From: Michael Lesar
To: Doris Mendiola
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Subject: Fwd: Comments and Observations on DG 1099 Draft

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H.L. Graves (HLG1)

October 4, 2002

Herman Graves
U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington, D.C. 20555

Subject: **DRAFT REGULATORY GUIDE DG-1099 COMMENTS AND OBSERVATIONS**

Dear Mr. Graves:

We have reviewed the subject draft regulatory guide and find it to be a positive step towards streamlining the process of design, evaluation, and quality assurance of concrete anchors used for structural members, systems, and components. The wider acceptance of ACI 349 Appendix B provisions, coupled with increased consistency between the ACI 355, ACI 318, and ACI 349 codes, should greatly enhance the design process of anchorages, which play an important role in assuring a ductile behavior for structures, systems, and components.

During our review, we annotated the draft guide with comments and observations, which we share with you in the attachment to this document.

We appreciate the opportunity to review the draft regulatory guide.

Sincerely,

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DRAFT REGULATORY GUIDE DG-1099 COMMENTS AND OBSERVATIONS

1. Under Section B. Discussion, in the fourth paragraph on Page 3, it is stated that research and test results have shown the pullout cone to be closer to a 35° cone, rather than the 45°cone assumed in the ACI 349-80 code. It should be noted that the pullout cones observed during tests vary with the embedment, being much larger than 45° for shallow embedments and in the 30° range for deeper embedments.

2. Under the Discussion of Regulatory Positions, Regulatory Position 1.2 supplements Section B.3 of ACI 349-01 in terms of the load factors by referring to Regulatory Position 1.3 which endorses the ACI 349-01 Section B.4 with the exception of the load factors used for the thermal and accident pressure loads.

   The specific load factors provided under Regulatory Position 1.3 are discussed separately under Item 4 below. Beyond those comments, we would like to recommend that the Regulatory Guide should specify goals, or expectations, associated with designing concrete structures using ACI 349.

   As an example, with parameters being the material strengths, code strength equations, and the design load combinations, it would be extremely beneficial to specify that the goal is to achieve a structural design that has a 1%, or less, probability of failure, that the material strengths should have a 95% or better probability of exceedance, i.e., less than 5% chance of being less than expected, and the code strength equations should have a 85% probability of exceedance, i.e., less than 15% probability of the actual strength being less than calculated using the code equations.

3. The discussion regarding Regulatory Position 1.7 provided on Page 5 covers potential problems associated with concrete block wall anchorages, further complicated when dynamic loads are present. As there are expansion anchor manufacturers that provide load capacities based on actual tests of concrete block walls, it would be beneficial to mention, under the discussion section, the possibility that the block walls where constructed using Pumice material. Because of the high void ratio, Pumice Concrete Masonry Units are superior in terms of thermal conductivity and fire resistance. However, individual block compressive strength could be as low as 700 psi, with the average being approximately 1000 psi. The lack of strength could cause the bolt expansion mechanism to actually cut into the pumice material, resulting in limited anchorage capacity.

4. Regulatory Position 1.3, presented on Page 6 of the Draft Regulatory Guide, accepts the load factors specified in ACI 349-01 Section 9.2.1, with the exception of the load factors for T_o and P_a. Specifically, Position 1.3.1 asks that 1.2 T_o be used in place of 1.05 T_o in load combinations 9, 10, and 11, Position 1.3.2 asks that 1.5P_a be used in place of 1.25 P_a in load combination 6, and Position 1.3.3 asks that 1.25 P_a be used rather than 1.15 P_a in load combination 7. With regard to this regulatory position we have the following comments and observations:

   - In the absence of goals, or expectations, as to the desired probability of failure to be achieved

by the design, as discussed under Item 2 above, the requirements do not reflect the conservatism level at which the load parameters are calculated. While the load factor increase should be applied to loads established as best estimates, loads defined at the 99% non-exceedance probability level should not require any further increase.

- The increased load factors do not necessarily result in structures that have enhanced structural behavior. The increase in the thermal effects via the load factor for a wall with reinforcement controlled by the thermal gradient induced moment will not enhance the design. The additional reinforcement required to carry the bending moment will increase the moment capacity while the shear capacity remains unchanged. Thus, the wall element will have decreased ductility, as the desire is to have the shear capacity higher than the moment capacity so the weak link is the reinforcement yielding rather than a sudden shear failure.
- The third observation deals with consistency. Regulatory Guide 1.142, Revision 2, issued November 2001 incorporated various research results that lowered the T_o load factor from 1.3 to 1.2, and supported P_a load factors that departed from the traditional Standard Review Plan one.

An image extracted from Regulatory Guide 1.142, Section C, Regulatory Position 6 is presented below.

6. The load factors used in Section 9.2.1 of ACI 349-97 are acceptable to the staff except for the following:

6.1 In load combinations 9, 10, and 11, 1.2 T_o should be used in place of 1.05 T_o.

6.2 In load combination 6, 1.4Pa should be used in place of 1.25Pa.

As can be seen, the 1.25 P_a in load combination 6 is revised to 1.4, rather than the 1.5 specified in the Draft Regulatory Guide DG-1099. Furthermore, load combination 7 of ACI 349 is left unchanged, without requesting that 1.25 P_a replace 1.15 P_a.

For consistency, the Regulatory Guide 1.142 requirements, which probably reflect the improved analytical tools available to calculate accident pressures, as well as the built-in conservatism in the P_a calculations, should be reflected in Draft Regulatory Guide DG-1099.

5. While the licensees and applicants may propose means other than those specified by the provisions of the Regulatory Positions, the positions should reflect what is acceptable to the staff. In this vein, wording in Regulatory Position 7, i.e., " . . . the NRC staff does not recommend the use of any type of anchors," should indicate that it is not acceptable to use the anchors discussed in this guide to anchor Seismic Category I components or systems to concrete block walls.

6. Section B.4.2.2 of Appendix B to ACI 349-01 limits the application of the code formulations for concrete breakout strength in tension and shear to anchors with diameters not exceeding 2 in.,

and embedments not exceeding 25 in. in depth. The Regulatory Guide should indicate what would be acceptable to the staff when the anchor diameter or the embedment exceeds the limits set in ACI 349-01.

It should be noted that for deeper embedments that are close to an edge, the ACI 349-01 formulations will result in decreased capacities as the embedment depth is increased. As such, this dichotomy may be addressed by accepting a higher anchor capacity associated with a shallower embedment (even though the anchor has a deeper embedment.)