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E. H. CREWS, JR.
VICE-PRESIDENT AND GROUP EXECUTIVE
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January 7, 1980

Mr. James P. O'Reilly, Director
United States Nuclear Regulatory Commission
Region II
101 Marietta Street, N. W.
Atlanta, Georgia 30303

Subject: Virgil C. Summer Nuclear Station
Inspection & Enforcement Bulletin
79-02 Revision 2
Docket No. 50-395
Nuclear Engineering File - 2.8950

Dear Mr. O'Reilly:

South Carolina Electric & Gas Company has reviewed IE Bulletin 79-02 Revision 2 dated November 8, 1979, and submits the attached written response as required.

Should you have further questions concerning this matter, please contact us.

Very truly yours,

E. H. Crews, Jr.

RW:EHC:jw

CC: Office of Inspection & Enforcement
Washington, D. C.

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V. C. SUMMER NUCLEAR STATION
UNIT 1
NRC BULLETIN 79-02
REVISION 2

RESPONSES

Bulletin Item 2, page 3 of 7, third paragraph.

The Bulletin factors of safety were intended for the maximum support load including the SSE. The NRC has not yet been provided adequate justification that lower factors of safety are acceptable on a long term basis. Lower factors of safety are allowed on an interim basis by the provision of Supplement No. 1 to IE Bulletin No. 79-02. The use of reduced factors of safety in the factored load approach of ACI 349-76 has not yet been accepted by the NRC.

Response:

Concrete expansion anchor bolts were initially designed to have a minimum factor of safety of four when subjected to all loading combinations, including those containing SSE as a component load. Subsequent evaluation, as discussed in more detail in response to Item 6 of this Bulletin, indicates that the factor of safety was not realized in all cases.

Bulletin Item 4, page 4 of 7, sixth paragraph.

Those licensees that have not verified anchor bolt preload are not required to go back and establish preload. However, additional information should be submitted which demonstrates the effects of preload on the anchor bolt ultimate capacity under dynamic loading.

Response:

Anchor bolt preload has been verified previously.

Bulletin Item 5, page 5 of 7, first paragraph.

Determine the extent that expansion anchor bolts were used in concrete block (masonry) walls to attach piping supports in Seismic Category 1 systems (or safety related systems as defined by Revision 1 of IE Bulletin No. 79-02). If expansion anchor bolts were used in concrete block walls:

a. Provide a list of the systems involved, with the number of supports, type of anchor bolt, line size, and whether these supports are accessible during normal plant operation.

b. Describe in detail any design consideration used to account for this type of installation.

c. Provide a detailed evaluation of the capability of the supports, including the anchor bolts, and block wall to meet the design loads. The evaluation must describe how the allowable loads on anchor bolts in concrete block walls were determined and also what analytical method was used to determine the integrity of the

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block walls under the imposed loads. Also describe the acceptance criteria, including the numerical values, used to perform this evaluation. Review the deficiencies identified in the Information Notice on the pipe supports and walls at Trojan to determine if a similar situation exists at your facility with regard to supports using anchor bolts in concrete block walls.

d. Describe the results of testing of anchor bolts in concrete block walls and your plans and schedule for any further action.

Response:

Expansion anchor bolts have not been used to anchor Seismic Category I piping systems to concrete block walls.

Bulletin Item 6, page 5 of 7, first paragraph.

Determine the extent that pipe supports with expansion anchor bolts used structural steel shapes instead of base plates. The systems and lines reviewed must be consistent with the criteria of IE Bulletin No. 79-02, Revision 1. If expansion anchor bolts were used as described above, verify that the anchor bolt and structural steel shapes in these supports were included in the actions performed for the Bulletin. If these supports cannot be verified to have been included in the Bulletin actions:

a. Provide a list of the systems involved, with the number of supports, type of anchor bolt, line size, and whether the supports are accessible during normal plant operation.

b. Provide a detailed evaluation of the adequacy of the anchor bolt design and installation. The evaluation should address the assumed distribution of loads on the anchor bolts. The evaluation can be based on the results of previous anchor bolt testing and/or analysis which substantiates operability of the affected system.

c. Describe your plans and schedule for any further action necessary to assure the affected systems meet Technical Specifications operability requirements in the event of an SSE.

Response:

A review of design calculation indicates that there are almost 200 instances in which structural shapes, primarily angles, have been used on the V. C. Summer Project as linear component supports attached directly to concrete surfaces with Hilti Kwik Bolts. More than one half of these supports are loaded such that only shear forces are transmitted to the anchor bolts. For the rest of these supports the arrangement of the angles and the direction of the applied loads is such that axial loads, usually in addition to shear loads, are induced in the anchor. In a few cases the axial load is compressive; in most cases it is tensile. Where Tensile loads exist, they are occasionally applied concentrically with respect to the expansion anchor; more often the load is applied with a significant eccentricity.

For purposes of this study a sample of 30 supports was chosen for reanalysis. It was comprised of 14 supports subject to shear only, 2 supports subject to concentric tension, 1 subject to compression, 5 subject to eccentric tension, and 8 subject to a combination of eccentric tension and shear. This sample is considered to be representative of the overall population of supports of this type. The results of this reanalysis is summarized in Table 1 which indicates that the factor of safety can be considered to be greater than four whenever the expansion bolt is not subject to eccentric tension. However, of the 13 supports which were subject to eccentric tension 9 were found to have a factor of safety less than four.

The relative low factors of safety in these cases is almost entirely attributable to the current concern that eccentrically applied loads can cause an angle to rotate about its toe, thereby forming a couple composed of a compression force in the concrete and an additional tensile force in the expansion bolt. This action, which was not adequately considered in previous analyses, can be called short direction prying and can increase the stress in the bolt to as much as 300% of that which would be determined from simple equilibrium of forces. The derivation of the factor applied to account for short direction prying is given in Figure 1.

Figure 2 shows a typical application of a Hilti bolted angle. This particular arrangement using actual geometry and loads for one of the supports was analysed using finite element techniques in order to evaluate the possible effect of prying in the long direction and also the adequacy of the short direction prying analysis. That analysis confirmed that the approach being used for short direction prying was conservative and that, also as shown in Figure 2 prying in the long direction is insignificant if indeed, present at all. The distribution shows compression parallel to the long axis of the angle, as caused by short direction prying, but no additional compression along the short side of the angle as would have to be necessary if long direction prying were present. Prying in the long direction, consequently, was not considered further.

Analytical work and appropriate redesign to ensure that all pipe support anchorages formed using expansion bolted structual shapes conform to the requirements of IE Bulletin 79-02 and the ASME Boiler and Pressure Vessel Code, Section III, will be included in the design verification efforts for Seismic Category 1 supports. Such efforts will be completed prior to placing plant systems into operation.

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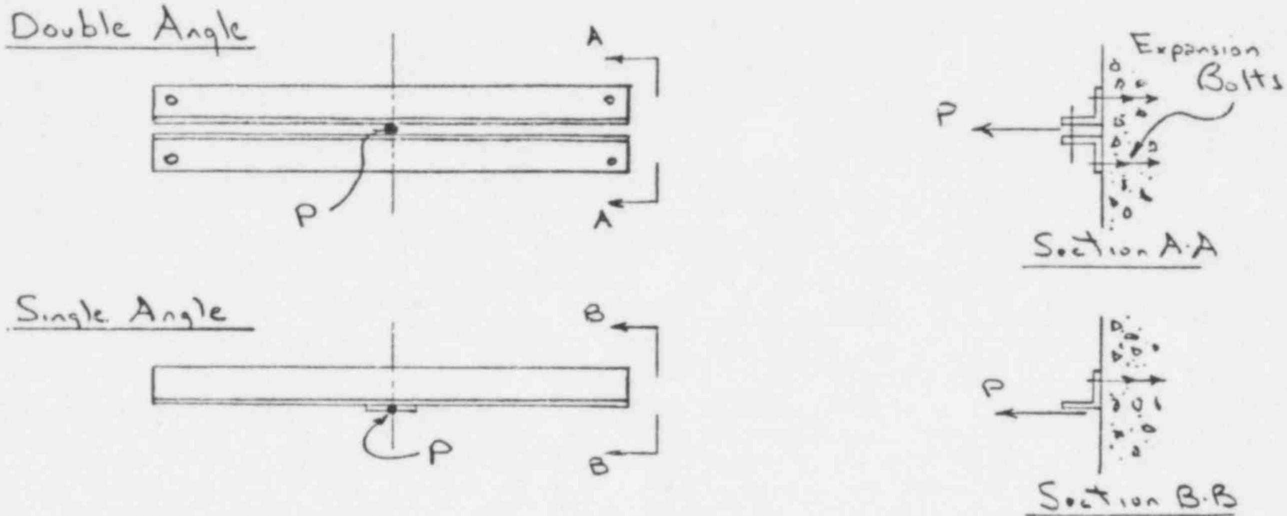
TABLE 1

RESULTS OF REANALYSIS OF EXPANSION BOLTED PLATES

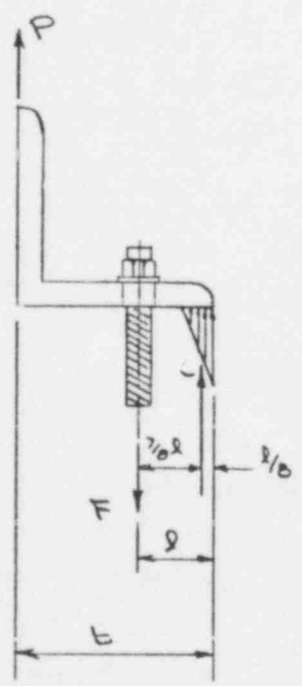
Loading Description	Pipe Support No.	Factor of Safety
Supports Subject to Shear Only		
	MK-VUH-013	4.2
	MK-BRH-013	5.6
	MK-SIH-316	6.0
	MK-CSH-200	8.4
	MK-BRH-007	8.3
	MK-SWH-258	6.6
	MK-VUH-087	7.4
	MK-CSH-204/115	15.4
	MK-SPH-056	9.9
	MK-VUH-003	16.6
	MK-VUH-100/101	8.4
	MK-SHW-154	5.9
	MK-SPH-032	9.2
	MK-VUH-062/063	15.5
Supports Subject to Concentric Tension Only		
	MK-CCH-775	11.9
	MK-WDH-018	12.8
Supports Subject to Compression Only		
	MK-CCH-071	very large
Supports Subject to Eccentric Tension Only		
	MK-CCH-113	1.8
	MK-VUH-191/192	2.3
	MK-RHH-032	3.2
	MK-SPH-074	3.2
	MK-RHH-026	11.0
Supports Subject to Eccentric Tension and Shear		
	MK-CCH-041	2.3
	MK-VUH-012	2.3
	MK-BRH-080	2.7
	MK-WDH-043	2.7
	MK-SWH-243	3.5
	MK-CSH-225	9.0
	MK-CSH-231	12.0
	MK-CSH-217	19.0

FIGURE 1

ECCENTRICALLY LOADED ANGLE
SUBJECT TO
SHORT DIRECTION PRYING



Derivation of Short Direction Prying Factor



Moments about location of C:

$$F \cdot 7\ell/8 = P(b - \ell/8)$$

$$F = \frac{8P}{7\ell}(b - \ell/8)$$

$$\therefore \text{Factor} = \frac{8}{7\ell}(b - \ell/8)$$

where

P = force per bolt as determined from equilibrium of forces, neglecting eccentricity of load

F = anchor bolt force

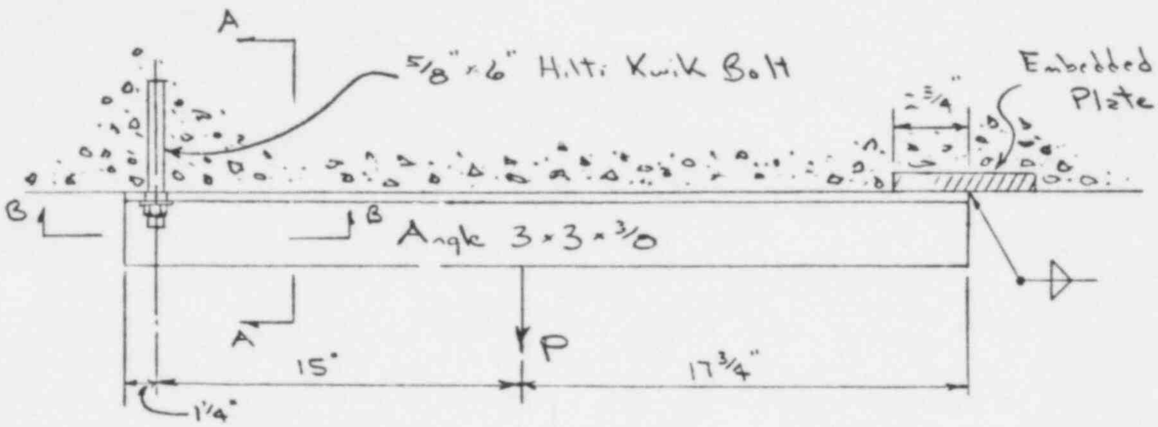
C = concrete compressive force resultant

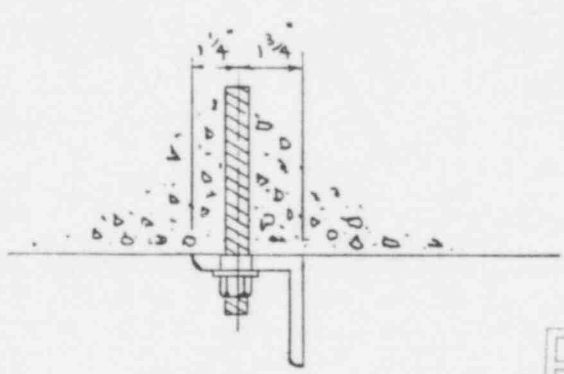
ℓ = width of compression area

b = width of angle

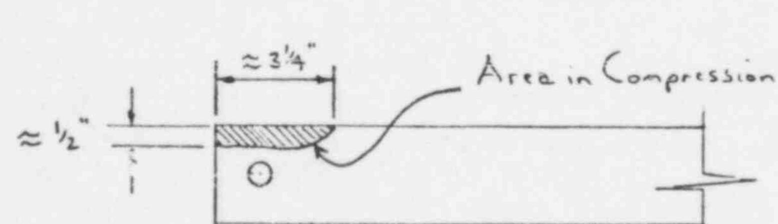
FIGURE 2

FINITE ELEMENT ANALYSIS OF TYPICAL EXPANSION BOLTED ANGLE





Section A-A



Section B-B