS & BATTERY CHARGERS SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: BATTERY CHARGER
DATE: MAR 23, 1990 DWG BY: R. GOULDY

PFM ITEMS 35, 36

STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

SUBJECT Battery Charger JOB No. SHEET 1 OF

REVISIONS: WJJ 4/3/90

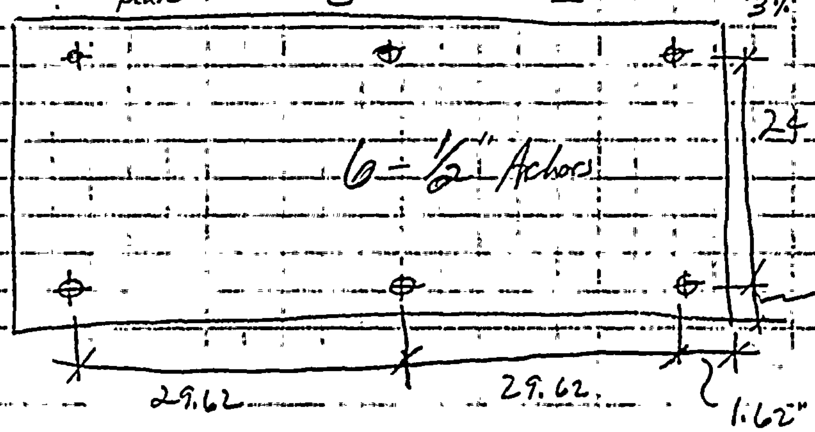
Battery Charger $\rho = 45$ pcf

Pt 3 SSE Control Bldg El 42 = 1% Damping V = 2/3 Horiz.

Control Bldg El 42

$Sa_{peak} = 0.675g$ at 1% damping $\Rightarrow Sa_{peak\,3\%} = \sqrt{\frac{1}{3}} \times 0.675 = 0.39g$

$Sa_{vert\,1\%\,ZPA} = 0.188g \Rightarrow Sa_{vert\,3\%\,ZPA} = 0.11g$



$$W = \frac{31.74''\,(62.48'')\,8.4''}{1728}\,(45) = 4.3^k$$

$$T_{bolt} = \frac{42''\,(4.3^k)\,0.39g - \left[[12+3.87]\,[1g-0.11g]\,4.3\right]}{3\,[24+3.87]}$$

$$T_{bolt} = 0.12^k$$

$$S_{bolt} = \frac{4.3^k\,(0.33g)\sqrt{2}}{6} = 0.34^k << 0.4\,T_{ALLOW}$$

OK

(27)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 36 - Battery Charger 4S

PART A. EQUIPMENT DESCRIPTION

I.D. Number D26 Building Control

Manufacturer EXIDE Elevation 42'

Model Number Other

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No

2. Condition of nearby concrete and embedments CRACKS

3. Length, size, number, and soundness of welds

4. Anchor bolt type, size and number 6-1/2 Φ DIA Rod Anchors

5. Are nuts present and apparently tight on all bolts?

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment
   b. URS Tables
   c. ANCHOR Program
   d. Other (explain) NEED BOLT LENGHT - OVERTURN Calculation → Calculation done for bounding calculation and is O.K.

2. Concerns (if any) CRACKS IN FLOOR - NOT problem because loads very low

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

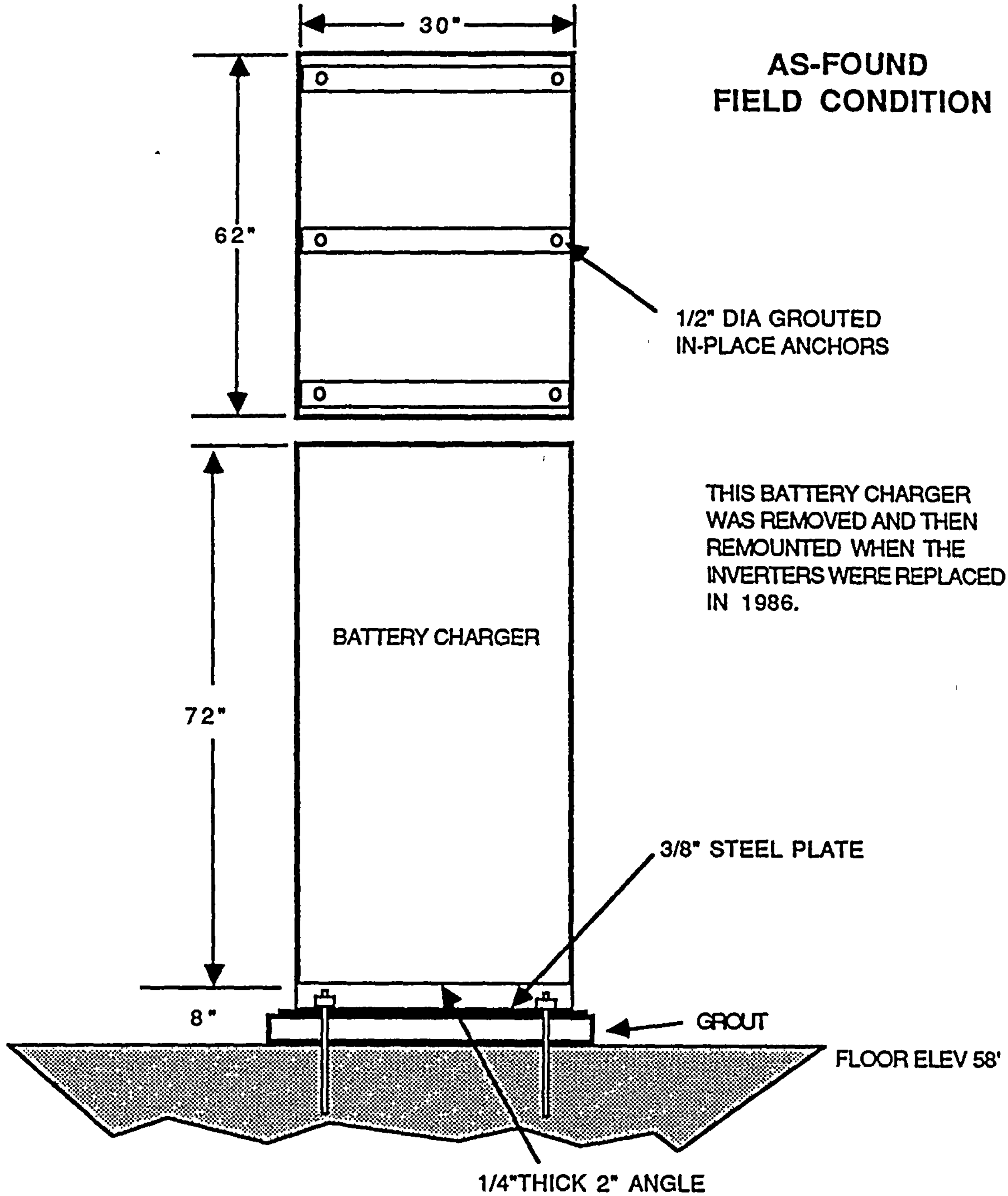
NAME John D. Stevenson DATE 4/4/90

NAME Robert P. Kennedy DATE 4/4/90

NAME John W. Reed DATE 4/5/90

__ITEM 36__ BATTERY Charger 4S

THE SRT WANTED THE BOLT ~~LENGHT~~ LENGTH CHECKED, AN OVERTURN calculation. The bounding calculation eliminated the need for the bolt ~~length~~ LENGTH check. Calculations showed A large margin.



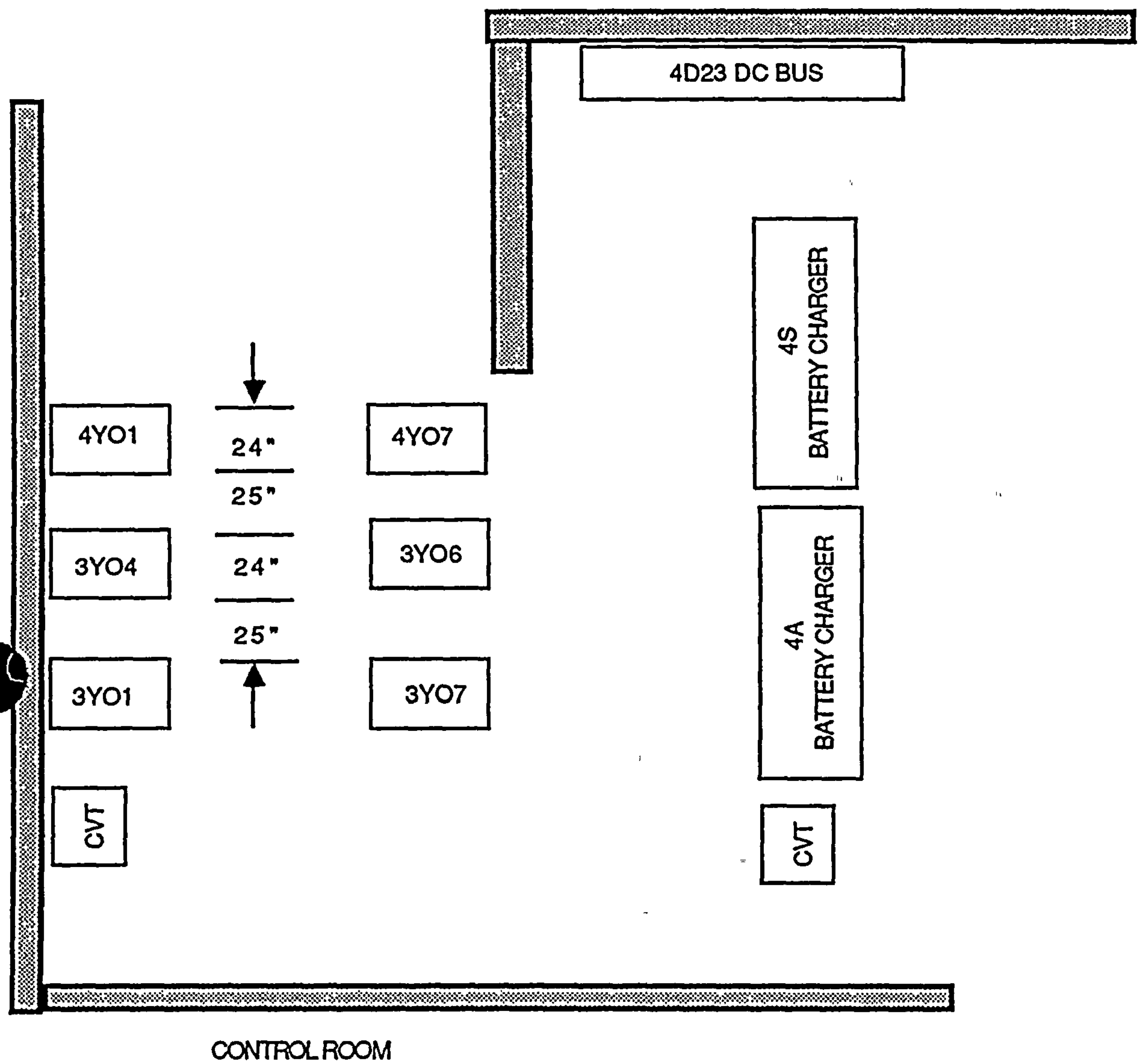
4S BATTERY CHARGER
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4S BATTERY CHARGER
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERNS WITH THIS ROOM OR THE ASSOCIATED EQUIPMENT.

INVERTERS & BATTERY CHARGERS SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: BATTERY CHARGER
DATE: MAR 23, 1990 DWG BY: R. GOULDY

(37)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 37 - Battery Rack 3A

PART A. EQUIPMENT DESCRIPTION

I.D. Number	3D03	Building	Control
Manufacturer		Elevation	30'
Model Number		Other	

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds 5/8" "J" Hilti
4. Anchor bolt type, size and number ____
5. Are nuts present and apparently tight on all bolts? ____

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Vendor calculation reviewed
2. Concerns (if any) ____

PART D. **SPATIAL SEISMIC INTERACTION CONCERNS** (if any) Need E/W & Y tie wire
• EAST SIDE SPACERS NEEDED.
→ SRT DID NOT REVIEW BLOCK wall Calculations.

PART E. **RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS** (if any)

APPROVED BY SRT

NAME	Robert P. Kennedy	DATE	4/5/90
NAME	John W. Reed	DATE	4/5/90
NAME	John D. Stevenson	DATE	4/5/90

ITEM 37 BATTERY RACK - 3D03

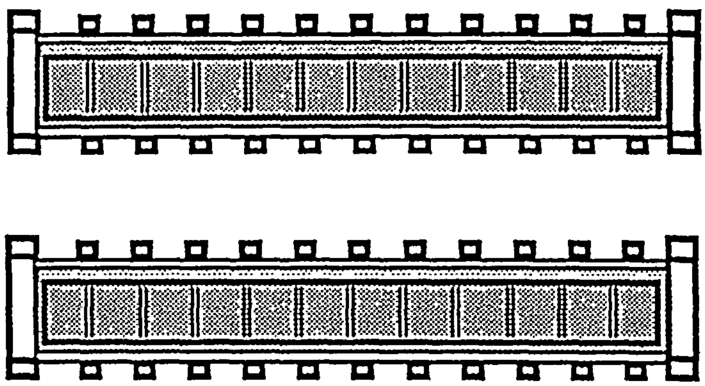
SRT REVIEWED VENDOR SEISMIC calculations for RACK DESIGN.

A SEISMIC INTERACTION CONCERN WAS identified which WOULD REQUIRE the Ceiling Lights to be tie-WIRED. to PREVENT the shade from falling.

The concrete block walls were not ANALYZED by the SRT.

AS-FOUND FIELD CONDITION

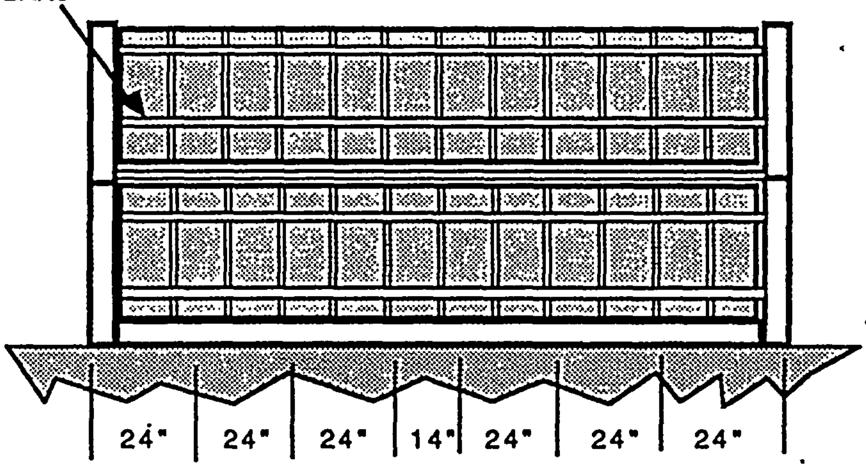
TWO SETS OF BATTERY RACKS MAKE UP THE 3A BATTERY



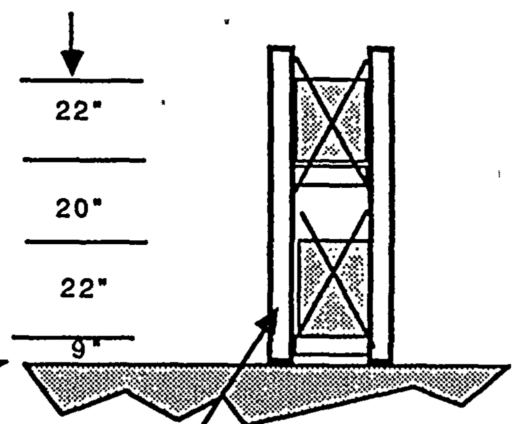
THESE RACKS ARE GOULD SEISMICALLY
QUALIFIED MANUFACTURED RACKS

5/8" DIA "J"
HILTI- BOLTS
AT EACH STEEL
SUPPORT

SUPPORT
BARS



STRUCTURAL STEEL SPACING



3" BOX STEEL

3A BATTERY RACK
SEISMIC MOUNTING WORKSHEET

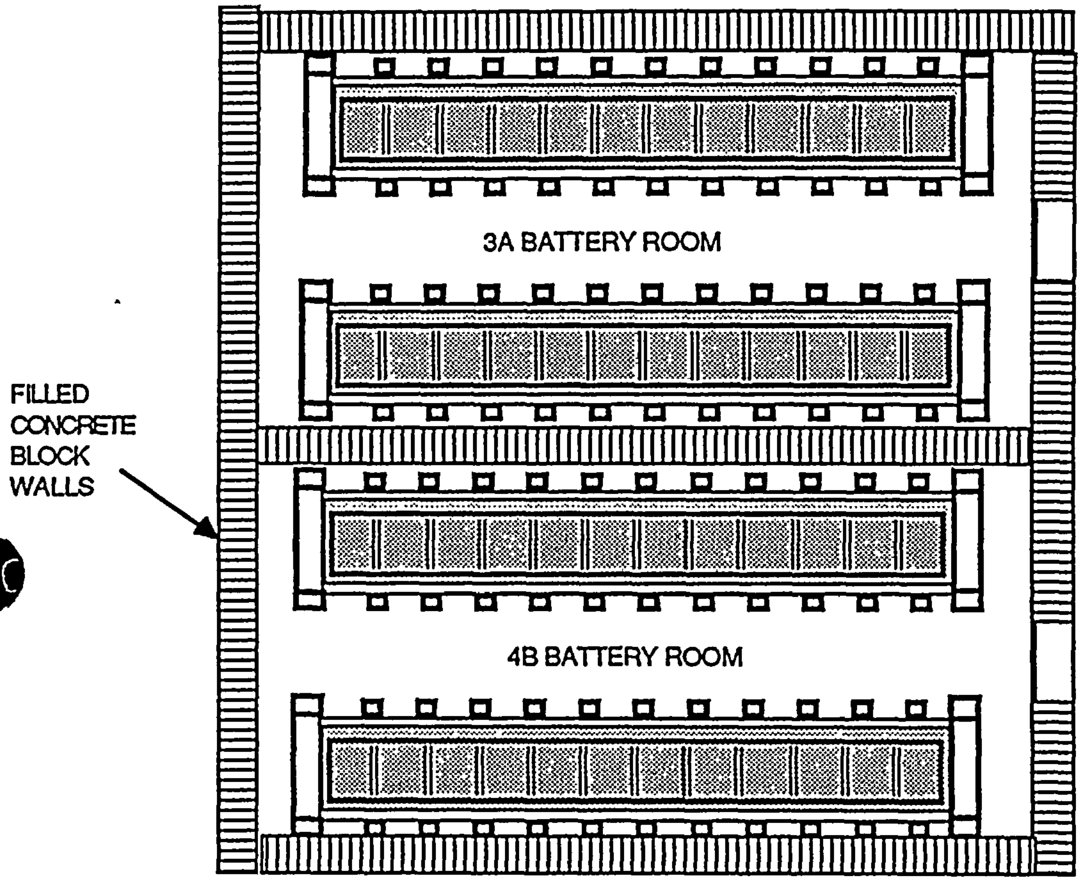
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: 3A BATTERY RACK	
DATE: MAR 23, 1990	DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT NOTED THE LIGHTS IN THESE ROOMS DID NOT NEED TO BE SAFETY WIRED TO THE FIXTURES BECAUSE OF THEIR SHORT LENGTH. THIS MINIMIZED THE PROBLEM OF SWAYING AND POSSIBLY COMING APART AND FALLING ON THE BATTERY BUS BARS. THE BLOCK WALLS IN THESE ROOMS WERE PART OF THE I&E BULLETIN 80-11 IMPROVEMENTS FOR BLOCK WALLS. THERE WERE NO OTHER SEISMIC INTERACTIONS CONCERNS WERE NOTED



30 FOOT ELEVATION
CONTROL BUILDING

3A BATTERY RACKS
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3A BATTERY RACK
DATE: MAR 23, 1990 DWG BY: R. GOULDY

19

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 38 - Battery Rack 3B

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3D24 | Building Control
Manufacturer ______ | Elevation 42'
Model Number ______ | Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number "J" Hilti Bolts
5. Are nuts present and apparently tight on all bolts? yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) ____ Vendor calculation reviewed
2. Concerns (if any) EAST END BATTERY spacers needed

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) TIE WIRE LAMPS BLOCK walls. SRT DID NOT Review BLOCK WALL Calculations

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90
NAME John W. Reed DATE 4/5/90
NAME Walter D. Stevens DATE 4/5/90

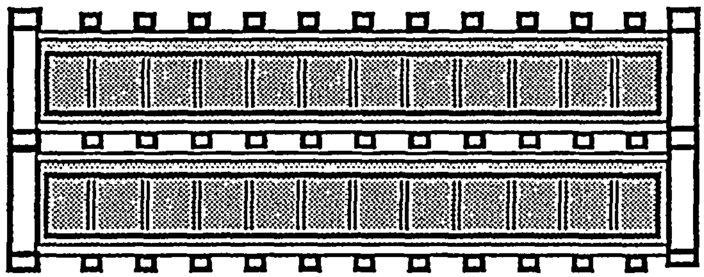
ITEM 38 BATTERY RACK - 3D24

SRT REVIEWED VENDOR SEISMIC Calculations for RACK DESIGN. EAST END SPACERS NEEDED.

A SEISMIC INTERACTION CONCERN WAS identified which WOULD REQUIRE the Ceiling Lights to be tie-WIRED. to PREVENT the shade from falling.

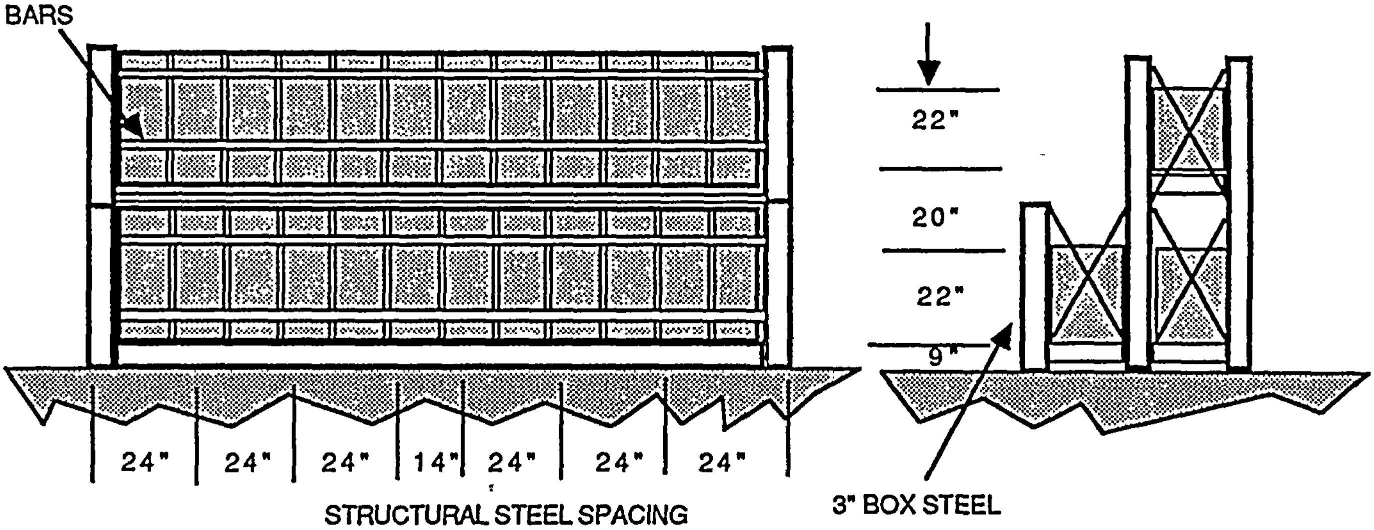
The concrete block walls were not ANALYZED by the SRT.

AS-FOUND FIELD CONDITION



THESE RACKS ARE GOULD SEISMICALLY QUALIFIED MANUFACTURED RACKS.

1/2" HILTI-BOLTS ARE USED ON THE SINGLE HEIGHT BATTERY RACKS AND 5/8" HILTI-BOLTS ARE USED ON THE DOUBLE HIGH BATTERY RACKS AT EACH SUPPORT STEEL COLUMN



3B BATTERY RACK
SEISMIC MOUNTING WORKSHEET

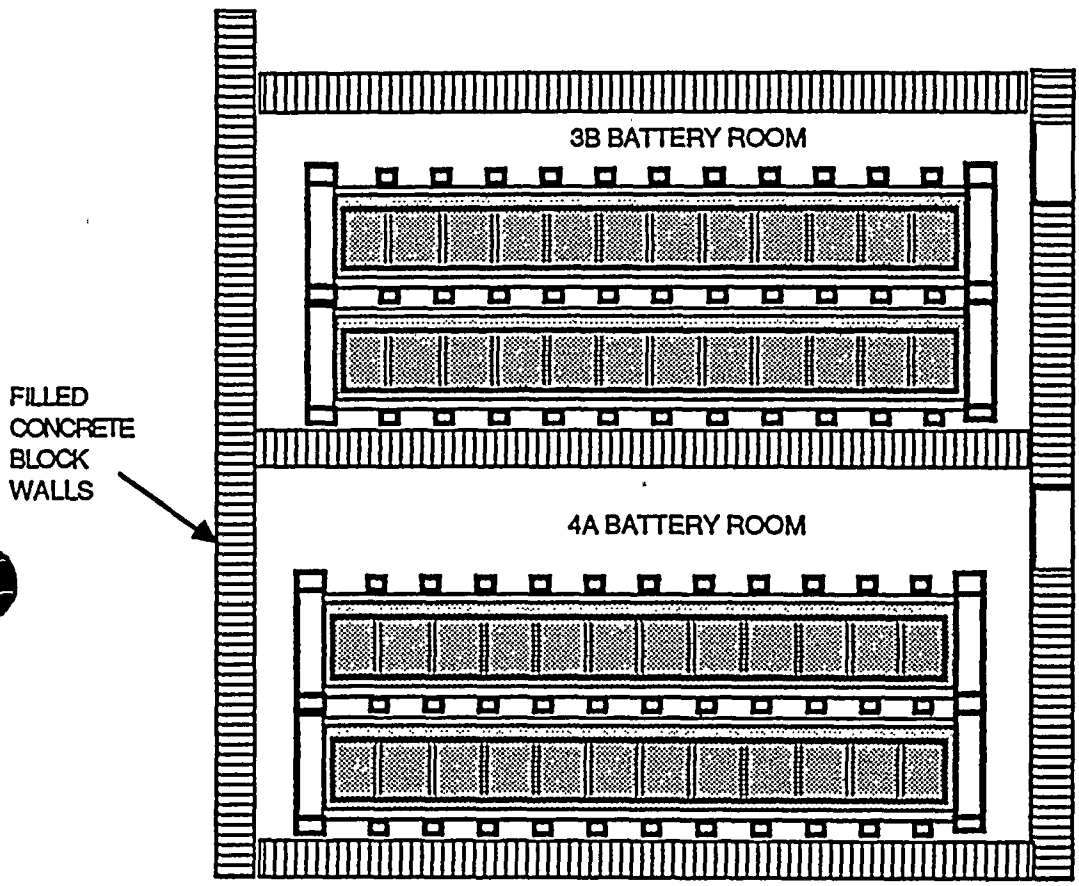
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B BATTERY RACK
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT NOTED THE LIGHTS IN THESE ROOMS NEED TO HAVE THE FIXTURES SAFETY WIRED TO THE CONDUIT TO PREVENT POSSIBLE FALLING ONTO THE BATTERY BUS BARS. THE BLOCK WALLS IN THESE ROOMS WERE PART OF THE GENERIC LETTER IMPROVEMENTS FOR BLOCK WALLS. NO OTHER SEISMIC INTERACTIONS CONCERNS WERE NOTED



42 FOOT ELEVATION
CONTROL BUILDING

3B BATTERY RACKS
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B BATTERY RACK
DATE: MAR 23, 1990 DWG BY: R. GOULDY

30

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 39 - Battery Rack 4B

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4D03 Building Control

Manufacturer ______ Elevation 30'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ___
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number 5/8" Hilti
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ___
   b. URS Tables ___
   c. ANCHOR Program ___
   d. Other (explain) Vendor calculations reviewed
2. Concerns (if any) ______

PART D. **SPATIAL SEISMIC INTERACTION CONCERNS (if any)** Lights may need to be tie wired & Block wall reviewed. Need spacer on EAST SIDE LOWER RACK SRT DID NOT REVIEW Block wall calculations

PART E. **RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)**

______

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90

NAME John W. Reed DATE 4/5/90

NAME John D. Stevenson DATE 4/5/90

ITEM 39 BATTERY RACK - 4003

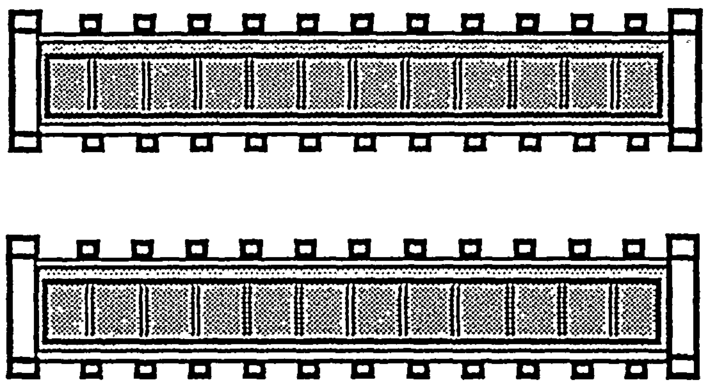
SRT REVIEWED VENDOR SEISMIC Calculations for RACK DESIGN. EAST END SPACERS NEEDED.

A SEISMIC INTERACTION CONCERN WAS identified which WOULD REQUIRE the Ceiling Lights to be tie-WIRED. to PREVENT the shade from falling.

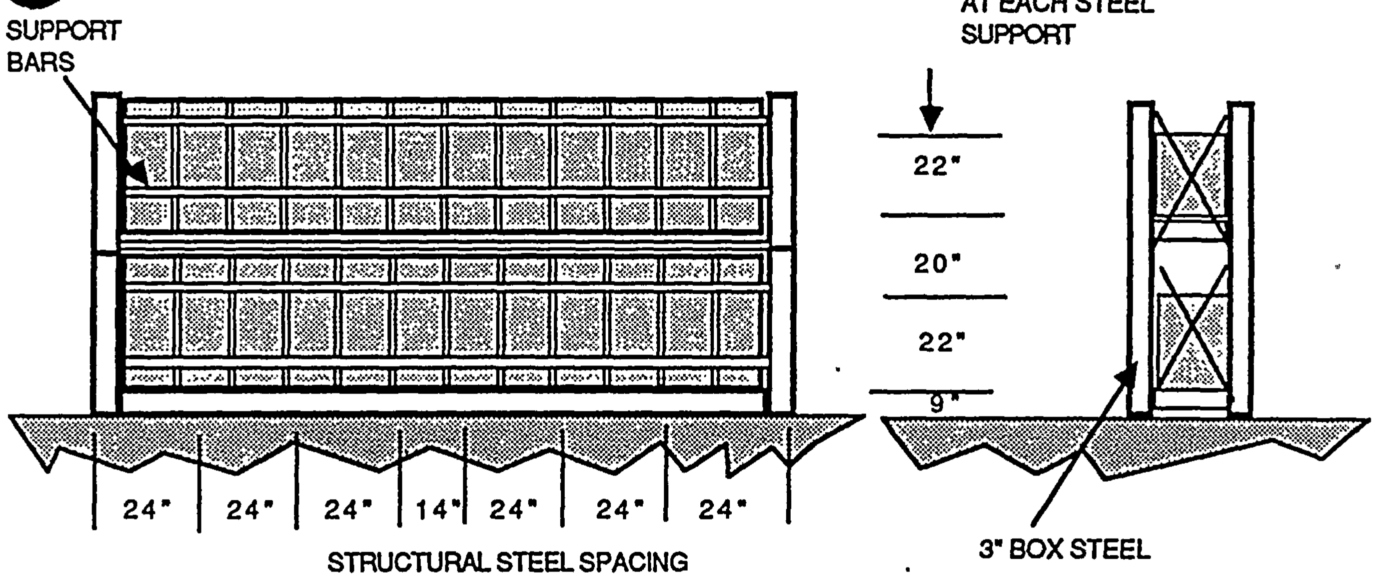
The concrete block walls were NOT ANALYZED by the SRT.

AS-FOUND FIELD CONDITION

TWO SETS OF BATTERY RACKS MAKE UP THE 4B BATTERY



THESE RACKS ARE GOULD SEISMICALLY QUALIFIED MANUFACTURED RACKS



4B BATTERY RACK SEISMIC MOUNTING WORKSHEET

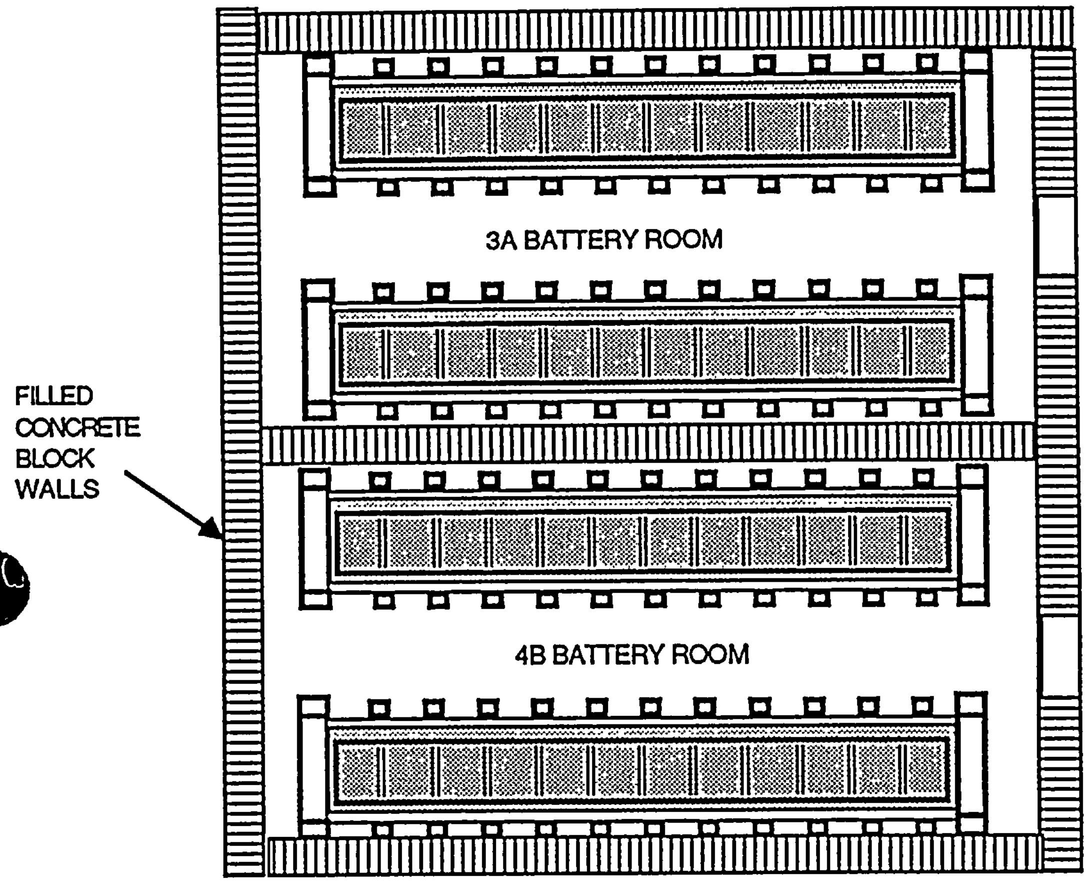
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B BATTERY RACK
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT NOTED THE LIGHTS IN THESE ROOMS DID NOT NEED TO BE SAFETY WIRED TO THE FIXTURES BECAUSE OF THEIR SHORT LENGTH. THIS MINIMIZED THE PROBLEM OF SWAYING AND POSSIBLY COMING APART AND FALLING ON THE BATTERY BUS BARS. THE BLOCK WALLS IN THESE ROOMS WERE PART OF THE I&E BULLETIN 80-11 IMPROVEMENTS FOR BLOCK WALLS. THERE WERE NO OTHER SEISMIC INTERACTIONS CONCERNS WERE NOTED



30 FOOT ELEVATION
CONTROL BUILDING

4B BATTERY RACKS
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B BATTERY RACK
DATE: MAR 23, 1990 DWG BY: R. GOULDY

(20)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 40 - Battery Rack 4A

PART A. EQUIPMENT DESCRIPTION

I.D. Number	4D24	Building	Control
Manufacturer		Elevation	42'
Model Number		Other	

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes x No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds ____
4. Anchor bolt type, size and number "J" Hilti bolts 2 per leg
5. Are nuts present and apparently tight on all bolts? Yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Vendor calculations reviewed
2. Concerns (if any) Acrylic end spacer installed.

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) TIE WIRE LAMPS Seismic strengthened block walls. SRT DID NOT Review Block wall calculations

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME	[signature]	DATE	4/5/91
NAME	[signature]	DATE	4/5/90
NAME	[signature]	DATE	4/5/90

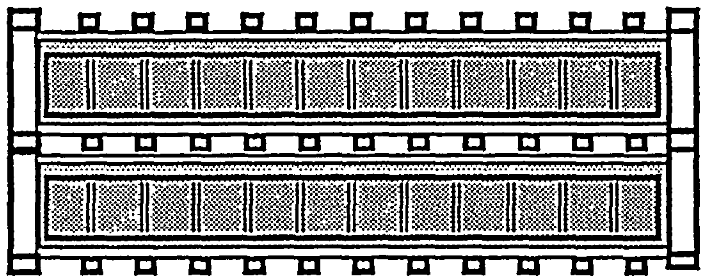
ITEM 40 BATTERY RACK - 4A

SRT REVIEWED VENDOR SEISMIC Calculations for RACK DESIGN. CHECK END SPACERS.

A SEISMIC INTERACTION CONCERN WAS identified which WOULD REQUIRE the Ceiling Lights to be tie-WIRED. to PREVENT the shade from falling.

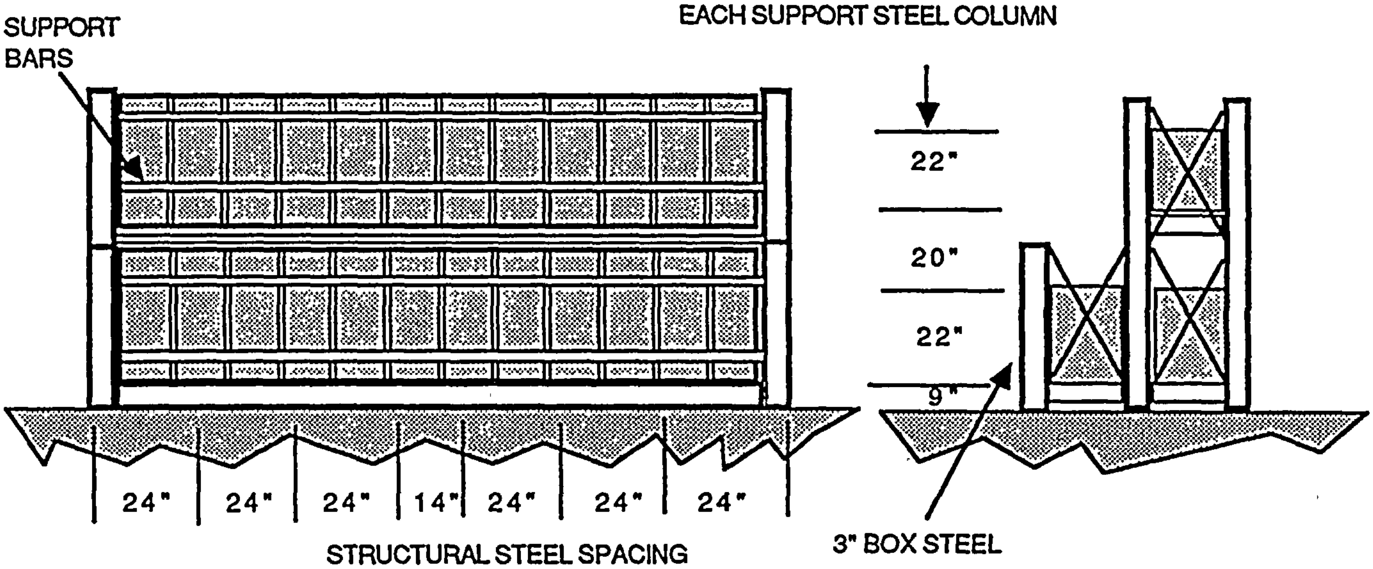
The concrete block walls were not ANALYZED by the SRT.

AS-FOUND FIELD CONDITION



THESE RACKS ARE GOULD SEISMICALLY QUALIFIED MANUFACTURED RACKS.

1/2" HILTI-BOLTS ARE USED ON THE SINGLE HEIGHT BATTERY RACKS AND 5/8" HILTI-BOLTS ARE USED ON THE DOUBLE HIGH BATTERY RACKS AT EACH SUPPORT STEEL COLUMN



STRUCTURAL STEEL SPACING

4A BATTERY RACK
SEISMIC MOUNTING WORKSHEET

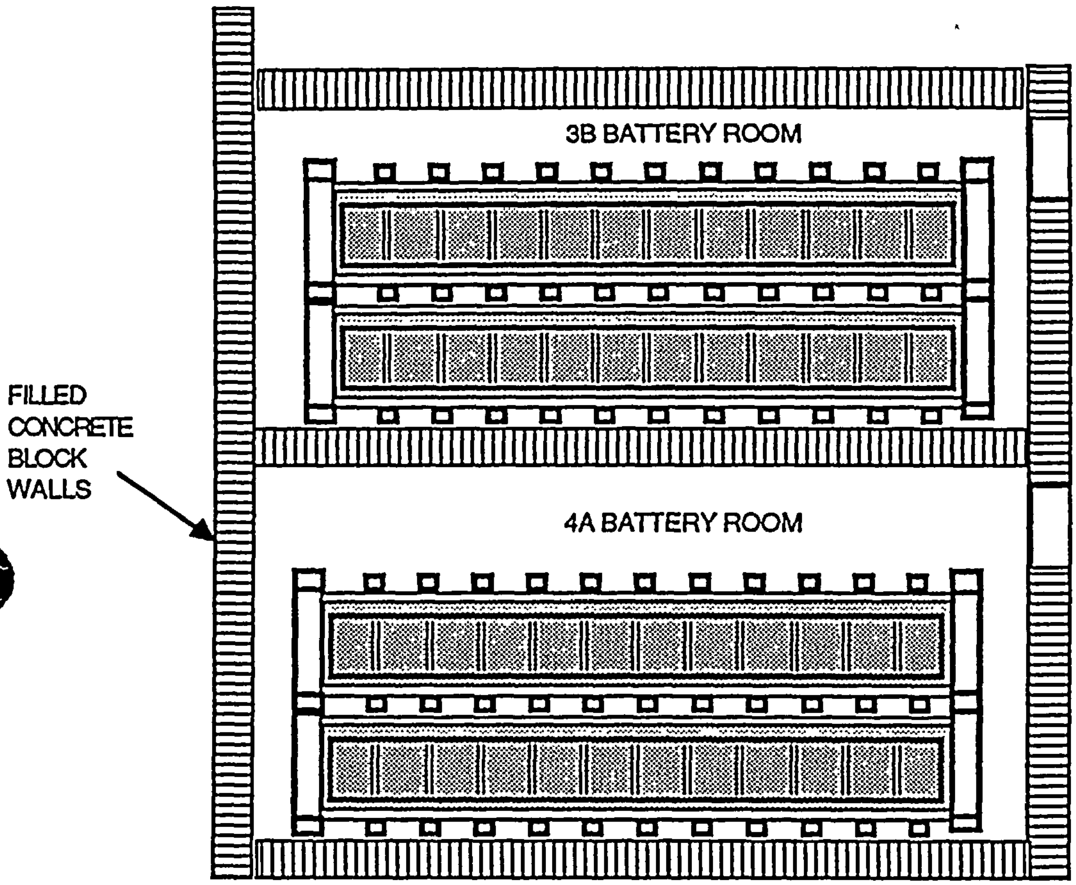
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4A BATTERY RACK
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT NOTED THE LIGHTS IN THESE ROOMS NEED TO HAVE THE FIXTURES SAFETY WIRED TO THE CONDUIT TO PREVENT POSSIBLE FALLING ONTO THE BATTERY BUS BARS. THE BLOCK WALLS IN THESE ROOMS WERE PART OF THE GENERIC LETTER IMPROVEMENTS FOR BLOCK WALLS. NO OTHER SEISMIC INTERACTIONS CONCERNS WERE NOTED



42 FOOT ELEVATION
CONTROL BUILDING

4A BATTERY RACKS
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4A BATTERY RACK
DATE: MAR 23, 1990 DWG BY: R. GOULDY

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90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 41 - Distribution Panels/Bus

PART A. EQUIPMENT DESCRIPTION

I.D. Number	3D01	Building	Control
Manufacturer		Elevation	30'
Model Number		Other	

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments ____
3. Length, size, number, and soundness of welds ____
4. Anchor bolt type, size and number 3/8" DIA 12 per length
5. Are nuts present and apparently tight on all bolts? Yes (1 loose)

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ✓
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) perform calculation
   → Calculation performed and accepted
2. Concerns (if any) 1 loose bolt.

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

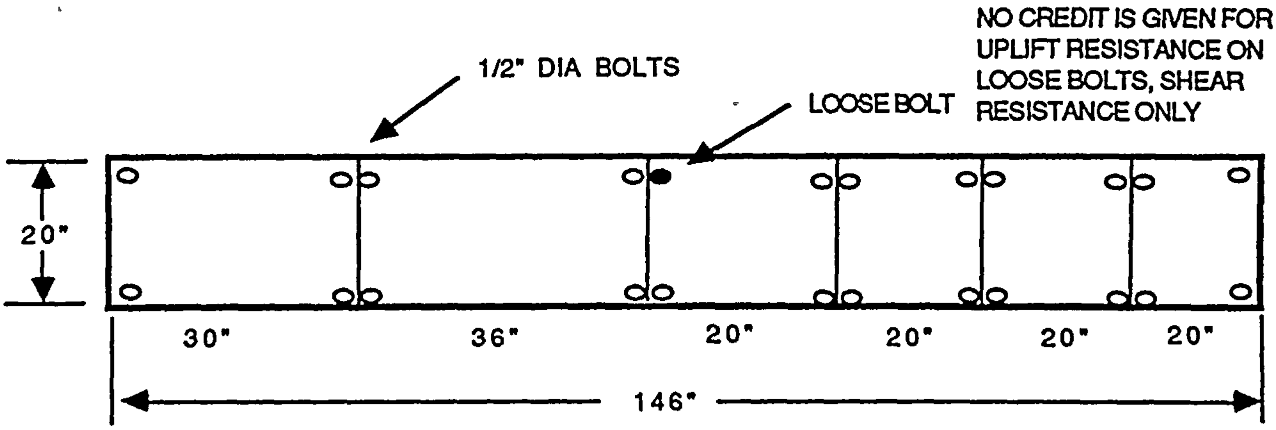
APPROVED BY SRT

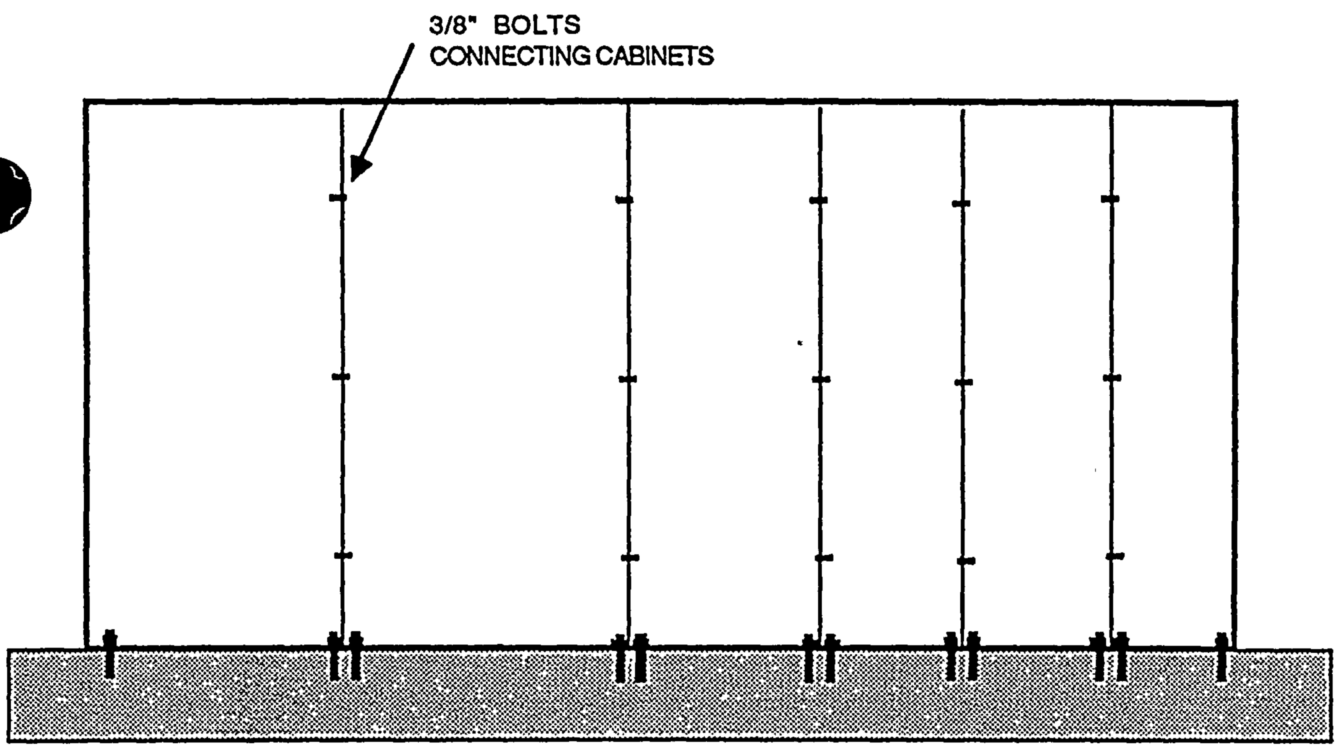
NAME	Robert P. Kennedy	DATE	4/5/90
NAME	[signature]	DATE	4/5/90
NAME	John D. Stevenson	DATE	4/5/90

ITEM 41 DISTRIBUTION PANEL / BUS - 3D01

THE SRT REQUESTED AN ~~UPLIFT~~ OVERTURN CALCULATION.
THE SRT REVIEWED THIS CALCULATION AND
ACCEPTED THE ANCHORAGE DESIGN.

AS-FOUND FIELD CONDITION





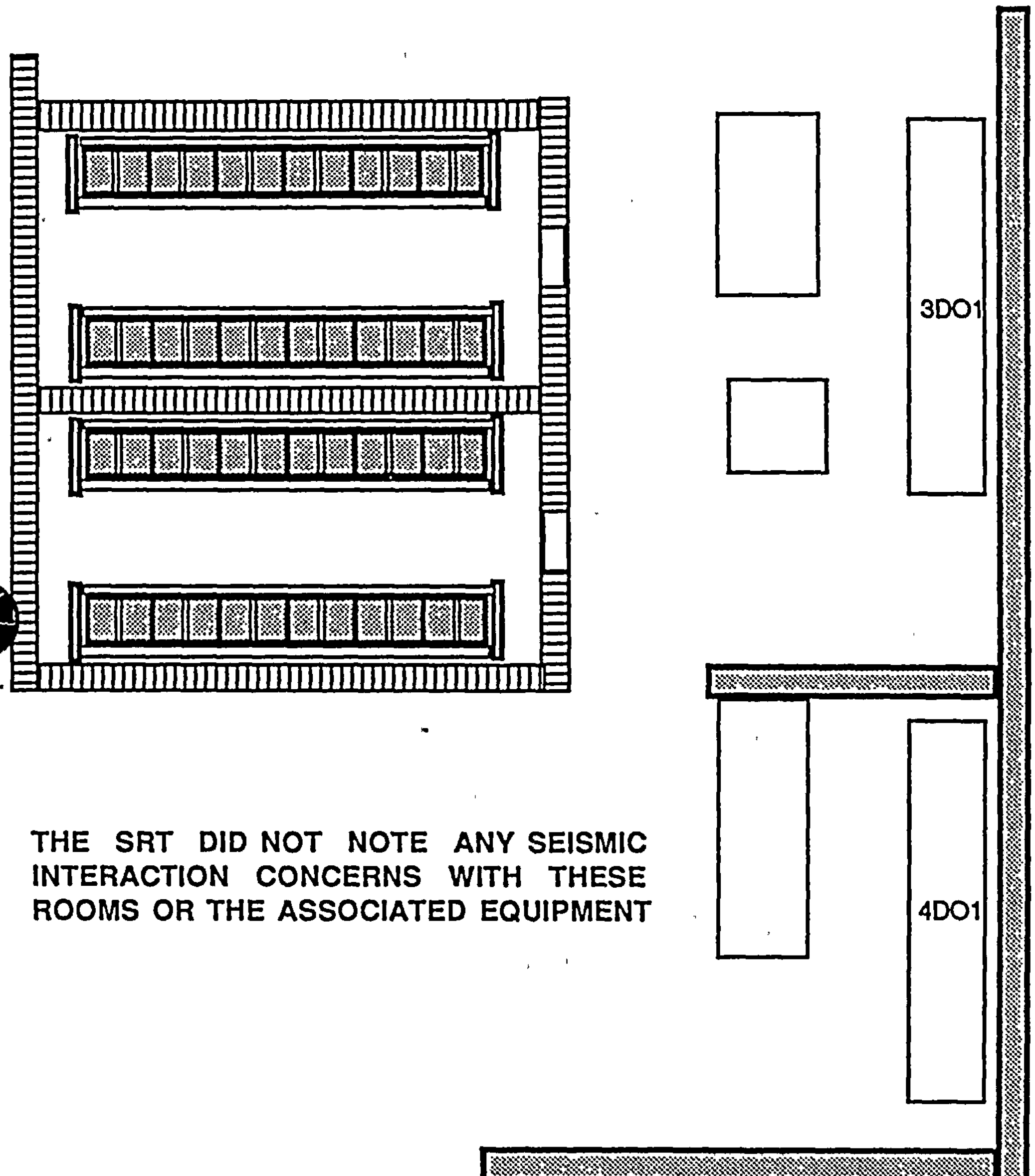
3D01 125v DC BUS
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3D01 125v DC BUS
DATE: MAR 28,1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT NOTE ANY SEISMIC INTERACTION CONCERNS WITH THESE ROOMS OR THE ASSOCIATED EQUIPMENT

30 FOOT ELEVATION

3DO1 125v DC BUS
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3D01 DC BUS
DATE: MAR 23, 1990 DWG BY: R. GOULDY

26

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 42 - Distribution Panels/Bus

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3D23 Building Control

Manufacturer ________ Elevation ~~30'~~ 40'

Model Number ________ Other ________

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds ________
4. Anchor bolt type, size and number 6 1/2" ϕ Bolts - capacity controlled by mounting plate & sheet metal connecting screws.
5. Are nuts present and apparently tight on all bolts? yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ✓
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) perform calculations
   → Calculations reviewed
2. Concerns (if any) ________

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) ________

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

____

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90

NAME [signature] DATE 4/5/90

NAME [signature] DATE 4/5/90

ITEM 42 DISTRIBUTION PANEL / BUS - 3D23

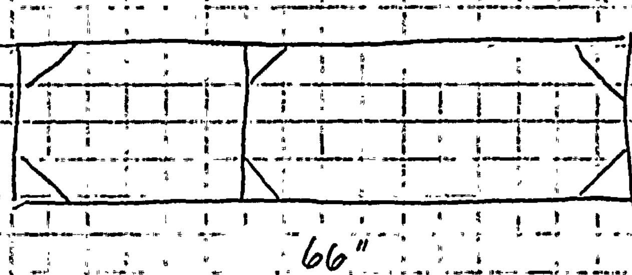
THE SRT REQUESTED AN OVERTURN CALCULATION. THE SRT REVIEWED THE CALCULATION AND ACCEPTED THE ANCHORAGE DESIGN.

STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

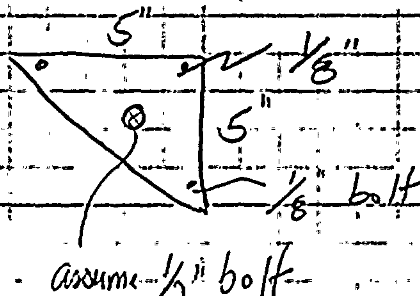
SUBJECT Dist. Panel JOB No. 90C1585 SHEET 1 OF 2

REVISIONS: WD 4/5/90

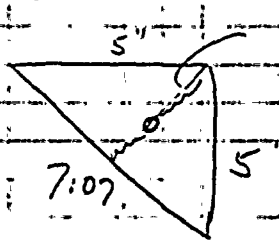
Ux. W = 1500 #



90" H



Calculate Plate (Corner) Capacity



$$M_{plastic} = \frac{0.9 (36) b (1/8)^2}{4}, \quad b = 1"$$

$$= 0.1266 \ \frac{k\text{-in}}{in}$$

$$M \left(\frac{7.07"}{2} - \frac{5"}{8} \right) 2\theta = P\Delta = P \frac{3.53"\,\theta}{2}$$

$$P = 420 \#$$

STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

SUBJECT: Dist Panel JOB No. SHEET 2 OF 2

REVISIONS: WD 4/5/90

Axial Capacity of Sheet Metal Bolts

Assume Type AB Sheet Metal Screws per ANSI 18.8.4

Per AISI $T_{ALL} = 18$ ksi, $S_{ALL} = 9$ ksi

$T_u = 1.7(18)\,0.7854\left(0.123 - \frac{0.9743}{20}\right)^2 = 133\#/\text{bolt}$

3 bolts have equivalent capacity of plate

Say Plate governs

Check Demand Forces on Bolts

Located El 42 Control Bldg

$Sa_{1\%} = 0.675g \Rightarrow Sa_{3\%} = 0.39g$

Peak Value

No Uplift against Long Axis

Short Axis: OTM = $0.39g \times 45'' \times 1500\# = 26.33$

RM = $(\sim 0.95)\,10 \times 1500 = 14.25$

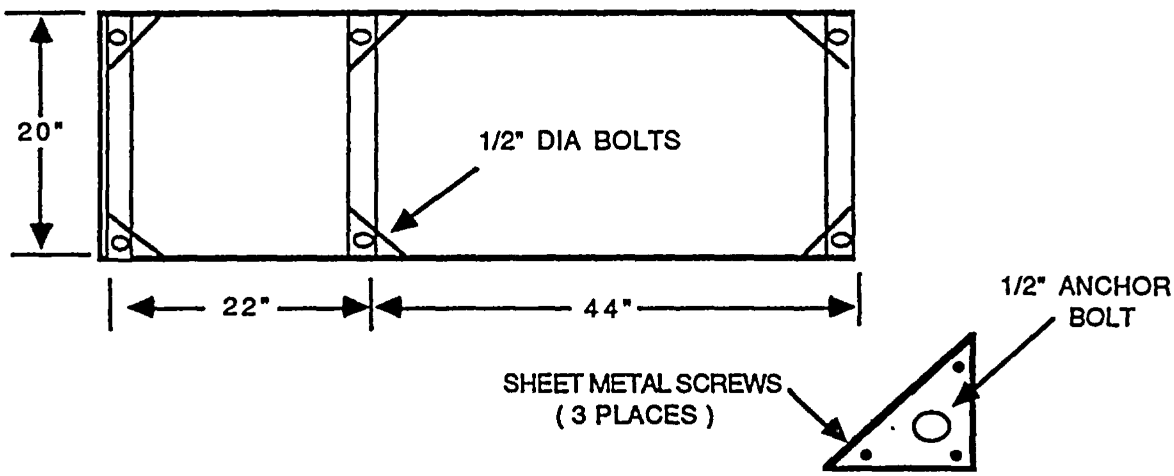
$T_{bolt} = \frac{26.33 - 14.25}{20(3)} = 201\# < 420\#$ Ok

$S_{bolt} = \frac{1500(0.39)}{6} = 98\# <$ Shear Friction $= 0.4(420)$ 168#

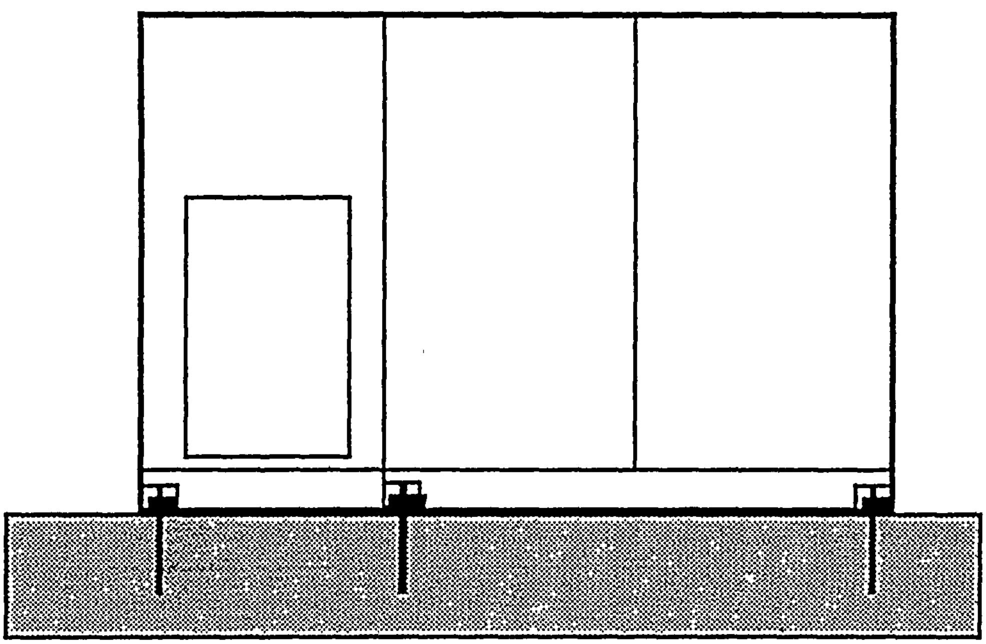
Ok

AS-FOUND FIELD CONDITION

THE SRT NOTED THAT SHEET METAL BRACKETS WILL BE THE CONTROLLING FACTOR FOR ANCHORAGE OF THIS BUS



ANGLE BRACKET DETAIL



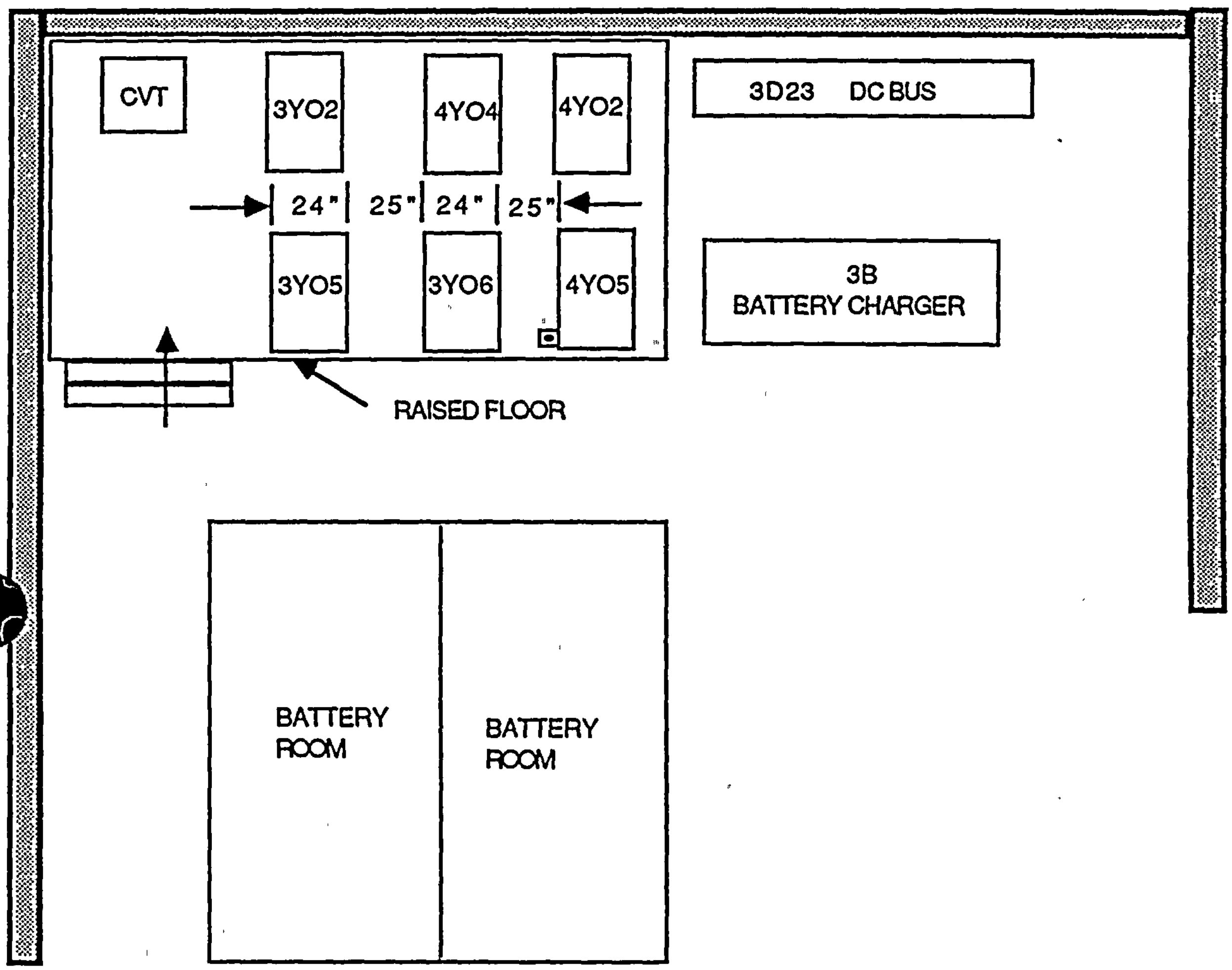
3D23 125v DC BUS
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3D23 125v DC BUS
DATE: MAR 28,1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT NOTE ANY SEISMIC INTERACTION CONCERNS WITH THIS ROOM OR THE ASSOCIATED EQUIPMENT.

3D23 125v DC BUS
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3D23 125v DC BUS
DATE: MAR 23, 1990 DWG BY: R. GOULDY

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90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 43 - Distribution Panels/Bus

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4D01 Building Control

Manufacturer ______ Elevation 30'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes ✓ No ____
2. Condition of nearby concrete and embedments ______
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number 3/8" ϕ Bolts 12 per length
5. Are nuts present and apparently tight on all bolts? Yes (3 loose)

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ✓
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) ____ perform Calculations
   → Calculations performed and accepted.
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

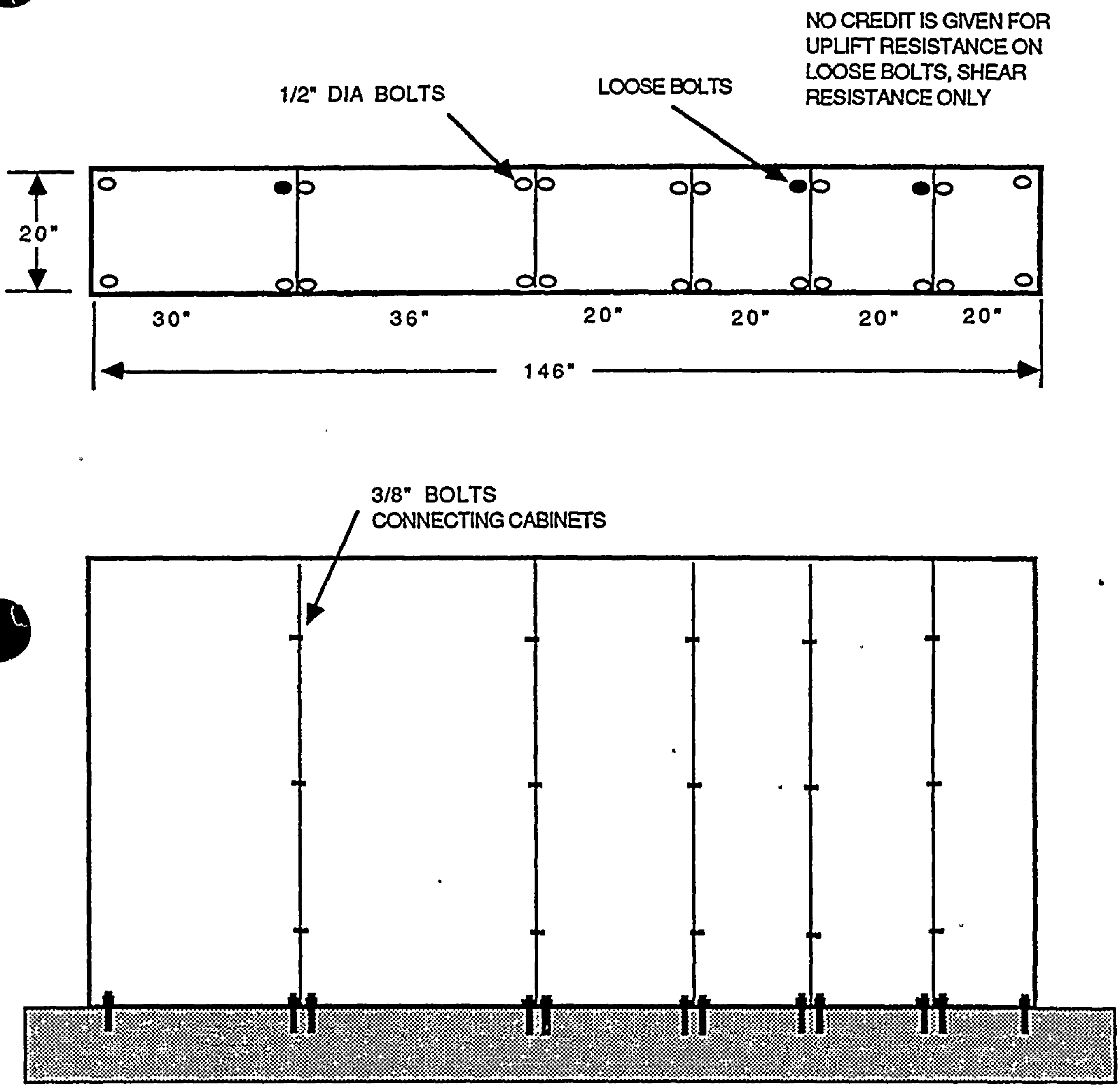
APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90
NAME [illegible signature] DATE 4/5/90
NAME John D. Stevenson DATE 4/5/90

ITEM 43 DISTRIBUTION PANEL / BUS - 4D01

The SRT REVIEWED THE PREVIOUS PANEL Calculations AND ACCEPTED THE ANCHORAGE DESIGN.

AS-FOUND FIELD CONDITION

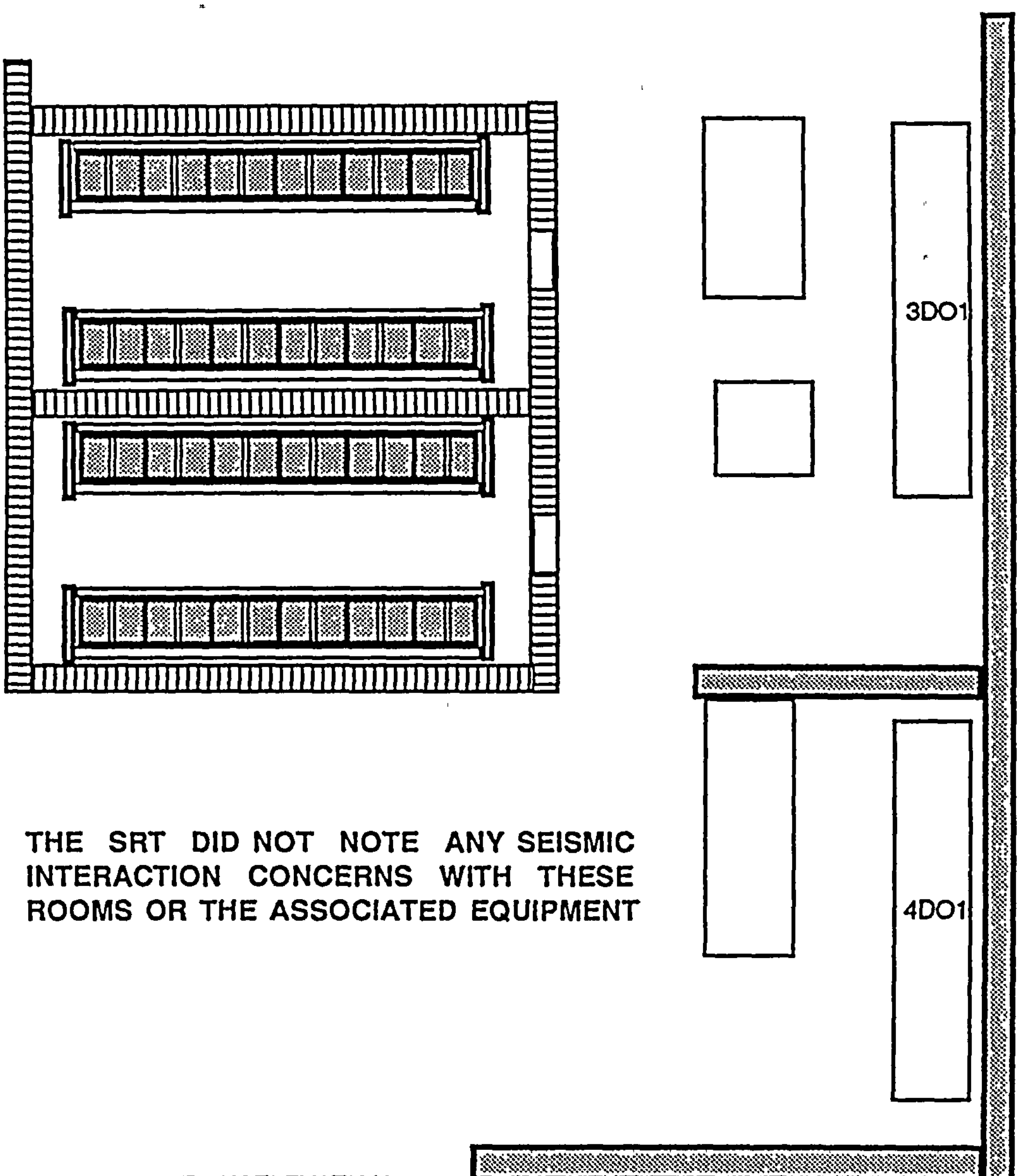


4D01 125v DC BUS
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT. ANCHORAGE SKETCH
COMPONENT: 4D01 125v DC BUS
DATE: MAR 28,1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT NOTE ANY SEISMIC INTERACTION CONCERNS WITH THESE ROOMS OR THE ASSOCIATED EQUIPMENT

30 FOOT ELEVATION

4DO1 125v DC BUS
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4D01 DC BUS
DATE: MAR 23, 1990 DWG BY: R. GOULDY

S&A
STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

SUBJECT: 4D01 Panel — JOB No. 90C1585 — SHEET 1 OF 1

REVISIONS: WD 4/5/90

FL 30 Control Bldg

$$W = 35\,pcf \times \frac{146 \times 20 \times 90}{1728} = 5300\#$$

$$Sa_{pk} = 0.25g \rightarrow Sa_{pk} = 0.43g$$

(1% Damping) (3% Damping)

Ref: Pt 2 SSE Horiz RS Control Bldg

$$OTM = \sqrt{0.43^2 + [0.4 \times 0.43]^2} \times 45 \times 5300 = 110\ in\text{-}k \quad (= 0.46g)$$

$$RM = 5300(10)(\sim 1g) = 53\ in\text{-}k$$

$$T_{bolt} = \frac{110 - 53}{20(9)} = 0.31^k = 300 \sim \#\ \text{Allowable}\ \underline{OK}$$

$$S_{bolt} = \frac{5300 \times 0.46g}{[12 + 9]} = 0.25^k < 700\#\ OK$$

Tension level deemed OK as we used pk of RS and relatively high weight density

25

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 44 - Distribution Panels/Bus

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4D23 Building Control

Manufacturer ______ Elevation 30'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number ~~3/8~~ 6 ea 1/2"φ anchors — Capacity controlled by mounting plate and sheet metal ~~connect~~ connects screws
5. Are nuts present and apparently tight on all bolts? yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ✓
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) perform calculation for anchorage. → Calculations reviewed
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME Robert P. Kennedy DATE 4/5/90

NAME John W. Reed DATE 4/5/90

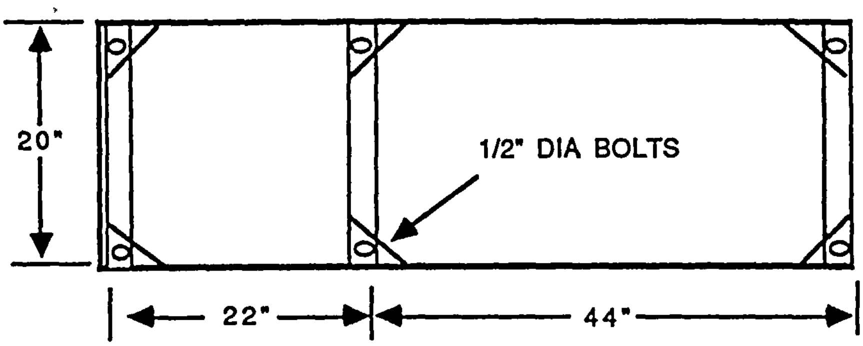
NAME Walter D. Stevenson DATE 4/5/90

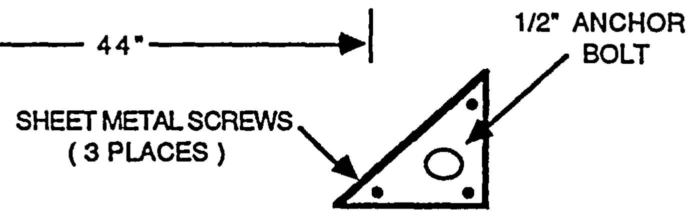
ITEM 44 DISTRIBUTION PANEL / BUS - 4D23

THE SRT REVIEWED OTHER PANEL calculations AND ACCEPTED the ANCHORAGE DESIGN.

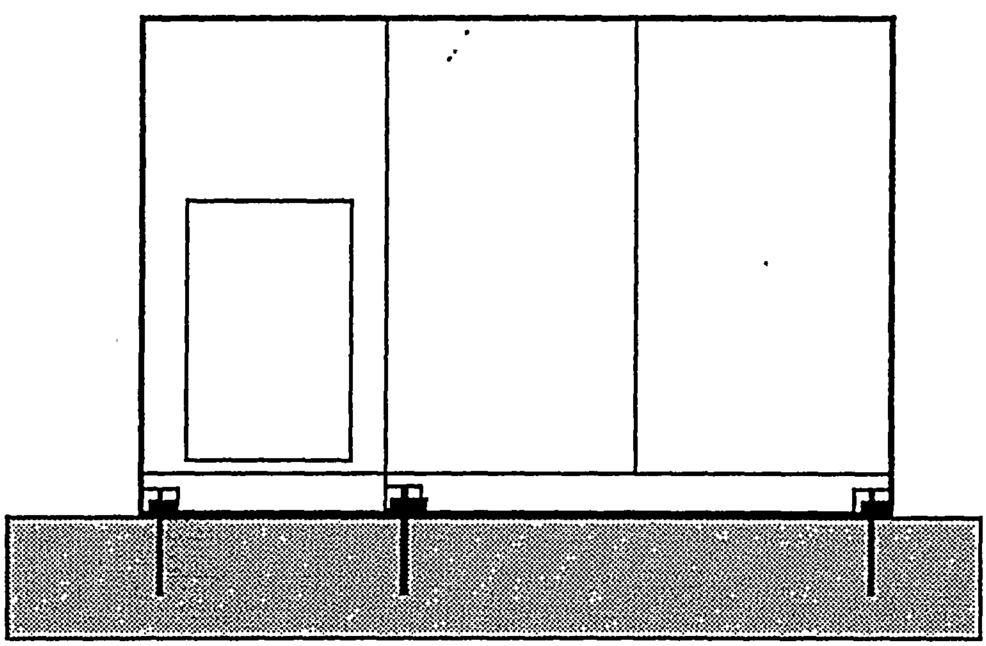
AS-FOUND FIELD CONDITION

THE SRT NOTED THAT SHEET METAL BRACKETS WILL BE THE CONTROLLING FACTOR FOR ANCHORAGE OF THIS BUS





ANGLE BRACKET DETAIL



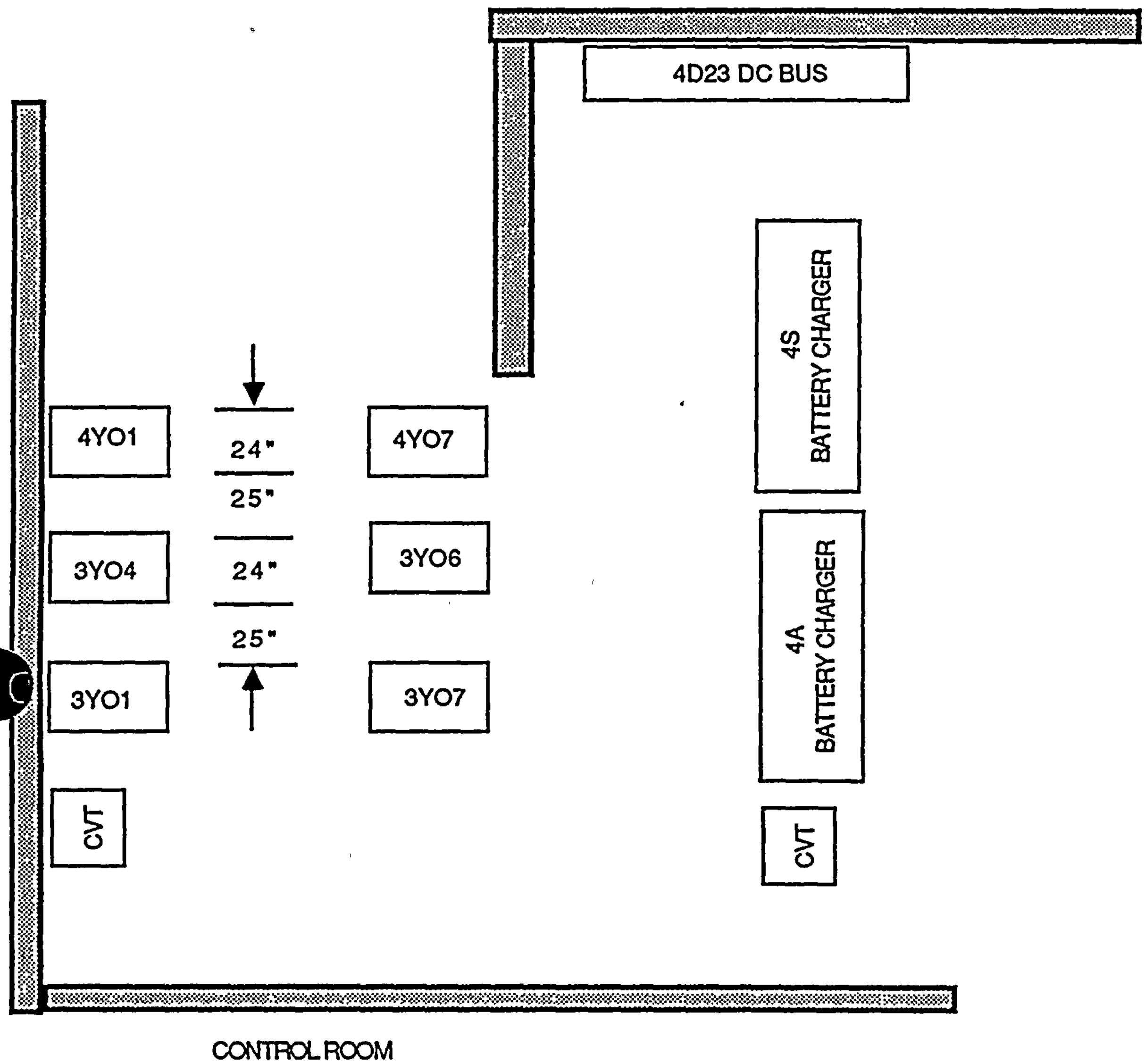
4D23 125v DC BUS
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4D23 125v DC BUS
DATE: MAR 28,1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERNS WITH THIS ROOM OR THE ASSOCIATED EQUIPMENT.

4D23 125v DC BUS
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4D23 125v DC BUS
DATE: MAR 23, 1990 DWG BY: R. GOULDY

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90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 45 - Inverter 3C

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3Y05 Building Control

Manufacturer ______ Elevation 42'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments Good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 5/8" "O" or "P" Hilti Bolts 4 per unit
5. Are nuts present and apparently tight on all bolts? Yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Very Impressed with new mounting
2. Concerns (if any) ______

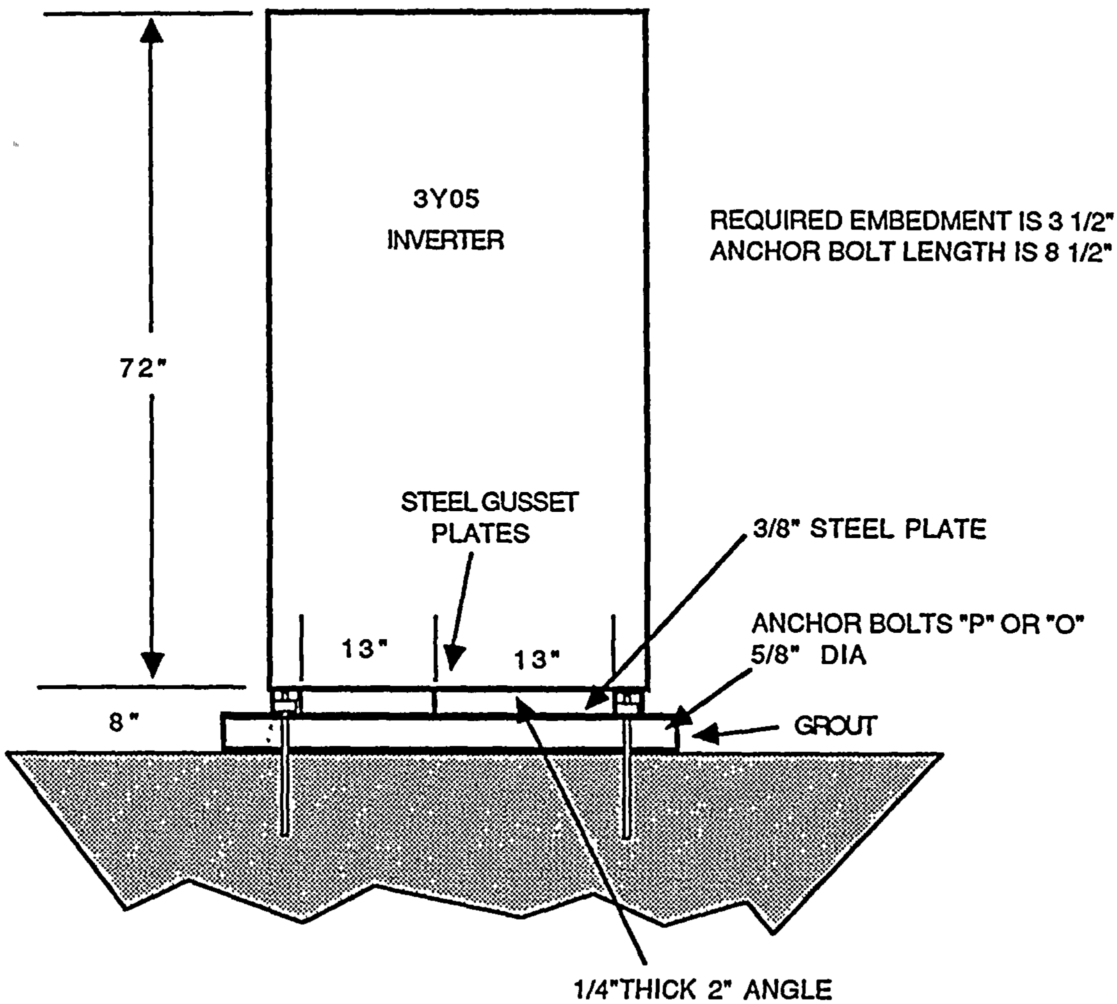
PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME John D. Stevenson DATE 4/4/90
NAME Robert P. Kennedy DATE 4/4/90
NAME John W. Reed DATE 4/5/90

AS-FOUND FIELD CONDITION

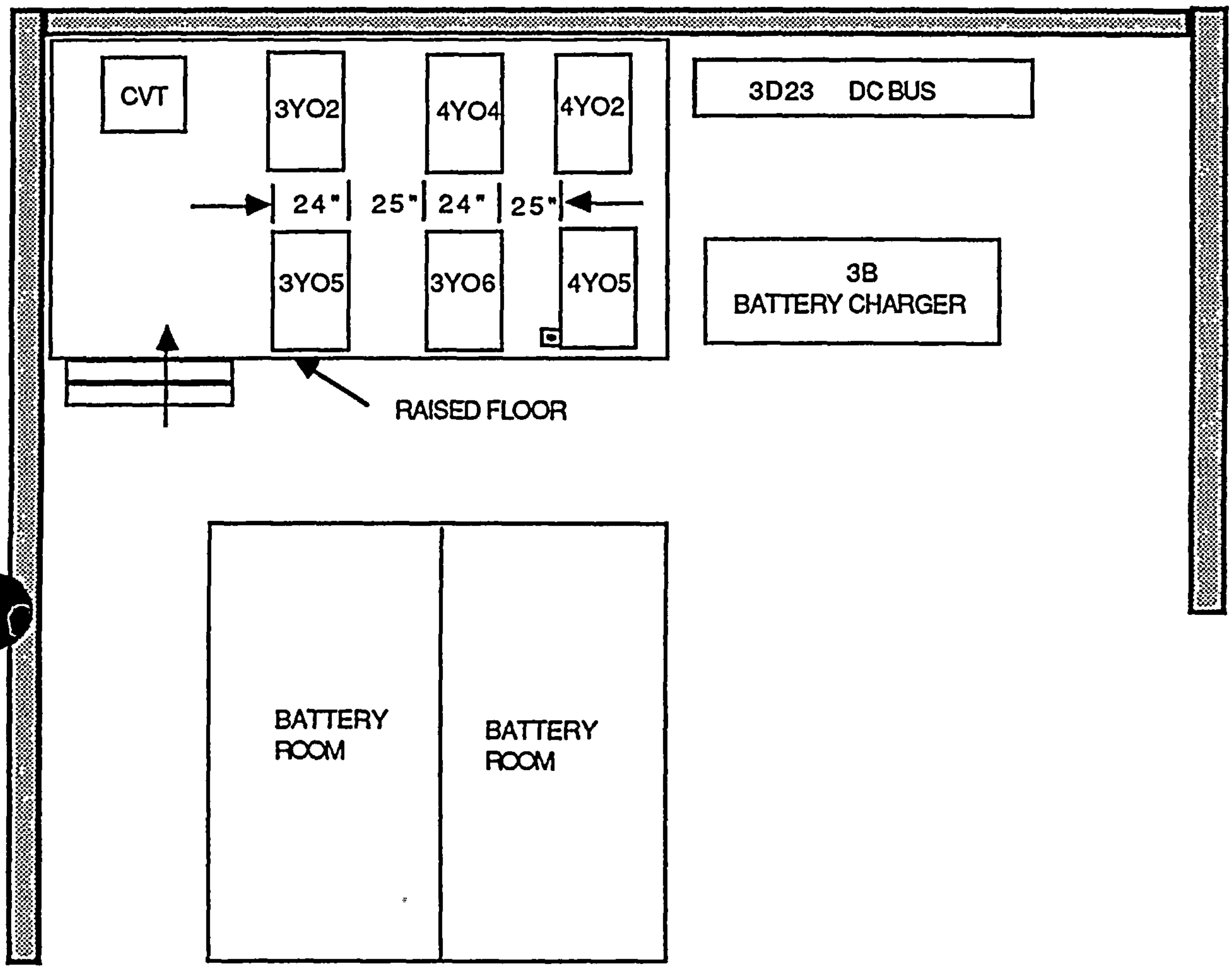


3Y05 INVERTER
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3Y05 INVERTER
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT NOTE ANY SEISMIC INTERACTION CONCERNS WITH THIS ROOM OR THE ASSOCIATED EQUIPMENT.

INVERTERS
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: INVERTERS
DATE: MAR 23, 1990 DWG BY: R. GOULDY

(22)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 46 - Inverter 3D

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3Y07 Building Control

Manufacturer ______ Elevation 42'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ______
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number "O" Hilti Bolts 8½ long
5. Are nuts present and apparently tight on all bolts? yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ______
   c. ANCHOR Program ______
   d. Other (explain) Impressed with mounting techniques
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE.

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

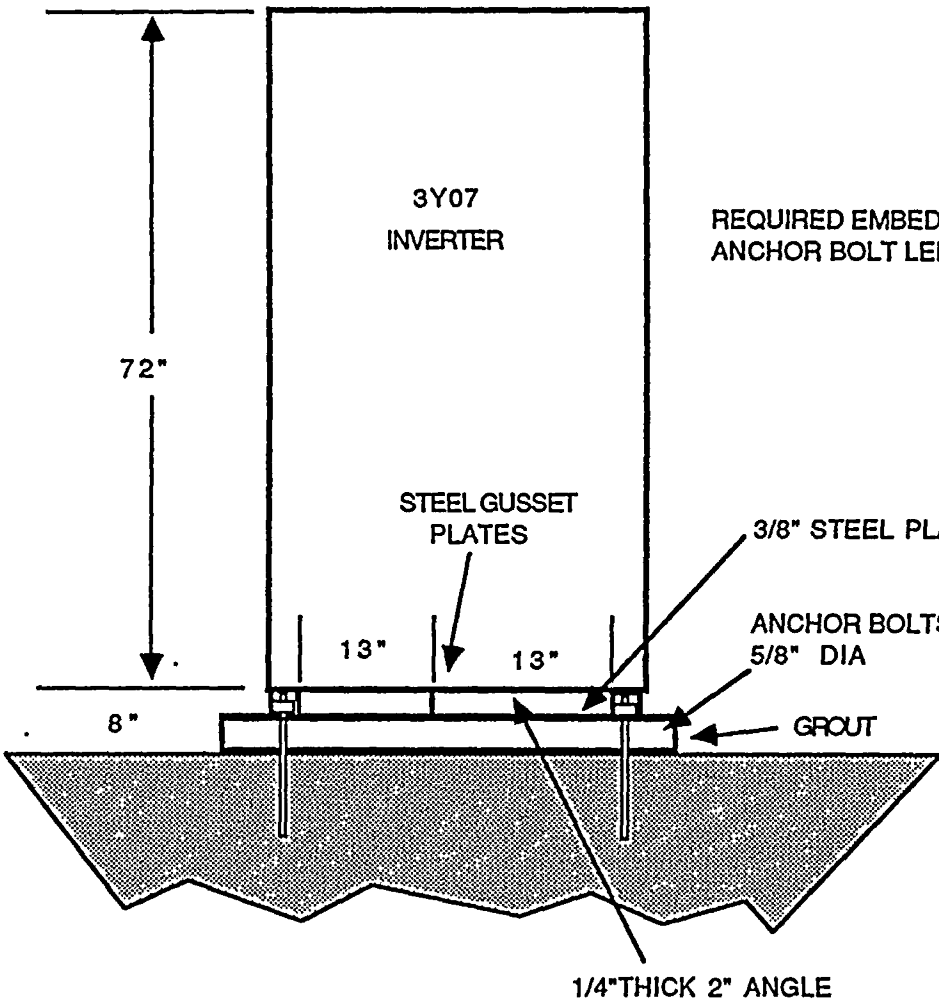
APPROVED BY SRT

NAME John D. Stevenson DATE 4/4/90

NAME Robert P. Kennedy DATE 4/4/90

NAME John W Reed DATE 4/5/90

AS-FOUND FIELD CONDITION



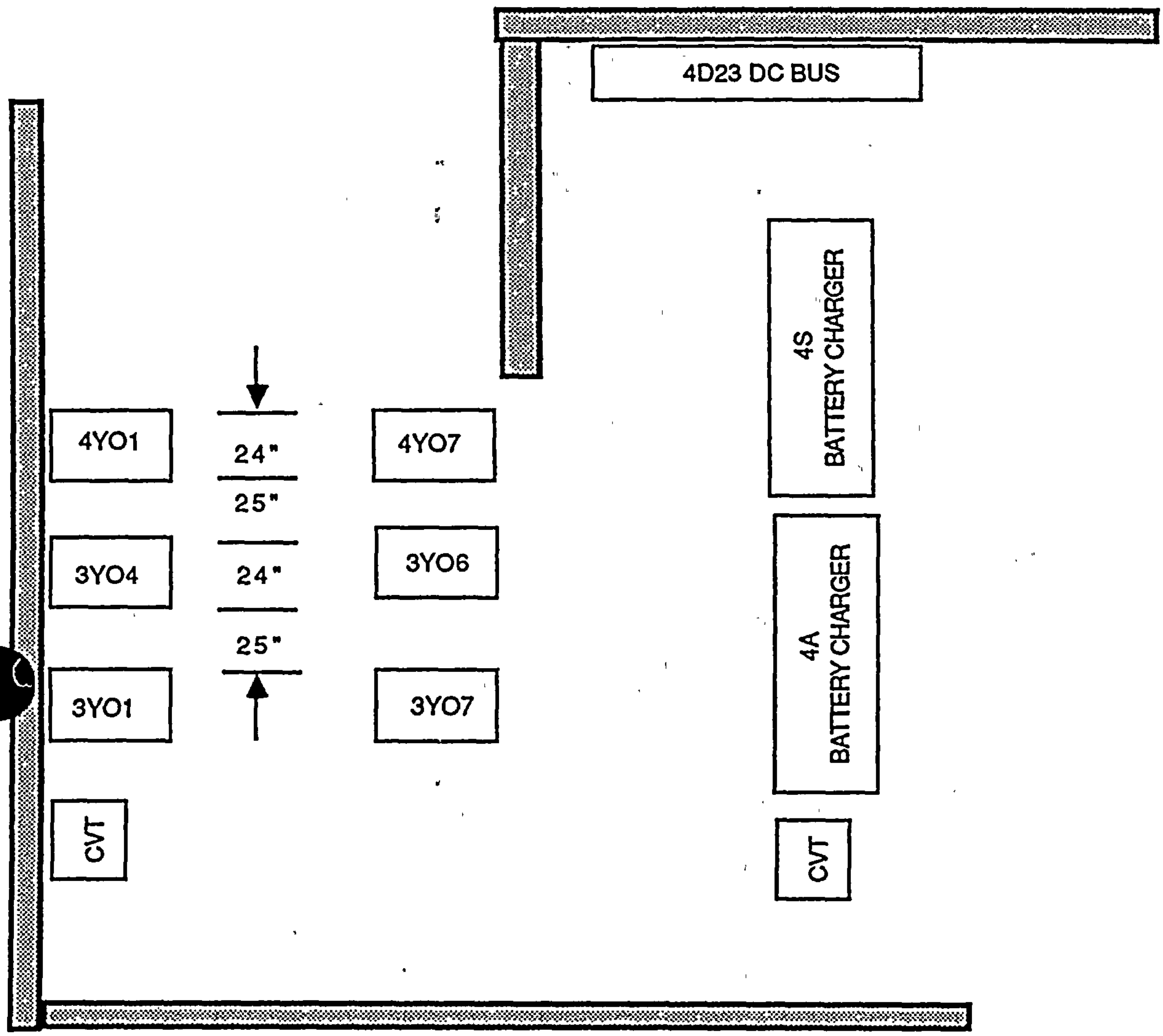
REQUIRED EMBEDMENT IS 3 1/2"
ANCHOR BOLT LENGTH IS 8 1/2"

3Y07 INVERTER
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3Y07 INVERTER
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



CONTROL ROOM

THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERNS WITH THIS ROOM OR THE ASSOCIATED EQUIPMENT.

INVERTERS & BATTERY CHARGERS SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: INVERTERS	
DATE: MAR 23, 1990	DWG BY: R. GOULDY

23

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 47 - Inverter 4C

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4Y05 Building Control

Manufacturer ______ Elevation 42'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number "O" Hilti Bolts
5. Are nuts present and apparently tight on all bolts? yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) impressed with mounting techniques
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

______

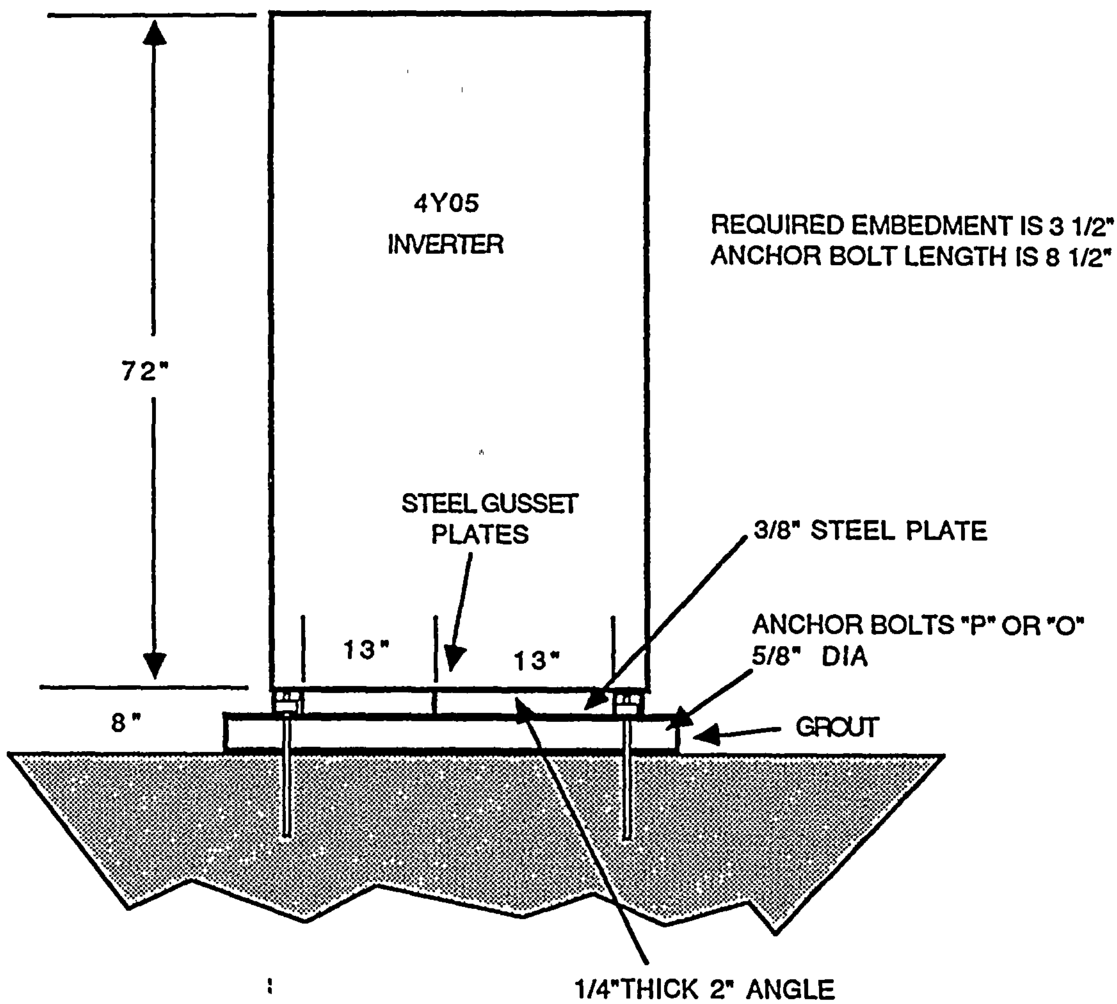
APPROVED BY SRT

NAME [signature] DATE 4/4/90

NAME [signature] DATE 4/4/90

NAME [signature] DATE 4/5/90

AS-FOUND FIELD CONDITION



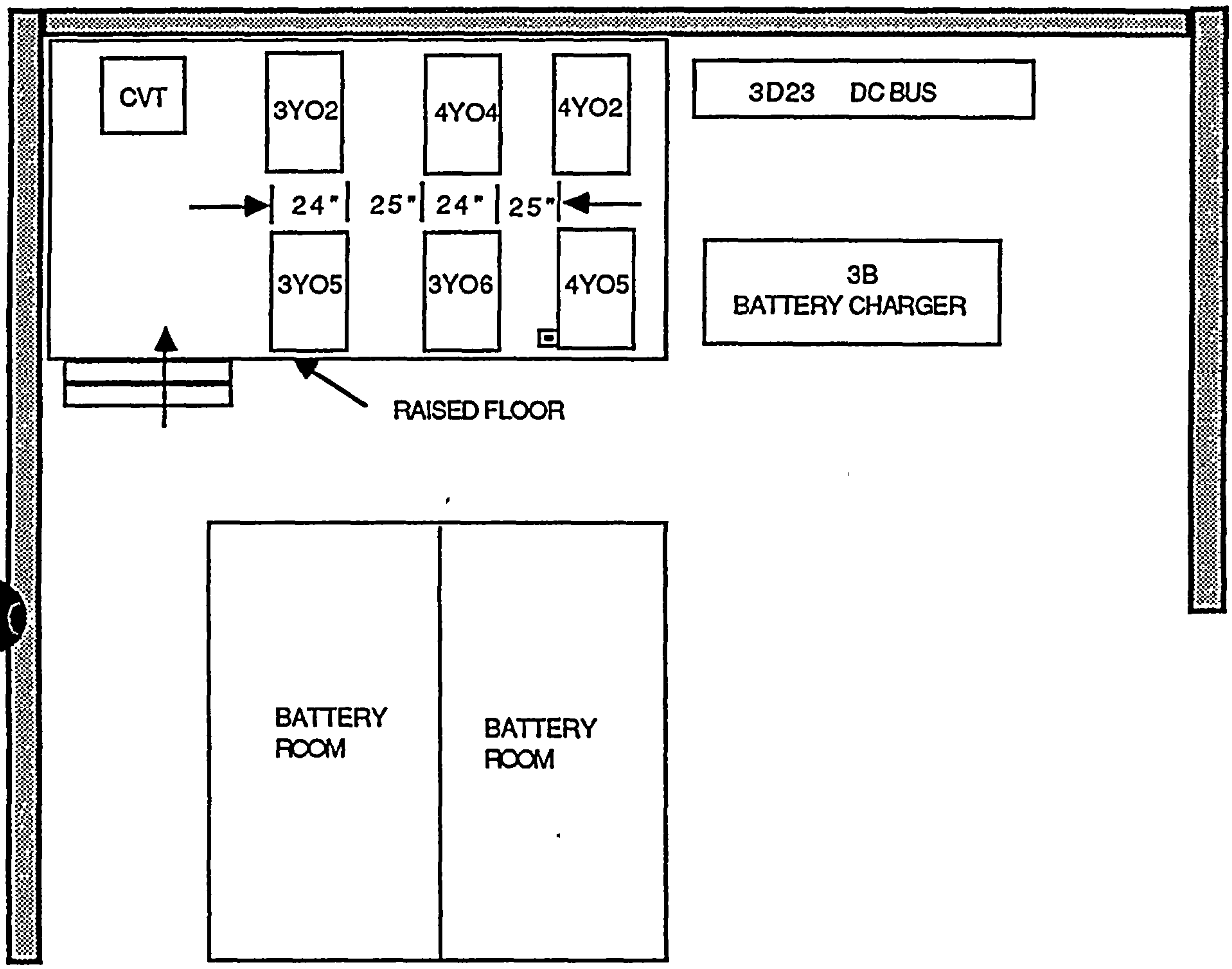
4Y05 INVERTER
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4Y05 INVERTER
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT NOTE ANY SEISMIC INTERACTION CONCERNS WITH THIS ROOM OR THE ASSOCIATED EQUIPMENT.

INVERTERS
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: INVERTERS
DATE: MAR 23, 1990 DWG BY: R. GOULDY

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90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 48 - Inverter 4D

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4Y07 Building Control

Manufacturer ______ Elevation 42'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number "O" Hilti Bolts
5. Are nuts present and apparently tight on all bolts? yes

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Impressed with mounting technique
2. Concerns (if any) ______

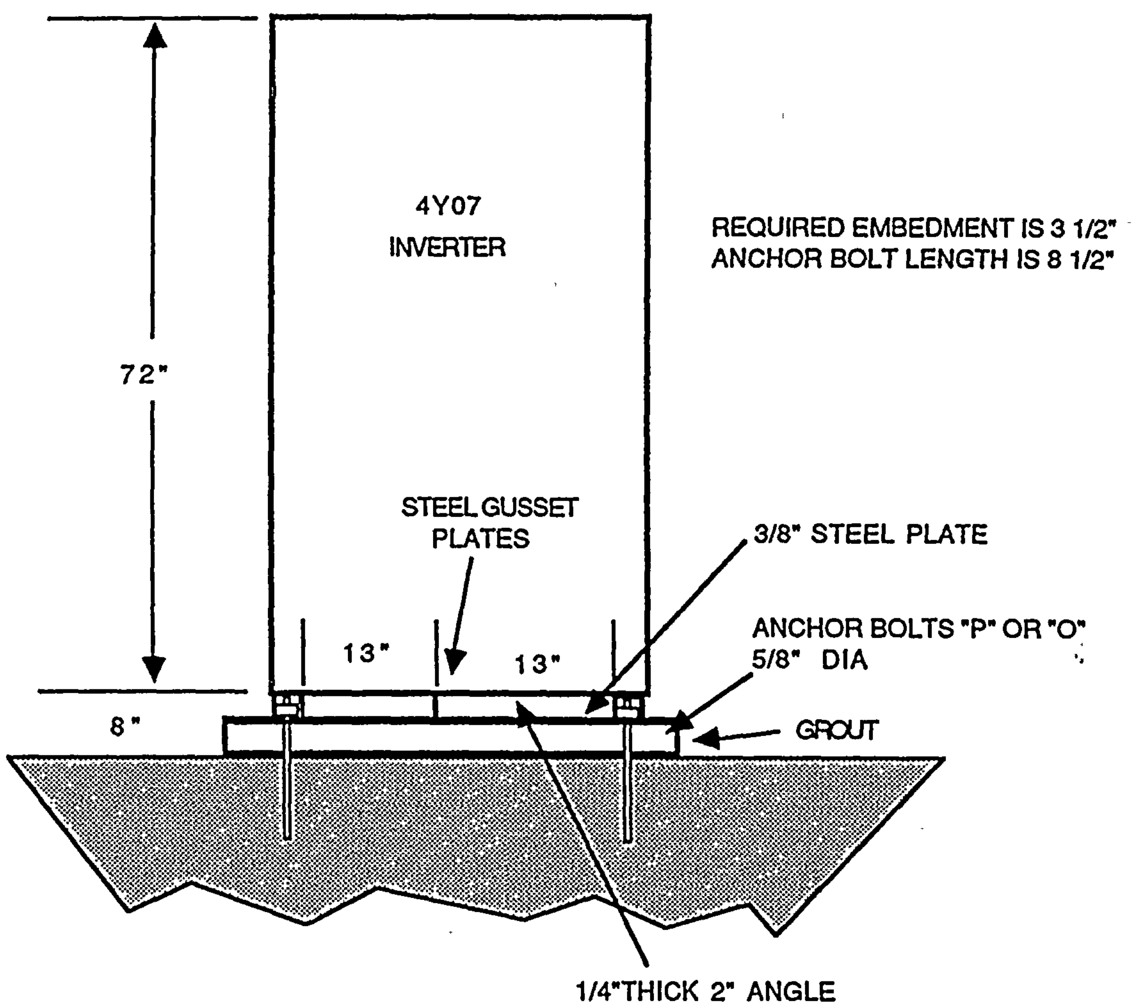
PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) ______

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME [signature] DATE 4/4/90
NAME [signature] DATE 4/4/90
NAME [signature] DATE 4/5/90

AS-FOUND FIELD CONDITION



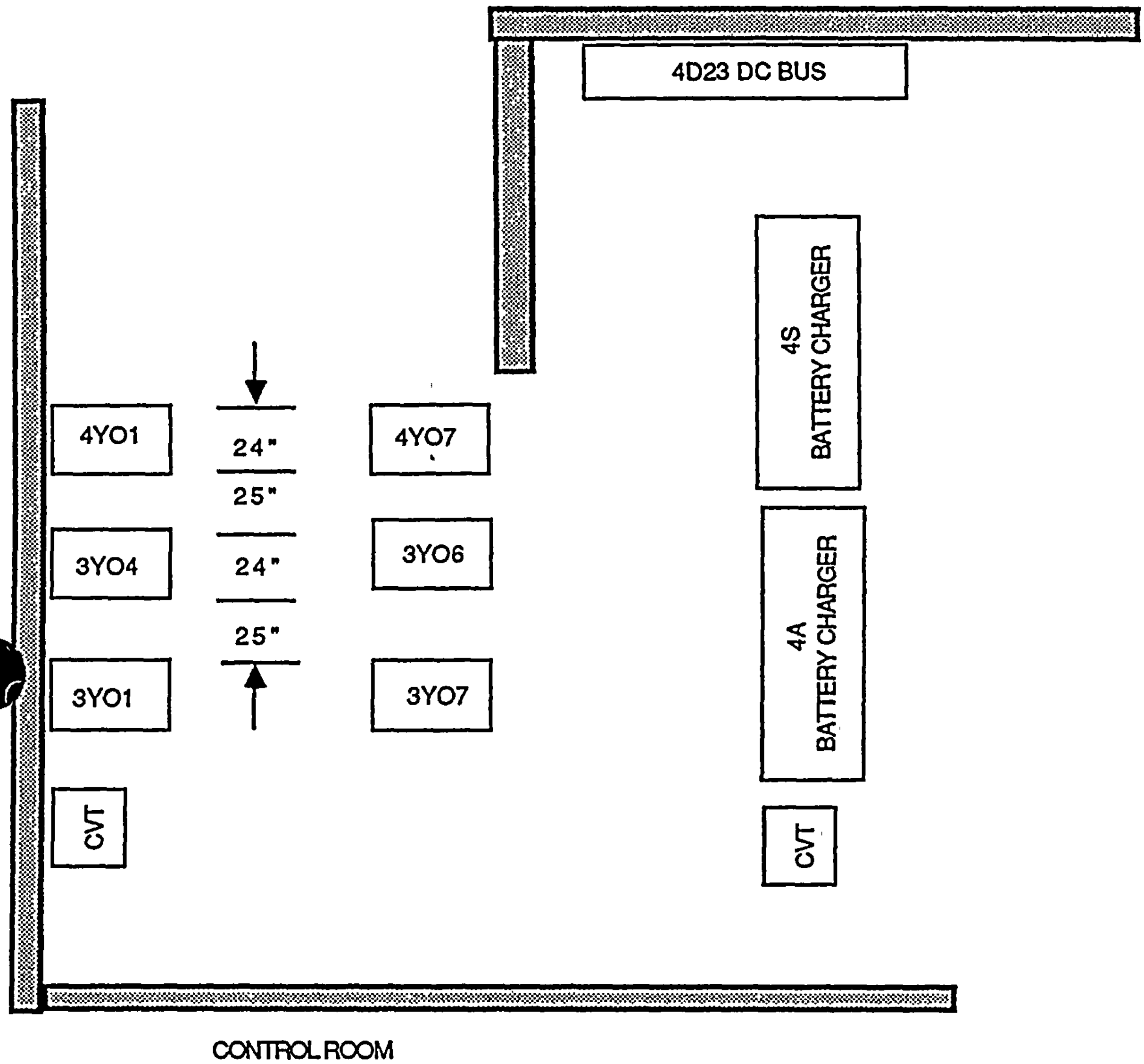
4Y07 INVERTER
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4Y07 INVERTER
DATE: MAR 23, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT NOTE ANY SEISMIC INTERACTIONS CONCERNS WITH THIS ROOM OR THE ASSOCIATED EQUIPMENT.

INVERTERS & BATTERY CHARGERS SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: INVERTERS
DATE: MAR 23, 1990 DWG BY: R. GOULDY

(14)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 49 - Sequencer 3A

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3C23A Building LC-Swgr

Manufacturer ____ Elevation 18'

Model Number ____ Other ____

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments ____
3. Length, size, number, and soundness of welds ____
4. Anchor bolt type, size and number ____
5. Are nuts present and apparently tight on all bolts? ____

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Adequate based on HA's Calculation
2. Concerns (if any) ____

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME John D. Stevenson DATE 4/4/90

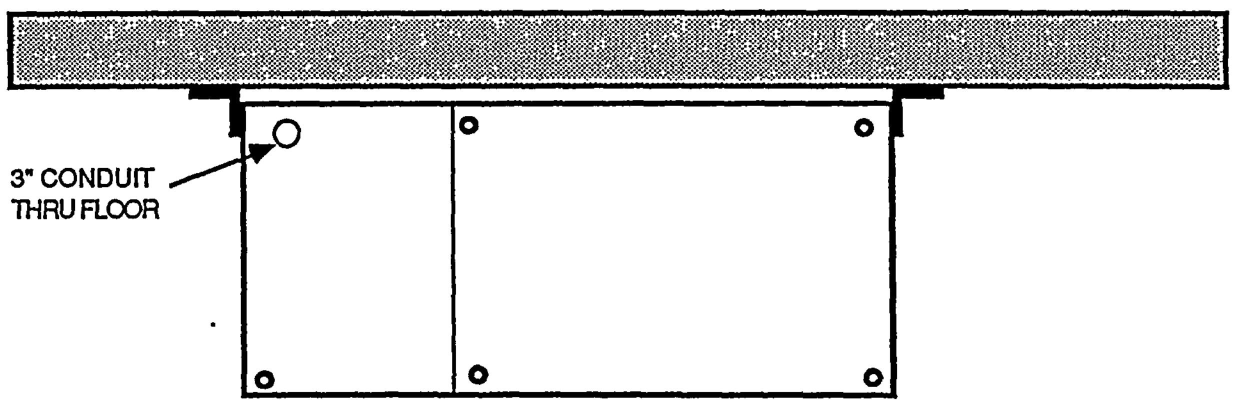
NAME Robert P. Kennedy DATE 4/4/90

NAME John W Reed DATE 4/5/90

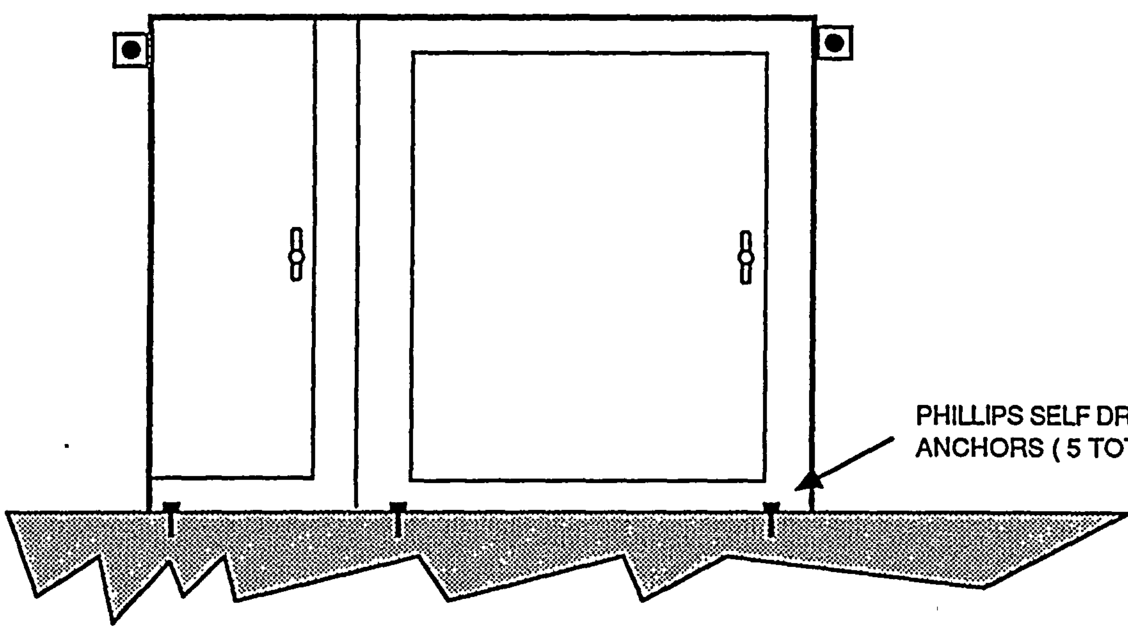
ITEM 49 SEQUENCER 3A

SRT JUDGED the ANCHORAGE AS ADEQUATE BASED ON THE 4A Calculation. (ITEM 51)

AS-FOUND FIELD CONDITION



THE SRT NOTED THAT THERE WERE TWO BRACKETS ON THE TOP OF THIS SEQUENCER CABINET



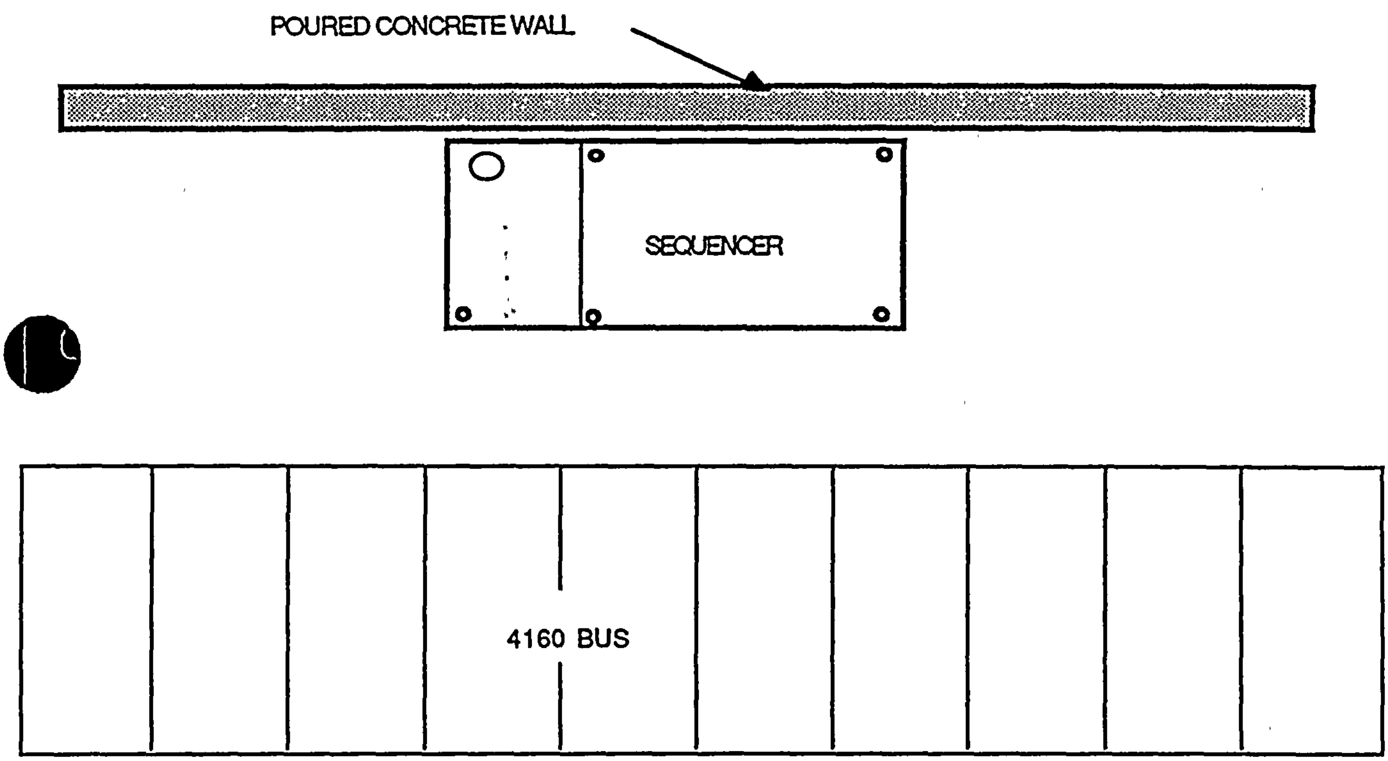
3A SEQUENCER
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3A SEQUENCER
DATE: MAR 28,1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT HAVE ANY SEISMIC INTERACTION CONCERNS



3A SEQUENCER
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3A SEQUENCER
DATE: MAR 28,1990 DWG BY: R. GOULDY

(13)

1a

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 50 - Sequencer 3B

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3C23B

Building LC-Swgr

Manufacturer

Elevation 18'

Model Number

Other

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds
4. Anchor bolt type, size and number ~~TO BE DETERMINE~~ - Phillips Self Drill - 3/8"
5. Are nuts present and apparently tight on all bolts?

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   - a. SRT Judgment X
   - b. URS Tables
   - c. ANCHOR Program
   - d. Other (explain) Anchorage just exceeds required capacity per calculation
2. Concerns (if any)

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any)

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any) ~~[illegible]~~ Utilize top brackets as found on Sequencer 3A. One more is needed.

APPROVED BY SRT

NAME John D. Stevenson DATE 4/4/90

NAME Robert P. Kennedy DATE 4/4/90

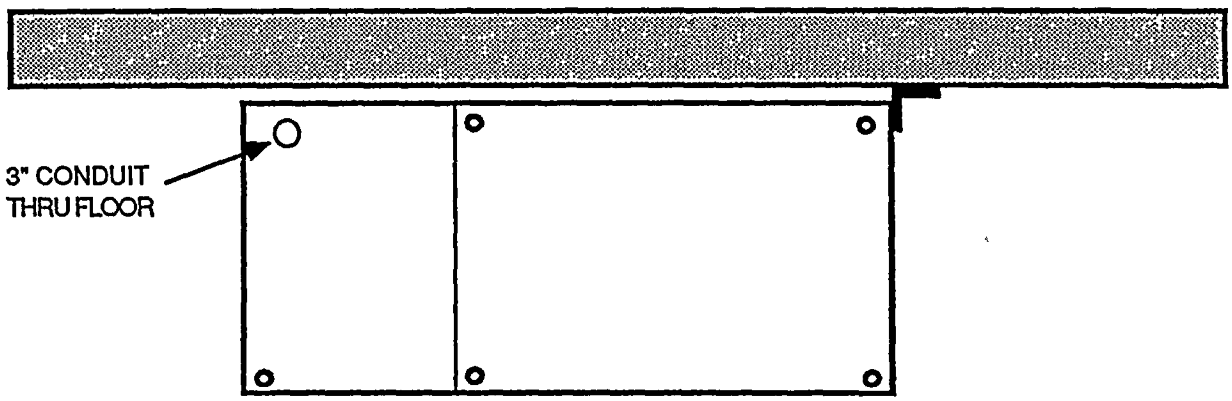
NAME John W. Reed DATE 4/5/90

ITEM 50 SEQUENCER 3B

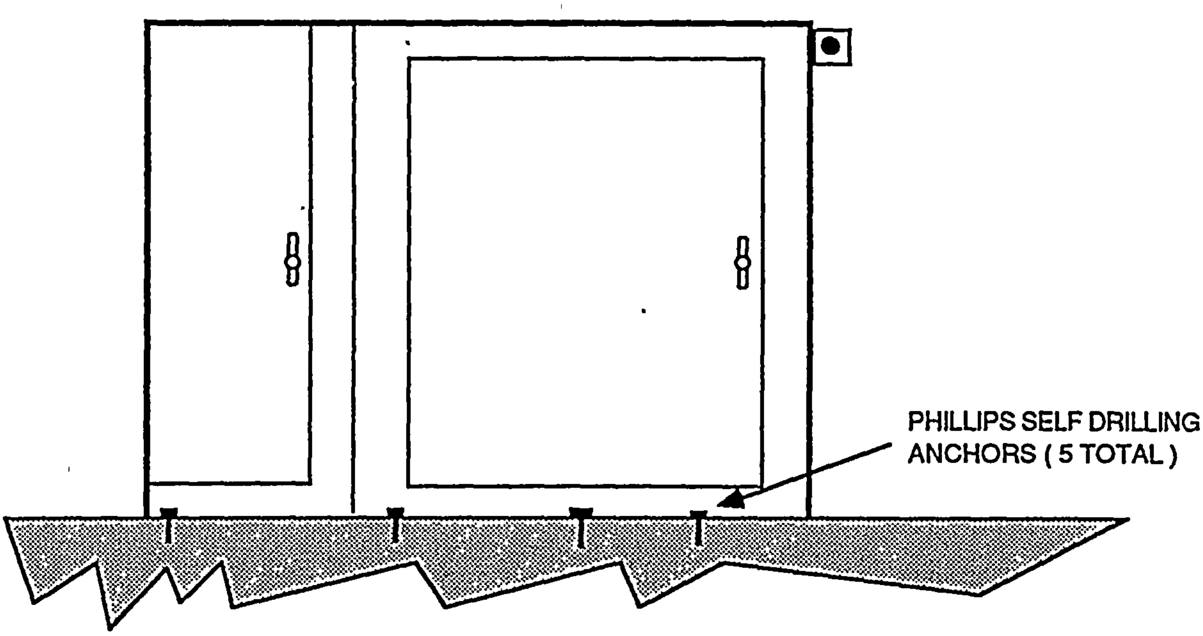
SRT JUDGED the ANCHORAGE to BE ACCEPTABLE BASED ON 4A Calculation. (ITEM 51)

SRT NOTED THAT TOP BRACKETS AS FOUND ON 3A WOULD PROVIDE ADDED ASSURANCE AND STRENGTH

AS-FOUND FIELD CONDITION



THE SRT NOTED THAT THERE WAS ONE BRACKET ON THE TOP OF THIS SEQUENCER CABINET



3B SEQUENCER
SEISMIC MOUNTING WORKSHEET

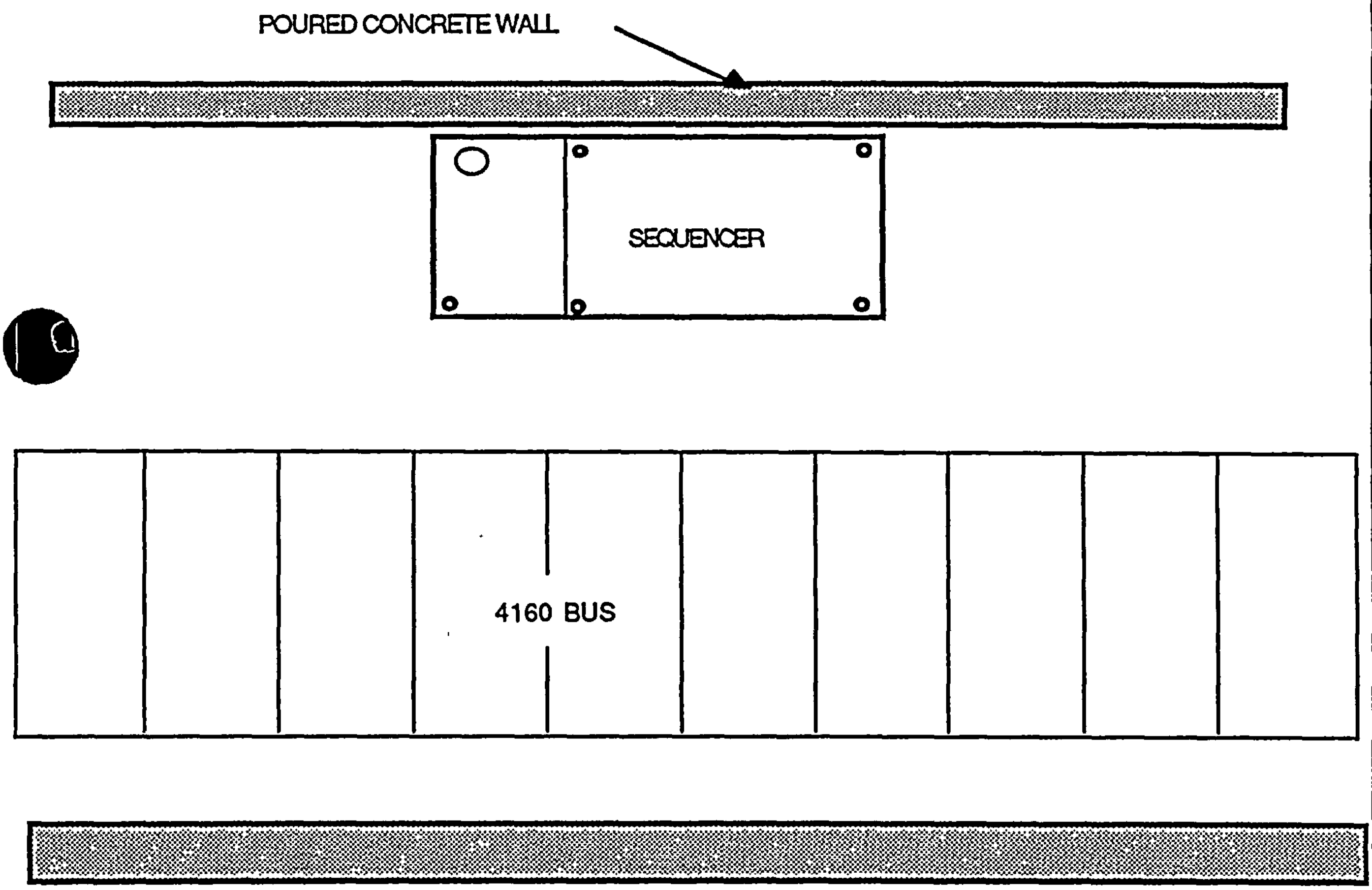
GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: 3B SEQUENCER	
DATE: MAR 28,1990	DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT NOTE ANY SEISMIC INTERACTION CONCERNS ASSOCIATED WITH THIS ROOM OR THE EQUIPMENT

3A 4160v BUS ROOM



3B SEQUENCER
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B SEQUENCER
DATE: MAR 28,1990 DWG BY: R. GOULDY

(41)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 51 - Sequencer 4A

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4C23A Building LC-Swgr

Manufacturer ______ Elevation 18'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number ~~TO BE DETERMINED~~ Phillips self drilled
5. Are nuts present and apparently tight on all bolts? N/A

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Capacity is slightly above required Calculation [illegible] anchorage is adequate
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

Top Brackets should be utilized as [illegible] on Sequencer 3A

APPROVED BY SRT

NAME John D. Stevenson DATE 4/4/90

NAME Robert P. Kennedy DATE 4/4/90

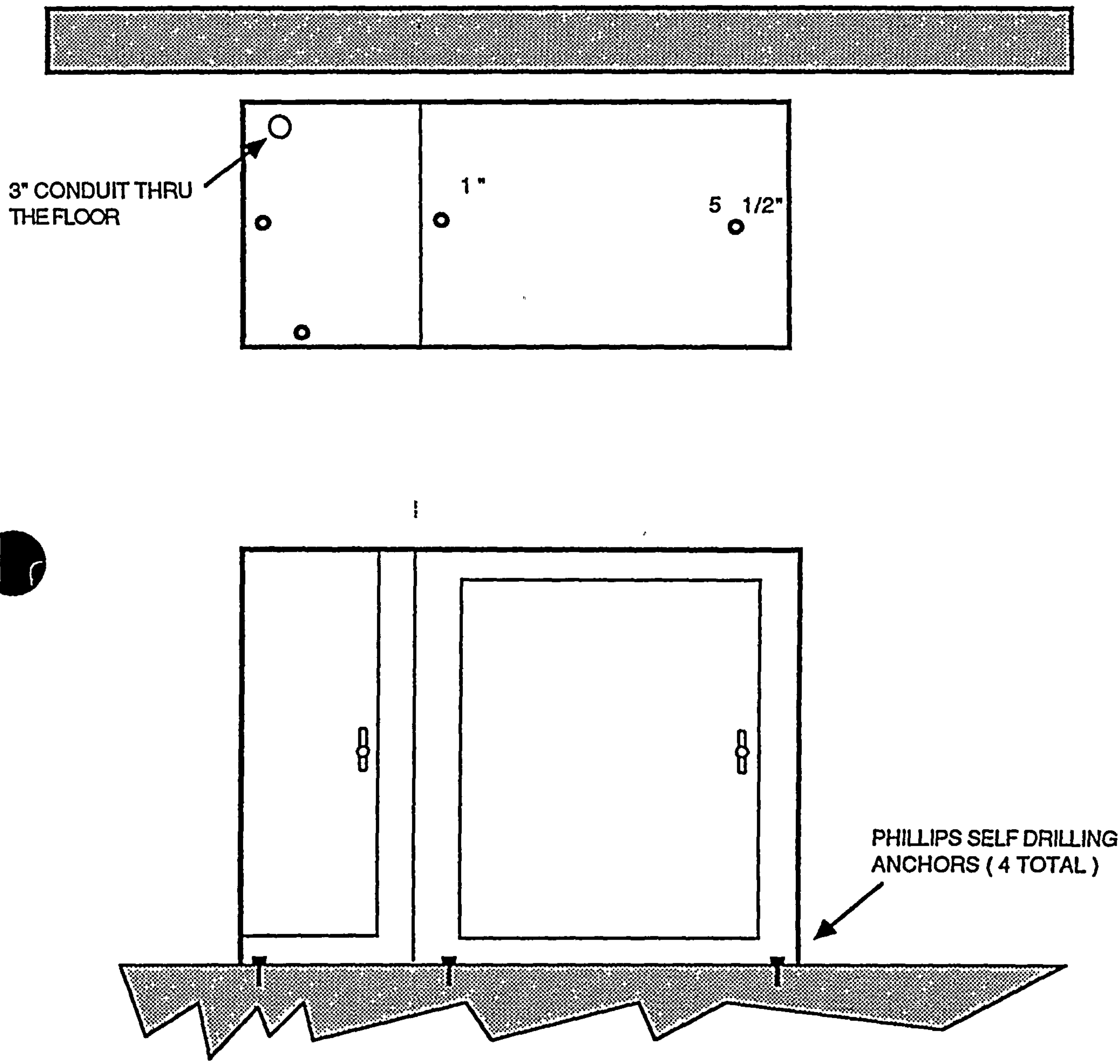
NAME John W. Reed DATE 4/5/90

ITEM 51 SEQUENCER 4A

THE SRT REQUESTED AN OVERTURN calculation to be used AS a bounding calculation for the SEQUENCERS.

The SRT NOTED that TOP Brackets AS found on 3A would ADD STRENGTH.

AS-FOUND FIELD CONDITION



4A SEQUENCER
SEISMIC MOUNTING WORKSHEET

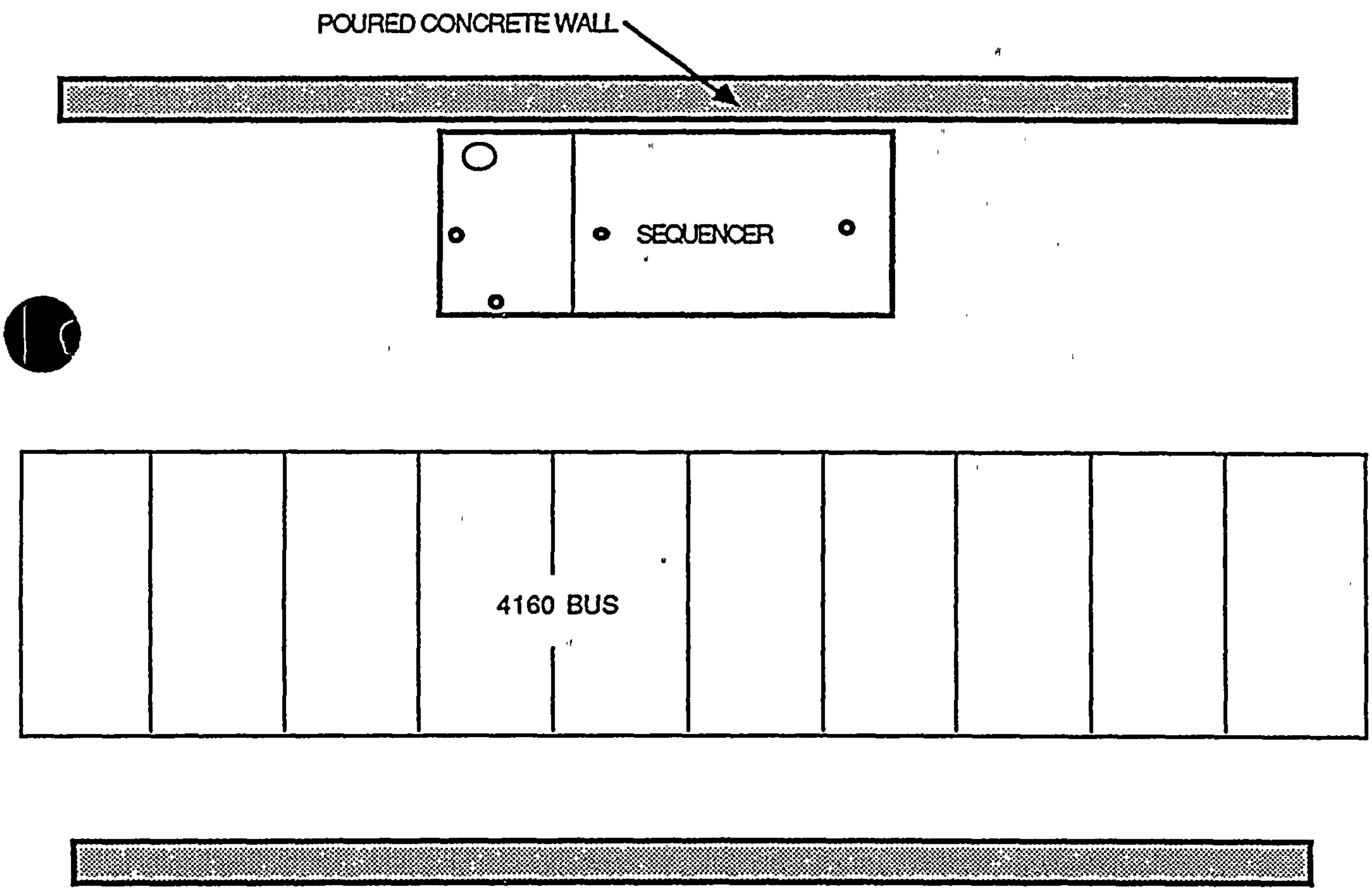
GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4A SEQUENCER
DATE: MAR 28,1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT NOTE ANY SEISMIC INTERACTION CONCERNS ASSOCIATED WITH THIS ROOM OR THE EQUIPMENT



4A SEQUENCER
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PSL 1 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4A SEQUENCER
DATE: MAR 28,1990 DWG BY: R. GOULDY

S&A Job # 901585

CALCULATION COVER SHEET

Calculation No: TPN-1SNC-90-00

Title: Anchorage Calculation for Sequencer 4A - Item #51, Bounding Calculation for Sequencer 3A, 3B & 4B - Items 49, 50 & 52

No.	Description	By	Date	Chk/Ver	Date	Appr	Date
0	INITIAL ISSUE	[illegible]	10/26/92	PRW	5/18/92	PRW	5/18/92

REVISIONS

LIST OF EFFECTIVE PAGES

CALCULATION NUMBER TPN-1530-90-00 REV. 0 10/20/90

PAGE	SECTION	REV	PAGE	SECTION	REV	PAGE	SECTION	REV
1	1.0 PURPOSE/SCOPE	0						
	2.0 REFERENCES	0						
2	3.0 METHODOLOGY	0						
	4.0 ASSUMPTIONS/BASES	0						
3	5.0 CALCULATIONS	0						
4	"	0						
5	"	0						
	6.0 RESULTS	0						
6	"	0						

SIA Job # 90C1585

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CALCULATION NUMBER TPN-ISJC-90-00 REV. 0 10/20/90

STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

SUBJECT CALC. #TPN-15JC-90-00 - ANCHORAGE CALCULATION FOR SEQUENCER 4A ITEM # 51
BOUNDING CALCULATION FOR SEQUENCER 3A, 3B & 4B - ITEMS 49, 50 & 52

S&A JOB No. 901585 SHEET 1 OF 6

REVISIONS
0 DDS 10/20/90
PRW 5/18/92

REF.

1.0 PURPOSE / SCOPE

DURING THE USI A-46 WALKDOWN OF TURKEY POINT UNIT 2 AND 3 A CONCERN WAS EXPRESSED THAT THE ANCHORAGE OF SEQUENCER 4A MAY NOT BE OF SUFFICIENT CAPACITY TO WITHSTAND THE LOADS FROM THE DEFINED MHE AT THE TURKEY POINT PLANT. SEQUENCER 4A WAS DETERMINED BY JUDGEMENT TO HAVE THE WEAKEST ANCHORAGE OF ALL OF THE SEQUENCERS (ITEMS 49, 50, 51 & 52). THEREFORE, THIS CALCULATION BOUNDS THE RESULTS FOR THE OTHER SEQUENCERS. THE SCOPE OF THIS CALCULATION ONLY INCLUDES ANCHORAGE.

2.0 REFERENCES

1. TURKEY POINT - GROUND RESPONSE SPECTRA 15% ACCELERATION, FIGURE 5A-2, TURKEY POINT FSAR, APPENDIX A.
2. SSRAP REPORT, "USE OF SEISMIC EXPERIENCE DATA TO SHOW RUGGEDNESS OF EQUIPMENT IN NUCLEAR POWER PLANTS," SENIOR SEISMIC REVIEW & ADVISORY PANEL, APRIL 16, 1990.
3. EPRI NP-5228, "SEISMIC VERIFICATION OF NUCLEAR PLANT EQUIPMENT ANCHORAGE," URS CORPORATION / JOHN A. BLUME & ASSOCIATES, ENGINEERS, SAN FRANCISCO, CALIFORNIA, MAY 1987.

S&A STEVENSON & ASSOCIATES a structural-mechanical consulting engineering firm	SUBJECT CALC # TPN-1SJC-90-00 - ANCHORAGE CALCULATION FOR SEQUENCER 4A ITEM # 51 BOUNDING CALCULATION FOR SEQUENCER 3A, 3B & 4B - ITEMS 49, 50 & 52 S&A JOB No. 90C1585 SHEET 2 OF 6 REVISIONS: 0 DJS 10/20/90; PRW 5/18/92

REF.

3.0 METHODOLOGY

THE METHODOLOGY EMPLOYED IS TO CALCULATE THE BOLT LOADING FOR EARTHQUAKE LOADS IN THE THREE ORTHOGANAL DIRECTIONS (2 HORIZONTAL AND 1 VERTICAL). THESE LOADINGS WILL BE COMBINED BY ADDING 100% OF THE LOAD IN THE WORST (MOST LOADED) DIRECTION AND 40% IN THE OTHERS. GRAVITY LOADS WILL THEN BE ADDED. THIS COMBINATION IS A CONSERVATIVE APPROXIMATION OF THE SRSS COMBINATION.

DAMPING TO BE USED IS 5% BY SRT JUDGMENT APPLICABLE TO ELECTRICAL CABINETS. SINCE THE

1,2 SEQUENCER IS LOCATED @ GRADE 1.0 x GROUND RESPONSE SPECTRA WILL BE USED AS AN ESTIMATE OF THE MEDIAN CENTERED FLOOR RESPONSE SPECTRA. A 1.25 FACTOR FOR CONSERVATISM WILL BE INCLUDED FOR ANCHORAGE LOADING.

4.0 ASSUMPTIONS / BASES

THE FOLLOWING ASSUMPTIONS WERE MADE IN PERFORMING THIS CALCULATION:

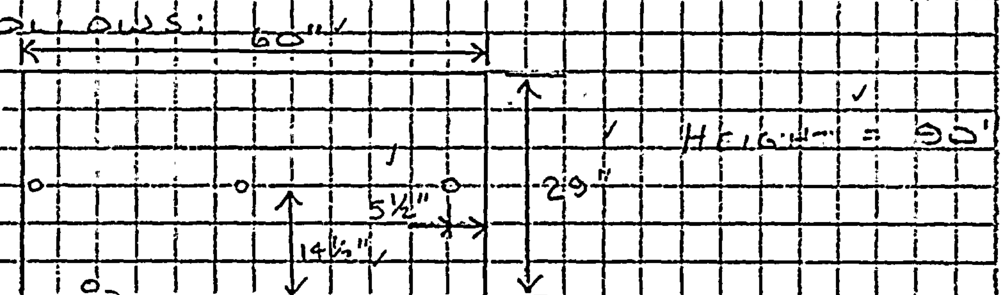
a) WEIGHT WILL BE CALCULATED USING THE GUIDANCE OF REF. 3, WHICH FOR GENERIC

Electrical cabinets uses 3 times the weight of the housing.

b. Will conservatively use peak of response spectra for estimating loads.

c. Will use generic expansion bolt allowables for the 3/8" Phillips anchors, in Ref. 3.

d. Anchorage layout measured in field is as follows:



This bolt will be neglected for the calculation of bolt tension

5.0 Calculation

A. Weight Calculation

Sheet metal thickness measured in the field is 3/16".

∴ Wt. of housing

$$W = \tfrac{3}{16}'' \cdot 2\left[90''(29'') + 60''(90'') + 29''(60'')\right] \cdot \frac{490\ \text{lb/ft}^3}{(12)^3\ \text{in}^3/\text{ft}^3}$$

$$= 1037\ \text{LB}$$

3 ∴ Total Wt. of Assembly = 3 × 1037 = 3110 LB

Using guidance of Ref. 2

S&A
STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

SUBJECT Calc TPN-15JC-90-00 – Anchorage Calculation for Sequencer 4A Item # 51
Bounding Calculation for Sequencer 3A, 3B & 4B – Items 49, 50 & 52
S&A JOB No. 90C1585 SHEET 4 OF 6

REVISIONS
0 DDS 10/20/90
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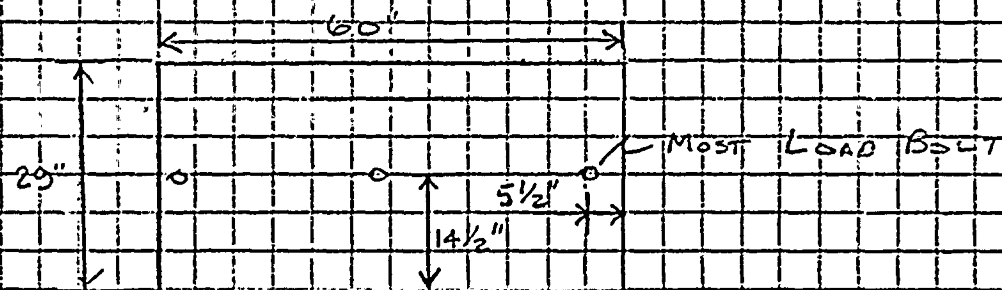
B. Load Calculation

From Response Spectra ~ Peak of Spectra for 5% Damping ~ .285 g

∴ Horizontal g_{LOAD} = 1.25 × .285 g = .3563 g ✓

Vertical g_{LOAD} = ⅔ · .3563 g = .238 g ✓

C. Center of Gravity of Panel Taken @ Center 45" From Base. ✓



E. Calculate Bolt Load in Tension

1. For Load in Weak Direction

$$T_{BOLT} = \frac{.3563\,g \cdot (45") \cdot 310^{LB}}{14.5" \text{ (3 BOLTS)}} = 1146.2 \text{ LBS/BOLT}$$ ✓

2. For Load in Strong Direction

$$T_{BOLT} = \frac{.3563\,g \cdot (45") \cdot 310}{54.5"} = 914.9 \text{ LBS/BOLT}$$ ✓

3. For Vertical Earthquake

$$T_{BOLT} = \frac{.238 \cdot (310)}{3 \text{ BOLTS}} = 24.6.3 \text{ LBS/BOLT}$$ ✓

S&A STEVENSON & ASSOCIATES a structural-mechanical consulting engineering firm	SUBJECT CALC # TPN-153C-90-00 - ANCHORAGE CALCULATION FOR SEQUENCER 4A ITEM # 51 BOUNDING CALCULATION FOR SEQUENCERS 3A, 3B & 4B - ITEMS 49, 50 & 52 — JOB No. 90C1585 S&A — SHEET 5 OF 6
REVISIONS	0 9BJ 10/20/90; PRW 5/18/92

4. TOTAL LOAD IN TENSION

$T_{BOLT} = 1146.2 + .4(914.9) + .4(246.3) - \frac{310^{LB}}{2}$ ← DEAD LOAD

$= 574.0^{LB}/_{BOLT}$ ✓

F. SHEAR LOAD/BOLT

$V = \sqrt{2} \cdot (.3563\,g) \cdot 310^{LBS} / 4 = 391.9^{LB}/_{BOLT}$ ✓

(√2 ← TWO HORIZONTAL DIRECTIONS; 4 BOLTS)

G. BOLT ALLOWABLES & CHECK FOR ADEQUACY

FROM REF. 3 BOLT ALLOWABLE FOR TENSION

(3/4 ← REDUCTION FACTOR FOR 3000 PSI CONCRETE)

3 $P_{nom} = \frac{3}{4} \cdot (1.46)^K = 1.095^K > 574^{LB}$ OK ✓

(.95 ← REDUCTION FACTOR FOR 3000 PSI CONCRETE)

3 $V_{nom} = .95 \cdot (1.42)^K = 1.349^K > 391.9^{LB}$ OK ✓

3 $\frac{V}{V_{AL}} = \frac{.3919}{1.349} = .290 < .3$ ∴ OK FOR INTERACTION ✓

(NO REDUCTION FOR INTERACTION)

6. RESULTS

BOLT LOADINGS WERE EVALUATED FOR LOADS FROM THE MHE DEFINED @ TURKEY POINT, PLUS DEAD LOAD. THE RESULTING BOLT LOADS WERE BELOW THE ACCEPTANCE CRITERIA. THE SRT ACCEPTED THE ANCHORAGE FOR ALL SEQUENCERS BASED ON THE BOUNDING CALCULATION FOR SEQUENCER 4A. HOWEVER, FOR SEQUENCER 4A, 4B AND 3B (ITEMS 50, 51 & 52) IT IS RECOMMENDED BY THE SRT THAT THE

STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

SUBJECT CALC # TPN-1SJL-90-00 - ANCHORAGE CALCULATION FOR SEQUENCER 4A ITEM #51
BOUNDING CALCULATION FOR SEQUENCER 3A, 3B & 4B - ITEMS 49, 50 & 52

S&A JOB No. 90C1585 SHEET 6 OF 6

REVISIONS
0 [initials] 10/20/92
PRW 5/18/92

TOP BRACKETS UTILIZED ON SEQUENCER 3A (ITEM 49) BE INSTALLED ON THE OTHER SEQUENCERS WITH BRACKETS MISSING.

(42)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 52 - Sequencer 4B

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4C23B — Building LC-Swgr

Manufacturer ____ — Elevation 18'

Model Number ____ — Other ____

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number ~~TO BE DETERMINED~~ Phillips Self Drill - 3/8"
5. Are nuts present and apparently tight on all bolts? N/A

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Calculation of uplift & shear with 3/8" phillips Anchors utilized - Capacity is slightly above required → Calculation performed anchorage is adequate
2. Concerns (if any) ____

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

TOP BRACKETS SHOULD be utilized AS 3A SEQUENCER has installed.

APPROVED BY SRT

NAME John D. Stevenson — DATE 4/4/90

NAME Robert P. Kennedy — DATE 4/4/90

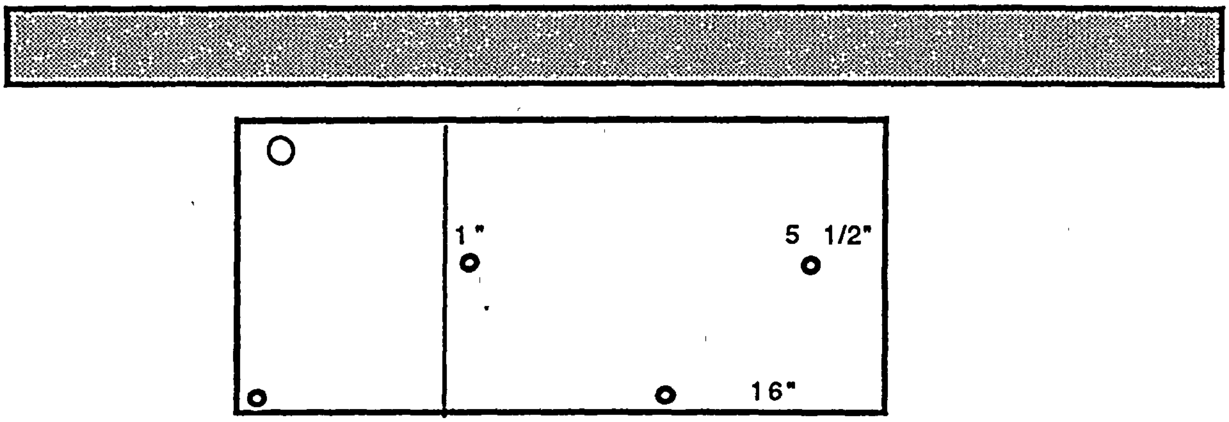
NAME John W. Reed — DATE 4/5/90

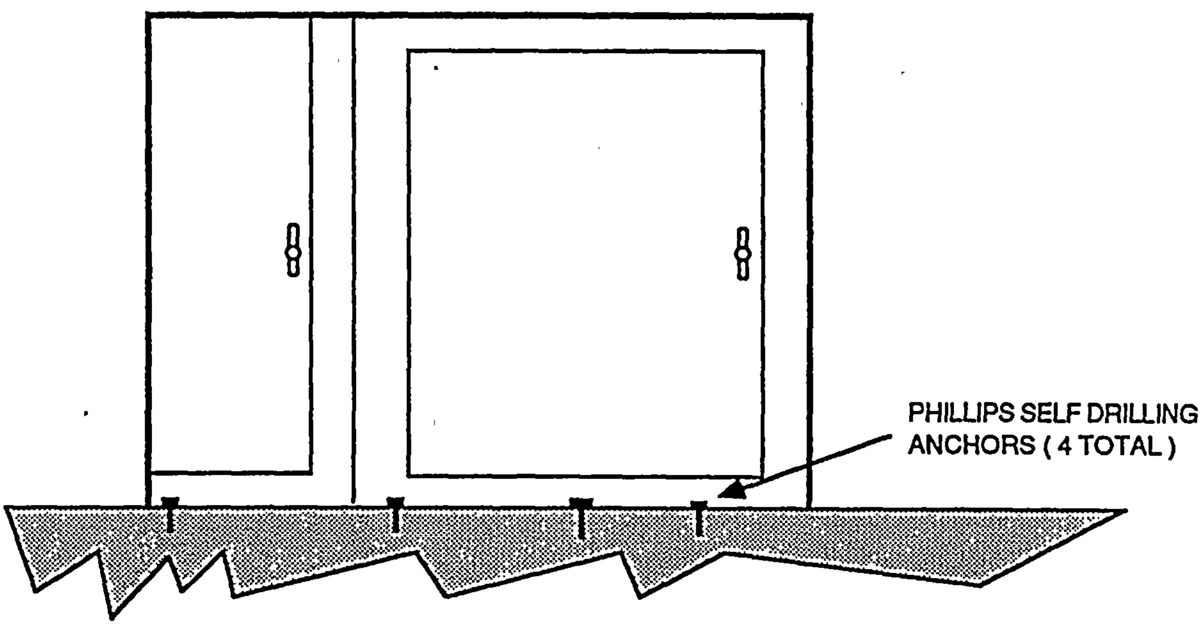
ITEM 52 SEQUENCE 4B

The SRT REVIEWED the ANCHORAGE AND the 4A Calculations AND JUDGED the design AS installed ACCEPTABLE

The SRT NOTED THAT the TOP BRACKETS, AS FOUND ON 3A, WOULD ADD STRENGTH.

AS-FOUND FIELD CONDITION





4B SEQUENCER
SEISMIC MOUNTING WORKSHEET

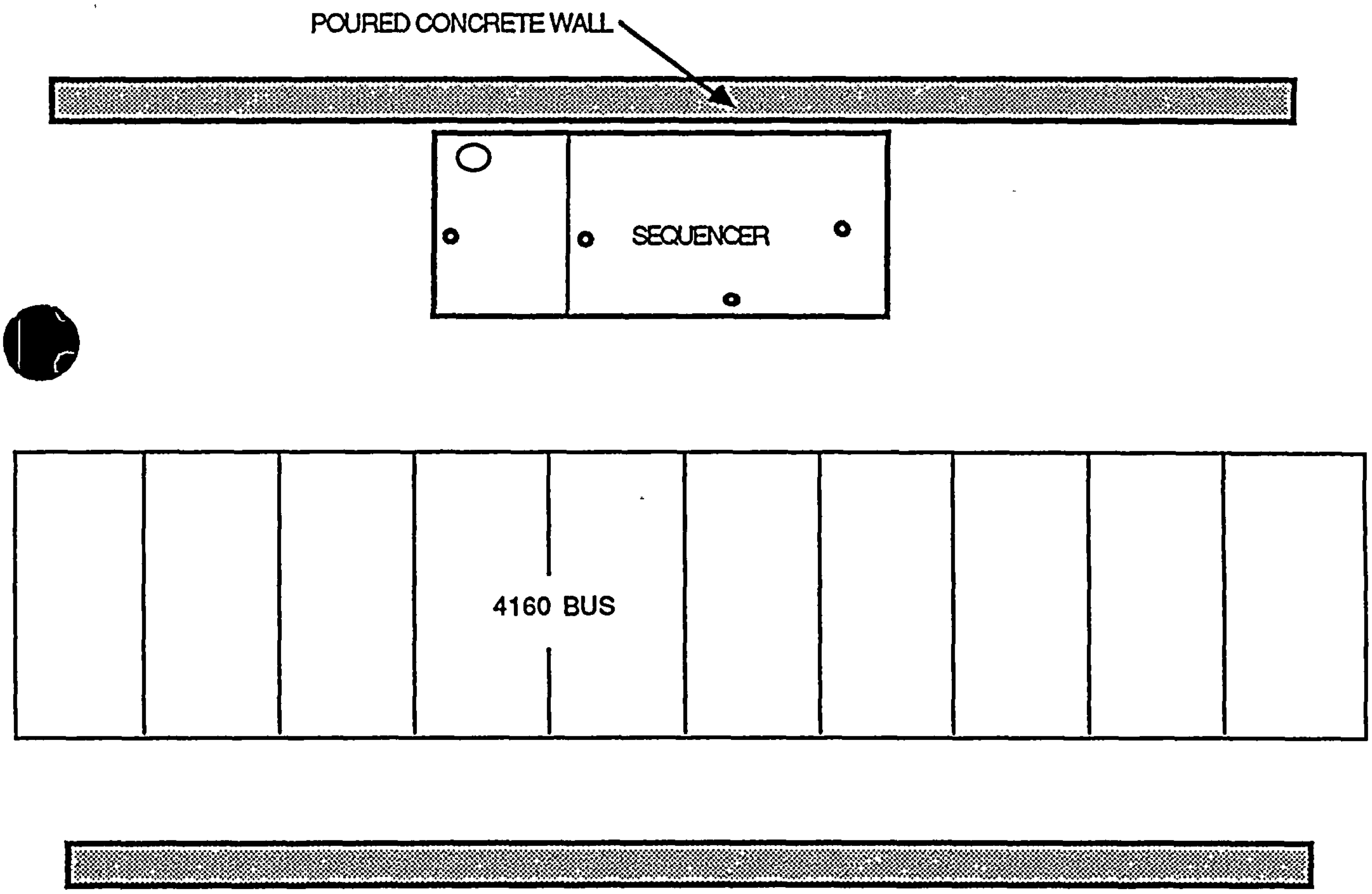
GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B SEQUENCER
DATE: MAR 28,1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION

THE SRT DID NOT NOTE ANY SEISMIC INTERACTION CONCERNS

ASSOCIATED WITH THIS ROOM OR THE EQUIPMENT



4B SEQUENCER
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE; USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PSL 1 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: 4B SEQUENCER	
DATE: MAR 28,1990	DWG BY: R. GOULDY

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90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 53 - CCW Heat Exchanger

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3B Building RAB

Manufacturer Elevation 18'

Model Number Other

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No
2. Condition of nearby concrete and embedments Good
3. Length, size, number, and soundness of welds
4. Anchor bolt type, size and number 4 3/4"φ bolts - total
5. Are nuts present and apparently tight on all bolts?

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? Yes
   a. SRT Judgment X
   b. URS Tables
   c. ANCHOR Program
   d. Other (explain) Pedestal & Anchor bolt Check
   Anchorage calculations reviewed and demonstrate adequate anchorage
2. Concerns (if any) Can not verify rebar in pedestal

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

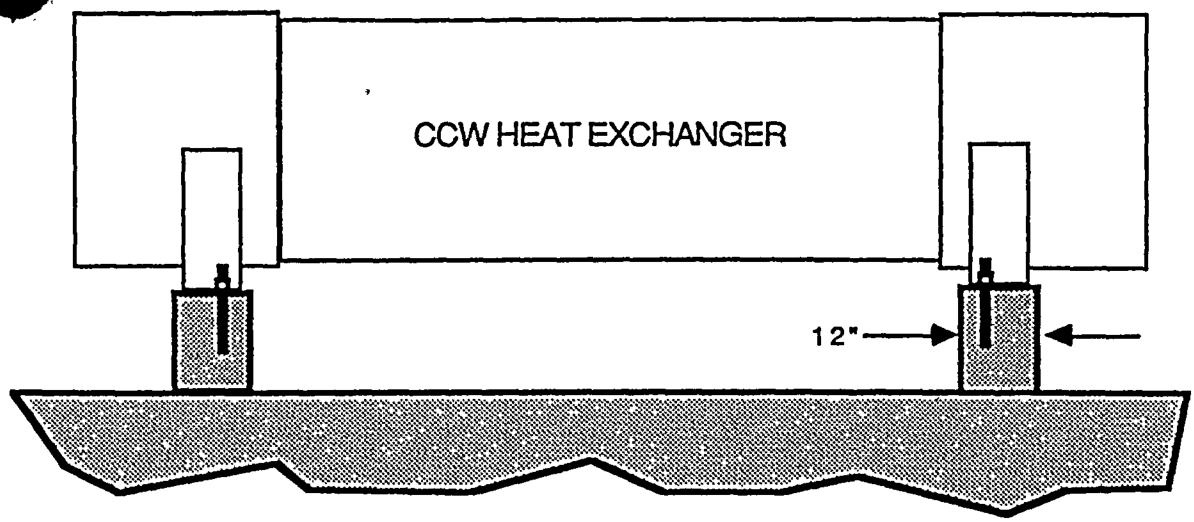
NAME Robert P. Kennedy DATE 4/5/90
NAME John W. Reed DATE 4/5/90
NAME John D. Stevenson DATE 4/5/90

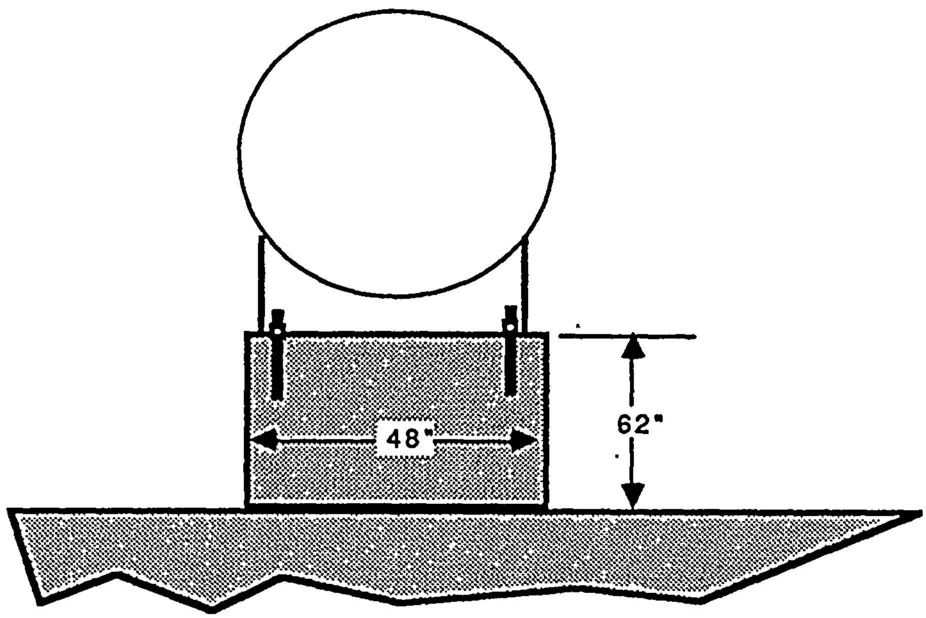
ITEM 53 CCW HEAT EXCHANGER

The SRT DID NOT REVIEW the PEDISTAL DESIGN.

REQUESTED Anchorage & BOLT check which were found ACCEPTABLE.

AS-FOUND FIELD CONDITION



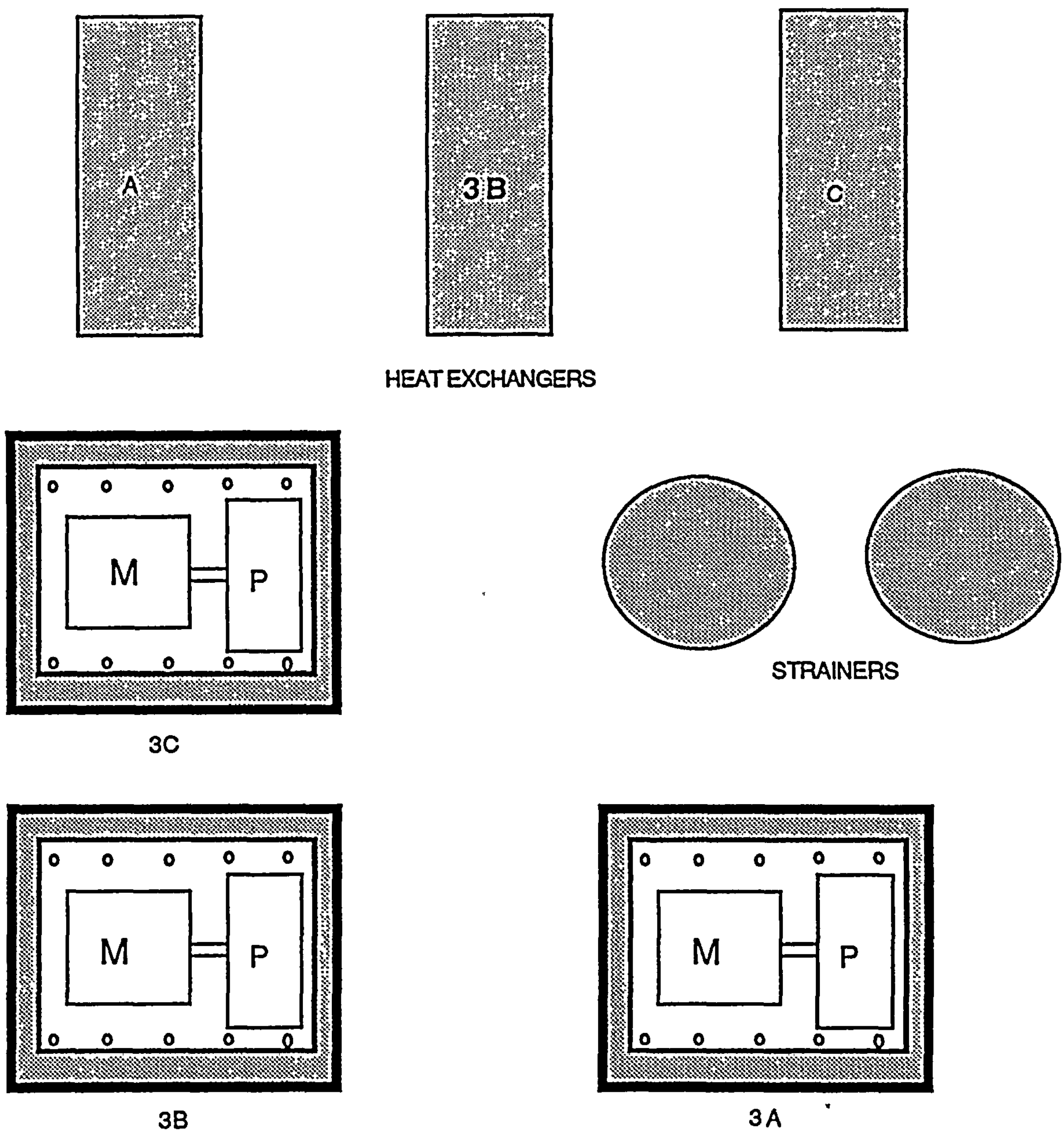


3B CCW HEAT EXCHANGER
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 3B CCW HEAT EXCHANGER
DATE: MAR 28, 1990 DWG BY: R GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT HAVE ANY SEISMIC INTERACTION CONCERNS WITH THIS PUMP ARRANGEMENT. THE STEEL GRATING ABOVE WAS REVIEWED AND FOUND TO BE BOLTED TO THE STEEL I-BEAMS

3B CCW HEAT EXCHANGER
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: 3B CCW HEAT EXCHANGER	
DATE: MAR 22, 1990	DWG BY: R. GOULDY

49

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 54 - CCW Heat Exchanger

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4B — Building RAB

Manufacturer ____ — Elevation 18'

Model Number ____ — Other ____

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds ____
4. Anchor bolt type, size and number 4 5/4" ϕ BOLT TOTAL
5. Are nuts present and apparently tight on all bolts? ____

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand? YES
   a. SRT Judgment X
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Anchorage calculations reviewed and demonstrate adequate anchorage.
2. Concerns (if any) Can not verify steel in pedestal

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) None

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

APPROVED BY SRT

NAME Robert P. Kennedy — DATE 4/5/90

NAME John W. Reed — DATE 4/5/90

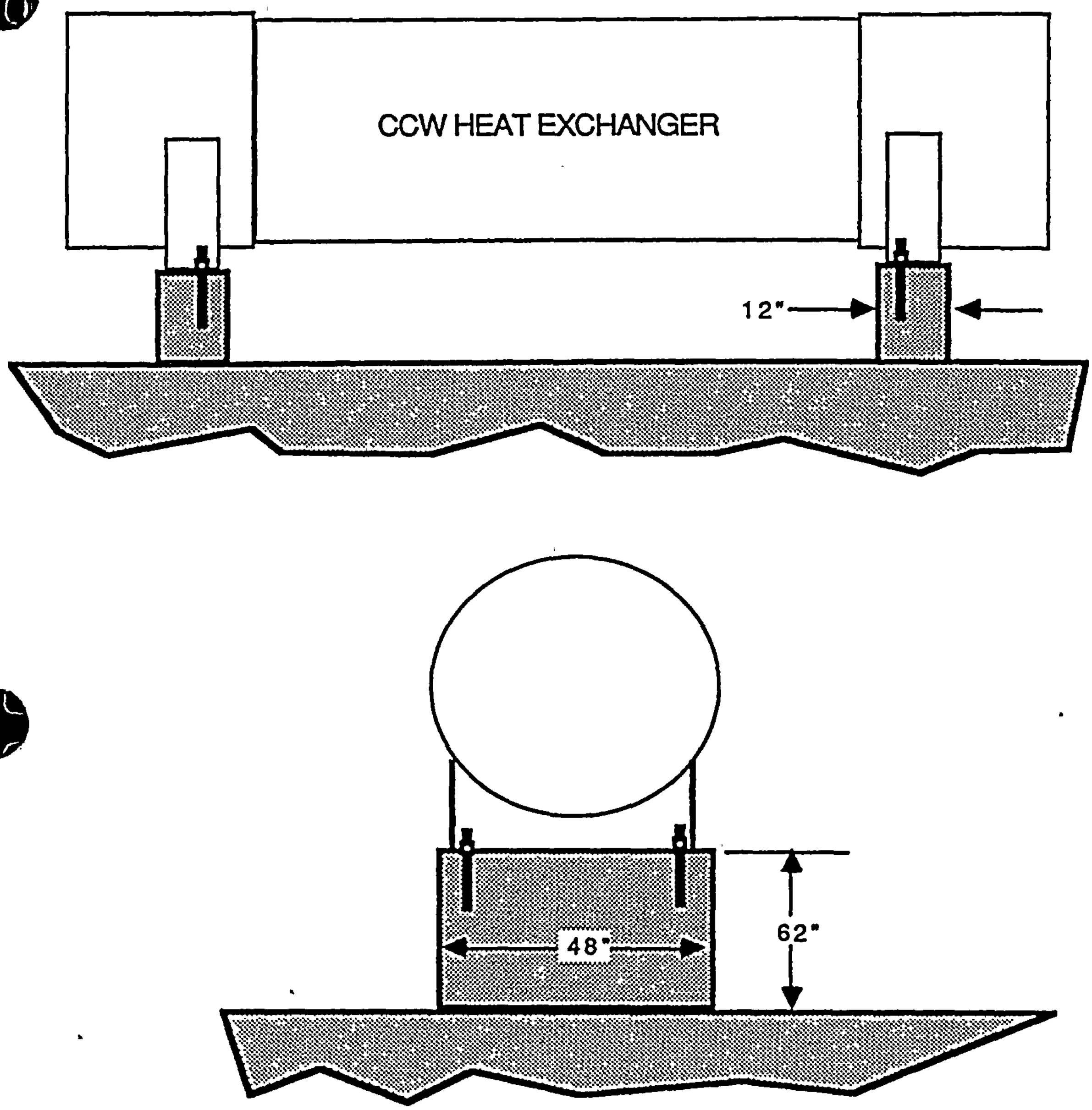
NAME James D. Stevenson — DATE 4/5/90

ITEM 54 CCW HEAT EXCHANGER

The SRT REVIEWED ANCHORAGE CALCULATIONS AND JUDGED the ANCHORAGE TO BE ACCEPTABLE.

The SRT DID NOT REVIEW the PEDISTAL DESIGN.

AS-FOUND FIELD CONDITION

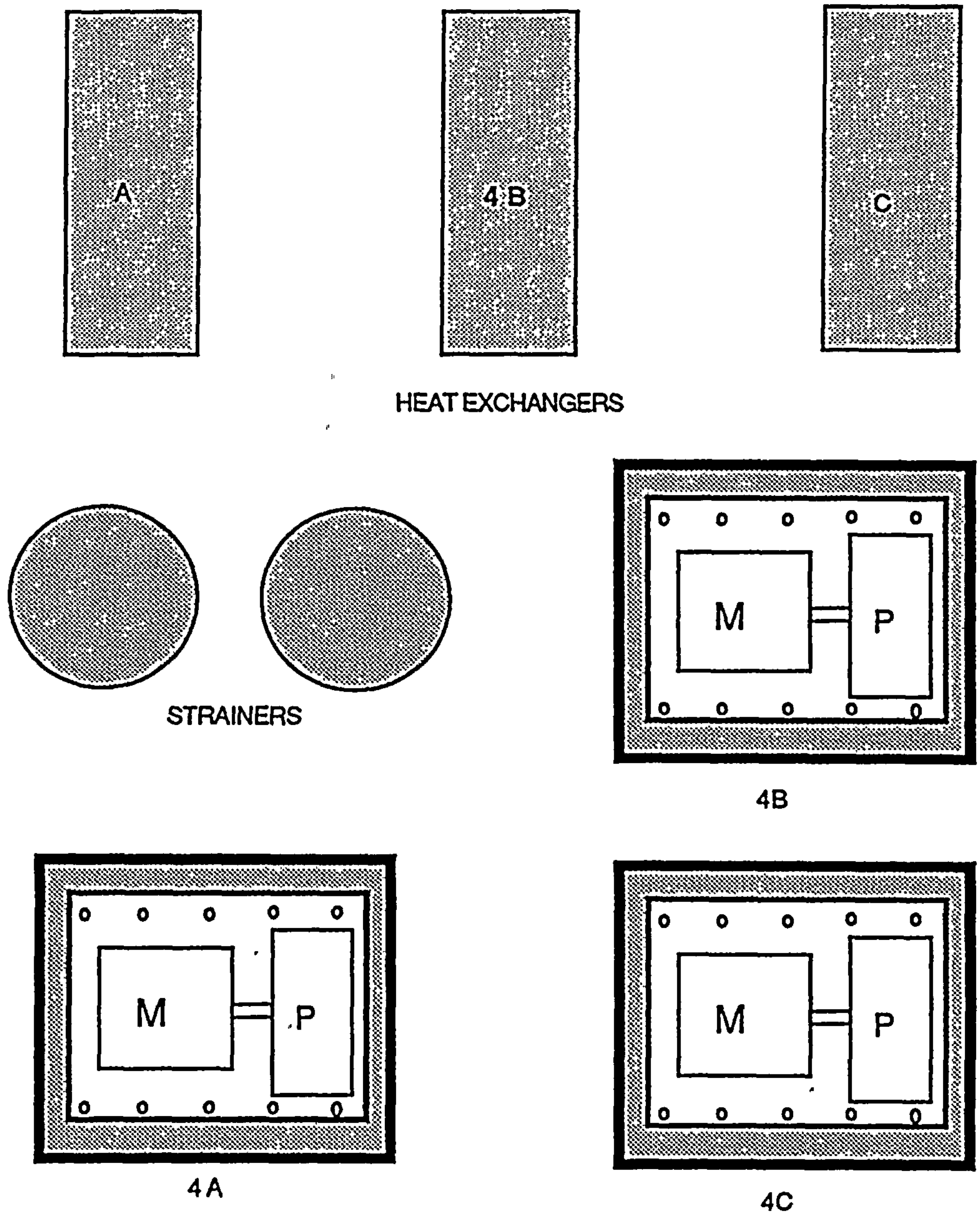


4B CCW HEAT EXCHANGER SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN	
EQUIPMENT ANCHORAGE SKETCH	
COMPONENT: 4B CCW HEAT EXCHANGER	
DATE: MAR 28, 1990	DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THE SRT DID NOT HAVE ANY SEISMIC INTERACTIONS CONCERNS WITH THIS PUMP ARRANGEMENT. THE STEEL GRATING ABOVE WAS REVIEWED AND FOUND TO BE BOLTED TO THE STEEL I-BEAMS

4B CCW HEAT EXCHANGER
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: 4B CCW HEAT EXCHANGER
DATE: MAR 22, 1990 DWG BY: R. GOULDY

(18)

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 55 - Vertical Panel 3B

PART A. EQUIPMENT DESCRIPTION

I.D. Number 3C05, 3C06 Building Control

Manufacturer ______ Elevation 42'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes ____ No ____
2. Condition of nearby concrete and embedments ______
3. Length, size, number, and soundness of welds ______
4. Anchor bolt type, size and number 1/2"Ø 22" to 24" each side
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) perform calculations. Reviewed CURB CONSTRUCTION DRAWING DETAILS. UTILIZED ULTRASOUND TO DETERMINE LENGTH. NOTE TOP OF PANEL BRACING to CEILING
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) Temporary lighting & metal egg crate ceiling on cart operators

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

ITEM 55 CONSIDERED AN OUTLIER BECAUSE OF CONCERN 2 ON THE ATTACHED PAGE. CONCERN 1 HAS BEEN RECONCILED BY REVIEW OF THE CALCULATIONS ATTACHED TO ITEM 56.

APPROVED BY SRT

NAME Robert P. Kennedy DATE 9/2/91

NAME John W Reed DATE 9/2/91

NAME John D. Stevenson DATE 9/2/91

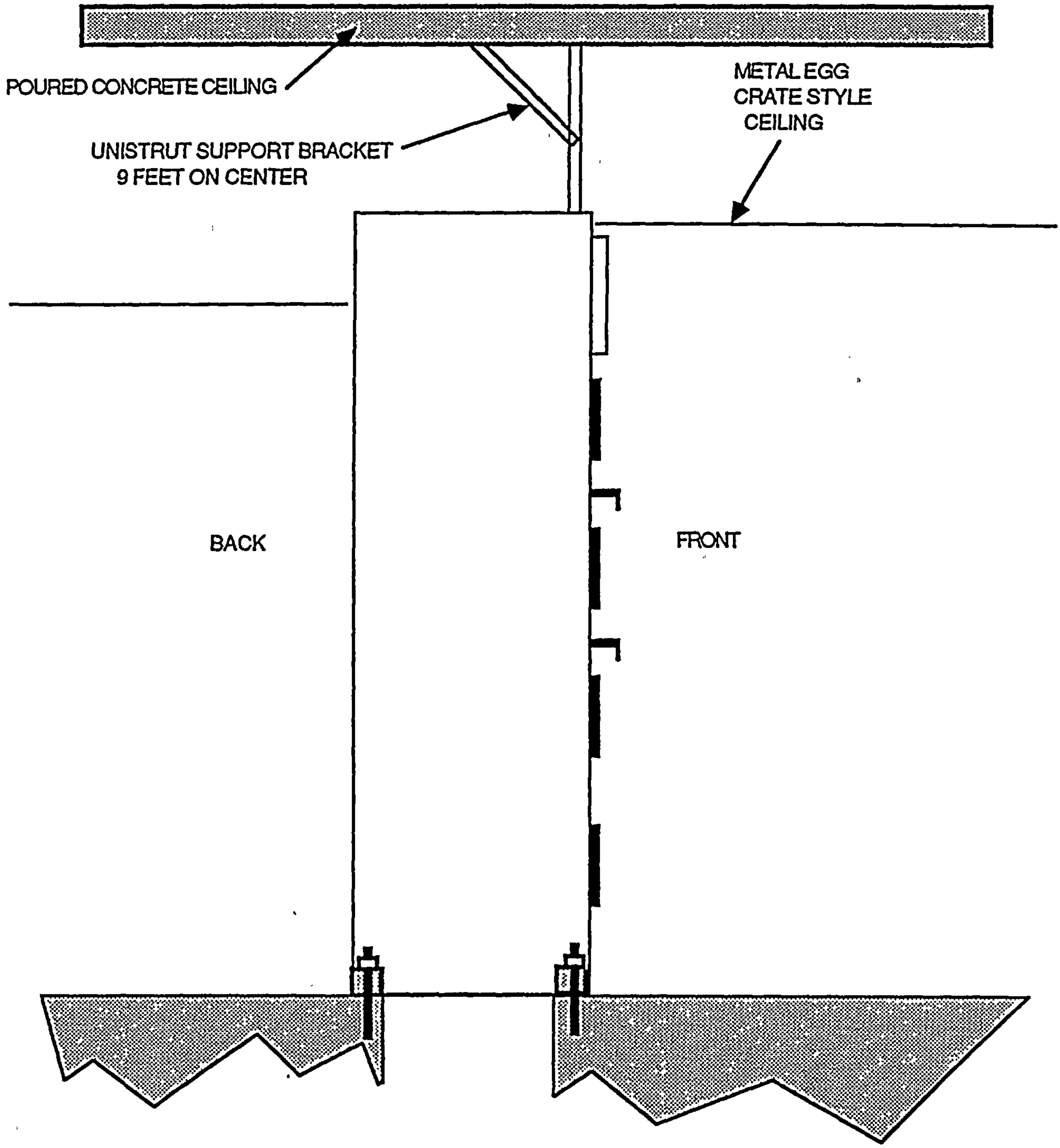
ITEM 55 CONTROL ROOM VERTICAL PANEL B

UNIT 3

1) The SRT REVIEWED the AS-built structure AND NOTED the curb ON which the VPB SITS. DRAWINGS WERE REVIEWED which showed REBAR IN the curb. The bolt length WAS DETERMINED USING AN ULTR-SOUND DEVICE OPERATED by A QUALIFIED MEMBER OF FPL's INSERVICE TESTING DEPARTMENT. The TOP OF the PANEL BRACING WAS Noted. Calculations were PERFORMED TO SHOW ADEQUACY.

2) AN INTERACTION CONCERN was raised About the Metal EGG CRATE ceiling. This could fall & injure the REACTOR operators & other staff members.

AS-FOUND FIELD CONDITION

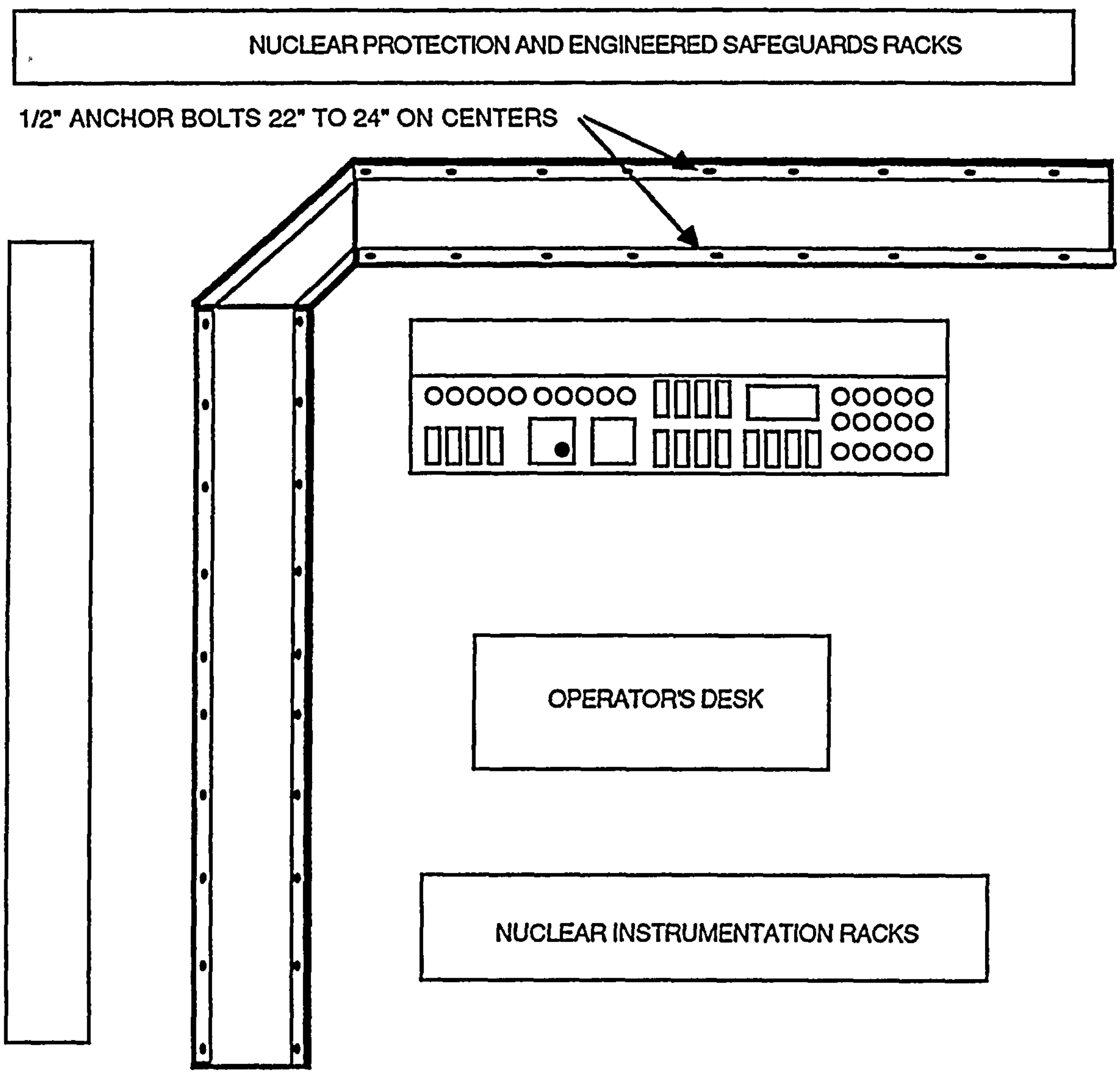


UNIT 3 VERTICAL PANEL B
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: VERTICAL PANEL B
DATE: MAR 28, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



UNIT 3 VERTICAL PANEL B
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: VERTICAL PANEL B
DATE: MAR 28, 1990 DWG BY: R. GOULDY

17

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Item 56 - Vertical Panel 4B

PART A. EQUIPMENT DESCRIPTION

I.D. Number 4C05, 4C06 Building Control

Manufacturer ______ Elevation 42'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ____
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 1/2" DIA spaced 22" to 24" both sides
5. Are nuts present and apparently tight on all bolts? present

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment ____
   b. URS Tables ____
   c. ANCHOR Program ____
   d. Other (explain) Perform Calculation & determine anchorage.
   → UTILIZED ULTRASOUND TO DETERMINE ~6" ANCHORS (4" min. embeddment) - Easily Safe for computed loads)
2. Concerns (if any) Edge distance Considered when the Calc is done. REVIEWED Curb drawing & NOTED Rebar LOCATIONS. NOTED TOP SUPPORT of PANEL DETAIL.

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) Temporary lighting and metal egg crate ceiling over control room can cut operator

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

ITEM 56 CONSIDERED AN OUTLIER BECAUSE OF CONCERN 2 ON THE ATTACHED PAGE. CONCERN 1 HAS BEEN RECONCILED BY REVIEW OF THE ATTACHED CALCULATIONS.

APPROVED BY SRT

NAME Robert P. Kennedy DATE 9/2/91

NAME John W. Reed DATE 9/2/91

NAME John D. Stevenson DATE 9/2/91

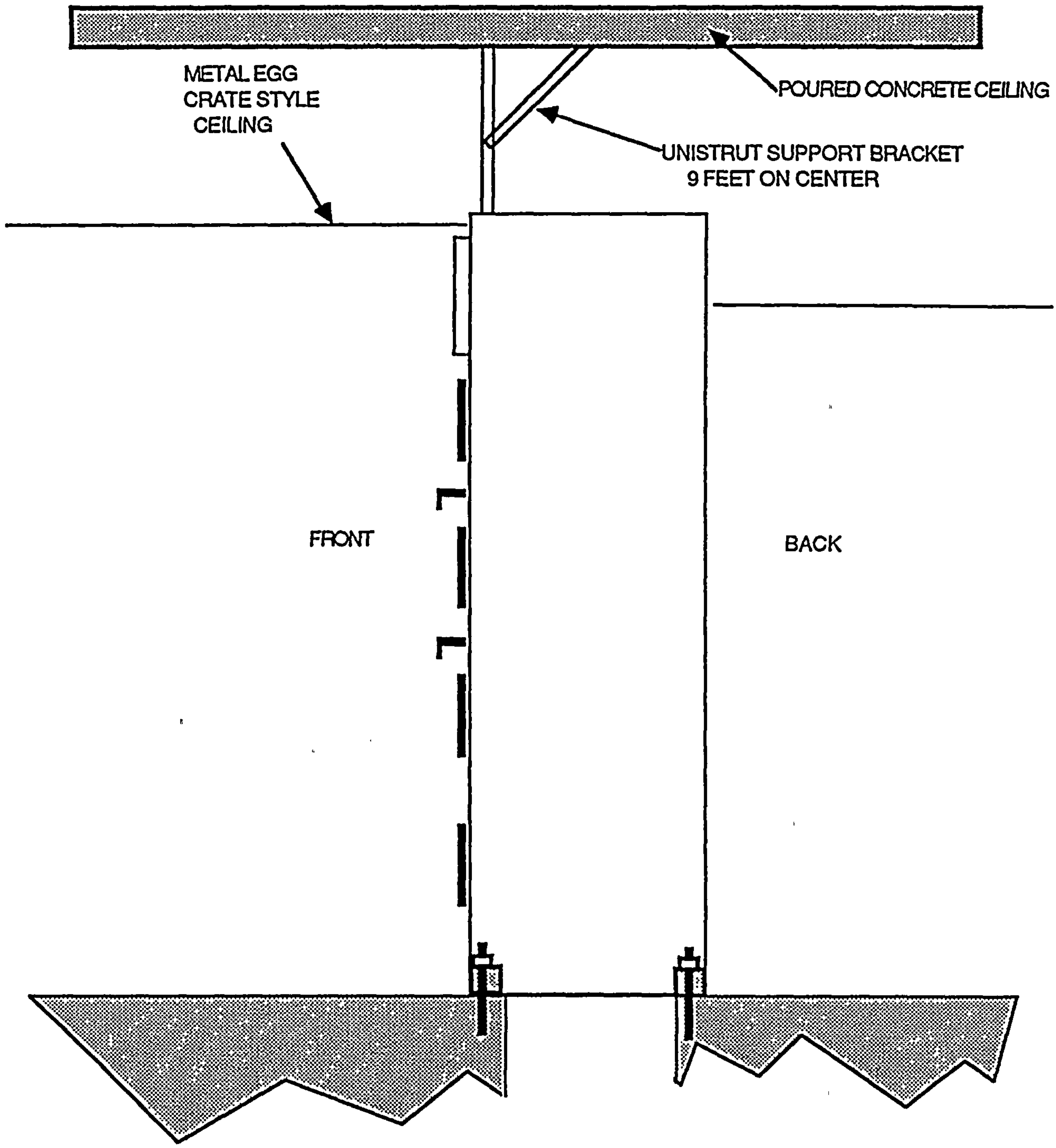
ITEM 56 CONTROL ROOM VERTICAL PANEL B

UNIT 4

1. The SRT REVIEWED the As-built structure AND NOTED the curb on which the VPB sits. DRAWINGS WERE REVIEWED which showed REBAR IN the curb. The bolt length WAS DETERMINED USING AN ULTR-SOUND DEVICE OPERATED by A QUALIFIED MEMBER OF FPL's INSERVICE TESTING DEPARTMENT. The TOP of the PANEL BRACING WAS Noted. Calculations were PERFORMED TO SHOW ADEQUACY.

2. AN INTERACTION CONCERN was raised About the metal EGG CRATE ceiling. This could fall & injure the REACTOR operators & other staff members.

AS-FOUND FIELD CONDITION



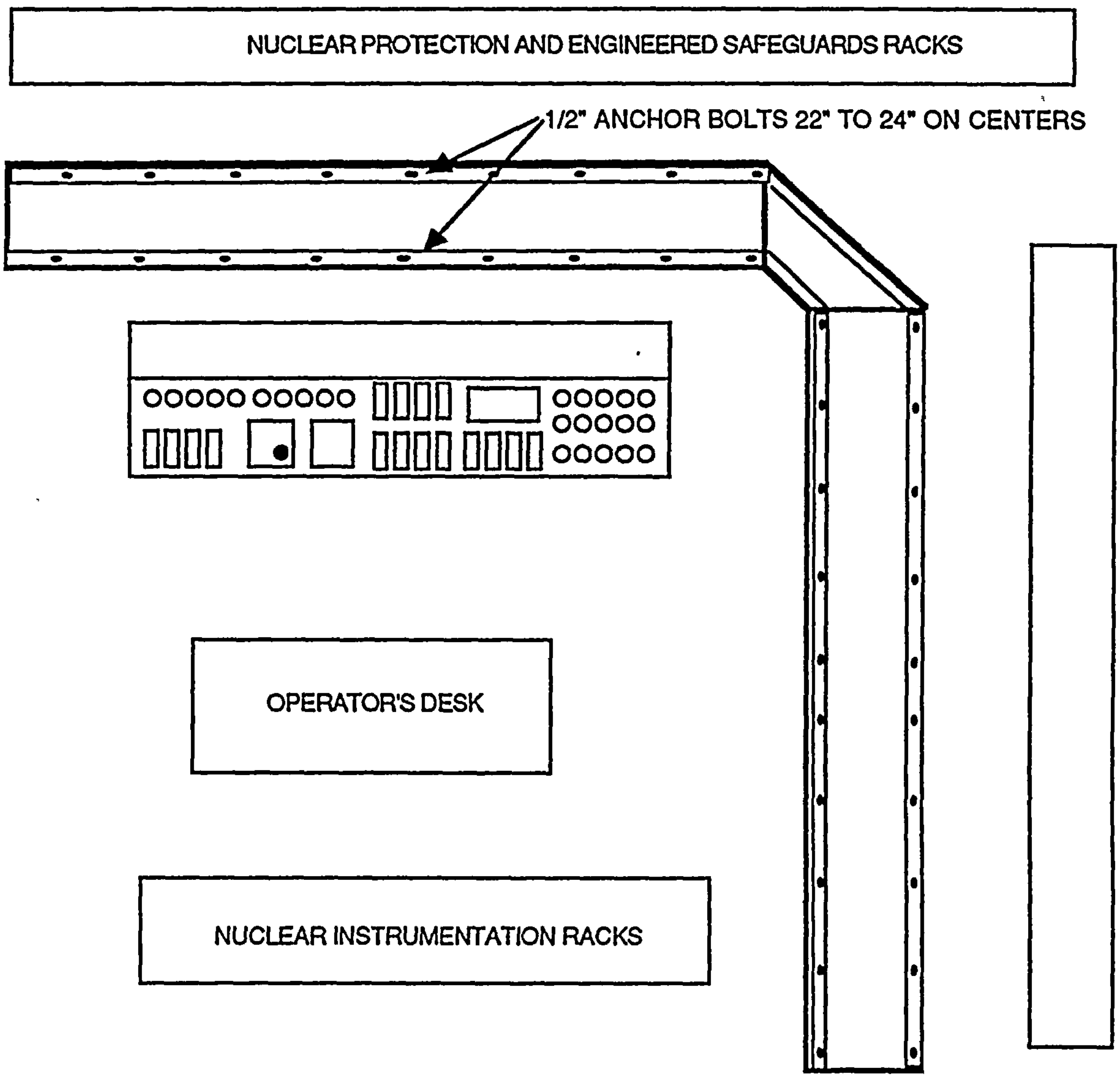
UNIT 4 VERTICAL PANEL B
SEISMIC MOUNTING WORKSHEET

GENERAL NOTES

1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: VERTICAL PANEL B
DATE: MAR 28, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



UNIT 4 VERTICAL PANEL B
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
2. SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: VERTICAL PANEL B
DATE: MAR 28, 1990 DWG BY: R. GOULDY

S$A JOB ⇒ 9CC1585

CALCULATION COVER SHEET

Calculation No: TPN-ISJC-91-001

Title: SUPPLEMENTARY ANCHORAGE CALCULATIONS TO PTN-O-J-C-90-003 ON VERTICAL PANEL 3B & 4B

No.	Description	By	Date	Chk/Ver	Date	Appr	Date
0	INITIAL ISSUE	[illegible]	8/6/91	RM	8/12/91	PRW	[illegible]

REVISIONS

LIST OF EFFECTIVE PAGES

CALCULATION NUMBER TPN-1SJC-91-001 REV. 0 8/6/91

PAGE	SECTION	REV	PAGE	SECTION	REV	PAGE	SECTION	REV
1	1.0 PURPOSE/SCOPE	0						
1	2.0 REFERENCES	0						
2	3.0 METHODOLOGY	0						
3	4.0 ASSUMPTIONS	0						
4	5.0 CALCULATIONS	0						
5	"	0						
6	6.0 RESULTS	0						

S&A JOB # 9001585

TABLE OF CONTENTS

CALCULATION NUMBER TPN-1530-91-001 REV. 0 8/6/91

STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

SUBJECT CALC # TPN-15JC-S&A 91-001 - SUPPLEMENTARY ANCHORAGE CALCULATIONS TO PTN-O-J-C-90-008 ON VERTICAL PANEL 3B & 4B ITEM 56

JOB No. 90C1585 SHEET 1 OF 6

REVISIONS: 0 — JWS 8/6/91; RM 8/12/91

1.0 PURPOSE / SCOPE

DURING THE USI A-46 WALKDOWN OF TURKEY POINT UNIT 3 & 4 A CONCERN WAS EXPRESSED REGARDING THE ANCHORAGE CAPACITY OF VERTICAL PANEL 3B & 4B. FLORIDA POWER & LIGHT PERFORMED

1 A CALCULATION ON THE ANCHORAGE CAPACITY TO ADDRESS THESE CONCERNS. THE SRT REVIEWED THIS CALCULATION AND RAISED SOME QUESTIONS WITH REGARD TO CERTAIN DETAILS. THIS CALCULATION WAS PERFORMED TO ADDRESS THESE QUESTIONS. THESE CALCULATIONS ARE SUPPLEMENTARY & DO NOT CONTAIN EVERYTHING NEEDED TO CONFIRM ANCHORAGE ADEQUACY.

1 THE REF. 1 CALCULATION CONTAINS THE ADDITIONAL INFORMATION. THE SCOPE OF THIS CALCULATION ONLY INCLUDES ANCHORAGE.

2.0 REFERENCES

1. FLORIDA POWER & LIGHT CALCULATION #PTN-O-J-C-90-008, SHEETS 44 TO 51, 5/1/90, REV 0.
2. TURKEY POINT - GROUND RESPONSE SPECTRA 15% ACCELERATION, FIGURE 5A-2, TURKEY POINT FSAR, APPENDIX A.

3. SSRAP Report, "Use of Seismic Experience Data to Show Ruggedness of Equipment in Nuclear Power Plants," Senior Seismic Review & Advisory Panel, April 16, 1990.

4. EPRI NP-5228, "Seismic Verification of Nuclear Plant Equipment Anchorage," URS Corporation/John A Blume & Assoc., Engineers

5. ACI-349-85, "Code Requirements for Nuclear Safety Related Concrete Structures," Appendix B Steel Embedments, American Concrete Institute, 1985.

3.0 METHODOLOGY

THE METHODOLOGY EMPLOYED IS TO CALCULATE THE BOLT LOADING FOR EARTHQUAKE LOADS IN THE THREE ORTHOGONAL DIRECTIONS (2 HORIZONTAL AND 1 VERTICAL). THESE LOADINGS WILL BE COMBINED BY ADDING 100% OF THE LOAD IN THE WORST (MOST LOADED) DIRECTION AND 40% IN THE OTHERS. THIS COMBINATION IS A CONSERVATIVE APPROXIMATION OF THE SRSS COMBINATION. GRAVITY LOADS WILL THEN BE ADDED.

THE RESPONSE SPECTRA @ ELEVATION 42' IN THE CONTROL ROOM. THREE PERCENT, 3%, DAMPING WILL BE USED AS APPLICABLE BY JUDGMENT OF THE SRT.

STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

SUBJECT CALC# TPN-ISJC-91-001 - SUPPLEMENTARY ANCHORAGE CALCULATIONS TO PTN-0-J-C-90-003 ON VERTICAL PANEL 3B & 4B ITEM 56

S&A JOB No. 90C1555 SHEET 3 OF 6

REVISIONS: 0 DDJ 8/6/91 RM 8/12/91

ACI 349, APPENDIX B PROCEDURES FOR SHEAR, PULLOUT AND SHEAR BUSTING WILL BE USED. THE PORTIONS OF THE REF. CALCULATION, THAT WERE QUESTIONED DURING THE REVIEW PROCESS WILL BE CORRECTED.

4.0 ASSUMPTIONS

THE FOLLOWING ASSUMPTIONS WERE MADE IN THIS CALCULATION:

a. WEIGHT OF PANEL IS 3 TIMES THE HOUSING WEIGHT.

b. PEAK OF RESPONSE SPECTRA FOR 3% EQUIPMENT DAMPING WILL BE USED.

c. ANCHORS ½" Φ HEADED CAST IN PLACE ANCHORS, A307 BOLTS.

d. SINCE PANELS ARE LONG, THE LONGITUDINAL HORIZONTAL EARTHQUAKE LOAD IS NEGLIGIBLE

S&A STEVENSON & ASSOCIATES a structural-mechanical consulting engineering firm	SUBJECT CALC# TPN-ISJC-91-001 - SUPPLEMENTARY ANCHORAGE CALCULATIONS TO PTN-0-1-C-SQ-037 ON VERTICAL PANEL 3B & 4B ITEM 56 — S&A JOB No. 90C1585 — SHEET 4 OF 6 — REVISIONS: 0 WJS 8/6/91, RM 8/12/91

5.0 CALCULATION

A. LOAD CALCULATIONS

1 WT. OF CABINET CALCULATED TO BE 435 LB/FT OF CABINET IN REF. 1 (PG 46 OF 52)

PEAK OF 1% FLOOR RESPONSE SPECTRA IS .679 g FOR 3% EQUIPMENT DAMPING, HORIZONTAL LOAD IS: $\sqrt{\frac{1}{3}} \times .679 = .392\,g$ (SINCE THIS IS FLOOR SPECTRA INPUT IT IS CONSERVATIVE) ✓

VERTICAL ACCEL = .1 g (PG. 47 OF REF. 1)

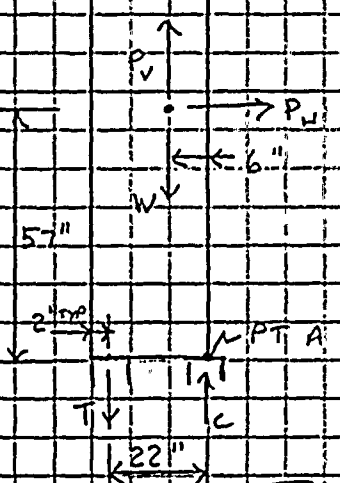
∴ HORIZONTAL LOAD/FT = 435 LB/FT · (.392 g) = 170.5 LB/FT ✓

VERTICAL LOAD/FT = 435 LB/FT · (.1 g) = 43.5 LB/FT ✓

WILL USE SAME C.G. LOCATIONS AS USED IN PG. 47 & 48 OF REF. 1

BY Σ MOMENTS ABOUT A

FOR EARTHQUAKE LOADS



$T_H = (170.5^{\#}/_{FT} \times 57'')/22'' = 441.8$ LB/FT ✓

$T_V = (43.5 \times 6'') \times .4 / 22'' = 4.7$ LB/FT ✓ (1.4 + .4V)

$C_{WEIGHT} = 435 \cdot (6'')/22'' = -118.6$ LB/FT ✓

$T_{TOTAL}/FT = 327.9$ LB/FT ✓

$V/FT = 170.5 / 2$ BOLTS (EACH SIDE) $= 85.3$ LB/FT ✓

TOTAL SHEAR & TENSION FOR A 2' BOLT SPACING

$T_{TOTAL}/BOLT = 2 \cdot (327.9) = 656$ LB/BOLT $V_{TOT}/BOLT = 2(85.3) = 171$ LB/BOLT

B. BOLT ALLOWABLE

1. FOR 1/2" ϕ A307 BOLT WITHOUT REDUCTION DUE TO EDGE EFFECTS OR EMBEDMENT DEPTH IS AS FOLLOWS FOR MHE

TENSION = 1.7 × 20 KSI = 34 KSI ✓
SHEAR = 1.7 × 10 KSI = 17 KSI ✓

FOR 1/2" ϕ BOLT ~ A = .196 □"

T_{AL} = .196 □" × 34 KSI = 6.66 K/BOLT ✓
V_{AL} = .196 × 17 KSI = 3.33 K/BOLT ✓

2. TENSION ALLOWABLE DUE TO CONE PULLOUT ✓

$A = \frac{2 \cdot (60°)}{360°} \cdot \pi (4)^2 + 2" \cdot (2 \cdot \cos 30°) \cdot 4" = 30.6\ IN^2$

ALLOWABLE STRESS PER ACI 349-85 SECTION B.5.1.2.1

$= 4 \phi \sqrt{f'_c} = 4 (.65) \sqrt{3000\ PSI} = 142.4\ PSI$ ✓
(CONSERVATIVELY ASSUME NO REBAR IN CURB)

$T_{AL} = \frac{30.6\ IN^2 \cdot 142.4}{1.5} = 2905\ LB/BOLT$ ✓
(1.5 – FACTOR OF CONSERVATISM SINCE THIS IS A BRITTLE FAILURE MODE ✓)

BOND IS NOT A CREDIBLE FAILURE MODE SINCE BOLT HAS HEAD. ✓

3. SHEAR ALLOWABLE DUE TO SIDE BURSTING

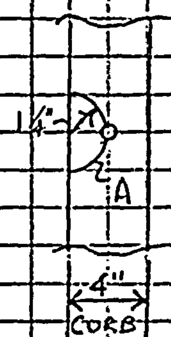
MINIMUM DISTANCE BETWEEN ℄ OF BOLT AND CURB OBSERVED DURING THE WALKDOWN WAS 1 1/4".

SUBJECT CALL # TPN - ISJ C - S&A JOB No. 90C1585 SHEET 6 OF 6

91-001 - SUPPLEMENTARY ANCHORAGE CALCULATIONS TO PTN-0-J-C-90-003 ON VERTICAL PANEL 3B & 4B ITEM 56

REVISIONS: 0 DDS 8/6/91 / RM 8/12/91

STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm



$A = \frac{\pi (1.25)^2}{2} = 2.45 \text{ in}^2$ ✓

ALLOWABLE STRESS $= 4\phi\sqrt{f'_c} = 4(.65)(\sqrt{3000 \text{ psi}})$
$= 142.4 \text{ psi}$ ✓

$V_{AL} = \frac{142.4 \text{ psi} (2.45)}{1.5} = 233 \text{ LB/BOLT}$ ✓

1.5 FOR A BRITTLE TYPE FAILURE

C. CHECK OF BOLT LOAD TO ALLOWABLE

$T_{AL} = 2905^{LB} > 656^{LB}$ OK

$V_{AL} = 233^{LB} > 171^{LB}$ OK ✓

SHEAR TENSION INTERACTION ✓

4) $\left(\frac{T}{T_{AL}}\right)^{5/3} + \left(\frac{V}{V_{AL}}\right)^{5/3} = \left(\frac{656}{2905}\right)^{5/3} + \left(\frac{171}{233}\right)^{5/3} = .68 < 1$ OK

6.0 RESULTS

LOADINGS ON BOLTS FOR VERTICAL PANELS 3B AND 4B ARE WITHIN ALLOWABLE STRESS LIMITS. THE ABOVE CALCULATIONS INCLUDED SEVERAL CONSERVATIVE ASSUMPTIONS. THE PEAK OF THE RESPONSE SPECTRA WAS USED; ACI 349 APPENDIX B ALLOWABLES FOR CONE TENSION PULLOUT & SIDE BURSTING WERE REDUCED BY A 1.5 FACTOR. THE MINIMUM SIDE EDGE DISTANCE WAS USED FOR V, WHEN THIS EFFECT WILL BE AVERAGED OVER SEVERAL BOLTS.

S&A

STEVENSON & ASSOCIATES
a structural-mechanical consulting engineering firm

SUBJECT ______ JOB No. 90C1585 SHEET 1 OF 1

Vertical Panel 3B + 4B

REVISIONS: WD 5/1/91

Djordjevic Reviewed Calculation PTN-0-J-C-90-0003

FP&L generated calculation for Vertical Panel anchorage.

FP&L used 3 x housing wt for total weight

FP&L followed ACI 349 App B procedures for shear cone pullout and shear bursting calculations.

W. Djordjevic concurs with analysis and recommends approval.

(8) Item 57

90C1585A/DATASHT

TURKEY POINT UNITS 3 AND 4
EQUIPMENT DATA SHEET

EQUIPMENT Diesel Generator Exciter Cabinet

PART A. EQUIPMENT DESCRIPTION

I.D. Number ______ Building D/G Building

Manufacturer Schoonmaker Elevation 18'

Model Number ______ Other ______

PART B. ANCHORAGE DESCRIPTION

1. Is equipment anchored? Yes X No ___
2. Condition of nearby concrete and embedments good
3. Length, size, number, and soundness of welds N/A
4. Anchor bolt type, size and number 4 1/2" J Bolts
5. Are nuts present and apparently tight on all bolts? ______

PART C. ANCHORAGE ADEQUACY

1. Does Seismic Capacity of Anchorage Exceed Demand?
   a. SRT Judgment X
   b. URS Tables ___
   c. ANCHOR Program ___
   d. Other (explain) Bounding Anchorage Calculation to be performed. Review Embedment Drawing → Calculation performed and acceptable
2. Concerns (if any) ______

PART D. SPATIAL SEISMIC INTERACTION CONCERNS (if any) NONE

PART E. RECOMMENDED COURSE OF ACTION TO RESOLVE (PART C) OR (PART D) OR OTHER CONCERNS (if any)

______

APPROVED BY SRT

NAME John D. Stevenson DATE 4/4/90

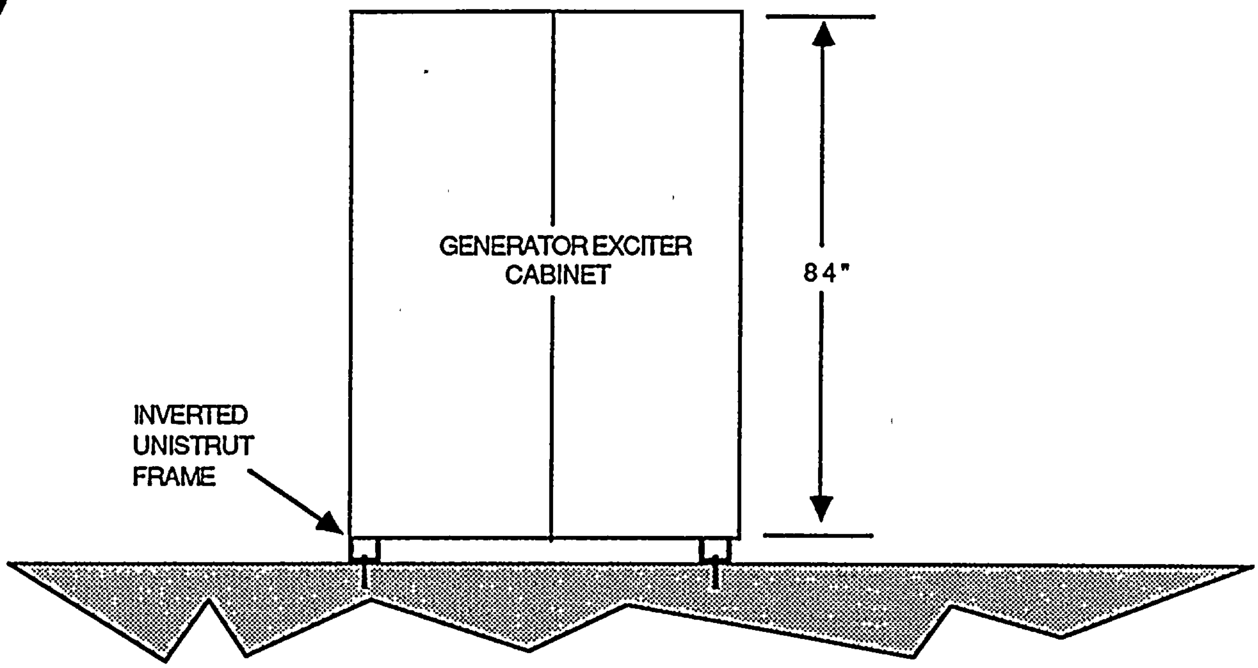
NAME Robert P. Kennedy DATE 4/4/90

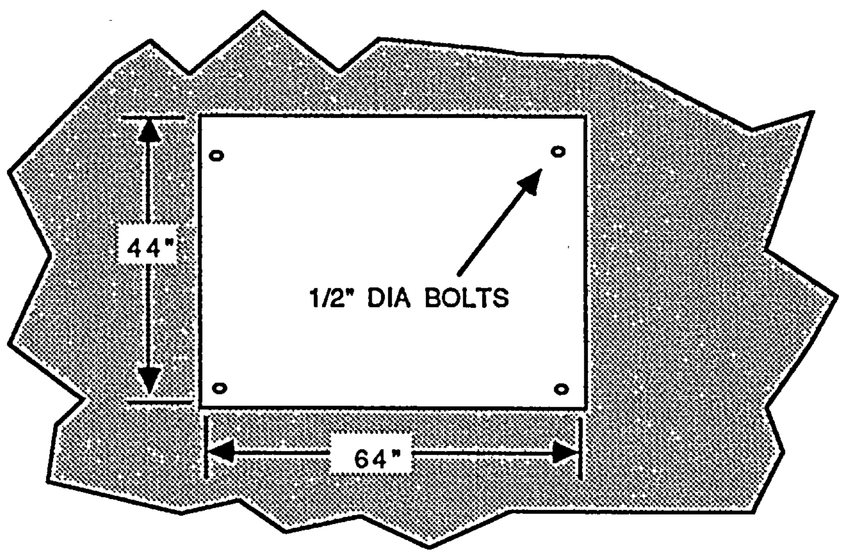
NAME John W Reed DATE 4/5/90

ITEM 57. ED/G EXCITER CABINET - B

The SRT REQUESTED AN OVERTURN Calculation for this cabinet. The Review of the Calculation determined that the cabinet was ADEQUATELY Anchored.

AS-FOUND FIELD CONDITION



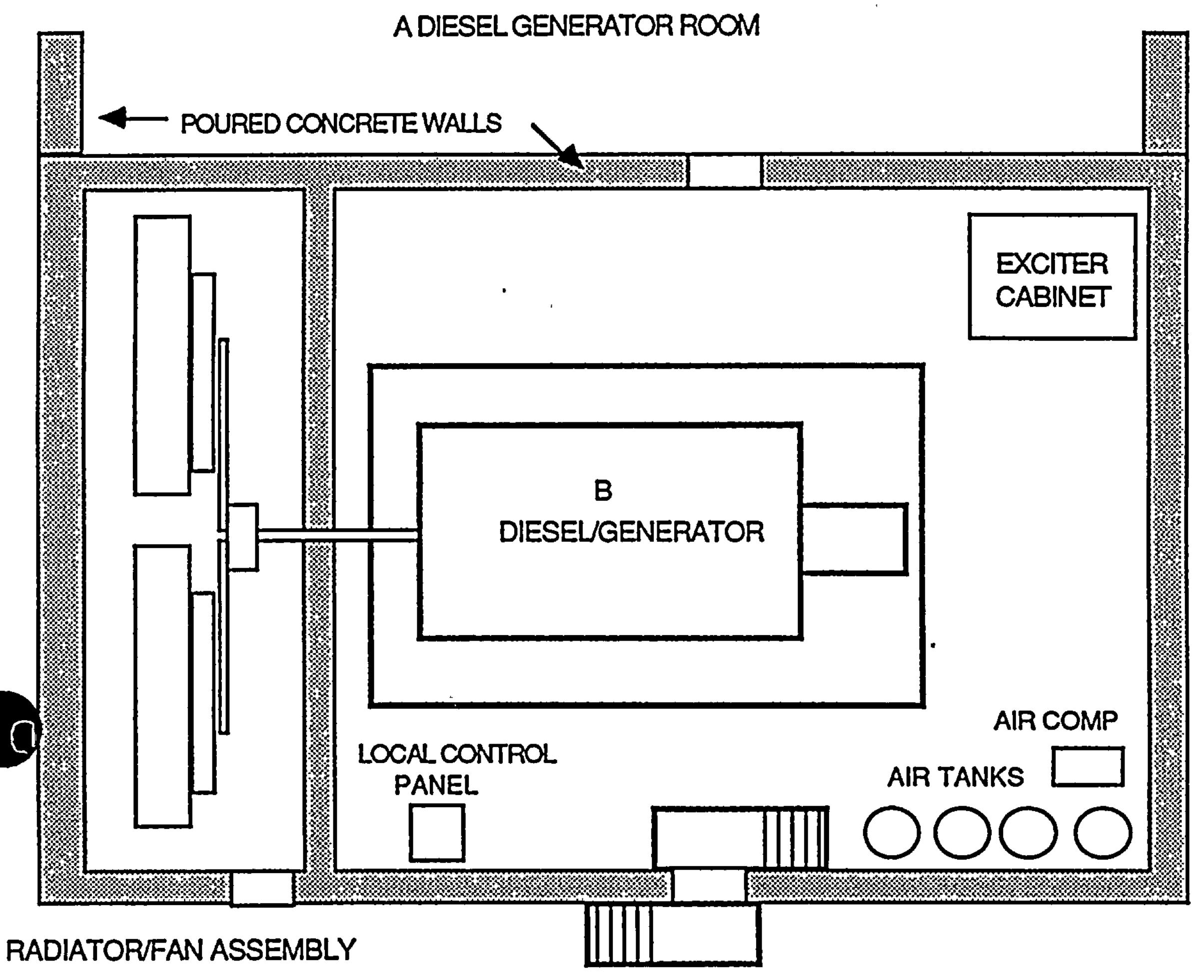


B DIESEL GENERATOR EXCITER
ELECTRICAL EQUIPMENT MOUNTING WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: B D/G EXCITER CABINET
DATE: MAR 22, 1990 DWG BY: R. GOULDY

AS-FOUND FIELD CONDITION



THERE WERE NO SEISMIC INTERACTION CONCERNS NOTED BY THE SRT.

B DIESEL GENERATOR SKID
SEISMIC INTERACTION WORKSHEET

GENERAL NOTES
1. DO NOT SCALE, USE DIMENSIONS TAKEN DURING FIELD WALK DOWN.
SKETCHES ARE INTENDED TO BE AN AID IN THE ANCHORAGE EVALUATION. SEE ENGINEERING DRAWINGS FOR SAFETY RELATED WORK.

PTN 3&4 GL 87-02 WALKDOWN
EQUIPMENT ANCHORAGE SKETCH
COMPONENT: B DIESEL GENERATOR ROOM
DATE: MAR 22, 1990 DWG BY: R. GOULDY

ATN ITEM 57

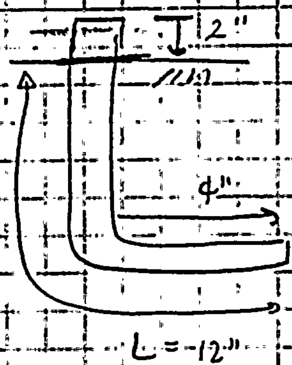
S&A
STEVENSON
& ASSOCIATES
a structural-mechanical
consulting engineering firm

SUBJECT ____ JOB No. ____ SHEET 1 OF ____

EDG Exciter Cabinet

REVISIONS: WD

Anchorage   See Drwg C-904



4 - ½" Anchors / Exciter

Assume bend = 4r = 2ϕ

Equivalent L = 8" + 4 - 2(½) + 8(½) = 15"

$T_{cap} = 15''(0.5'')\,\pi \times 1.2 \times \frac{25.4^2}{4.45} = 4.1^K$

Volume of Exciter Cab = $\frac{64'' \times 44'' \times 90''}{1728} = 146\ ft^3$

$W = 146 \times 35\ \#/ft^3 = 5^K$

$Shear/bolt = \frac{5\,(0.33g)\sqrt{2}}{4} = 0.6^K/bolt$

Check if cabinet can develop tension

$OTM = \frac{90}{2}\,(0.33g)\,5^k = 74^{k\text{-}in}$

$RM = 22\,(5) = 110\ k\text{-}in$ No tension in bolts

APPENDIX D

Peer Review Report

March 5, 1993
113002\L930305

George G Thomas
Project Manager
Stevenson and Associates
9217 Midwest Avenue
Cleveland, OH 44125-2415

Dear Gary:

Re: Peer Review of Turkey Point Unit # 3 & 4 A46 Program

This letter completes my review of the Turkey Point Unit 3 & 4 A46 Program.

1. **Draft Report.** The draft report on the A46 evaluation was very complete. This facilitated my review. My review of the draft report on the A46 effort: *"Plant Specific Seismic Adequacy Evaluation of Turkey Point Units 3 and 4 to Resolve Unresolved Safety Issue (USI) A-46 and Generic Letter (GL) 87-02,"* prepared by Stevenson & Associates for Florida Power & Light, December 31, 1992, is contained in my letter of February 26th. My comments are minor, and many were editorial in nature, often to clarify my understanding. If any of the suggested understandings in my letter are incorrect, I would appreciate it if you could bring this to my attention.

If the report is revised to reflect any of my comments, I would be pleased to review the next revision of it.

2. **Sample Walkdown.** I performed a walkdown on January 22, 1993. I was able to walkdown many of the components in the program. My primary emphasis was on anchorage and seismic spatial interaction. I did not identify any new issues that were not identified in the earlier walkdowns.

Only some of the modifications identified in the A46 report were complete at the time of my walkdown. The modifications appeared to be carried out in a very conservative manner, especially considering the low seismicity of the Turkey Point site. I later verified that paperwork was in progress for many other modifications.

3. **Review of Documentation.** *FPL* has prepared a folder on each of the components in its A46 program. I reviewed several of these folders, some in detail, and others only briefly. The folders typically contained information/drawings on anchorage, including details that could not be determined from a walkdown.

I identified no new issues in my review.

4. **Components in Review.** My review was restricted to seismic issues. Whether the appropriate components are included in the St Lucie Unit 1 A46 program is beyond the scope of my review.

5. FPL A46 Program. I assume that section 3.2.3.6, which is titled *"Miscellaneous"* could also have been titled *"All Other Equipment"* with the intent of addressing all other program equipment not specifically identified by type or class. However, GL 87-02 does include cable trays, and I could not find where they are mentioned in the program or report. If cable trays have been omitted from the program, the omission may need to be explained.

Conclusion. I found no significant deficiencies in the A46 review effort that was performed on Turkey Point Units 3 and 4. I also found no deficiencies in the plant in my walkdown.

Having a draft report to review, and the folders on each component in the program, particularly as complete as they are, greatly facilitated my review. With this level of detail available, I thought the review was very efficient and proceeded very smoothly.

I did note that some tank outliers had not been resolved at the time of my review.

Thanks again for involving me in this job. I appreciate the opportunity to support ***Stevenson & Associates*** in this work.

Sincerely,
The *Readiness* Operation, Inc.

Paul Smith

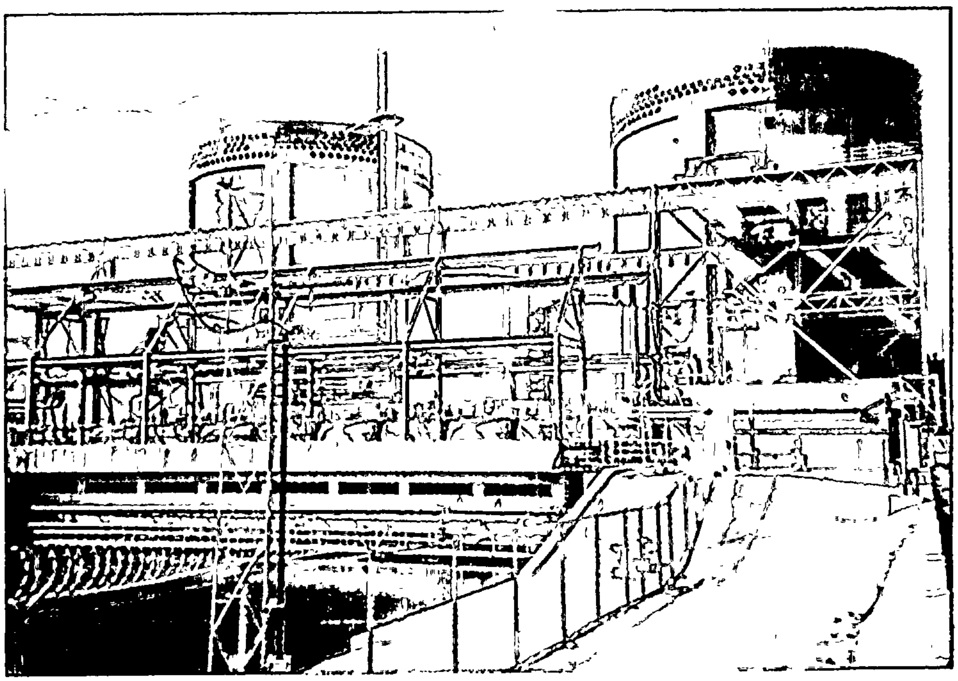
Paul Smith
President

xc John Luke, FP&L

APPENDIX E

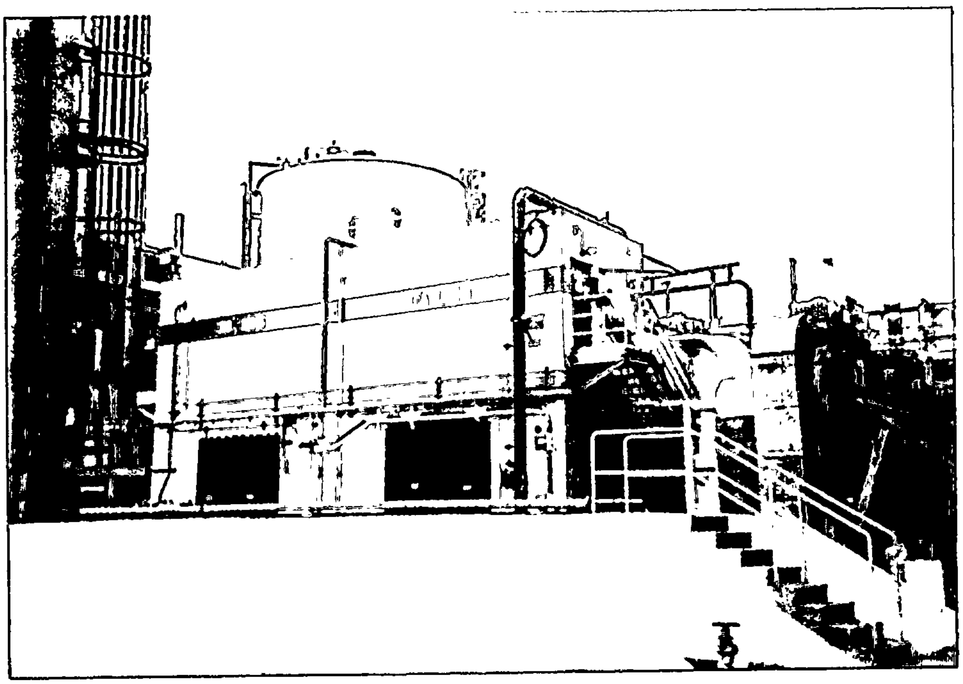
COMPONENT PHOTOGRAPHS

COMPONENT PHOTOGRAPH



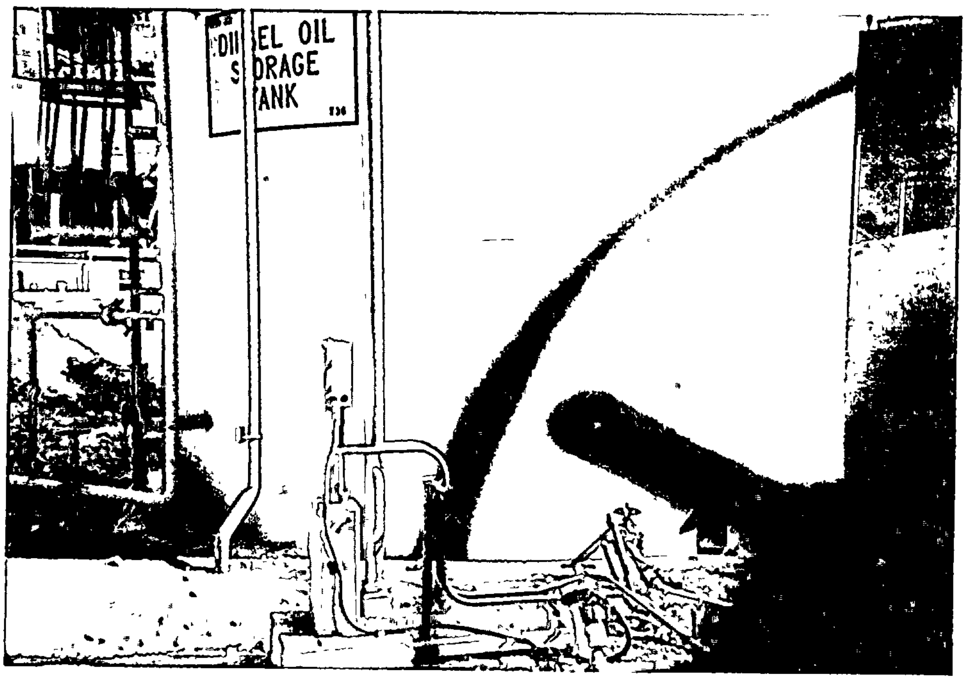
INTAKE COOLING WATER PUMPS

COMPONENT PHOTOGRAPH



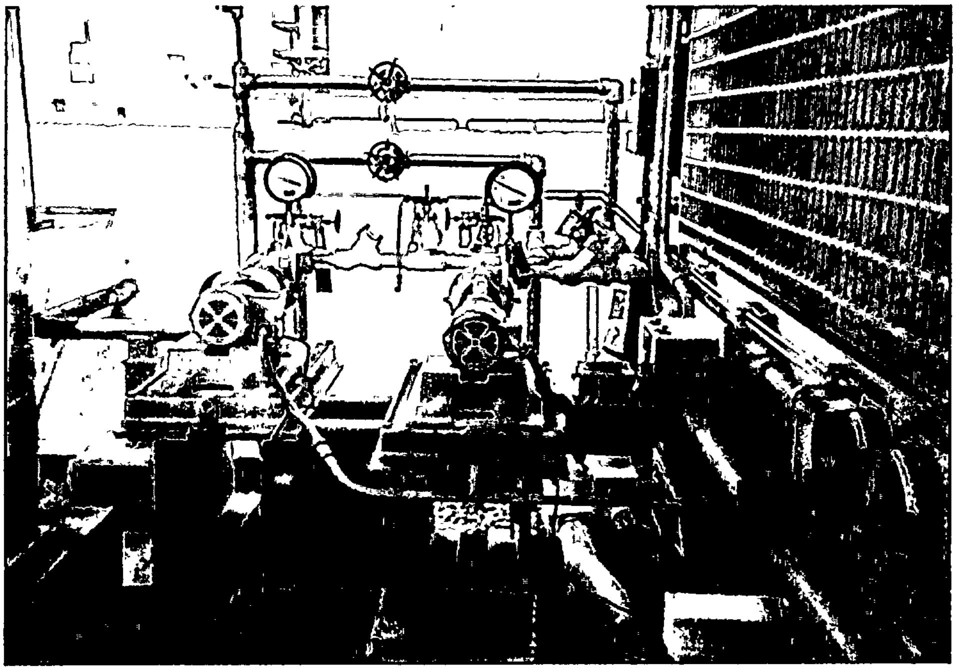
EDG BUILDING

COMPONENT PHOTOGRAPH



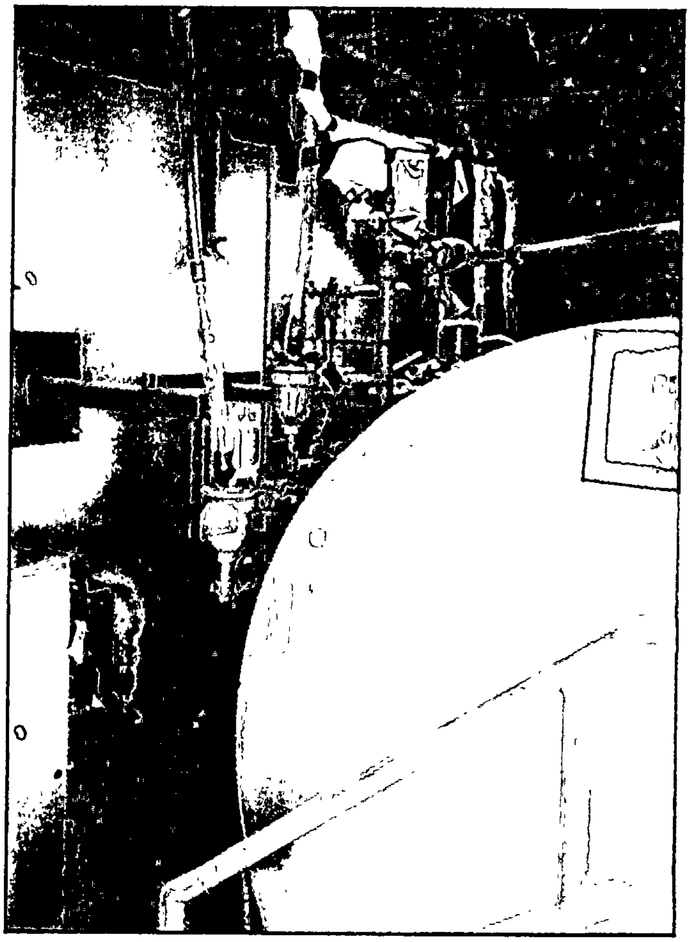
DIESEL OIL STORAGE TANK

COMPONENT PHOTOGRAPH



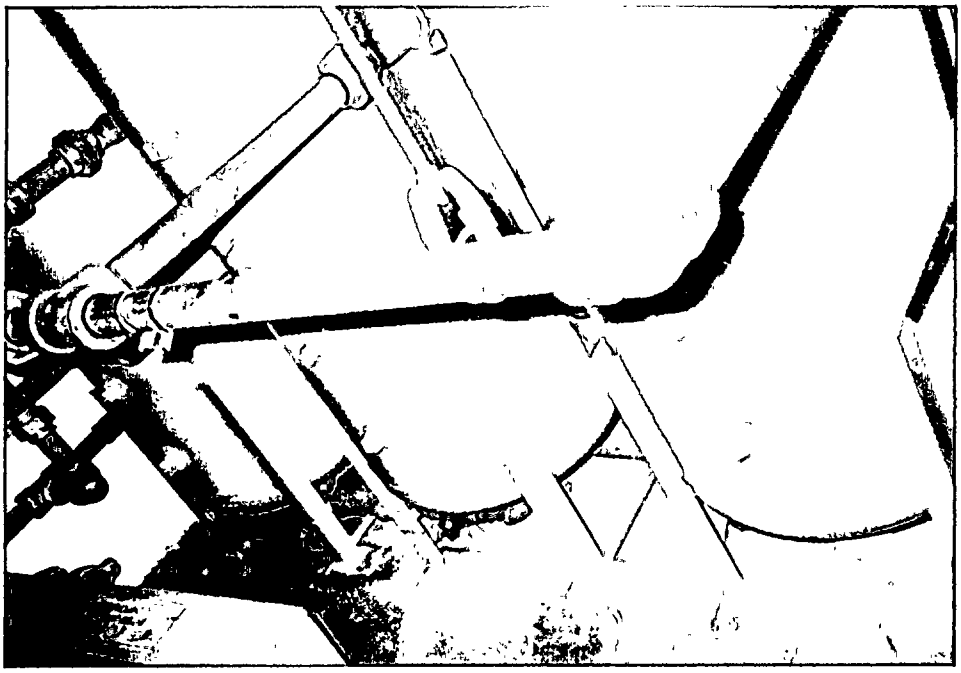
B DIESEL OIL TRANSFER PUMP

COMPONENT PHOTOGRAPH



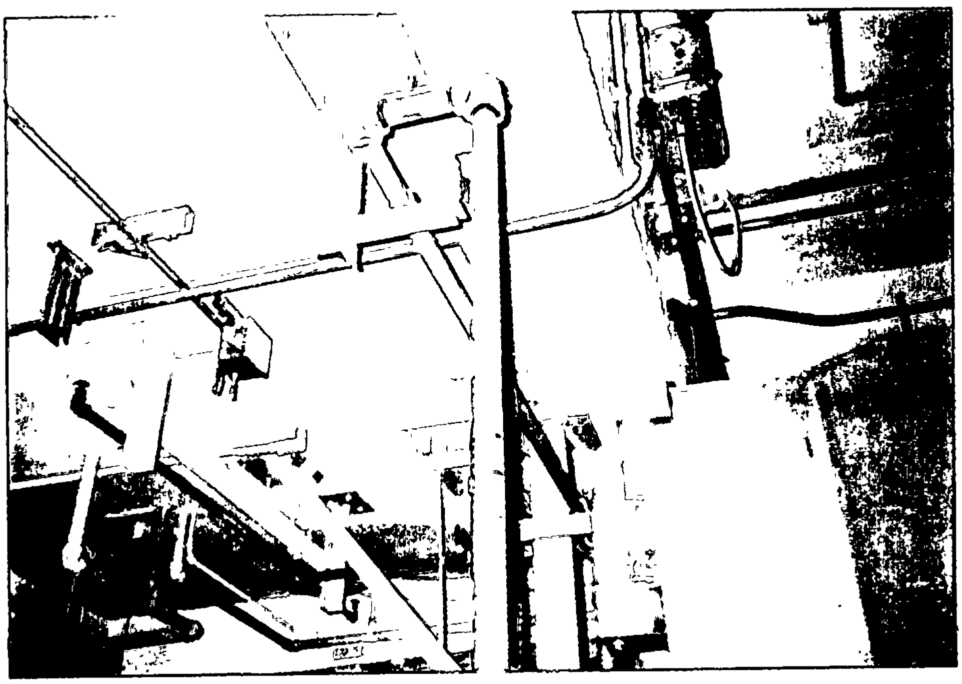
B EDG DAY TANK

COMPONENT PHOTOGRAPH



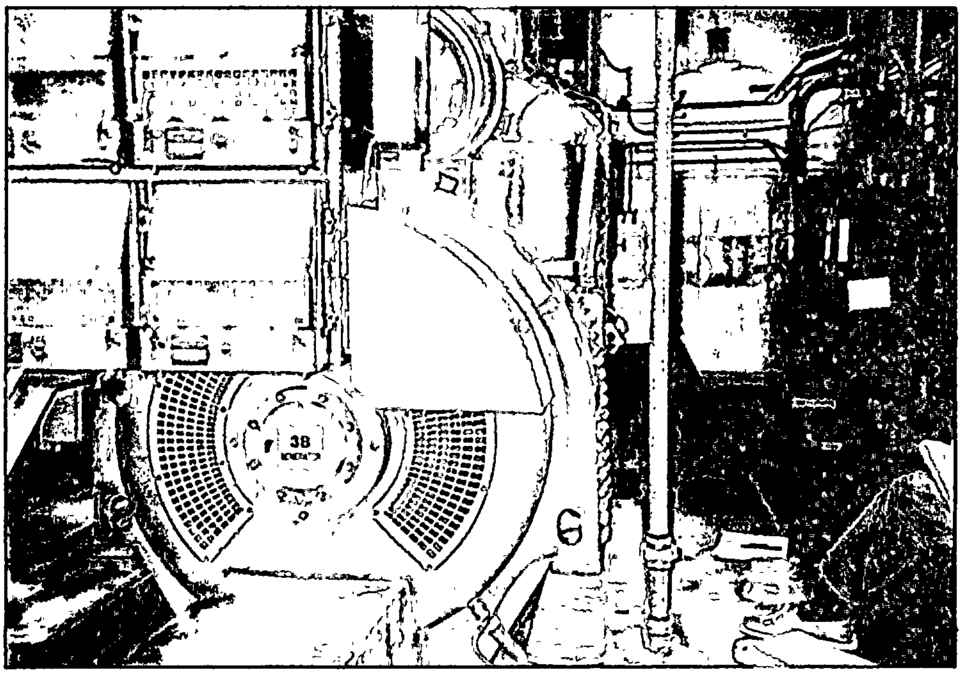
B EDG AIR START TANKS

COMPONENT PHOTOGRAPH



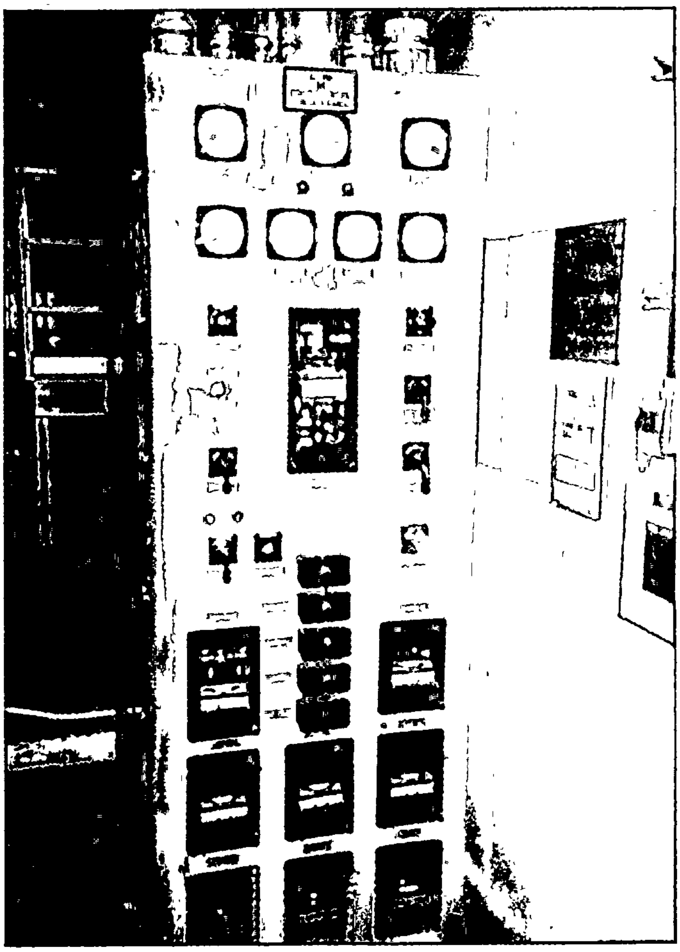
3B EDG AIR START PIPING

COMPONENT PHOTOGRAPH

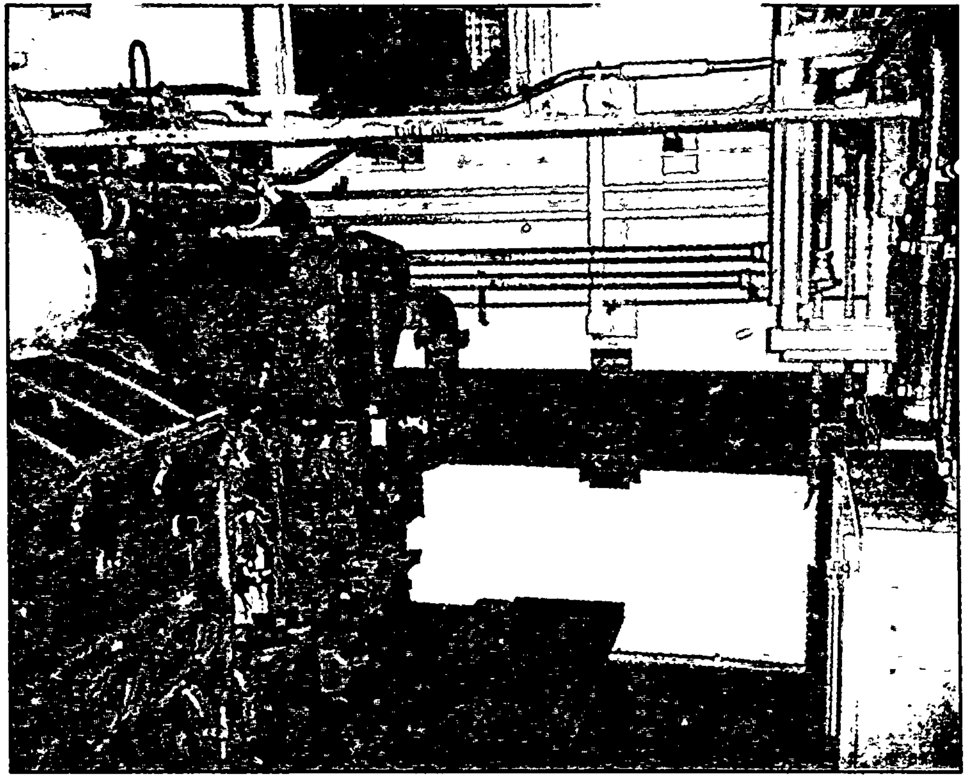


B EMERGENCY DIESEL GENERATOR SKID

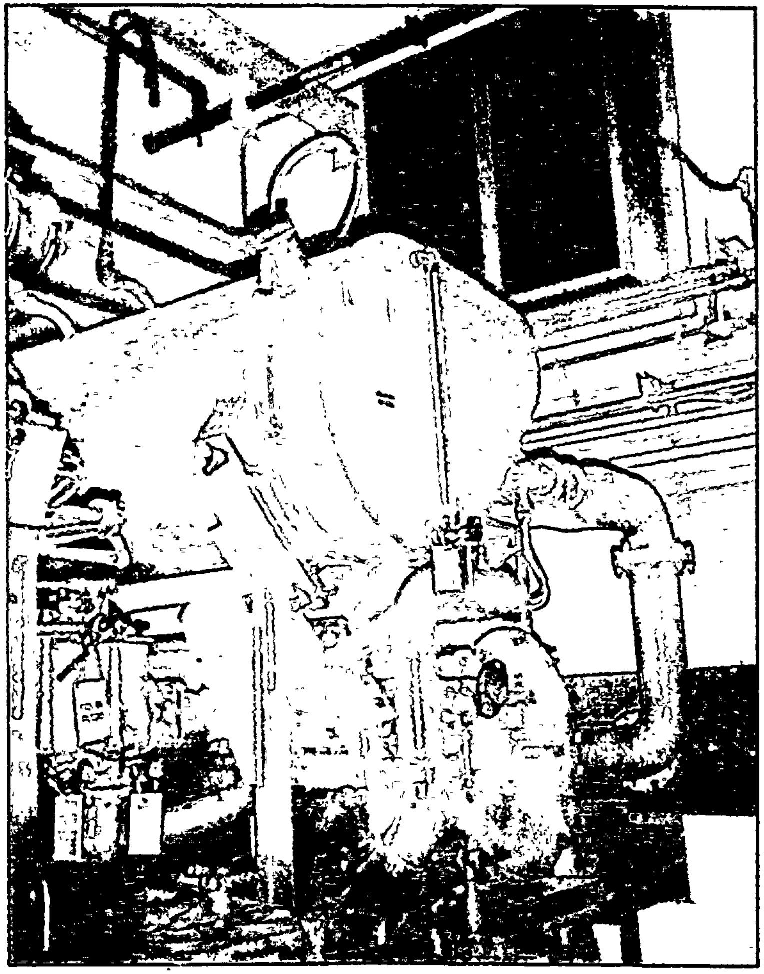
COMPONENT PHOTOGRAPH



4C12 EDG LOCAL CONTROL
PANEL B

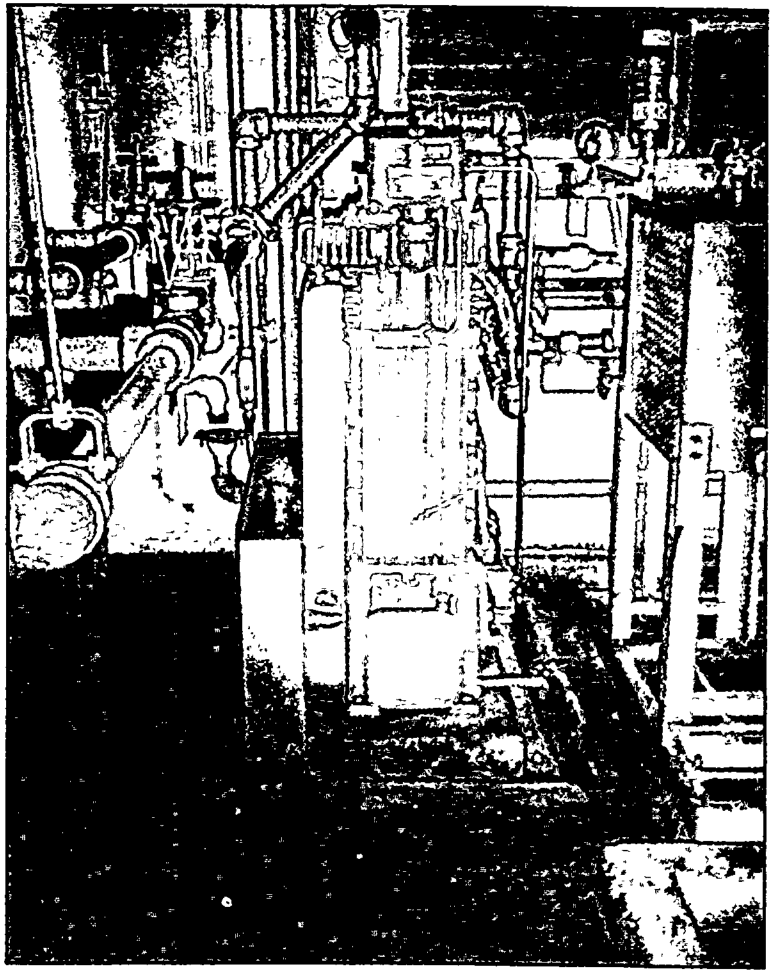


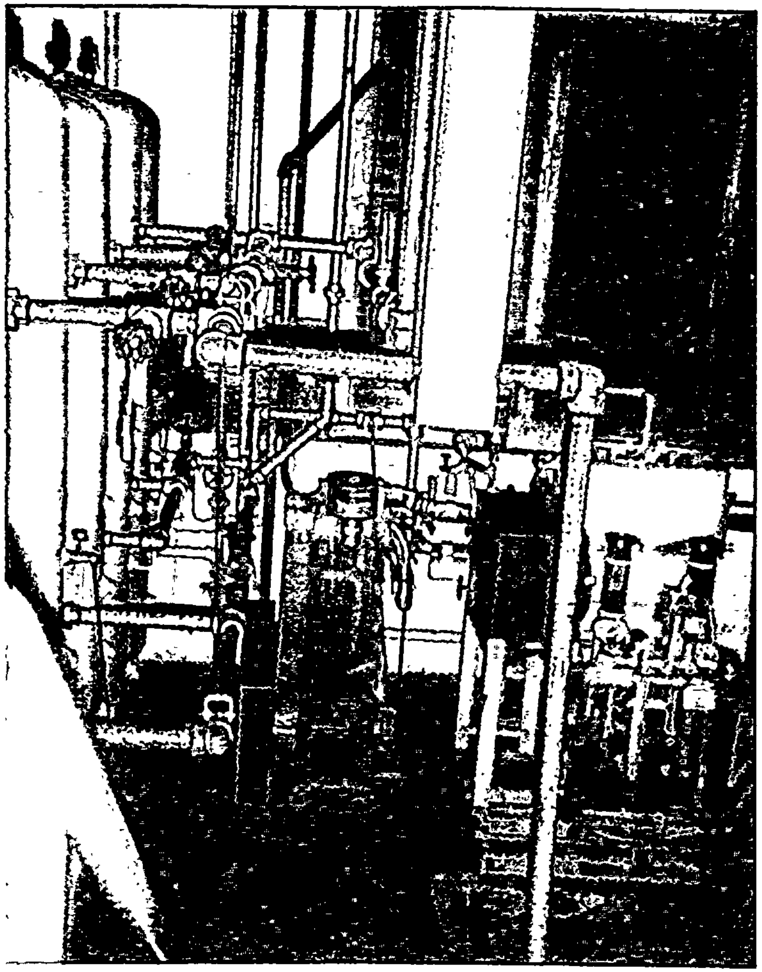
UNIT 3 ARRANGEMENT IS CLEAR FROM SEISMIC INTERACTION CONCERNS



UNIT 4 ARRANGEMENT IS CLEAR FROM SEISMIC INTERACTION CONCERNS

DIESEL COOLING WATER SURGE TANK SIGHT GLASS

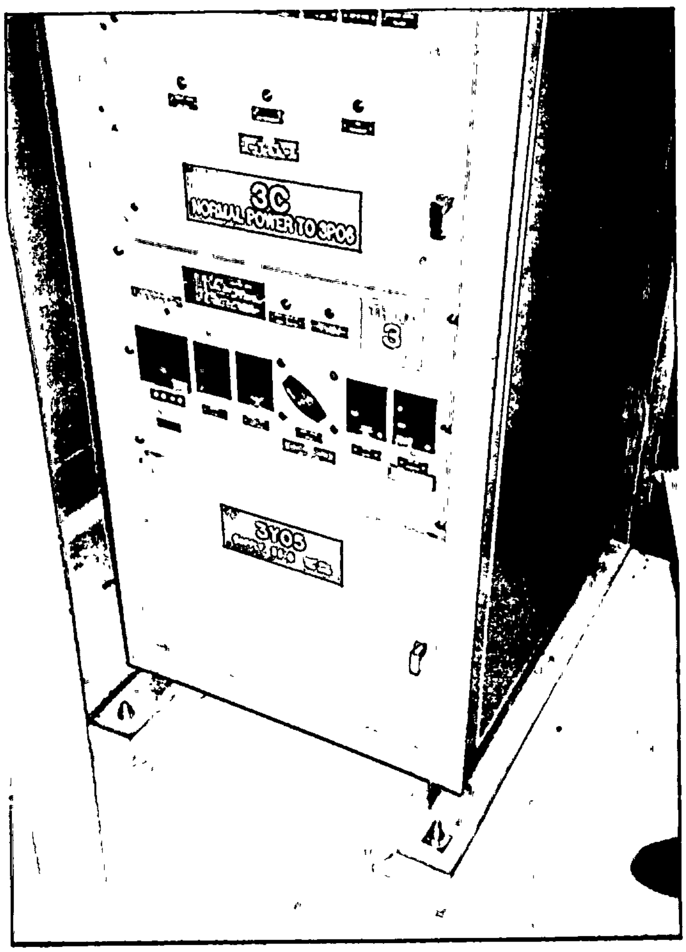




NEW DIESEL STARTING AIR COMPRESSOR AND FILTER

UNIT 3 IS SHOWN, TYPICAL FOR UNIT 4

COMPONENT PHOTOGRAPH



3Y05 INVERTER 3C

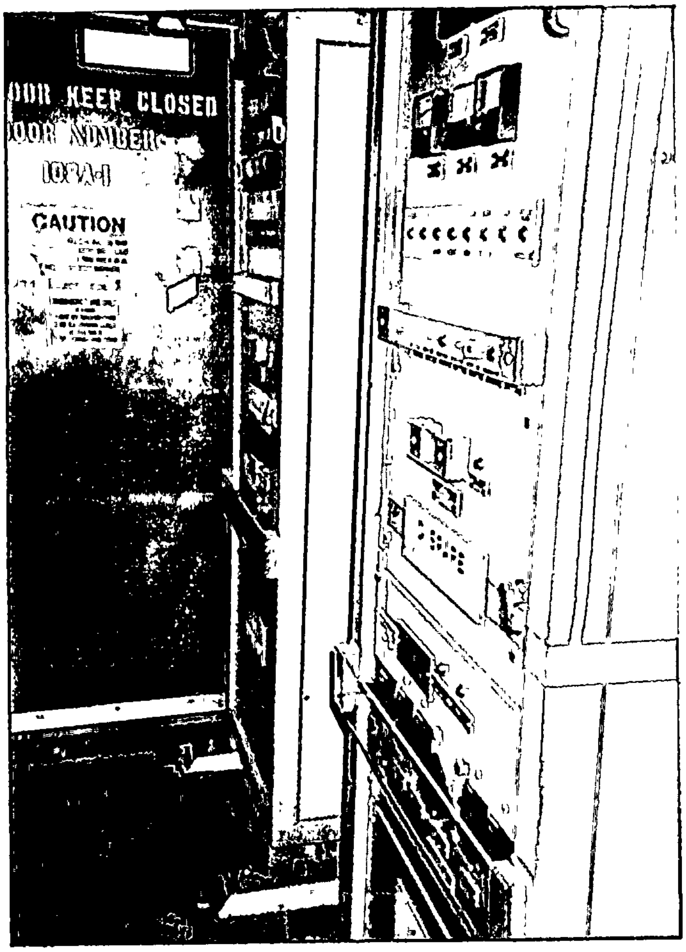
COMPONENT PHOTOGRAPH

3Y07 INVERTER 3D

COMPONENT PHOTOGRAPH

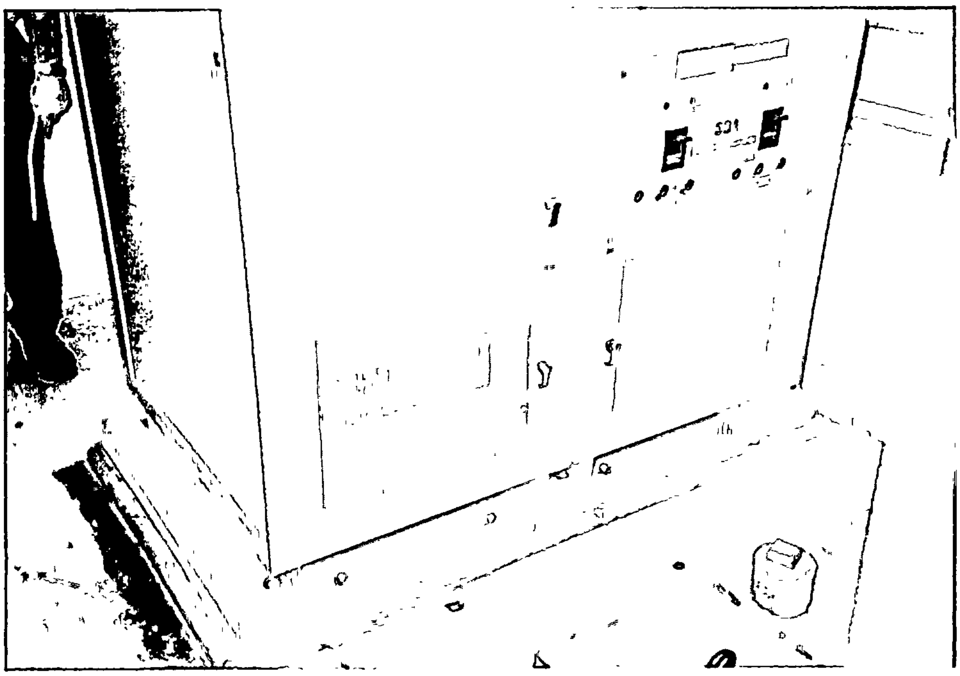
4Y05 INVERTER 4C

COMPONENT PHOTOGRAPH



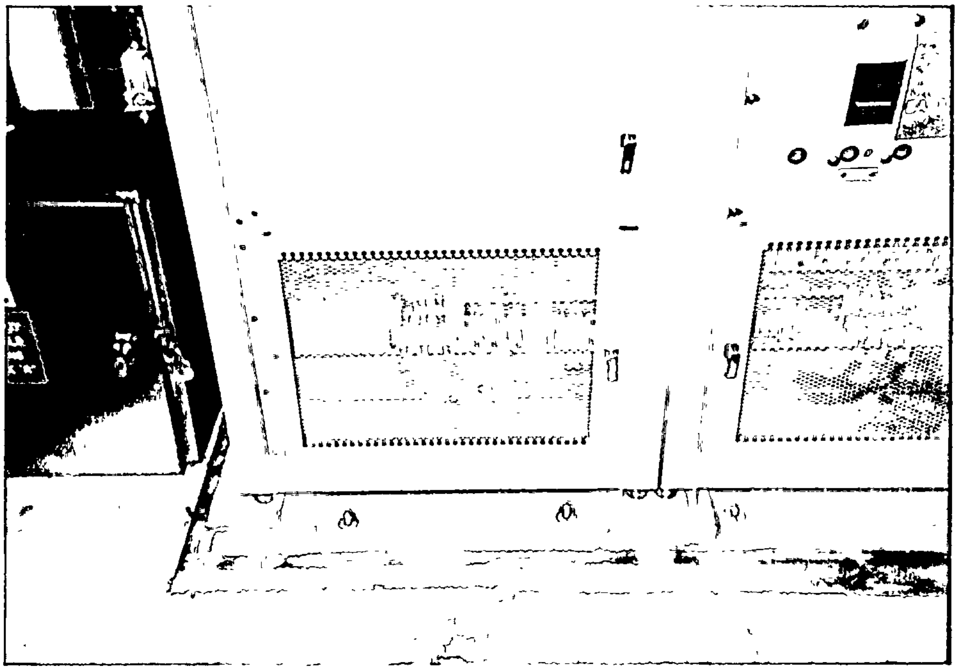
4Y07 INVERTER 4D

COMPONENT PHOTOGRAPH



BATTERY CHARGER 3B

COMPONENT PHOTOGRAPH

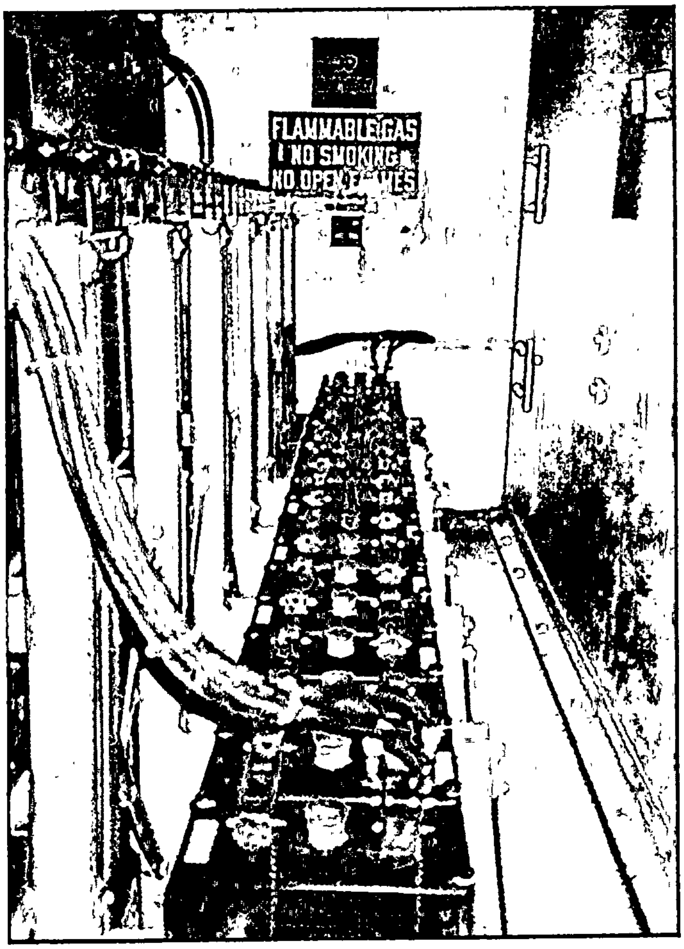


BATTERY CHARGER 4A

COMPONENT PHOTOGRAPH

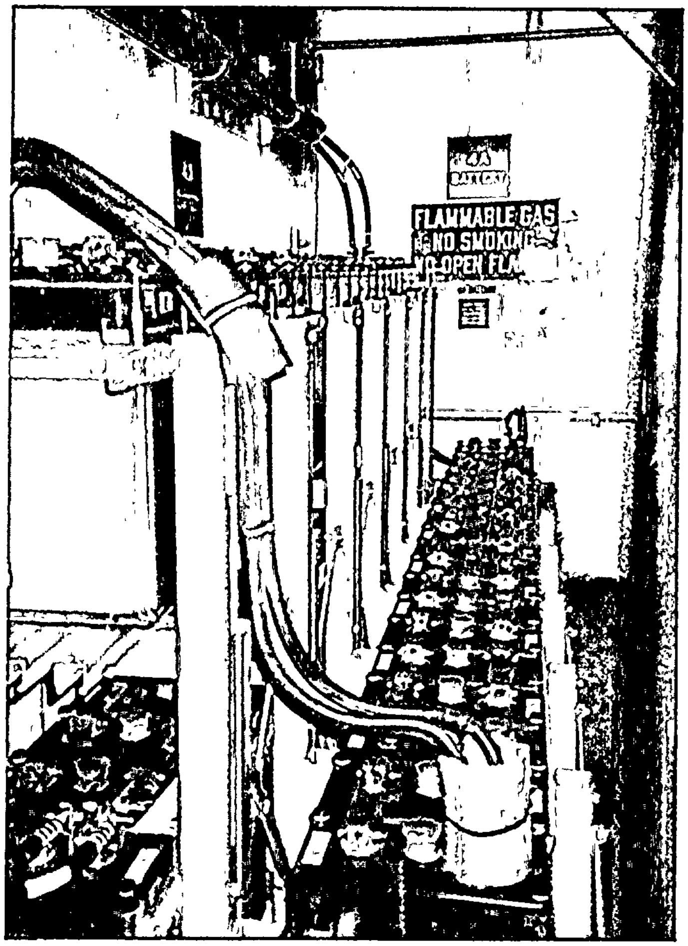
3D03 BATTERY RACK 3A

COMPONENT PHOTOGRAPH



3D24 BATTERY RACK 3B

COMPONENT PHOTOGRAPH

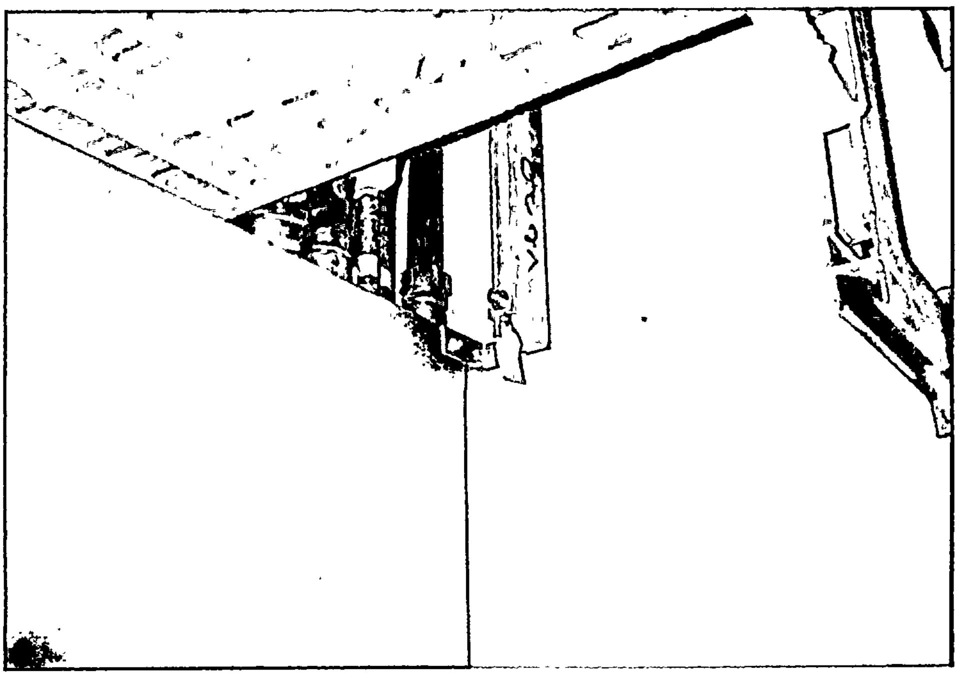


4D24 BATTERY RACK 4A

COMPONENT PHOTOGRAPH

4D03 BATTERY RACK 4B

COMPONENT PHOTOGRAPH

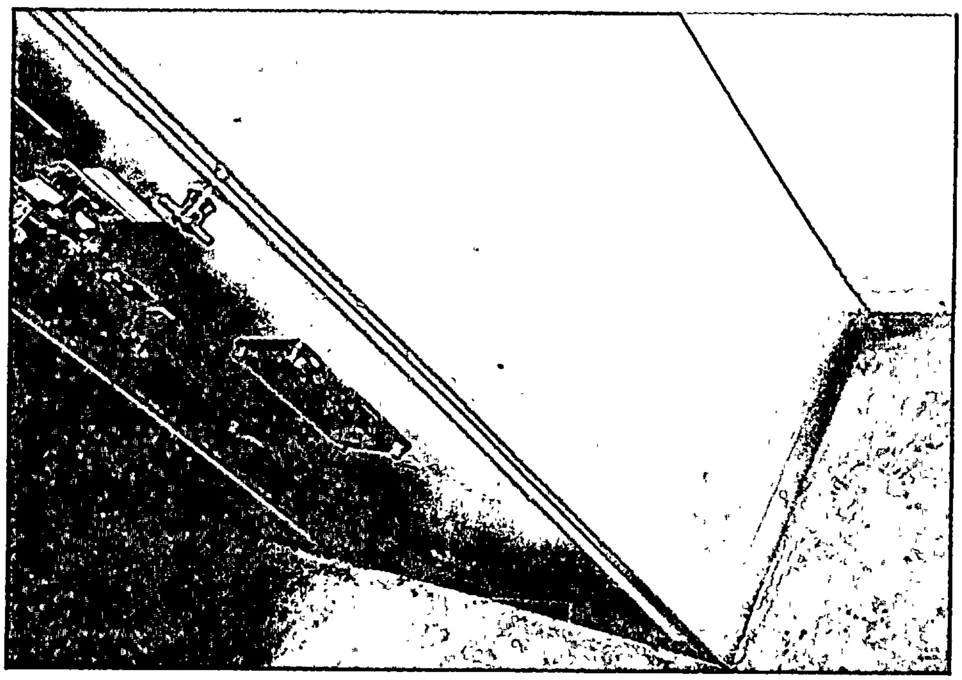


3C23A SEQUENCER 3A

COMPONENT PHOTOGRAPH

3C23B SEQUENCER 3B

COMPONENT PHOTOGRAPH

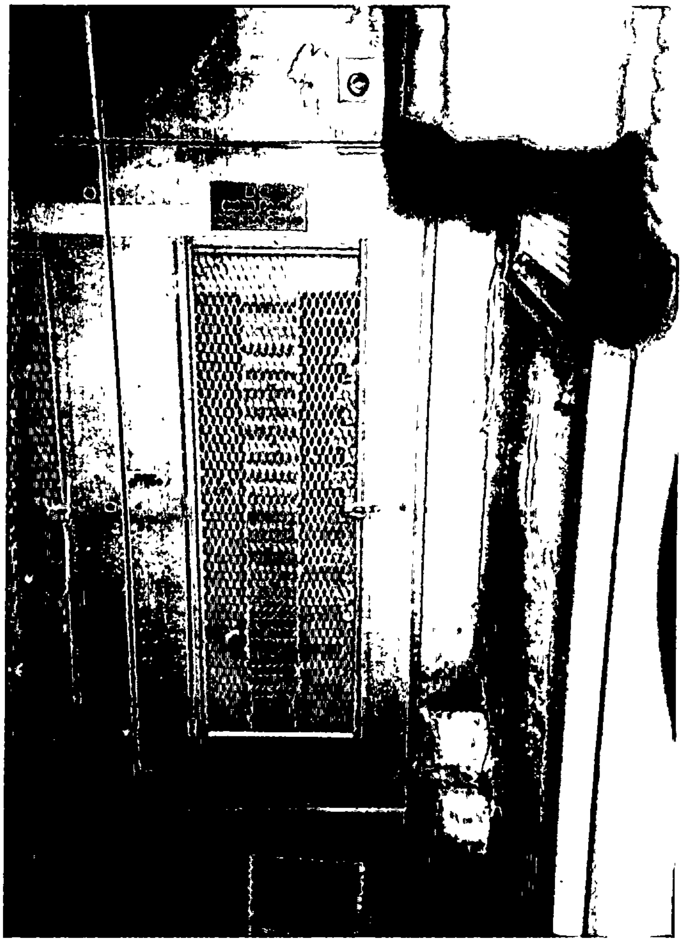


4C23A SEQUENCER 4A

COMPONENT PHOTOGRAPH

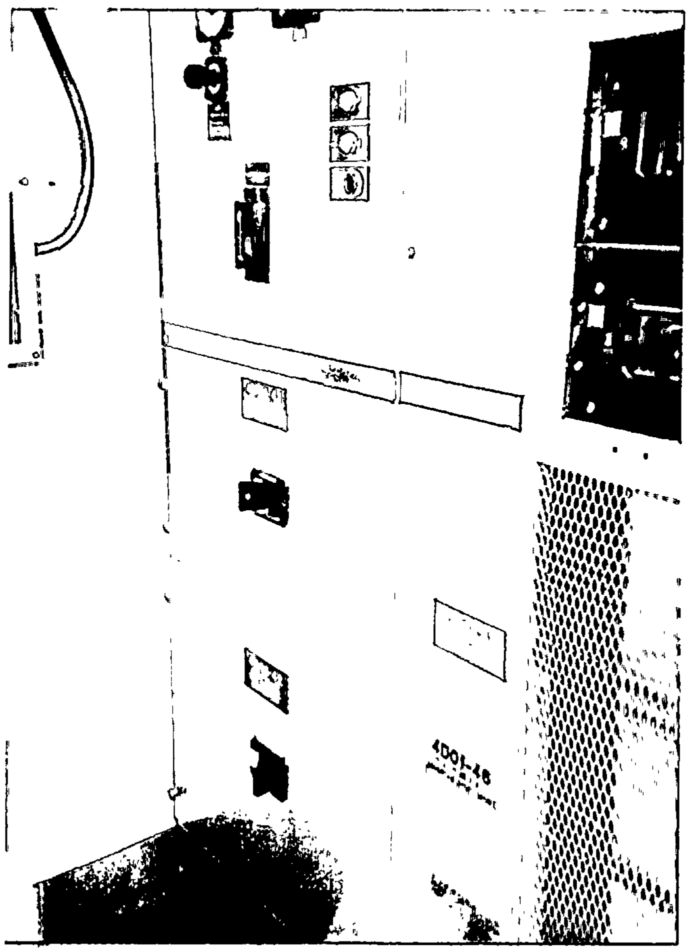
4C23B SEQUENCER 4B

COMPONENT PHOTOGRAPH



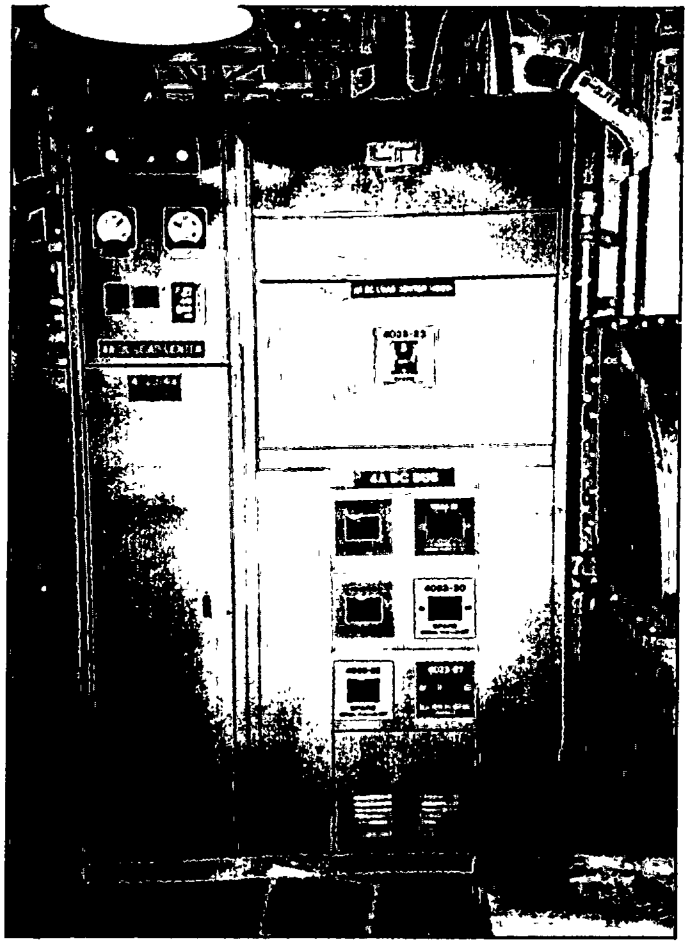
3D01 DISTRIBUTION PANELS/BUS

COMPONENT PHOTOGRAPH



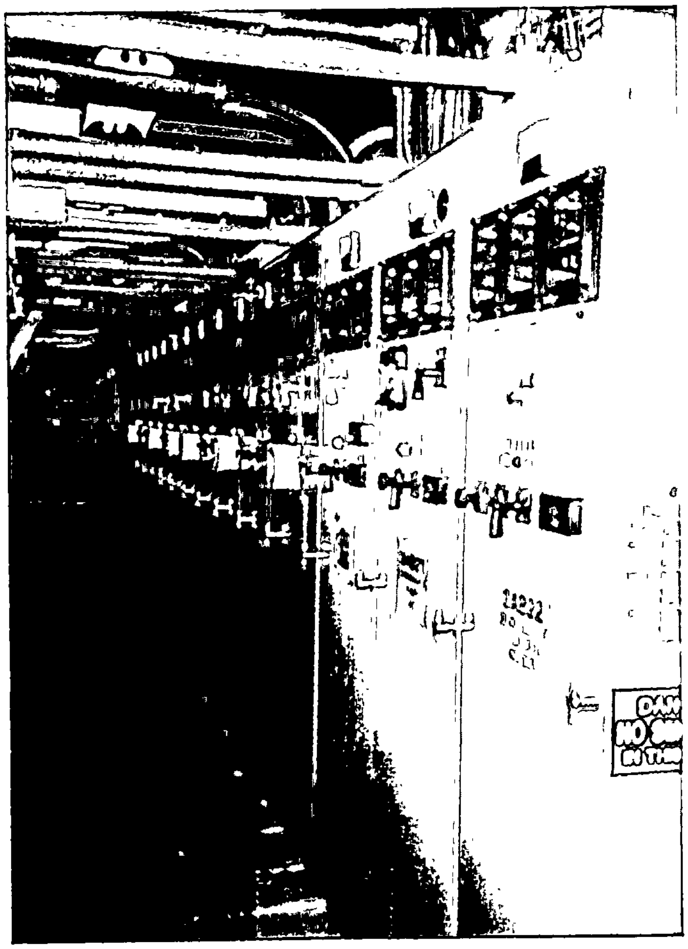
4D01 DISTRIBUTION PANELS/BUS

COMPONENT PHOTOGRAPH



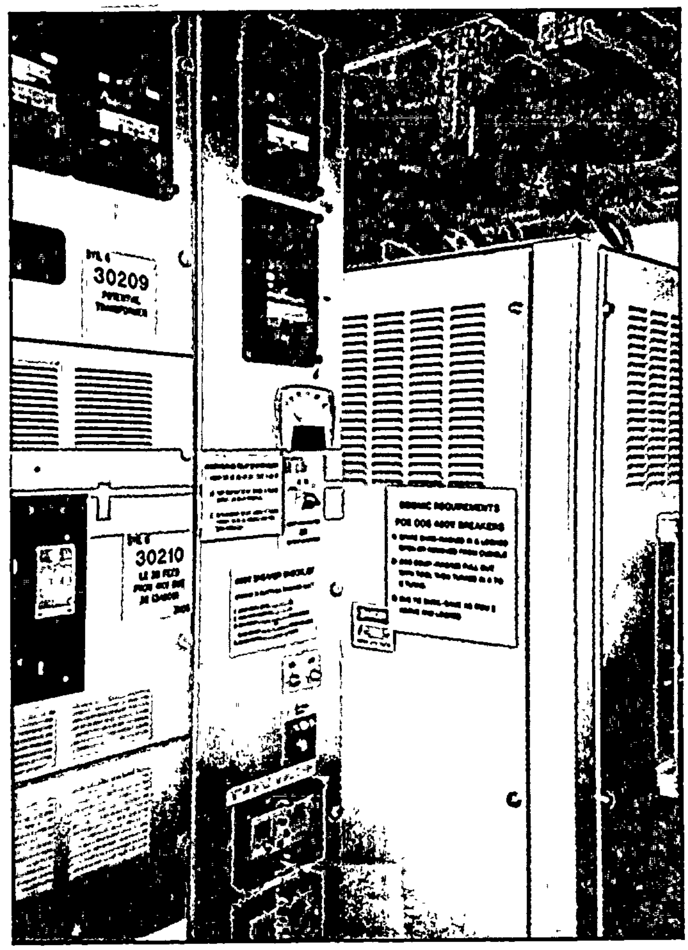
4D23 DISTRIBUTION PANELS/BUS

COMPONENT PHOTOGRAPH



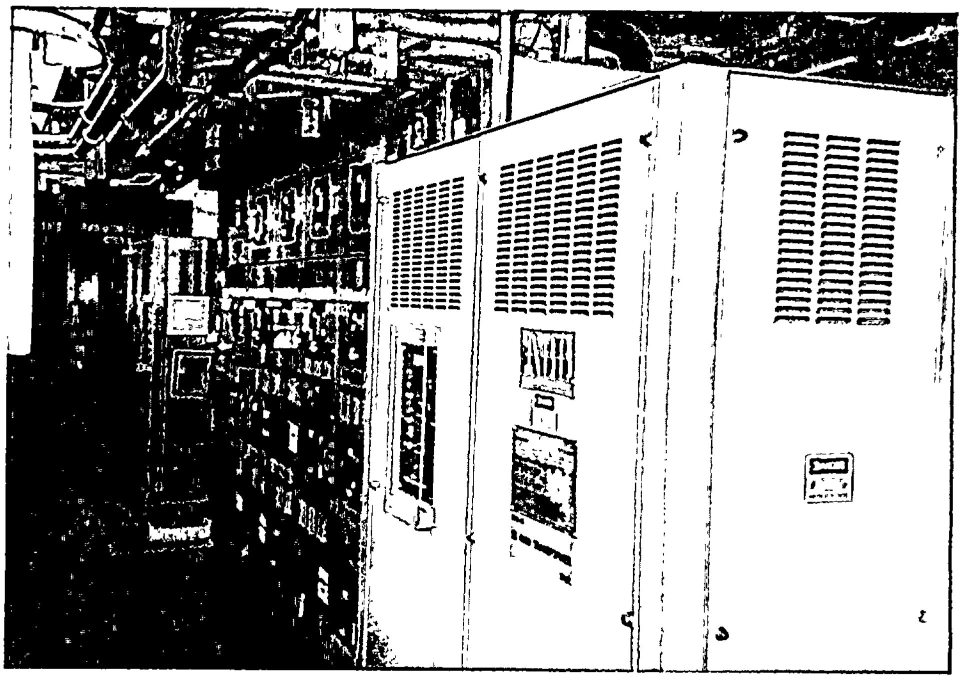
3AB 4.16V SWITCHGEAR 3B

COMPONENT PHOTOGRAPH



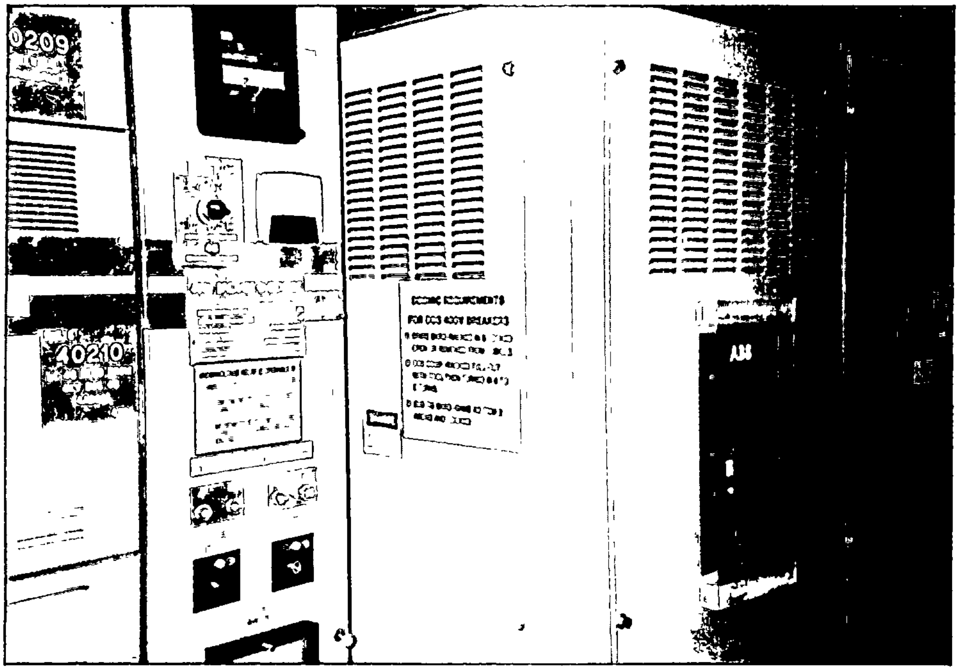
3B02 480V HVPDS LOAD CENTER 3B
(Includes Transformer)

COMPONENT PHOTOGRAPH



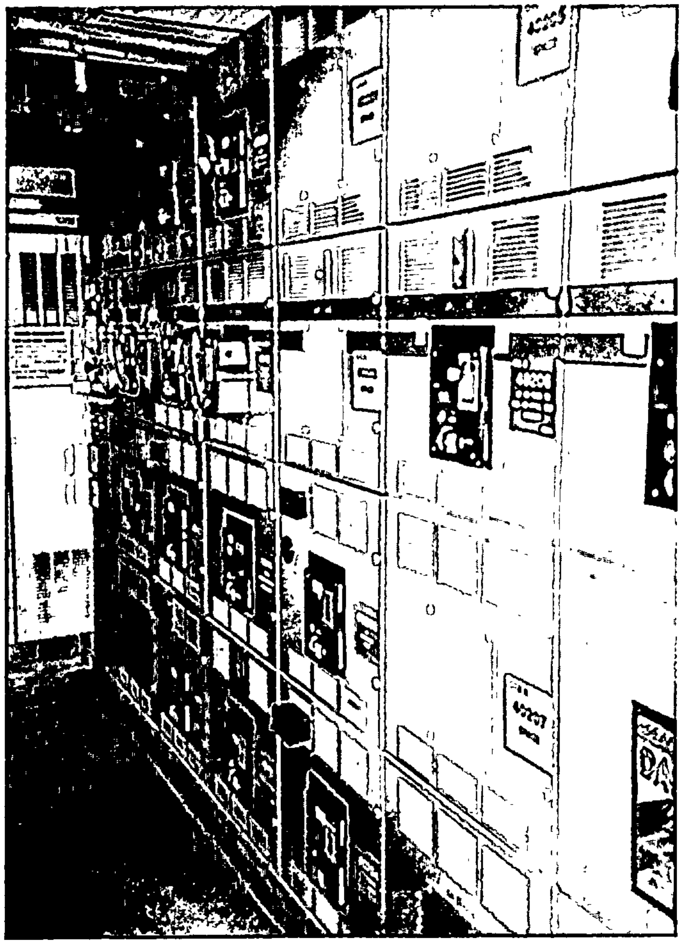
480V HVPDS LOAD CENTER 3D
(Includes Transformer)

COMPONENT PHOTOGRAPH



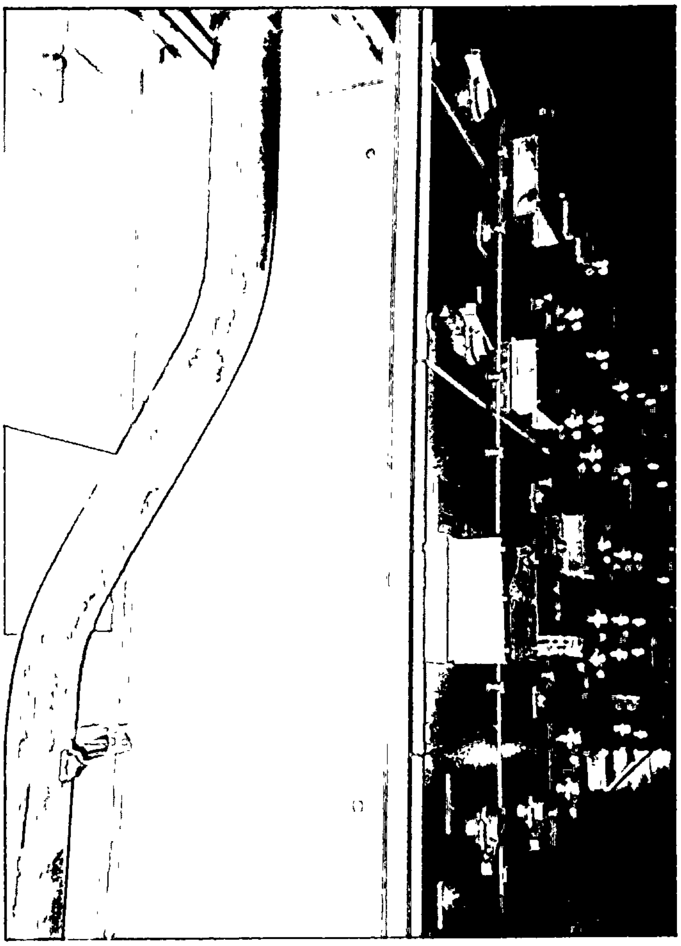
4B02 HVPDS LOAD CENTER 4B
(Includes Transformer)

COMPONENT PHOTOGRAPH



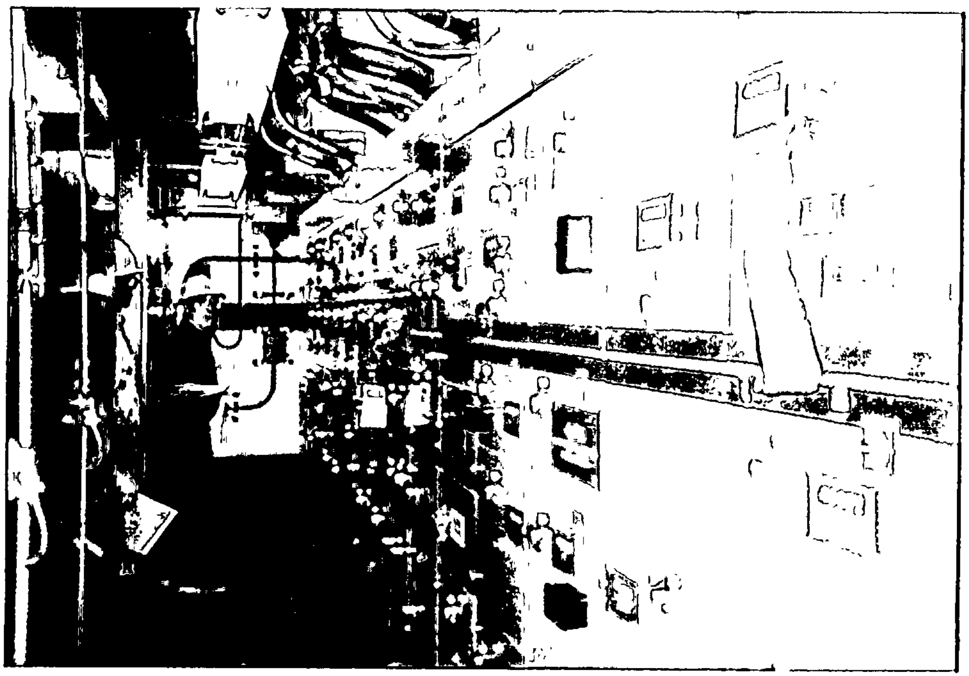
4B04 480V HVPDS LOAD CENTER 4D
(Includes Transformer)

COMPONENT PHOTOGRAPH



3B06 480V MOTOR CONTROL
CENTER 3B

COMPONENT PHOTOGRAPH

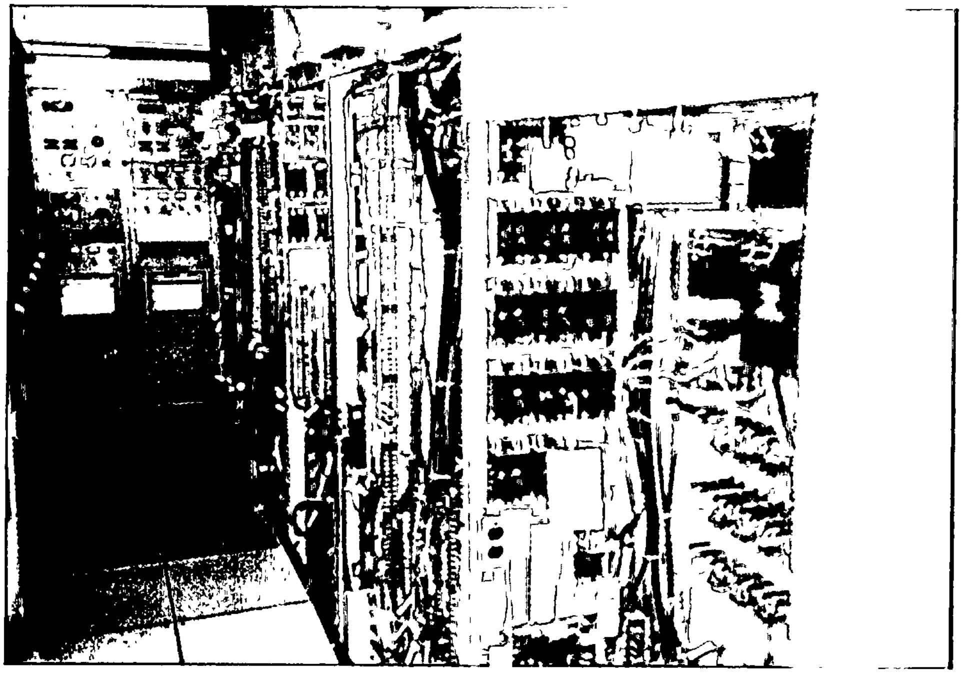


4B06 480V MOTOR CONTROL
CENTER 4B

COMPONENT PHOTOGRAPH

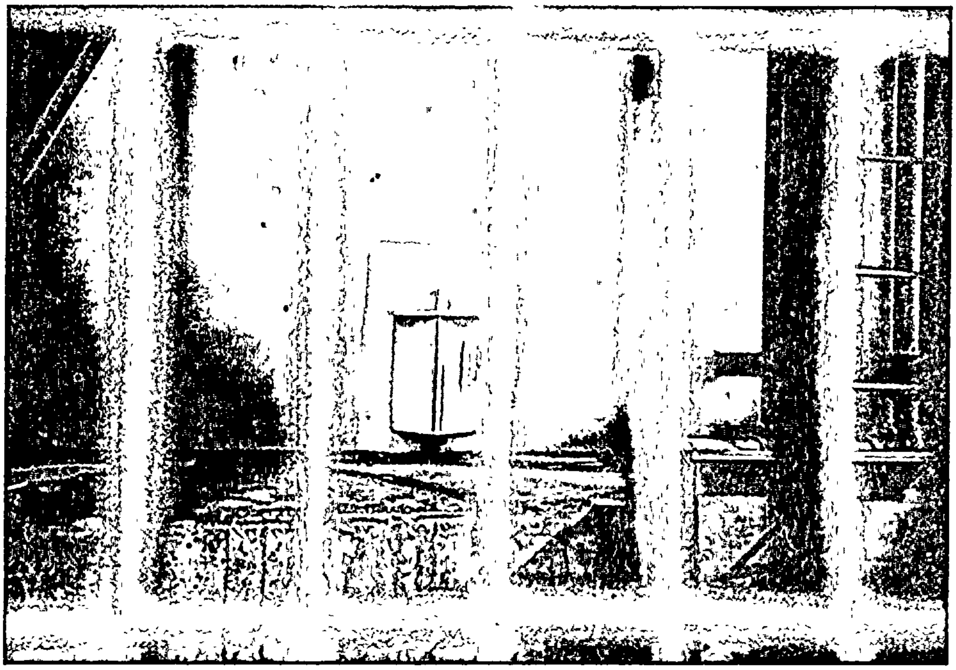
3C05, 3C06, VERTICAL PANEL 3B

COMPONENT PHOTOGRAPH



4C05, 4C06, VERTICAL PANEL 4B

COMPONENT PHOTOGRAPH



UNIT 3 CONDENSATE STORAGE TANK

COMPONENT PHOTOGRAPH

SEISMIC HOLDER FOR PORTABLE FAN