CRITERIA DOCUMENT
R. E. GINNA NUCLEAR POWER PLANT
PIPING SEISMIC UPGRADING PROGRAM

WESTINGHOUSE ELECTRIC CORPORATION
Pittsburgh, Pennsylvania

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1.0 Summary Description of the Program

1.1 Summary

1.1.1 The purpose of this program is to upgrade certain seismic piping systems at Ginna Station to more current requirements and to provide a seismic data base for use with modifications, the ISI program, and NRC requests for information.

1.1.2 Attachment 1 to this document is the minutes of the meeting between RG&E and the NRC outlining the scope, purpose, and schedule of the program.

1.1.3 Systems Included

Portions of the following piping systems are to be included in this program:

Reactor Coolant System
Main Steam
Main Feedwater
Auxiliary Feedwater
Safety Injection
Residual Heat Removal
Containment Spray
Chemical and Volume Control
(1) Auxiliary Spray
(2) Letdown
(3) Seal Water
(4) Charging
Steam Generator Blowdown
Service Water
Component Cooling

1.1.4 Piping Analysis Scope

1.1.4.1 Section 1.2.2 defines the main lines of each system which are to be re-analyzed and re-supported as necessary.

1.1.4.2 Attachment 2 to this document defines the lines included in the program and the criteria used to select the lines.

1.1.4.3 All main line and branch piping, valves, nozzles, and supports shall be evaluated against the criteria established for the program.

1.2 Program Functional Criteria

1.2.1 Criteria for Selection of Lines in the Piping Upgrade Program

1.2.1.1 Only piping that is considered seismic Category I as identified by the color coded P&ID's in Appendix A of the Ginna Station QA Manual shall be included.

1.2.1.2 Main runs of piping included shall be based on the following criteria.

1.2.1.3 Main runs of piping which are 2 1/2 inch and larger and critical 2 inch piping.

1.2.1.4 Main runs which provide the fluid flow path to/or from equipment required for safe shutdown and LOCA mitigation based on SEP. Equipment does not include instrumentation.

1.2.1.5 Selected additional main runs not included in 1.2.2 but which are a primary part of the systems included in the upgrade program.

1.2.1.6 Branch lines included shall be based on the following criteria.

1.2.1.6.1 Branch lines shall be included in the analyses as necessary to determine the local effects of the branch lines on the main runs and to assure adequate flexibility exists in the branch line to prevent local overstress in the branch due to main run displacements.

1.2.1.6.2 Branch lines whose section modulus is greater than 15% of the main run section modulus shall be included in the analysis for an appropriate distance and/or number of supports.

1.2.1.6.3 Branch lines whose section modulus is less thn 15% of the main run section modulus do not need to be explicitly included in the analysis.

1.2.2 Lines Selected

1.2.2.1 Reactor Coolant System (EFD 33013-424 Rev. D)

Primary Loop

Surge Line

Pressurizer Spray Lines From the Cold Legs to the Pressurizer

1.2.2.2 Main Steam (EFD 33013-534, Rev. 1)

The 30" lines from both SG's through the penetrations and up to the MSIV's.

Inlet piping up to safety and relief valves.

1.2.2.3 Main Feedwater (EFD 33013-544, Rev. 4)

The 14" lines from the SG's through the penetrations and up to check valves 3992 and 3993.

1.2.2.4 Auxiliary Feedwater (EFD 33013-544, Rev. 4)

The discharge lines from the two motor driven pumps and the turbine driven pumps up to the main feedwater connections.

The condensate and service water suction lines from the pumps to check valves 4014, 4017, 4018 and to valves 4013, 4027, 4028.

1.2.2.5 Safety Injection (EFD 33013-425, Rev. C)
(EFD 33013-432, Rev. B)

The 10 inch SI accumulator discharge lines to the cold legs.

SI pump suction lines from the RWST through 896 A&B and 825 A&B to the three pumps.

The SI pump discharge lines from the three pumps to the SI accumulator discharge lines and to the two hot leg connections.

The boric acid lines from the boric acid storage tanks to the SI pump suction line.

The 4 inch alternate SI suction line from valves 1816 A&B to the pump.

The 10 inch low head SI suction from the RWST to valve 854.

The 6 inch/8 inch header from the RWST to valves 857 A, B, and C.

The 8 inch suction lines from contain sump B to valves 850 A&B and the 6 inch branch lines to valves 1810 A&B.

The low head safety injection lines from valves 852 A&B to the RCS.

1.2.2.6 Residual Heat Removal (EFD 33013-435, Rev. B)
(EFD 33013-436, Rev. E)

The 10 inch suction lines from the loop A hot leg to the two RHR pumps.

From valves 850 A&B to the pumps.

From valve 854 to the suction header.

The two pump discharge lines through heat exchangers and to the common 10 inch return.

The 10 inch return through penetration P111 and to the B cold leg.

The discharge cross-connect including valves 709C and D.

The heat exchanger by-pass line including valves 712 A&B.

The two lines from the RHR heat exchanger outlets to valves 857 A&B and 1816B.

The recirculation line from the RHR return through valve 822B to the RHR suction line.

The two lines from the RHR return to valves 852 A&B.

1.2.2.7 Containment Spray (EFD 33013-436, Rev. E)
(EFD 33013-435, Rev. B)

The two suction lines from RWST header to the spray rings.

The two pump discharge lines and spray rings.

The two eductor lines from the pump discharges to the pump suctions.

The spray additive lines from the tank through 836 A&B and to the two eductors.

1.2.2.8 Chemical and Volume Control (EFD 33013-426, Rev. 2, 433, Rev. 0)
(EFD 33013-427, Rev. B, 434, Rev. 2)

The auxiliary pressurizer spray line from the connection at regenerative heat exchanger outlet line to the pressurizer spray line.

The letdown line from the RCS through the regenerative heat exchanger, through the non-regenerative heat exchanger, through valve TCV 145 to the volume control tank.

The 4 inch header from the VCT and the 3 inch suction lines to the three charging pumps.

The three charging pump discharge lines to the acoustic filter.

The 2 inch charging lines from the acoustic filter through the regenerative heat exchanger to both the hot and cold leg connections.

The 3 inch seal water header from the acoustic filter and the two 2 inch lines to the RCP seals.

The 2 inch seal water return lines from the RCP seals and the 3 inch return header thrugh the seal water heat exchanger to

the VCT. Includes 3/4 inch piping through flow transmitters 175, 176, 177, and 178.

The 4 inch line from the RWST through valves LCV 112B and 358 to the charging pump suction header.

1.2.2.9 Steam Generator Blowdown (EFD 33013-522, Rev. A)

The two 2 inch lines from the SG's through the penetrations to the isolation valves.

1.2.2.10 Service Water System (EFD 33013-529, Rev. G)

The inlet piping to both diesel generators including the cross-connection between the diesels, the 16, 14, and 10" supply to the Turbine Building up to valve 4613.

The outlet piping from both diesel generators to an anchor point outside the diesel generator room.

The 20 inch supply lines and header inside the Auxiliary Building.

The 18, 14, and 6" supply lines from the 20 inch header to the two component cooling water heat exchangers and the spent fuel pool heat exchanger.

The normal discharge lines from the component cooling water heat exchangers and the spent fuel pool heat exchangers and the spent fuel pool heat exchanger including the 20 inch discharge inside the Auxiliary Building.

The 3 inch supply and normal discharge headers to and from the SIS pumps and equipment coolers in the Auxiliary Building (includes piping through valves 4738, 4739, and 4739A.)

The 16 and 14 inch supply headers inside the Intermediate Building. Including piping through valves 4040, 4623, 4639, and 4756.

The 10 inch supply to the Turbine Building up to valve 4614.

The 4 inch supply lines to the AFW pumps.

The 2½ inch and 8 inch supply and discharge lines to and from the 1A, 1B, 1C and 1D Containment Ventilation Cooling Coils and Fan Motors.

The 2½ inch supply and discharge lines for the reactor compartment coolers, including piping through valves 4625, 4626, and 4624.

The 4 inch supply to the air conditioning water chillers up to the isolation valves 4663 and 4733.

The common discharge header for the ventilation coolers up to an anchor point outside the Intermediate Building.

1.2.2.11 Component Cooling Water (EFD 33013-435, Rev. B, 436, Rev. E)

The 14 suction header and 10 inch suction lines to the CCW pumps.

The CCW pump discharge lines to the CCW heat exchangers.

The 4 inch and CCW surge tank line.

The 10 and 14 inch supply headers out of the CCW heat exchangers.

The 10 and 14 inch supply lines to both residual heat exchangers.

The 10 and 14 inch return lines from the residual heat exchangers to the CCW pumps suction header.

The 2 inch supply and return lines to the RHR pump coolers.

The 14 and 8 inch supply and return headers servicing the reactor coolant pumps and reactor supports.

The 3 and 4 inch supply and return line to both reactor coolant pump motors.

The 6 inch supply and return lines for the reactor supports from the 2 inch headers to penetrations 130 and 131.

The 2 inch supply and return lines for the excess letdown heat exchanger from the 8 inch header to penetrations 124 and 126.

The 6, 4, and 2 inch supply and return lines for the non-regenerative heat exchanger and the seal water heat exchanger.

The 2 inch supply and return lines for both containment spray and both safety injection pumps.

1.2.3 Floor Response Spectra

1.2.3.1 Gilbert Associates shall prepare floor response spectra and structural displacement data based on current NRC criteria. The analysis model shall consider interaction between all the various structures.

1.2.3.2 Response spectra and displacements shall be developed for the following structures:

Containment
Containment Interior
Auxiliary Building
Intermediate Building
Control Building
Diesel Generator Building
Turbine Generator - See Note 1
Facade - See Note 2

<u>Notes</u>

1. Only as needed for portions of safety related piping and safety related equipment in the Turbine Building.

2. Only if needed for Main Steam and Feedwater Piping.

1.2.4 Schedule

1.2.4.1 The current schedule to complete the project in two phases.

Phase 1: Complete the piping analysis and installation of piping supports inside containment by the end of the 1981 refueling outage.

Phase 2: Complete the piping analysis and installation of piping supports outside containment by the end of the 1982 refueling outage.

1.2.4.2 A detailed schedule shall be developed to permit planning, monitoring, and control of the project activities.

1.2.5 Westinghouse Responsibilities

Westinghouse will have the following responsibilities:

1.2.5.1 The technical lead, as well as project coordination and schedule responsibility for the analysis and redesign program.

1.2.5.2 The technical lead to assure the correct and required information is obtained to perform the analyses.

1.2.5.3 Consult RG&E and Gilbert Associates (GAI) and request response spectra.

1.2.5.4 Development of criteria document

1.2.5.5 Perform normal and seismic stress analysis of the required piping systems.

1.2.5.6 Develop support design information (stiffness, gaps and general layout, etc.) for additional supports required.

1.2.5.7 Develop detailed stress report.

1.2.5.8 Define stiffness limits for defining rigid supports.

1.2.5.9 Define an analytical method for handling common pipe supports.

1.2.5.10 Define criteria for seismic supports, i.e., snubber lockup, and support gap tolerances.

1.2.6 Gilbert Responsibilities

Gilbert will have the following responsibilities.

1.2.6.1 Provide Westinghouse the required response spectra and seismic displacements.

1.2.6.2 Develop the required piping isometric drawings.

1.2.6.3 Provide Westinghouse the required analysis data.

1.2.6.4 Develop stiffness information and characteristics for existing supports.

1.2.6.5 Complete the additional support design and analysis as defined by the interface between Westinghouse and Gilbert. (e.g., support embedment, load analysis, development of procurement data).

1.2.6.6 Evaluate existing supports for capability of carrying piping loads and modify as required.

1.2.6.7 Evaluate existing structures for capability of carrying piping loads and modify as required.

1.2.6.8 Provide final "as built" drawings of piping, supports and structures and completed analysis isometrics.

1.3 General Data Requirements

For the seismic upgrading program, it is necessary to obtain the information required to perform the piping system analyses. In this section the information required, the procedures used, the requirements pertaining to field verification, and the information required on the isometrics is defined.

1.3.1 Field Measurements and Field Survey

1.3.1.1 Piping Information

The actual configuration of the piping system will be compared to the piping design drawings noting pipe size, locations of supports, valves, insulation thickness, and branch connections. Fittings and welds are located where insulation does not interfere. Additional fittings and welds are assumed to be located per the existing drawings. Types of welds, fittings, and insulation are assumed to be per the applicable specifications. Equipment support locations are assumed to be per the equipment drawing or "as-built" when requested by Westinghouse. Drawings were made for any pipe routing not in agreement with the design drawings. Dimensions along the axis of the pipe were recorded to ± 4". All available valve tag information was recorded, dimensions to end of operator or handwheel recorded, and orientation of the operator or handwheel noted. This information was used to generate as-built piping and isometric drawings and to determine valve type, weight, c.g. and manufacturer.

1.3.1.2 Support As-Built

The actual support design will be compared to the support design drawing. A comparison is made of material sizes and lengths, weld sizes and pipe to support clearances. Any discrepancies are noted. All existing supports in the field are tagged with the original design support number or given a new "N" number if no design drawing exists. As-built support drawings for each support are then made from the data gathered in the field. For dimensions greater than one inch, the tolerance is ± 1/8 inch, for dimensions less than one inch, the tolerance is ± 1/16 inch.

1.3.1.3 Unavailable Information

Any information that is unavailable, such as spring can sizes or valve data due to missing tags or support members embedded in concrete, is documented and an assumption made based on all available data. If the physical configuration and dimensions match the design drawing, it is assumed the item was installed in accordance with the design drawing.

1.3.2 Supplemental Data Requirements

1.3.2.1 Given below is a summary of the information, supplementing the piping isometrics, required by Westinghouse to perform the piping analyses.

1.3.2.1a Piping material and schedule.

1.3.2.1b Piping insulation size and weight including metal jackets.

1.3.2.1c Operating/design temperatures and pressures in the piping systems.

1.3.2.1d Definition of analysis information for fittings (e.g., tees, elbows, etc.) flanges, valves, and nozzles.

1.3.2.1e Master valve list.

1.3.2.1f Vendor's catalogs associated with pipe supports (e.g., hangers, snubbers, etc.).

1.3.2.1g Hanger index.

1.3.2.1h Data pertaining to supports from which stiffness and stresses and allowable loads can be determined.

1.3.2.1i Definition of boundary conditions to be used in the analysis associated with penetrations (e.g., anchor fixed/flexible, etc.).

1.3.2.1j Support Drawings.

1.3.2.1k General arrangement and layout drawings showing concrete.

1.3.2.1l Equipment support drawings.

1.3.2.1m Drawings defining size, material, etc., for equipment (e.g., tanks, valves, heat exchangers, etc.) which must be modeled in the piping systems.

1.3.2.1n Appurtences and integral supports and the associated stress indices.

1.3.2.2 Where information is lacking, undecipherable or otherwise inadequate, photographs, field measurements, similarity comparisons or other means shall be taken to assure that the analysis information used is correct. Where this is not possible, a range should be established which can be used to study the effect of the inadequate information on the analysis. The analyses performed should be based on "as-built" data as verified from field measurements.

1.3.2.3 All pipe nozzles which are part of the analysis scope are to be identified giving location, size, nozzle type, and thickness.

1.3.3 Isometric Requirements

1.3.3.1 Isometrics will be prepared reflecting "as-built" conditions. They should be certified-for-analysis. The information which will be contained on the drawing will be:

1.3.3.1a Location, type, and directionality of all supports.

1.3.3.1b Location and type of all shop and field welds. This information is not always available, because it is covered by insulation. It is noted on the isometrics when available. See Section 1.3.1.1.

1.3.3.1c Pipe size, schedule, material, and insulation weight.

1.3.3.1d Temperature and pressure for design and normal (operating) conditions.

1.3.3.1e Location and type of all anchors and branch terminal points.

1.3.3.1f Piping classification boundaries.

1.3.3.1g Valve types and locations with associated valve identification numbers.

1.3.3.1i Definition of symbols and units used.

1.3.3.1j Global coordinates which can be used to check closure and provide references, attachment points. (This will be shown on piping orthographic drawings).

1.3.3.1k Reference north direction.

1.3.3.1l Location and size of all appurtences welded to pipe.

2.0 Reference Documents

A. USAS B31.1 Code 1967

B. ANSI B31.1 Code Summer 1973 Adenda

C. ASME Section III Appendix XVII

D. ASME Section III Subsection NF

E. AISC Specification For Design, Fabrication, And Erection of Structure Steel for Buildings, 6th Edition.

F. USNRC Regulatory Guide 1.60 - Damping Values

G. USNRC Regulatory Guide 1.61 - Damping Values

H. USNRC Regulatory Guide 1.92 - Combination of Modal Responses

I. USNRC Regulatory Guide 1.122

J. USNRC Regulatory Guide 1.124 - Service Limits and Loading Combinations.

K. USNRC IE Bulletins
- 79-02 Pipe Support Base Plate Design Using Concrete Expansion Anchor Bolts 3/8/79 Rev. 1, 6/21/79 Rev. 2, 11/8/79
- 79-04 Incorrect Weights for Swing Check Valves Manufactured by Velan Engineering Corp., 3/30/79
- 79-07 Seismic Stress Analysis for Safety Related Piping 4/14/79
- 79-14 Seismic Analysis for As-Built Safety Related Piping Systems 7/2/79 Revision 1, Supplement 1 8/15/79, Supplement 2 9/7/79

L. ACI-349 Appendix B - Embedments

M. Hilti Criteria for Component Support Embedments

N. RGE Analysis and Design Conditions Document

O. Dames & Moore Site Evaluation Study Proposed Brookwood Nuclear Power Plant

P. Dames & Moore Supplementary Foundation Study Proposed Brookwood Nuclear Power Plant

3.0 Seismic Response Spectra Development

3.1 The purpose of the present dynamic analysis is to primarily generate floor response spectra and maximum floor displacements at the mass points of the structural model to be used for upgrading of the selected piping systems at the Ginna Station. The plant specified horizontal and vertical seismic accelerations for the Ginna Station have been determined as 0.08g for Operating Basis Earthquake (OBE) and 0.20g for Safe Shutdown Earthquake (SSE). The floor response spectra will be generated for major floor elevations for the following structures, corresponding to three orthogonal directions (one vertical and two horizontal) for 1%, 2% and 4% damping values for OBE and 2%, 3%, 4% and 7% for SSE:

1. Containment Building
2. Containment Interior
3. Auxiliary Building
4. Intermediate Building
5. Control Building
6. Diesel Generator Building
7. Turbine Building

3.2 If required, an additional floor response spectra at 5% damping for OBE and SSE will be generated for the Containment Interior, Auxiliary Building, Intermediate Building and Control Building. For the flexible floor framing system, the floor response spectra at the center of the floor will be different from those at the edge of the floor due to vertical input. To include the effect of flexible floor system, the floor response spectra will be generated in a two step approach for the specified location when required.

3.3 Description of Structures

3.3.1 The plant buildings are located in a relatively level meadow area with a finished grade elevation of approximately 270'-0". The major plant structures are supported on the Queenston Formation bed rock (red sandstone) or atop natural or compacted granular soils immediately above the bed rock. The Queenston Formation is generally found at a depth of 30 to 40 feet below natural grade.

3.3.2 Containment Building

The Containment Building is founded on rock. The bottom of the foundation mat elevation is 231'-8" with the deepest foundation around the reactor vessel at elevation 208'-0". The containment cylinder is founded on rock (sandstone) and anchored by means of post-tensioned rock anchors whereby rock acts as an integral part of the containment structure. The Containment Building is isolated from other buildings. The Containment Building is a reinforced concrete vertical right cylinder with a flat base and a hemispherical dome. It is 99 feet high to the spring line of the dome and has an inside diameter of 105 feet.

3.3.3 Containment Interior

The containment base floor is at elevation 235'-8". The intermediate floor and operating floor are of reinforced concrete and supported on structural steel framing at elevations 253'-3" and 278'-4" respectively. The structural steel box columns are supporting overhead cranes. The top of the crane rail is at elevation 331'-0". The crane girder has a bumper at each end which is in contact with the containment shell. Interior walls are of reinforced concrete.

3.3.4 Auxiliary Building

The Auxiliary Building is located south of the Containment Building and founded on rock. The bottom of the foundation mat elevation is 233'-8", with the deepest foundation for decay heat removal area at elevation 217'-0" with the sump at elevation 214'-0". Rock elevation in this area is approximately at elevation 235'-0". The west end of the superstructure of the Auxiliary Building is connected with a portion of the Service Building, and on the northwest with the Intermediate Building. However, the foundation of the Auxiliary Building is independent of these building foundations. The basement floor is at elevation 235'-8". The intermediate and operating floors are of reinforced concrete supported on reinforced concrete walls and are at elevation 251'0" and 271'-0" respectively. The superstructure is of braced structural steel framing with high and low roofs at elevations 328'-0" and 312'-0", approximately. The high roof area has an overhead crane, with the top of the crane rail at elevation 310'-9".

3.3.5 Intermediate Building

The Intermediate Building is located on the north and west of the Containment Building, and is founded on rock. The west end has a retaining wall where the floor at elevation 253'-6" is supported. The bottom of the retaining wall footing is at

elevation 233'-6". Rock elevation in this area is approximately at elevation 239'-0". Foundations for interior columns are on individual column footings and embedded a minimum of 2'-0" in solid rock. The basement floor slab is of reinforced concrete and is at elevation 253'-8". The upper floors are of reinforced concrete supported on structural steel framing. The floors on the north of the Containment Building are at elevations 278'-4", 298'-4", and 315'-4" with the structural steel framed roof at elevation 336'-4". The southwest floors are at elevation 271'-0" and 293'-0" with the structural steel framed roof at elevation 318'-0".

3.3.6 Control Building

The Control Building is located adjacent to the southeast corner of the Turbine Building and is supported by a mat foundation. The foundation of the Control Building is supported on the natural compacted granular material. The rock elevation in this area is approximately at elevation 240'-0". Bottom elevation of the deepest portion of the foundation mat is at elevation 245'-4", with a structural slab supported at elevation 250'-6" with a thickened slab for column footing. The Control Building has reinforced concrete walls on the south and west side up to the roof elevation, while the concrete wall on the east side is up to grade level. The basement slab is at elevation 253'-8". The intermediate floors are of reinforced concrete, supported on structural steel framing system and are at elevations 271'-0" and 289'-6". The roof is of reinforced concrete supported on a structural steel truss and is at elevation 310'-4".

3.3.7 Diesel Generator Building

The Diesel Generator Building is located beyond the northeast corner of the Turbine Building and is supported on strip and spread footings at elevation 243'-0". The rock elevation in this area is at elevation 240'-0". The foundation structures are supported on the natural compacted granular material. The Diesel Generator Building has reinforced concrete walls on all four sides. The basement floor is of reinforced concrete slab at an elevation of 253'-8". The roof is of structural steel framing with decking and is at elevation 275'-10".

3.3.8 Turbine Building

The Turbine Building is located north of the Intermediate Building and is supported by a combination of perimeter grade beams and a structural mat. The mat foundation of the turbine generator is independent of the surrounding Turbine Building foundations. The Turbine Building foundation is supported on the natural compacted granular material which overlays the natural rock. Rock elevation in this area is approximately at elevation 239'-0". The bottom of the perimeter column foundation mat varies from elevation 245'-3"

on the south side along the Intermediate Building to approximately 246'-9". The bottom of the turbine generator foundation mat is at elevation 243'-0". The circulating water discharge tunnel is supported at elevation 242'-2". Where condensate pumps are located, the entire area is filled with lean concrete having a bottom elevation of 229'-8". Area between the turbine generator foundation and the perimeter column mat foundation is supported on compacted granular material with the bottom of the mat at elevation approximately 251'-6". The basement floor is reinforced concrete and is at elevation 253'-6". The mezzanine and operating floors are reinforced concrete and are supported on structural framing at elevation 271'-0" and 289'-6" respectively. The superstructure is a braced structural steel frame, with the roof at elevation 356'-11 3/4". The building has an overhead crane, 125T/25T capacity, with the top of the crane rail at elevation 330'0".

3.3.9 Service Building

The Service Building is located on the west side of the Intermediate Building and is founded on compacted soil. The bottom of the mat is approximately at elevation 252'-8" with a localized thickened mat for column footings. The deepest foundation for the sump is at elevation 247'-3". Natural compacted granular soil is approximately at elvation 255'-0". The mat is supported on the east side by a retaining wall on column line 3 with the Intermediate Building. The basement floor is reinforced concrete and is at elevation 253'-8". The main floor slab is reinforced concrete supported on structural steel framing and is at elevation 271'-0". The roof is composed of structural steel framing with decking at elevation 287'-4". The superstructure is structural steel framing system with exterior block walls all around.

3.4 Analysis Method

3.4.1 Safety Class Seismic Category 1 Structures are analyzed using STARDYNE, a general purpose linear elastic finite element program. The analysis uses a modal superposition method which includes all significant modes. The program calculates the damping values for the dynamic modes involved in the analysis reflecting structural damping of various materials. Each model is analyzed for the simultaneous application of three orthogonal statistically independent earthquake time histories for both OBE and SSE. The horizontal earthquakes are input along the E-W and N-S axis of the models for all structures except the Containment Building and Containment Interior. The horizontal input for these two structures is along their principal axes. The absolute acceleration time histories of the structural response of a particular mass point are used to generate the floor response spectra.

3.4.2 The Containment Building and Containment Interior are modeled separately from the remaining plant structures.

3.4.3 The composite model of the remaining plant structures includes the Auxiliary Building, the Intermediate Building, the Service Building, the Turbine Building, the Control Building, and the Diesel Generator Building.

3.4.4 The maximum response due to horizontal and vertical input are combined in accordance with the requirements of USNRC Regulatory Guide 1.92.

3.4.5 Lumped mass models for the Reactor Building and other interconnected buildings are developed. The mass points of a building are always chosen at the points of physical mass concentration, e.g., heavy floors, and include the masses of floors, equipment and walls as required. The model of the interior of the Containment Building will also include the primary loop model with the building structural model.

3.4.6 The peaks of the floor response spectra are broadened 15 percent on each side in accordance with USNRC Regulatory Guide 1.122 to account for variation in structural and soil properties.

3.5 Seismic Input

3.5.1 Design Response Spectra

The design basis earthquakes, OBE and SSE, response spectra for the plant are developed on the basis of USNRC Regulatory Guide 1.60. The expected maximum ground seismic acceleration values for the plant are based upon the plant site geologic investigations and seismologic recommendations.

The vertical design response spectra values are 2/3 those of the horizontal design response spectra for frequencies less than 0.25 cps. For frequencies higher than 3.5, cps, they are the same, while the ratio varies between 2/3 and 1 for frequencies between 0.25 and 3.5 cps. For frequencies higher than 33 cps, the design response spectra follows the maximum ground acceleration line. This is in accordance with the requirement of USNRC Regulatory Guide 1.60.

The majority of the safety class structures as described in Section 8 are founded on rock, except the Control and Diesel Generator Buildings. The properties of the rock are as follows:

Shear Wave Velocity	5000 ft/sec
Density	158 lb/ft
Poisson's ratio	0.15
Shear Modulus (G)	254 x 106 lbs/sq ft

(Reference: Dames & Moore Site Evaluation Study)

3.5.2 Artificial Time History

Two earthquakes (OBE and SSE) representing horizontal and vertical artificial time histories shall be used as an input for generating floor response spectra. Artificial time histories to be used are compatible with the requirements of USNRC Regulatory Guide 1.60.

3.6 Critical Damping Values

The values of structural damping used as a percentage of critical damping for safety class structures are in compliance with USNRC Regulatory Guide 1.61.

3.6.2 Floor response spectra are generated at each preselected mass point, in each of the three orthogonal directions for damping values 1%, 2% and 4% for OBE and 2%, 3%, 4% and 7% for SSE.

3.7 Soil Structure Interaction

3.7.1 Soil Spring Data

The soil data used to determine the soil structure interaction spring stiffnesses and damping values are derived from the available soil data for the plant. (Reference Dames & Moore Supplemental Foundation Study) Upper and lower bound values are provided for the soil spring stiffness values. The average values are used for the analysis. The soil stiffness properties are input as a set of six discrete springs in each model (one for each general degree of freedom), not supported on rock. The springs are connected to a single nodal point on each of the models. This nodal point is located horizontally at the centroid of the plan views of the base mat outlines. The other ends of the springs are considered as being fixed. The soil springs represent a pure stiffness unit, and do not require or represent any length. The structures which are supported on rock are considered fixed because the embedment has only negligible effect on the dynamic response. No soil structure interaction is considered.

3.7.2 Soil Damping

Damping in this analysis is represented in the form of structural damping in accordance with USNRC Regulatory Guide 1.61 and soil radiational damping based on elastic half space theory.

3.8 Procedure Used for Modeling

3.8.1 The basic technique used for modeling is to represent the dynamic system by a system of lumped masses located at the elevation of mass concentration, such as floor slabs. For structures such as the containment shell, having continuous mass distribution, a sufficient number of mass points are chosen so that the vibration mode of interest can be adequately defined. Soil is represented by springs.

3.8.2 The Containment Building model is an independent structure, while the model for the balance of plant buildings consists of an assemblage of beam elements having structural beam properties, interconnected at nodal points.

3.9 Methods Used to Account for Torsional Effects

A structure with an eccentricity between the mass center and the center of rigidity greater than five percent of the dimension of the structure normal to the input direction, is considered to have pronounced torsional modes. For a structure with pronounced torsional modes, or in other words, where the horizontal responses are significantly coupled, a three dimensional model is used in the analysis to calculate the actual torsional responses. In the model, walls are simulated as single members and floors are treated as a rigid diaphragms. Mass centers and centers of rigidity are calculated and considered in the geometry of the model. The acceleration time history is input at the support of the model to calculate the actual torsional effects. For a symmetrical building, a two dimensional model will give the same result as a three dimensional model, because the components of the mode shapes are uncoupled. Responses due to horizontal excitations and vertical excitation are calculated separately but the effects are additive in determining forces throughout the structure.

4.0 Piping Systems Analysis

4.1 Presented in this section are the analytical methods criteria and stress criteria which will be used in the piping system seismic upgrading program. The seismic analysis methods will employ dynamic system analysis techniques, and where applicable, equivalent dynamic static analysis. The stress criteria will conform to piping code USAS B31.1 which was the licensing base for the Ginna Station.

4.2 The criteria described in this section will apply to the piping systems defined in Section 1.2.2.

4.3 Background

4.3.1 In the years since the Ginna Station was designed, seismic analysis techniques have become more rigorous and the ASME Boiler and Pressure Vessel Code Section III, Nuclear Power Plant Components, has been published, reflecting changes in analysis, design, and quality control techniques. The purpose of these criteria is to establish requirements for performing the upgrading seismic analyses of the above piping systems using current technology.

4.3.2 The original design criteria used for the seismic design Category I piping and supports of the Ginna Station are defined by the following codes.

4.3.2.1 Seismic design Category I piping

USAS B31.1 Code

4.3.2.2 Supports

AISC Specification for Design, Fabrication, and Erection of Structure Steel for Buildings, 6th Edition

4.3.3 The piping code, USAS B31.1, was updated on June 30, 1973 revising the piping stress analysis formulas and stress intensification factors. The primary stress equations are similar to those given in the ASME Section III code of that time. The stress intensification factors given in this version of the code were expanded to include more fittings than in previous edition, as well as higher values for certain existing fittings. In the piping system seismic upgrading program, the ANSI B31.1 Code, Summer 1973 Addenda, will be used primarily, with the following exception. The piping criteria will not consider the B31.1 Summer 1973 Addenda stress intensification factors for butt and socket welds, since they are constrictively higher than the original design basis 1967 B31.1 stress intensification factors. Use of this version of the Code will therefore maintain the philosophy of B31.1, and reflect the concepts of ASME Section III.

4.3.4 The support criteria defined by the AISC Code was used as the basis for formulating 1974 Subsection NF of ASME Section III, which is concerned with the structural criteria for component supports. Therefore, Subsection NF of ASME Section III will be used to evaluate the structural adequacy of the piping supports.

4.4 Loads

4.4.1 The piping systems will be analyzed for the following loading conditions:

4.4.1.1 Deadweight Condition - deadweight and design pressure.

4.4.1.2 Design Condition - operational basis earthquake (OBE) combined with maximum operating thermal, deadweight, OBE displacements, and design pressure.

4.4.1.3 SSE Seismic Condition - safe shutdown earthquake (SSE) combined with operating pressure and deadweight and normal operating thermal.

4.4.2 In the seismic upgrading program the loss-of-coolant accident will not be considered.

4.4.3 The seismic pipe stresses will be determined using seismic loads generated considering the piping systems to have the following damping values. Small diameter piping systems, diameter less than 12-inch,

For OBE the damping value is 1%.

For SSE the damping value is 2%.

Large diameter piping systems, diameter equal to or greater than 12 inches,

For OBE the damping value is 2%.

For SSE the damping value is 4%.

4.4.4 An envelope of seismic response spectra at support points on the piping model will be employed in the analyses to generate the OBE and SSE seismic loads.

4.5 Stress Criteria

4.5.1 Piping

The loading combinations and associated stress limits to be used for the piping systems which are part of the seismic upgrading programs are given in Table V-1. As stated in Section 4.4.2, pipe rupture loads are not considered; as such, the stress limits used for the SSE condition do not

correspond to the faulted condition, as they could be for the SSE evaluation, but to the emergency condition stress limits. This is consistent with the FSAR and is conservative. The piping stresses are to be calculated using the formulas given in ANSI B31.1-1973, 1973 Summer Addenda. Thermal stresses are to be evaluated per ANSI B31.1-1973, Summer 1973 Addenda requirements.

4.5.2 Equipment Nozzles (excluding valve nozzles)

4.5.2.1 Primary Equipment

The maximum loads that the main feedwater piping and steam line piping are permitted to transmit to the steam generator nozzles are given in Table V-II.

The allowable loads for the seal injection and component cooling system nozzles on the reactor coolant pump and motor are listed in Table V-III.

4.5.2.2 Auxiliary Equipment

For Class 1 and 2 auxiliary equipment nozzles, i.e., tanks, pumps, and heat exchangers, the reactions imposed by the attached piping shall be compared with the following:

(1) P = Axial force $\leq 0.01 \times S_y \times A$

(2) M_b = Bending moment $\leq 0.1 \times S_y \times Z$

(3) M_T = Torsional moment $\leq 2(0.1 \times Sy \times Z)$

(4) V = Shear force $\leq 0.01 \times Sy \times A$

where

S_y = Yield stress of pipe at operating temperature as given in ASME Section III (psi).

A = Material cross-sectional area of pipe (in2)

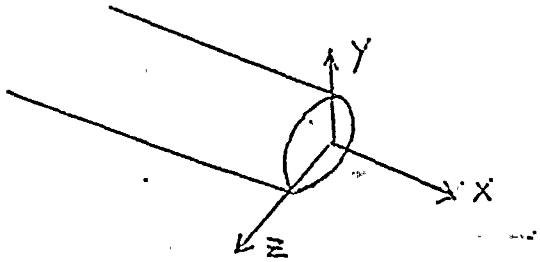
Z = Section modulus of pipe

P = Axial force = f_x

$M_b = \sqrt{M_y^2 + M_Z^2}$

M_T = Torsional moment = M_X

V = Shear force = $\sqrt{f_y^2 + f_Z^2}$



These allowables are to be used as guides by the piping analyst. For equipment of this vintage, some qualification to the actual calculated load may be required.

4.5.3 Valves

The applicable valve nozzle load acceptance criteria depends on whether the valve is classified as being active or inactive.

4.5.3.1 An active valve is defined as one that is required to operate so that the plant can go from normal full power operation to cold shutdown following an earthquake. A valve must perform some mechanical motion in accomplishing its design function in order to qualify for this designation. For active valves, the pipe loads at the pipe/valve interface shall be limited to current Westinghouse acceptability limits.

Valve Type	Operability End Nozzle Load Limits
Swing Check	$\sigma_{max} \leq Sy$; with $\sigma_{bending} \leq 0.75\ Sy$ $\sigma_{torsion} \leq 0.5\ Sy$
Safety	a. Closed position - loads shown on applicable vendor drawings. b. Open position - $\sigma_{max} \leq 0.75\ Sy$
Other than Swing Check and Safety (includes diaphragm valves)	$\sigma_{max} \leq 3/4\ Sy$; with $\sigma_{bending} \leq 0.5\ Sy$ $\sigma_{torsion} \leq 0.5\ Sy$

σ_{max} = Maximum principal stress (using pipe properties) in the attached piping at the pipe-to-valve interface due to combined axial, shear, torsional and bending moment loads including pressure effects for specified loading conditions.

$\sigma_{bending}$ = Maximum fiber stress in the attached piping at the pipe-to-valve interface (using section modulus of pipe) due to resultant bending moment loads for specified loading conditions.

$\sigma_{torsion}$ = Maximum fiber stress in the attached piping at the pipe-to-valve interface (using pipe properties) due to torsional moment loads for specified loading conditions.

Sy = Yield stress (in tension) at design temperatures of material ASME SA-376, Type 316, for stainless steel valves and ASME SA-106, Grade B for carbon steel valves for operability end nozzle load limits.

4.5.3.2 All valves that are not classified as active are considered inactive and the structural integrity of the valve must be assured. Since valves are stronger than the attached pipe (without a history of gross failure of their pressure boundaries), as long as the stresses of the piping attached to the valve remain within the limits stated in this document, the valve integrity is assured.

4.5.3.3 In addition to the above requirements, the seismic accelerations of both active and inactive valves shall be calculated. If accelerations are less than 2.1g in the vertical direction and 2.1g in each of two perpendicular horizontal directions for SSE, then the valve is satisfactory. If accelerations are greater than or equal to 2.1g, case-by-case analysis will decide acceptability or unacceptability. The OBE accelerations shall be kept to one-half of the SSE acceleration allowables.

4.5.3.4 The piping analyst is responsible for checking both the nozzle loads and seismic accelerations outlined above. Any suggestions on supporting the valve operator in order to reduce seismic accelerations or pipe overstress problems will be evaluated on a case-by-case basis, as required.

4.6 Analysis

4.6.1 Analytical Procedure

4.6.1.1 The defined auxiliary piping/support systems will be evaluated incorporating three-dimensional static and dynamic models which include the effects of the supports, valves and equipment. The static and dynamic analysis employs the displacement method, lumped parameters, stiffness matrix formulation and assumes that all components and piping behave in a linear elastic manner.

4.6.1.2 The response spectra model analysis technique will be used to analyze piping.

4.6.1.3 The seismic analyses will be based on the OBE and SSE being initiated while the plant is at the normal full power condition.

4.6.1.4 The percentage of the critical damping value to be used in the analysis of the piping system is given in Section 4.4.2. The analysis procedures for damping are given below.

4.6.1.5 For a coupled system with different damping and different structural elements, such as would be the case in analysis with coupling between concrete structures and welded steel components, the method to be used for damping is either to: (a) use the damping which results in the highest load, (b) inspect the mode shapes to determine which modes correspond with a particular structural element, and then use the damping associated with that element having predominant motion, or (c) use composite modal damping value for each mode which is calculated by weighting the damping in each subsystem by the amount of strain energy in each subsystem.

4.6.1.6 For piping systems interconnected between floors of a structure and/or building, the envelope of the respective floor response spectra shall be used in the seismic analysis.

4.6.1.7 The piping will be analyzed for the simultaneous occurrence of two horizontal components and one vertical earthquake input component.

4.6.1.8 The response spectra associated with each earthquake component shall be applied in each direction separately. The combined modal response for each item of interest (e.g., force, displacement, stress) resulting from each component analysis will be combined by the square-root-of-the-sum-of-the-squares method.

4.6.1.9 The combination of modal responses will be in accordance with Regulatory Guide 1.92 or, as an acceptable alternative, in accordance with subsection 3.7.3.4 of Westinghouse RESAR-41 as described below. The total seismic response for each analysis shall be obtained by combining the individual modal response utilizing the square-root-of-the-sum-of-the-squares method.

4.6.1.10 For systems having modes with closely spaced frequencies, the above method shall be modified to include the possible effect of these modes. The groups of closely spaced modes shall be chosen such that the difference between the frequencies of the first mode and the last mode in the group does not exceed 10 percent of the lower frequency. Combined total response for systems which have such closely spaced modal frequencies will be obtained in accordance with Regulatory Guide 1.92 or, as an acceptable alternative, the following method.

Frequency groups are formed starting from the lowest frequency and working toward successively higher frequencies. No frequency should be included in more than one group. The resultant unidirectional response for systems having such closely spaced modal frequencies shall be obtained by the square-root-of (a) the sum-of-the-squares of all modes, and (b) the product of the responses of the modes in various groups of closely spaced modes and associated coupling factors, ε. The mathematical expression for this method (with R as the item of interest) is:

$$R_i^2 = \sum_{j=1}^{N} R_{ij}^2 + 2 \sum_{j=1}^{S} \sum_{K=M_j}^{N_j-1} \sum_{\ell=K+1}^{N_j} R_{iK} R_{i\ell} \varepsilon_{K\ell}, \text{ for: } \ell \neq K$$

where:

R_i = resultant unidirectional response for direction i; i=1, 2, 3

R_{ij} = absolute value of response of direction i, mode j

N = total number of modes considered

S = number of groups of closely spaced modes

M_j = lowest modal number associated with group j of closely spaced modes

N_j = highest modal number associated with group j of closely spaced modes

$\varepsilon_{K\ell}$ = coupling factor with

$$\varepsilon_{K\ell} = \left[1 + \left(\frac{\omega_K' - \omega_\ell'}{(\beta_K' \omega_K + \beta_\ell' \omega_\ell)}\right)^2\right]^{-1}$$

and

$$\omega_K' = \omega_K \left[1 - (\beta_K')^2\right]^{1/2}$$

β_K = fraction of critical damping in closely spaced mode K

t_d = duration of the earthquake (seconds)

Total response, R_T is:

$$R_T = \left[\sum_{i=1}^{3} R_i^2 \right]^{1/2}$$

4.6.1.11 The analyses performed for piping and supports will not include stresses resulting from SSE induced differential motion. These stresses are secondary in nature, based on ASME Code rules for piping (NB-3652, NB-3656, F-1360) and component supports (NF-3231). The safe shutdown earthquake, being a very low probability single occurrence event, is treated as a faulted condition. Therefore, consistent with present ASME philosophy, the secondary stresses associated with the SSE induced differential motion will not be evaluated when performing seismic analysis per the response spectrum method. The basic characteristic of these stresses is that they are self-limiting. Local yielding and minor distortions will satisfy the initial conditions that caused the stress to occur. OBE induced differential motion is to be considered.

4.6.1.12 The analysis of equipment subjected to seismic loading involves several basic steps, the first of which is the establishment of the intensity of the seismic loading. Considering that the seismic input originates at the point of support, the response of the piping and its associated supports, based upon the mass and stiffness characteristics of the system, will determine the seismic accelerations which the equipment must withstand. Three ranges of equipment/support behavior that affect the magnitude of the seismic acceleration are possible:

1. If the equipment is rigid relative to the structure, the maximum acceleration of the equipment mass approaches that of the structure at the point of equipment support. The equipment acceleration value in this case

corresponds to the low period region of the floor response spectra.

2. If the equipment is very flexible relative to the structure, the internal distortion of the structure is unimportant and the equipment behaves as though supported on the ground.

3. If the periods of the equipment and supporting structure are nearly equal, resonance occurs and must be taken into account.

Also, equipment/support systems having natural frequencies greater than 33 Hz are considered rigid. The natural frequencies will be determined, based on the as-built condition and appropriately considered in the analysis.

4.6.1.13 The static load equivalent or static analysis method involves the multiplication of the total weight of the equipment or component member by the specified seismic acceleration coefficient. The magnitude of the seismic acceleration coefficient is established on the basis of the expected dynamic response characteristics of the component. Components which can be adequately characterized as single-degree-of-freedom systems or are rigid are considered to have a modal participation factor of one. Seismic acceleration coefficients for multi-degree-of-freedom systems which may be in the resonance region of the amplified response spectra curves are increased by 50 percent to account conservatively for the increased modal participation.

4.6.1.14 For small piping (2" and smaller) as an option to dynamic analysis, either the equivalent dynamic or static rigid range approach can be used. If the small piping system has low operating temperature, then the pipe lines can be analyzed using equivalent static loads based on spacing table techniques. The static rigid range approach is used for rigid piping systems which are defined as having natural frequencies greater than 33 Hz. In this case, the piping system is analyzed with static equivalent loads corresponding to acceleration in the rigid range of the applicable response spectrum curves. Both horizontal and vertical static equivalent loads are applied to rigid piping systems. The response of the piping system for two orthogonal horizontal directions and one vertical direction are combined on a square-root-of-the-sum-of-squares basis.

4.6.1.15 For any piping that can be shown to be rigid (lowest natural frequency greater than 33 Hz), as an option to performing a dynamic analysis, the static rigid range approach may be used.

4.6.1.16 The following branch line analytical procedure and criteria will be used:

1. The branch line is not included in the run model if its section modulus is 15% or less of the run section modulus.

2. For branch lines which have section moduli greater than 15% of the run section modulus, the branch line will be modeled initially for a distance of 15'0". If it is later determined by the piping analyst that additional modeling information is required, it will be provided and included within the analysis model.

3. In the run analysis where the branch line has not been included, the branch allowable bending moments will be included. Using B31.1 Summer 1973 Addenda, Formula 12, the branch allowable moment can be expressed as follows:

$$M_{BR} = \text{Branch Allowable Moment} = \frac{Z_B}{0.75i} \; KS_h - \left(\frac{P\,Do}{4tn}\right)_R$$

Note: This cannot be more than 15% of the run allowable stress (ks_h)

The revised formula becomes:

$$\frac{PDo}{4tn} + \frac{0.75i}{Z_R} M_A + \frac{Z_B}{0.75i}\left(kS_h - \left(\frac{PDo}{4tn}\right)_R\right) \leq kS_h$$

4. For branch lines which are not included in the model, supports within 10 feet of the run should be noted since a support near the run pipe could effect the branch line flexibility.

4.6.1.17 Piping which extends beyond the scope of the seismic upgrading program effort will be included within the analysis only insofar as it affects fluid lines within scope. In general, piping should be modeled for a distance which covers a minimum of one rigid support in each of the three global directions. Case by case judgements will be made when the above is insufficient or infeasible.

4.6.2 Piping Systems Models

4.6.2.1 Piping Modeling Techniques for Static Analysis

The piping system models are to be represented by an ordered set of data which numerically describes the physical system.

The spatial geometric description of the piping model is based upon the as-built isometric piping drawings and equipment drawings. Node point coordinates and incremental lengths of the members are determined from these drawings. Node point coordinates are input on network cards. Incremental member lengths are input on element cards. The geometrical properties along with the modulus of elasticity, E, the coefficient of thermal expansion, α, the average temperature change from ambient, ΔT, and the weight per unit length, w, are specified for each element. The supports are represented by stiffness matrices which define restraint characteristics of the supports.

A network model is to be made up of a number of sections, each having an overall transfer relationship formed from its group of elements. The linear elastic properties of the section are to be used to define the characteristic stiffness matrix for the section. Using the transfer relationship for a section, the loads required to suppress all deflections at the ends of the section arising from the thermal and boundary forces for the section are obtained. These loads are incorporated into the overall load vector.

After all the sections have been defined in this manner, the overall stiffness matrix K and associated load vector, to suppress the deflection of all the network points, is to be determined. By inverting the stiffness matrix, the flexibility matrix is to be determined. The flexibility matrix is multiplied by the negative of the load-vector to determine the network point deflections due to the thermal and boundary force effects. Using the general transfer relationship, the deflections and internal forces are then determined at all node points in the system. The support loads [F] are also computed by multiplying the stiffness matrix K by the displacement vector [δ] at the support point.

The models used in the static analyses are to be modified for use in the dynamic analyses by including the mass characteristics of the piping and equipment.

The lumping of the distributed mass of the piping systems is to be accomplished by locating the total mass at points in the system which will appropriately represent the response of the distributed system. Effects of the equipment motion will be obtained by modeling the mass and the stiffness characteristics of the equipment in the overall system model when required.

The supports are again represented by stiffness matrices in the system model for the dynamic analysis. Hydraulic shock suppressors which resist rapid motions are to be considered in the analysis.

From the mathematical description of the system, the overall stiffness matrix [K] is to be developed from the individual element stiffness matrices using the transfer matrix $[K_R]$ associated with mass degrees-of-freedom only. From the mass matrix and the reduced stiffness matrix, the natural frequencies and the normal modes are to be determined.

The effect of eccentric masses, such as valves and extended structures, are considered in the seismic piping analyses. These eccentric masses are modeled in the system analysis, and the torsional effects caused by them are evaluated and included in the total system response. The total response must meet the limits of the criteria applicable to the safety class of the piping.

4.6.2.2 Valve Model

Valves will be included in the piping system model. The model employed should reflect non-rigid behavior as well as rigid behavior. For rigid valves, the model used should consist of a rigid beam element from the center of the run pipe to the center of gravity (cg) of the valve. The mass of the valve should be located at the valve cg. For non-rigid valves, the model should have two masses.

4.6.2.3 Equipment Model

Where the stiffness and mass of the equipment attached to the piping will influence the piping system being analyzed, the piping model must include the equipment effect. This is to be accomplished by including in the piping model a model of the equipment to the detail necessary.

4.6.2.4 Interaction Effects

Interaction of other piping systems are to be considered when their response will effect the response of the line being analyzed. The reactor coolant loop, RCL, should be included in the piping system model to the extent of detail required. If the lines being analyzed are relatively small diameter and/or low temperature the RCL need not be included in the model. This is because these lines are so flexible that the RCL deflection will not induce significant stresses in the lines, or that the RCL response characteristics will not cause exciting forces different from those associated with the inner containment building.

Where branch piping is attached to the piping being analyzed, its effect on the piping of interest is accounted for by modeling in accordance with the criteria of 4.6.1.16.

4.6.3 Piping Supports

4.6.3.1 The stiffness of the supports shall be considered in the piping system models. The local subsystem stiffness of all piping and equipment supports shall be determined considering the pipe or equipment supports along with the structural steel and/or concrete effect. The localized subsystem stiffness of all piping and equipment supported by reinforced concrete members (including concrete pedestals) shall be considered when significant. The stiffness shall be based on the face of concrete interface.

4.6.3.2 Rigid supports shall be modeled in accordance with the following criteria.

Nominal Pipe Size	K_{min} Rigid (lb/in)	$K_{\theta min}$ Rigid (in/lb/rad)
$\leq$ 2 inch	1×10^5	1×10^7
3-4 inch	5×10^5	5×10^7
$\geq$ 6 inch	1×10^6	1×10^8

Use of the above guidelines eliminates excessive support stiffness calculation effort, while yielding satisfactory support displacement results (i.e., thermal deflections < .02 inch, rotations < .0002 radians).

4.6.3.3 "Common pipe supports" refer to those supports to which two or more pipes are attached in such a way that significant coupling occurs between the pipes. When all attached pipes are the same size and the distances to adjacent supports are similar, the local subsystem stiffness shall be based on the deflections resulting from an equal load acting at all support points. When different size pipes are attached, or if the distances to adjacent supports are not similar, a stiffness matrix relating the forces and displacements at the points of attachment to one another shall be provided to the piping analyst for his use in uncoupling the piping systems.

4.6.3.4 Hydraulic seismic supports (snubbers) generally lock up at an excitation frequency of approximately 1 Hz, with a piping displacement of .05 inches. Mechanical snubbers activate in a frequency range of 1 to 6 Hz with a similar piping displacement of .05 inches. As piping system frequencies seldom exist below this range, seismic supports will be modeled as active during all seismic events.

4.6.3.5 Supports will be considered active statically in any given direction provided the support gap in that direction does not exceed .125 inches. This .125 inch tolerance is essentially construction variance, which does not alter the designed function of the support. Supports with gaps greater than .125 inch will be incorporated as follows. System analysis will first assume that the support is not active; piping displacements resulting from this run will then be used to ascertain the validity of this assumption. If incorrect, reanalysis will incorporate an active support statically.

5.0 Piping Supports Analysis

Presented in this section is the stress criteria which will be used to evaluate the piping system supports associated with the seismic upgrading program.

5.1 Loads

The piping system component supports will be evaluated to the following combinations of resultant piping system imposed loads and support inertia effects:

1. Normal Condition: Deadweight and maximum operating thermal
2. Design Condition: Deadweight, maximum operating thermal and operational basis earthquake.
3. SSE Condition: Deadweight, normal operating thermal and safe shutdown earthquake.

5.2 Stress Criteria

The piping system component supports will be designed and evaluated for the loading conditions specified in Section 5.1. The loading combinations and associated stress limits which are part of the seismic upgrading program are given in Table VI-1. The stress limits given are consistent with the FSAR Appendix 4A commitments. The allowable stress criteria is in accordance with Subsection NF of the ASME Section III Code, 1974. Note that faulted condition stress allowables from Appendix F of the ASME Section III Code and US NRC Regulatory Guide 1.124 will be used to analyze the supports for the SSE condition. The variance in allowable criteria between the piping and supports will not cause over or under-designs to occur, as the satisfaction of the OBE condition to the working stress limits will in all cases be most stringent. The component support embedments will be evaluated using current analytical techniques in accordance with Hilti Technical Information. The expansion anchorages shall meet the requirements set forth in NRC IE Bulletin No. 79.02.

For anchors which separate Seismic Category I piping systems from non-seismic Category I piping, the loads from the Seismic Category I side will be doubled. The effects of friction on supports will be considered for pipes having thermal movements. The value of μ will be 0.75.

6.0 Codes, Standards and Regulatory Requirements

6.1 The seismic upgrading program will encompass piping systems which are Seismic Category I, 2 1/2" and larger, within the following structures; containment, interior structure, turbine, auxiliary, intermediate, control, and diesel generator buildings. Branch line inclusions and class break overlaps are exceptions to the above.

6.2 Seismic Category I systems are analyzed to the ANSI-B31.1 Summer 1973 Code. Seismic Category I systems do not include non-nuclear safety (NNS) systems.

6.3 The codes and standards to which the seismic upgrading program systems will comply are outlined in Sections 4.3.2 through 4.3.4.

7.0 System Design and Operating Conditions

The design and operating conditions to which the piping systems will be analyzed are defined within the RGE Operating and Design Conditions Documents. System thermal analyses evaluate the normal 100% power condition, as well as other abnormal operating transient conditions. The most severe upset conditions will satisfy equation 4B of Table V-1, Loading Combinations and Stress Limits Table for Piping.

Seismic analyses will incorporate the GAI developed response spectra for both the operational basis and safe shutdown earthquake cases. Spectra will be derived from buildings and elevations applicable to the individual analysis lines.

APPENDIX

TABLE V-1

LOADING COMBINATIONS AND STRESS LIMITS FOR PIPING

	Loading Combinations	Stress Limits
1. Deadweight:	Design Pressure + Deadweight	$P_m \leq S_h$ $P_L + P_B \leq S_h$
2. OBE Seismic:	Design Pressure + Deadweight + Design Earthquake Loads (OBE)	$P_m \leq 1.2\ S_h$ $P_L + P_B \leq 1.2\ S_h$
3. SSE:	Operating Pressure + Deadweight + Maximum Potential Earthquake Loads (SSE) + Normal Operating Thermal	$P_m \leq 1.8\ S_h$ $P_L + P_B \leq 1.8\ S_h$
4. Thermal:	A. Maximum Operating Thermal + OBE Displacements	$S_E \leq S_A$
	B. Design Pressure + Deadweight + Maximum Operating Thermal + OBE Displacements	$P_L + P_B \leq (S_h + S_A)$

Where

P_m = primary general membrane stress; or stress intensity

P_L = primary local membrane stress; or stress intensity

P_B = primary bending stress; or stress intensity

S_A, S_h = allowable stress from USAS B31.1 Code for pressure piping

S_E = thermal expansion stress from USAS B31.1 code for pressure piping

TABLE V-II

ALLOWABLE STEAM GENERATOR NOZZLE LOADS

FEEDWATER NOZZLE

Condition	F_x	F_y	F_z	M_x	M_y	M_z
Thermal	15	40	40	2000	3000	3000
Pressure	+221	0	0	0	0	0
Weight	5	15	5	250	500	500
Seismic OBE	150	150	150	1500	2000	2000
Seismic DBE	200	200	200	2000	3000	3000

STEAM NOZZLE

Condition	F_x	F_y	F_z	M_x	M_y	M_z
Thermal	100	50	50	3000	5000	5000
Pressure	+692	0	0	0	0	0
Weight	20	10	10	50	500	750
Seismic OBE	150	150	150	5000	5000	5000
Seismic DBE	200	200	200	7500	7500	7500

Notes:

1) All loads are ± unless indicated
2) Units are kips and in-kips.
3) Coordinate system.

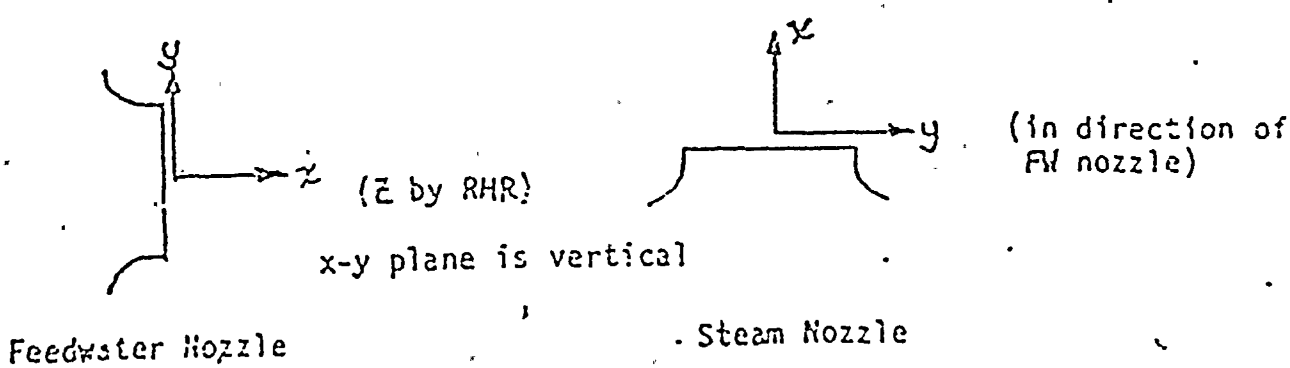


TABLE V-III

REACTOR COOLANT PUMP AUXILIARY NOZZLE UMBRELLA LOADS

Nozzle	Condition/Load	F_x (lbs)	F_y (lbs)	F_z (lbs)	M_x (in-lbs)	M_y (in-lbs)	M_z (in-lbs)
Seal Injection	Thermal	350	100	300	3500	2800	2000
	Deadweight	10	-80	10	300	250	400
	Seismic OBE	250	50	225	1600	4500	2000
	Seismic SSE	800	250	350	3200	15000	4000
No. 1 Seal Bypass	Thermal	75	70	40	300	315	1525
	Deadweight	5	-25	1	75	50	350
	Seismic OBE	50	50	45	900	1200	900
	Seismic SSE	160	170	170	1650	2550	2000
No. 1 Seal Leakoff	Thermal	400	200	300	2000	2000	2000
	Deadweight	1-	-80	5	300	250	400
	Seismic OBE	500	400	500	1000	5000	2000
	Seismic SSE	800	500	600	2000	8000	3500
No. 2 Seal Leakoff	Thermal	75	100	100	300	350	1600
	Deadweight	5	-25	5	75	75	400
	Seismic OBE	50	100	100	900	1500	1200
	Seismic SSE	160	170	170	1650	2500	2000
No. 3 Seal Injection	Thermal	90	45	45	290	290	180
	Deadweight	15	35	10	90	45	180
	Seismic OBE	90	150	150	480	560	480
	Seismic SSE	180	300	300	960	1120	960
No. 3 Seal Leakoff	Thermal	90	45	45	290	290	180
	Deadweight	15	35	10	90	45	180
	Seismic OBE	90	150	150	480	560	480
	Seismic SSE	180	300	300	960	1120	960
Thermal Barrier CCW In & Out	Thermal	75	200	150	3200	1300	2500
	Deadweight	20	-75	1	5	5	150
	Seismic OBE	100	250	100	1000	1200	1200
	Seismic SSE	200	700	200	4500	3000	3600

TABLE V-III (Cont)

REACTOR COOLANT PUMP AUXILIARY NOZZLE UMBRELLA LOADS

Nozzle	Condition/Load	F_x (lbs)	F_y (lbs)	F_z (lbs)	M_x (in-lbs)	M_y (in-lbs)	M_z (in-lbs)
Upper Bearing	Thermal	100	100	100	300	300	200
Oil Cooler &	Deadweight	5	-80	5	100	50	200
Air Cooler	Seismic OBE	100	300	300	500	600	500
CCW In & Out	Seismic SSE	200	600	600	1000	1200	1000
Lower Bearing	Thermal	95	340	305	470	480	525
Oil Cooler	Deadweight	10	-35	10	100	125	125
CCW In & Out	Seismic OBE	90	90	90	290	290	180
	Seismic SSE	90	90	90	290	290	180

Notes:

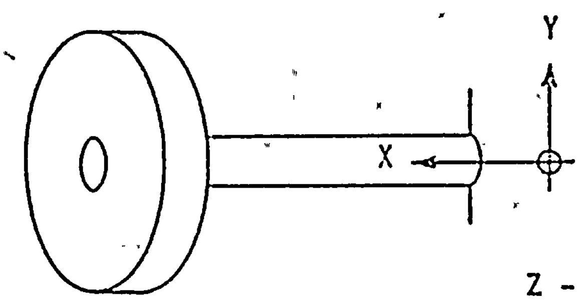
1) Values at +/- unless otherwise specified.

2) Loads on the No. 3 seal connections apply only if a No. 3 "Double Dam" seal is supplied.

3) Loads on pump nozzles are to be applied at the nozzle to shell juncture.

4) Loads on motor nozzles are to be applied at the flange end.

5) Coordinate System:



Z - by Right-Hand-Rule

TABLE VI-1

LOADING COMBINATIONS AND STRESS LIMITS FOR SUPPORTS ON PIPING SYSTEMS

Loading Combination		Stress Limits
Normal:	D or D + F + T	$\leq$ Working Stress(1)
Upset:	D $\pm$ E or D + F + T $\pm$ E	$\leq$ Working Stress(1)
Faulted:	D $\pm$ E' or D + F + T_o $\pm$ E'	$\leq$ Faulted Stress(2)

Deadweight and thermal are combined algebraicly

D = Deadweight

T = Maximum operating thermal condition for system

F = Friction Load (3)

E = OBE (Intertia load + seismic differential support movement)

E' = SSE (Inertia load + seismic differential support movement)

T_o = Thermal - Operating Temperature

(1) Working stress allowable per Appendix XVII of ASME III.

(2) Faulted stress allowable per Appendix XVII, Subsection NF, and Appendix F of ASME III and USNRC Regulatory Guide 1.124. Safety Class 1 supports will be evaluated and designed in accordance with position 8 of Regulatory Guide 1.124.

(3) Whenever the thermal movement of the pipe causes the pipe to slide over any member of a support, friction shall be considered. The applied friction force applied to the support is the lesser of μ W or the force generated by displacing the support an amount equal to the pipe displacement.

μ = .75
W = Normal load (excluding seismic) applied to the member on which the pipe slides.

TABLE VI-1 (CONTINUED)

LOADING COMBINATIONS AND STRESS LIMITS FOR SUPPORTS ON PIPING SYSTEMS

(4) Expansive anchorages shall meet the requirements of NRC IE Bulletin 79-02.

Component Standard Supports (New and Existing)

For component standard supports which have certified load capacity data sheets (LCDS), the loads given on the LCDS shall serve as the maximum allowable load for the given loading condition.

For component standard supports which do not have certified LCDS, the catalog allowable load at the time of manufacture will be prorated for the various loading conditions by the same factor used for the same component with a LCDS. The prorated load shall serve as the maximum allowable load for the given loading condition.

Supports Fabricated from Non Catalog Items

The stress limits for supports fabricated from non-catalog items shall be based on allowable stresses from ASME III, ANSI or ASTM material standards at the time of procurement for the material used. If the material is not known, it is assumed to be A-36 carbon steel.

Attachment 1

to

Ginna Station

Seismic Upgrading Program

Scope Document

EWR 2512

RG&E/NRC Meeting Minutes

July 24, 1979

Revision 1

September 24, 1979

RGE Decision to Upgrade Ginna Station Seismic

Analysis of Category I Piping Systems

I. 3-Year Program Commitment May 1979

- Dynamic analysis of essential safety systems to current standards for dynamic analysis.
- Modifications to piping as required to upgrade to new standard to extent practical.

II. Basis for Original Seismic Qualification

- Housner ground response spectrums .08 DBE, 0.2 SSE with 0.5% critical damping.
- Equivalent Static Analysis of 2½" and larger Cat I piping systems.

$$S_{\substack{Seismic \\ SSE}} + S_{DW} + S_{press} \leq 1.8\ S_h$$

- Field run piping 2" and less to conservative B31.1 code spacing criteria for vertical and horizontal forces.
- Design verification by dynamic analysis of 2 piping systems inside containment A RHR, B Main Steam.
- System walkdown by seismic Westinghouse, GAI, RGE engineers, June 1969.
- Documentation (minimal record keeping requirements of late 1960s).

III. Challenges to Existing Seismic Analysis

- Major Modification Programs (high energy backfits outside containment 1974, Standby Auxiliary System 1975, Spent Fuel Pit Cooling 1977)
- Corporate Decision 1974 to design and construct major modification to current codes and standards - Section 3 with dynamic analysis including structural response.

- NRC seismic SEP review program (structures, equipment, piping) independent review of original seismic qualification using current analysis techniques.

- Current Regulatory Seismic Concerns.

  IE Bulletins 79-02 Anchor Bolts
  79-04 Velan Valves
  79-07 Algebraic Summation
  79-14 As-Built Configuration

IV. Benefits to RGE of Seismic Upgrade Analysis Upgrade Program

- Provides a consistent design basis seismic analysis baseline for essential Cat I piping systems for future evaluation during next 10 years.

- Provides a level of design documentation for analysis and support design consistent with current practice and record keeping requirements.

- Permit a systematic approach to development of design and analytical data versus chaotic efforts associated with current and future bulletin concerns.

- Provide seismic and input data based on current system configuration to SEP evaluators (scheduled to maximize manpower productivity).

- Provides consistent means of evaluation for future modification requirements (i.e. SEP, Three Mile Island, High Energy Inside Containment, etc.)

- Upgrades plant seismic design to current industry standards. Includes effects of soil-structure interaction, structural amplification, higher damping values, multi-mode behavior.

GINNA STATION

SEISMIC UPGRADING PROGRAM
RGE/NRC MEETING
BETHESDA, MD

JULY 24, 1979

1. Scope

- structures
  - containment and interior structure
  - turbine, auxiliary, intermediate, control, diesel generator buildings
- systems
  - seismic category I, 2½" and larger, main runs critical 2" within above structures
  - initial program - main steam, main feedwater, auxiliary feedwater, service water, containment spray, auxiliary spray, safety injection, residual heat removal
  - CVCS - charging, letdown, seal water
  - expanded program - reactor coolant system, component cooling system
- downgrading
  - waste disposal system
- exclusions
  - screenhouse
  - standby auxiliary feedwater building and system
  - spent fuel pool cooling system
  - buried piping (principally service water)
  - LOCA and pipe break
  - no fatigue analyses being performed
  - pressurizer relief valve discharge piping

2. <u>Structural Analysis</u>

- method

original plant design utilized ground response spectra
upgrading program will use floor response spectra dynamic lumped mass model

1. coupled - containment and internal structure (includes RCS)
2. interconnected buildings - turbine, auxiliary, intermediate, control, diesel generator
3. 2D for symmetrical buildings
4. 3D for structures with significant torsional modes
5. large equipment masses included
6. vertical amplification of floors and beams calculated separately
7. soil structure interaction will be included in model

ground response spectra based on 0.08g OBE, 0.20g SSE

artificial time histories used as input for generating floor response spectra

differential displacements to be calculated for OBE only

- criteria

Reg. Guide 1.60 - response spectra
Reg. Guide 1.61 - damping values
Reg. Guide 1.92 - combination of modal responses

3. <u>Piping Analysis</u>

- method

original plant design utilized equivalent static analysis
upgrading program will use response spectra modal analysis
response spectra will envelope points of piping supports
3D dynamic model

1. support stiffnesses to be included
2. eccentric masses, such as valve operators, included

3. equipment masses and stiffnesses included where necessary

4. effect of reactor coolant system included for large secondary lines

5. effect of branch lines included with main run

loading conditions

1. normal - design pressure + deadweight S_h

2. design - OBE + design pressure + deadweight $1.2\ S_h$

3. SSE - SSE + operating pressure + deadweight $1.8\ S_h$

4. thermal - OBE displacements + thermal S_a
   pressure + deadweight + thermal +
   OBE displacements $S_a + S_h$

stresses due to OBE differential motion only will be calculated

- criteria
  USAS B31.1-1973 - stress criteria (Summer 1973 Addenda)
  Reg. Guide 1.60 - damping values
  Reg. Guide 1.92 or RESAR 41 - combination of modal responses

  criteria developed for allowable loads on equipment models, valves, and branch piping

4. Support Analysis

- method
  original plant component supports utilized manufacturers standards

  fabricated supports designed and fabricated to AISC Code

  upgrading program will analyze supports in 3 stages

  1. calculation of stiffnesses for piping analyses

  2. comparison of new loads against original

  3. redesign of existing supports and design of new supports as necessary

embedments will be included in evaluating integrity of existing supports

base plate flexibility will be included

loading combinations evaluated will be same as piping

- criteria
  ASME III, Subsection NF - stress criteria (1974)
  Reg. Guide 1.124 - service limits and loading combinations
  ACI-349, App. B - embedments

5. <u>Modifications</u>

- existing supports
  replace load rated supports where new loads exceed existing rating

  replace or modify structural steel members (including base plates) and welds as required to meet stress limits

  replace embedments where necessary to meet new loads and safety factors

- structures

  local modification/reinforcement of existing structural steel and concrete where necessary for increased loads

6. <u>Output</u>

- isometrics
  as-built isometrics containing all "seismic input" information dimensions, wall thickness, materials, valves, support location and type, etc.

- stress reports
  summary and detailed stress reports for piping
  correspond to isometrics
  support and nozzle loads
  summary reports of support analyses
  comparison of calculated values with code allowables

- as-built drawings
  piping orthographic drawings
  pipe support location and detail drawings
  rated support loads

26.0 REVISION STATUS SHEET

Page	Latest Rev.	Page	Latest Rev.	Page	Latest Rev.

Criteria for selection of lines in the piping upgrade program

1.0 Only piping that is considered seismic Category I as identified by the color coded P&ID's in Appendix A of the Ginna Station QA Manual shall be included.

2.0 Main runs of piping included shall be based on the following criteria.

2.1 Main runs of piping which are 2½ inch and larger and critical 2 inch piping.

2.2 Main runs which provide the fluid flow path to/or from equipment required for safe shutdown and LOCA mitigation based on SEP. Equipment does not include instrumentation.

2.3 Selected additional main runs not included in 2.2 but which are a primary part of the systems included in the upgrade program.

3.0 Branch lines included shall be based on the following criteria.

3.1 Branch lines shall be included in the analyses as necessary to determine the local effects of the branch lines on the main runs and to assure adequate flexibility exists in the branch line to prevent local overstress in the branch due to main run displacements.

3.2 Branch lines whose section modulus is greater than 15% of the main run section modulus shall be included in the analysis for an appropriate distance and/or number of supports.

3.3 Branch lines whose section modulus is less than 15% of the main run section modulus do not need to be explicitly included in the analysis.

Lines Selected

The following main lines are included in the Piping Seismic Upgrade Program:

1.0 Reactor Coolant System

1.1 Primary Loop

1.2 Surge line

1.3 Pressurizer spray lines from the cold legs to the pressurizer.

2.0 Main Steam

2.1 The 30" lines from both SG's through the penetrations and up to the MSIV's.

2.2 Inlet piping up to safety and relief valves.

3.0 Main Feedwater

3.1 The 14" lines from the SG's through the penetrations and up to check valves 3992 and 3993.

4.0 Auxiliary Feedwater

4.1 The discharge lines from the two motor driven pumps and the turbine driven pumps up to the main feedwater connections.

4.2 The condensate and service water suction lines from the pumps to check valves 4014, 4017, 4018 and to valves 4013, 4027, 4028.

5.0 Safety Injection

5.1 The 10 inch SI accumulator discharge lines to the cold legs.

5.2 SI pump suction lines from the RWST through 896 A&B and 825 A&B to the three pumps.

5.3 The SI pump discharge lines from the three pumps to the SI accumulator discharge lines and to the two hot leg connections.

5.4 The boric acid lines from the boric acid storage tanks to the SI pump section line.

5.5 The 4 inch alternate SI suction line from valves 1816 A&B to the pump.

5.6 The 10 inch low head SI suction from the RWST to valve 854.

5.7 The 6 inch/8 inch header from the RWST to valves 857 A, B, and C.

5.8 The 8 inch suction lines from contain sump B to valves 850 A&B and the 6 inch branch lines to valves 1810 A&B.

5.9 The low head safety injection lines from valves 852 A&B to the RCS.

6.0 Residual Heat Removal

6.1 The 10 inch suction lines from the loop A hot leg to the two RHR pumps.

6.2 From valves 850 A&B to the pumps.

6.3 From valve 854 to the suction header.

6.4 The two pump discharge lines through heat exchangers and to the common 10 inch return.

6.5 The 10 inch return through penetration P111 and to the B cold leg.

6.6 The discharge cross-connect including valves 709C and D.

6.7 The heat exchanger by-pass line including valves 712 A&B.

6.8 The two lines from the RHR heat exchanger outlets to valves 857 A&B and 1816B.

6.9 The recirculation line from the RHR return through valve 822B to the RHR suction line.

6.10 The two lines from the RHR return to valves 852 A&B.

7.0 Containment Spray

7.1 The two suction lines from RWST header to the spray rings.

7.2 The two pump discharge lines and spray rings.

7.3 The two eductor lines from the pump discharges to the pump suctions.

7.4 The spray additive lines from the tank through 836 A&B and to the two eductors.

8.0 Chemical and Volume Control

8.1 The auxiliary pressurizer spray line the connection at regenerative heat exchanger outlet line to the pressurizer spray line.

8.2 The letdown line from the RCS through the regenerative heat exchanger, through the non-regenerative heat exchanger, through valve TCV 145 to the volume control tank.

8.3 The 4 inch header from the VCT and the 3 inch suction lines to the three charging pumps.

8.4 The three charging pump discharge lines to the acoustic filter.

8.5 The 2 inch charging lines from the acoustic filter through the regenerative heat exchanger to both the hot and cold leg connections.

8.6 The 3 inch seal water header from the acoustic filter and the two 2 inch lines to the RCP seals.

8.7 The 2 inch seal water return lines from the RCP seals and the 3 inch return header through the seal water heat exchanger to the VCT. Includes 3/4 inch piping through flow transmitters 175, 176, 177, and 178.

8.8 The 4 inch line from the RWST through valves LCV 112B and 358 to the charging pump suction header.

9.0 Steam Generator Blowdown

9.1 The two 2 inch lines from the SG's through the penetrations to the isolation valves.

10.0 Service Water System

10.1 The inlet piping to both diesel generators including the cross-connection between the diesels, the 16, 14, and 10" supply to the Turbine Building up to valve 4613.

10.2 The outlet piping from both diesel generators to an anchor point outside the diesel generator room.

10.3 The 20 inch supply lines and header inside the Auxiliary Building.

10.4 The 18, 14, and 6" supply lines from the 20 inch header to the two component cooling water heat exchangers and the spent fuel pool heat exchanger.

10.5 The normal discharge lines from the component cooling water heat exchangers and the spent fuel pool heat exchangers and the spent fuel pool heat exchanger including the 20 inch discharge inside the Auxiliary Building.

10.6 The 3 inch supply and normal discharge headers to and from the SIS pumps and equipment coolers in the Auxiliary Building includes piping through valves 4738, 4739, and 4739A.

10.7 The 16 and 14 inch supply headers inside the Intermediate Building. Including piping through valves 4040, 4623, 4639, and 4756.

10.8 The 10 inch supply to the Turbine Building up to valve 4614.

10.9 The 4 inch supply lines to the AFW pumps.

10.10 The 2½ inch and 8 inch supply and discharge lines to and from the 1A, 1B, 1C and 1D Containment Ventilation Cooling Coils and Fan Motors.

10.11 The 2½ inch supply and discharge lines for the reactor compartment coolers, including piping through valves 4625, 4626, and 4624.

10.12 The 4 inch supply to the air conditioning water chillers up to the isolation valves 4663 and 4733.

10.13 The common discharge header for the ventilation coolers up to an anchor point outside the Intermediate Building.

11.0 <u>Component Cooling Water</u>

11.1 The 14 suction header and 10 inch suction lines to the CCW pumps.

11.2 The CCW pump discharge lines to the CCW heat exchangers.

11.3 The 4 inch and CCW surge tank line.

11.4 The 10 and 14 inch supply headers out of the CCW heat exchangers.

11.5 The 10 and 14 inch supply lines to both residual heat exchangers.

11.6 The 10 and 14 inch return lines from the residual heat exchangers to the CCW pumps suction header.

11.7 The 2 inch supply and return lines to the RHR pump coolers.

11.8 The 14 and 8 inch supply and return headers servicing the reactor coolant pumps and reactor supports.

11.9 The 3 and 4 inch supply and return line to both reactor coolant pump motors. P 123, 125, 127, 126

11.10 The 6 inch supply and return lines for the reactor supports from the 8 inch headers to penetrations 130 and 131.

11.11 The 2 inch supply and return lines for the excess letdown heat exchanger from the 8 inch header to penetrations 124 and 126.

11.12 The 6, 4, and 2 inch supply and return lines for the nonregenerative heat exchanger and the seal water heat exchanger.

11.13 The 2 inch supply and return lines for both containment spray and both safety injection pumps.

[illegible]