

August 20, 1979

UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

In the Matter of )  
VIRGINIA ELECTRIC AND POWER COMPANY ) Doc. Nos. 50-338 OL  
(North Anna Power Station, Units ) 50-339 OL  
1 and 2) (Pumphouse Settlement)

INTERVENOR ARNOLD'S MEMORANDUM OF PROPOSED FINDINGS  
REGARDING SERVICE WATER PUMPHOUSE SETTLEMENT

Upon sua sponte review of the Atomic Safety and Licensing Board's initial decision authorizing issuance of an operating license for North Anna Nuclear Power Station Units 1 and 2, the Atomic Safety and Licensing Appeal board affirmed the decision with respect to most matters, but withheld its approval in connection with two plant safety issues: 1) settlement beneath the Unit 1 and 2 service water pumphouse, and 2) the probability of unacceptable damage from missiles generated either inside or outside the facilities. Subsequently, the Appeal Board called for an evidentiary hearing on these two plant safety issues which was held in Bethesda, Maryland, on June 18, 19, and 20, 1979. Intervenor Arnold limited her participation in these hearings to cross-examination of Applicant and Staff witnesses on the pumphouse settlement issue. In accordance with the agreed upon schedule set forth in the

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Appeal Board's Memorandum and Order of June 21, 1979, Intervenor Arnold offers the following proposed findings on the pumphouse settlement issue.

### Introduction

Intervenor Arnold accepts as far as they go, the Staff's proposed findings describing the service water pumphouse settlement (including Introduction, Description of Service Water System, Soil Mechanics, Settlement History, and the first three paragraphs of the section on Dewatering)(Staff Proposed Findings, pp. 2-19). With certain exceptions discussed below, this factual background surrounding the settlement problem is not in dispute. Rather, the principal issue before the Appeal Board is whether the Applicant's solution to the problem and the technical specification governing that solution provide reasonable assurance that the health and safety of the public will be protected, particularly in light of continuing, poorly understood settlement of the pumphouse. Simply stated, the Applicant and Staff maintain that the Applicant's solution and the proposed technical specification do provide such assurance; Intervenor Arnold maintains that they do not.

An evaluation of the safety significance of modifying, through a technical specification change, the allowable settlement of the service water pumphouse must begin with the assumption that the initial technical specification dealing with settlement was also established with the intent to protect the health and safety of the public (See Tr. 352-353). Since the

technical specification change proposed by the Staff and Vepco allows for increased settlement of the pumphouse approaching the flexible limits of the service water piping system, it follows that implementation of the new technical specification will entail a greater risk to the health and safety of the public. The disturbing fact in this is that the greater risk is not counterbalanced by any additional measures designed to insure the integrity of the piping system.\* The expansion joints upon which the Applicant places so much reliance were in place at the time the initial technical specification settlement limits were established in the fall of 1977 (Tr. 353). Nothing has changed in this regard. In fact, the only change that has occurred is that settlement of the pumphouse has nearly reached the original technical specification limits, thereby necessitating either a change in the limits, or anticipation of plant shutdown.

\* The Applicant and Staff take comfort in the fact that even if the service water piping system were to fail as a result of settlement induced stresses, safety would be assured by the auxiliary pump system drawing from Lake Anna (Vepco SWPH Test. p. 33). If the auxiliary system were the salvation that the Applicant and Staff would have us believe, there would be no need at all for a technical specification requiring plant shutdown when settlement reached a certain limit and before the pipes failed. Obviously, therefore, failure of the expansion joints poses some danger. One disturbing thing about the Applicant's reliance on the auxiliary pump system as a backup is the fact that the Applicant only evaluated use of the system when the plant is in a Mode Five, cold shutdown condition (Id. at 31). No evaluation was made or required by the Staff of the safety consequences of having to shift to the auxiliary system during power operation of the plant (Tr. 121, 284).

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The Method for Measuring Continuing Expansion Joint Integrity Is Inadequate

The Applicant's reliance upon service water piping expansion joints to maintain the integrity of the piping in the face of continuing pumphouse settlement is cause for concern because the method by which expansion joint performance is measured is so indirect and imprecise. The expansion joints themselves are subject to a variety of stresses created by lateral offset, compression of the joints, extension of the joints, and angular offset of the joints (Tr. 93). With respect to each of these stresses, the expansion joint has a limit, beyond which it will fail (Id.). Several external factors contribute to these various stresses, among them, soil weight, pumphouse settlement (Tr. 101-102, 212), and thermal variations (Tr. 214-218).

The Applicant has done a computer analysis to determine the amount of pumphouse settlement that would create stresses of the kind described above so as to cause the expansion joints to reach their design limits (Tr. 99, 100-101). The settlement limit obtained by this analysis, is the only criterion the Applicant proposes to use to determine if the expansion joints are functioning properly and have not been over stressed (Tr. 104). In other words, only if settlement reaches a certain amount will the Applicant anticipate that the joints are approaching their functional limits. He has no apparent means of directly monitoring, or plans to directly monitor, the functioning of the expansion joints (Tr. 104).

The Applicant's indirect method of measurement is all the more alarming in light of the uncertainty surrounding the precise nature of the expansion joints' failure mechanism. The Applicant testified that the mechanism of failure of the joints would be pinhole leaks (Tr. 113). The basis for this conclusion was testing undertaken by the manufacturer of the expansion joints (Tr. 114). However, although the Applicant had some knowledge of the testing that had been done on the expansion joint by the manufacturer (Tr 238-242), he was unaware of the specifics of manufacture (Tr. 279), and was denied access to the proprietary computer codes used in analyzing the margin of safety in the expansion joints (Tr. 245-246). The Applicant was uncertain as to the manner in which a pinhole leak might expand (Tr. 222), and both the Applicant and the Staff appeared to be largely ignorant of the previous performance of expansion joints in similar situations, or even whether they had been so used at all (Tr. 222-223, 379).

In response to questioning regarding how an unanticipated failure of the expansion joints would be detected, the Applicant's witness suggested that in the case of a 3000 gpm leak not detectable on control room flow indicators, reliance would be placed on the operator's noticing flooding of the expansion joint enclosure while making his rounds (Tr. 224). Even given the Applicant's belief that expansion joint failure is an unlikely event, reliance on a visual detection of flooding during an inspection round occurring once per four

hours is insufficiently reliable to insure protection of the public health and safety.

The Applicant's Past Monitoring Performance Requires That Stringent Monitoring Requirements be Included in the Technical Specification

Assuming, arguendo, that the Appeal Board was satisfied with the proposal to determine expansion joint integrity through the indirect and imprecise means of settlement measurement by surveying, the Applicant's history of surveying would constitute independent grounds for concern. At the outset, it should be noted that throughout the North Anna operating license proceedings, concerns have been raised about Vepco's competence and commitment to operate North Anna Units 1 and 2 in a safe manner and in compliance with NRC requirements. In authorizing the issuance of an operating license, the Atomic Safety & Licensing Board found that Vepco had the necessary competence and commitment (6 NRC 1127, 1177 (1977)). Its findings in this regard, however, were not made without concerns also being expressed that certain events had reflected unfavorably on Vepco's technical qualifications and that Vepco had lagged in upgrading its management to provide necessary leadership and control to ensure proper operation of its plants (Id. at 1149-1152). While the licensing Board's findings regarding commitment and competence have been affirmed by this Appeal Board, one is forced to conclude that these same issues continue to be germane in the more limited area of monitoring pumphouse settlement.

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Of principal concern are the events surrounding the monitoring of pumphouse settlement between July, 1977 and March, 1978. The initial technical specification requiring Vepco to report to the NRC when pumphouse settlement reached 75% of .15 feet went into effect on November 26, 1977 (Tr. 154). Stone & Webster, Vepco's architect-engineer for the North Anna facility, participated in the drafting of these technical specifications (Tr. 159). An investigation by the NRC's office of Investigation and Enforcement (I&E) revealed that during, or at most shortly before, the time Stone & Webster and Vepco began drafting the technical specification governing pumphouse settlement, Stone & Webster already had obtained survey results showing that the pumphouse had settled to 76% of the .15 foot limit soon to be established by the technical specification (Staff SWPH Test., App. C, p. 5).

It is true of course, that in August, 1977, the settlement technical specification and its 75% reporting requirement were not yet in effect. It is also true, as Vepco pointed out, that in any event, Stone & Webster monitoring data would not have been a basis for verifying compliance with the technical specification, since their monitoring was not of the required Second Order, Class II accuracy (Tr. 160). Nevertheless, it seems reasonable to expect that the August survey results, which showed nearly twice the settlement of the previous survey in May, would have been viewed as cause for alarm and prompted further investigation. At the very least, the results should either have prompted an immediate Second Order, Class II survey,

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or else been reported to the Staff when the technical specification became effective in November. None of these things happened, however. The Applicant's explanation for this was that the August survey results did not reach the appropriate persons within Vepco or Stone & Webster until sometime in 1978 (Tr. 161-165; Staff SWPH Test., App. C, p. 7; Tr. 426).

The "oversight" with respect to the August, 1977, survey data alone calls into question the Applicant's competence and care in the monitoring of settlement. The whole matter is even more disturbing, however, in light of the fact that the Applicant had other indications between July and December, 1977, also apparently ignored, which suggested that settlement of the pumphouse had increased substantially. In March and July of 1977, the surveying firm of Moore Hardy & Carrouth (MH&C) whom Vepco had hired to conduct settlement surveys to Second Order, Class II accuracy, obtained survey results indicating that the pumphouse had settled to nearly twice the level that it had reached by December, 1976 (Id.). While the MH&C July figures were equivalent to only 42% of the soon to be established technical specification limit, the fact that they were nearly double the December, 1976 MH&C figures should have been some cause for alarm. That it was not, is evidenced by the fact that MH&C did no further surveying until December, 1977 (Id.). This five month lag may not seem unusual in light of Vepco's testimony that MH&C was only required to monitor at six month intervals (Tr. 156, 169). The fact is, however, that while MH&C may only have been required to monitor at six month

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intervals, they actually were monitoring much more frequently prior to July, 1977. In the year prior to obtaining the July, 1977 settlement measurements, MH&C conducted six measurements at intervals of three months or less (Staff SWPH Test. App. C, p. 5). Yet, following the July readings, they did not monitor again for five months.

Mr. Cartwright testified for the Applicant that his understanding was that MH&C actually was required to monitor pump-house settlement "on demand" by Vepco (Tr. 156, 169). If this was in fact the case, it seems surprising that Vepco did not "demand" further surveys following the dramatic increase in settlement shown by the MH&C July, 1977 figures. Even if Vepco was not aware of the even more dramatic Stone & Webster survey results, it would have been prudent for them to seek further survey information on the basis of the MH&C July data alone. That they did not is even more confounding in view of the fact that it was during this time period that they were developing the technical specification for pumphouse settlement monitoring and reporting.

The monitoring events from July, 1977 to December, 1977 reflect badly enough on Vepco's competence. Two other aspects of pumphouse monitoring history, while perhaps not as significant, nevertheless also raise doubts about the Applicant's competency. Again, as in the case of the July-December 1977 monitoring, these events may not involve a specific violation of NRC regulations or requirements. Rather, they indicate a lack of necessary prudence on the part of the Applicant in

constructing and operating its nuclear facilities. To a large extent, it is an Applicant's competence and prudence upon which the public must rely if its health and safety is to be adequately protected.

The first of these two areas of concern involves the amount of lag time that has occurred between the time settlement surveys were taken, and results of those surveys were made available to Vepco. An I&E inspection on December 6-8, 1978, found that on occasion, up to four months had elapsed between the time the MH&C surveys were made and the data from those surveys was transmitted to the licensee's engineers (Staff SWPH Test., App. B, p. I-2). Vepco was informed at that time that the time interval between making the surveys and analyzing the data had to be reduced (Id.). Yet, on a subsequent inspection from March 5-15, 1979, I&E inspectors discovered that the most current pumphouse settlement survey data at the plant site were the November 20, 1978 readings (Staff SWPH Test. App. C, p. 11). The results of MH&C surveys made in January and February, 1979 had as of March 7, 1979, not yet been received from MH&C (Id.). While Vepco has indicated that time delays have been reduced as a result of a new internal procedure which they have established (Tr. 124-125), their obvious slowness in improving this performance, particularly in the face of warnings by I&E inspectors, cannot be ignored.

The second area of concern involves the carelessness demonstrated by the Applicant in originally establishing survey marks to be used in monitoring pumphouse settlement and expansion

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joint performance. The expansion joints were installed in the service water piping between August and October of 1976 (Vepco SWPH Test. p. 24; Tr. 90). The Applicant must have known at that time that future differential or absolute settlement would be a critical factor in whether or not the expansion joints maintained their integrity, and that therefore, some means of measuring such settlement would have to be devised (Tr. 399). Yet surprisingly, the Applicant established no survey markers on the service water lines near the expansion joints until July, 1977 (Tr. 390). Certainly, prudence would have called for establishing survey markers coincidentally with the installation of the expansion joints (Tr. 400-401). As a result of Vepco's failure in this regard, the job of determining what additional amount of settlement can be withstood by the expansion joints has been made more difficult (Tr. 397, 400-401). Rather than being able to measure differential settlement directly through survey readings, it has been necessary to estimate at least that portion of the differential settlement that occurred from the time the expansion joints were installed to the time the survey markers were installed (Staff SWPH Test.p. 36-37).

The aforementioned failings on the part of the Applicant with respect to monitoring performance must be viewed seriously and require at a minimum that any new technical specification governing settlement contain strict, exacting, and frequent monitoring and reporting requirements. The Applicant argues that with respect to reporting survey results, strict

requirements need not be included in the technical specifications since Vepco's own internal reporting procedures now require that survey results be reported within seven days (Tr. 122, 124). Vepco's lack of diligence in the past with respect to reporting, however, gives little confidence in any new internal procedures. In view of Vepco's past record, it would be prudent on the Staff's part to establish survey result reporting requirements within the technical specification. While I&E may have the authority to enforce Vepco's internal procedures, it is not unreasonable to assume that violation of a technical specification will be considered more serious than violation of an internal procedure.\* It is essential with this Applicant that the seriousness of reporting failures be crystal clear at the outset.

Continuing Settlement Requires Additional Caution

The previously discussed problems of expansion joint monitoring methods and Vepco's monitoring performance are, even viewed in isolation, cause for concern. In considering a technical specification change that will authorize continued plant operation despite pumphouse settlement far greater than originally predicted, the Appeal Board must take into account in addition to these problems the fact that the pumphouse is continuing to settle. In other words, monitoring methods and

\* Staff witnesses were unable to state at the hearing whether as a matter of policy, I&E considered violation of technical specifications more serious than violation of internal procedures (Tr. 415-416).

performance would still be of concern even had settlement ceased. They are of even greater concern, however, in the face of continuing, poorly understood settlement.

The uncontroverted fact is that settlement of the North Anna Unit I pumphouse continues (Tr 311). Vepco suggests that the fact that settlement has been gradual for the past twenty months is an indication that periods of significant abrupt settlement are over (Vepco SWPH Test. p. 20). Only additional time will tell on this score. At any rate, as far as the Staff is concerned, future rapid settlement cannot be ruled out (Tr. 341). It must be noted also, that the the June/July 1979 settlement figures provided by counsel for the Applicant in his letter of July 23, 1979, when roughly plotted on Figure 7G of the Applicant's testimony, show a pumphouse settlement rate greater than that of the previous twenty months.

Other aspects of the settlement problem also suggest a cautionary approach. To begin with, the settlement that has occurred thus far is not completely understood, particularly insofar as the time-rate of settlement is concerned (Tr. 312-313). Moreover, the Applicant and Staff are not in complete agreement on how certain phenomena such as an increase in groundwater will affect settlement (Tr. 358-360). Another consideration is that the service water pipes north of the expansion joints are also settling (Tr. 107). Their settlement has been greater than that of the north wall of the pumphouse for reasons that are also not clearly understood (Vepco SWPH Test. p. 22; Tr. 107).

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It is of course, differential settlement that is one of the key factors affecting expansion joint integrity (Tr. 356). Although absolute settlement of the pumphouse alone can create differential settlement between the pumphouse and the pipes, ultimately it is differential rather than absolute settlement that must be measured carefully (Id.). It is for this reason that the proposed technical specification (actually issued by the Staff on June 28, 1979) establishes with respect to the pumphouse, limits on differential settlement only, rather than on both absolute or total settlement and differential settlement (Id.). The differential settlement limit in the new technical specification is, for all practical purposes, identical to the differential limit established in the original technical specification when one adjusts for the fact that the limits are measured from different points in time (Tr. 388).\* The .22 feet of differential settlement allowed by the new technical specification is designed to be consistent with the amount of movement (0.25 ft) which the expansion joints were designed to accommodate without exceeding stress and fatigue limits (Staff SWPH Test. p. 37).\*\*

\* The original technical specification allowed differential settlement of .25 ft measured from December, 1975. The new technical specification allows differential settlement of .22 ft measured from July 1977. The Staff estimates that between December, 1975 and July, 1977, there were .03 ft of differential settlement. Thus, when adjusted for the different measurement dates, the limiting values are the same.

\*\* The Applicant originally proposed a technical specification establishing an average settlement limit of .33 ft., which, he calculated, would create movements superimposed on the expansion joints representing about 54% of the dynamic allowable

Although the Staff believes that the .22 ft. differential settlement figure is a conservative one (Staff SWPH Test. pp. 36-37), the aforementioned uncertainties regarding settlement causes, use of settlement monitoring as a means of measuring expansion joint stress, and Vepco's questionable monitoring abilities, suggest that additional conservatism is in order to insure that the expansion joints are kept well short of design limits. At a minimum, any change in the original technical specification should be extremely conservative at least until such time as either: 1) the Staff is substantially satisfied that further abrupt settlement of the service water pumphouse and the service water piping is unlikely, or 2) an accurate method of directly measuring stress or fatigue of the expansion joints is devised and substituted for the indirect method employing settlement surveys. An appropriately conservative technical specification should set a differential settlement limit substantially lower than the .25 ft of differential movement which the expansion joints were designed to accommodate (See Staff SWPH Test., p. 37). In addition, it should

(Con't from previous page) and 40% of the static allowable (Vepco SWPH Test., p. 26). It is not entirely clear from the record, however, how the Applicant's .33 ft of average settlement correlates with the Staff's .22 ft of differential settlement. Since the implication of the Staff's testimony is that the .22 ft of differential settlement would bring the expansion joints close to their design limits, it would appear that the Applicant's .33 ft of average settlement corresponds to a lesser amount of differential settlement. Testimony by Mr. Wert for the Applicant suggested that the .33 ft of average settlement corresponds to approximately only  $\frac{1}{2}$  inch or .042 ft. of differential settlement, considerably less than that allowed by the Staff's proposed technical specification (Tr. 315, 331; See generally, Tr. 323-331).

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also retain a total or absolute settlement limit for the two northwest corners of the pumphouse (See Vepco SWPH Test., Fig. 6, SM-10, SM-7), so as to provide an indication of the seriousness or lack thereof of continuing pumphouse settlement.\*+

If the Applicant is correct in his assessment that henceforth absolute settlement will be extremely small, he should have no objection to a technical specification limit on absolute settlement only slightly greater than the .15 ft limit established by the original technical specification. If the Applicant is correct in his analysis, the new absolute limit will probably never be reached. If the Applicant is incorrect in his assessment, however, and future abrupt settlement does occur, a technical specification limit on absolute pumphouse settlement could insure that the Staff will receive timely notice of the settlement and be in a position to take appropriate action.

#### Conclusion

On the foregoing evidence, the Applicant's survey method of monitoring expansion joint performance, and a technical specification embodying a differential limit of .22 ft are not sufficiently precise and conservative, respectively, to adequately protect the health and safety of the public. In order to satisfy the health and safety requirement, the Staff must

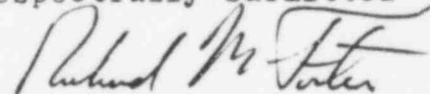
\* Differential settlement data would not, by itself, provide such an indication, since if both the pumphouse and piping together fell to China, there would be no differential between them, although the absolute settlement problem would be severe.

+ The Staff's proposed (now implemented) technical specification does include an absolute settlement limit for service water piping north of the expansion joints.

be required to:

1. Adopt a technical specification on service water pumphouse settlement which,
  - a) imposes a more stringent limit on differential settlement than .22 ft.
  - b) imposes an absolute settlement limit for the service water pumphouse only marginally greater than the original limit of .15 ft.
  - c) establishes a time limit for the time between which settlement surveys are made, and the data is computed and reported to the Applicant, which time limit should not exceed 7 days.
  - d) requires that monitoring of settlement should occur once every 31 days.
2. Direct the Applicant to develop and implement a method for measuring expansion joint integrity through direct measurement of the expansion joint, rather than through interpretation of settlement data.

Respectfully submitted



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Counsel for  
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Dated: August 20, 1979

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CERTIFICATE OF SERVICE

I certify that I have served a copy of Intervenor Arnold's Memorandum of Proposed Findings Regarding Service Water Pumphouse Settlement on each of the persons named below by first-class mail, postage prepaid:

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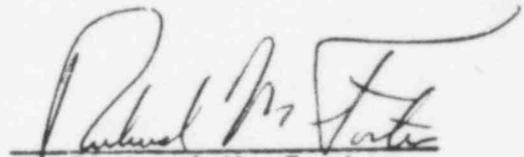
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