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EISENHUT,D.G. Division of Licensing

SUBJECT: Forwards info supplementing util 831011 & 14 ltrs re tornado loading parameters,matl properties & allowable stresses used in evaluation of masonry walls in 4.16-kV switchgear & cable spreading rooms,per anonymous allegation.

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J. O. SCHUYLER
VICE PRESIDENT
NUCLEAR POWER GENERATION

October 27, 1983

Mr. Darrell G. Eisenhut, Director
Division of Licensing
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Docket No. 50-275, OL-DPR-76
Diablo Canyon Unit 1
Turbine Building Tornado Loads: Additional Information

Dear Mr. Eisenhut:

On October 11 and 14, 1983, PGandE submitted to the NRC Staff information relating to an allegation by an anonymous individual concerning the tornado design analysis of masonry walls located in the turbine building. In those submittals, PGandE stated that the masonry walls in the 4.16 kV switchgear and cable-spreading rooms were evaluated using a linear-elastic (working stress) analysis. This evaluation indicated all of these masonry walls were capable of withstanding tornado loads identified in the FSAR.

The enclosure to this letter supplements the October 11 and 14, 1983 letters and provides additional information to clarify our earlier submittals with respect to tornado loading parameters, material properties, and allowable stresses used in the evaluation.

It is PGandE's position that the additional information provided in the enclosure is sufficient to address completely the allegation on tornado design criteria related to masonry walls.

Kindly acknowledge receipt of this letter on the enclosed copy and return it in the enclosed addressed envelope.

Sincerely,

J. O. Schuyler

J. O. Schuyler

Enclosure

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ENCLOSURE

TURBINE BUILDING TORNADO LOADS: ADDITIONAL INFORMATION

The following additional information supplements the information provided in PGandE letters dated October 11, 1983 and October 14, 1983.

Applicability of Tornado Loads to Internal Walls

The Diablo Canyon Final Safety Analysis Report (FSAR) describes the parameters used in reviewing the capability of the turbine building internal masonry walls to resist tornado loads. Included in the FSAR are four combinations of tornado loads based on (a) direct wind pressure (200 mph wind) and (b) atmospheric pressure drop (0.86 psi). The applicability of these loads to the masonry walls making up the 4.16 kV vital switchgear and cable-spreading rooms located in the turbine building is discussed below.

(a) For direct wind pressure to act on internal walls, the external protection (metal siding) would have to be blown off by the tornado. In those areas where the turbine building siding directly encloses the 4.16 kV switchgear and cable-spreading rooms, the metal siding has been strengthened to resist 200 mph tornado wind loads. Should the unstrengthened siding adjacent to these rooms be blown off, some of the masonry walls could experience direct wind pressures.

(b) The maximum potential atmospheric pressure drop is specified in the FSAR as 0.86 psi. This is an upper bound on the pressure differential that any wall, internal or external, could experience. For an internal wall to actually experience a pressure differential, an air vent path connecting the outside air to the air in that internal room would have to be established. This path could occur only after loss of the turbine building external siding. Since the rooms are not air tight, venting would occur. This venting would reduce the pressure differential on internal walls to a value less than the 0.86 psi potential.

Therefore, the four FSAR loading combinations listed below and which include both effects discussed above for which the turbine building 4.16 kV vital switchgear and cable-spreading room (internal) masonry walls have been evaluated, are conservative.

(1) maximum wind load alone

(2) maximum wind + 1/2 maximum pressure drop

(3) maximum pressure drop (with building depressurization)

(4) maximum wind + 1/2 maximum pressure recovery

Table 1 of PGandE's October 14, 1983 submittal and Table 1A of this submittal provide data from the most critical of the above four load combinations. A combination of these two tables demonstrates that turbine building masonry walls are capable of withstanding all of these combinations of the tornado wind loads, even when the loads are calculated conservatively.

Use of Actual Material Strengths

The tornado loading review of the turbine building masonry walls was performed with actual material strengths. Justification of the use of actual material properties was provided in PGandE's October 14, 1983 submittal.

The use of actual rebar yield stress, fy, was also discussed in the October 14 submittal. In January 1977, J. A. Blume and Associates provided a report to PGandE summarizing the actual strengths of various materials used in Diablo Canyon. The Blume report included investigation of the grade 40 rebar used in the turbine building masonry walls. Blume sampled 80% of the material test reports which were prepared by Pittsburgh Testing Lab. The data was analyzed and an average rebar yield stress of 51,390 psi was calculated. The Blume report contains a listing of the yield values from the lab test reports. Copies of these reports are available for review at PGandE.

Actual material strength was also used in determination of the masonry strength, f'm. Table 4.3 of the ACI 531R-79 masonry code provides values of masonry strength as a function of block strength. The PGandE specification for concrete block required tests to be performed as acceptance criteria for blocks to be used at Diablo Canyon. To satisfy this requirement, the block supplier, Air-Vol Block, Inc., provided a certificate stating that "all masonry units supplied...conform to all requirements of the plans and specifications."

Block testing was performed by Central Coast Laboratories. Some representative Central Coast Lab test reports were sent to the NRC staff in a July 7, 1981 report addressing seismic qualification of masonry walls in compliance with IEB 80-11. These test reports indicate block compressive strength, based on the gross area of the block. Table 3.4 of the ACI 531 code identifies block compressive strength based on net area. Therefore, the gross compressive strengths of the blocks were compiled from all the test data supplied by Air-Vol Block Inc. and then converted to a net area basis consistent with ACI 531. The average gross and net block compressive strengths are 1434 psi and 3830 psi, respectively. The Central Coast Lab block test reports are available for review at PGandE.

Stresses in Steel Columns Used to Stiffen Masonry Walls

Steel columns have been used to stiffen the masonry walls making up the 4.16 kV vital switchgear rooms (the cable-spreading room masonry walls do not have any such stiffeners). When the capability of the switchgear room masonry walls to resist tornado loads was reviewed, the stresses in the steel column stiffeners were also reviewed. Working stress design methodology and FSAR tornado wind loads were used in the review. The results of the review of the steel columns is provided in Table 1A. The shear stresses listed are the ratio of the shear capacity to the maximum calculated shear stress. The flexural stresses listed are the ratio of flexural moment capacity to the maximum calculated moment. Allowable stresses used to determine the shear and moment capacities do not exceed those recommended in Part 1 of the AISC steel code, increased by a factor of 1.6 for extreme environmental loading. These allowable stress criteria are in conformance with Section 3.8.4 of the Standard Review Plan. All of the steel column stiffeners have been qualified.

In-Plane Shear Stresses

Tornado wind loads could induce in-plane shear stresses in masonry walls if a masonry wall was oriented perpendicular to a second wall and was used to provide out-of-plane support for that second wall.

All of the 4.16 kV vital switchgear and cable-spreading room masonry walls located in the turbine building have been reviewed for susceptability to in-plane shear stresses. None of these masonry walls provide out-of-plane support for any other walls and therefore none are subject to tornado induced in-plane shear stresses.

Mechanical Anchorage Along Masonry Wall Boundaries

The masonry walls at Diablo Canyon are used primarily as partition walls (non-structural). Attachment of these walls to the building structure is accomplished with mechanical anchors. Consideration of the shear strength of the mortar joint between the last block and the concrete structure was not used in the evaluation. "Slug-In" expansion anchors were embedded along the bottom edges of the masonry walls abutting concrete. Other supported edges of the walls are attached to the building structure (concrete or steel) with clip angles. In cases when transfer of large loads from the block wall to the building structure is required, the "Slug-In" anchors are supplemented with clip angles. The clip angles bear up against the masonry walls and are attached to the building structure with "Hilti Kwik-Bolt" expansion anchors (for attachment to concrete) or with structural bolts/welds (for attachment to building steel).

In some cases the continuity of the supplemental clip angles is interrupted by an existing interference (e.g., conduit, pipe). Generally, the interruption is only a few inches long and is of no consequence. However, in a few cases, the interruptions are longer. The capability of the wall to span across the interruption and to transfer boundary reactions to clip angles adjacent to the interruption has been confirmed for these cases.

TABLE IA

$\frac{\text{CAPACITY}}{\text{DEMAND}}$ FOR TORNADO LOADS

4.16kV Vital Switchgear Room

Wall No.	Steel Column Stress	
	Bending	Shear
T-19a	3.69	9.89
T-19b	3.69	9.89
T-19c	3.69	9.89
T-20a	3.18	8.35
T-20b	3.18	8.35
T-21a	3.18	8.35
T-21b	3.18	8.35
T-22b	7.12	17.41
T-22c	7.12	17.41

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