NORTHERN STATES POWER COMPANY

PRAIRIE ISLAND NUCLEAR GENERATING PLANT UNITS 1 & 2

SEISMIC QUALIFICATION OF AUXILIARY FEEDWATER SYSTEMS

(NRC GENERIC LETTER NO. 81-14)

July 14, 1981

UNITED STATES NUCLEAR REGULATORY COMMISSION

NORTHERN STATES POWER COMPANY

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

Docket No. 50-282
50-306

LETTER DATED JULY 14, 1981
RESPONDING TO NRC LETTER DATED FEBRUARY 10, 1981 (GENERIC
LETTER 81-14) SEISMIC QUALIFICATION OF AUXILIARY FEEDWATER SYSTEMS

Northern States Power Company, a Minnesota corporation, by this letter dated July 14,1981 hereby submits in response to NRC letter dated July 14, 1981, information concerning the seismic qualification of the Prairie Island Auxiliary Feedwater Systems as requested by NRC Generic Letter 81-14.

This submittal contains no restricted or other defense information.

NORTHERN STATES POWER COMPANY

By L.O. Mayer
L O Mayer
Manager of Nuclear Support Services

On this 14th day of July, 1981, before me a notary public in and for said County, personally appeared L O Mayer, Manager of Nuclear Support Services, and being first duly sworn acknowledged that he is authorized to execute this document on behalf of Northern States Power Company, that he knows the contents thereof and that to the best of his knowledge, information and belief, the statements made in it are true and that it is not interposed for delay.

Betty J. Dean

BETTY J. DEAN
NOTARY PUBLIC - MINNESOTA
RAMSEY COUNTY
My Commission Expires Dec 16 1987

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1.0 ABSTRACT

This report presents the results of the review performed to ensure the seismic qualifications of the Auxiliary Feedwater System.

Sections 1.0 through 3.0 contain discussion pertaining to the seismic requirements, methodologies, and criteria required by the various disciplines for the seismic qualification of this system. Also, included in Section 2.0 is a discussion of the field inspections performed to document non-safety related equipment in the area of the Auxiliary Feedwater Systems and to document by visual inspection the requirements for seismic qualification of the primary supply.

Section 4.0 contains recommendations for improvements to the electrical and control components of the Auxiliary Feedwater System.

Section 5.0 contains a list of all mechanical deficiencies. Section 6.0 contains a summary of operating procedures. Section 7.0 contains the conclusions which refer to Appendix A. Appendix A contains completed Table I of NRC Generic Letter No. 81-14.

In general, the Auxiliary Feedwater System including the secondary water supply (cooling water system) is seismically qualified with exception of the deficiencies listed in Section 4.0 and 5.0.

2.0 SEISMIC QUALIFICATION OF PIPING AND MECHANICAL COMPONENTS IN THE AFW SYSTEMS

2.1 INTRODUCTION

This report verifies that the seismic qualification of Auxiliary Feedwater (AFW) Systems are in compliance with NRC Generic Letter No. 81-14. The Auxiliary Feedwater System at Prairie Island Nuclear Generating Plant (Units 1 and 2) have been designed and maintained as seismically qualified systems. The AFW systems are able to function following the occurrence of earthquakes up to and including a Design Basis Earthquake postulated for the plant. The AFW systems design utilize Type I Components including piping in accordance with Design Class I criteria for the plant. The Cooling Water System is the source of the water supply for the seismically qualified AFW Systems. The portion of the Condensate System which is the primary source of the Auxiliary Feedwater supply is not seismically qualified.

Procedures are incorporated in the operation of the plant to switch from primary source (the Condensate System) to the secondary source (the Cooling Water System) in the event of a loss of primary source of supply.

The seismically qualified AFW System boundaries from suction to discharge include those portions of the system required to accomplish the AFW System function and connected branch piping including at least one valve in each branch piping which provides capability to isolate the AFW system. The valve(s) in the branch piping are either normally closed or capable of automatic or manual closure

2.1 INTRODUCTION (CONT'D)

when the safety function is required. This feature is further discussed in Section 2.2. In addition, the AFW System boundary also includes any portion of the branch piping beyond the aforementioned valve(s) up to the first structural anchor or equipment connection. Smaller branch piping originating beyond the boundary valve is not considered.

The AFW system within the above defined boundary includes portions of the Auxiliary Feedwater, Cooling Water, Auxiliary Steam, Main Steam and Feedwater Systems. The AFW system is designed and constructed to withstand a Design Basis Earthquake postulated for the plant utilizing the analytical, testing, evaluation methods and acceptable Class I Criteria consistent with other safety grade systems in the plant. These systems are also included within the scope of seismic related NRC IE Bulletins 79-02, 79-04, 79-07, 79-14 and 80-11 and IE Information Notice 80-21.

A seismic evaluation of the primary supply piping was also performed.

2.2 SEISMIC DESIGN VERIFICATION

All piping, in general, and components within the specified boundary of the AFW System are QA Type I, Design Class I as defined for the plant and are designed as such. In order to confirm compliance to the seismic design criteria, pertinent documents have been reviewed. Seismic analysis of the piping or component and its review and approval assured compliance.

All piping within the boundaries have been verified for seismic qualification. Valves within the boundaries were verified for seismic qualification.

AFW systems piping have been analyzed using Fluor Power Services (FPS) computer program PIPESTRSS and received an independent review and approval within the FPS organization.

The seismic qualification of the power supplies and initiation and control systems for the aux feedwater system was evaluated by Teledyne Engineering Services. Data was gathered and evaluated, after which a team of engineers qualified in seismic analysis individually inspected each electrical component covered under items 4 and 7 (Table 1) of NRC letter 81-14. The evaluation was based more on experience and engineering judgement than on detailed analysis, although analysis was applied in cases where the structural adequacy of the anchorage was not obvious by inspection. The evaluation resulted in the conclusion that the anchorage of most of the Auxiliary Feedwater System Electrical Components is adequate to withstand a Safe Shutdown Earthquake.

The Auxiliary Feedwater, Cooling Water and Auxiliary Steam Systems are discussed in detail in the following sections.

2.2.1 Auxiliary Feedwater System

The Auxiliary Feedwater (AF) System includes piping from the Auxiliary Feedwater pumps to the Steam Generators and branch piping up to the second valve which is normally closed or a valve capable of automatic closure. Portions of the main feedwater

2.2 SEISMIC DESIGN VERIFICATION (CONT'D)

2.2.1 Auxiliary Feedwater System

piping up to the first motor operated valve upsteam of the AF piping connection are also included. These valves when closed will isolate the piping in the direct flow path of the auxiliary feedwater.

The piping within the AF system have been seismically qualified and meets the criteria for Design Class I piping. A verification of seismic qualification for all valves was performed. Some valves of size 2 inches and under were exempt from seismic qualification in accordance with the specifications. All remaining valves were purchased with Design Class I seismic qualification as a specified requirement. Seismic analysis, review and approval documentation for certain VELAN valves were not found in the files. It appears from pertinent documents that seismic calculations were performed for these valves. Since the search for the documents was not exhaustive and since seismic analysis was required by the specification, it is felt that these valves were seismically qualified. All other equipment in the system was found to have the required seismic qualification.

2.2.2 Cooling Water System

The Cooling Water System boundaries include piping from Design Class I pump discharge to Auxiliary Feedwater pump suction and the ring header which provides a redundant path of cooling water supply to Units 1 and 2 and connected branch piping included at least one valve to isolate the system to provide its safety related function.

2.2 SEISMIC DESIGN VERIFICATION (CONT'D)

2.2.2 Cooling Water System

The Cooling Water System provides cooling water to a number of essential systems in addition to the Auxiliary Feedwater pump supply. These systems will remain functional in the event of an accident. Branch runs with a nominal pipe size of 4 inches and larger which supply cooling water to non-essential systems are provided with valves capable of automatic closure with the exception of a supply line to the sprinkler system with a nominal pipe size of 4 inches. Branch runs with nominal pipe size smaller than 4 inches can be isolated by manual closure of the valves. These valves are readily accessible for operation.

All piping within the defined boundaries, with the exception of four (4) branch runs with nominal pipe size of 2 inches which are identified in Section 5, have been seismically qualified. Valves 2 inches and smaller are exempted from seismic qualification in accordance with the specifications. All remaining valves and equipment were found to be seismically qualified.

2.2.3 Auxiliary Steam System

The Auxiliary Steam System boundaries include the 3 inches diameter steam piping from the main steam header to the Auxiliary Feedwater Pump Turbine and portions of the Main Steam System from the steam generator up to the first isolation valve. These main steam isolation valves which provide a boundary for the AFW system within the Auxiliary Steam System are capable of automatic closure. The safety relief valves in the Main Steam System within the boundaries

2.2 SEISMIC DESIGN VERIFICATION (CONT'D)

2.2.3 Auxiliary Steam System

are normally closed and the dump valves are designed to operate at the set pressure. All piping within the boundaries except drains to traps have been seismically qualified. Equipment and valves with the exception of those smaller than 2 inches are also seismically qualified.

2.3 WALKDOWN OF THE AFW SYSTEMS

A walkdown of the AFW system piping within the defined boundaries including the primary water supply piping was performed by personnel experienced in the design, analysis and evaluation of nuclear piping systems.

2.3.1 Auxiliary Feedwater, Cooling Water and Auxiliary Steam Systems

All piping and equipment within these systems (except as noted in Section 5) are seismically qualified. The walkdown of these systems identified and located piping or components which were not designed in accordance with Class I design criteria or which could have potential for damaging the AFW system piping.

2.3.2 Primary Water Supply (Condensate) System

This system is not designed in accordance with Class 1 seismic design criteria. The purpose of the walkdown was to determine the extent of seismic resistance inherent in the piping system based on the present support system and to study the possibility of upgrading this system to the same grade as the rest of the AFW systems.

The majority of the piping in this system is in trenches. Supports

2.3 WALKDOWN OF THE AFW SYSTEMS (CONT'D)

2.3.2 Primary Water Supply (Condensate) System

in this system are designed for dead weight load plus .5g seismic load. The existing support system will provide adequate seismic resistance in the direction lateral to the header pipe (north-south). Additional seismic restraints in the east-west direction would improve the seismic resistance of the primary system piping.

2.4 SEISMIC QUALIFICATION CRITERIA

The following Sections provide a description of seismic analysis methods employed, seismic input, load combinations which include the Design Basis Earthquake, allowable stresses and qualification testing. Seismically qualified piping and components satisfy these criteria.

2.4.1 Seismic Analysis Methods

2.4.1.1 Design Class I Piping

AFW systems have been subjected to a multidegree-of-freedom dynamic seismic analysis utilizing modal techniques and the response spectrum method. The piping system is modeled as a lumped mass system. Valves and valve operators were considered as lumped masses in the pipe, applied at the center of gravity of the valve. The stresses, deflections and accelerations at each point were determined by the square root of the sum of the squares method.

Seismic effects of piping systems due to the relative displacement of structures and differential seismic movements at points of attachment to the structure have been considered. These movements are imposed as the boundary conditions in a static displacement analysis.

2.4 SEISMIC QUALIFICATION CRITERIA

2.4.1.1 Design Class I Piping

All movements are superimposed in such a manner as to yield the maximum relative displacements. The resulting stresses were combined with stresses due to other loading conditions as given in Table 1 (see following page).

All Class I piping is isolated by structural anchors from piping for which Class I analysis is not required. Class II or Class III pipe which is connected to Class I pipe is analyzed as Class I up to a structural or equipment anchor which provides a means for isolating the Class I piping from the Class II or III piping.

2.4.1.2 Class I Mechanical Components

Class I Mechanical components are designed to be capable of continued safe operation within normal design limits when subjected to the combination of normal operating loads and the Operating Basis Earthquake loads. For the Design Basis Earthquake the mechanical components are designed so that deflections or distortions resulting from the combination of normal operating loads and twice the OBE loads shall not prevent their proper functioning, shall not endanger adjacent or attached equipment, and shall not cause the equipment to operate in an uncontrolled manner.

In general, mechanical components and its supports are designed to be sufficiently rigid so that its natural frequency or frequencies will be out of the range of reasonance with the building structure where it is located. A proper mathematical model is used to determine the natural frequency or frequencies of the

TABLE 1

LOAD COMBINATION FOR CLASS 1 COMPONENTS

1.	Normal	Dead + Live
2.	Normal & Operational Basis Earthquake (OBE)	Dead + Live + OBE
3.	Normal & Design Basis Earthquake (DBE)	Dead + Live + DBE
4.	Normal & Pipe Rupture	Dead + Live + DBA (or other pipe rupture loads if greater)
5.	Normal & Design Basis Earthquake & Pipe Rupture	Dead + Live + DBE + DBA (or other pipe rupture loads if greater)

DBA - Design Basis Accident as defined for the plant

Extracted from the F.S.A.R., Table B.7-1

component. For a single-degree-of-freedom model, a static analysis is performed by applying the accelerations at the mass center corresponding to the natural frequency of the component. In the case of a multidegree-of-freedom model, the model superposition is used to determine the responses of the dynamic system. For those components for which the natural frequency cannot be determined the peak values of the floor response accelerations multiplied by the maximum torsional acceleration factor is applied at the mass center of the component to determine the seismic responses.

2.4.2 Seismic Input

Seismic analysis is accomplished by the response spectrum method utilzing the applicable floor response spectra. The floor response spectra were obtained by the dynamic multidegree-of-freedom modal analysis of the structures.

2.4.3 Load Combinations

Load combinations for piping and components are listed in Table 1. Two type of seismic loading are considered, Operational Basis Earthquake (OBE) and Design Basis Earthquake (DBE).

2.4.4 Allowable Stresses

The plant operating condition categories are Normal, Upset, Emergency and Faulted conditions as defined in Section B.7 of the FSAR. The design stress limits for piping are given in Tables 2 and 3 (see following pages). The design stress limits for components

TABLE 2

LOADING CONDITIONS AND STRESS LIMITS: PRESSURE PIPING IN ACCORDANCE WITH ANSI B31.1

Loading Condition	Stress Limits
1. Normal Condition	$P \leq S$
2. Upset Condition	$P \leq 1.25$
3. Emergency Condition	$P \leq 1.5$ (1.2S)
4. Faulted Condition	For Stainless Steel Design Limit Curves as defined in Figure B.7-3 in Reference 1. For Carbon Steel $P \leq S_y$ or 1.8S whichever is higher**.

Where:

P = Stress

S = Allowable stress from ANSI B31.1, code for Power Piping, 1967

S_y = Minimum specified yield strength (ASME B&PV Code, Section III, Table N-421 or equivalent).

** At some points of high local stress, intensification P may exceed this limit. For such points local piping deflection will be limited to twice the calculated OBE deflection to insure no loss of function in the "Faulted Condition".

(Extracted from the F.S.A.R., Table B.7-3)

TABLE 3

LOAD COMBINATION AND STRESS LIMITS FOR

Class I Components

LOAD COMBINATION	STRESS LIMIT
1. Normal (Deadweight, thermal and pressure	Normal Conditions
2. Normal & Operational Basis Earthquake	Upset Condition
3. Normal & Design Basis Earthquake	Faulted Condition
4. Normal & Pipe Rupture	Faulted Condition
5. Normal & Design Basis Earthquake & Pipe Rupture	Faulted Condition

(Extracted from the F.S.A.R., Table B.7-5)

2.4 SEISMIC QUALIFICATION CRITERIA

2.4.4 Allowable Stresses

other than pressure vessels and piping are the allowable stress of the material as given in the applicable codes and 90% of the yield strength of the material for the upset and faulted conditions, respectively.

For the Operational Basis Earthquake, the nuclear steam supply system is designed to be capable of continued safe operation or return to power operation. In case of Design Basis Earthquake it is ensured that the AFW system does not lose its capability to perform the required safety function. This capability is ensured by maintaining the stress limits discussed above. The stresses induced in the AFW system by the DBE are limited so that they do not cause a rupture in the system. The AFW system is adequately protected such that damage from pipe rupture of adjacent high energy piping will not result in a loss of the system safeguard function.

2.4.5 Qualification Testing

1. Continuous Test:

   The test was executed at frequencies incremented within the range of significant structural response. The test consisted of the application of a continuous sinusoidal motion corresponding to the maximum structural acceleration for which the equipment was to be qualified and for an appropriate length of time. The equipment was properly mounted during testing so as to reflect the field installed condition and energized if required.

2.4 SEISMIC QUALIFICATION CRITERIA

2.4.5 Qualification Testing

2. Sine Beat Test:

   Natural or resonant frequencies were detected by scanning from the lowest practical frequency to 25 Hz. The test at resonant frequencies consisted of the application of sine beats of peak acceleration values corresponding to that for which the equipment was to be qualified. The duration of the beat for each particular test frequency was chosen to most nearly produce a magnitude of equipment response equivalent to that produced by the particular floor acceleration with proper damping ratio. The equipment was properly mounted during testing so as to reflect the field installed condition and energized if required.

Seismic input values used for analysis or testing purposes to verify the adequacy of Class I components were obtained from Reference 3.

3.0 SEISMIC QUALIFICATION OF STRUCTURES SUPPORTING OR HOUSING AFW SYSTEMS

3.1 SUMMARY

A review of engineering design calculations, the FSAR, structural drawings and other pertinent reports was done to establish seismic design criteria and their implementations as they apply to NRC's Generic Letter 81-14 for the Auxiliary Feedwater Piping System.

The seismic design criteria, seismic input, and methodology for their implementations are briefly described in subsequent sections.

Our review indicates that all structural components were properly designed for the seismic criteria at the time of its original design.

3.2 INTRODUCTION

A review was conducted to identify the structures and ares which directly house or support the Auxiliary Feedwater (AFW) System and to review their design criteria and design implementation.

A brief description of the AFW system is provided in order to clearly define the scope of the work.

The primary source of supply for the AFW System is from the condensate makeup storage tank and through a piping system to the suction of the Auxiliary Feedwater Pumps. The AFW Systems' safeguard source of supply is the Cooling Water System. This area was also reviewed from the source of supply to the area where the AFW system connects.

The water supply for the Cooling Water System is obtained from Sturgeon Lake, which in reality is the backwaters of the Mississippi River.

3.2 <u>INTRODUCTION</u> (CONT'D)

Normally, water enters the system through the Circulating Water intake canal and flows to the screenhouse. A redundant system provides water in an emergency situation. This Emergency Cooling Water System consists of an intake crib and a 36" diameter intake pipe. This pipe is routed below the bottom of the intake canal and enters the emergency pump bay of the screenhouse.

Cooling water is pumped and then conveyed through the screenhouse via a series of pipes to an underground piping system located between the Screenhouse and the Turbine Room. Recently an addition to the Administration Building was constructed in this area. Upon entering the Turbine Room area the piping turns upwards, from below grade, and continues southward under the mezzanine floor to the Auxiliary Feedwater Pump area.

The Auxiliary Feedwater System's water supply is withdrawn from the Cooling Water System at this point and is fed to either the motor driven or the turbine driven Auxiliary Feedwater pumps.

The Cooling Water piping continues into the Auxiliary Building at this point and serves numerous functions in this building. The Auxiliary Feedwater piping originates at the discharge of the Auxiliary Feedwater pumps and is routed through the Auxiliary Building to the Shield Building. It traverses the annulus space and penetrates the reactor containment and continues to the steam generator.

Another piping system directly related to the AFW System is the steam

3.2 INTRODUCTION (CONT'D)

supply used to drive the turbine driven AFW pumps. This system originates at the Main Steam header located outside the shield building and runs in a northerly direction through the Auxiliary Building to the inlet of the turbine drives for the AFW pumps located in the Turbine Building.

3.3 STRUCTURE IDENTIFICATION AND CLASSIFICATION

Reference 6 lists the various structures or areas and provides the design classification as given in the FSAR (Reference 1) and as designed by Fluor Power Services. Equipment attachments to structural members were originally designed considering all loads including seismic as supplied by the equipment supplier. The methodologies, load combinations and allowable stresses are discussed in Section 3.4, Seismic Qualifications.

3.4 SEISMIC QUALIFICATIONS

3.4.1 Methodologies

3.4.1.1 Shield Building, Auxiliary Building and Turbine Building

The design of the Shield Building, Auxiliary Building and the Turbine Building was based on a dynamic analysis performed by John A. Blume and Associates, Engineers (Reference 2). The results of the analysis were prepared for the Operating Basis Earthquake (0.06g). Values for the Design Basis Earthquake (0.12g) were obtained by doubling the results for the Operating Basis Earthquake.

A mathematical cantilever model with lumped mass points was prepared. The model is a discrete mass system with masses lumped at each floor

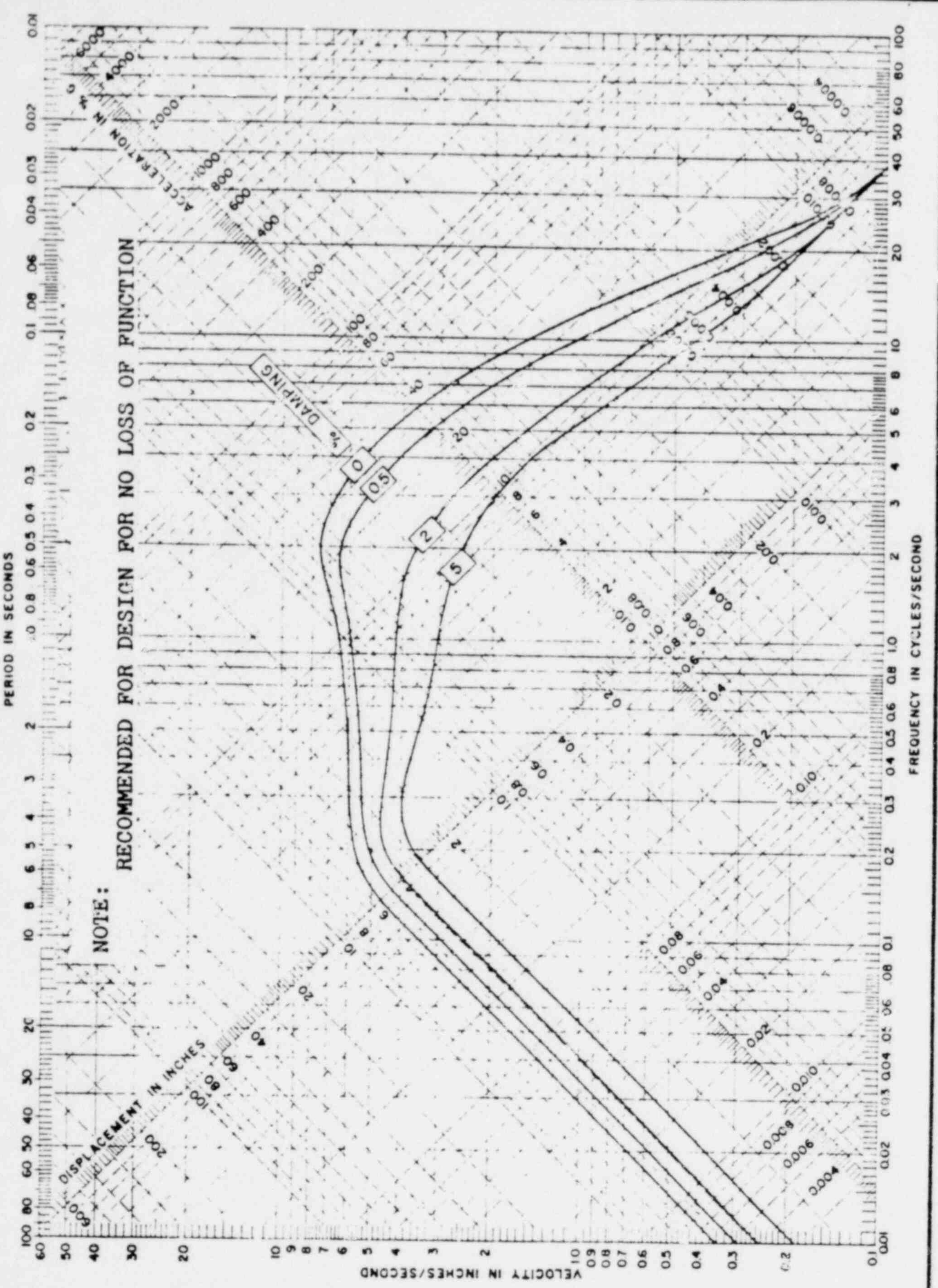
3.4 SEISMIC QUALIFICATIONS

3.4.1.1 Shield Building, Auxiliary Building and Turbine Building

and roof level, at points of intersection of diagonal bracing in the steel structures, and at intermediate points in the shield and containment structures. The structure has been idealized as a three-dimensional model with 190 degrees of freedom that include north-south and east-west translation for symmetrical elements and both translation and torsional rotation for unsymmetrical and irregular elements. Each mass point represents the mass of the concrete and steel structural elements at a particular level plus the tributary mass of the equipment and walls between adjacent levels.

Soil-structure interaction was represented by translational and rotational springs in the model. In general, the moments of inertia and effective shear areas of the vertical elements between the mass points were determined for the concrete structures by cutting a horizontal section through the building between the mass points and computing the moments of inertia and shear areas of the wall thus intersected. The stiffness of the braced steel structures were computed by considering the axial deformation of the bracing members. Centers of mass and rigidity were calculated by conventional methods of structural analysis.

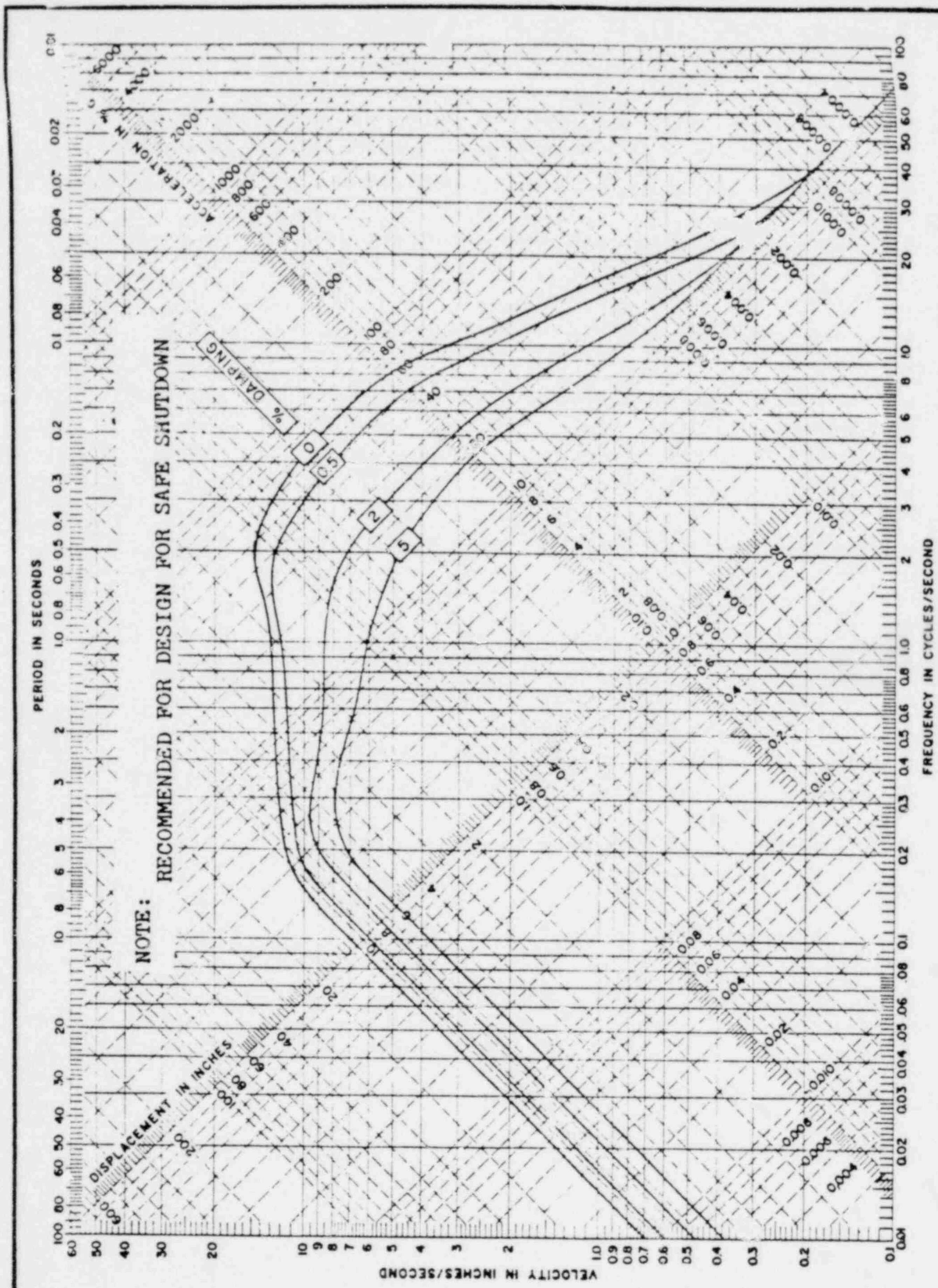
The spectral methods was used for the dynamic analysis of the Reactor-Auxiliary-Turbine Building. The response spectra used for this analysis are shown on Figures 1 and 2 (see following pages). The maximum response for each mass point for each mode were computed and were combined, to determine the total response, by adding the



RECOMMENDED RESPONSE SPECTRA

OPERATING BASIS EARTHQUAKE - 6% ACCELERATION

FIGURE 1



RECOMMENDED RESPONSE SPECTRA

DESIGN BASIS EARTHQUAKE - 12% ACCELERATION

FIGURE 2

TABLE 4

DAMPING VALUES

Item	Percent of Critical Damping
Containment Vessel	1.0
Shield Building	2.0
Steel Structures	2.0
Reinforced Concrete Construction	2.0
Foundation	5.0

3.4 SEISMIC QUALIFICATIONS

3.4.1.1 Shield Building, Auxiliary Building and Turbine Building

square root of the sum of the squares of the maximum response of each mode. The structure was analyzed for earthquake motion in both the north-south and east-west directions acting non-concurrently.

Individual modes of vibration were identified as being due primarily to the deformation of specific structural elements (or a combination of such elements) and were assigned appropriate damping values. The damping values used for various structural systems are listed in Table 4.

Curves showing the maximum translational accelerations, displacements, shears, and moments and torsional accelerations, moments and rotation were prepared for the Shield Building, Containment Vessels, Auxiliary Building, Fuel Tank Area, and Turbine Building. The structures were designed to resist the seismic shears and moments including torsional effects plus a vertical acceleration of 0.04g acting simultaneously with the horizontal acceleration. The allowable stresses in this case were not increased above the code allowables.

The structures were then reviewed to ensure that it could resist twice the seismic shears and moments described above without hindering the ability of the plant to safely shut down. A vertical acceleration of 0.08g acting simultaneously with twice the horizontal accelerations was used for design as criteria for safe shutdown of the plant. The allowable stresses for this case are indicated in Section 3.6.

Changes in soil properties and structural conditions were made after

3.4 SEISMIC QUALIFICATIONS

3.4.1.1 Shield Building, Auxiliary Building and Turbine Building

the initial analysis was completed and a review of the calculations was undertaken that indicated all previous results should be increased by ten percent. This was done. Detailed discussions are presented in Reference 2.

3.4.1.2 Cooling Water and Auxiliary Feedwater Piping Systems

The Cooling Water and the Auxiliary Feedwater piping systems in the buildings were analyzed using the Response Acceleration Spectra obtained from the building analysis as given in Reference 3. The pipes and their supports were designed based on the dynamic analysis. The support loads were imposed on the various structural elements. Hanger loads consisting of dead plus thermal plus DBE were routed to the structural department. Upon receipt of these loads the original calculations were reviewed to ensure adequate structural support.

3.4.1.3 Class I Areas of Screen House

The Class I areas of the Screenhouse were statically designed by applying the seismic factors listed below:

Operational Basis Earthquake:	0.09 horizontal 0.05 vertical
Design Basis Earthquake:	0.18 horizontal 0.10 vertical

Class I Equipment supports, piping and pipe hanger were designed using the Response Acceleration Spectra obtained from the building analysis as given in Reference 3.

3.4.1.4 Emergency Water Intake Crib

The emergency water intake cribe was statically designed by applying the seismic factors listed below:

3.4 SEISMIC QUALIFICATIONS

3.4.1.4 Emergency Water Intake Crib

Operational Basis Earthquake:	0.09 horizontal 0.05 vertical
Design Basis Earthquake:	0.18 horizontal 0.10 vertical

3.4.1.5 Emergency Cooling Water Intake Crib

The design of the buried emergency cooling water intake pipe was governed by possible liquefaction consideration. Therefore settlements due to possible liquefaction were accounted for by providing gimbal joints to allow for movement of the pipe. In addition the pipe was bedded in a non-liquefiable backfill and covered with compacted or uncompacted non-liquefiable backfill material.

A further evaluation of the buried emergency cooling water intake pipe was completed in a report entitled "Evaluation of Emergency Cooling Water Intake Pipeline Under the Proposed Dike" (Reference 4).

3.4.1.6 Buried Cooling Water Pipe Between The Screenhouse and the Turbine Building

The seismic effect on the buried emergency cooling water pipe located between the screenhouse and the turbine room was expected to be insignificant. For a further discussion see Volume 5, Appendix B, pages B.7-4a and B.7-4b of the FSAR (Reference 1). A further evaluation of this piping was completed in a report entitled "Administrative Building Addition - Safety Evaluation of Class I Cooling Water Piping" (Reference 5).

3.5 LOAD COMBINATIONS INCLUDING DBE

For Class I structures the conditions of loading for the Design Basis

3.5 LOAD COMBINATIONS INCLUDING DBE (CONT'D)

Earthquake included:

Dead Load + Live Load + Snow Load + Design Basis Accident + Design Basis Earthquake

3.6 ALLOWABLE STRESSES

3.6.1 Reinforced Concrete Structures

For Design Basis Earthquake loading combinations, Class I Structures, the allowable stress for reinforced concrete are 1-1/2 times ACI-318-63 allowable values. Listed below are the actual allowable stress used in the design of Units 1 and 2 of the Prairie Island Nuclear Generating Plant.

		Reinforcing Steel Stresses			
		A 615 Grade 40		A 615 Grade 60	
Criteria	Concrete Stresses	Allowable Working Stress-psi	Percent of Min Spec Yield (1)	Allowable Working Stress-psi	Percent Min Spec Yield (1)
1-1/2 times ACI 318-63 allowable values	0.675	30,000	75	36,000	60

Minimum specified yield points of steel reinforcement are as follows:

A 615 Grade 40 40,000 psi
A 615 Grade 60 60,000 psi

3.6.2 Steel Structures

For Design Basis Earthquake loading combinations, Class I Structures, the allowable stresses for Structural Steel were 1-1/2 times the AISC Allowable values.

4.0 SEISMIC QUALIFICATION OF ELECTRICAL AND INSTRUMENTATION AND CONTROL COMPONENTS IN THE AFW SYSTEMS

4.1 Power Supplies

The anchorage of power supplies and related equipment used by the Aux Feedwater System is designed, constructed and maintained to withstand a Safe Shutdown Earthquake consistent with other safety-grade systems at Prairie Island. Several items were noted by Teledyne Engineering Services, which need further evaluation:

1. Provide anchor bolts to unload plug wells on one 4160 V switchgear cabinet.
2. Replace a bolt missing in each of several 480V switchgear cabinets.
3. Modify the anchorage of motor control centers.
4. Modify battery rack design, and protect the batteries from ancillary equipment.
5. Test the frequency of fundamental modes of vibration and associated damping magnitudes for selected panels, racks, and cabinets. Redesign and stiffen the support for components for which the fundamental response is less than 6 Hz.

4.2 Initiation and Control Systems

The anchorages of initiation and control system components associated with the Aux Feedwater System are designed, constructed, and maintained to withstand a Safe Shutdown Earthquake consistent with other safety-grade systems at Prairie Island. Several items were noted by Teledyne Engineering Services, which need further evaluation:

4.2 Initiation and Control System (Cont'd)

1. Improve the mounting of selected pressure indicators and conduits.

2. Protect control room panels from ancillary equipment.

3. Test the frequency of fundamental modes of vibration and associated damping magnitudes for selected cabinets, racks, and panels, and the local control switch for a motor operated valve. Redesign and stiffen the support for components for which the fundamental response is less than 6 Hz.

5.0 DEFICIENCIES

5.1 Auxiliary Feedwater, Cooling Water and Auxiliary Steam Systems

1. As discussed in Section 2.2 four (4) Cooling Water branch runs within the AFW system boundaries have not been analyzed. These lines are identified below with the isolation valve tag number at the 30 inch diameter cooling water header and the unit coolers served by these branches.

   CL-99B-2
2CL-99B-2 — Auxiliary Feedwater pump unit coolers

   CL-99B-3
2CL-99B-3 — Charging pump motor unit coolers

   Based on the present support system provided and based on engineering judgement, these branch piping possess some inherent seismic resistance.

2. The modeling of the wall sleeve where the 30 inches diameter cooling water header pipes penetrate the Screenhouse at Column Row B_1, may not be conservative. These portions of the piping are contained in Parts IV and V of the Cooling Water system.

3. A reanalysis or initial analysis of some portions of the Auxiliary Feedwater, Cooling Water, and Auxiliary Steam systems have been performed as a result of the NRC IE Bulletin 79-14. Review of stress analysis is complete. Any remaining work is being handled in accordance with the procedures established for the implementation of IE Bulletin 79-14.

4. Certain concerns identified during the walkdown regarding non-

5.0 DEFICIENCIES (CONT'D)

5.1 Auxiliary Feedwater, Cooling Water and Auxiliary Steam Systems

seismic components with potential for damaging AFW systems have not been resolved. The items requiring further evaluation include:

a. Evaluate adequacy of attachments of electrical boxes 1185 and 1768.

b. Re-evaluation of adequacy of turbine building HVAC ductwork.

c. Re-support small conduits resting on cooling water supply piping.

d. Evaluate and resupport unit coolers in AFW pump room.

e. Evaluate adequacy of HVAC ductwork in Auxiliary Building which is routed above the Auxiliary Steamline supplying the turbine driven AFW pump.

5. The floor anchor plates supporting cooling water strainers 11, 12, 21, and 22 must be reviewed for the increased loading conditions documented in the revised report for cooling water screenhouse Part I.

6. Drain piping to traps in the Auxiliary Steam System are not analyzed.

5.2 Primary Water Supply (Condensate) System

This system is Design Class III and is not analyzed for earthquake and, therefore, not considered as part of the safety related AFW systems. However, based on the walkdown of the system it is felt that minor modification could enhance the seismic resistance of the

5.2 Primary Water Supply (Condensate) System

system substantially. Structural anchors may be required to isolate the water supply path from the condensate make-up storage tank to the auxiliary feedwater pumps from the remaining portions of the condensate system. The block supports outside the turbine building up to the condensate make-up storage tank may not adequately resist a Design Basis Earthquake. The condensate make-up storage tank and the foundation for the condensate make-up storage tank should be reviewed with respect to a Design Basis Earthquake.

6.0 SUMMARY OF OPERATING PROCEDURES

Prairie Island requires immediate shutdown of an AFW pump if suction is lost for any reason. Additionally as condensate storage tank level decreases actions are prescribed to afford additional water sources to the Condensate Storage Tanks. However, as a last resort instructions are provided for valving in the safety grade Cooling Water Supply to the AFW pump suction. The switch is simply made by opening one motor operated valve in each AFW pump suction piping.

7.0 CONCLUSIONS

Except for the deficiencies discussed in Section 4.0 and 5.0, and excluding the primary water supply, the AFW system is seismically qualified. Appendix A contains the completed Table I from NRC Generic Letter 81-14. Note that the table refers to sections within this report which include the documented deficiencies.

Recommendations regarding improvements to several components have been made. In some cases specific modification can be made without further analysis. However, in most cases more testing, analysis and design work will be required before modification is possible. The evaluation of seismic qualification of aux feedwater electrical equipment is included within the scope of IE Information Notice 80-21 and its addenda (or subsequent bulletin). The analysis, testing, and improvement of a broad range of electrical devices could potentially result from completion of the work relating to 80-21. In order to avoid duplication of effort and allow a consistent design approach, it is preferable to defer further testing and redesign until the requirements relating to 80-21 are more clearly defined. Therefore, it is impossible to provide a firm schedule as to when these modifications can be accomplished. However, we will keep you informed as to the progress being made and submit a schedule when one becomes apparent.

8.0 REFERENCES

(1) Facility Description and Final Safety Analysis Report, Prairie Island Nuclear Generating Plant, Northern States Power Company, Minneapolis, Minnesota.

(2) Earthquake Analysis: Reactor - Auxiliary - Turbine Building, Prairie Island Nuclear Generating Plant, JAB-PS-02, amendment 9. Report prepared by John A. Blume and Associates, Engineers, dated January 22, 1971.

(3) Earthquake Analysis: Reactor - Auxiliary - Turbine Building, Response Acceleration Spectra, Prairie Island Nuclear Generating Plant, JAB-PS-04, Amendment 9. Report prepared by John A. Blume and Associates, Engineers dated FEbruary 16, 1971.

(4) Evaluation of Emergency Cooling water Intake Pipeline Under the Proposed Dike dated February 26, 1981, Activity 000246, FN-3763.

(5) Administrative Building Addition - Safety Evaluation of Class I Cooling Water Piping dated May 30, 1979, Activity 000252, FN-3094.

(6) Verification of Seismic Qualification for Structures Supporting or Housing AFW System, Prepared by Fluor Power Services, dated June 16, 1981.

APPENDIX A

TABLE I OF NRC GENERIC LETTER 81-14

TABLE 1

AUXILIARY FEEDWATER SEISMIC QUALIFICATION

(1) Pumps/Motors

(2) Piping
(See Section 5.0 for Deficiencies)

(3) Valves/Actuators

(4) Power Supplies
(See Section 4.1 for Discussion)

(5) Primary Water and Supply Path
(See Section 5.2 for Discussion)

(6) Secondary Water and Supply Path *
(See Section 5.1 for Deficiencies)

(7) Initiation and Control System
(See Section 4.2 for Discussion)

(8) Structures Supporting or Housing these AFW System Items

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*Applicable only to those plants where the primary watery supply or path is not provided, however, a seismically qualified alternate path exists.