September 12, 1986

Docket No. 50-412

Mr. J. J. Carey, Vice President
Duquesne Light Company
Nuclear Group
Post Office Box 4
Shippingport, PA 15077

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Dear Mr. Carey:

Subject: Interim Review Results of WHIPJET

By letters dated September 6 and October 10, 1985 Duquesne Light Company formally submitted information regarding the WHIPJET program (application of leak-before-break criteria to balance-of-plant piping). By letter dated March 3, 1986 we provided our preliminary assessment and position on this issue. In addition, we have had five progress report meetings, one special meeting on August 13, 1986, and numerous conference calls to obtain additional information.

In the August 13 meeting your staff requested that we communicate an interim review status to you, describing issues that are resolved, issues that have major problems and issues that have minor problems. In that meeting we terminated the discussion of the issuance of an exemption or CP amendment since these legal documents are all predicated upon the availability of a favorable safety evaluation, which we have not yet been able to prepare at this time. However, we believe that the description of the present status in Enclosures 1 and 2 should be useful to you. Our concerns in these enclosures have been either formally sent to DLC or informally discussed with DLC representatives.

We believe the remaining two major problem areas are the lack of material test data and the detectable leak rate for ferritic piping.

Based on the preliminary information submitted, to date, for austenitic pipe lines and our assessment of fracture mechanics and leak rate analyses, it appears that only lines 6 inches and greater in diameter will satisfy the current margins for leak before break in NUREG-1061, Vol. 3. However, the final stability and fatigue analyses and results have not been submitted by DLC. Until the information in Enclosures 1 and 2 and the stability and fatigue analyses are submitted for our review, we will not be able to reach a final conclusion and provide a completed safety evaluation.

We have requested that an audit be scheduled in September 1986 at Stone and Webster (S&W) offices in Boston. The purpose of this audit is to address questions on piping analysis methodology and design procedures to minimize the effects of fluid transients (Enclosure 2 questions). Any additional questions will also be covered in the audit at S&W.

Sincerely,

Peter S. Tam, Project Manager
PWR Project Directorate #2
Division of PWR Licensing-A
Office of Nuclear Reactor Regulation

Enclosures:
As stated

cc w/enclousres:
See next page

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Enclosure 1

POSITIONS AND REQUESTED INFORMATION

1. Subject: Representativeness of plant materials to test materials

Position:

a. DLC will verify that the materials in the plant are conservatively represented by the test materials.

b. DLC will catalog the materials available for fabrication into test specimens (ferritic pipe and weld rod). DLC will choose the three heats (pipe and weldment) based on upper and lower bound values of yield and average yield strength. If there is not enough material in a given heat with limiting yield strength (e.g. upper bound value) the matrix of three tests of each heat may be altered in order to use the bounding material, provided the total number of tests is unchanged.

c. DLC will have all the material certifications available for staff review.

d. For the non-nuclear piping in the WHIPJET Program NRC will require that bounding toughness and tensile properties be used in the fracture mechanics analyses to ensure that the evaluation is conservative.

Requested Information: DLC will construct a table of weld and base metal material properties for the nuclear grade piping in the WHIPJET program. The table will also include the vendor and date of purchase of the piping spool pieces. DLC will expand the table of test materials presented at the April 10, 1986, meeting to include material properties for the weld wire used in the test program.

DLC will discuss the weld fabrication procedures used to fabricate test specimens relative to the procedures used throughout the plant. This discussion should justify that the toughness values of the pipe welds in the WHIPJET Program are not non-conservative relative to the toughness values indicated from the test program.

DLC will propose a method of categorizing material properties for the non-nuclear piping in the WHIPJET Program.

Similarly, DLC will construct tables of austenitic weld and austenitic base metal material properties for piping in the WHIPJET Program. DLC will demonstrate that the austenitic weld and austenitic base metal materials whose fracture properties are quoted from the literature to be used in the WHIPJET Program are representative of the materials in the plant.

Status: DLC has deleted the testing of materials from the WHIPJET Program. As an alternative DLC has submitted test data from the literature for austenitic steel piping and welds. Our preliminary evaluation is that this data appears to be acceptable. Test data for ferritic piping and welds has not yet been submitted.

2. Subject: Test methods related to development of J-R curves.

Position: a. The staff recommends testing only 6" and 8" pipe rather than including 3" and 4" pipe specimens.

b. DLC will test an uncracked 6" or 8" pipe to verify the assumption that the plastic displacement in the bend tests are only due to the crack. Span length and other experimental conditions must be the same for cracked and uncracked pipe.

Requested Information: DLC agrees to meet this position as stated. No additional information needed.

Status: The materials testing has been deleted from the WHIPJET Program. Refer to status on Subject 1.

3. Subject: PICEP/Leak Detection

Position: a. DLC should define on a system-by-system basis the smallest leak rate that can reasonably be found in a timely manner consistent with their inservice leakage detection method.

b. Unless the licensee provides justification for considering lower leak rate margins, the staff's position is that a factor of 10 must be applied to a. to determine the leakage size crack from PICEP. Item c. contains factors to be considered when providing justification.

c. The staff considers that the following factors contribute to the need for the one order of magnitude safety margin:

1) Computational reliability of PICEP as influenced by parameters such as flaw size and shape and as evidenced comparisons of experimental and analytical results,

2) Uncertainty in stress distributions,

3) Effect of plugging of cracks by corrosion products,

4) Equipment response and human response,

5) Background leakage.

d. Consistent with the position taken in NUREG 1061, Vol. 3, redundancy in leak detection methods will be required. Acceptable methods of achieving redundancy include:

1) mass balance,

2) temperature or humidity monitors,

3) visual inspection,

4) acoustic monitoring, and

5) augmented ISI for ferritic piping.

Requested Information: a. DLC will develop information relative to the Duane Arnold data to demonstrate the effects of system cooldown on the flow rate predictions of PICEP.

b. DLC will evaluate the leak rate from the observed flaw in Duane Arnold using stress report inputs. DLC will demonstrate that the predicted leak rate from PICEP for the Duane Arnold flaw based on the Duane Arnold stress report is consistent with the experience at Duane Arnold.

c. At the May 20, 1986, meeting DLC will discuss their planned methods for complying with position 3.d. on redundancy.

Specifically, DLC should address (1) how leak rate limits will be implemented into plant operation, (2) what actions are required of operators when leaks are observed, and (3) where administrative controls for these activities will be documented.

Status: The staff considers that a leak rate limit of 0.5 gpm inside containment to be detectable subject to resolution of position d) above. In the August 27, 1986, meeting DLC presented general procedures that will ensure 0.5 gpm unidentifiable leakage is not from pipe cracks and these procedures should resolve position d). The staff requests that the salient points in the procedure be included in section 10 of the WHIPJET report. DLC has also not defined detectable leakage rate outside containment.

Basic agreement by DLC on the leak rate margin of 10 was obtained at the August 27, 1986, meeting in Bethesda with the staff.

4. Subject: Susceptibility to corrosion and fatigue

Position: DLC will demonstrate by reference to service experience that the piping systems in the WHIPJET Program are not susceptible to corrosion or fatigue. DLC should document the sources of their conclusions. DLC should also specify the thresholds for corrodants and temperature in the austenitic materials review for corrosion screening.

Requested Information: DLC will expand the discussion on susceptibility to flow stratification induced fatigue to include the reactor coolant system and the residual heat removal system.

NUREGs 0679 and 0691 indicate that there has been service experience of both corrosion and fatigue cracking in the CVCS. DLC should specifically address this concern as it relates to Beaver Valley 2.

Status: Complete.

5. Subject: Fatigue crack growth analysis

Position: a. DLC will perform as realistic an analysis as possible using service level A and B loads. The aspect ratio for the crack in the fatigue evaluation should be 6. The aspect ratio will remain constant throughout the analysis.

Unless otherwise justified the maximum allowable flaw depth is the smaller of

1) 60% of the wall thickness, or

2) the depth at which the plastic zone is equal to the remaining ligament.

b. The length of the fatigue crack must be less than both:

1) the length of the instability thru-wall at 2 (N+SSE)

2) 1/2 (instability thru-wall flaw at (N+SSE)).

Comment: DLC indicated that they no longer intend to do ASME Code Section III Class 1 fatigue analysis for Code Class 2 and 3 systems. Rather they will perform Section XI fatigue crack growth analyses for all break locations in the program. This is acceptable to the staff.

Requested Information: a. DLC will indicate whether they will meet this position. DLC will develop additional information to justify the da/dn relationship on page 1 of Section V of the April 10, 1986, progress report.

b. DLC will provide a step-by-step discussion of their procedure for performing fatigue crack growth analysis including a description of the methods used to calculate membrane and bending stress and the associated stress intensity factors.

Status: The DLC report indicates that the fatigue analyses will comply with NRC criteria and has provided a step-by-step discussion of their procedures. The staff has not completed its review of these procedures. In addition, DLC's justification of the da/dn relationship is incomplete and DLC has not submitted computational results to demonstrate compliance with the criteria.

6. Subject: Ferritic Pipe Behavior Below the Upper Shelf Energy (USE) Temperature

Position: DLC will determine whether there are any ferritic piping systems in the program that will be below USE temperatures when failure from postulated loading (such as SSE) could result in a safety concern. If this is possible, DLC will have to use appropriate fracture mechanics methods and material properties.

Requested Information: DLC indicated in the April 10, 1986, meeting that the piping systems in the WHIPJET Program will always be greater than 200°F when called upon for service. DLC will provide information to confirm that the USE for the SA106GrB piping and the welds in that piping is greater than 200°F.

Status: Complete.

7. Subject: Positive Displacement Pumps

Position: DLC will determine the systems still in the WHIPJET Program that have positive displacement pumps and will indicate for those pumps how vibration fatigue has been minimized to acceptable levels.

Requested Information: This position is satisfactorily addressed in Section IV.D.2 of the April 10, 1986, progress report.

Status: Complete.

8. Subject: Fracture Mechanics Computer Program Validation

Requested Information: DLC will describe the methods used to validate the fracture mechanics computer codes intended to be used in the WHIPJET Program.

Status: Information submitted in the August 11, 1986 report is under review by the staff.

9. Subject: Fracture Mechanics Analysis

Position and Requested Information: DLC must provide analysis and results that indicate their analysis complies with margins recommended by the staff.

Status: DLC has provided only a preliminary procedure and results; final results and sample calculations must be provided. DCL and the staff agreed at the August 27, 1986 meeting, that the leak rate calculations will use the mean fit of the stress-strain properties for the base metal and the fracture mechanics stability analysis will use lower bound base metal and weld metal properties. Since DLC will be using lower bound fracture mechanics properties and will be evaluating each break location, including the location with the highest stress, the staff indicated that margin of two on the length of the thru-wall instability flaw (under normal plus SSE loading) could be reduced by 10%.

10. Subject: Pipe Fitting

Position: The WHIPJET Program must consider all materials (pipe, fittings, safe-ends, and welds) in a line of pipe.

Status: The discussions in the last paragraphs of Sections 4.1.3.3 and in 4.1.3.4 do not address the staff concern that the entire line of pipe must be evaluated to determine limiting stress locations. DLC at the August 27, 1986 meeting indicated that the limiting

LBB locations were selected based upon the high stress points in the entire piping system including fittings as determined by the ASME Code and standard piping analysis procedures. When this information is included in the WHIPJET report, this iter will be complete.

11. Subject: Equipment Support Evaluation

Position: Section 4.1.4 does not adequately address the effect of support integrity on LBB evaluations of non-nuclear safety (NNS) high energy piping.

Status: DLC, at the August 27, 1986 meeting , indicated that they have performed an evaluation to demonstrate that the NNS high energy piping systems in the WHIPJET Program are qualified for Normal plus SSE loading. When this information is reported in the WHIPJET report, this item will be complete.

BEAVER VALLEY, UNIT 2 WHIPJET PROGRAM
INFORMATION RELATIVE TO PWR-A ENGINEERING BRANCH AUDIT

I. GENERAL

1. DLC states in Section 5.1.2 of their May 14, 1986, WHIPJET Draft Report that the linear (ΔT_1) and nonlinear (ΔT_2) components of the through wall temperature distributions during thermal transients were conservatively approximated by 80% and 50% of the fluid temperature change (ΔT). DLC will be required to demonstrate that these approximations are conservative since ΔT_1 and ΔT_2 are functions of the fluid velocity, material thermal properties, fluid temperature change, rate of change of fluid temperature and pipe outside diameter conditions.

   Status: Information submitted in the August 11, 1986, report is under review by the NRC staff.

2. DLC indicates in Section 5.5.1.3 of their May 14, 1986 WHIPJET Draft Report that only 10% of the effects of the nonlinear component of the through wall temperature distribution during thermal transients will be included in their WHIPJET total inside wall stress calculation. DLC will be required to justify this percentage in greater detail than that which is discussed in Section 5.5.1.3.

   Status: Information submitted in the August 11, 1986, report is under review by the NRC staff.

3. DLC will be required to identify typical piping components in the WHIPJET Program, e.g., valves, elbows, tees, reducers, etc. whose wall thicknesses are greater than the thicknesses of the connected piping. These increased thicknesses could affect the distribution of internal forces in piping systems and cause higher thermal transient stresses in the connecting welds than in the connected piping.

A staff evaluation of the effects of thickness mismatch in such piping and fittings was submitted in Region I Inspection Report 50-412/85-24 dated December 2, 1985. However, the subject of potentially high thermal transient stresses was specifically addressed in this evaluation.

Status: A response by DLC on this issue will be required.

4. DLC will be required to explain how fatigue concerns due to thermal fluctuations caused by uneven mixing in tees or branch connections were assessed.

Status: A response by DLC on this issue will be required.

5. DLC will be required to explain the interaction between their Bulletins 79-02 and 79-14 verification programs and the WHIPJET program.

Status: A response by DLC on this issue will be required.

II. WATER HAMMER

1. In Section 4.2.2 of the May 14, 1986 Draft Progress Report, DLC stated that: 1) in general the approach taken to address BVPS-2 water hammer concerns was to prevent or minimize water hammer effects through system design features and operating procedures, and 2) to assure that water hammer events initiated in the secondary systems do not compromise the performance of the Westinghouse supplied safety-related systems and components, the results of Westinghouse water hammer investigation have been reflected in design interface requirements for the balance of plant (BOP) design.

DLC will be required to provide information to verify that the system design features and operating procedures are adequate to address water hammer concerns. In particular, DLC will be required: 1) to identify documentation, including system design descriptions (SDDs), Piping and Instrumentation Diagrams (P&IDs), operating procedures and Westinghouse-BOP interface requirements for the piping systems in the BVPS-2 WHIPJET Program, which would substantiate that the DLC approach to address water hammer concerns has been properly implemented and 2) be prepared to make available for review during the audit such documentation for a vet to be identified piping system.

Status: This item will addressed in a staff audit scheduled during September 1986.

2. Justification will be required for the omission of the Steam Generator Blowdown System from section 4.2.2 of the WHIPJET Program Progress Report dated August 11, 1986.

Status: A response by DLC on this issue will be required.

3. DLC was previously requested to modify its list of fluid transients to provide additional details of its assessments of these transients. Where transients were characterized as applicable, DLC was requested to identify the operating procedures which addressed the water hammer concerns and the analyses in which the transient related loads had been quantified and included in the piping stress analyses. DLC should be prepared to have the modified list of transients for review during the audit.

It appears that only normal operating conditions have been addressed in the list. Other operating conditions (e.g., emergency and faulted) as well as testing conditions should be addressed to assess inadvertent water hammer occurrences during these conditions.

Status: This item will be addressed in a staff audit scheduled during September 1986.

III. STAFF EVALUATION OF CHEMICAL/VOLUME AND CONTROL PIPING SYSTEM STRESS ANALYSIS *

As a part of this audit, the staff through its consultant, ETEC, will conduct a detailed evaluation of the Chemical/Volume and Control (CHS) piping system stress analysis. The items listed below are indicative of the type of information that will be required to enable the staff to complete this evaluation. If, as a result of this review, the staff identifies any unacceptable safety-related findings, the staff will request information relative to these findings as they apply to other WHIPJET Program systems to determine the possible generic consequences.

1. Since the analysis of record for the ASME Class 2 & 3 and ANSI/ASME B31.1 portions of the CHS piping system is based on stress intensification factors and the DLC WHIPJET piping analyses are to be based on ASME Code Section III, Class 1 stress indices, DLC will be required to demonstrate how its analysis of record for the CHS was modified for the WHIPJET analyses.

* The information need in Part III of this enclosure may be modified as a result of discussions to be held during September.

2. DLC will be requested to explain its procedures for assessing interactions between piping models in its analyses. Explanation regarding branch line effects and consideration of anchor motions will be required.

3. DLC will be requested to explain its criteria for assuring that dynamic analyses of piping systems fully account for the total physical mass of the system including consideration of masses of supports.

4. DLC will be requested to explain and justify its modelling procedures for masses offset from the piping centerline, such as valve/operator assemblies, which could induce inertial effects in the piping systems.

5. DLC will be requested to explain and justify its procedures regarding support and anchor (e.g., nozzle or branch connection) stiffnesses which could affect the distribution of internal loads in piping analyses.

6. DLC will be requested to explain and justify its procedures regarding the effects of trapeze type or multiple-component type and eccentric supports and their potential to provide restraints not accounted for in the piping analyses.

7. DLC will be requested to explain how the local effects of integral attachments are considered in its piping analyses.