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Mr. James P. O'Reilly, Director
Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, Suite 3100
Atlanta, Georgia 30303

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Dear Mr. O'Reilly:

I. E. Bulletin No. 79-02 emphasizes the importance of ensuring that concrete expansion anchor bolts are properly installed to withstand the loads transmitted through the baseplates and that baseplates are in conformance with the design assumptions of flexibility or rigidity. Deficiencies associated with these items were recognized on North Anna Unit No. 1 and reported under the provisions of 10CFR50.55(e). Our letters of November 8, 1976, Serial No. 315; March 22, 1977, Serial No. 093; May 13, 1977, Serial No. 198; and July 19, 1977, Serial No. 318 represented our final reports on these items. Extensive engineering, construction, and quality control procedures were developed and implemented during this period to ensure that North Anna Unit 1 would meet the criteria which are now being addressed by I.E. Bulletin No. 79-02.

Item 5 of I. E. Bulletin No. 79-02 requests that all holders of operating licenses for power reactor facilities complete Items 1 through 4 for installed pipe support base plates with concrete anchor bolts. These items are addressed below for North Anna Unit 1.

1. Baseplate flexibility has been accounted for in the calculation of anchor bolt loads for all Category I concrete founded pipe supports. As an out-growth of an I & E investigation conducted at North Anna in 1976, criteria were developed to evaluate baseplate flexibility and this criteria was used to evaluate those pipe supports previously installed. The supporting analysis used in developing these criteria utilized a ratio of the distance between a loaded member of the baseplate and the baseplate bolts to the baseplate thickness rather than the ratio between the unstiffened edge distance and the baseplate thickness which Item 1 states can be used in lieu of supporting analysis.

Stone and Webster Engineering Document 11715 EDCR P1922G, and supplement revisions was used as the basis for designing, reviewing, and modifying baseplates to assure baseplate flexibility was considered for determination of anchor bolt loads. To determine curves and values

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used in EDCR P1922G, a public domain program titled "ANSYS" developed by Swanson Analysis System, Inc. of Houston, Pa. was used. "ANSYS" is a finite element analysis program that has capabilities which include modeling baseplates, concrete foundation, attachments and bolts undergoing various loading conditions.

Stone and Webster modeled baseplates utilizing varying thicknesses, loads, anchor bolt patterns and shapes with the "ANSYS" program. The results of this finite element analysis modeling was compared with results of manual calculations considering the baseplate was rigid. EDCR P1922G identified baseplate evaluation criteria from the results of the "ANSYS" study. Using this criteria, it was determined which supports, if analyzed using finite element methods, would give higher than manually calculated anchor bolt loads. This allowed the continued use of manual calculations as geometric parameters had been identified by the use of "ANSYS" that gave limits for conservative results by manual means.

The results of the "ANSYS" program showed that for square or rectangular baseplates with 4 or more bolts, for d/t ratios of less than or equal to 5/1 where d is the distance from the side of the support member to the farthest row of bolts on the same side of the member and t is the thickness of the baseplate. Baseplates falling outside these geometric limits as determined by field measurement were considered to have some degree of flexibility since finite element analysis could result in higher anchor bolt loads than would be calculated using a rigid analysis. Baseplates in this category were re-evaluated and modified as necessary to ensure that maximum anchor bolt loads would not exceed the allowable bolt loads and that baseplate stresses would not exceed the allowable design stress. The field check and modification of existing supports was carried in I & E records as Item 77-12/6 and was audited and closed by NRC Region II letter 50-338/77-54 of November 22, 1977. All pipe supports added after these checks were designed using guidelines to assure rigidity.

2. The majority of the pipe support expansion anchor bolts are of the "Hilti-Kwik" design which are wedge and sleeve type anchor bolts with a minimum design factor of safety of four based on manufacturer's test data. During the early stages of construction, some "Phillips Self Drilling Anchors" were used. These are considered shell type anchor bolts and where used they have a design factor of safety of at least five.

The factors of safety were used to establish allowable bolt loads which were not exceeded in design. The allowable loads are based on a concrete strength of 3000 psi which is the minimum used in Category I structures. Quality control records generally show concrete strengths in the 4000 psi to 5000 psi range. Since anchor bolt loads did not exceed the allowable loads and since concrete strengths are often

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higher than the design strength, the actual factors of safety can be expected to exceed the values stated above which are the minimum factors of safety used.

3. Cyclic loading was not specifically considered as a design requirement; however, as part of the inspection program described in Item 4 below, anchor bolts were torqued to a value corresponding to the allowable bolt design loads. This requirement of applying a torque to the anchor bolts was incorporated into the current anchor bolt installation procedures followed for anchor bolts installed after the implementation of the inspection program. The effect of torquing the bolts is to apply a preload which is considered to give the anchor bolts cyclic load capability since the actual design loads would not exceed the calculated preload applied to the bolt.
4. In conjunction with the correspondence mentioned in the first part of this letter, a detailed anchor bolt inspection program was instituted in 1977. All anchor bolts in Category I pipe supports installed at that time were ultrasonically measured to ensure adequate embedment depth and were torqued to a value corresponding to the allowable design loads.

The results of this field inspection verified anchor bolt size, embedment, and preloading. For "Phillips Self Drilling Anchors" the proper thread engagement was verified. Full documentation exists for this program. Anchor bolts for pipe supports added or modified after this inspection were covered by expanded construction and quality control procedures which used a sampling system for verification.

In summary, the procedures implemented on North Anna Unit No. 1 ensure that anchor bolts have been designed and installed in a manner which satisfy the requirements of I. E. Bulletin 79-02. Therefore, no additional inspection or analytical work is required.

Very truly yours,

C. M. Stallings

C. M. Stallings
Vice President-Power Supply
and Production Operations

cc: Mr. Victor Stello, Director
Office of Inspection and Enforcement

Mr. Harold R. Denton, Director
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