TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT

UNITS 1 AND 2

EVALUATION OF BLACK AND VEATCH INDEPENDENT REVIEW

MARCH 16, 1984

By INDEPENDENT REVIEW POLICY COMMITTEE

E. Gray Beasley
Chairman, Independent Review Policy Committee

J. W. Anderson
Manager of Quality Assurance

C. Bonine
Manager of Construction

R. W. Cantrell
Manager of Engineering Design

H. N. Culver
Director of Nuclear Safety Review Staff

R. M. Pierce
OEDC Project Manager for Watts Bar

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT
INDEPENDENT REVIEW
FINAL SUMMARY REPORT

I. EXECUTIVE SUMMARY

From September 1982 through February 1984, Black and Veatch (B&V) performed an independent third party review of the Watts Bar Nuclear Plant (WBN) auxiliary feedwater system to determine if the as-built system met the commitments in the FSAR. In April 1983, B&V issued their initial report which identified 428 findings; 212 were classified as resolved in that no deviation had occurred, 183 were classified as open in that no final conclusion had been reached as to the existence of a deviation, 33 were classified as confirmed in that deviations had occurred.

Through a program which provided to Black and Veatch additional information and identified corrective actions for both past and future work for B&V concurrence, most of the findings were successfully resolved. In February 1984, B&V issued a supplemental report in which three identified findings remained unresolved--two open items and one confirmed item remain. These three items are addressed specifically in this report.

In a separate and parallel activity, a senior team of TVA staff conducted an evaluation of the B&V findings to assess the significance to other WBN unit 1 and 2 systems. Of the 428 findings, TVA determined that 280 findings did not represent deviations from the licensing commitments and were categorized as not requiring further evaluation. The remaining 148 findings were sorted into 25 categories consisting of either individual findings or groups of similar findings.

From detailed evaluation the B&V findings and the TVA generic evaluation of the applicability of the B&V findings on other WBN systems, TVA has concluded the following:

1. The B&V review effort was of sufficient scope and depth to identify significant deviations, if they existed, in the as-built auxiliary feedwater system from commitments made in the FSAR.

2. The evaluation of the generic applicability of the B&V findings was of sufficient scope and depth to identify the deviations from licensing commitments existing in similarly designed and constructed WBN systems.

3. All significant deviations from the licensing basis that have been identified as a result of the B&V review and the TVA generic review have been either corrected or have had corrective action identified that is considered acceptable. Corrective action has included both actions regarding completed work and program or procedural changes to assure that future work will be completed in an acceptable manner.

4. Safety evaluations were performed for those deviations from the licensing basis. These analyses indicate that had these deviations not been identified, and corrective action not taken, there is no direct indication that the affected structure, system or component would not have performed its safety function. The corrective actions taken provide an increased margin in safety.

5. Based upon the review and evaluation efforts by B&V and TVA, there is reasonable assurance that the WBN facility, as design and constructed by TVA, is capable of performing its safety functions.

II. BACKGROUND

On April 26, 1982, TVA met with the Nuclear Regulatory Commission (NRC) to summarize the technical and quality programs that ensure TVA's nuclear plants are designed and constructed to satisfy regulatory requirements and to fulfill the commitments made in licensing documents. At that meeting and in the supporting detailed report, TVA presented an overview of the TVA and OEDC organizational structure, the programs in place for nuclear plant design and construction, the perceived strengths and weaknesses of these programs, and the assurance programs established to verify these technical programs.

Although TVA's position was that WBN was being built in accordance with design and construction requirements and in accordance with the licensing application, TVA committed in September 1982 to perform an independent review of a selected Watts Bar unit 1 system. This review was intended to respond to concerns created by design and implementation deficiencies identified in that timeframe at other utilities and to respond to the recommendations made by TVA's Nuclear Safety Review Staff (NSRS) and by the Region II Office of the NRC's Office of Inspection and Enforcement.

The independent review was conducted on the design and construction activities for the unit 1 auxiliary feedwater system (AFW). This comprehensive assessment was undertaken to provide TVA with additional confirmation that Watts Bar is designed and constructed adequately and that the deficiencies in the technical and quality programs which had been identified were, in fact, satisfactorily resolved. Specifically, the review was scoped to verify that TVA has developed an adequate design from the bases and criteria specified in the licensing application (all docketed information) and, subsequently, implemented an adequate construction program to meet the functional licensing requirements of the system.

TVA evaluated a number of potential contractors to perform the independent review. TVA selected B&V because their proposal approach to the review was consistent with the purpose, the competence and seniority of the reviewers was excellent, and they were clearly independent of TVA. Following their selection, TVA and B&V met with NRC to describe the scope and objectives of the review, the basis for the selection of the AFW system, a definition of the boundaries of the AFW system to be included in the review, the basis for selection of B&V, the proposed schedule, and the basic groundrules for the review.

B&V initiated its review in September 1982 and continued for approximately seven months. This endeavor consisted of about one month of preparation, which included familiarization with the plant and preparation of written procedures for conducting the work; about 1-1/2 months of onsite review of both the plantsite and the TVA design offices in Knoxville; and 4-1/2 months for further reviewing and evaluating finding reports initiated during the onsite review phase and for preparing and printing the report. The B&V independent review report was issued on April 14, 1983 (see reference 1).

On September 21, 1983, the NRC met with TVA to outline a course of action to complete the independent review program. NRC requested TVA and B&V to work together to move each of the open or punchlist items into either the confirmed or resolved category (see reference 2). The NRC also directed that TVA submit to B&V for their concurrence the proposed corrective action for each of the confirmed items.

As a result of the September 1983 meeting with NRC, TVA provided additional information to B&V on each of the 271 findings not totally resolved in the April 1983 B&V report. B&V issued their supplemental report on February 7, 1984 (see reference 3). The specific information submitted by TVA for each finding is documented in the B&V supplemental report.

III. ORGANIZATION AND RESPONSIBILTY FOR REVIEW EFFORT

Within TVA three special organizations were set up: a policy committee, a program team and a task force. The policy committee had overall responsibility for the independent review. The program team dealt with individual findings and the task force looked at generic applicability.

The Office of Engineering Design and Construction (OEDC) appointed an executive level policy committee to provide general guidance for the review, to review the findings, and to recommend necessary internal actions based on the implications of the B&V findings as they relate to the adequacy of the overall design and construction of Watts Bar. E. G. Beasley, Assistant to to the Manager of OEDC, served as chairman of this policy committee. He worked with the TVA program manager to ensure close communication with the policy committee as key issues were identified. The policy committee was composed of:

J. W. Anderson, Manager of Quality Assurance

R. M. Pierce, OEDC Project Manager for Watts Bar

H. H. Mull, Manager of Construction (C. Bonine became a member after H. H. Mull's retirement)

H. N. Culver, Nuclear Safety Review Staff Director

M. N. Sprouse, Manager of Engineering Design (R. W. Cantrell became a member after M. N. Sprouse's retirement)

The administration and management of the independent review were conducted by a TVA program manager. H. L. Jones, Staff Specialist in Engineering Design's (EN DES) Nuclear Engineering Support Branch (NEB), was appointed to this position. (Homer E. McConnell, Staff Specialist, replaced Henry Jones as program manager on October 31, 1983.) To ensure the program manager's ability to utilize all necessary resources in support of the review, he functionally reported to the Manager's Office (OEDC). The technical administration of the review was handled through the NEB by the program manager. The program manager's responsibilities included:

(1) OEDC responsibility for managing the review
(2) Administration of the contract through the NEB
(3) Primary TVA contact on all correspondence and communication with B&V on the technical aspects of the review and primary interface with B&V's reviewers
(4) Chairman of the OEDC program team
(5) Lead responsibility for processing any deficiencies identified by B&V for review and definition of corrective action plans.

Both the policy committee chairman and the program manager filled key roles in the interactions with the B&V reviewers to resolve potential deficiencies. To aid the policy committee chairman and program manager in administering the review effort within TVA, a program team consisting of a representative from each affected branch within EN DES (electrical, mechanical, civil, nuclear, and the design project) and a construction site representative was established. Chaired by the program manager, the responsibilities of the team members included:

(1) Ensuring the independence of B&V by providing a structured communication mechanism between the review organization and TVA to eliminate any influence upon the review direction

(2) Providing liasion between the program team and the TVA organization being represented

(3) Acting as a liasion to obtain necessary administrative and technical information from branch/project personnel for use by B&V during their onsite review or for use by the program manager or policy committee

(4) Providing supplemental information to aid B&V in the evaluation and assessment of potential deficiencies during their classification of findings

(5) Evaluating the impact of each finding and providing guidance and review of TVA determined corrective action, if needed, for each finding.

The program manager and the program team were primarily responsible for TVA's involvement during the initial review and through the first level classification of the findings. The Executive Policy Committee assumed responsibility for the second level review of the findings prior to their final classification by B&V. This detailed review was primarily performed by the policy committee chairman who worked with the individual committee members as necessary to formulate TVA's final response to the findings.

Since the policy committee represented the Manager of OEDC and was comprised of highly experienced individuals from a cross section of design, construction, quality, and licensing areas, this response also included, when appropriate, the policy committee's professional evaluation of the finding for consideration by B&V in their final classification of the finding. These efforts were closely coordinated with the program manager and with the program team to provide any additional technical or administrative information which would aid in satisfactorily resolving the finding.

Prior to the formal issuance of the B&V report, the policy committee established a task force of senior OEDC and Office of Quality Assurance (OQA) personnel to perform an internal evaluation of the generic applicability of the Black and Veatch finding reports. The task force was specifically assigned responsibility to perform the following functions:

- Recommend an overall methodology for generic evaluation of the B&V findings
- Select and assign OEDC line organizations to perform the detailed generic evaluation
- Establish and maintain surveillance over implementation of the generic evaluation
- Coordinate the utilization of B&V information generic to other TVA nuclear units
- Document and ensure retention of records generated by the evaluation

The members of the task force were:

H. L. Jones, Staff Specialist, and OEDC Program Manager for the Black and Veatch Review through 10/31/83 (Chairman)

E. H. Cole, Assistant to the Watts Bar Design Project Manager

D. R. Denton, Principal Civil Engineer, Civil Engineering Support Branch

J. A. McDonald, Chief, Quality Improvement Staff, OQA and former NRC Resident Inspector at Watts Bar

R. W. Olson, Principal Construction Engineer, WBN (R. C. McKay, Supervisor, 79-14 Program, WBN, replaced R. W. Olson on March 9, 1983)

IV. TVA PROCESSING OF FINDING REPORTS

In the initial review of a finding report by TVA, program team members and the line organization reviewed the finding report for corrective action. When corrective action was determined to be appropriate, the action was initiated by using procedures in an existing TVA change control program. Where the finding was determined to be a deviation, normal TVA rules for processing conditions adverse to quality were followed.

Subsequent submittals from B&V were reviewed to provide additional information and, as appropriate, additional corrective actions were taken. Each of the 428 findings has been individually logged, tracked, and updated when appropriate.

When the B&V report (reference 1) was issued, it contained 24 confirmed findings related to one mishandled engineering change notice and 9 other confirmed findings. These 10 confirmed items have been given special attention.

In reference 3, all but three findings were resolved. One finding, G901 on cable ampacity with fire retardant coating remained confirmed (note G901 was also confirmed in reference 1). As a result of the continued B&V concern TVA issued a nonconformance report. The nonconformance was resolved through detailed calculations for each of the power cables in cable trays which confirmed that in all cases the full load current is less than the allowable current. Appendix A more fully explains what was done and the TVA position.

In the B&V supplementary report the remaining two unresolved findings were classified as open. The open findings are F508 concerning embedded plate analysis and F511 concerning spectrum broadening for seismic analysis. On these two findings it is TVA's position that the WBN design (and subsequent plant construction) are in agreement with the license basis and consistent with the intent of the specific regulation. The TVA position on these findings is summarized in Appendix B and Appendix C.

V. APPLICABILITY TO OTHER SYSTEMS

The task force evaluation process was initiated by a generic review of each B&V finding and an indepth review of the circumstances surrounding each finding. Based on the comprehensive study of each individual finding report, it was determined that only 148 of the 428 warranted detailed review for generic applicability to other Watts Bar units 1 and systems. It should be noted that some of the findings included in the 148 findings were resolved by B&V in reference 1. Further, based on the detailed scrutiny by the task force, some of the findings that were not resolved by B&V were determined to not have generic implications. The remaining 280 finding reports generally involved items where design or construction was not complete at the time of the B&V review, or items where TVA and B&V determined that the licensing basis commitment had been met. These 280 finding reports were tabulated by the task force and eliminated from further generic review.

The 148 findings warranting detailed generic review were sorted by the task force and grouped into 39 categories which bounded the generic issue. Further evaluation by the task force reduced this to 25 categories of findings. Appendix D is a tabulation of the task force categories and a listing of the Black and Veatch finding reports included in each category. The categorization was examined and approved by the policy committee. Considering the nature of the category, the task force assigned a responsible OEDC line organization to perform a detailed analysis for generic applicability of each category. This review required:

(a) evaluation for cause
(b) evaluation to determine the extent of the deviation
(c) evaluation for licensing basis conformance
(d) identification of ongoing or necessary corrective action for completed and future work
(e) implementation and/or inspection of corrective action for completed work and future work

When distributed to the responsible line organization each category included a preliminary evaluation by the task force of items a-d above as input to the responsible organization's final evaluation. Upon completion of these final evaluations by the responsible organization, the task force reviewed and concurred in the responses. Disagreement concerning the adequacy of the response by the line organization was referred to the policy committee for resolution.

Each category for WBN unit 1 and unit 2 has been evaluated and corrective action addressed to the satisfaction of the responsible organization, the task force, and the policy committee. The evaluation record for each category has been provided to TVA's Office of Quality Assurance (OQA). Follow-up verification of the corrective actions (item (e)) will be performed by OQA as part of the established OQA surveillance and audit program.

The generic calculation of the 25 categories is summarized as follows (note categories 4, 6 and 30 had 2 parts and hence 28 items):

For six (categories 31, 32, 33, 34, 36, and 38) of the 25 generic categories, the detailed review and assessment revealed that there was no deviation from the license commitment. For these seven categories there was no corrective action for past or future work.

For ten of the categories (3, 4A, 5, 6B, 13, 18, 20, 25, 30A and 39), the review and study revealed some deviations from licensing commitments which did satisfy licensing bases. Evaluation of these categories resulted in corrective action for future work and, if appropriate, corrective action for past management controls.

For five of the categories (6A, 7, 9, 12 and 19), there was some generic deviation from the licensing commitments but broad base corrective action previously identified and already scheduled by TVA had identified these deficiencies and could be expected to bring past work up to the bases specified in the license application. The evaluation of these categories did result in some modifications to the existing planned corrective action for some future work.

Seven of the categories (4B, 11, 14, 23, 30B, 35 and 37) represented deviations from the licensing commitments which also were deviations from the licensing bases. Evaluation of these categories resulted in corrective action for past work and corrective action for future work. For these seven categories, TVA evaluated the nuclear safety implications had the generic condition not been detected and corrected. The safety evaluations were accomplished using the same procedures and program used to evaluate conditions adverse to quality. These analyses indicate that had these deviations not been identified, and corrective action taken, there is no direct indication that the affected structure, system, or component would not have performed its safety function.

VI. CONCLUSIONS

From detailed evaluation the B&V findings and the TVA generic evaluation of the applicability of the B&V findings on other WBN systems, TVA has concluded the following:

1. The B&V review effort was of sufficient scope and depth to identify significant deviations, if they existed, in the as-built auxiliary feedwater system from commitments made in the FSAR.

2. The evaluation of the generic applicability of the B&V findings was of sufficient scope and depth to identify the deviations from licensing commitments existing in similarly designed and constructed WBN systems.

3. All significant deviations from the licensing basis that have been identified as a result of the B&V review and the TVA generic review have been either corrected or have had corrective action identified that is considered acceptable. Corrective action has included both actions regarding completed work and program or procedural changes to assure that future work will be completed in an acceptable manner.

4. Safety evaluations were performed for those deviations from the licensing basis. These analyses indicate that had these deviations not been identified, and corrective action not taken, there is no direct indication that the affected structure system of component would not have performed its safety function. The corrective actions taken provide an increased margin in safety.

5. Based upon the review and evaluation efforts by B&V and TVA, there is reasonable assurance that the WBN facility, as design and constructed by TVA, is capable of performing its safety functions.

REFERENCES

1. Black and Veatch's "Watts Bar Nuclear Plant, Auxiliary Feedwater System Independent Review Report, B&V Project N 10520" dated April 12, 1983.

2. Thomas M. Novac's letter to H. G. Parris dated September 30, 1983 (NEB 831011 605).

3. Black and Veatch's "Watts Bar Nuclear Plant Auxiliary Feedwater Independent Review Supplementary Report, B&V Project N10520" dated February 7, 1984.

APPENDIX A

Watts Bar Nuclear Plant
Units 1 and 2

Black & Veatch Finding G901

ELECTRICAL CABLE AMPACITY AND EFFECT OF FIRE RETARDANT COATINGS

This finding deals with the assumption that the TVA specified spacing between grouped three-phase medium-voltage power circuits routed in cable trays is necessary to provide natural convection between each cable bundle to meet cable ampacities. It also deals with the concern that the existing ampacity data on the flame-retardant coating does not exactly duplicate the installed cable coating, occurring around and between the grouped three-phase circuits, which essentially eliminates convective air flow between cable bundles.

TVA utilizes a minimum 2/0 AWG cable size for medium-voltage power applications. When installed in cable trays, the 2/0 AWG cables may be random lay with no required spacing between them. TVA practice is to install medium-voltage power cables larger than 2/0 AWG as grouped three-phase circuits, stacked in pyramids, and spaced from other grouped cable bundles in trays by a nominal distance equal to the radius of the largest cable. This spacing is provided to minimize the induced electro-motive forces between phases of the circuits when the cables are under load. This spacing is not required (cables may actually touch) where cables enter or exit the tray and at tray fittings. No credit is taken for this spacing in determining cable ampacities.

TVA has recalculated [EN DES Calculations (EEB 840203 901)] the Class 1E medium-voltage power cable ampacity for cables in cable trays. The allowable ampacities for these cables were calculated on a 100 percent load factor with all cables fully loaded and not spaced, and with no duty cycle or load diversity considerations. This assures conservative results. Industry Standard, ICEA No. P-54-440, "Ampacities Cables in Open-Top Cable Trays," was used in calculations of TVA cable ampacities for their specific application, assuming no spacing between cable bundles. This assumption is consistent with this standard which is also based on no spacing of cables in trays.

Using the guidelines of ICEA P-54-440 together with the printout of the Watts Bar Nuclear Plant (WBN) Cable Schedule Summary, allowable ampacity was determined for 100 percent of cables routed in cable trays designated for medium-voltage, Class 1E power cables. Each of the cable tray segments for each train A and B tray network were examined for the quantity and mixture of cable sizes (2/0 AWG and 4/0 AWG). Since 4/0 AWG cables are bundled as three-phase groupings, the bundled pyramids were assumed to be touching for the purpose of calculating the depth of cables (in inches) in that tray segment. The 2/0 AWG cables were assumed to be random lay in the tray. The ampacity for each cable size was determined from Table 33 of ICEA P-54-440 by interpolation for calculated cable depth. The allowable ampacity was then obtained by adjusting for actual cable diameter by direct proportion to the cable diameters used in ICEA P-54-440.

The derating value for the fire-retardant cable coating was taken from test data of Factory Mutual Research Report No. J. I. OFOQ5.AF, "Examination of the Effect of Vimasco Cable Coating No. 2-B on Ampacity in Cable Trays," dated December 19, 1980. This test was based on 4/0 AWG power cables arranged in the cable tray, neatly stacked three cables deep. This

configuration had each cable, except the ones in the tray corners, touching other cables on at least three sides thus, eliminating air flow between cables. The test was conducted in three steps. First, the uncoated cable was energized to obtain its rated continuous copper temperature of 90°C. In the second step the energized cable was tested with a 1/8-inch coating thickness applied to exposed surfaces of cables, and produced only 0.2°C temperature rise from the uncoated cable. Thirdly, the test was repeated except the configuration had an additional 1/8-inch thickness of applied cable coating (1/4-inch thickness total). This third and final step test produced a 1.1°C temperature rise compared to the uncoated cable, but part of this temperature rise can be attributed to the fact that the average conductor temperature was 91.9°C, compared to an average of 90°C for the steps 1 and 2 tests. The 1.1°C temperature rise equates to a 1.62 percent ampacity derating for applied coating to unspaced cables in cable tray. Since TVA's applied cable coating thickness varies between 1/8-inch and 1/4-inch, the 1.62 percent maximum derating value was applied to the calculated allowable ampacities of the TVA cables without spacing in the tray.

The calculated cable ampacity of each cable was reviewed for all node segments of its routing to establish its lowest allowable ampacity. This allowable ampacity was compared to that cable's full-load current, obtained from WBN data. In all cases, the allowable ampacity of each cable exceeded its full-load current.

From a review of the results of the calculations, the worst case ampacity condition occurred in eight consecutive train B node segments having a tray loading of six 4/0 AWG and twenty-seven 2/0 AWG cables. At these node segments, the allowable ampacity for the 4/0 cables is 250.7 amperes, and the full load current is 215 amperes; these cables have a 15 percent margin in ampacity. The ampacity of the 2/0 cables is 143.8 amperes; three of

these twenty-seven cables have a full load ampacity of 138 amperes. Thus, there is a 2.6 percent ampacity margin for these three cables. The remaining twenty-four 2/0 cables have a full load current ranging from 30 to 63 amperes, and they have a more conservative margin in ampacity of 80.9 percent to 57.5 percent, respectively. These margins are conservative since no duty cycle or load diversity was considered in the ampacity calculations.

Therefore, from the results of the allowable ampacity calculations and after derating for cable coating, TVA concludes that adequate margin exists for the installed Class 1E medium-voltage power cables installed in cable trays. This margin ensures that the rated continuous copper temperature of 90°C of these cables will not be exceeded.

APPENDIX B

Watts Bar Nuclear Plant
Units 1 and 2

Black and Veatch Finding F508

BASEPLATE DESIGN

Finding F508 covers the design of baseplates for pipe supports in the auxiliary feedwater system. The finding originally addressed the design methods used for determining loads in concrete anchorages and stresses in the baseplate.

The Black and Veatch (B&V) final evaluation indicates that the finding would remain open for two reasons relating to OIE Bulletin 79-02:

1. No information was supplied to B&V which indicated NRC acceptance of a factor of safety of less than 5.0 for expansion anchors.
2. No data or test results were supplied to B&V which indicated that prying action was considered in TVA's baseplate evaluation for OIE Bulletin 79-02.

With respect to the first reason, TVA has calculated the factor of safety in response to NRC Bulletin 79-02. TVA has submitted a final report to NRC Region II on Bulletin 79-02 for WBN unit 1*. The report includes the results of a sampling program for expansion anchored plates. The results

*L. M. Mills' letter to NRC dated August 26, 1983 (NEB 830830 634).

of the sample show that the factor of safety for about 80 percent of the supports at WBN is greater than 5.0 and the remaining 20 percent have a factor of safety of at least 4.0. The anchor loads used to calculate these factors of safety assessed the effects of baseplate flexibility.

The report to NRC Region II includes justification for the acceptability of a factor of safety of 4.0. This issue is also the subject of an unresolved item identified during an NRC Region II inspection (390/84-05-01). TVA is developing a response for this unresolved item.

The second concern involves prying action. Baseplates for pipe supports and similar attachments which are loaded with tensile loads or bending moments may develop prying forces. The mechanism which results in prying for a typical pipe support is illustrated in Figure B1. The magnitude of the prying force depends primarily on the following variables; the stiffness of the plate, the stiffness of the anchor, and the preload in the anchor. If prying action exists, the prying force will place additional tensile load in the anchor.

As part of TVA's evaluation for NRC-OIE Bulletin 79-02, a sample of 40 expansion-anchored baseplates was analyzed using flexible plate analysis. The plates were originally analyzed using rigid plate analysis. The flexible plate analyses showed that no prying force exists for these plates because the corners of the plates adjacent to the tensile anchors lifted off the concrete (see Figure B2). This indicates that expansion anchor deformations resulted in sufficient plate movement to relieve prying forces.

The flexible plate analysis was performed using a finite element program (BASEPLATE II) which considers the three primary variables mentioned above. The anchor stiffnesses used were obtained from load deflection curves from anchor tests. A preload was not used. The self-drilling anchors are not capable of maintaining a significant preload because of their short length and low steel stress. If the plates in the sample had remained in contact with the concrete, the finite element analysis would have verified the existence of a prying force and would have included its effect in the anchor load.

In summary, TVA evaluated prying action for the 79-02 Bulletin work but this evaluation showed that prying forces do not develop for baseplates with self-drilling expansion anchors. This determination has been validated by testing.

PRYING ACTION FOR BASEPLATES

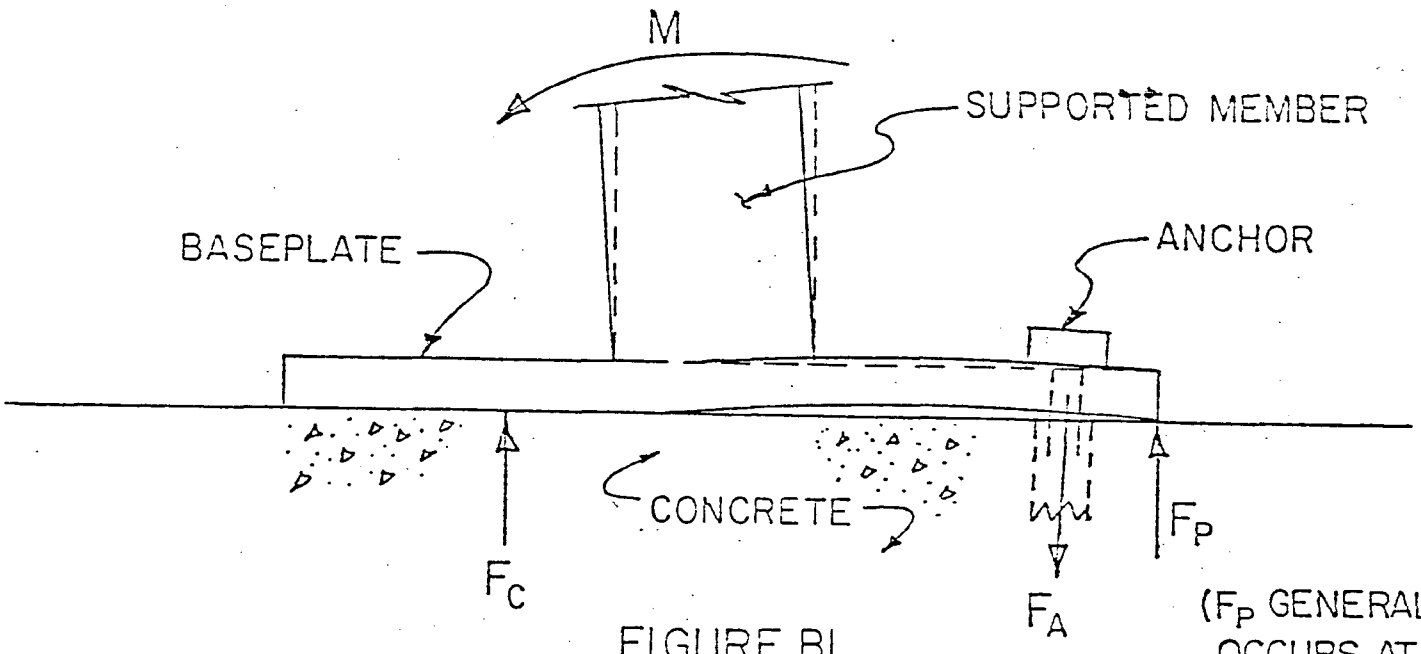

FIGURE B1

NOTE: DEFORMATIONS ARE EXAGGERATED

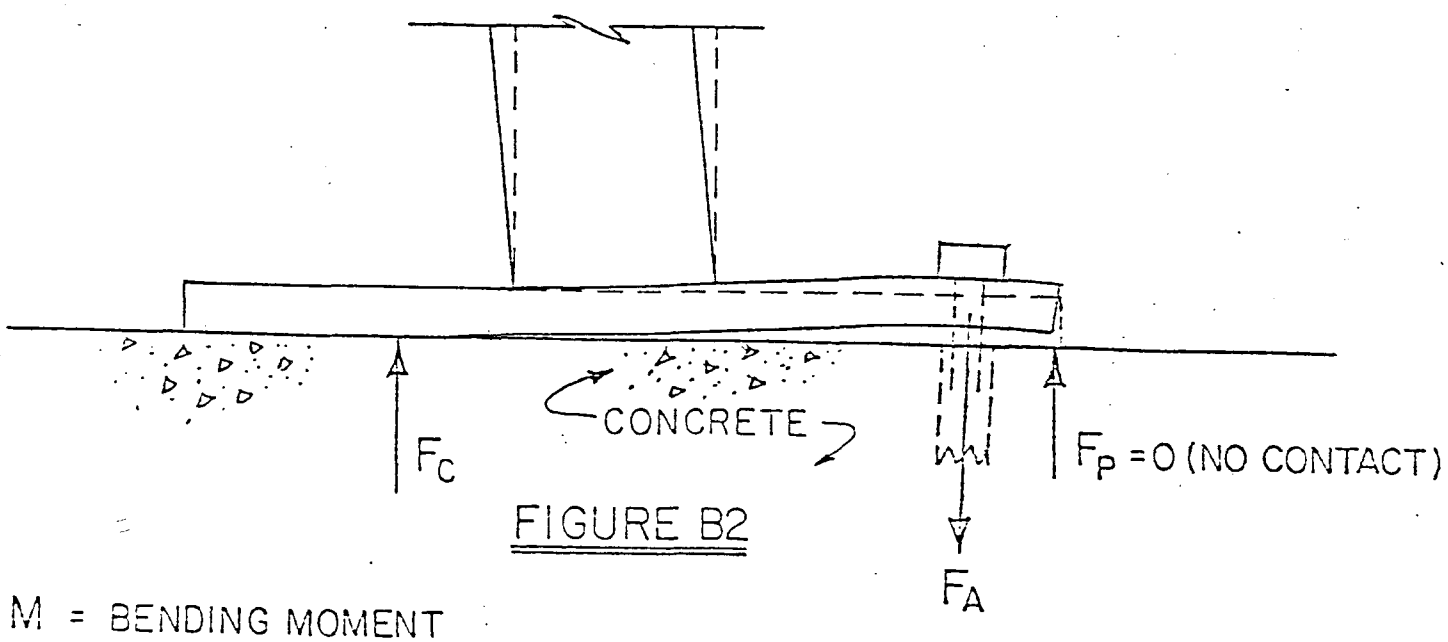

FIGURE B2

M = BENDING MOMENT
F_C = RESULTANT BEARING FORCE ON CONCRETE
F_A = ANCHOR TENSILE LOAD
F_P = PRYING FORCE

APPENDIX C

Watts Bar Nuclear Plant
Units 1 and 2

Black and Veatch Finding F511

SEISMIC SPECTRA BROADENING

The original Black and Veatch finding stated "In the review of the TPIPE analysis of problem N3-3-10A, it was noted that the input spectra were not properly broadened as required by FSAR section 3.7.2.9. Two specific types of problems were detected. Sheet 2 of reference 1 presented a comparison of the broadened spectrum used in the TPIPE analysis against the rough* spectrum reported in the EDS report on the auxiliary building seismic analysis. The comparison was made for the 0.5-percent OBE vertical response.

"A. At a period of about 0.04 second, the broadened spectrum did not envelop the rough spectrum and it did not appear that the rough spectrum had been shifted to the right, towards longer periods, in creating the broadened spectrum. That is, the right side of the broadened spectrum overlaid the right side of the rough spectrum, in the 0.04 second area, instead of being to the right of the rough spectrum.

*Rough spectrum refers to the unbroadened spectrum.

"B. The second type of problem was seen at a period of about 0.15 second. Where a rough spectrum peaks, the broadened spectrum should have a plateau with the same magnitude of spectral acceleration. The width of the plateau should be 20 percent of the period at which the peak occurs (10 percent to each side). The acceleration values to each side of the spectral peak at about 0.15 second were 0.6100 and 0.6061. The correct values should have been 0.6100.

"A cursory review of CEB 80-09 (December 15, 1980) indicated the second type of problem occurred in other spectra, including spectra numbered 330, 401, 628, and 638. The first type of problem could also exist.

"These problems may not seriously affect this particular piping problem (N3-3-10A). However, the primary concern was that the procedure TVA had chosen for implementing the 10-percent variation required by FSAR 3.7.2.9 had not been properly performed or checked."

In the exchanges of information between B&V and TVA, B&V suggested that TVA examine areas in which the finding applied to to determine the true effect of the error in the peak broadening procedure. It was suggested that particular attention be paid to areas with modal responses near the improperly broadened peaks. The B&V position was that the finding could be resolved in one of two ways.

A. TVA could provide evidence of NRC acceptance of TVA's handling of the peak broadening procedure.

B. Show by a reanalysis of affected piping systems that sufficient margin exists in the computed stresses to compensate for the expected maximum errors in peak broadening.

B&V felt correctly that they did not have the authority to accept a percentage deviation from a licensing commitment and that a closeout of the issue would require an evaluation of the effects of the error on the system. Since the issue of peak broadening was a licensing issue and not a purely technical issue, it was felt that the NRC must rule on the acceptability of a percentage deviation from a licensing commitment.

TVA's inspection of the spectrum revealed that the peak shown at a period of 0.04 second was broadened by 10 percent. However, the broadening was done incorrectly since it did not result in a flattened peak but, rather, a sloping one. This problem was identified in NCR WBNCEB8206 dated April 13, 1982, prior to the independent review.

Peak broadening of the acceleration response spectra used in piping analysis at WBN was done with TVA in-house computer programs. The broadened spectra peaks were not level (horizontal) but had a slight "slope" due to a user input error in one of these computer programs.

A 100-percent review of all spectra broadened using this program was performed. It was found that the maximum error that could possibly occur was 7.8 percent in the seismic response and the maximum error could occur only under a set of conditions that was unlikely to occur in nuclear piping systems. Those conditions were:

1. The system under review had only one significant natural frequency and that frequency corresponded to the point of maximum deviation on the response spectrum.

2. The piping system under review had several significant natural frequencies, each occurred at a peak on the response spectrum, and each occurred at the point of maximum peak error.

In actual practice, natural frequencies would not be randomly distributed with regard to broadening errors. Therefore, the errors in responses and stresses for a typical piping system would always be less than 8 percent. As noted above, the maximum error for an idealized worst-case piping system was 8 percent. Furthermore, the piping was not designed for earthquake loads alone; rather, those loads were combined with several other loadings to form load combinations. The stresses for the load combination were required to meet design allowables. It was TVA's position, based on engineering judgment, that the error in total combined stress from horizontal peak broadening was less than 2 to 3 percent.

In summary, the error described by Black and Veatch finding F511 was identified by a significant NCR, WBNCEB8206, dated April 13, 1982. This significant NCR was reviewed by TVA using the procedures for determining reportability. TVA concluded that the finding was not reportable. An EN DES review team report and NCR WBNCEB8206 were reviewed as part of a special safety assessment of WBN conducted by Region II NRC inspectors from July 27 through August 6, 1982, and a follow-up inspection in September 1983.

TVA considered this NCR to have been resolved in accordance with our license application. The NCR action and the reasoning presented above, TVA felt, justified closing the item.

It is our understanding that B&V did not question TVA's engineering judgment concerning the magnitude of the potential error that could be introduced. However, B&V did not feel that sufficient documentation was submitted to confirm this judgment. In addition, the documentation submitted did not demonstrate to B&V's satisfaction that the NRC had accepted this deviation from the licensing commitment.

APPENDIX D

Watts Bar Nuclear Plant
Units 1 and 2

TASK FORCE GENERIC CATEGORIES AND ASSOCIATED B&V FINDING REPORTS

TASK FORCE CATEGORY	CATEGORY DESCRIPTION	B&V FINDING REPORT NOS.
3	Logic/control drawings do not agree with electrical drawings	F101, F102, F103, F104, F105, F106, F107, F110, F111, F114, F115, F116, F117, F123, F124, F127, F129, F130, F131, F141, F802, F803, F804, F805, F806
4	Failure to design/maintain design records as specifically described in FSAR	F118, F121, F303, F304, F305, F306, F309, F313, F502, F504, F511, F513
5	Procurement forms & flow diagrams specified different requirements for various valves	F307, F308, F314, F328, F335, F336, F894, F895, F896, F897
6	Discrepancies between design documents (analysis results, load tables, isometric drawings, flow diagrams, etc.) used in the design of piping systems	F310, F319, F324, F325, F346 F571, F868
7	Nonconforming conditions in construction of previously inspected and accepted pipe supports	F367, F704, F718, F719, F726, F734, F736, F737, F749, F772, F773, F774, F776, F819, F884, F919, F920
9	Failure to adequately control and evaluate embedded plate capacity when multiple attachments were made to the plate by CONST	F506, F710, F711, F712, F713, F724R1, F730R1, F731R1
11	Inadequate documentation of operational modes data used in the analyses of piping systems	F331, F373
12	Failure by EN DES & CONST to properly implement and document the alternate analysis criteria for seismically supported piping	F347

TASK FORCE CATEGORY	CATEGORY DESCRIPTION	B&V FINDING REPORT NOS.
13	Termination information on the documentation was in error and was not updated to reflect the actual configuration	F142
14	Various supports on the AFW systems have not been modified, redesigned, or initially designed per revised analysis of ECN 2576	F369, F371, F756, F767, F783, F784, F788, F794, F845, F853, F855, F899, F911, F949, F950, F951, F955, F958, F963, F964, F965, F821
18	A technical note on a piping support drawing (47A050-IT Note 3) was found to be invalid for some applications	F761
19	Equipment cannot be determined to be environmentally qualified to NUREG-0588	F140, F144
20	No procedure for documenting time delay relay settings that are determined by preoperational tests and the preoperational test did not identify or require the documenting of these settings	F113, F125, F126, F132, F801
23	The auxiliary feed pump turbine trip and throttle valve FCV-1-51 is not included in the active valve list. The design of the valve schematic does not include the required control room by-pass & test indication, nor automatic bypass of the "open" torque switch.	F128, F133
25	Flange evaluations were omitted in some analysis calculations.	F322
30	Failure to satisfy design criteria for monitoring 1) operability and 2) providing adequate electrical protective devices for the motor-driven auxiliary feedwater pump lube oil pump.	F100, F136
31	Editorial discrepancies in licensing documents.	F119, F321
32	Incompatible hanger drawings and piping isometrics.	F753, F858, F865, F866, F932, F939, F942, F976, F983

TASK FORCE CATEGORY	CATEGORY DESCRIPTION	B&V FINDING REPORT NOS.
33	Inadequate cable tagging.	F807, F809
34	"Out of function" feature of a drawing was not in agreement with the latest design drawing showing the detailed design of the "out of function" feature.	F857, F910, F982, F984, F985, F986, F987, F988, F989, F992, F993
35	Instantaneous trip setting for motor-operated valve breakers is not in accordance with EN DES criteria and vendor recommendations.	F137
36	The cable tray fill criteria (FSAR section 8.3.1.4.5) is not assured of being met because of the less than conservative nominal values used for cable cross sectional areas in the cable routing program.	F135
37	Valve wiring circuits are designed such that the red and green indicating lights on the unit control board will light dimly upon malfunction of the P-auto contact of the Westinghouse W-2 control switch on the unit control board.	F112
38	Evaluation to determine if design of thermal overload bypass circuits met requirements of commitments to RG 1.106 and IEEE 279-1971.	F108, F122
39	The specific configuration of 6.9-kV bundled cables in trays has not been tested for the effects of fire retardant coating on the ampacity of the cable.	G901