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November 1, 1983

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Mr. R. L. Spessard, Director
Division of Engineering - Region III
U.S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, IL 60137

Subject: Dresden Station Units 2 and 3
Quad Cities Station Units 1 and 2
Blume Criteria Support Evaluation
NRC Docket Nos. 50-237, 50-249,
50-254, and 50-265

References (a): J. G. Keppler letter to Cordell Reed dated July 14, 1982.

(b): B. Rybak letter to R. L. Spessard dated September 1, 1983.

Dear Mr. Spessard:

This letter transmits the information committed to in Reference B and includes the proposed schedule, an assessment of the safety significance, a discussion of the treatment of non-safety related hangers which are included in the safety related analyses and a discussion of Commonwealth Edison's position with respect to completion of the Safe Shutdown Path (SSDP) Confirmatory Action Letter (CAL) requirements.

Attachments 1 and 2 address the safety significance of this project. In summary considering the results of an assessment of the conservatisms inherent to the piping analyses, of an operability assessment of a sample of "no action" supports and of a review of the previously performed 79-14 piping operability assessments, they all indicate that the existing hanger configurations do not significantly reduce the safe operation of the plant.

Attachment 3 provides the discussion of the treatment of the non safety related hangers which are modelled in the safety related analyses.

Attachment 4 presents the proposed schedule for completion of this work. The schedule commits to completion of the SSDP systems on Dresden by September 1, 1984 and Quad Cities by December 1, 1984. The balance of the "no-action" support modifications would be completed by June 1, 1985. The schedule presents an improvement over the SSDP dates (February 1, 1985) previously discussed with the NRC.

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Finally, the NRC requested a definition of the CECo position with respect to the SSDP CAL commitments. As recently discussed in a meeting with Region III the NRC had assumed that all SSDP supports would be analyzed in detail as part of the CAL. They based this on the first sentence in Item 1 of the CAL which states "Analyze and modify to meet FSAR requirements of the safety related piping including suspension systems . . .".

The CECo interpretation of the CAL was that its basis was to define a schedule for completion of the existing 79-14 program for piping which was defined as being part of a Safe Shutdown Path. This was based on the first paragraph of the CAL which states ". . . regarding remaining work and schedules to complete the IE Bulletin 79-14 requirements." As stated, the CAL requirements were then to apply to the existing 79-14 procedures and philosophies. Basically the existing 79-14 process, developed by Commonwealth Edison and our A/E and reviewed accepted by the NRC required that a review of as-built piping hanger locations be made to determine if they agreed with the original design requirements. If they did the program requirements were met. For the supports in question the as-built locations did meet the original design requirements and no further action was required. Therefore, it is the CECo position that Edison responded "in good faith" to the requirements of the CAL. The basis of our program is solely to upgrade the documentation of these supports and is not considered a continuation of the 79-14 requirements.

If there are any further questions on the above please contact this office.

Very truly yours,

B. Rybak

B. Rybak
Nuclear Licensing Administrator

lm

cc: NRC Resident Inspector - Dresden
NRC Resident Inspector - Quad Cities

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Attachment 1 to Impell
Letter 0591-102-003
October 10, 1983

SUPPORT OPERABILITY EVALUATION
for the
BLUME CRITERIA SUPPORT DOCUMENTATION PROJECT

Introduction

IE Bulletin 79-14 requirements have been met for all safety-related piping at Dresden 2 and 3 and Quad Cities 1 and 2. This was done using either original Blume Criteria piping spans and support loads, or full qualification and/or modifications to FSAR requirements.

Twenty percent of the supports were shown to be acceptable using the Blume Criteria (Blume Criteria supports). The remaining supports were qualified using criteria which were more conservative than the Blume Criteria. Commonwealth Edison has decided to upgrade these Blume Criteria supports to achieve the same design margins for all safety-related pipe supports. This will improve the uniformity and documentation and provide a known, consistent design basis for all supports.

Up to half of the Blume Criteria supports may have to be modified to achieve this conservative, consistent design basis. The modifications will consist of minor strengthening of U-bolts, baseplates, anchor bolts, etc. Through this process, the design will be improved above and beyond original criteria, and all safety-related pipe support documentation will be consistent.

Since some Blume Criteria safety-related supports will be modified in this upgrade project, the NRC raised the issue of whether a safety concern exists. On July 14, 1982, Impell/ Commonwealth Edison presented to the NRC a strong technical justification for not performing support operability evaluations for the 79-14 effort. Also, Impell confirmed the operability of all piping systems at that time. To further substantiate that operability limits are satisfied for all Blume Criteria supports, Commonwealth Edison recently committed to have Impell perform an additional operability evaluation on a sample of the supports located by the Blume Criteria.

This report describes the approach and presents the results of this operability evaluation. The study clearly demonstrates that operability is assured for all safety-related supports at Dresden and Quad Cities. Thus, a safety concern does not exist.

Approach

Line Selection - Impell selected two safe shutdown piping systems, one at each plant. These are D3-DGSW-01B(c) at Dresden and Q2-DGSW-03B(c) at Quad Cities. These were selected because they had a reasonable number of Blume Criteria supports (seven on Dresden, six on Quad Cities) and they are safe-shutdown systems.

Operability Criteria - Operability criteria (Reference 1) were developed for the evaluation of these supports. The load combination includes gravity and the Design Basis Earthquake. The acceptance criteria are based on Supplement 1 of IE Bulletin 79-02 for concrete anchor bolts, ASME Section III Subsection NF Service Level D allowables for structural steel, structural welds, and catalog items, FSAR limits for structural steel web crippling, and ultimate test data for lateral loads on U-bolts. These criteria are in compliance with NRC Regulatory Guide 1.124.

These operability criteria include considerable conservatisms in order to minimize the effort required to evaluate support functionality. For example, any of the plastic analysis methods allowed by the Code would provide additional relief.

Procedure - First, the supports were evaluated to determine if they met FSAR acceptance criteria for all FSAR load combinations. Those which did not meet FSAR limits were then evaluated using the operability criteria. Alternatively, the piping analysis was rerun without some of the Blume Criteria supports to determine if the piping met FSAR allowables without them.

Results

All thirteen of the Blume Criteria supports either met operability or FSAR design limits, or were not needed to meet FSAR design limits for the piping. Table 1 summarizes the results.

Three of the thirteen supports were shown to be unnecessary to meet FSAR design limits for the piping. Two met FSAR limits for all components. Six met FSAR limits for all components except the U-bolts, which met the operability criteria. The remaining two met FSAR limits for the majority of components, with only one item on each being qualified using the operability criteria (one of these also used the operability criteria for its U-bolt).

Conclusion

These results clearly demonstrate the operability of all Blume Criteria supports at Dresden and Quad Cities. The great majority of support components met conservative FSAR design limits and the remainder met the conservative operability criteria used in this evaluation.

The results of this evaluation, together with the general levels of conservatism associated with the FSAR limits and operability criteria, clearly demonstrate that plant safety is assured during the course of the Blume Criteria Support Documentation Project.

Reference

1. Impell Project Instruction Number 40, "Pipe Support Operability Evaluation", Revision A, August 29, 1983.

TABLE 1

BLUME CRITERIA SUPPORT OPERABILITY EVALUATION RESULTS

Plant	Support	Met FSAR Limits	Met Operability Criteria	Piping met FSAR without Support
Dresden	3-3933-18			X
	3-3933-15	X[1]		
	3-3933-14	X[1]		
	3-3933-11	X		
	3-3933-26			X
	3-3933-3			X
	3-3933-1		X[2]	
Quad Cities				
	2-3962-H184	X[1]		
	2-3962-H185	X[1]		
	2-3962-29-119	X[1]		
	2-3962-H186	X[1]		
	SK-RFI-S-2162	X		
	2-3962-2R-118		X[3]	

Notes

1. All components met FSAR except U-Bolt, which met operability criteria
2. All components met FSAR except channel member, which met operability criteria
3. All components met FSAR except U-Bolt and angle member, which met operability criteria

IMPELL CORPORATION

Attachment 2 to Impell
Letter 0591-102-003
October 10, 1983

PIPING SYSTEM OPERABILITY JUSTIFICATION FOR THE BLUME CRITERIA SUPPORT DOCUMENTATION PROGRAM

Introduction

The Blume Criteria Support Documentation Program will result in modifications to approximately ten percent of the piping supports on safety-related piping systems at Dresden and Quad Cities. These modifications will consist of minor strengthening of isolated parts of pipe supports to meet conservative criteria established for support design at these plants. All modifications will be complete by June of 1985. Once complete, all safety related piping and pipe supports will have consistant design margins in excess of those required.

During this project, Impell considers that strong, conclusive justification for continued safe operation of these plants exists. Impell conducted two analytical operability evaluations during the 79-14 effort. These demonstrated wide margins of safety for both the piping and supports. Also, each safety-related piping system was shown to meet conservative operability criteria supported by these studies during the 79-14 project. These results, along with generic evidence gathered during the past few years, were presented to the NRC on July 14, 1982.

This attachment summarizes the technical justification of piping system operability for the Blume Criteria Support Documentation Project.

Discussion

The criteria used for the design of piping and supports in nuclear power plant design are widely accepted as appropriately conservative design bases.

However, it has been recently proposed that the Code requirements are overly conservative when applied to cases involving short-term dynamic loads, such as the DBE. Diverse nuclear industry groups, such as the ASME code committees, Electric Power Research Institute (EPRI), the NRC, and concerns in foreign countries (e.g. Japan and West Germany), have for the past few years been investigating this issue. The final resolution of the issues and changes to the Code are still several years away, however, the trend in the results is clear - piping systems subjected to short-term dynamic loads can maintain integrity and functionality at stress levels well above Code allowables without a decrease in safety margins.

Significant identifiable conservatisms exist in the piping procedures and code criteria used on the 79-14 project. These conservatisms include:

- Damping value of 1/2 percent for the OBE and DBE loading. Observed damping values for piping systems at high stress levels are much higher due to effects including gaps in support components and flexible boundary conditions. Current Pressure Vessel Research Council (PVRC) task group activities are investigating redefining damping to higher, more reasonable values on the order of 3 - 7 percent.

- DBE to OBE loading ratio of 2.0. Use of Reg. Guide 1.60 criteria results in typical ratios of 1.4 to 1.7.

- Strain rate effects are neglected. These effects can significantly increase the yield stress by at least 10 percent for typical dynamic loading cases.

- Stress intensification and flexibility factors are extremely conservative as defined in the linear elastic analysis. These factors result in greater susceptibility to yielding under smaller loads in components such as elbows and tees; however, there is no consideration for load redistribution to other components following initial yield.

- Boundary conditions are conservatively chosen.

- Pressure effects which greatly increase the ultimate load capacity of components are not taken credit for, although pressure stresses are included in the evaluations.

- Component thicknesses are normally greater than the nominal dimensions specified. This increase in thickness can have a significan effect on component capacity.

- Actual material strengths are generally at least 10 percent greater than Code specified minimums.

Current Code allowables for dynamic loading are also recognized as extremely conservative, especially for seismic motion. For elastically-calculated stress levels actual yielding of the piping systems are expected to be of a limited local nature. This prediction is based on the characteristics of seismic motion as well as the nonlinear behavior of piping systems:

- The energy in any seismic motion is finite. As a piping system yields locally, much of the input energy is absorbed as strain energy, and the kinetic energy of the system is reduced.

- Nonlinear damping effects significantly decrease the response of a system after some amount of yielding.

- The inertial effects of a typical piping system limit the deformations and hence the extent of local yielding.

- Piping system redundancy allows yielding at multiple locations. In this manner, system collapse due to formation of a mechanism is highly unlikely, and loading will be redistributed to different components such that excessive yielding will not occur in any one component.

- Yielding of a given support does not result in loss of support for an entire piping system. Systems have been shown to be functional when 60 percent of the supports yielding. Yielded supports absorbs significant energy and reduce the total seismic response of the piping system.

Additional qualitative insight into the dynamic behavior of piping can be obtained from operating plants which have experienced strong ground motions. The El Centro Steam Plant, Lawrence Livermore Laboratory, and the Hamaoka Units in Japan have all been subjected to earthquake motion without disruption of operation. SRV discharge piping systems in BWR plants have also been subjected to dynamic loads without damage, where conventional analysis indicates dynamic stresses well above current Code allowables.

Recently, the PVRC Task Group on Dynamic Lading has undertaken a program to develop more rational criteria for the evaluation of piping systems under transient loading. This group recognizes the conservatism in current ASME Code practice, and is sponsoring research into the behavior of typical piping systems under dynamic loads to direct Code considerations towards the actual response and failure modes of those systems.

Several experimental programs to investigate the yielding of piping systems have recently been completed or are currently underway. ANCO Laboratories has performed two sets of dynamic tests on Kraftwerk Union piping systems in configurations of up to 300 feet in length with a variety of components and standard piping support systems. These systems were subjected to both low and high frequency loads of various amplitudes corresponding to seismic and aircraft impact loads, respectively. The maximum low frequency excitations with a maximum peak acceleration of 12 g were applied for durations of ten seconds. The maximum high frequency excitations with a maximum peak acceleration of 24 g over the 20 to 40 Hz frequency range were applied for durations of approximately one second. Peak acceleration response of 50 g, peak displacements of 50 cm, and plastic strains in excess of 0.6 percent were reported. Linear elastic analysis predicted dynamic stresses over four times ASME Code allowables. Even for these extreme loads, there was no observed failure due to plastic collapse, leakage, or loss of pressure-retention capacity. This program was presented to West German licensing agencies to justify existing installations without backfitting for dynamic loads, and to provide licensing support for the elimination of primary stress requirements for these loads on small bore (less than 2-inch diameter) piping.

High-excitation testing to benchmark dynamic nonlinear analysis methods for piping is currently being conducted for EPRI. One test has been competed on a 4-inch Schedule 40 ferritic steel piping system. This system has a length of 20 feet and consists of two elbows and three runs of piping. The system was designed to ASME Class 2 rules. The system was pressurized to design allowables and subjected to various dynamic excitation levels corresponding to seismic events. The primary purpose of this initial test was to demonstrate the feasibility of dynamically exciting piping systems to levels far in excess of current Code allowables. The maximum dynamic excitation level correspond to seven to eleven times a typical SSE spectra for a plant in a low to moderate seismic region. This excitation level results in stresses which exceed Level D Code allowable stress limits by a factor greater than three. Permanent and visible deformatis were observed, but there was no plastic collapse or loss of structural integrity in the pressurized piping. Input accelerations were greater than 14 g, and response accelerations were greater than 21 g in one elbow. Plastic strains greater than 1.5 times the yield strains were recorded.

These dynamic tests on piping systems indicate that typical piping systems can withstand extreme seismic loading conditions without plastic collapse. These results verify that the identified conservations are large.

Conclusion

Justification of operability of the existing Dresden and Quad Cities piping systems is therefore provided by:

- Inherent conservatisms in standard piping system modeling, analysis, and design techniques
- Demonstrated functionality of typical nuclear plant piping systems subjected to seismic events and high-excitation dynamic testing.
- Extremely low probability of occurrence of a DBE with the plant in the present design condition.

The margins of safety of the safety-related piping at both Dresden and Quad Cities are certainly adequate given the large levels of conservatism in the design.

Attachment 3 to Impell
Letter 0591-102- 003
October 10, 1983

SEISMIC/NON-SEISMIC CLASS BREAK PIPING DESIGN

The NRC requested clarification regarding the method used on the 79-14 and Blume Criteria Support Documentation projects to evaluate the seismic/non-seismic class break piping systems.

The extent of piping system modeling on the non-seismic side of the class break is provided in Project Instruction number 31, Revision 0 for the 79-14 project (Impell Job number 0590-003). In general, the non-seismic piping and supports were modeled to at least 3 changes in piping direction, of which no consecutive 3 directions are in the same plane. The boundary point at the end of this region was conservatively modeled as pinned. This procedure provides a sufficient representation of the effects of the non-seismic piping on the seismic piping, resulting in a conservative design of the seismic piping and supports.

To assure seismic piping and seismic supports stresses are acceptable, two non-seismic supports in each orthoganal direction were qualified to meet FSAR limits. Alternatively, a single axial support was qualified. All support qualification was based on conservative loads from the computer analysis using the modeling procedure described above.

The procedures for piping analysis and support design of seismic/non-seismic class break piping systems for the Blume Criteria Support Documentation project are the same as they were for the 79-14 project.

7.0 PROJECT SCHEDULE

FIGURE 7-1