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August 31, 1982

Mr. Dennis M. Crutchfield
Chief, Operating Reactors Branch No. 5
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

Subject: Oyster Creek Nuclear Generating Station
License DPR-16
Docket No. 50-219
SEP Topic III-5A, "Effects of Pipe Breaks on Structures, Systems, and Components Inside Containment"

Reference: (a) Letter from Nuclear Regulatory Commission (D. Crutchfield) to GPUN (P. Fiedler) dated June 29, 1982, "Oyster Creek - SEP Topic III-5A, Effects of Pipe Breaks on Structures, Systems, and Components Inside Containment"

Enclosed is a report which responds to Reference (a), the final NRC evaluation of Oyster Creek SEP Topic III-5A. Reference (a) identified four areas which need further resolution. Each of these areas is addressed in the enclosed report, and were also discussed at a meeting with the NRC on July 16, 1982. Based on the meeting, we understand that each of the four areas is now satisfactorily resolved.

Sincerely,

P. B. Fiedler
Vice President and
Director - Oyster Creek

A035

cc: Ronald C. Haynes, Administrator
Region I
U.S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, Pa. 19406

NRC Resident Inspector
Oyster Creek Nuclear Generating Station
Forked River, N. J. 08731

July 22, 1982

OYSTER CREEK NUCLEAR GENERATING STATION

SEP TOPIC III-5A

EFFECTS OF PIPE BREAKS ON STRUCTURES, SYSTEMS AND COMPONENTS INSIDE CONTAINMENT

1. Purpose

The purpose of this document is to respond to the Nuclear Regulatory Commission final evaluation of Oyster Creek SEP Topic III-5A, which identified four areas requiring further resolution. These areas are:

(1) Basis for acceptability of consequences of cascading breaks.

(2) Further justification of pipe whip interaction with the containment wall.

(3) Evaluation of effects of damage from jet impingement on mechanical equipment.

(4) Any significant changes in total pipe stresses as a result of SEP Topic III-6, Seismic Design Consideration.

2. Cascading Breaks

a. The NRC SER requests a basis for concluding that the available mitigating systems can cope with the combined blowdown effects of cascading breaks, or alternatively requests justification that cascading blowdown effects will not occur.

b. Evaluations of cascading breaks are contained in the GPUN report of July 30, 1979. In summary:

- Each instance where a whipping pipe could contact another secondary pipe was identified.

- The evaluation showed that pipe breaks in any of the secondary pipes contacted as a result of a postulated primary pipe break would not result in contact with a vulnerable target, i.e., a target needed to achieve safe shutdown.

- In particular, all interactions due to one pipe whipping into a second nearby pipe system involved lines which individually had been evaluated as part of the primary pipe whip study, and were found not to contact vulnerable targets.

- It was concluded concurrent breaks in two or more lines have the same effects, i.e., there is no contact with vulnerable targets.

c. This evaluation was summarized again in the GPUN letter to the NRC dated November 12, 1981.

d. It is concluded that sufficient basis has already been documented for concluding that the required safe shutdown equipment would be available for coping with cascading breaks.

e. With regard to the effects of multiple pipe breaks on the reactor blowdown and ECCS response, postulated breaks in two or more piping systems could increase the largest break area assumed in docketed safety analyses. For example, concurrent breaks of steam and feed system lines or steam and recirculation lines would result in an area greater than the 26-inch recirculation system line break, which is the limiting break for Oyster Creek. However, although performance of ECCS analyses per Appendix K is not required for break areas greater than the largest reactor piping and none have been performed, it is our judgment based on a large number of ECCS analyses covering a wide range of break sizes and types that the effect of adding a steam or feed line break (or other break above the reactor core) to the base case recirculation line break would not significantly alter the results. The reasons for this are that the steam break addition would increase inventory loss somewhat, but would also increase the blowdown rate, thereby permitting initiation of core spray earlier in the transient. These effects would be roughly off-setting.

Evaluations in the GPUN report of July 30, 1979, indicate that multiple failures of recirculation lines will not occur. In particular, none of the cascading breaks identified in the evaluations involve contact of a whipping recirculation line with another recirculation line.

Based on the above, cascading pipe breaks are not expected to have any significant impact on ECCS performance.

3. Pipe Whip Interaction with Containment

a. The NRC SER questioned the validity of static tests performed by CB&I, which showed that if the loading area is sufficiently large, the containment wall can deform without failure until deformation is limited by the concrete shield wall. The SER indicates that suitable dynamic load factors must be considered, and requests further justification that the impact load or energy produced as a result of postulated pipe breaks for piping greater than 14-inch diameter does not exceed the load or energy required to penetrate containment.

   In addition, the NRC SER indicated that the impact area of a 14-inch or larger pipe may be smaller than the assumed contact area, i.e., the area of a 14-inch diameter circle. Specifically, with regard to 4-1/2-inch pipe crush test data used to show that whipping pipes would flatten on contact with containment, the NRC SER indicated that correlation of such data is difficult.

b. The GPUN report of July 30, 1979, included an evaluation of the applicability of the CB&I static tests to dynamic loading conditions which would be experienced as a result of pipe whip. The following examples of a beam loaded by a weight, W, illustrate the basis for this evaluation:

   - When loading is static, a beam loaded with a weight, W, will experience a deflection of δ and an applied load of W.

   - For the classic dynamic loading condition, where the weight is initially suspended above the beam and is then dropped onto the beam, the beam must deflect by 2δ to absorb the energy of the weight. The applied loading in this case is 2W, i.e., there is a dynamic load factor of two.

- For a dynamic load situation where deflection is limited to δ, the beam load is also limited, i.e., to W, and the dynamic load factor is one. The difference from the static load case is that the deflection is achieved faster (i.e., at a higher strain rate). This case is similar to the pipe whip situation, where deflection and load are limited by contact with the concrete shield wall.

- Similarly, strain rates of the containment wall would be higher in the event of pipe whip interactions than the strain rates experienced during the CB&I tests, but load required to produce the required deflection (2.75 inches) would be the same unless there are significant strain rate effects on the material strength or ductility. Accordingly, the evaluation in the GPUN report of July 30, 1979, covered the effects of strain rate on the carbon steel (A212B) containment material. This evaluation showed:

  (1) High strain rate does not significantly affect the ductility of the containment wall material.

  (2) Material strength is increased slightly, which would be beneficial.

- Accordingly, it was concluded that the static CB&I tests are applicable to dynamic loading conditions.

c. The GPUN report of March 16, 1982, showed that the load required to flatten any of the high energy piping greater than 14-inch diameter is a small fraction of the interaction load. Specifically, the flattening load is less than 16 percent of the load required to deform the containment wall until it makes contact with the concrete shield.

The flattening load was determined based on correlation of 4-1/2-inch diameter pipe crush test data. The test data agreed well with a simple theoretical model. The model was applied conservatively to large sized pipes, i.e., high values of pipe strength compared to code allowable values were assumed and increased strength at high strain rates was accounted for. There is a large margin between the predicted flattening load and allowable load (a factor of about six), so that a highly accurate model is not necessary. For the same reason, differences in the detailed loading configurations between the model and an actual impact would not affect the overall conclusion. Accordingly, it is considered that this evaluation provides sufficient basis for concluding that large whipping pipes (greater than or equal to 14 inches) would flatten on contact with the containment wall and provide contact area at least as large as a 14-inch diameter circle, the configuration used in the CB&I tests.

The evaluation contained in the GPUN report of March 16, 1982, assumed that contact occurs between a rounded surface of the piping and the containment wall. Additional evaluations have been performed of the piping system configurations to determine if there are more limiting situations with regard to pipe/wall contact area. These evaluations are based on the circumferential breaks which have previously been identified in large size piping systems in the GPUN report of July 30, 1979. The conclusions of the evaluations may be summarized as follows:

- There is no configuration which could result in the broken end of a pipe impinging directly on the containment wall. The basic reason for this is that the jet loads from a break cause the pipe to move away from the break, with the broken end the "trailing" rather than "leading" surface of the pipe.

- There are configurations which could result in contact occurring with the side of a pipe and at its broken end. This situation would occur, for example, where the configuration upstream of the break consists of a straight pipe section, an elbow, and then a plastic hinge. The broken pipe could move in an arc around the plastic hinge, and make contact with the containment wall at an oblique angle. Such "glancing blows" are not considered limiting, however, because:

(1) The load required to flatten the pipe end is less than the flattening load for contact with a rounded section of piping.

(2) The jet load would be oriented nearly parallel to the contacted surface. The loads would be substantially lower than for cases where the jet is normal to the contacted surface.

(3) The specific loading configuration of the CB&I tests bounds this type of localized loading. In particular, the load in the CB&I tests was applied through a two-inch thick plate of 14-inch diameter. The plate was stiff relative to the tested segment of containment wall, so that all load was applied via the rim of the plate. Accordingly, the actual contact area for the test was likely well below the contact area for "glancing blow" type of contact.

d. Based on the above considerations, it is considered that this area is resolved.

4. <u>Evaluation of Jet Impingement on Mechanical Equipment</u>

- The NRC SER indicates that the effects of jet impingement should be considered and evaluated regardless of the ratio of impinged and postulated broken pipe sizes.

- Such an evaluation was performed and discussed with the NRC on June 21, 1982.

- A draft report of this evaluation was given to the NRC on July 16, 1982. The evaluation shows that there are no adverse effects of such jet impingement.

- It is considered that this area is resolved.

5. <u>Changes to Pipe Stress as a Result of SEP Topic III-6</u>

a. The NRC SER indicates:

- There may be some differences in points of high stress in piping systems as a result of seismic reevaluations. These could result in differences in postulated piping break locations.

- Nevertheless, a large number of break locations have been postulated, and provide a spectrum of postulated pipe breaks which include or envelope the most likely break locations inside containment. The NRC SER further states that the number of breaks evaluated (150) is comparable to the number which would be evaluated for a current OL plant.

- Any significant changes in total pipe stresses as a result of SEP Topic III-6 should be reviewed to demonstrate conformance with the conclusions of evaluations to date.

b. It is considered that, as indicated by the NRC, a large sample of breaks has been considered and the spectrum of postulated pipe breaks does include or envelope the most likely break locations inside containment. Accordingly, it is considered that further evaluations to reflect the final results of SEP Topic III-6 are not likely to affect the overall conclusions of the high energy line break evaluations and, therefore, are not necessary.