January 23, 2003

MEMORANDUM TO: Robert A. Gramm, Chief
Section 1
Project Directorate IV
Division of Licensing Project Management

FROM: Kamal A. Manoly, Chief **/RA/**
Civil and Engineering Mechanics Section
Mechanical and Civil Engineering Branch
Division of Engineering

SUBJECT: SAFETY EVALUATION FOR COOPER NUCLEAR STATION LICENSE CONDITION 2.C.(6) SEISMIC EVALUATION, DOCKET NO.: 50-298

References:

(1) Letter, Nebraska Public Power District to U.S. NRC, “License Condition 2.C.(6) Seismic Evaluation, Cooper Nuclear Station, NRC Docket No. 50-298, DPR-46,” dated February 26, 2002.

(2) Letter, Nebraska Public Power District to U.S. NRC, “Supplemental Information Related to License Condition 2.C.(6) Seismic Evaluation, Cooper Nuclear Station, NRC Docket No. 50-298, DPR-46,” dated June 9, 2002.

(3) Letter, Nebraska Public Power District to U.S. NRC, “Response to Request for Additional Information Related to Nebraska Public Power District’s Seismic Reevaluation Proposed to Address Cooper Nuclear Station License Condition 2.C.(6), Cooper Nuclear Station, NRC Docket No. 50-298, DPR-46,” dated September 27, 2002.

(4) Letter, Nebraska Public Power District to U.S. NRC, “Response to Draft Request for Additional Information on the Supplemental Information submitted by Nebraska Public Power District for Cooper Nuclear Station License Condition 2.C.(6), Cooper Nuclear Station, NRC Docket No. 50-298, DPR-46,” dated November 25, 2002.

The Mechanical and Civil Engineering Branch (EMEB) of the Division of Engineering has completed its review on the documents (References 1, 2, 3 and 4) submitted by the Nebraska Public Power District (NPPD), in conjunction with the implementation of License Condition 2.C.(6) at Cooper Nuclear Station (CNS).

Docket No.: 50-298
CONTACT: Y.S. Kim, DE/EMEB
415-2729

Based on our review and evaluation of the NPPD's submittals, we conclude that there is reasonable assurance that the main steam line piping from the main steam isolation valves (MSIV) to the main turbine condenser and the turbine building at CNS will be seismically adequate for the proposed MSIV leakage path system.

It should be noted that our acceptance of the experience-based methodology as presented by NPPD is restricted to its application for ensuring the pressure boundary integrity and functionality of the MSIV leakage path system. The staff's acceptance of the methodology for this application is not an endorsement for the use of the experience-based methodology for other applications at CNS. In addition, it should be noted that the staff's review did not include the new floor response spectra (FRS) that were developed by NPPD for the Turbine Building (Reference 3) under Part 50.59.

Our safety evaluation is provided in the attachment. We consider our efforts on TAC No. MB4654 complete.

Attachment: As stated

January 23, 2003

Based on our review and evaluation of the NPPD's submittals, we conclude that there is reasonable assurance that the main steam line piping from the main steam isolation valves (MSIV) to the main turbine condenser and the turbine building at CNS will be seismically adequate for the proposed MSIV leakage path system.

It should be noted that our acceptance of the experience-based methodology as presented by NPPD is restricted to its application for ensuring the pressure boundary integrity and functionality of the MSIV leakage path system. The staff's acceptance of the methodology for this application is not an endorsement for the use of the experience-based methodology for other applications at CNS. In addition, it should be noted that the staff's review did not include the new floor response spectra (FRS) that were developed by NPPD for the Turbine Building (Reference 3) under Part 50.59.

Our safety evaluation is provided in the attachment. We consider our efforts on TAC No. MB4654 complete.

Attachment: As stated

<u>Distribution:</u>
GImbro
MThadani
EMEB-RF

DOCUMENT NAME: G:\EMEB\KIM\COOPER-SER.WPD
ADAMS ACCESSION NO.:ML030230023

OFFICE	EMEB:DE		EMEB:DE	

NAME	YKim	KManoly
DATE	01/17/2003	01/21/2003

OFFICIAL RECORD COPY

SAFETY EVALUATION FOR COOPER NUCLEAR STATION
LICENSE CONDITION 2.C.(6) SEISMIC EVALUATION
DOCKET NO.: 50-298

1.0 INTRODUCTION

Nebraska Public Power District (NPPD) submitted information in conjunction with the implementation of License Condition 2.C.(6) at Cooper Nuclear Station (CNS) on February 26, 2002 (Reference 1) and its supplemental information on June 9, 2002 (Reference 2). The staff reviewed the information and issued requests for additional information (RAIs) on August 6 and October 21, 2002, and NPPD responded to the RAIs on September 27 and November 25, 2002, respectively (References 3 and 4). This evaluation addresses the seismic adequacy of the main steam line piping from the main steam isolation valves (MSIV) to the main turbine condenser and the turbine building at CNS for the proposed MSIV leakage path system.

2.0 EVALUATION

2.1 Seismic Demand

2.1.1 Safe Shutdown Earthquake

The safe shutdown earthquake (SSE) for CNS is based on the N69W component of the 1952 Kern Country earthquake recorded at Taft, California, scaled to a peak ground acceleration (PGA) of 0.2g. The vertical PGA is taken as 2/3 of the horizontal PGA as stated in the CNS Updated Safety Analysis Report (USAR) (Reference 5).

2.1.2 Location of Equipment and Piping

NPPD stated in Reference 1 that the majority of the piping and equipment in the scope of the MSIV leakage pathway evaluation at CNS is in the Turbine Building. The balance of the equipment is in the Reactor Building's steam tunnel and torus compartment.

2.1.3 Turbine Building

NPPD states in References 2 and 3 that its contractor, Stevenson & Associates, generated a set of new floor response spectra (FRS) for the Turbine Building (TB). The new FRS was generated using the soil-structure interaction analysis method and Regulatory Guide 1.60 ground response spectrum (GRS) anchored to the CNS SSE of 0.2g. The FRS were developed in accordance with the guidance in NUREG-0800 (NRC Standard Review Plan (SRP), Sections 3.7.1 and 3.7.2). NPPD states in Reference 4 that it is in the process of reviewing the FRS developed by the contractor. During a teleconference call on November 6, 2002, NPPD indicated that the FRS were developed for the inclusion in the plant licensing basis under Part 50.59. This is acceptable to the staff.

2.1.4 Reactor Building

NPPD stated in Reference 2 that 2.0 X SSE ground response spectrum (GRS) is used as the seismic demand for all elevations in the Reactor Building (RB) up to and including 932'-6". This is based on the NRC's acceptance of the Generic Implementation Procedure for USI A-46 (GIP-2), Section 4.2.4, in which it states that realistic, medium centered FRS based on the IPEEE Review Level Earthquake (RLE) can be scaled to obtain realistic, median centered FRS derived from the site SEE. This is acceptable to the staff.

2.1.5 Piping and Pipe Support

NPPD stated that the criteria established in the NEDC-31858P, BWROG submittal (Reference 6) and approved in the NRC Safety Evaluation (SE) (Reference 7) are used for evaluation of the piping welds. For piping with non-welded joints (e.g., threaded), a one-third (1/3) reduction in the allowable unsupported spans is applied to the piping systems containing threaded fittings. The NRC has accepted the 1/3 reduction in the allowable unsupported spans for piping systems containing threaded fittings for other MSIV leakage pathway applications. Piping systems containing friction or cast iron components are classified as outliers and require a more detailed review and evaluation. The staff found the criteria for seismic demands for various piping runs in the MSIV leakage pathway to be acceptable.

2.1.6 Equipment

NPPD stated that equipment were evaluated according to the requirements of the GIP-2. This is acceptable to the staff since NRC accepted this approach for the resolution of USI A-46.

2.1.7 Condenser

The CNS condenser is located below grade at the lowest level of the turbine building (Elevation 877.5 ft.). The applied seismic demand is the CNS SSE GRS, which is acceptable to the staff.

2.2 Seismic Capacity

2.2.1 Seismic Verification Walkdowns

In order to confirm the functional capability of the leakage pathway, NPPD performed a seismic verification walkdown of the MSIV leakage pathway. NPPD indicated in its submittal (Reference 1) that the walkdown was performed by "seismic capability engineers" as defined by the "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment, Rev. 3". Data gathered during these walkdowns was used as input for seismic evaluations and analyses, and for identifying potential seismic interaction concerns.

The staff found the walkdowns performed by NPPD, as well as the corrective actions taken for the identified outliers, to be acceptable.

2.2.2 Turbine Building

The seismic integrity of the Turbine Building (TB) that houses the leakage pathway piping systems and equipment was evaluated. In Reference 1, NPPD states that the majority of the piping and equipment in the scope of the MSIV leakage pathway evaluation at CNS is in the TB. The TB is built with reinforced concrete from the ground up to the operating floor and the remaining portion of the turbine building above the operating floor is constructed with structural steel. NPPD performed an evaluation of the TB concrete structure to determine its capability of remaining structurally intact without gross structural failure following a postulated SSE. Based on the results of the evaluation, NPPD concluded that there is sufficient margin in the original design to ensure the concrete portion of the TB structure will remain intact during and following an SSE. The staff concurs the NPPD's conclusion.

2.2.3 Main Turbine Condenser

The main turbine condenser is a twin-shell, horizontal tube unit. The condenser shell units are massive structures, with 7/8-inch thick steel walls, that contain substantial internal bracing and are seismically rugged. Each of the two shell units of the main turbine condenser is approximately 40 ft X 30 ft X 48 ft high. The base of each condenser shell unit is rigidly mounted to the reinforced concrete TB base mat which is 26 feet below grade.

An evaluation of the seismic ruggedness of condensers and condenser anchorage for GE BWR plants is reported in Reference 6. The configurations of the GE BWR condensers were compared to condensers in the earthquake experience data. Condensers in the earthquake experience data exhibited substantial seismic ruggedness even when they were not designed to resist earthquakes. Comparisons of condenser designs in GE BWR plants with those in the earthquake experience database revealed that GE plant designs are similar to those that exhibited good earthquake performance. The study concluded that a failure and significant breach of a pressure boundary in the event of a design basis SSE is highly unlikely. This conclusion was further verified by a detailed comparison of the CNS condenser configuration to condensers in the earthquake experience data. Based on the above, the staff concludes there is reasonable assurance that the main turbine condenser is seismically adequate for the proposed MSIV leakage path system.

2.2.4 Main Turbine Condenser Anchorage

The shell units of the main turbine condenser are self-supporting structures that do not require any external support from the TB structure at any point other than the base anchorage. The base anchorage includes bolts for tension restraint, a centrally located seismic shear key, and a thrust anchor for resisting operating loads. NPPD performed a calculation to evaluate the seismic capability of the main turbine condenser anchorage for postulated SSE loading. NPPD stated that the results of the calculation for the tension and shear in the condenser shell anchorages are adequate to ensure that the condenser units will remain intact for postulated SSE loading. The staff concurs the NPPD's conclusion.

2.2.5 MSIV Leakage Pathway (Piping)

For the MSIV leakage pathway, NPPD conducted walkdowns to compare the subject piping systems to piping systems that have experienced strong motion earthquakes and to verify the seismic adequacy of the main steam leakage path piping. This method utilizes a comparison of piping system demand versus experience-based capacity, augmented by extensive walkdowns, worst-case calculations, and documentation to assure acceptable piping spans, piping support configurations, design attributes, and the absence of known seismic vulnerabilities.

2.2.5.1 Comparison to Experience Data

2.2.5.1.1 Piping and Pipe Supports

The piping material data, size, and schedules were obtained from piping and instrument diagrams (P&IDs) and line specifications. Table 6-1 of Reference 1 presents a summary of the various piping, sizes, schedules, diameter-to-thickness (D/t) ratios and ASTM/ASME material designation for each of the walkdown packages. Table 6-2 presents a general summary of the same data for the piping systems, which constitute the experience data. In Table 6-3, NPPD also presented a comparison of the D/t ranges of the CNS piping to the experience data piping. The CNS piping systems in the leakage path are enveloped by the experience data with the following exceptions:

(1) The experience data does not specifically identify the existence of 5" diameter piping.
(2) The CNS 3/4" piping has a lower bound D/t ratio of 3.4 versus 5 in the experience data.
(3) The CNS 1" piping has a lower bound D/t ratio of 4 versus 5 in the experience data.
(4) The CNS 1" piping has a lower bound D/t ratio of 5 versus 7 in the experience data.
(5) The CNS 24" piping has a lower bound D/t ratio of 20 versus 23 in the experience data.

NPPD stated that for items (2) through (5), these lower D/t ratios are due to the use of thicker wall piping which would be stronger and have higher capacity than the experience data piping and therefore is not a concern. For item (5), the exceedance is only 12 percent which is less than typical piping system fabrication tolerances. NPPD considered that this piping is adequately represented in the experience data. The 5" diameter piping in item (1), although not explicitly represented in the database, is enveloped by those of larger and smaller sizes of piping. Therefore, NPPD concluded that this piping is adequately enveloped by the experience data and the supporting analysis. The staff concurs the NPPD’s conclusion.

Table 6-4(a) of Reference 1 provides a summary of the allowable stress capacity of the predominant piping materials of the experience data piping. Table 6-4(b) provides a similar summary for the CNS piping. These tables demonstrate that the CNS piping in the leakage pathway is adequately represented in the piping experience data.

In addition, Table 6-5 of Reference 1 provides a summary of minimum and maximum ratios of the actual CNS vertical support spans to the suggested ANSI B31.1 deadweight spans and the actual CNS lateral support spans to the suggested ANSI B31.1 spans. Table 6-6 provides suggested B31.1 deadweight support spans. Figures 6-1 through 6-4 compare the CNS vertical support span ratios (VSR) and lateral-to-vertical support span ratios (LVSSR) to the experience piping span data. These figures show that the CNS piping support spans are well represented and adequately enveloped by the piping experience data, and are acceptable to the staff.

2.2.5.1.2 Related Equipment

Other equipment in the scope of the leakage pathway review include valves, instruments, and tanks which are referred to as related equipment in this evaluation. The SQUG GIP-2 methodology, documented in Reference 8, was employed to address the seismic adequacy of the equipment. GIP-2 provides a formal procedure for evaluating these classes of equipment against the earthquake experience data. The NPPD’s implementation of the GIP-2 procedure at CNS is documented separately in Reference 9.

In Reference 1, NPPD compared the CNS SSE ground spectrum to the GIP-2 Reference Spectrum and GIP-2 Bounding Spectrum, and found that the CNS spectrum is well bounded by the GIP-2 spectrum. The staff finds this acceptable.

2.2.5.2 Analytical Evaluations

2.2.5.2.1 Piping

The majority of piping systems under review were originally designed to the 1967 B31.1, "Power Piping Code". The original design only considered loadings due to pressure, dead load, design mechanical loads, and thermal loads. The capacity criteria used for piping system limited analytical reviews and detailed analyses, which included consideration of a design basis SSE, are provided in References 1, 2 and 3.

NPPD performed simplified and detailed piping analysis which were conducted for selected systems in the MSIV leakage path. Detailed response spectra modal analysis response spectra were conducted for several piping systems. The analysis was a realistic seismic analysis with intermodal and inter spatial combinations by the SRSS method. In addition, to the seismic analysis, deadweight and normal operating thermal analyses were conducted.

Three piping systems were selected for detailed computer analysis: (1) Main Steam System (including the By-Pass piping), (2) Primary Leakage Pathway, and (3) Alternative Leakage Pathway. These systems were selected because they are the primary mechanisms for the delivery of the MSIV leakage to the condenser.

In addition, localized equivalent static analyses were used to (1) evaluate the effects of seismic anchor motions (SAMs), (2) evaluate spatial interaction conditions, (3) evaluate localized areas of seismic vulnerability, and (4) determine loads used in the detailed support evaluations.

NPPD stated in References 1 and 3 that this analytical methodology was used for the Monticello MSIV leakage pathway submittal and it was accepted by the NRC (Reference 7). In addition, NPPD stated that the analytical results indicates that the piping systems at CNS have adequate capacity to maintain leak-tight structural integrity during and after a postulated SSE. The staff has reviewed the above information and found them to be acceptable.

2.2.5.2.2 Pipe Supports

Detailed support qualifications were conducted for all supports associated with the piping analysis described in the previous Section, 2.2.5.2.1 Piping. NPPD stated that selection of supports for detailed support qualifications were based on identifying or establishing worst case supports during the walkdowns. The basis for the determination of these worst case supports included consideration of the following: (1) short, fixed, or hard spot rod hangers that were judged to be susceptible to fatigue failure during a design basis SSE event; (2) U-bolts susceptible to significant lateral loads; (3) supports that were judged to be most susceptible to failure during a design basis seismic event based on field review; and (4) supports judged to have no ductile anchorages.

The evaluation criteria for welded and bolted anchorages were the same as those provided in the AISC Steel Construction Manual except the allowable stress was increased by a factor of 1.7 when an SSE load was included. The GIP-2 criteria for concrete expansion anchor bolts developed by SQUG were used for the evaluation of the adequacy of concrete expansion anchor bolts. These criteria are acceptable to the staff as discussed in References 7 and 8.

Table 6-10 provides a summary of the number of supports subjected to detailed analytical reviews and the basis of these reviews. Theses supports represent over 30% of the support population in the MSIV leakage path. From this review, NPPD concluded that it is reasonable to assume that the supports for the MSIV leakage path piping have adequate seismic capacity. The staff concurs with the NPPD's conclusion.

2.2.5.2.3 Related Equipment

NPPD used the GIP-2 methodology described in Reference 8. Seismic capacity, caveat compliance, anchorage, and seismic spatial interaction concerns were reviewed. The GIP-2 Bounding spectrum that was obtained from earthquake experience data was used to establish seismic capacity of all related equipment.

NPPD stated that the majority of the related equipment are valves located at the lower elevations, and valve operability is not a concern for CNS because the applicable valves are either not required to reposition to establish the leakage path, or fail safe with respect to the leakage path. The staff concurs with NPPD's determination.

3.0 CONCLUSION

Based on the above evaluation, the staff concludes that upon completion of the equipment and piping support modifications identified in References 1, 2, 3 and 4, there is reasonable assurance that the main steam line piping from the main steam isolation valves (MSIV) to the main turbine condenser and the turbine building at CNS will be seismically adequate for the proposed MSIV leakage system. The staff's conclusion is based on (1) the design attributes of the CNS main condenser are generally enveloped by those of the condensers in the earthquake experience database, and that the condenser assembly has sufficient anchorage capacity, (2) the non-seismically analyzed leakage path pipes are represented by those in the earthquake experience database that demonstrated good seismic performance, (3) the detailed analyses and the worst case analysis performed for the non-seismic portion of the main steam drain lines indicated adequate safety margins for piping stresses and support loads, (4) the criteria and methodologies used for the piping analyses have been previously reviewed and accepted by the NRC for other plants, and (5) the turbine building has been adequately designed to withstand the SSE loads. The staff, therefore, concludes that the NPPD's proposed MSIV leakage path system is acceptable.

It should be noted that the staff's acceptance of the experience-based and GIP-2 methodology as presented by NPPD in this review is restricted to its application for ensuring the pressure boundary integrity and functionality of the MSIV leakage path system. The staff's acceptance of the methodology for this application is not an endorsement for the use of the experience-based methodology for other applications at CNS. In addition, it should be noted that the staff's review did not include the new floor response spectra (FRS) that were developed by NPPD for the Turbine Building (Reference 3) under Part 50.59.

4.0 REFERENCES

(1) Letter, Nebraska Public Power District to U.S. NRC, “License Condition 2.C.(6) Seismic Evaluation, Cooper Nuclear Station, NRC Docket No. 50-298, DPR-46,” dated February 26, 2002.

(2) Letter, Nebraska Public Power District to U.S. NRC, “Supplemental Information Related to License Condition 2.C.(6) Seismic Evaluation, Cooper Nuclear Station, NRC Docket No. 50-298, DPR-46,” dated June 9, 2002.

(3) Letter, Nebraska Public Power District to U.S. NRC, “Response to Request for Additional Information Related to Nebraska Public Power District’s Seismic Reevaluation Proposed to address Cooper Nuclear Station License Condition 2.C.(6), Cooper Nuclear Station, NRC Docket No. 50-298, DPR-46,” dated September 27, 2002.

(4) Letter, Nebraska Public Power District to U.S. NRC, “Response to Draft Request for Additional Information on the Supplemental Information submitted by Nebraska Public Power District for Cooper Nuclear Station License Condition 2.C.(6), Cooper Nuclear Station, NRC Docket No. 50-298, DPR-46,” dated November 25, 2002.

(5) Cooper Nuclear Station Updated Safety Analysis Report

(6) GE Topical Report, NEDC-31858P-A, Revision 2, “BWROG Report for Increasing MSIV Leakage Rate Limits and Elimination of Leakage Control Systems," August, 1999.

(7) Letter from NRC to NS, “Safety Evaluation on Seismic Verification of the MSIV Leakage Path at Monticello (TAC No. 96238),” in 1998.

(8) “Supplemental Safety Evaluation Report No. 2 on Seismic Qualification Utility Group’s Generic Implementation Procedure, Revision 2, Corrected February 14, 1992.”

(9) “Cooper Nuclear Station Verification of Seismic Adequacy of Mechanical and Electrical Equipment, Unresolved Safety Issue A-46 (SQUG),” Nebraska Public Power District