50-440

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001
August 4, 1999

LICENSEE: Cleveland Electric Illuminating Company

FACILITY: Perry Nuclear Power Plant, Unit No. 1

SUBJECT: SUMMARY OF APRIL 15, 1999, MEETING ON PERRY STRAINER TESTING FACILITY

On April 15, 1999, the U. S. Nuclear Regulatory Commission (NRC) staff met at the Power Generation Technologies (PGT) testing facilities in Knoxville, Tennessee, with representatives of PGT, Enercon Services, Illinois Power Company (Clinton Power Station), Entergy (Grand Gulf Nuclear Station) and FirstEnergy Nuclear Operating Company (Perry Nuclear Power Plant). The purpose of the meeting was to discuss the status of the Mark III program designed to determine and validate the submerged structure drag loads of newly installed emergency core cooling system strainers at the Perry, Grand Gulf, and Clinton facilities. The meeting was intended to discuss both the analytical, and supporting testing programs that are being used to justify the submerged structure design drag loads of the strainer. A list of the meeting participants is included as Attachment 1 and a detailed discussion of the meeting is provided as Attachment 2. Handouts were not provided.

Since all three licensees have installed the new strainers under the criteria established in 10 CFR 50.59, this visit by the NRC staff to the testing facilities of PGT was the first opportunity to become familiar with the analytical and testing details of the program, which has been used to validate the submerged hydrodynamic design loads of the strainer. The visit was very successful in providing a current status report to the staff.

Future plans were also discussed. It was indicated that new information on this topic would not be available for about 6 to 9 months (i.e., October or November 1999). During this interval, a significant effort will be underway to evaluate the large amount of test data. Normally, the staff would have a concern that resolution could not be achieved without further intermediate discussions with the licensees. However, based on the information gained during this visit, the

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staff believes that the issue is well in hand and that a successful resolution is probable. Due to the preliminary nature of the information provided to the staff, handouts of the presentation were not provided.

Original Signed By
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Docket No. 50-440

Attachments: 1. List of Meeting Participants
2. Meeting Summary

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PERRY TESTING SITE
APRIL 15, 1999
KNOXVILLE, TENNESSEE
PERRY STRAINER TEST/ANALYTICAL

BACKGROUND

The purpose of the meeting was to discuss the Mark III program designed to determine and validate the submerged structure drag loads of newly installed emergency core cooling system (ECCS) strainers at the Perry, Grand Gulf, and Clinton facilities. The reason for the effort to install these large ECCS strainers into the suppression pool of Mark III containments began from knowledge gained in an event at the Swedish Barseback nuclear power plant. The event demonstrated that a pipe break could generate and transport large quantities of insulation and other debris into the suppression pool. This debris could be so large in volume that deposits onto the strainer surfaces could cause the ECCS pumps to lose the necessary net positive suction head (NPSH). To address this concern, NRC issued Bulletin 96-03, " Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors," on May 6, 1996. The purpose of this bulletin was to alert all owners of Boiling Water Reactors (BWRs) of the potential for clogging ECCS suppression pool suction strainers by debris generated during a loss-of-cooling accident (LOCA). Additionally, each licensee was to report to the NRC whether, and to what extent, appropriate action was being taken. Once determined, the licensee was to notify the NRC when actions associated with the bulletin were completed.

The Perry Nuclear Power Plant was identified within the bulletin's background because of two events involving clogging of ECCS strainers that occurred at the plant on January 16, and April 14, 1993. Because of these events, it was found that deleterious effects on strainer pressure drop could be caused by the filtering of fiberglass materials entrained on the ECCS strainer surfaces. Because of these events, the licensee immediately decided to install larger and stronger strainers at Perry. These strainers were installed in early 1993 and represented the first U.S. based BWR to improve the strainer design as a result of the debris clogging issue.

After the installation of these new strainers, there were no major milestones until the issuance of Bulletin 96-03. In its response to Bulletin 96-03, dated November 4, 1996, the licensee provided a description of planned actions, the schedule for implementation, and proposed technical specifications. The licensee's intent was to replace the existing strainers with much larger strainers. The response also indicated that the FirstEnergy Nuclear Operating Company, the licensee for Perry, had elected to work jointly with the Clinton and Grand Gulf licensees to resolve the issues raised by Bulletin 96-03.

Attachment 2

The final resolution is a replacement strainer that employs a floor mounted strainer that completely surrounds the suppression pool. In cross section, the strainer resembles a lobster trap. The large strainer is designed to achieve a very low approach velocity at the surface of the strainer, sufficient to minimize compaction of debris at the strainer surface, thereby allowing greater flow through the debris and the strainer. This design is also intended to have a strainer that has little or no added pressure drop when it is loaded with debris.

Because of the unique configuration of this design, it was necessary to test all aspects of the strainer. Testing was performed to determine the strainer performance in both a clean condition as well as fully loaded with debris. Beyond performance testing, there also was need for testing relative to the determination of submerged structure drag loads. It is this latter testing phase that was the focus of this particular site visit. The performance testing has been previously discussed in other documents and is much broader in scope than the drag loads testing. As a result, performance testing will not be discussed within the context of hydrodynamic load testing which is the focus of this report.

All three licensees have recently installed the new suction strainers in accordance with the criteria set forth in 10 CFR 50.59. As a result, limited documentation has been provided to the staff, even though the strainers have been installed. This visit by the staff to the Power Generation Technologies (PGT) testing facilities was the first opportunity for the staff to become aware of the analytical and testing details of the program used to validate the submerged hydrodynamic loads of the strainer.

DISCUSSION

The meeting was held on April 15, 1999, between the NRC staff and the Perry licensee with support from their contractors. The contractors included the staff of PGT, the testing contractor, and Dr. T. Sarpkaya, a world expert in the field of submerged structure drag loads. The meeting site was the testing facility at PGT in Knoxville, Tennessee, where scaled testing had been conducted for the new strainer design. The meeting agenda consisted of witnessing a series of demonstration tests followed by a presentation of the analytical methodology and a preliminary discussion of the test data results. Representatives from both Grand Gulf and Clinton attended the meeting.

The purpose of the meeting was to provide a status briefing of both the analytical methodology as well as a preliminary discussion of testing results. Each of the three licensees have made available, at their plant site, the documentation of their 10 CFR 50.59 process. These records have not been reviewed by the staff because the acceptability of the loads is dependent upon the confirmation of the values used in the analysis via the testing program. Therefore, the staff has decided to defer final review of the pool dynamic loads until the licensee has completed the evaluation of the test data.

The process by which this effort would be conducted was generally described. It was indicated that the evaluation of the test data would not be completed prior to October 1999. Once completed, the results would be submitted on the Perry docket and would form the basis of a future meeting with the staff. It would report the results as best estimate and would be reported as proprietary information. In conjunction with the data, the complete analytical methodology would also be submitted on the Perry docket. The docketing of these two reports would be the first detailed presentation of the process used to design and test the new strainers. Perry would also provide information to show how well the analytical methods predicted the test data for the specific Perry strainer design. The final report for Perry will also focus on the margins that exist between the tested results and the design loads used to structurally design the strainers. This report will include the calculated stresses associated with the installed strainer.

For both Clinton and Grand Gulf, the process will be very similar. Each plant will reference the data evaluation and analytical methodology reports that were submitted on the Perry docket. Each plant will then submit a report to show how well the analytical methods predicted the test data for their specific strainer design. In addition, each plant will report on the demonstrated margins that were achieved between the design loads and the best estimate test results for the installed strainers. As in the Perry report, the individual plants will provide the stresses associated with the installed strainer. Although the plant-specific information may vary from plant to plant, the general approach will be retained.

The various reports, as described above, are expected to be available to the staff shortly after October 1999. In addition, the exact method of reporting was not finalized by any of the three plants. It was noted that some information could be limited to the site and not submitted to the staff as part of the official docketed record. This level of detail needs to be worked out as the nature and depth of the various reports becomes more known. It was indicated that the intent was to provide the staff with as much detail as desired. But, due to the potentially large volume of information, it may be prudent to limit the distribution to the site. Obviously, site material would always be available for staff review. With this brief overview, the meeting began with the testing program.

The staff witnessed several tests designed to determine the hydrodynamic loads that could be imposed on the strainer. It was noted that the tests observed by the staff were demonstration tests and were not part of the official record. This meant that the tests were conducted in the same manner as those designed to become part of the data base, but the data would not be saved.

Observing the tests proved to be very useful in that instrumentation accuracy and noise levels could be better understood by actually seeing the data being processed. Having witnessed tests from several other testing programs, the staff concluded that this program has the lowest noise to data ratio of any of the programs. As a result, the data have not required any data averaging over a specified time period to smooth the resulting data. This has been necessary for other programs. This by itself should not be considered as a negative item for the other programs, but rather a positive element of this program. Another interesting aspect was the fact that there have been no instrumentation failures during the course of testing. Generally, a certain percentage of instrumentation failures during the testing period is considered to be normal. This is another indication of a well engineered program. All in all, the experience of witnessing this series of demonstration tests gave the staff a better feel for the ways the test data were obtained and processed for future evaluation.

The discussion concerning the testing program began by indicating that the testing program had been completed as of March 28, 1999. The testing consisted of 630 tests. Within this test matrix, tests were conducted at two different scales. The models were 12 and 18 inches in diameter, consisting of both solid and perforated plates. Because testing involved discrete objectives, the program was easily separable into phases. After each test phase, audit type evaluations of the data were performed to ensure that the data were both consistent and supportive of the analytical results. Once the results were finalized, testing was allowed to proceed to the next stage.

In spite of these audit type evaluations, it was reiterated that this meeting was held only 17 days after completion of the testing. Therefore, the following discussion must be tempered by the fact that data evaluation has just begun and will continue for many months. The views that were provided to the staff were considered as very preliminary and should only be considered as providing an overall feeling of the results.

Within these limitations, Dr. Sarpkaya began on a very positive note. He stressed that to date, there has not been any information that would question the appropriateness of the analytical methodology nor the analytical results which were used to design the plant-specific strainers. The general conclusion is that the data were anticipated and will justify the values used in the strainer design.

Within this ground work, Dr. Sarpkaya began with a general observation that this testing program has significantly extended the field of knowledge of acceleration drag. By example, he stated that prior to this testing the maximum Reynolds Number which contained test data was limited to 20,000. This is true for the range of the Keulegan Carpenter number between 0 and 0.5, which represents prototypical conditions for the Mark III strainer. This recently completed testing has extended the data base to 100,000. So beyond the importance of the plant-specific information, the data are of scientific interest.

Dr Sarpkaya then proceeded to share some of the preliminary findings that have been uncovered to date, and to respond to specific questions.

> The staff noted that the testing rig appeared rather massive and seems to have the potential of influencing the natural frequency of the system. As a result, he was asked whether or not this effect could possibly impact the test results. He was very positive in saying that this would have no effect on the test results. The technical basis for this conclusion would be provided in the forthcoming report mentioned earlier.
>
> The next question that was raised was the possible impact of water temperature on the results. It was noted that about all of the tests were run with water temperatures very close to 55°F. This is much colder than the expected range of suppression pool temperature that could vary between 55°F and 150°F. This temperature difference effect was heightened when it was noted that the water viscosity would be reduced in half when the temperature is varied from 65°F to 160°F. Dr Sarpkaya indicated that the only effect would be to change the Reynolds Number. Since the test matrix will vary the Reynolds Number over a wide range, the changing viscosity will be accounted for in the results.
>
> It was observed during the demonstration tests that the duration of the tests went on for a considerable length of time. In light of this observation, it was asked how long the data needed to be taken? In water, the amplitude of the vibration damped very quickly. Therefore, data were taken as long as the data showed a readable forcing function. In air, where the damping function is significantly less, it was felt that 25 cycles was considered as being sufficient for all data resolution.

Impact of the perforated plate dimensions came up in the discussion. Plate thickness has proven not to be a factor. This can be demonstrated both analytically as well as being supported by test results. The same was said for hole diameter. The only thing that mattered in this regard was the overall void fraction or beta of the perforated plate. This parameter does have a significant effect on the overall results and must be modeled very carefully.

This concluded the main presentation of the testing program. The last agenda item focused on the welding consideration of the perforated plate. During an earlier meeting this issue arose and the licensees indicated that they would prepare a response. They were now prepared to address this issue.

The presentation began with the considerations that went into the program. They indicated that wherever possible, the design took advantage of the plate edge. The perforated plate normally has a half- to one-inch edge of solid material at the end of each sheet of stock. Using this solid strip of metal for welding allowed a reduced length of weld where welding was done with actual perforated plate. For welding in the perf ated area, the holes were prepared by initially drilling a conical hole which is then backfilled with weld material. It was described as a plug weld. There seemed to be general agreement that this was an excellent technique for welding perforated plate.

Testing of the welds was another important factor in the program. Coupons were prepared and tested to assure high strength welds. In addition, each welder was trained in the proper technique of perforated plate welding. Samples of each welder's work were tested to assure the high welding standards were maintained. Upon completion of the discussion, it seemed that the licensees had the issue well in hand and had taken all of the necessary steps to assure satisfactory welds of the strainer design.

CONCLUSIONS

At the end of the meeting, it was repeated that the results discussed should be viewed as very preliminary. The information was provided in the spirit that it reflects the current understanding of the data. Based on this understanding, it was stated that the contractors evaluating the data have not found any surprises that would cause one to reflect on the design basis for the strainer. It was noted that all three licensees using this strainer design have done so under 50.59. They collectively indicated that they don't expect to have any scheduled reports for the NRC for about 6 to 9 months. This, however, does not mean that the NRC staff will not be kept informed if the need arises. During this time, the licensees will be reevaluating the status of the strainer design under the criteria of 10 CFR 50.59. If any significant reduction of margin would occur, it will trigger a response to the NRC.

Principle Contributor: J. Kudrick

Date: June 29, 1999