Northern States Power Company

Monticello Nuclear Generating Plant
2807 West Hwy 75
Monticello, Minnesota 55362-9637

May 29, 1998

US Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

MONTICELLO NUCLEAR GENERATING PLANT
Docket No. 50-263 License No. DPR-22

Demonstration of the Seismic Qualification of the MSIV
Leakage Path at Monticello (TAC No. 96238)

Ref. 1 Letter from M.F. Hammer, NSP, to NRC Document Control Desk, "NSP Response to Supplemental Request for Additional Information Concerning the Monticello Nuclear Generation Plant Power Rerate Program (TAC No. M96238)," March 26, 1998

Ref. 2 Letter from M.F. Hammer, NSP, to NRC Document Control Desk, "Submittal of Information Regarding the Seismic Verification of the MSIV Leakage Path at Monticello (TAC No. M96238)," April 17, 1998

By letter dated March 26, 1998 (Ref. 1), NSP informed the staff of its intent to take credit for fission product removal in the main steam lines and the condenser in certain Monticello accident scenarios under rerate operating conditions. By letter dated April 17, 1998 (Ref. 2), NSP provided supplemental information on the seismic qualification of the MSIV leakage path to the condenser.

A conference call was held between the staff and NSP regarding the scope and content of Ref. 2. NSP subsequently decided to resubmit the subject information. Attachment 2 contains NSP's amended submittal. This letter supersedes Ref. 2 entirely.

Please contact Joel Beres at (612) 295-1436 if additional information is required.

M F Hammer

Michael F. Hammer
Plant Manager
Monticello Nuclear Generating Plant

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c: Regional Administrator - III, NRC
NRR Project Manager, NRC
Sr. Resident Inspector, NRC
State of Minnesota, Attn: Kris Sanda
J. Silberg, Esq.

Attachments
Attachment 1 NRC Affidavit
Attachment 2 Seismic Verification of MSIV Leakage Path

UNITED STATES NUCLEAR REGULATORY COMMISSION

NORTHERN STATES POWER COMPANY

MONTICELLO NUCLEAR GENERATING PLANT DOCKET NO. 50-263

Demonstration of the Seismic Qualification of the MSIV
Leakage Path at Monticello (TAC No. 96238)

Northern States Power Company, a Minnesota corporation, by letter dated May 29, 1998 provides information regarding the seismic qualification of the MSIV leakage path to the condenser for the Monticello Nuclear Generating Plant to a US Nuclear Regulatory Commission (NRC). This letter contains no restricted or other defense information.

NORTHERN STATES POWER COMPANY

By

Michael F. Hammer
Plant Manager
Monticello Nuclear Generating Plant

On this 29th day of May 1998 before me a notary public in and for said County, personally appeared Michael F. Hammer, Plant Manager, Monticello Nuclear Generating Plant, and being first duly sworn acknowledged that he is authorized to execute this document on behalf of Northern States Power Company, and that to the best of his knowledge, information, and belief the statements made in it are true.

Samuel I. Shirey
Notary Public - Minnesota
Sherburne County

SAMUEL I. SHIREY
NOTARY PUBLIC - MINNESOTA
My Comm. Exp. Jan. 31, 2000

Attachment 2

Seismic Verification of MSIV Leakage Path

1.0 Introduction

The Monticello Nuclear Generating Plant (MNGP) power rerate radiological analysis has taken credit for deposition and holdup of radioactive iodine in the steam lines downstream of the Main Steam Isolation Valves (MSIVs) and in the main condenser. The main condenser and a pathway from the MSIVs were evaluated to assure they would retain sufficient structural integrity following a safe shutdown earthquake (SSE) to transport the MSIV leakage. The MSIV leakage pathway includes leakage through the MSIVs via the main steam piping and main steam drains to the condenser.

The methodology suggested in NEDC-31858P (Reference 1) was used to seismically evaluate this pathway. This report will discuss the applicability of this methodology for Monticello and how this methodology was used for the seismic evaluation of the pathway. This report will summarize the seismic evaluation that was performed for the piping and equipment in the MSIV leakage path for Monticello. The evaluation demonstrates that a reliable pressure boundary can be maintained in the pathway for the MSIV leakage to reach the condenser during and after a seismic event.

The method of seismic evaluation relies in part on the use of earthquake experience data and similarity principles. Plant specific analyses of piping and equipment were used in combination with the experience method. The evaluation method and results are described in this report.

Guidance on the use of experience method for qualification of piping systems is described in reference 1 and also in the supporting documents cited within the reference. Reference 1 provides an evaluation of the MSIV leakage issue for General Electric boiling water reactors, including Monticello. The Seismic Qualification Utilities Group (SQUG) Generic Implementation Procedure (GIP) described in reference 2 was used for seismic qualification of certain existing equipment in the MSIV leakage path.

2.0 Scope of Piping and Equipment

The primary components in the MSIV leakage path which are relied on for pressure boundary integrity are the main condenser, the Main Steam (MS) lines from the MSIVs to the turbine stop valves and to the turbine bypass valves, and the drain lines to the condenser. Figure 2-1 shows a simplified diagram of the leakage pathway.

The MSIV leakage pathway that has been selected utilizes the drain lines from each of the four main steam lines. These drain lines are located downstream of the MSIVs and connect into a drain header that connects to the condenser. The leakage path utilizes three separate drain lines from the MS piping to the drain header. The three drain lines include the main steam drain lines, the main steam cross tie drain, and the turbine bypass line drain. Each of these lines can be isolated by Motor Operated Valves (MOVs). Each MOV has a bypass line with a restricting orifice. Since the MOVs are not powered by essential power and they are normally closed valves, it is assumed that the leakage will be through the MOV bypass lines via the restricting orifices. This provides a passive pathway for the MSIV leakage to reach the condenser because no valve positioning or operator action is necessary to establish the pathway.

The branch lines which interconnect with the MSIV leakage path were included in the scope of the piping that was reviewed. The scope of the branch lines included the connection from the pathway to a location such as a closed valve that would assure that the MSIV leakage would be confined within the branch line, and leakage would be transferred to the condenser.

The turbine bypass valves are normally closed and fail closed. Because these types of valves are not well represented in the experience data, it was conservatively assumed that the valves would fail open as a result of the seismic event, and leakage would therefore go past the turbine bypass valves directly to the condenser. The piping from the turbine bypass valves to the condenser connects near the bottom of the condenser and was included in the scope of this evaluation.

The leakage path piping, equipment and supports are located in the following areas.

Reactor Building	Turbine Building	Recombiner Building
- HPCI Room - RCIC Room - Torus Area - Main Steam Tunnel	- Condenser Bay - Steam Jet Air Ejector (SJAE) Room - Mechanical Vacuum Pump Room - Condenser Bay to SJAE Room Pipe Chase - Condensate Backwash Receiving Tank Room	All areas

Table 2-2 presents a summary of the valves, in-line equipment, and attached equipment included in the scope. The piping was also segmented into 40 walkdown packages. Table 2-1 identifies the piping packages.

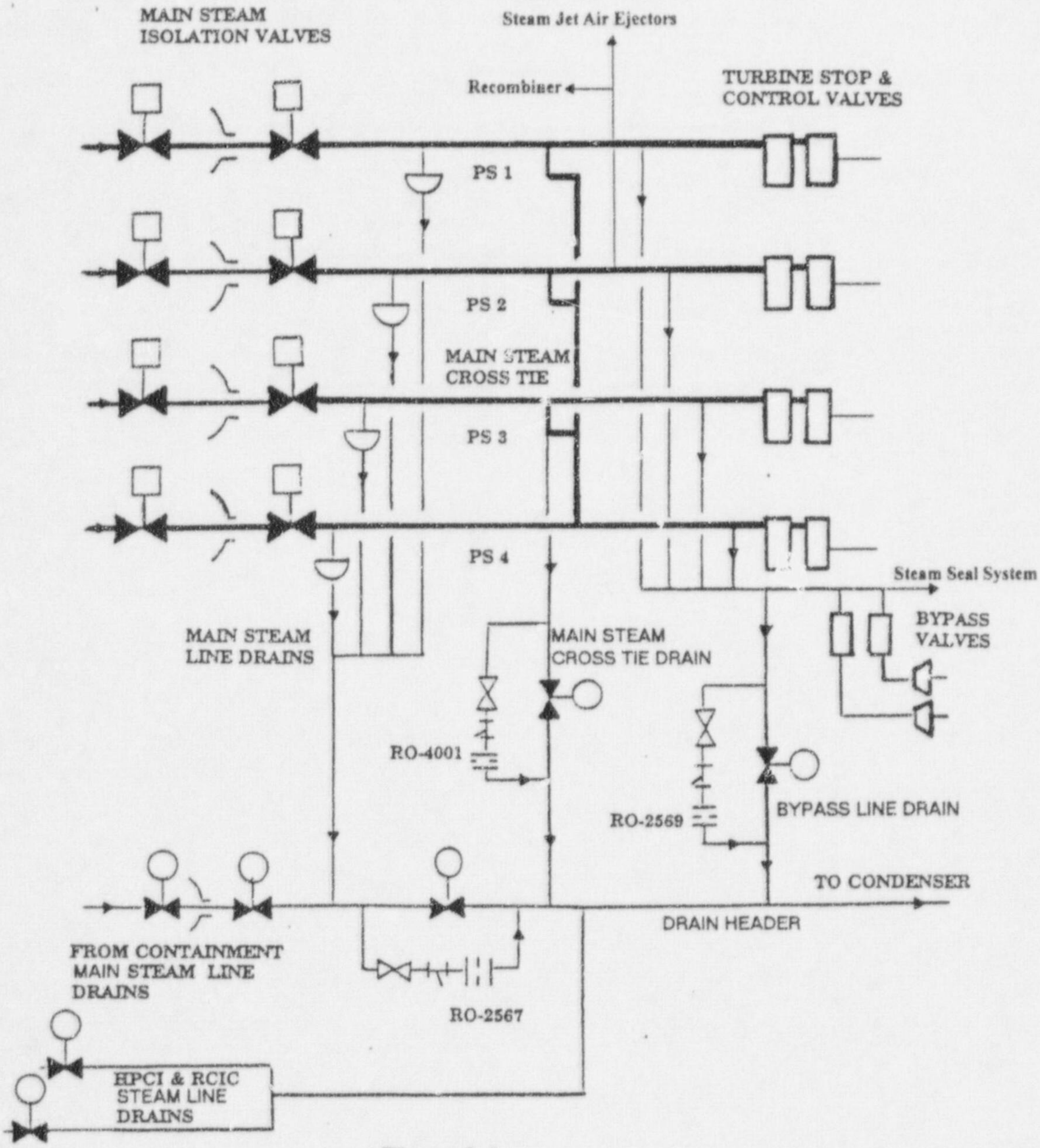


Figure 2-1

Monticello Main Steam Isolation Valve Leakage Pathways to the Main Condenser

Table 2-1: MSIV Piping Package List

Package	Piping System Description	Location
2913-1	Main Steam Drain	Condenser Bay/Steam Tunnel
2913-2	Main Steam Drains	Condenser Bay
2913-3	Pressure Equalizing Lines	Condenser Bay
2913-4	Piping from 10 P57-10-E to M 1617	Condenser Bay
2913-5	Pipe from Condenser Nozzle 8 to SJAE E-2B	SJAE/Pipe Tunnel/Cond. Bay
2913-6	Condenser Nozzle 8 to SJAE E-2B	SJAE/Pipe Tunnel/Cond. Bay
2913-7	RV33-6 -HB lines	SJAE/Pipe Tunnel/Cond. Bay
2913-8	RV34-6 -HB lines	SJAE/Pipe Tunnel/Cond. Bay
2913-9	MS to SJAE E-2A/E-2B	SJAE/Pipe Tunnel/Cond. Bay
2913-10	Air Injector Piping	SJAE Room
2913-11	T72 and T33 Tank Lines	SJAE/MPV/Hallway
2913-12	From SJAE to Tank T72 and Off Gas System	SJAE Room
2913-13	Off Gas Piping	Recombiner Bldg/Buried
2913-14	Off Gas Piping	Recombiner Bldg/Buried
2913-15	Drain Tank Feed and Discharge Lines	SJAE/MPV Rooms
2913-16	Off Gas Steam Tap Line	SJAE/Pipe Tunnel/Cond. Bay
2913-17	Off Gas Small Bore Piping	SJAE/MPV Rooms
2913-18	Off Gas Sample Line	Con. Bay/SJAE/MPV Rooms
2913-19	Off Gas Sample System	SJAE/MPV Rooms
2913-20	SHP System Steam Trap/Dryer	SJAE Room
2913-21	Recombiner Trains	Recombiner Bldg/Buried
2913-22	HPCI Pump Seal Lines	Reactor Building
2913-23	Gland Blower Discharge Line	Reactor Building
2913-24	MO-1739 Equalizing Line	Condenser Bay
2913-25	MO-4000 Equalizing Line	Condenser Bay
2913-26	Pressure Averaging System	Condenser Bay/Turbine Deck
2913-27-1	Steam Seal System, Section 1	Condenser Bay
2913-27-2	Steam Seal System, Section 2	Condenser Bay
2913-27-3	Steam Seal System, Section 3	Condenser Bay
2913-27-4	Steam Seal RV Drain Lines	Condenser Bay
2913-28	HPCI/RCIC Control Lines	Reactor Building
2913-29	Off Gas Blower Discharge	Buried/SJAE Room
2913-30	Hydrogen Water Chemistry System	Recombiner Bldg
2913-31	Main Steam Stop Valve Drains	Condenser Bay
2913-32	Bypass Valve Discharge Lines	Condenser Bay
2913-33	Backwash Tank Drain Line	Backwash Tank Room/Hallway
2913-34	Pump P-3 Feed/Discharge Pipe	MVP Room
2913-35	T72 Tank Drain/Control Lines	MPV Room
2913-36	SJAE Drain Lines	SJAE Room
2913-37	Various I&C Lines	SJAE Room/Condenser Bay
2913-38	V813 Tank Drain/Level Lines	Condenser Bay
2913-39	Feedwater Heater Steam Trap Drain Lines	Condenser Bay
2913-40	Misc Main Steam Drains and I&C Lines	Condenser Bay

Table 2-2: MSIV Leakage Path Equipment List

Equipment ID(s)	Description
17-104	SAMPLE CHAMBER
17-116	OFF GAS SAMPLE RACK
17-136	OFF GAS SAMPLE BOX
AO-1083A, AO-1083B	11 CDSR SUCT. ISOL.
AO-1084A, AO-1084B	12 CDSR SUCT ISOL
SV-1, SV-2, SV-3, SV-4	TURBINE HIGH PRESSURE STOP VALVES
CV-1242, CV-1243	SJAE STEAM SUPPLY
CV-2046A, CV-2046B	STEAM DRAIN TO MAIN CONDENSER
CV-2082A, CV-2082B	RCIC STEAM LINE DRAIN TO MAIN CONDENSER
CV-4164, CV-4165	HWC O_2 FLOW TO RECOMBINER CONTROL VALVE
E-1A, E-1B	HIGH PRESSURE, LOW PRESSURE CONDENSER
E-204	HPCI GLAND SEAL CONDENSER
E-2A, E-2B	AIR EJECTORS
E-4	STEAM PACKING EXHAUSTER
K-200	GLAND SEAL BLOWER
K-3A, K-3B	STEAM PACKING EXHAUSTER BLOWERS
LCV-7581	V-813 24" DELAY TANK VALVE
MO-1048, MO-1049	STM PACKING EXHAUSTER BLOWER DISCH VALVES
MO-2374	MAIN STEAM LINE DRAIN - OUTBOARD
MO-2564	STEAM LINE DRAIN DOWNSTREAM MSIVs
MO-2565	STEAM LINE DRAIN ORIFICE BYPASS
MO-1045	STEAM SEAL REG FEED VALVE
MO-4000	MAIN HEADER PRESSURE EQUALIZER DRAIN
MOIST-SEP	MOISTURE SEPARATOR
PCV-7489A, PCV-7489B	A RECMB TRAIN OG INLET VALVES
PCV-7496A PCV-7496B	OFFGAS BYPASS RETURN TO CONDENSER
PCV-7497A, PCV-7497B	OG STEAM SUPPLY VALVES
PCV-7498A, PCV-7498B	OG TRAIN STEAM SUPPLY VALVES
RV-1007, RV-1011	SAFETY/RELIEF VALVE
RV-1212, RV-1213	SAFETY/RELIEF VALVE
RV-1244, RV-1245	SJAE STEAM SUPPLY RELIEF VALVES
T-33	CONDENSATE BACKWASH RECOVERY TANK
T-72	SEPARATOR TANK
V-813	DRAIN COLLECTOR TANK
V-F-11	HIGH EFFICIENCY FILTER

3.0 Application of Experience Data

The staff and licensees have recently addressed seismic qualification of equipment in operating nuclear power plants as part of the resolution of Unresolved Safety Issue A-46. Subsequent evaluations demonstrated that many non-seismically designed structures, systems, equipment and components have substantial inherent seismic ruggedness. The Seismic Qualification Utility Group (SQUG) was formed in 1981 after an agreement with the NRC to develop alternative methods to resolve seismic safety issues for critical systems and components in operating nuclear stations. The primary method of equipment evaluation developed by SQUG and the staff uses empirical data from past earthquakes and from shake table tests (seismic experience data).

The seismic experience data approach includes the following objectives

Documentation of the most common causes of seismic damage or operational difficulties in facilities that contain structures, systems, equipment and components similar to those in nuclear stations.

Credible definition of the threshold of seismic motion for various types of documented earthquake damage and shake table tests.

Identification of structures, systems, equipment and components that typically are not damaged in earthquakes much larger than design basis earthquakes for nuclear stations and other facilities and in shake table tests. These data provide insights to actual seismic design margin.

Development of seismic integrity criteria that can credibly predict the performance of structures, systems, equipment and components in future earthquakes.

3.1 Experience Based Piping Capacity

Experience from past strong motion earthquakes at conventional power plant and industrial facilities indicates that piping systems designed to industrial standards are rugged and can resist earthquakes of at least 0.5 g peak ground acceleration (PGA) [1]. This experience data includes piping systems which were not specifically designed for seismic loads. For all strong motion earthquakes affecting power stations in the United States since 1952, the amount of piping system failures observed was a very small percentage (much less than 0.01 percent) of the total piping at risk. This leads to the conclusion that failure of piping in earthquakes is caused primarily by local conditions of weakness in the piping systems rather than global conditions of piping design or construction.

Local failures in piping systems can stem from the following.

- Relatively low piping flexibility in regions of relatively large displacements where piping is attached to building structures, massive equipment, or other piping.

- Low piping ductility associated with the use of cast iron, PVC or other low-ductility materials.

- Threaded pipe joints or other regions of reduced cross section with sharp corners susceptible to fatigue, ratchet cracking, or rupture when subjected to cyclic seismic loads.

- Regions of degraded pipe caused by corrosion or erosion.

- Weak joints associated with friction type connections, or weak joints or repairs which result from poor welding.

- Failure of piping associated with loss of non-ductile pipe supports.

For this effort, walkdown evaluations compared the subject piping systems to piping systems which have actually experienced strong motion earthquakes (experience data) to verify the seismic adequacy of the main steam piping leakage path. This process differs from the practice used historically in the nuclear power industry where the seismic adequacy of piping systems has been determined by analysis explicitly using computer modeling techniques. The results of the screening evaluation process work have been benchmarked against computer analysis results, which also demonstrate that the screening methodology can reliably be used to demonstrate the seismic adequacy of piping systems. This method utilizes a capacity vs. demand spectrum comparison, augmented by extensive walkdowns, worst-case calculations, and documentation to insure acceptable piping spans, piping support configurations, design attributes, and the absence of known seismic vulnerabilities.

The capacity spectra that were used in the establishment of the piping seismic capacity were based on the experience surveys and evaluations conducted in Reference [1]. Damage surveys at the facilities investigated indicated a very low piping failure (<0.01%) and concluded that this failure rate was a result of isolated local weakness in piping systems which could be best screened by an in-plant walkdown. Reference [1] provides a seismic database from 123 sites occurring over 25 different earthquakes. The peak ground acceleration (PGA) estimates far exceed Monticello's design basis PGA of 0.12g for all but one site (Cachi Dam, Valle de Estrella Costa Rica earthquake) for which the PGA was 0.12g.

Figure 3-1 shows selected ground acceleration response spectra plotted against the MNGP SSE ground spectrum from three documented earthquakes occurring in California. These include the 1971 San Fernando (Valley Steam Plant – USGS Estimate), the 1979 Imperial Valley (El Centro Steam Plant), and the 1989 Loma Prieta (Moss Landing). The Valley Steam Plant record was obtained from Reference 8 and the remaining records are from Reference 1. All of these earthquakes produced ground motions well in excess of the MNGP SSE ground spectrum.

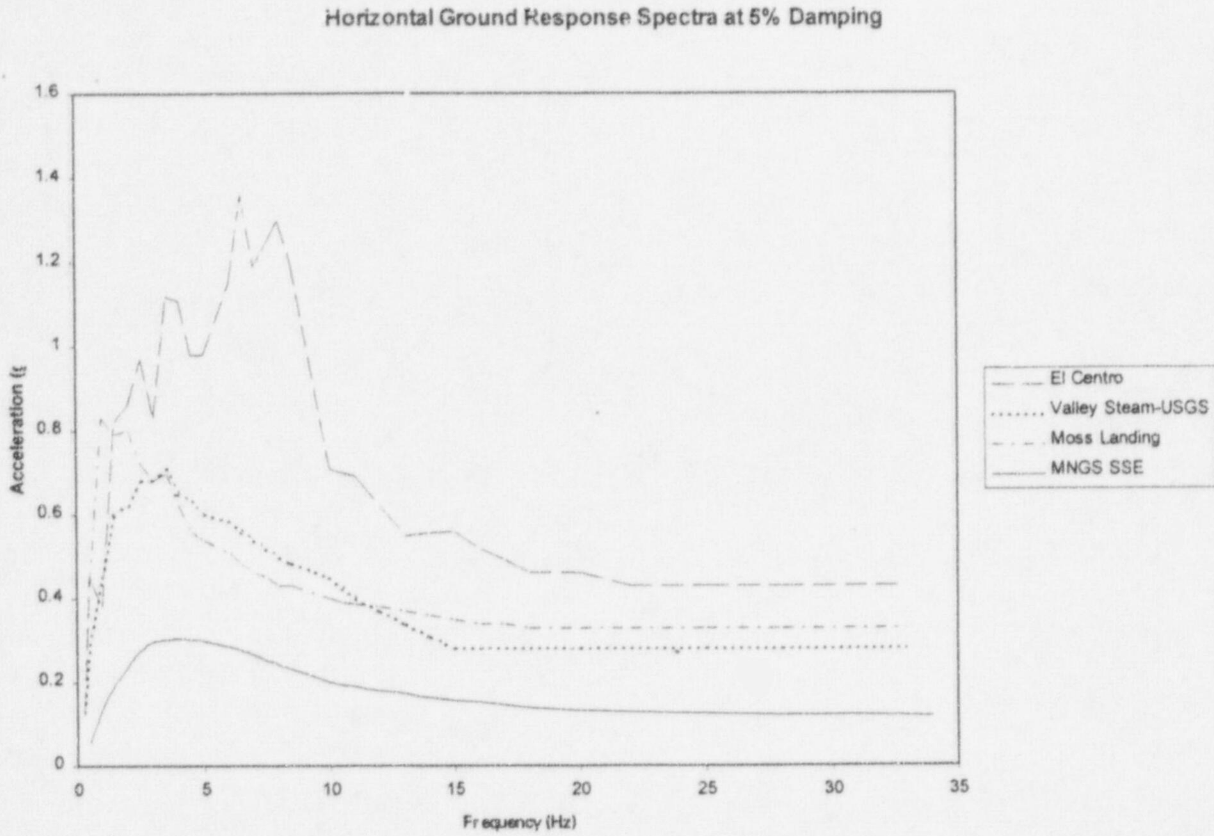


Figure 3-1: Selected Spectra from References [1], [8] vs MNGP SSE Ground Spectrum

Figure 4.1 of Appendix D of Reference [1] presents ground spectra at several of the survey sites and also shows the MNGP Design Response Spectrum.

Appendix D of Reference [1] describes the review and survey of piping experience data in relationship to main steam piping and condensers

3.2 Experience Based Condenser Capacity

An evaluation of the seismic ruggedness of condensers and condenser anchorage for GE BWR plants is reported in Reference [1]. 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 data revealed the GE plant designs are similar to those that exhibited good earthquake performance. The study concluded that a failure and significant breach of pressure boundary in the event of a design basis earthquake is highly unlikely and contrary to a large body of historical experience data. The conclusions of that study were verified by detailed comparison of the Monticello condenser configuration to the earthquake experience data. The comparison included a detailed evaluation of the Monticello condenser anchorage capacity.

3.3 Experience Based Capacity of Related Equipment

Other equipment in the scope of the leakage path review includes valves, instruments, and tanks which are referred to as *Related Equipment* in this report. The SQUG GIP methodology, documented in reference 2, is well suited to address the seismic adequacy of the equipment listed above. The GIP provides a formal procedure for evaluating these classes of equipment against the earthquake experience data. The GIP has been reviewed by the NRC as documented in Ref. 3. The implementation of the GIP procedure at Monticello is documented in Reference [4].

Figure 3-2 shows the GIP Reference Spectrum, the GIP Bounding Spectrum, and the MNGP SSE ground spectrum. Figure 3-2 shows that the MNGP SSE spectrum is well bounded by the GIP Spectrum.

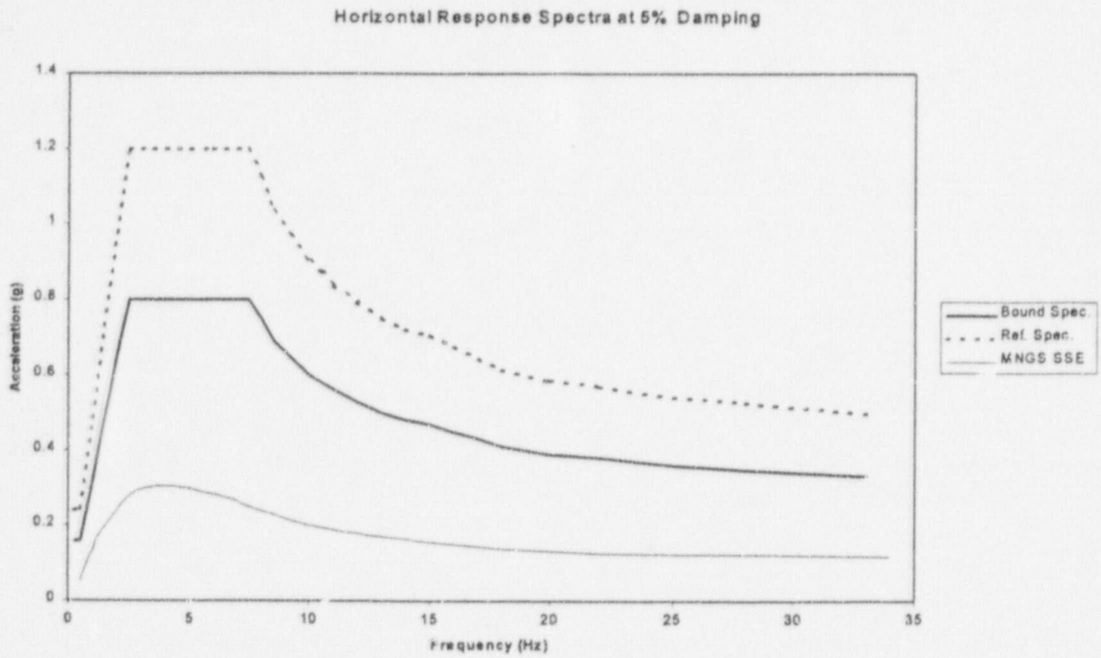


Figure 3-2: GIP Bounding Spectrum, GIP Reference Spectrum and MNGP SSE ground spectrum

4.0 Seismic Evaluation Methodology

4.1 Piping and Supports

The evaluation of piping included the following.

Walkdowns of the piping systems and associated supports which included identification of items judged to have inadequate seismic capacity, worst case pipe supports, and items requiring limited analytical reviews.

A comparison of piping system demand versus experience-based capacity.

Limited analytical reviews and pipe support evaluations for piping systems identified during the walkdowns.

Generation of Piping System Seismic Screening Work Sheet (PSSSWS), a formal method of documenting the walkdown, the limited analytical reviews, the worst case support evaluations, and the final seismic capacity evaluation.

The sections below provide details on the piping and support evaluations.

4.1.1 Comparison to the Experience Data

Piping Considerations

The leakage path piping was compared to the piping in the experience data to insure the piping systems fall within the database contained in Reference [1] and within the ANSI B31.1 Power Piping Code. Key parameters in the comparison include the following.

(a) Piping is fabricated and designed to B31.1, B31.3 or ASME BPVC Section III.
(b) Piping sizes and materials fabrication fall within experience data.
(c) Piping support vertical and lateral span ratios fall within the data base assumed by verifying the following span criteria below are met. These span criteria were based on a review of the data in reference [1].

For Welded Steel Pipe:
- Vertical Spans are less than (1.5) times the suggested B31.1 Deadweight Spans.
- Horizontal Spans are less than six times the suggested B31.1 Deadweight Spans.

For Threaded Steel Pipe:
- Vertical Spans are less than (1.5) times the suggested B31.1 Deadweight Spans.
- Horizontal Spans are less than four times the suggested B31.1 Deadweight Spans.

(d) Piping operating pressures and temperatures fall within the experience data.
(e) Piping does not exhibit known failure modes or areas of potential weakness.
(f) Piping support system is adequate, consistent with the piping systems in the experience data, and would be expected to exhibit a ductile failure mode.

A comparison to the experience data was performed for the Monticello leakage path piping and is documented in Section 5 herein. For that comparison, materials, sizes, spans, and temperature ranges were compared to piping in the experience data to verify that the Monticello piping is adequately represented in the experience data.

Equipment Considerations.

In many instances, piping systems terminate at mechanical equipment such as pumps and tanks. There are three items of concern at these equipment piping interface locations.

(a) Anchorage of the equipment

(b) Nozzle loads applied to the equipment by the piping

(c) Equipment displacements applied to the piping system.

The walkdown procedure requires that the Seismic Review Team (SRT) address these concerns. The SRT members were qualified in accordance with applicable industry criteria.

4.1.2 Limited Analytical Review of Piping and Supports

This section defines the capacity criteria that was used in the limited analytical reviews of piping systems and in the evaluation of worst case supports. The capacity criteria is a stress-based criteria, and the demand criteria is in terms of an applicable input seismic excitation level. For specific analytical reviews such as Rod Hanger Fatigue reviews, a different Demand/Capacity criteria is used and is defined in the applicable analytical review package. For piping systems for which limited analytical reviews or analyses were conducted the capacity criteria below was used:

$$P + .75 * i * [(M_A/Z)] \leq 1.0\ S \qquad (4.1)$$

$$P + .75 * i * [(M_A/Z) + (M_{BI}/Z)] \leq 2.4\ S \qquad (4.2)$$

$$i * [M_C/Z + M_{Bsam}/Z] \leq 2\ S_A \qquad (4.3)$$

P = Pressure Loadings
M_A = Applied Moments Due to Deadweight Loadings
M_{BI} = Applied Moments due to SSE seismic Inertial Loadings
M_{Bsam} = Range of Applied SSE Moments due to Seismic Anchor Motion (SAM) Loadings
M_C = Range of Applied Moments due to Thermal Expansion and Thermal Anchor Motions
Z = Piping Section Modulus
S = Allowable Primary Stress limit per the B31.1 Code
S_A = Allowable Expansion Stress range per B31.1 Code
i = Stress intensification factor as defined in the B31.1 Code

Equation 4.1 is the standard deadweight allowable stress equation per the B31.1 Power Piping Code. In equation 4.2, S is the basic allowable material stress per the B31.1 Power piping Code which is the lesser of 5/8 Sy (2/3 Sy in later code editions) or Su/4. The majority of the piping under review is A-106B Carbon steel pipe which has S=15000 psi, Sy=35000 psi and Su=60000 psi. Therefore Equation 4.2 limits the Pressure + Deadweight + Seismic Inertial Stresses to less than 1.03 Sy which insures elastic behavior. Equation 4.3 addresses self-limiting, secondary stress, where S_A for carbon steel pipe is approximately 1.5 S which is approximately 22,500 psi, and therefore 2.0 S_A is approximately 1.2 Sy.

The piping support acceptance criteria used in the worst case support evaluation is as follows:

(a) Structural Steel

DWT+TH $\leq$ 1.0 AISC Allowable (4.4)
DWT+TH+SSE (Inertia and SAM) $\leq$ 1.7 AISC Allowable (4.5)

(b) Component Supports

DWT+TH $\leq$ 1.0 ANSI/MSS SP-58 Allowable (4.6)
DWT+TH+SSE (Inertia and SAM) $\leq$ 1.7 ANSI/MSS SP-58 Allowable (4.7)

This will insure that the maximum stresses in the support members are at or slightly less than the material yield stress. In many of the MNGP calculations a factor of 1.6 was used in lieu of 1.7. This adds additional conservatism to the calculations and support evaluations. The 1.7 is based on the Part II allowables of the AISC Steel Construction Manual.

4.2 Condenser

The seismic adequacy of the Monticello condenser was verified by reference to the BWROG report on MSIV leakage [1]. In Appendix D of reference 1, the seismic demand at earthquake experience sites with condensers was compared to seismic demand at GE BWR sites including Monticello. Condensers of similar configuration to Monticello experienced strong motion in excess of the Monticello design basis earthquake without failure. Reference 1 concluded that a condenser failure from a design basis earthquake at any GE BWR site was highly unlikely. In addition, the adequacy of the Monticello specific condenser configuration was verified by a comparison of the Monticello condenser to the earthquake experience data and by an evaluation of the Monticello condenser anchorage capacity.

4.3 Related Equipment Capacity

The seismic adequacy of related equipment was verified using the GIP methodology as detailed in reference 2. Seismic capacity, caveat compliance, anchorage, and seismic spatial interaction concerns were addressed. The GIP Bounding Spectrum that was obtained from earthquake experience data was used to establish seismic capacity of all related equipment.

The majority of the related equipment are valves located at the lower elevations. Valve operability is not a concern for Monticello because all of the valves in Table 2-2 are not required to reposition to establish the leakage path or fail safe with respect to the leakage path. Since there is no reliance on standby power, none of the motor-operated valves were credited for operation.

4.4 Related Building Capacity

The equipment and piping are confined to three buildings: the Reactor building, the Turbine building and the Recombiner building. The Reactor building is a Class 1 structure and has been designed to withstand the earthquake loads associated with the Monticello SSE. The Recombiner building was designed and built for seismic Class I conditions; however, the design criteria for this building was later downgraded to Class II in accordance with Regulatory Guide 1.143. See Section 12.2.2.9 of the MNGP USAR [6]. Portions of the Turbine building are also Class I (e.g., switchgear room) and have been designed to withstand the effects of the SSE where the applied accelerations are those from equivalent elevations of the Reactor building. See Section 12.2.1.9 of the MNGP USAR [6].

The Reactor building equivalent elevation accelerations were used because an explicit dynamic model of the Turbine building was not developed. The Class I portions of the Turbine building are within the reinforced concrete structure of the building. Consequently, the reinforced concrete portion of the structure may be considered to be designed to Class I requirements even though the USAR only designates specific rooms and areas as Class I. All of the piping is located within the concrete portion of the Turbine building. The equipment is located in the concrete portion of the Turbine building with the exception of a few instruments which are located at the operating floor of the Turbine building (elevation 951'). The Turbine building above elevation 951' is a steel superstructure and is classified as Class II; however, the superstructure was also seismically evaluated for the Reactor building SSE equivalent elevation accelerations. See Section 12.2.1.4 of the USAR [6].

4.5 Seismic Demand

All items in the leakage pathway were evaluated for the SSE demand. The SSE ground response spectrum is identified in the MNGP Updated Safety Analysis Report. The MNGP SSE ground response spectrum is shown in Figure 3-1. The corresponding SSE horizontal peak ground acceleration (PGA) is 0.12g. The vertical demand was taken as 2/3 of the horizontal demand. The sections below describe SSE input for equipment in the leakage path.

4.5.1 Piping Seismic Demand

<u>Comparison of Demand To Experience-Based Capacity Spectrum</u>

The majority of the piping is located in the Turbine Building, Recombiner Building or buried. A small amount of the piping is located in the Reactor Building including the Steam Tunnel. The demand spectrum for piping in the Turbine Building, Recombiner Building, and buried piping is the 5% damped MNGP SSE design basis ground

Response Spectrum (Figure 3-1). Based on the comparison of experience based spectra contained in References 1 and 8, the capacity spectra all envelop the MNGP SSE ground spectrum with significant margin. The demand spectrum for piping in the Reactor Building was the 5% damped amplified floor response at the applicable elevation.

Limited Analytical Reviews of Piping

For limited analytical reviews of piping in the Turbine Building and the Recombiner building (all of which is less than 40' above grade) when dynamic analysis is applied, the horizontal piping demand is based on the 5% damped MNGP ground response spectrum shown in Figure 3-1 multiplied by a factor of 1.5. This method for estimating median-centered amplified floor spectra was used because amplified floor response spectra for these buildings at Monticello does not exist. The vertical demand is 2/3 of the horizontal demand. The resulting spectra were considered to be acceptable for the following reasons.

(a) The ground response spectrum is the licensing basis spectrum for the plant.

(b) The piping which is located at elevations less than 40' above grade is in a concrete shear wall building, and the largest majority of this piping is below grade near the building foundation. Consequently, no significant building amplification of the design basis ground response spectrum would be anticipated.

(c) The Monticello floor spectra are classified as "Conservative Design" spectra by the staff [4].

For limited analytical reviews of piping systems when static analysis techniques are applied, the demand static load coefficient was 1.5 times the peak of the ground response spectrum in the horizontal direction and 1.5 times two-thirds of the peak of the ground response spectrum in the vertical direction.

For piping in the reactor building the horizontal demand was based on the applicable 5% damped amplified floor response spectrum and the vertical demand was 2/3 of the horizontal demand.

Limited Analytical Review of Buried Piping System

For the evaluation of buried piping systems, the seismic demand is the design basis SSE ground response spectrum.

Worst Case Support Reviews

Seismic loads for use in worst case support reviews are determined as follows.

(a) The span length of piping which would be expected to be restrained by the support in question was determined. This span length included an additional equivalent length of piping for included valves, or other in-line components.

(b) The total weight per unit length of piping considering pipe material weight, fluid weight, insulation weight, and any other weights in the piping system was determined.

(c) For determination of horizontal loads the value determined in (b) was multiplied by the peak of the applicable horizontal response spectrum. For vertical loads 2/3 of the horizontal value was used. The applicable horizontal spectrum for all piping except that in the reactor building was 1.5 times the 5% damped ground response spectrum. For the reactor building, the applicable amplified floor response spectra was used.

4.5.2 Condenser Demand Spectra

The Monticello condenser is located below grade at the lowest level of the Turbine Building (Elevation 911). The applied seismic demand was the SSE ground spectrum shown in Figure 3-1.

4.5.3 Related Equipment Demand Spectra

Applied seismic demand for related equipment is based on the SSE ground spectrum shown in Figure 3-1 and the corresponding Floor Response Spectra (FRS). Consistent with the Monticello USAR [6], the Reactor Building FRS at an equivalent elevation is used to define the FRS for equipment in the turbine and recombiner buildings. These FRS were also used for USI A-46 resolution and were judged to be "conservative design" spectra when used with the GIP [4]. In addition and consistent with the GIP methodology, 1.5 times the ground spectrum was optionally used as "realistic, median centered" demand for some equipment items meeting the GIP 40-foot-above-grade elevation limitation and the 8 Hertz lower bound frequency limitation. This was only done for equipment at or below grade. As with the piping, the largest majority of the equipment is located at the lowest elevations in the buildings.

5.0 Summary of Seismic Evaluation Results

5.1 Piping and Supports

5.1.1 Results Summary

The piping material data, size, and schedules were obtained from piping and instrument diagrams (P&IDs) and line specifications. The line specifications also provide the design pressure and temperature data. Exceptions to the above were the GE supplied Steam Seal System and Moisture Separator Systems. Material and pipe size data for this system was taken from GE documents. The main steam lines between the MSIVs and the main turbine have been previously evaluated to meet the requirements of Class I loading which includes SSE loads.

The walkdowns evaluated the seismic capacity of the subject piping system. As part of the walkdown, pipe supports, equipment supports and other modifications to reduce the seismic vulnerability of piping systems being screened were specified. These modifications were then considered in the evaluation of the acceptability of the piping systems. If necessary a detailed evaluation and verification calculation was conducted for the as-built modifications.

Worst case supports were identified, and detailed evaluations were conducted for these supports. Rod hangers susceptible to fatigue failure, "hard spot" short rod hangers, and U-bolts subjected to significant lateral loads were identified. Detailed evaluations were conducted to evaluate both the fatigue capacity of the rod hangers and the lateral load capacity of the U-bolts. See section 5.1.4 for a summary of these qualifications.

The downstream side of the steam seal system was determined to be the worst case piping system based on the size of the system and its support configuration. For this system a detailed analysis using the criteria of ASME BPVC, Appendix N was conducted. In addition, limited analytical reviews were conducted for portions of other piping systems which could be considered outside the screening criteria, which involved complex spatial interactions, or for which a highly accurate prediction of piping support loads was required. One worst-case analytical review was conducted for all buried piping systems. See section 5.1.3 for a summary of these analyses.

5.1.2 Correlation with the Piping Experience Data

After completion of the piping system walkdowns, evaluations were conducted to insure that the Monticello piping systems fall within the range of the piping systems which constitute the experience data.

<u>Piping Sizes</u>

Table 5-1 presents a summary of the various piping, sizes, schedules and D/t ratios for each of the walkdown packages. Table 5-2 presents a general summary of the same data for the piping systems which constitute the experience data. More detailed summaries of the piping and the associated experience data are contained in Reference [1]]. Table 5-3 presents a comparison of the D/t ranges of the

Monticello piping to the experience data piping. The Monticello 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 3-1/2" and 5" diameter piping.
2. The Monticello 1" piping has lower bound D/t of 4 versus 5 in the experience data.
3. The Monticello 24" piping has lower bound D/t ratio 20 versus 23 in the experience data.
4. The 18" Monticello piping has an upper bound D/t ratio 48 versus 43 in the experience data.

For items (2) and (3), 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 are not a concern. For (4), the exceedance is only 12 percent which is less than typical piping system fabrication tolerances. Therefore, this piping is adequately represented in the experience data. The 3 1/2" diameter piping and the 5" diameter, although not explicitly in the database, are enveloped by larger and smaller sizes. In addition, the 5" and 3 1/2" piping is in the steam seal system that was analyzed in detail. Therefore, this piping is adequately enveloped by the experience data and the supporting analysis.

Materials

Table 5.4(a) provides a summary of the allowable stress capacity of the predominant piping materials of the experience data piping. Table 5.4(b) provides a similar summary for the Monticello piping. These tables demonstrate that the Monticello piping in leakage path is adequately represented in the experience data piping.

Support Spans

Table 5.5 provides a summary of minimum and maximum ratios of the actual vertical support spans to the suggested ANSI B31.1 deadweight spans and the actual lateral support spans to the suggested ANSI B31.1 spans. Table 5.6 provides the suggested B31.1 deadweight support spans. Figures 5-1 through 5-4 compare the Monticello piping maximum span ratios, Vertical Support Ratio (VSR) and Lateral to Vertical Support Span Ratio (LVSSR) to the experience piping span ratio data. These figures demonstrate that the Monticello piping support spans are well represented and adequately enveloped by the piping experience data.

5.1.3 Summary of the In-depth Piping Analyses

This section provides a summary of the simplified and detailed piping analysis which were conducted for selected systems in the MSIV leakage path. Detailed dynamic computer based piping analyses were conducted for several piping systems. The criteria used in these piping evaluations and qualifications are given in section 4.1.2. Table 5.9 provides a summary of these analyses and the associated bases.

In addition to detailed dynamic piping analyses described in Table 5.9, localized equivalent static analyses were used to (1) evaluate SAMs, (2) evaluate spatial interaction concerns (3) evaluate localized areas of seismic vulnerability and (4) to determine loads used in the detailed support evaluations. Table 5.10 provides a summary of the equivalent static analyses conducted.

The steam seal discharge system piping was selected as the worse case piping system and required a detailed analysis. This was based on several factors including amount of piping, pipe size variety, flexibility, and large in line equipment. judgment with the following considerations.

A detailed enveloping dynamic analyses was conducted for buried portions of the piping systems contained in six of the walkdown packages. These analyses included Soil Structure Interaction effects for the Turbine, Reactor, and Recombiner Buildings and evaluated both displacement effects and wave passage effects.

5.1.4 Summary of Detailed Support Qualifications

Detailed Support Qualifications were based on identifying or establishing worse case supports during the walkdowns. The basis for the determination of these worst case supports included the following concerns.

(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. In many cases a system may contain multiple U-Bolts that could experience significant lateral loads. In such cases one or two enveloping evaluations for such a system were conducted.

(3) Supports that were judged to be the most susceptible to failure during a design basis seismic event based on field review.

(4) Supports on piping systems for which detailed seismic analyses were conducted.

Table 5.11 provides a summary of the number of supports subjected to detailed analytical reviews and the basis of these reviews. These supports represent approximately 15% of the support population in the MSIV leak path. In addition, these supports are most susceptible to failure during a design basis seismic event. By demonstrating the acceptability of these supports, it is reasonable to assume that the supports for the MSIV leak path piping has adequate seismic capacity.

5.1.5 Results

The results and outlier resolution for piping and supports is listed in Table 5-8.

5.2 Condenser

Table 5-7 lists design data for the Monticello condenser and for the two experience data sites listed in Reference [1], Appendix D, Table 4-3 (Moss Landing 6 & 7, and Ormond Beach 1 & 2). The Monticello condenser design data is similar to or bounded by data for the two experience data sites. The Monticello SSE ground spectrum, which is the demand spectrum for the condenser, is enveloped by the Moss Landing and Ormond Beach spectra. The Monticello condenser design data is also well represented by the data presented in Reference [1], Appendix D, Table 4-3. The comparison verifies that the results of the Reference [1] evaluation for structural integrity are applicable to the Monticello condenser.

The Monticello condenser anchorage consists of eight guided supports with one support located at each corner of the two condenser shells. At each support, the condenser base bears against a steel plate shear lug that is welded to an embedded sole plate. The shear lugs rigidly resist lateral loads but are arranged to allow thermal growth. Three 1.75 inch diameter cast-in-place anchor bolts are also located at each support (24 total). These bolts resist vacuum uplift loads. Companion bolt holes in the condenser base are 2.75 inches in diameter to allow for thermal growth. Figures 5-5 and 5-6 show guided support layout and details.

By Appendix D of Ref. 1, GE evaluated lower and upper bound anchorage capacities of experience data and GE BWR condensers. For this evaluation, two capacity levels specific to the Monticello condenser were determined by detailed calculation for rigid and ductile behavior. Capacities were derived from equations for capacities of anchorage elements defined in codes such as AISC Manual of Steel Construction, ACI-349. Capacities were defined in terms of allowed lateral acceleration. The calculations conservatively assume that cast-in-place bolts will not resist load in combination with the shear lugs. This is conservative because the condenser has oversized bolt holes and the potential non-ductile failure of shear lugs.

For Monticello, a rigid-behavior anchorage capacity was obtained by crediting only the shear lug load path at a support. Based on a detailed evaluation, the rigid-behavior capacity of the condenser anchorage was determined to be 0.15g. The capacity is controlled by the direction transverse to the turbine axis. The shear lug load path capacity parallel to the turbine axis is 0.16g. A ductile-behavior anchorage capacity was obtained by crediting only the cast-in-place anchor bolts. The shear lug load path was assumed to fail in a brittle manner prior to bolt engagement and is given no credit in the ductile-behavior calculation. Based on detailed evaluation, the ductile-behavior capacity of the condenser anchorage transverse to the turbine axis was determined to be 0.24g. Parallel direction capacity is similar to transverse direction capacity. The rigid-behavior capacity of 0.15g exceeds the SSE PGA of 0.12g. The condenser shells are squat steel plated box structures with substantial internal stiffening, and the condenser is considered to be effectively rigid. Therefore rigid-behavior capacity exceeds SSE demand of 0.12g.

The Monticello lower and upper bound shear areas for the transverse direction are 0.000078 and 0.00021 square inches per pound respectively. The values for the parallel direction are 0.00010 and 0.00023 square inches per pound respectively. These values are above corresponding values for the experience data sites shown in Figures 4-10 and 4-11 of Appendix D of Ref. 1

The comparison of condenser data and the anchorage capacity evaluations demonstrates that the conclusions presented in Reference [1], Appendix D can be applied to the Monticello condenser. That is, a failure and significant breach of the condenser pressure boundary in the event of a design basis earthquake is highly unlikely and contrary to the experience data.

The condenser was also subject to a walkdown inspection which was summarized in a Screening Evaluation Work Sheets (SEWS). Some surface cracking of embedment grout was observed at support locations. The condenser was declared an outlier pending repair of the grout. This grout was repaired during the recent refueling outage at Monticello.

5.3 Related Equipment

The condenser and the majority of related equipment were walked down. A Screening Evaluation Work Sheet (SEWS) was completed for each item. Each SEWS contains a capacity versus demand comparison, a checklist of bounding spectrum caveats, an anchorage review checklist, a spatial interaction checklist, notes, and attached pictures (if available). The SEWS identify the determination of whether the item is acceptable or is an outlier and are signed by the SRT. The list of related equipment is provided in Section 2. Table 5-8 contains a list of equipment outliers and the associated resolution.

The majority of the related equipment are valves. All valves were found to meet GIP screening criteria. Valve operability is not a concern because all of the valves in Table 2-2 are passive in the case of motor-operated valves, or fail safe as in the case of air- and solenoid-operated valves.

Table 5-1: Summary of Piping Properties for the Monticello Leakage Path Piping

Walkdown Package	Pipe Size NPS (in)	Pipe Schedule	Pipe OD (in)	Pipe Wall (in)	OD/t	Material ASTM/ASME Designation
2913-1	6	80	6.625	0.432	15	A106B
	3	80	3.5	0.3	12	A106B
	1	160	1.315	0.25	5	A106B
2913-2	10	80	10.75	0.593	18	A106B
	2	160	2.375	0.344	7	A106B
	1-1/2	160	1.9	0.281	7	A106B
2913-3	18	80	18	0.938	19	A672, Gr. 70
	10	80	10.75	0.593	18	A672, Gr. 70
2913-4	4	80	4.5	0.337	13	A106B
2913-5	16	STD	16	0.375	43	A53B/A106B
	12	STD	12.75	0.375	34	A53B/A106B
	10	STD	10.75	0.365	29	A53B/A106B
2913-6	16	STD	16	0.375	43	A53B/A106B
	12	STD	12.75	0.375	34	A53B/A106B
	10	STD	10.75	0.365	29	A53B/A106B
2913-7	6	40	6.625	0.28	24	A53B/A106B
	3/4	80	1.05	0.154	7	A53B/A106B
2913-8	6	40	6.625	0.28	24	A53B/A106B
	3/4	80	1.05	0.154	7	A53B/A106B
2913-9	3	160	3.5	0.438	8	A106B
	3	STD	3.5	0.216	16	A53B/A106B
	2	160	2.375	0.344	7	A106B
	1	80S	1.315	0.179	7	304SS
	1	80	1.315	0.179	7	A53B/A106B
2913-10	6	80	6.626	0.432	15	CS(1)
2913-11	18	STD	18	0.375	48	A53B/A106B
	12	STD	12.75	0.375	34	A53B/A106B
	10	40	10.75	0.365	29	A53B/A106B
	8	40	8.625	0.322	27	A53B/A106B
2913-12	6	160	6.625	0.718	9	A106B
	6	120	6.625	0.562	12	A106B
	6	80	6.625	0.432	15	A106B
	4	80	4.5	0.337	13	A106B
2913-13	24	80	24	1.22	20	SA106B
	6	120	6.625	0.562	12	SA106B
	4	120	4.5	0.438	10	SA106B
2913-14	6	120	6.625	0.562	12	A106B
	4	120	4.5	0.438	10	A106B
2913-15	3	160	3.5	0.438	8	A106B
	2	XXH	2.375	0.436	5	A106B
	1	XXH	1.315	0.358	4	A106B
2913-16	4	120	4.5	0.438	10	A106B
	3	160	3.5	0.438	8	A106B

Table 5-1: Summary of Piping Properties for the Monticello Leakage Path Piping

Walkdown Package	Pipe Size NPS (in)	Pipe Schedule	Pipe OD (in)	Pipe Wall (in)	OD/t	Material ASTM/ASME Designation
2913-17	1	160	1.315	0.25	5	A106B
2913-18	1	160	1.315	0.218	6	A106B
	1	160	1.315	0.218	6	A312-304L
	1/2" Tubing	N/A	0.625	0.049	13	A312-304
	1/2" Tubing	N/A	0.625	0.049	13	A376-316
2913-19	1	80	1.315	0.179	7	A106B
	1	80	1.315	0.179	7	A312-304
	1/2" Tubing	N/A	0.625	0.049	13	A312-304
	1/2" Tubing	N/A	0.625	0.049	13	A376-316
2913-20	1	XXH	1.315	0.358	4	SA106B
	1/2	XXH	0.84	0.294	3	SA106B
2913-21	4	120	4.5	0.438	10	SA106B
2913-22	1	80	1.315	0.179	7	A106B
	3/4	160	1.05	0.219	5	A106B
2913-23	3	40	3.5	0.216	16	A53B/A106B
	3	40	3.5	0.216	16	A312-304L
2913-24	1	160	1.315	0.25	5	A106B
2913-25	1-1/2	160	1.9	0.281	7	A106B
	1	160	1.315	0.25	5	A106B
2913-26	2	40	2.375	0.154	15	SS(2)
	1-1/2	40	1.9	0.145	13	SS(2)
	1	40	1.315	0.133	10	SS(2)
	3/4	40	0.75	0.113	7	SS(2)
	1/2" Tubing	N/A	0.625	0.035	18	SS(2)
2913-27-1,-2,-3	16	40	16	0.5	32	CS(1)
	12	40	12.75	0.406	31	CS(1)
	10	80	10.75	0.593	18	CS(1)
	10	40	10.75	0.365	29	CS(1)
	8	40	8.625	0.322	27	CS(1)
	6	80	6.625	0.432	15	CS(1)
	6	40	6.625	0.28	24	CS(1)
	5	80	5.563	0.375	15	CS(1)
	5	40	5.563	0.258	22	CS(1)
	4	40	4.5	0.237	19	CS(1)
	3-1/2	80	4	0.3	13	CS(1)
	3	40	3.5	0.216	16	CS(1)
	2	40	2.375	0.154	15	CS(1)
	1-1/2	40	1.9	0.145	13	CS(1)
	1	40	1.315	0.133	10	CS(1)
2913-27-4	1-1/2	40	1.9	.145	13	CS(1)
	3/4	40	1.050	.113	9	CS(1)
2913-28	1-1/2	160	1.9	0.281	7	A106B
	1	160	1.315	0.25	5	A106B
2913-29	14	STD	14	0.375	37	A53B/A106B
	10	40	10.75	0.365	29	A53B/A106B

Table 5-1: Summary of Piping Properties for the Monticello Leakage Path Piping

Walkdown Package	Pipe Size NPS (in)	Pipe Schedule	Pipe OD (in)	Pipe Wall (in)	OD/t	Material ASTM/ASME Designation
	3	40	3.5	.216	16	A53B/A106B
	1-1/2	80	1.9	.2	10	A53B/A106B
2913-30	3/4	XXH	1.050	.308	3.5	A106B
	3/4	XXS	1.050	.308	3.5	B42-Copper
	1/2	XXS	.840	.294	3.0	B42-Copper
	1/4	XXS	.540	.119	4.5	B42-Copper
2913-31	1	40	1.315	.133	10	CS(1)
2913-32	8	100	8.625	.593	14.5	A106B
2913-33	6	40	6.625	.28	24	A106B
	2	80	2.375	.218	11	A106B
2913-34	1-1/4	40	1.660	.140	12	A106B
	5	40	5.563	.258	21.5	A106B
	5	40	5.563	.258	21.5	Cast Iron (3)
2913-35	2	80	2.375	.218	11	A106B
	1	80	1.315	.179	7.5	A106B
	1/2	80	.840	.147	6	A106B
2913-36	2	80	2.375	.218	11	A106B
2913-37	3/4	80	1.050	.154	7.0	A106B
	1/2 - Tubing	.065" Wall	.5	.065	7.7	SS(2)
	5/8 - Tubing	.065" Wall	.625	.065	9.5	SS(2)
	5/8 - Tubing	.065" Wall	.625	.065	9.5	A213-304L
2913-38	3/4	80	1.050	.154	7.0	A106B /A312-304L
	3/8 - Tubing	.065	.375	.065	5.8	SS(2)
2913-39	6	.375 Wall	6.625	.375	17.5	A106B/A312-304L
	3	40	3.5	.216	16	A106B/A312-304L
	3/4	80	1.050	.154	7	A106B/A312-304L
2913-40	3/4	160	1.050	.218	5	A106B
	1/2 - Tubing	.065" Wall	.5	.065	7.7	SS(2)

(1) CS = Carbon Steel Pipe;

(2) SS = Stainless Steel Pipe

(3) Cast Iron was Fittings Only and Limited Analytical Review was Conducted to Demonstrate Acceptability

Table 5-2: Seismic Experience Piping Data [1]

Plant	Pipe Size NPS (in)	Pipe Schedule	Pipe OD (in)	Pipe Wall (in)	OD/t
Valley Steam Plant Units 1 and 2	24	20	24.00	0.375	64
	20	20	20.00	0.375	53
	18	30	18.00	0.437	41
	16	30	16.00	0.375	43
	14	30	14.00	0.375	37
	12	40	12.75	0.406	31
	12	30	12.75	0.33	39
	10	160	10.75	1.125	10
	8	160	8.6250	0.906	10
	6	40	6.6250	0.28	24
	4	160	4.5000	0.531	8
	4	40	4.5000	0.237	19
	3	160	3.5000	0.437	8
	3	80	3.5000	0.3	12
	3	40	3.5000	0.216	16
	2	160	2.3750	0.343	7
	2	40	2.3750	0.154	15
	1 1/2	160	1.9000	0.281	7
	1 1/2	40	1.9000	0.145	13
	1	40	1.3150	0.133	10
	3/4	160	1.0500	0.218	5
	3/4	40	1.0500	0.113	9
Moss Landing Units 1, 2, & 3	16	N/A	16.00	1.394	11
	12	N/A	12.75	1.148	11
Moss Landing Units 4 & 5	24	40	24.00	0.687	35
	24	N/A	24.00	1.066	23
	-	N/A	18.30	2.287	8
	16	40	16.00	0.5	32
	16	N/A	16.00	0.902	18
	-	N/A	13.20	1.668	8
Moss Landing Units 6 & 7	30	N/A	30.00	0.632	47
	26	N/A	26.00	1.128	23
	18	N/A	18.00	3.444	5
	12	N/A	12.75	2.444	5
	12	N/A	12.75	0.601	21
Ormond Beach Units 1 & 2	30	N/A	30.00	1.298	23
	30	N/A	30.00	0.719	42
	21	N/A	21.00	3.793	6

Table 5-2 Seismic Experience Piping Data [1]

Plant	Pipe Size NPS (in)	Pipe Schedule	Pipe OD (in)	Pipe Wall (in)	OD/t
Humboldt Unit 3	12	80	12.75	0.687	19
	10	80	10.75	0.593	18
	6	80	6.625	0.432	15
El Centro Steam Plant	20	STD	20.00	0.375	53
	18	160	18.00	1.7810	10
	18	XS	18.00	0.5000	36
	18	STD	18.00	0.3750	48
	14	40	14.00	0.4370	32
	14	STD	14.00	0.3750	37
	12	160	12.75	1.3120	10
	12	STD	12.75	0.3750	34
	10	40	10.75	0.3650	29
	8	160	8.625	0.9060	10
	8	120	8.625	0.7180	12
	8	40	8.625	0.3220	27
	6	120	6.625	0.5620	12
	6	40	6.625	0.2800	24
	4	80	4.500	0.3370	13
	4	40	4.500	0.2370	19
	3	160	3.50	0.4370	8
	3	80	3.50	0.3000	12
	3	40	3.50	0.2160	16
	2	160	2.375	0.3430	7
	2	80	2.375	0.2180	11
	2	40	2.375	0.1540	15
	1 1/2	160	1.90	0.2810	7
	1 1/2	80	1.90	0.2000	10
	1 1/2	40	1.90	0.1450	13
	1	80	1.315	0.1790	7
	1	40	1.315	0.1330	10
	3/4	80	1.050	0.1540	7
	3/4	40	1.050	0.1130	9

Table 5-3: D/t Range Comparison

Nominal Pipe Size (NPS) (ID)	Monticello Piping D/t Ranges	Experience Data Piping D/t Ranges
¾	3.5-9	5-9
1	4-10	5-20
1-1/4	12	
1 ½	7-13	7-13
2	5-15	5-15
3	8-16	8-16
3 1/2	13	
4	10-19	8-19
5	15-22	
6	9-24	9-24
8	27	10-31
10	18	10-29
12	31-34	10-34
14	37	32-37
16	32-43	11-43
18	19-48	5-41
24	20	23-35

Table 5-4(a): Predominant Materials of the Experience Data

Material ASTM Designation	ANSI B31.1 Allowable Stress, psi
A53 B	15000
A106 B	15000
A335	14000
A120	(1)
A139	12000

(1) Stress allowables not provided by B31.1. B31.9 provides an allowable stress value of 10000.

Table 5-4(b): Predominant Materials of Monticello Piping

Material ASTM Designation	ANSI B31.1 Allowable Stress, psi
A53 B	15000
A106 B	15000
312-304	15900
376-316	17000
312-304L	13700
B42 - Copper	6000 (1)

(1) This is the lowest value for B42 Copper given in the B31.1 Code.

Table 5-5: MNGP Span Ratios in Comparison to ANSI B31.1 Suggested Deadweight Spacing

Walkdown Package	*Pipe Type SB = Small Bore (<2.5") LB= Large Bore (>2.5") [Based on Predominant Pipe Size]*	*Maximum Vertical Support Actual Spacing Ratio to B31.1 Suggested Support Spacing (2)*	*Minimum Vertical Support Actual Spacing Ratio to B31.1 Suggested Support Spacing*	*Maximum Lateral Support Actual Spacing Ratio to B31.1 Suggested Support Spacing (LVSSR-Max) (2)*	*Minimum Lateral Support Actual Spacing Ratio to B31.1 Suggested Support Spacing (LVSSR - Min)*
2913-1	LB	1.5	1	4.2	1
2913-2	SB	1.5	.5	3	.5
2913-3	LB	1	1	3	1
2913-4	LB	2.2 (1)	1.5	7	1
2913-5	LB	1.5	1	3	2
2913-6	LB	1.5	<1	2	2
2913-7	LB	1	.5	5	N/A
2913-8	LB	1	.5	5	N/A
2913-9	LB	1	.75	6.2	5.5
	SB	1	.75	2	1
2913-10	LB	1	N/A	1.5	1
2913-11	LB	1	1.25	5.25	2
2913-12	LB	1.5	<1	2.75	1
2913-13	LB	(3)	(3)	(3)	(3)
2913-14	LB	(3)	(3)	(3)	(3)
2913-15	SB	1	<1	1.5	<1
2913-16	LB	2	1	2.5	1
2913-17	LB	1.5	<1	6	<1
2913-18	SB	1.5	1.3	5.5	1.3
2913-19	LB	(3)	(3)	(3)	(3)
2913-20	SB	1.5	<1	2	1
2913-21	LB	1.5	1	1.5	1
2913-22	SB	1	.5	1.5	1
2913-23	LB	1.5	1	5	5
2913-24	SB	1	1	1.5	1
2913-25	SB	1	1	2	1
2913-26	SB	1.5	<1	1.5	<1
2913-27-1,-2,-3	LB,SB	(4)	(4)	(4)	(4)
2913-27-4	SB	1.5	1	5	2
2913-28	SB	1	1	3	1
2913-29	LB	2	<1	2.7	2.7
2913-30	SB	1	<1	2	1
2913-31	SB	1.5	1	5.0	2
2913-32	LB	1	1	3	2
2913-33	LB,SB	1	1	2	1
2913-34	LB,SB	1	1	2	1

Table 5-5: MNGP Span Ratios in Comparison to ANSI B31.1 Suggested Deadweight Spacing

Walkdown Package	*Pipe Type SB = Small Bore (<2.5") LB: Large Bore (>2.5") [Based on Predominant Pipe Size]*	*Maximum Vertical Support Actual Spacing Ratio to B31.1 Suggested Support Spacing (2)*	*Minimum Vertical Support Actual Spacing Ratio to B31.1 Suggested Support Spacing*	*Maximum Lateral Support Actual Spacing Ratio to B31.1 Suggested Support Spacing (LVSSR-Max) (2)*	*Minimum Lateral Support Actual Spacing Ratio to B31.1 Suggested Support Spacing (LVSSR - Min)*
2913-35	SB	1.5	1	4	2
2913-36	SB	1	1	3	1
2913-37	SB	2	1	4	1
2913-38	SB	(3)	(3)	(3)	(3)
2913-39	LB,SB	(3)	(3)	(3)	(3)
2913-40	SB	1	1	2	1

(1) These spans exclude consideration of spring hangers.

(2) Spans include consideration of modified or added supports.

(3) These lines had obvious seismic design & short spans; accepted by inspection without detailed span evaluation.

(4) This was a worse case system and was qualified by detailed analysis.

Table 5-6: Nominal Suggested Vertical Deadweight Spans per ANSI B31.1

Monticello Nominal Pipe Size** (in)	Outside Pipe Diameter (in)	Suggested B31.1 Deadweight Spans (ft) Water Service	Steam. Gas or Air Service
3/4	1.050	6*	8*
1	1.315	7	9
1 1/2	1.900	9*	11*
2	2.375	10	13
3	3.500	12	15
3 1/2	4.000	11*	12*
4	4.500	14	17
5	5.563	16	19*
6	6.625	17	21
8	8.625	19	24
10	10.750	21*	26*
12	12.750	23	30
14	14.000	25*	33*
16	16.000	27	35
18	18.000	29*	37*
24	24.000	32	42

* Interpolated values -- not given directly in ANSI B31.1.

** There are small amounts of 1/2" piping and I/C tubing (1/8", 1/4", 1/2", 5/8" and 3/4") not presented in this table.

Table 5-7: Monticello Condenser Design Data Versus Experience Data [1]

Parameter	[illegible]	Moss Landing 6 & 7	Ormond Beach 1 & 2
Manufacturer	Worthington	Ingersoll Rand	Southwestern
Flow Type	Single Pass	Single Pass	Single Pass
Shell Dimensions (L x W x H)	HP: 40' x 30' x 35' LP: 36' x 30' x 35'	65' x 36' x 47'	52' x 27' x 20'
Tube Area per Shell	HP: 210,000 ft^2 LP: 189,000 ft^2	435,000 ft^2	210,000 ft^2
Shell Material	ASTM A285C	ASTM A285C	ASTM A285C
Shell Thickness	¾ inch	¾ inch	¾ inch
Operating Weight	HP: 1,900,000 lbs. LP: 1,800,000 lbs.	3,115,000 lbs.	1,767,000 lbs.
Tube Material	Type 304 S.S.	Al-brass	90-10 Cu-Ni
Tube Size	1 inch	1 inch	1 inch
Tube Length	36 to 40 feet	65 feet	53 feet
Tube Wall Thickness	18 to 22 Bwg	18 Bwg	20 Bwg
Number of Tubes	20,056 per shell	25,590	15,220 per shell
Tube Sheet Material	Munz Metal	Munz Metal	Munz Metal
Tube Sheet Thickness	1¼ inch	1½ inch	1¼ inch
No. of Tube Support Plates	13 per shell	15	14
Tube Support Plate Material	ASTM A285C	not identified	ASTM A285C
Tube Support Plate Thick.	3/4 inch	3/4 inch	5/8 inch
Tube Support Plate Spacing	33 inches	48 inches	36 to 36.5 inches
Waterbox Material	ASTM A285C	2% Ni cast iron ASTM A-48 CL 30	ASTM A285C
Waterbox Plate Thickness	3/4 inch	N/A	5/8 to 1 inch
Expansion Joint	Rubber belt	Rubber belt	St. steel
Hot Well Capacity	43,000 gallons	20,000 gallons	34,338 gallons
Hot Well Hold Time	2 min	N/A	N/A

Table 5-8: Summary of Concerns and Resolution

Identifier	Concerns	Resolution
Package 2913-4	Spatial interaction	Loose equipment moved or restrained
Package 2913-5	Loose hanger	Hanger repaired
Package 2913-4	(a) Broken U-Bolt (b) Missing U-Bolts (c) Spatial interaction	(a) Replaced (b) Installed (c) Potential target conduits determined to be not required for normal or accident conditions
Package 2913-11	(a) Lack of Lateral Restraint (b) Loose rod hanger (c) Short rod hanger (d)Poorly supported I&C line	(a) Support modified (b) Repaired (c) System qualified assuming this rod hanger failed (d) Reroute/resupport line
Package 2913-12	(a) Loose U-Bolt (b) Loose rod hanger (c) Additional lateral support required	(a) Repaired (b) Repaired (c) U-Bolt added
Package 2913-16	(a) Lack of lateral restraint (b) Spatial interaction	(a) Support modified (b) Block wall braced
Package 2913-19	(a) Sample Chamber Lacks Vertical Support (b) Tubing could Fall From Trays (c) Tubing needs lateral/vertical restraint (2 places) (d) Spatial interaction for SV-2 and 17-104	(a) Support added (b) Bands and covers added to trays (c) Restraint added (d) Lead blocks restrained
Package 2913-20	(a) Missing U-Bolt (b) Spatial interaction	(a) U-Bolt installed (b) Block wall braced
Package 2913-22	Spatial interaction	Crane rail demonstrated to be seismically adequate
Package 2913-24	(a) Lateral support required (b) Short rod hanger	(a) Support added (b) Piping qualified assuming hanger would fail.
Package 2913-26	(a) Lack of seismic support (b) Loose rod hanger (c) Loose U-Bolt	(a) Line resupported for earthquake (b) Repaired (c) Repaired
Package 2913-27-1	Lack of Lateral Support	Two new supports added
Package 2913-27-2	Lack of lateral support & spatial interaction concerns	Seven new pipe supports added
Package 2913-27-4	Lack of lateral support	Three supports added
Package 2913-28	Missing support	Support reinstalled
E-2A, E-2B, E-4	Anchorage	Bracing was added to reduce anchor loads
T-33	Anchorage	Bracing and anchors were added
V-813	Anchorage	Plates added

Table 5-8 Summary of Concerns and Resolution

Identifier	Outlier Issue	Proposed Resolution
17-116, 17-104	Interaction	Shield blocks restrained
2913-OSVS-1	Corrosion/Erosion	Piping Systems are in the Erosion/corrosion Monitoring Program.
2913-OSVS-2	Possible Corrosion	Piping Systems are in Erosion/Corrosion Monitoring Program.
2913-OSVS-3	Spatial Interaction	Added Support to 14" Piping.
E-1A, E-1B	Cracked grout	Repaired with high strength epoxy grout.
2913-27-4	Piping Overspans	Added three supports
2913-40	Inadequately supported	Re-support the tubing system

Table 5.9 - Summary of Detailed Analysis Conducted

Walkdown Package No.	Description	Basis for Detailed Analysis
2913-27-1	Steam Seal System - Discharge Portion. All large bore piping (>2 in diameter) including all possible leak paths to the condenser. Displacements at all small bore (2" and under) connections to the large bore lines were determined and used in evaluation of SAM effects on the Small Bore Systems	Worse Case System
2913-27-1	Steam Seal System - 2" Branch Line	Did not meet screening criteria
2913-27-1	Steam Seal System - 2" Branch Lines	Did not meet screening criteria
Multiple	Four Large Bore (30" & 36" diameter) Moisture Separator Systems (from Moisture Separators to the Intermediate Stop and Control Valves)	Spatial Interaction Concerns with several piping systems in the leak path
2913-27-2	Steam Seal System - 2" Branch lines	Did not meet screening criteria - two hard spot rod hangers did not pass rod fatigue review. Analysis assumed these hangers failed.
2913-27-2	Steam seal system - 2" Branch Line and two 12" Steam Bypass lines	Spatial Interaction Concerns
2917-24	Steam Equalizing Line	Determined Support Loads
2917-12	SJAE to Tank T72	Determine Anchor Loads
2917-36	SJAE Drain Lines	Evaluate the effects of corrosion on a portion of the piping system
2917-30	Oxygen Injection Piping	Although th[illegible] line was well supported, the ASTM B[illegible] material is not represented in the experience database of references [1]
2917-37	Steam Seal System I/C tubing	Did not meet screening criteria

Table 5.10 - Summary of Equivalent Static Analyses Conducted

Based for the Equivalent Static Analyses	Number of Equivalent Static Analyses conducted for this Reason
Evaluate SAMs	2
Evaluated Spatial Interactions	8
Evaluate Local Vulnerabilities	2
Determined Support loads for Evaluation	5

Table 5.11 - Summary of the Detailed Support Qualifications

Basis of the Qualification	Number of Supports Evaluated
Rod Fatigue Concerns	25
Lateral U-Bolt Concerns	23
Worse Case Support Reviews	44
Supports on systems subjected to detailed Analysis	30
Modified or Added Pipe Supports	31
Total	153

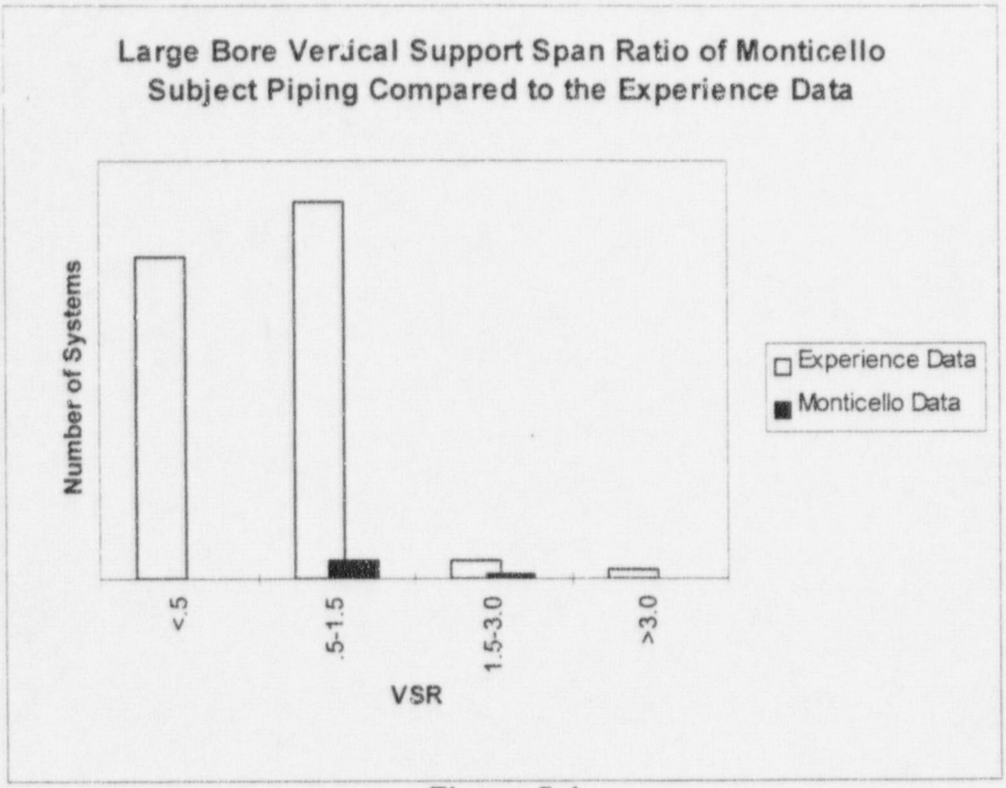


Figure 5-1

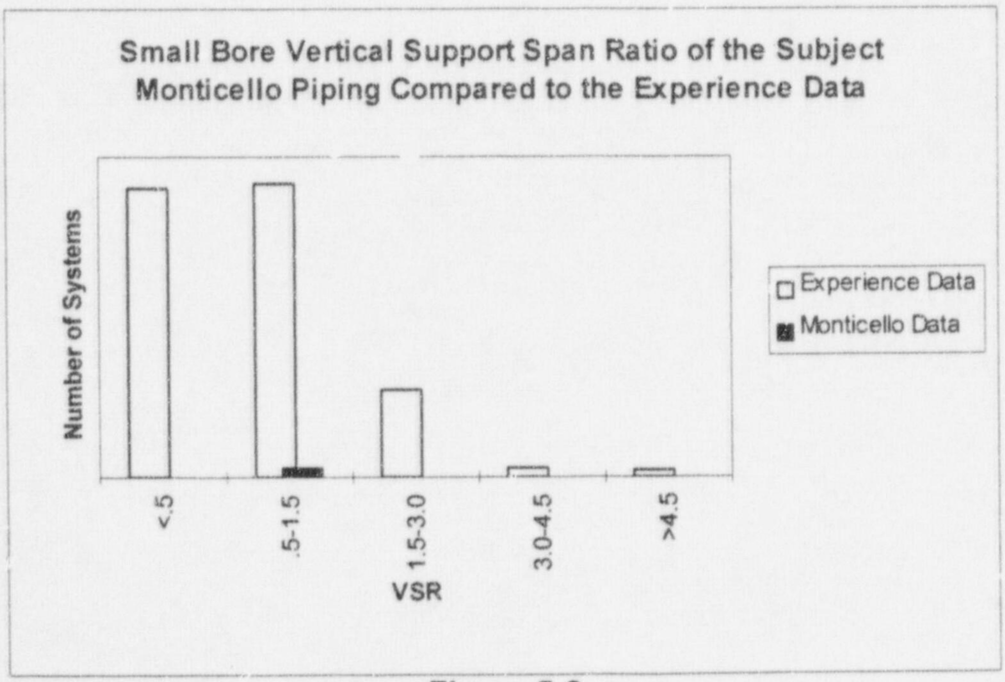
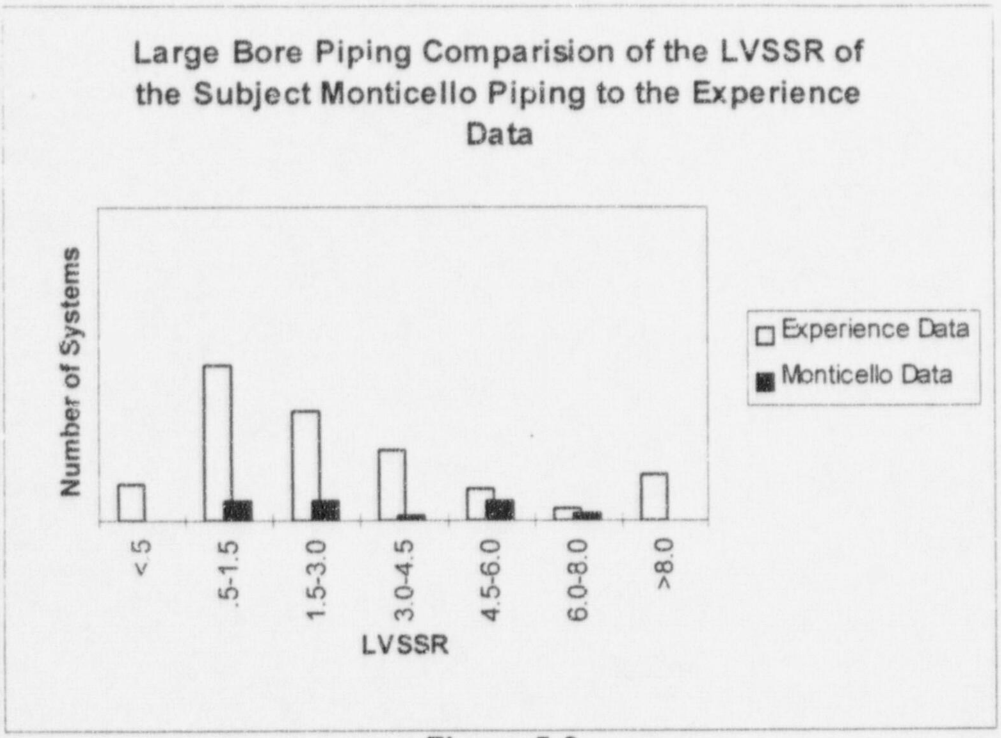


Figure 5-2



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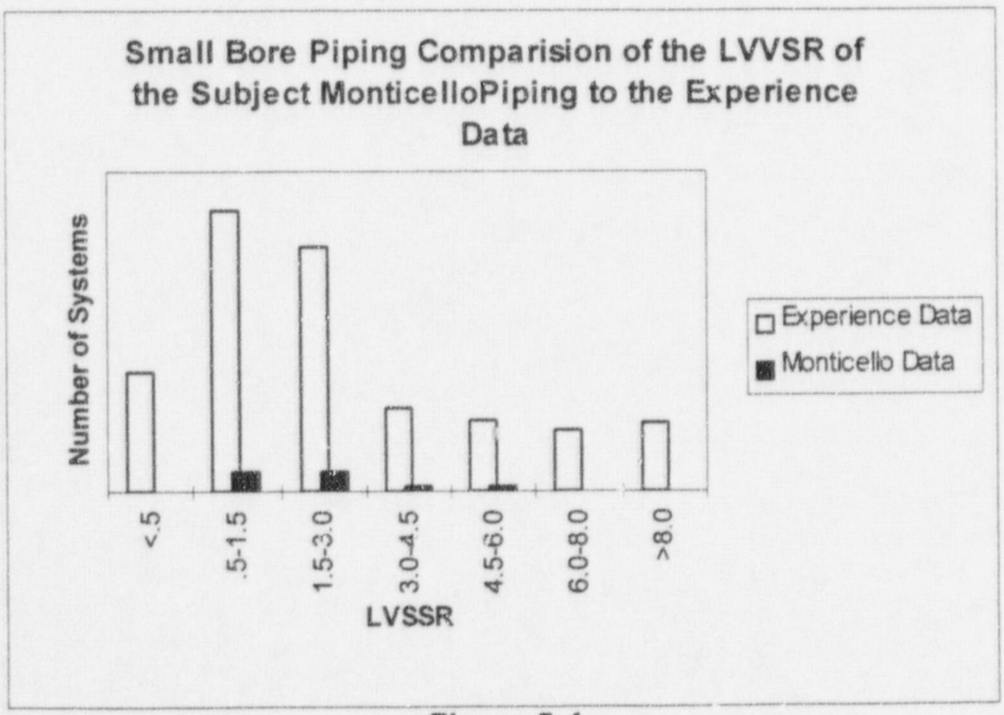

Figure 5-4

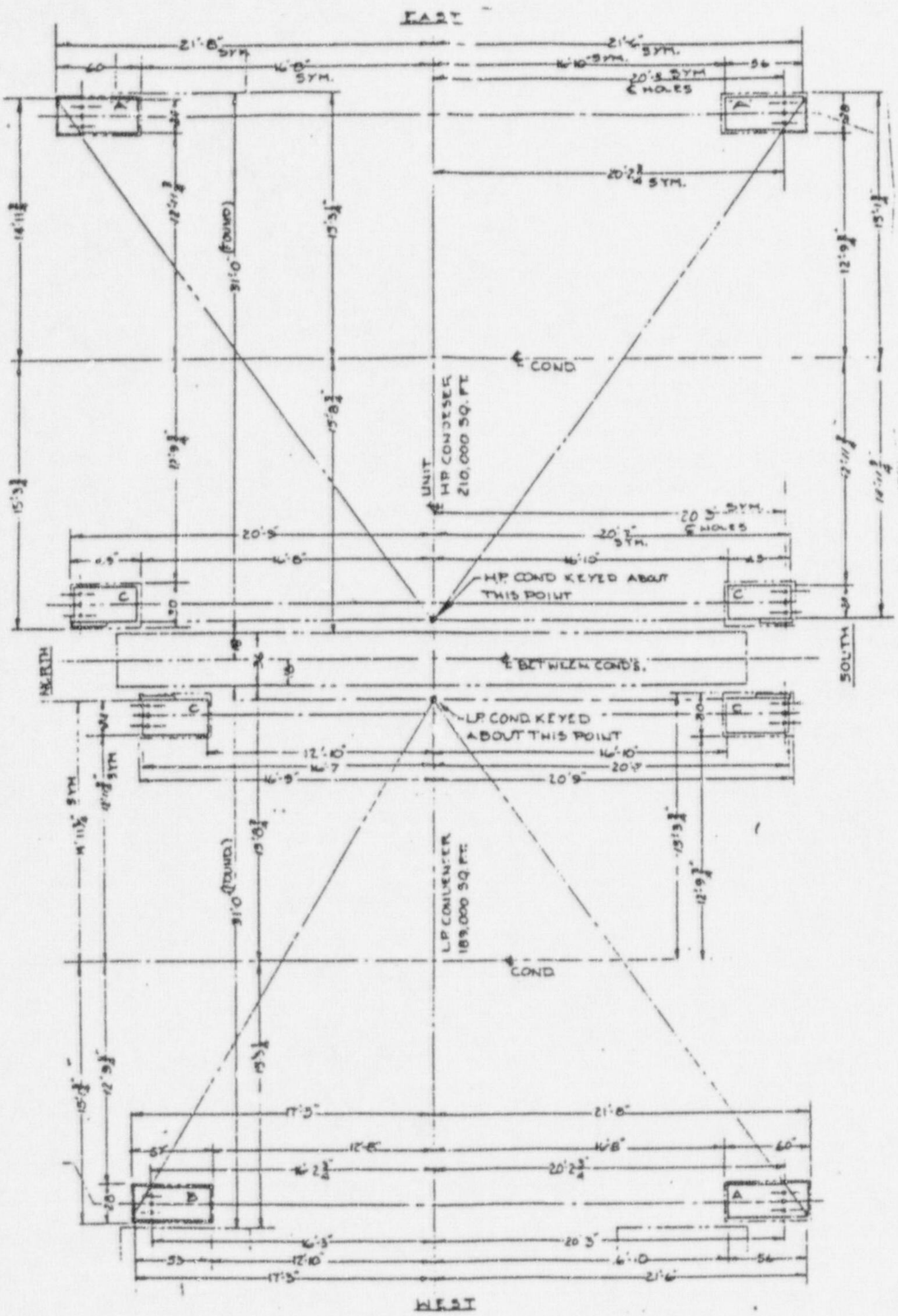

Figure 5-5: MNGS Condenser support layout from Worthington DR-127368 Rev. B

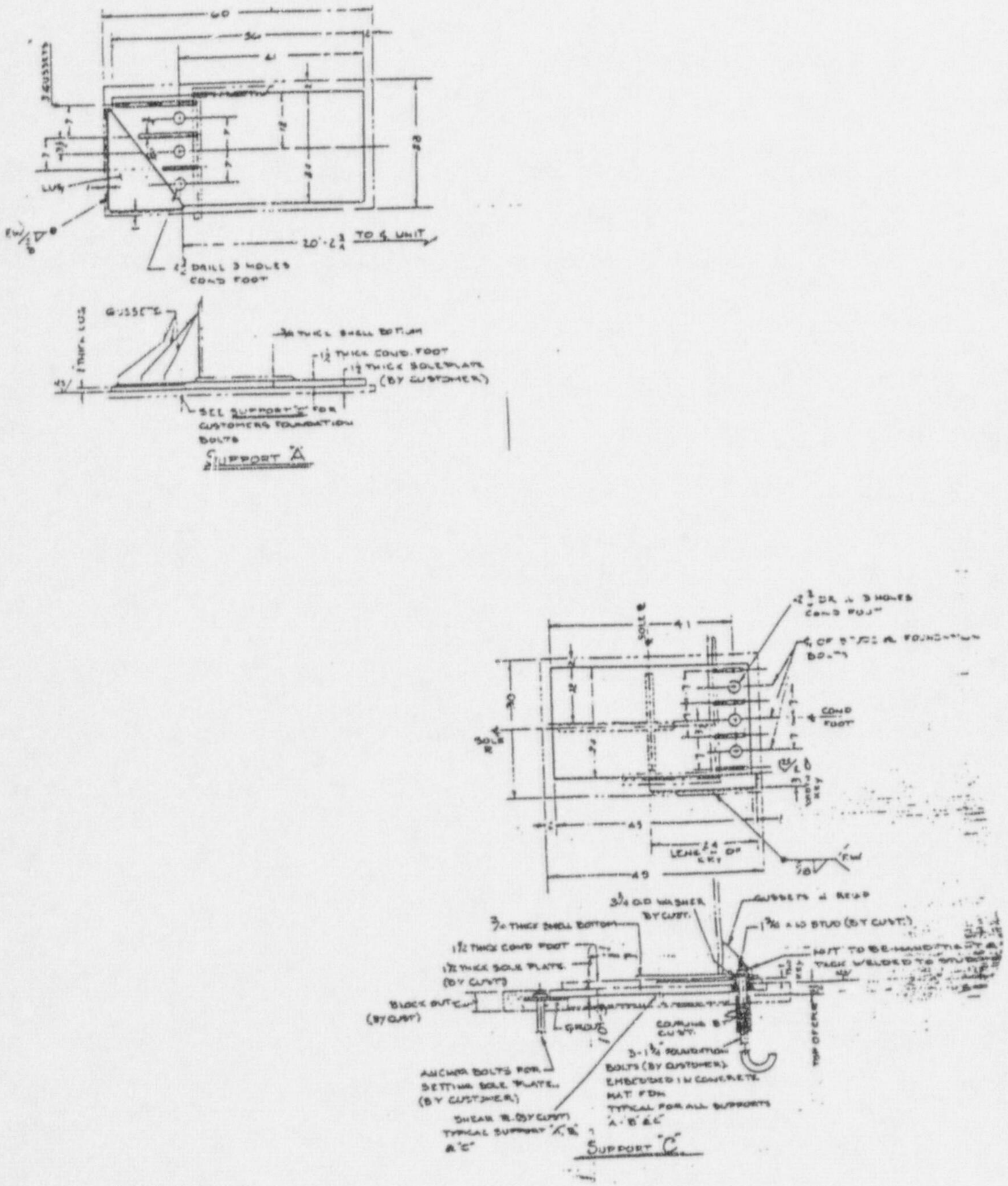

Figure 5-6: MNGS Condenser support details from Worthington DR-127368 Rev. B, Support B is similar to Support A

6.0 References

[1] NEDC-31858P, Revision 2, General Electric, "BWROG Report for Increasing MSIV Leakage Ratio Limits and Elimination of Leakage Control Systems," September 1993, (principally Appendix D thereof).

[2] EPRI/SQUG, "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment," Revision 2, February 1992.

[3] "Supplemental Safety Evaluation Report No. 2 (SSER #2) on GIP-2, "USNRC, Washington, DC, May 22, 1992.

[4] "Monticello Nuclear Generating Plant Verification of Seismic Adequacy of Mechanical and Electrical Equipment, Unresolved Safety Issue A-46 (SQUG)," Northern States Power Company, November 1995.

[5] EPRI Report NP-5617 Volume 1 and 2, "Recommended Piping Seismic Adequacy Criteria Based on Performance during and after Earthquakes," January 1988.

[6] Monticello, Updated Safety Analysis Report (USAR).

[7] SSRAP, "Use of Experience and Test Data to Show the Ruggedness of Equipment in Nuclear Power Plants, Rev. 4.0, February 1991.

[8] Safety Evaluation – Duane Arnold Energy Center – Amendment No. 207 to Facility Operating License No. DPR-49, February 22, 1995.

TRANSMITTAL MANIFEST

NORTHERN STATES POWER COMPANY

NUCLEAR LICENSING DEPARTMENT

MONTICELLO NUCLEAR GENERATING PLANT

Demonstration of the Seismic Qualification of the MSIV Leakage Path at Monticello (TAC No. 96238)

Manifest Date: May 29, 1998

Correspondence Date: May 29, 1998

Monticello Internal Site Distribution Special Instructions

Kaleen Hilsenhoff.......USAR File .... Yes___ No_x_
Steve Ludders ....NRC Commitment.....Yes___ No_x_
Lila Imholte.................Monti OC Sec............Yes___ No_x_ - 12, No dist to OC members below if YES
SAC Secretary ....Monti SAC..................Yes___ No_x_ - 5

Monticello Internal Site Distribution:

Monti Document Control File
M F Hammer, Plant MGR, SAC, OC
C A Schibonski, GSE, OC
E M Reilly, GSM, OC
J E Windschill, GSRS, OC
B D Day, GSO, OC
Dennis Zercher
Steve Hammer
J C Grubb, NGSS, OC
L L Nolan, GSSA, OC
MGR MTC, OC
Monticello Oper Exp Coord
A E Ward, NCD
Monti Site Lic File
NRC Resident Inspector's Office

NSP Internal Distribution

G T Goering, Chairman, SAC
W A Shamla, Dir Gen Qual Serv, SAC
Communications Dept Yes___ No_x_

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