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and 50-323

MEMORANDUM FOR: John F. Stolz, Chief, Light Water Reactors Branch No. 1, DPM

FROM: D. P. Allison, Project Manager, Light Water Reactors Branch No. 1, DPM

SUBJECT: INFORMAL DOCUMENTS - DIABLO CANYON 1 & 2

The attached draft material was provided informally by PG&E in order to expedite our review leading up to Supplement No. 6 to the Safety Evaluation Report. All of this material has been subsequently superseded by material submitted formally. The purpose of this memorandum is to document the material in the files and the public document rooms.

Original Signed By
Dennis P. Allison

D. P. Allison, Project Manager
Light Water Reactors Branch No. 1
Division of Project Management

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Diablo Canyon
Unit 2

In this summary of the differences between reports, "The Evaluation for Effects of Postulated Pipe Break Outside Containment", Diablo Canyon Units 1 and 2, prepared by Nuclear Services Corp, we have identified the differences and itemized them according to title headings.

We can say essentially that the two units are very similar and were analysed in the same manner, but differences do exist between the units and the reports.

On page 9 (NSC 2), Section 3.2 Identification of High Energy Systems we have the following differences:

3.2.2 Design Basis Breaks

Design basis breaks for Unit 2 are postulated to occur in the same systems as Unit 1 as identified in Section 5.2 of Reference 2. However, the line designations (numbers) differ between the two plants in some instances, therefore several additional lines were considered for postulated breaks as listed below.

694	4016	4035	4058	4187
3972	4017	4036	4059	4188
3974	4018	4047	4065	4189
3975	4019	4048	4091	4190
3977	4020	4049	4093	4191
3979	4021	4050	4095	4192
3980	4022	4051	4097	4193
4007	4023	4052	4099	4194
4012	4031	4054	4101	4195
4013	4032	4055	4184	
4014	4033	4056	4185	
4015	4034	4057	4186	

(All of these are in the Turbine Building. Mostly Reheater Drain Piping. Some is Feedpump and Heater #2 Drain Pump Piping.)

Already covered in a letter.

In Section 4.2 Environmental and Jet Effects on Plant Equipment, modifications are basically the same, with the following exceptions:

4.2.1 Area GE/GW, Elevation 115' to 140'

For the purposes of discussion the GE/GW area between elevation 115' and 140' has been divided into three zones, as shown on Figure 4.2-1. Zone 1 consists of the area to the east of the wall near column line R. The only high energy lines in this area are the steam generator blowdown lines and the steam lines to the auxiliary feedwater turbine. For Zone 2 the direct jet impingement zone extends west from the wall near column line R to a point approximately 15' west of column line L. Zone 3 extends from this point west to column line J.

4.2.1.1 Electrical Conduit

- Zone 1

The jets from the high energy lines in this area can potentially cause high local loading on exposed conduits. Therefore, vital conduit in this area will be reinforced at midspan to ensure that in the event of overloading one of the conduit supports, the auxiliary support can carry the load.

High temperatures (212°F) resulting from design breaks in the steam lines to auxiliary feedwater turbine can potentially have adverse effects on the operation of the electro-hydraulic actuators for the auxiliary feedwater control valves which are located in this area. Since the plant operator will probably be unable to detect these breaks by any of the available automatic trip logics, the actuators will be susceptible to long time exposure at 212°F. Therefore, it is recommended that a temperature detection system be installed near the valves to alert the operator of temperature increases (Reference 18).

This is being done

- Zone 2

By selective routing of vital conduit away from the direct jet impingement zone, the need for additional plant protection has been minimized. Most of the vital conduit and cable runs have been rerouted away from the vicinity of the main steam and feedwater line containment penetrations and the main steam line safety valve riser pipes. Cables and conduits servicing vital equipment in this zone have been routed below the floor at elevation 115' and are returned to the area through floor penetrations at the appropriate location. Vital conduit will be placed against the web of structural beams for added protection where necessary. Much of the exposed conduit in Zone 2 is either non-vital or not required for the mitigation of the consequences of a high energy line break in this area, therefore protective measures are unnecessary.

- Zone 3

This zone is characterized by relatively low potential jet impingement forces (< 10 psig), therefore it was deemed unnecessary to remove all vital conduit from this area. However, vital conduit in this area must be reinforced at midspan as on Unit 1.

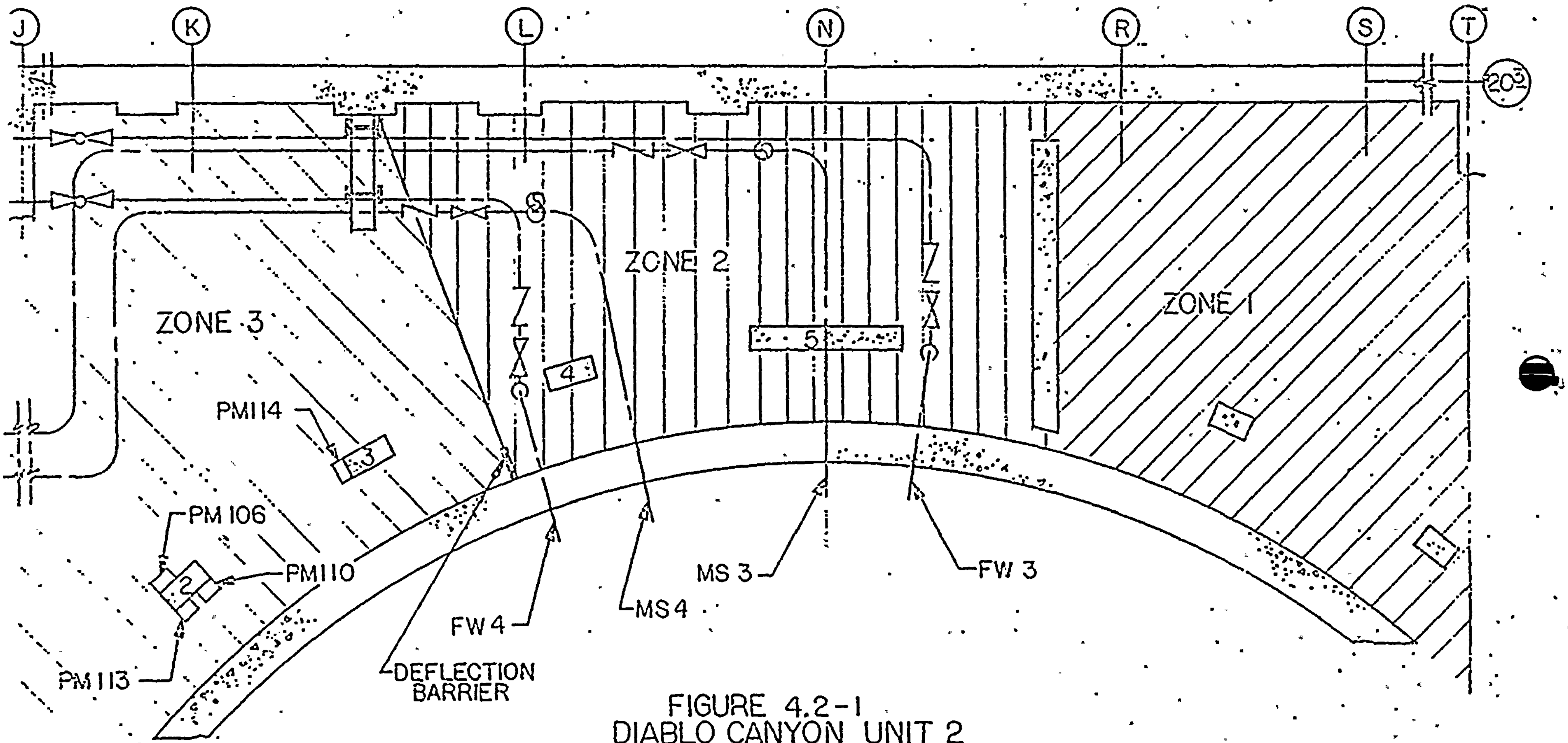

FIGURE 4.2-1
DIABLO CANYON UNIT 2
AREA GE-GW EL 115'-140'

4.2.1.5. Deflection Barriers

As a result of the extensive conduit rerouting in the GE/GW area within Zone 2, it has been possible to eliminate the containment barrier plates which were required for Unit 1 as discussed in 4.1.1.1.1 and 4.1.1.1.3 of Reference 3. Removal of these barriers will not have an adverse effect on equipment in Zones 1 and 3.

The impingement barrier surrounding the main steam line riser pipes which was required for Unit 1 is unnecessary for Unit 2 as a result of equipment relocation and conduit rerouting. The trajectory of the jet from breaks associated with these risers is upwards and along the ceiling. The subsequent loading on distant reinforced conduit in Zone 3 is low (< 10 psig); therefore, no additional protection is required.

The large vertical deflection plate between feedwater line 4 and the containment electrical penetrations which was utilized for Unit 1 is also required for Unit 2. This deflection plate will direct potential jet impingement away from the electrical penetrations at the containment.

4.2.1.6 Impingement Sleeves

Impingement sleeves on main steam and feedwater lines will be necessary at the same postulated break locations as on Unit 1 (Reference 6). Because of the conduit and instrumentation relocations, sleeve end barriers are required at only three locations (mainsteam nodes 4070 and 3180, and feedwater node 1403) to preclude unacceptable damage to electrical conduit and penetrations.

4.2.2.3 Impingement Sleeves

Impingement sleeves will be required for Unit 2 at the Unit 1 equivalent locations. However, due to conduit rerouting, sleeve end barriers will be required only at nodes 1213 and 1113 on the feedwater, and 1180 and 2187 on the mainsteam.

In Section 4.3 Thermal Hydraulic Analyses analyses used for Unit 1 apply directly to Unit 2 high energy lines except for the lines in Section 3.2.2 which are not common to both units

4.3.1.3 Other High Energy Lines

Many of the other high energy lines for Unit 2 are different from the Unit 1 other high energy lines. For this reason the forces for the other high energy lines have been revised for Unit 2 and are based on Revision 6 of the Line Designation Table (Reference 20). The assumptions, criteria and method of analysis utilized in determining the reaction forces are identical to those used for Unit 1 (see Section 3.0 of Reference 4).

The calculated reaction forces for Unit 2 other high energy lines are summarized in Tables 4.3-1, 4.3-2, and 4.3-3. Since no frictional losses are accounted for, the values are conservative.

In Section 4.4 Pipe Whip Analyses again both units were analysed directly due to similarities. The exceptions are as follows:

Section 4.4.2.1 Turbine Steam Supply System

It should be noted that lines 1396, 1398, 2685, and 3593 which were included in the Unit 1 report do not exist in the Unit 2 piping system.

4.4.2.3 Extraction Steam and Heater Drip Systems

The high energy portions of the extraction steam and heater drip systems considered in the analyses are different from those analyzed for Unit 1. That is, lines 1192 and 1193, which were included in the Unit 1 report, are no longer considered since they are not part of the Unit 2 system. As shown in Figure 4.4-16, additional lines which were analyzed include:

- Line number 4034 - 8" line from the east high pressure moisture separator reheater drain tank 2-2A, connecting to line 4050 which terminates at feedwater heater 2-1C.

- Line number 4035 - 8" line from the east high pressure moisture separator reheater drain tank 2-2B, connecting to line 4051 which terminates at feedwater heater 2-1A.

- Line number 4036 - 8" line from the east high pressure moisture separator reheater drain tank 2-2C, connecting to line 4052 which terminates at feedwater heater 2-1B.

- Line number 4187 - 6" line from the east low pressure reheater drain tank 2-2A, terminating at the low pressure west moisture separator reheater #2 drain tank 2-1.

- Line number 4188 - 6" line from the east low pressure reheater drain tank 2-2B, terminating at the low pressure west moisture separator reheater #2 drain tank 2-1.

- Line number 4189 - 6" line from the east low pressure reheater drain tank 2-2C, terminating at the low pressure west moisture separator reheater #2 drain tank 2-1.

Section 4.4.3 Evaluation of Postulated Break Locations

For the most part the analysis performed on Unit 1 can be directly applied to Unit 2 due to their similarities. The Unit 2 analyses which differ from Unit 1 are discussed in the following paragraph.

The turbine building is the only area in which any significant changes occur. Line numbers 1192, 1193, 1396, 1398, 2685, 3593, and 4198, which were analyzed for Unit 1, are not part of the Unit 2 system; therefore, they do not appear in the Unit 2 tables. However, line numbers 4034, 4035, 4036, 4187, 4188, and 4189, which are unique to Unit 2, have been analyzed, and the specific protection that the restraints on these lines provide is presented in Table 4.4-34.

Tables 4.4-1 to 4.4-34 are Restraint Summaries of Unit 2 lines; and Figures 4.4-1 to 4.4-16 are pipe whip mathematical models and break locations of lines similar to Unit 1.

Section 4.5 Structural Evaluation for Unit 2 is the same as for Unit 1. In Table 4.5-1 to Table 4.5-14 Comparison of Applied Restraint Loads to Allowable Restraint Loads, slight differences have been noted.

Section 5.0 Design Modifications deals with the design requirements of Rod Restraint which were not included in Unit 1. Discussion of Design Loads, Additional Structural Modifications and Impingement Barriers and Sleeves concludes the differences between the units. Other Tables and Figures are similar to Unit 1 in format.

5.0 DESIGN MODIFICATIONS

This section defines the requirements for design modifications which, upon implementation, will provide a protection system that meets the criteria and objectives of this report. In most instances effective alternative designs are feasible, so the suggested designs should not be construed as the only means for providing the required protection. However, the comprehensive analyses of this evaluation have demonstrated that with the suggested modifications the events related to the rupture of a high energy line will not prevent safe shutdown of the reactor. Furthermore, since the efficacy of the system is sensitive to the modification requirements, significant deviations may create an imbalance such that reanalysis of the affected areas would be required.

5.1 Design Requirements for Rod Restraints

The major element of the proposed protection system is the rod restraint. Rods have been designated for numerous locations along main steam and feedwater lines 1, 2, 3, and 4 and along other significant high energy lines throughout the plant, as identified in Section 4.4. In order for the restraint systems to function properly, each rod restraint must meet certain design specifications relating to rod diameter and length, effective gap, and material properties.

Tables 5-1 through 5-10 define the requirements for rod dimensions and maximum effective gaps for proposed restraints in Areas I and II. Unless otherwide noted, a set of two parallel U-bolts (four rods) of the dimensions specified are required at each location. In order to minimize the effective gap and thus reduce the dynamic loads, rod-beams (Figure 4.5-1) rather than U-bolts have been used at numerous locations.

5.1.1 Effective Gaps and Set Positions

The effective gap value, which is one of the parameters of the dynamic pipe whip analysis, provides the basis for establishing the position of the U-bolt (or rod-beam) with respect to the pipe. Effective gap values are related to pipe and restraint geometry by one of two relationships which depend on the direction of predicted thermal movements. The first case is applicable when increased pipe temperatures induce thermal movement toward the restraint, and the second case is applicable when thermal movement is away from the restraint.

Case 1 (See Figure 5-1)

$$EG = C_L + 0.285 (ID - OD) + g$$

Case 2 (See Figure 5-1)

$$EG = C_L + \delta_L + 0.285 (ID - OD) + g$$

where:

ID = Inside diameter of U-bolt saddle = $OD + 2C_T + \delta_T$

OD = Outside diameter of the pipe (or impingement sleeve)

C_T = Minimum allowable transverse clearance between the saddle and pipe (or impingement sleeve) as established by design criteria

C_L = Minimum allowable longitudinal clearance between the saddle and pipe (or impingement sleeve) as established by design criteria

δ_T = Absolute value of transverse thermal deflection of the pipe from cold to hot position

δ_L = Absolute value of longitudinal thermal deflection of the pipe from cold to hot position

EG = Effective gap for the pipe in the hot condition

g = Radial gap between impingement sleeve and pipe (if applicable)

For a rod-beam restraint, the effective gap is the clearance between the rod beam and the pipe in the hot position.

Since the effective gap does not represent the physical distance between the pipe and rod, for the final design and field adjustment of the U-bolts and rod beams it will be necessary to determine the set position dimensions (transverse and longitudinal gaps) for the cold pipe position. The set positions are related to the effective gaps for the two possible thermal movement cases as follows.

U-bolt:

$$G_L = EG_R - 0.285\,(ID - OD) + \delta - g - T$$

Rod-Beam:

$$G_L = EG_R + \delta - g - T$$

where:

G_L = Longitudinal gap between saddle (or rod-beam) and pipe in the cold position

$$\delta = \begin{cases} +\delta_L, & \text{Case 1} \\ -\delta_L, & \text{Case 2} \end{cases}$$

T = Fabrication and installation tolerance

EG_R = Maximum allowable effective gap as defined in Tables 5-1 through 5-10.

5.1.2 Material Property Requirements

In order to ensure that unacceptable loads are not developed in the rod restraints, or at attachment structure, annealed 304 material properties should, in general, be certified within specified bounds. All analyses were based on the assumption that the material properties meet the following requirements.

1. The actual stress-strain curve shall fall below the upper bound curve shown in Figure 4.5-2. This requirement limits upper bound loads.

2. The strain associated with the ultimate stress (ε_{σ_u}) shall be greater than 0.43 in/in. This requirement insures adequate capacity for the rods.

3. The available strain energy for the actual material shall be greater than that provided by the nominal material (Figure 4.5-2). This restriction can be represented by the following relationship:

$$E = \int_0^{\varepsilon_{ma}} \sigma(\varepsilon)\, d\varepsilon \geq 13.57$$

where

E = strain energy per unit volume $\left(\frac{\text{in-kips}}{\text{in}^3}\right)$

σ = stress (ksi)

ε = strain (in/in)

$\varepsilon_{ma} = \frac{\varepsilon_{\sigma u}}{2}$ (in/in)

$\varepsilon_{\sigma u}$ = strain at ultimate stress (in/in).

This requirement effectively establishes the acceptable lower bound.

If the actual properites do not meet the preceding requirements, load acceptability may be confirmed by satisfying either of two options:

1. The rod diameter and/or length may be appropriately adjusted, or
2. The restraint allowable is shown to be adequate when the deviations are taken into account.

5.1.3 Design Loads

Although existing structure is available at some restraint locations, supplementary structure will generally be necessary to provide load reaction and rod attachment points. Conceptual designs have been established for supplementary steel structure but precise capacities have not been determined. To provide an added safety margin, development of preliminary concepts to final designs will be based on design loads equal to 1.25 times the predicted upper bound restraint load (See Section 4.5.3). The design loads and the type of rod attachment structure are tabulated for each restraint in Tables 5-1 through 5-10.

5.2 Additional Structural Modifications

Modification to selected existing frame restraints in the form of structural shims is necessary to control the amount of kinetic energy generated during a ruputre event. The shims act to reduce the gap through which the pipe moves prior to impact and thus are effective in attenuating the dynamic load amplification at restraints. A list of shim requirements with clearance dimensions is provided in Tables 5-11 and 5-12.

Other changes to existing restraints, aside from the addition of rods, consist of adding supplementary beams, strengthening connections by welding or increasing the number of bolts, and increasing bolt preload. In addition, some secondary members must be removed or trimmed in order to provide adequate clearance to prevent impact during spurious pipe motion. A description of each of the necessary modifications is provided in Table 5-13.

Additional secondary modifications to the plant design include:

1. Retention of the construction opening in the wall along row J at elevation 115' in area GW.

2. Adding doors in wall openings of area GE between El. 115' and El. 140' with design capacity to withstand 3.3 psi overpressure.

5.3 Impingement Barriers

Due to rerouting and relocation of a substantial portion of the electrical equipment and conduit, the requirements for jet impingement barriers in area

GE/GW for Unit 2 are less extensive than was the case for Unit 1. Only one barrier is needed to afford adequate protection from postulated breaks in this area. The barrier will be attached to the containment outer wall at a location west of the penetrations for main steam and feedwater line 4. The jet forces will not directly impinge on the barrier so expected design loads are negligible.

In order to protect the component cooling water heat exchangers and the associated electrical conduits, valves and piping from the effects of jet impingement, it is necessary to construct an impingement barrier around the exchangers. The barrier will consist of steel plates supported by a steel frame structure similar to the barrier design for Unit 1. The frame extends from six feet south of column line 19 past the south end of the component cooling water heat exchangers and from this point to row G and is between the foundation at El. 85' and the substructure for the floor slab at El. 104'-7½ ". The wide flange beams are attached to the foundation with bolted base connections and beam attachment at El. 104' is accomplished by connecting to the existing structural steel. The steel plates will be welded to the support structure except at the south end, where the panels are removable.

5.4 Jet Impingement Sleeves

Impingement sleeves at eighteen main steam and feedwater pipe elbows have been proposed as a means of preventing unacceptable jet impingement onto essential equipment and structures. Some of the sleeves will also be fitted with end barriers to prevent the jet from escaping through the annular space

at the termination points of the sleeve. The basic sleeve and end barrier designs will be similar to those used for Unit 1. Locations, thickness, length and end barrier requirements for each of the sleeves are presented in Tables 5-14 and 5-15.

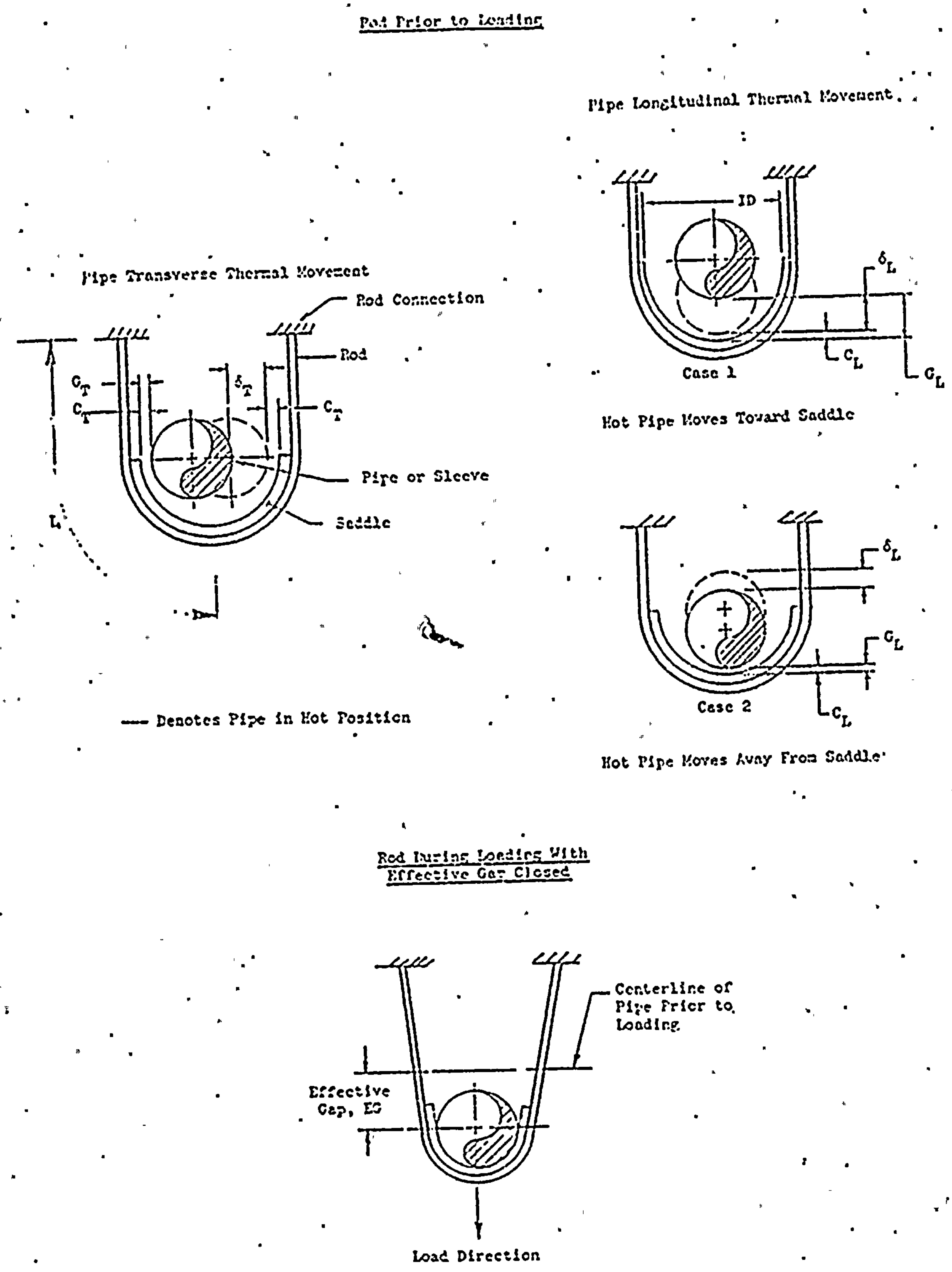

FIGURE 5-1
EFFECTIVE GAPS AND SET POSITIONS FOR U-BOLT RESTRAINTS

TABLE 4.3-1

DIABLO CANYON UNIT 2

REACTION FORCE APPROXIMATION FOR SUBCOOLED WATER HIGH ENERGY LINES

Line No.	Description	Break Area (ft^2)	Operating Pressure (psig)	Operating Temperature (°F)	Saturation Pressure (psig)	Force Initial (Kips)	Force Steady State (Kips)
93	FW PPS to Phos. Mix Tee	0.0205	1015.3	371	160	2.997	0.95
189	Main Steam Leads 1 & 2	0.3326	918.3	536	916	(43.981)	87.7
459, 460, 481	FW Htr Outlet	1.2271	546.3	202	~0	96.532	0.50
482, 483, 484	FW Htr Outlet	1.2271	545.3	258	17	96.536	6.0
485, 486, 487	FW Htr Outlet	1.2271	544.3	310	62	96.179	21.9
491	FW Htr Bypass	1.2271	550.3	202	~0	97.239	7.2
493	FW Htr Cond/Hdr	1.9688	544.3	310	62	154.312	35.2
494, 495, 496	FW Htr Inlet	1.2271	544.3	310	62	96.179	21.9
497, 498, 499	FW Htr Outlet	1.2271	543.3	367	151	96.002	53.4
500	FW Bypass	1.5764	544.3	310	62	123.556	28.1
501[2]	FW Htr Outlet Header	4.4794	543.3	367	151	350.447	136.4[2]
503, 504	FW Pump Suction	2.7917	465.3	369	156	187.053	125.4
538	FW Pumps Disch HDR	5.080	1015.3	371	160	742.712	234.086
541, 542	FW Pump Discharge	2.3889	1015.3	371	160	349.265	110.1
543	FW Inlet Hdr	4.1307	1015.3	371	160	603.922	190.3
544, 546, 548	FW Htr Inlet	1.4180	1015.3	371	160	207.316	65.3
545, 547, 549	FW Htr Outlet	1.4180	1015.3	434	343	207.316	140.1
550	FW Htr Header	4.1307	1015.3	434	343	603.922	408.0
551	FW Htr Bypass	0.8521	1015.3	434	343	124.580	84.2
552, 553	FW Pump Recir.	0.3174	1015.3	371	160	46.404	14.6
554, 555, 556 and 557	SG FW Supply	1.1174	1015.3	434	343	163.367	110.4
569, 570, 571	Aux FW Lines	0.0458	1285.3	434	343	8.477	4.5
572, 575, 576	Aux FW Lines	0.0458	1285.3	434	343	8.477	4.5
577, 578	Aux FW Lines	0.0458	1285.3	434	343	8.477	4.5
694	Feedwtr PP 2-2 Recirc	0.3474	1015.3	371	160	50.791	37.118
812, 813, 814 and 815	MT Turb Stm Inlet Drain	0.0205	915.3	536	916	(2.702)	5.4
820	HP Turb Drain	0.0205	383.3	444	383	(1.131)	2.3
830, 832	MS Dump Drip Leg	0.2007	902.3	536	916	(26.077)	52.9
836	Rehtr Start-Up Vent	0.0123	902.3	534	901	(1.598)	3.2

TABLE 4.3-1 (Cont.)

DIABLO CANYON UNIT 2

REACTION FORCE APPROXIMATION FOR SUBCOOLED WATER HIGH ENERGY LINES

Line No.	Description	Break Area (ft^2)	Operating Pressure (psig)	Operating Temperature (°F)	Saturation Pressure (psig)	Force[1] Initial (Kips)	Force[1] Steady State (Kips)
857	MN Steam Dump Drip	0.0123	902.3	534	901	(1.598)	3.2
1040, 1041	S.G. Blowodwn Hdr	0.0294	918.3	536	916	(3.888)	7.8
1042, 1043	S.G. Blowdown Hdr	0.0294	918.3	536	916	(3.888)	7.8
1101	FW Htr Bypass	2.7917	550.3	367	151	221.223	121.6
1104	Htrs Conds Out Hdr	1.2271	546.3	202	~0	96.532	3.2
1105, 1107	Htrs Conds Out Hdr	1.9688	546.3	202	~0	154.980	2.0
1106	Htrs Conds Out Hdr	2.7917	546.3	202	~0	219.615	1.4
1109	Htrs Conds Out	2.7917	544.3	310	62	218.811	49.8
1111,1112,1113	Htr Cond. Inlet	1.2271	544.3	202	~0	96.161	0.30
1179	Htr Drain Discharge	1.5764	493.3	373	165	111.980	74.9
1183	Htr Drain Recirc.	0.2007	493.3	373	165	14.257	9.5
1226,1227,1228	FW Heater Cnds Drip	0.3472	367.3	381	183	18.364	18.3
1338	NW 40% Dump Drip Dran	0.01227	920.3	536	916	(1.626)	3.2
1357	RC PPS Barrier Hdr	0.1465	2485.3	650	1993	(52.430)	84.1
1359, 1363	FW Htr Conds Rv In	0.0513	420.3	381	183	3.105	2.7
1375,1377,1379	FW Htr Level Spill	0.3472	367.3	381	183	18.363	18.3
1381	FW Htr Cnds RV 97 In	0.0513	420.3	381	183	3.105	2.7
1899	FW Pump Discharge	4.1307	1015.3	371	160	603.922	190.3
2478, 2479	SG FW Lead	2.3889	1015.3	434	343	349.265	236.0
3013	FW PP 1-2 Recirc to Cnds	0.3472	1015.3	370	158	50.762	15.8
3401	Htr 1 Extr Stm PCV Dr	0.0205	383.3	444	383	(1.132)	2.3
3411,3412,3413	MN Stm Leads 4	0.01227	915.3	535	908	(1.617)	3.2
3415	MN Stm Leads Drain Hdr	0.3326	915.3	535	908	(43.838)	87.0
3419,3420,3421	MN Stm Leads 3	0.01227	915.3	535	908	(1.617)	3.2
3425,3426,3427	MN Stm Leads 2	0.01227	915.3	535	908	(1.617)	3.2
3431,3432,3433	MN Stm Leads 1	0.01227	915.3	535	908	(1.617)	3.2
3438,3439,3440	MN Stm Lead Turb. Dr	0.02051	915.3	535	908	(2.703)	5.4
3441	MN Stm Lead Turb. Dr	0.02051	915.3	535	908	(2.703)	5.4
3444, 3445	MN Stm Lead FCV Dr	0.01227	915.3	535	908	(1.617)	3.2

TABLE 4.3-1 (Cont.)

DIABLO CANYON UNIT 2

REACTION FORCE APPROXIMATION FOR SUBCOOLED WATER HIGH ENERGY LINES

Line No.	Description	Break Area (ft^2)	Operating Pressure (psig)	Operating Temperature (°F)	Saturation Pressure (psig)	Force[1] Initial (kips)	Force[1] Steady State (kips)
3446, 3447	MN Stm Lead FCV Dr	0.01227	915.3	535	908	(1.617)	3.2
3768, 3769	MN Stm Lead Drip Pot	0.02051	915.3	535	908	(2.703)	5.4
3770, 3771	MN Stm Lead Drip Pot	0.02051	915.3	535	908	(2.703)	5.4
3774	Htr 1 Extr Stm DP	0.02051	383.3	444	383	(1.132)	2.3
3870	SG 1 & 2 FW Lead	3.7569	1015.3	434	343	549.270	371.1
3874,3876,3878	SG Blwdn Cleanup Hdr	0.0205	918.3	536	916	(2.710)	5.4
3880	SG Blwdn Cleanup Hdr	0.0205	918.3	536	916	(2.710)	5.4
3887,3888,3889	Retrs LP DP/DR	0.02051	383.3	442	375	(1.132)	2.2
3890, 3892	Retrs LP DP/DR	0.02051	383.3	442	375	(1.132)	2.2
3894	W Rhtrs LP Htg Stm DP Dn	0.02051	383.3	442	375	(1.132)	2.2
3917, 3918	MN Stm Leads BP	0.05132	915.3	535	908	(6.764)	13.4
3972,3974,3975	Retr Drn TR 2-X Cnd Dump	0.3329	902.3	534	901	(43.254)	60.48[2]
3977,3979,3980	Retr Drn TR 2-X Cnd Dump	0.3329	902.3	534	901	(43.254)	60.48[2]
4007	Htr 2 Drn Pump Disch Hdr	0.7854	493.3	373	165	55.791	37.322
4012,4013,4014	Retr 2-X LP Htg Stm Out.	0.3474	371.3	440	367	(18.574)	36.718
4015,4016,4017	Retr 2-X LP Htg Stm Out.	0.3474	371.3	440	367	(18.574)	36.718
4031,4032,4033	Wst HP Drn Tnk 2-1X Drip	0.3329	889.3	532	885	(42.630)	59.394[2]
4034,4035,4036	Est MJ-R Hp Dr Tk 2-2X"	0.3329	889.3	532	885	(42.630)	59.394[2]
4047,4048,4049	Wst HP Drn Tnk 2-2x Drip	0.3474	375.3	532	885	(18.775)	61.98[2]
4050,4051,4052	Est MS-R Hp Dr Tk 2-2X"	0.3474	375.3	532	885	(18.775)	61.98[2]
4054,4055,4056	Retr 2-1X HP Htg Stm Out.	0.3329	889.3	532	885	(42.630)	59.[illegible]
4057,4058,4059	Retr 2-2X HP Htg Stm Out.	0.3329	889.3	532	885	(42.630)	59.39[2]
4065	Htr-2 Drn Tk Pump Dsch Hdr	1.5763	493.3	373	165	111.972	52.43[2]
4184,4185,4186	Wst LP MS-R Dk Tk 2-1X Dr	0.2006	371.3	441	371	(10.725)	21.433
4187,4188,4189	Est LP MS-R Dk Tk 2-X Drp	0.2006	371.3	441	371	(10.725)	15.0[2]
4190,4191,4192	Wst LP Dr Tk 2-1X Cnd Dmp	0.2006	371.3	441	371	(10.725)	21.433
4193,4194,4195	Est LP DR TK 2-2X Cnd Dmp	0.2006	371.3	441	371	(10.725)	21.433

NOTES: [1] Steady state force assumed to start at time zero if the initial force is less than steady state force. Initial force is in parenthesis if less than steady state force.

[2] A thrust coefficient of 1.4 was used to establish steady state force (see Section 3.5.3 of Ref. 4).

TABLE 4.3-2

DIABLO CANYON UNIT 2

REACTION FORCE APPROXIMATION FOR SUBCOOLED BORIC ACID SOLUTION[1] HIGH ENERGY LINES

Line No.	Description	Break Area (ft^2)	Operating Pressure (psig)	Operating Temperature (°F)	Saturation Pressure (psig)	Force[2] Initial (Kips)	Force[2] Steady State (Kips)
26	Let Down Ht/Exch Inlet	0.02331	350	380	181.0	(1.18)	1.22

NOTES: [1]Assumes Boric Acid solution acts like water.

[2]Steady state force assumed to start at time zero if the initial force is less than steady state force. Initial force is in parentheses if less than steady state force.

TABLE 4.3-3

DIABLO CANYON UNIT 2

REACTION FORCE APPROXIMATION FOR SATURATED STEAM HIGH ENERGY LINES

Line No.	Description	Break Area (ft^2)	Operating Pressure (psia)	Force[1] Initial (Kips)	Force[1] Steady-State (Kips)
225, 226	Steam Outlet Lines	3.687	933	487.6	613.7
227, 228	Steam Outlet Lines	3.687	933	487.6	613.7
433[2]	Rehtr 1 & FW Htr 1 Stm Hdr	2.882	398	159.1	See Fig. 3-37[2]
583, 584	HP Turb Main Steam Leads	3.687	933	487.6	613.7
585, 586	HP Turb Main Steam Leads	3.687	933	487.6	613.7
587	40% Dump Hdr	3.220	930	424.4	534.2
589	Lead 4 to 40% Dump Hdr	2.653	930	349.7	440.2
590	35% PCV Header	4.293	933	567.7	714.6
591, 592	Lead 2/4 to 35% PCV Header	1.485	933	196.4	247.2
593, 594	Aux FP-1 Steam Leads	0.0884	893	11.2	14.1
595, 596	Rehtr 1/2 HP Htg Stm Sup. Hdr	0.7375	933	97.5	122.8
597,598,599	Rehtr/HP Htg Stm Inlet	0.3326	917	43.2	54.4
601[3],602,603	Rehtr HP Htg Stm Inlet	0.3326	917	43.2	See Fig. 3-36[3]
616,617,618	Rehtr/LP Htg Stm Inlet	0.3472	390	18.8	23.7
619,620,621	Rehtr/LP Htg Stm Inlet	0.3472	390	18.8	23.7
632, 633	FP 1/2 Dr Turb Main Stm	0.0884	893	11.2	14.1
662,663,664	40% Dump Route	0.7375	930	97.2	122.4
665,666,667	40% Dump Route	0.7375	917	95.8	120.6
668,669,670	40% Dump Route	0.7375	917	95.8	120.6
671,672,673	40% Dump Route	0.7375	917	95.8	120.6
758, 759	Lead 1/3 35% PCV Hdr	1.485	933	196.4	247.2
760	Aux FP Turb 1 Main Stm	0.0884	933	11.7	14.7
799,800,801,802	HP Turb Stm to LP Rehtr	0.7854	398	43.4	54.8
803	HP Turb Ext to LP Reht	1.6229	398	89.6	113.3
804, 805	Rehtrs 1/2 LP Htg Stm Sup Hdr	0.7854	398	43.4	54.8
806, 807	40% Stm Dump Hdr	1.485	930	195.7	246.4
808, 809	40% Stm Dump Hdr	3.220	930	424.4	534.2
810	Gland Main Stm Supply	0.0884	930	11.7	14.7
811	HP Turb Stm to LP Rehtr	1.6229	398	89.6	113.3
816,817,818,819	HP Turb Stop Valve Drain	0.02051	930	2.7	3.4

TABLE 4.3-3 (Cont.)

DIABLO CANYON UNIT 2

REACTION FORCE APPROXIMATION FOR SATURATED STEAM HIGH ENERGY LINES

Line No.	Description	Break Area (ft^2)	Operating Pressure (psia)	Force[1] Initial (Kips)	Force[1] Steady-State (Kips)
1063, 1084	Rehtr Excess Stm Hdr.	0.01227	917	1.6	2.0
1065, 1066	MN Stm Lead Relief VLV Hdr	2.6528	933	350.8	441.6
1196,1197,1198	FW Htr Extr Stm Inlet	0.9576	382	50.6	64.1
1244	FW Htr Oper Vent Manifold	0.02051	382	1.1	1.4
1245	FW Htr Oper VH	0.08840	382	4.7	5.9
2273,2274,2275	Leads 3/2/1 40% Dump Hdr	2.6528	933	350.8	441.6
2391, 2392	LP Rehtr Excess Stm	0.01227	378	0.6	0.8
2395	FW Htr 1 Vent Hdr	0.0884	382	4.7	5.9
2446	Aux Sy Mn Stm Sup Header	0.3326	930	43.8	55.2
2948	MN Stm Gland Sup X-T1B	0.0884	930	11.7	14.7
3552	FW Htrs 1 Starting Vent Hdr	0.02051	382	1.1	1.4
3871,3878,3875,3877	Rehtr Hp Coil Excess Stm	0.01227	917	1.6	2.0
3879,3881,3883,3885	Rehtr Lp Coil Excess Stm	0.01227	378	0.6	0.8
4018,4019,4020	Rehtr 2-1X HP Equalizing VT	0.05134	917.1	6.671	8.264
4021,4022,4023	Rehtr 2-2X HP Equalizing VT	0.05134	917.1	6.671	8.264
4069	Flash Tank Vap Outl to Cond	0.2006	933.0	26.526	32.866
4091, 4093	Rehtr 2-1X LP Dr Ln Vent Hdr	0.05134	386.0	2.745	3.457
4095,4097,4099,4101	Rehtr 2-1X Lp Dr Ln Vent Hdr	0.05134	386.0	2.745	3.457

NOTES: [1]Initial force not used. Steady state force was assumed to act at time zero.

[2]PRTHRUST run made (see Figure in Reference 4).

[3]Frictional losses considered (see Figure in Reference 4).

interfaces among the computer codes, and features of the codes which maintain compliance with the Acceptance Criteria. The individual codes are described in detail in References (3) through (6).

77-27

7

The analysis presented here was performed using the October, 1975 version of the Westinghouse Evaluation Model. This version includes the modifications to the models, referenced above, as specified by the NRC in Reference (7) and complies with Appendix K of 10CFR Part 50. The October, 1975 Westinghouse Evaluation Model is documented in References (8) through (10).

The analyses were performed using an upper head fluid temperature equal to the hot leg temperature. The effect of using the hot leg temperature in the reactor

PREVIOUS CHANGE

vessel upper head region is described in References (13) and (14). An analysis was performed using the Salem No. 2 plant as a reference plant (Reference 15). The only significant differences between Diablo Canyon and the reference plant is in the containment parameters which are discussed in detail below. Thus, the reference analysis was used for establishing the limiting break for Diablo Canyon. The containment has internal steel and concrete structural heat sinks which conform to the guidelines of Branch Technical Position CSB 6-1. The reference analyses identify $C_D = 0.6$ as the limiting break discharge coefficient; the reanalysis for Diablo Canyon is based on $C_D = 0.6$.

LATEST CHANGE

Diablo Canyon Unit 2 parameters are used to perform the analysis. Unit 2 is at a higher power (3411 Mwt) than Unit 1, and in addition, a comparative analysis was performed at the same power level ~~with~~ for both units, which showed that Unit 2 parameters resulted in a peak clad temperature 14°F higher than Unit 1. Thus, Unit 2 parameters are conservative for Unit 1.

The containment backpressure is calculated using the methods and assumptions described in Reference (2), Appendix A. Input parameters used in the reference analysis and the Diablo Canyon analysis are presented in Tables 3a and 3b, respectively.

The containment initial conditions of 90°F and 14.7 psia are representatively low values anticipated during normal full-power operation. The initial relative humidity was conservatively assumed to be 98.8 percent.

The condensing heat transfer coefficients used for heat transfer to the steel containment structures for the limiting breaks are given in Figure 16a for the reference analysis and Figure 16b for the Diablo Canyon analysis.

June 20, 1977

To: Leon Engle, USNRC

From: J. A. Moch/W. H. Nutting, PG&E

Subject: Equipment Failures During a Degraded Grid Voltage Condition at Millstone, Unit 2 (Diablo Canyon Units 1 and 2)

In reference to Mr. John F. Stolz's letter of June 6, 1977, due to time required to collect data and perform analyses, we expect to submit the requested information by October 15, 1977.

W. H. Nutting
WHNutting

WHN:aa

ROUGH DRAFT
May 5, 1977

"Temperature Monitoring of ESF Electrical Equipment"

Scope: The system should provide continuous monitoring and a continuous record of the ambient temperatures in spaces containing major ESF electrical components.

The system should be redundant in nature with redundant sensors, recorders, alarms and power sources.

The system should alert the control operator of any high temperature conditions. Attached is a table listing equipment spaces, recorders and alarms.

Discussion: Each equipment space will have 2 strip chart recorders capable of providing many days of continuous temperature records. The temperature sensor, probably an RTD or T/C, shall be suitably mounted in the space to sense ambient temperature.

Each recorder shall have a contact closure output whenever a predetermined set point is exceeded. This output shall feed into a local alarm unit with visual indication and identification of problem area. The local alarm units retransmit a common alarm signal to the annunciator in the Main Control Room. Each local alarm unit is capable of reflashing the main annunciator each time a new off-normal condition is detected even though one alarm condition exists.

EQUIPMENT SPACE	ELEV.	TEMP. RECORDER	POWER SOURCE	LOCAL ANNUNC.	ELEV.	MAIN CONTROL ROOM ALARM WINDOW
480V BUS F	100	TR4FA	1A	ANT-1A	100	480V BUS VENT FAILURE
"	100	TR4FB	1B	ANT-1B	100	"
480V BUS G	100	TR4GA	1A	ANT-1A	100	"
"	100	TR4GB	1B	ANT-1B	100	"
480V BUS H	100	TR4HA	1A	ANT-1A	100	"
"	100	TR4HB	1B	ANT-1B	100	"
BATTERY 11	115	TRB11A	2A	ANT-2A	115	BATTERY/DC EQUIP. VENT FAILURE
"	115	TRB11B	2B	ANT-2B	115	"
BATTERY 12	115	TRB12A	2A	ANT-2A	115	"
"	115	TRB12B	2B	ANT-2B	115	"
BATTERY 13	115	TRB13A	2A	ANT-2A	115	"
"	115	TRB13B	2B	ANT-2B	115	"
D.C. EQUIP. 11	115	TRD11A	2A	ANT-2A	115	"
"	115	TRD11B	2B	ANT-2B	115	"
D.C. EQUIP. 12	115	TRD12A	2A	ANT-2A	115	"
"	115	TRD12B	2B	ANT-2B	115	"
D.C. EQUIP. 13	115	TRD13A	2A	ANT-2A	115	"
"	115	TRD13B	2B	ANT-2B	115	"

RHR PUMP 11	64	TRRHR1A	3A	ANT-3A	73	E.S.F. PUMP ROOM, HIGH TEMP
"	64	TRRHR1B	3B	ANT-3B	73	"
RHR PUMP 12	64	TRRHR2A	3A	ANT-3A	73	"
"	64	TRRHR2B	3B	ANT-3B	73	"
SPRAY PUMPS	73	TRSPA	3A	ANT-3A	73	"
"	73	TRSPB	3B	ANT-3B	73	"
CHG PUMP 1	73	TRCP1A	3A	ANT-3A	73	"
"	73	TRCP1B	3B	ANT-3B	73	"
CHG PUMP 2	73	TRCP2A	3A	ANT-3A	73	"
"	73	TRCP2B	3B	ANT-3B	73	"
CHG PUMP 3	73	TRCP3A	3A	ANT-3A	73	"
"	73	TRCP3B	3B	ANT-3B	73	"
CCW PUMP 1	73	TRCC1A	3A	ANT-3A	73	"
"	73	TRCC1B	3B	ANT-3B	73	"
CCW PUMP 2	73	TRCC2A	3A	ANT-3A	73	"
"	73	TRCC2B	3B	ANT-3B	73	"
CCW PUMP 3	73	TRCC3A	3A	ANT-3A	73	"
"	73	TRCC3B	3B	ANT-3B	73	"
S.I. PUMP 1	85	TRSI1A	3A	ANT-3A	73	"
"	85	TRSI1B	3B	ANT-3B	73	"

S.I. PUMP 2	85	TRSI2A	3A	ANT-3A	73	E.S.F. PUMP ROOM HIGH TEMP
"	85	TRSI2B	3B	ANT-3B	73	"
DIESEL GEN. 11	85	TRDG11A	4A	ANT-4A	85	DIESEL/4KV SWGR HIGH TEMP
"	85	TRDG11B	4B	ANT-4B	85	"
DIESEL GEN 12	85	TRDG12A	4A	ANT-4A	85	"
"	85	TRDG12B	4B	ANT-4B	85	"
DIESEL GEN 13	85	TRDG13A	4A	ANT-4A	85	"
"	85	TRDG13B	4B	ANT-4B	85	"
4KV SWGR BUS F	119	TRSGFA	4A	ANT-4A	85	"
"	119	TRSGFB	4B	ANT-4B	85	"
4KV SWGR BUS G	119	TRSGGA	4A	ANT-4A	85	"
"	119	TRSGGB	4B	ANT-4B	85	"
4KV SWGR BUS H	119	TRSGHA	4A	ANT-4A	85	"
"	119	TRSGHB	4B	ANT-4B	85	"
CABLE SPREAD ROOM	128	TRCSA	5A	ANT-5A	128	CABLE SPREADING RM/SSPS HI-TEMP
"	128	TRCSB	5B	ANT-5B	128	"
SSPS ROOM	140	TRPSA	5A	ANT-5A	128	"
"	140	TRPSB	5B	ANT-5B	128	"