UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO DIFFERENTIAL SETTLEMENT BETWEEN CATEGORY I STRUCTURES

NORTH ANNA POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-338 AND 50-339

1.0 SUMMARY

This Safety Evaluation deals with the licensee's request to change the plant Technical Specifications (TS) related to the differential settlement between the service building (SB) and the Unit 2 main steam valve house (MSVH). The licensee has requested that the present allowable differential settlement of 0.03 foot between these two buildings be increased to 0.047 foot because its analysis indicated that the buried, 24-inch diameter, service water pipes running between the two buildings could withstand the increased differential settlement to 0.047 foot (Ref. 1). The immediate reason for the request, however, was that the settlement measurement indicated that the differential settlement between the two buildings first exceeded 75% of the allowable value, and then exceeded 100% of the allowable value of 0.03 foot. After reviewing the licensee's submittals with the technical assistance of the Brookhaven National Laboratory (BNL) staff, including a surveying specialist, the NRC staff has concluded that the TS should not be changed. The basis for the staff's decision is that the licensee's subsequent report (Ref. 2) corrected its earlier incorrect survey procedures and the present differential settlement between the SB and the MSVH is less than 75% of the allowable value. Furthermore, the staff is not satisfied with the licensee's pipe stress analysis that supports the increased value of the differential settlement.

2.0 BACKGROUND

The licensee, Virginia Electric and Power Company (VEPCO), started its formal program of monitoring the settlements of Category I structures at North Anna in May 1976 (Ref. 3). In August 1976 the licensee's survey of the SB indicated apparent settlements from the as-built elevations that would have caused increased stresses on the four 24-inch-diameter buried service water lines beneath the footings of this structure (Ref. 1). These lines are encased in four-foot-thick reinforced concrete, and run between the SB and the MSVH. Pipe stress analysis confirmed that the pipes might be overstressed. To relieve the increased stresses in the pipes due to prior settlement, the licensee removed a portion of the concrete encasement, cut the service water lines and rewelded them in 1977, thus establishing a baseline for future settlement measurements by assuming zero settlement at that time. Based on the settlement history of Point 171 on Column C-17 in the SB, the licensee projected that a decreased rate of settlement equivalent to secondary compression of the foundation soil would occur in the future and that, over

the life of the plant (40 years), this would result in only 1/4 inch of additional settlement. This projected settlement of 1/4 inch was increased by 50% to provide a safety margin in the stress analysis of the service water pipes. This led to a value of 0.03 foot (approximately equal to 1/5 X 1/4 inch) for the allowable differential settlement of the service water pipes. Therefore, the plant TS, proposed in October 1977, contained an allowable differential settlement of 0.03 foot between the SB (Point 117) and the MSVH (Point 113).

About 3 years after the above prediction, the measured differential settlement between Point 117 in the SB and Point 113 in the MSVH exceeded 75% of the TS limit. Based on the updated settlement data, the licensee then projected that an additional settlement of 0.06 ft. to 0.08 ft. would occur during the remaining life of the plant, and that the allowable differential settlement of 0.03 ft. would be exceeded in 2 years. However, continued surveys conducted monthly until October 1982 showed the measured differential settlement to have decreased to 50% of the allowable value, instead of exceeding the allowable value as predicted.

In 1987, the licensee surveyed Point 113R (which replaced Point 113) using a shortened Philadelphia Rod due to overhead obstructions and noted that 75% of the allowable differential settlement had again been exceeded. In 1988 the licensee submitted a TS change request to increase the allowable differential settlement from 0.03 ft. to 0.047 ft., stating that pipe stresses would still be below the code allowable values (Ref. 1).

In February 1989, the licensee's survey indicated that the differential settlement between Points 117 and 113R equaled 100 percent of the allowable value of 0.03 ft. The NRC staff visited the site on February 22, 1989, discussed the problem with the licensee's staff, and requested additional information from the licensee. The licensee's responses to the NRC staff's questions stated that (1) its survey that showed 100% of the allowable differential settlement between Points 117 and 113R was incorrect because of the use of non-standard survey rods, and that (2) an accurate survey using the Invar rod showed that only 67 percent of the allowable differential settlement had occurred (Ref. 2).

On March 24, 1989, the NRC staff visited the site again, this time with two consultants (one of whom is a Surveying Specialist), to examine the licensee's surveying procedures. During this visit, the consultants performed an independent survey to determine the difference in elevations of the Points 117 and 113R using their own survey instruments. The consultants' survey results agreed very well with the licensee's survey using the Invar rod (Ref. 4).

In October 1989 the licensee submitted a comprehensive report describing the entire history of settlement monitoring at North Anna, and requested changes to TS related to settlement monitoring of all Category I structures (Ref. 5). This Safety Evaluation, however, covers only the licensee's original request related to the monitoring of the SB and MSVH. The licensee's request related

to other structures, including the service water pump house, will be reviewed in a separate evaluation.

3.0 EVALUATION

This Safety Evaluation of the licensee's request for changing the TS related to the settlement monitoring of the SB and the MSVH focuses on the following two aspects of the problem:

1. The reasons for the oscillating pattern of the differential settlement between the SB and the MSVH instead of the normally expected monotonically increasing settlement pattern; and

2. The reasonableness of the licensee's request to increase the allowable value of differential settlement from 0.03 ft. to 0.047 ft.

Regarding the oscillating nature of the differential settlement data, the licensee states that it was mainly due to errors in surveying e.g., the use of non-standard rods for leveling and indirect measurement of elevations of the Points 117 and 113R located in the two buildings. The licensee has now shown to the satisfaction of the consultants and the NRC staff that consistent use of the Invar Rod will eliminate the major cause of the survey error. The licensee has also proposed a method to determine the change in elevation of points 113R and 117 by direct measurement from a single instrument set-up in the future. The NRC accepts the licensee's explanation of the erratic nature of the differential settlement measurements made earlier. The NRC staff also finds acceptable the licensee's proposed method of direct measurement of the future change in elevations of points 117 and 113R in order to determine the additional differential movement of these points in the future. Since the differential settlement between the two points has previously approached the allowable limit, the direct reading method should provide an accurate means of determining the future (additional) differential settlement by eliminating random survey error associated with survey loops.

In addition to accepting the licensee's explanation regarding the surveying error, the NRC consultants (Ref. 6) recommend and the staff agrees that additional soil borings extending to sound bedrock levels should be made to help make a reasonable estimate of the settlement of the foundation soil in the proximity of the SB and the MSVH.

The licensee's request to increase the allowable differential settlement value between the SB and the MSVH is not acceptable to the NRC staff. As explained in Reference 6, and as admitted by the licensee, the accuracy of the elevations of points 117 and 113R established by past surveys is questionable, and, therefore, the differential settlement values are equally questionable. In view of the uncertainty of the current values of the actual differential settlement to which the buried pipes are subjected, it is not prudent to increase the allowable differential settlement between the SB and the MSVH. Furthermore, the staff has not yet accepted the licensee's pipe stress

analysis results (Ref. 7). Based on the agreement between the NRC staff and the licensee about the accuracy of the revised survey procedures, and on the fact that the recent measurements indicate the differential settlement between the SB and the MSVH to be less than 75% of the TS limit, the NRC staff rejects the licensee's request to change the Technical Specification Section 3/4.7.12, Table 3.7.5 related to the differential settlement between the SB and the MSVH.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based on a review of the licensee's submittals (Refs. 1, 2, and 5), the NRC staff rejects the licensee's request to change the Technical Specification related to the settlement monitoring of the SB and the MSVH. However, the staff accepts the licensee's proposal to determine the additional differential settlement that may occur in the future between the SB and the MSVH by direct measurement of the elevations by a single instrument set-up.

Date: March 31, 1992

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5.0 REFERENCES

1. Letter dated March 10, 1988 from W. L. Stewart, VEPCO, to USNRC, Subject: Proposed Changes to Technical Specifications - Settlement of Class 1 Structures.

2. Letter dated March 23, 1989 from W. R. Cartwright, VEPCO, to USNRC, Subject: Request for Additional Information Settlement of Class I Structures.

3. Letter dated February 20, 1981 from B. R. Sylvia, VEPCO, to J.P. O'Reilly, NRC, Subject: Differential Settlement North Anna Units 1 & 2.

4. Memorandum dated August 10, 1989 from G. Bagchi to H. N. Berkow, Subject: VEPCO's request for change in Technical Specification 3/4.7.12 - Site Visit and Meeting on May 24, 1989 at North Anna Power Station Units 1 & 2.

5. Letter dated October 2, 1989 from W. L. Stewart, VEPCO, to USNRC, Subject: Proposed Technical Specifications Change - Settlement Monitoring Program.

6. Letter dated December 14, 1989 from Dr. K. K. Bandyopadhyah, BNL, to R. Pichumani, NRC, Subject: North Anna Unit 2, Survey Results Related to Settlement of Buildings, FIN-3841, Task No. 19.

7. Memorandum dated March 6, 1990 from L. B. Marsh to L. B. Engle, Subject: Pipe Stress due to Differential Settlement - North Anna Unit 2.