



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 26, 1994

Docket Nos. 50-282
and 50-306

LICENSEE: Northern States Power Company
FACILITY: Prairie Island Nuclear Generating Plant
SUBJECT: MAIN STEAM LINE BREAK METHODOLOGY

A meeting was held at NRC Headquarters on May 19, 1994, with Northern States Power (NSP) to discuss Prairie Island's (PI) Main Steam Line Break analysis. Enclosure 1 provides a list of attendees. Enclosure 2 provides the licensee's handout.

During a recent licensee review of the PI Main Steam Line Break (MSLB) analysis, some problems were identified. The review determined that inputs in the analysis were incorrect. These incorrect assumptions included:

- 1) using 110% of the Technical Specification Reactor Coolant System flow instead of 115%;
- 2) using an incorrect safety injection line volume;
- 3) using 50 Btu/lbm as a value for feedwater enthalpy instead of 405 Btu/lbm.

When these inputs were corrected and the analysis was rerun with all other conservative assumptions retained, the result exceeded the containment pressure limit of 46 psig by approximately 1 psig. Additional cases of the analysis were performed removing some conservatism. The reduced conservatism included credit for the closure of the broken loop non-return check valve and modeling of liquid entrainment using WCAP-8822, "Mass and Energy Releases Following a Steam Line Break," for model D steam generators. PI has model 51 steam generators; however, the data for the model D steam generators is more conservative. The results of the additional cases are summarized in Table 5 of Enclosure 2.

The licensee is using a new methodology for containment response to a MSLB. The Dynode code is used to calculate mass and energy release profiles which are input to the CONTEMPT code for containment response analyses. The licensee has been previously found qualified for use of CONTEMPT; however, the staff's review of the licensee's qualifications to use Dynode (in 1983) is limited to core response analyses. The licensee indicated that it plans to submit for approval a report describing the use of Dynode for containment mass and energy release analysis.

There were questions from the staff regarding equipment qualification (EQ) and long-term containment high temperature response resulting from the higher calculated mass and energy releases. NSP stated that the loss of coolant accident event is limiting for EQ; therefore, there were no new EQ concerns.

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May 26, 1994

The licensee performed an internal Justification for Continued Operation (JCO) and concluded that there was no reduction in the margin of safety and there were no unreviewed safety questions. The staff informed the licensee that the changes discussed at the May 19, 1994, presentation were acceptable. The JCO should be documented as an existing plant record and should be available for future audits.

If you have any questions regarding this summary, please contact me at (301) 504-3024.



Marsha Gamberoni, Project Manager
Project Directorate III-1
Division of Reactor Projects - III/IV
Office of Nuclear Reactor Regulation

Enclosures:

1. List of Attendees
2. Licensee Handout

cc w/enclosures:
See next page

May 26, 1994

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Original signed by:

Marsha Gamberoni, Project Manager
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cc w/enclosures:
See next page

*See previous concurrence

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Prairie Island Nuclear Generating
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MEETING SUMMARY, FOR MEETING HELD ON 5/19/94

DATED: May 26, 1994

Docket File

NRC & LPDRs

PD31 Reading

W. Russell/F. Miraglia, 12/G/18

L. Reyes, Acting

J. Roe

J. Zwolinski

L. Marsh

C. Jamerson

OGC

E. Jordan, MNBB-3701

M. Caruso, 8/E/23

L. Lois, 8/E/23

R. Lobel, 8/H/7

W. Long, 8/H/7

A. Dummer, 8/D/1

ACRS (10)

B. McCabe, EDO, 17/G/21

W. Kropp, RIII

cc: Licensee & Service List

LIST OF ATTENDEES
MAIN STEAM LINE BREAK METHODOLOGY
May 19, 1994

<u>NAME</u>	<u>ORGANIZATION</u>
M. Gamberoni	NRC
M. Caruso	NRC
L. Lois	NRC
R. Lobel	NRC
W. Long	NRC
A. Dummer	NRC
R. Anderson	NSP
G. Eckholt	NSP
O. Nelson	NSP
P. Shah	NSP
K. Wright	NSP
T. Breene	NSP
D. Kern	NET Corp.

NSP - NRC Meeting
Prairie Island
Main Steam Line Break Analysis
Problem Resolution and JCO

Washington, D.C.
May 19, 1994

Agenda

- ◆ Background
- ◆ Problem Identification
- ◆ New Analysis
- ◆ Results and Conclusions

NSP - NRC Meeting
Prairie Island
Main Steam Line Break Analysis
Problem Resolution and JCO

Washington, D.C.
May 19, 1994

◆ Objective

- Describe Analysis Done for Main Steam Line Break
- Obtain Justification for Continued Operation

PI Unit 2 Cycle 16 - operating

PI Unit 1 Cycle 17 - refueling, startup in mid-June

List of Acronyms

Aux FW	Auxilliary Feedwater
BAST	Boric Acid Storage Tank
DE	Double-Ended (break)
EOC	End Of Cycle
FSAR	Final Safety Analysis Report
FW	Feedwater
HFP	Hot Full Power
HZP	Hot Zero Power
MSIV	Main Steam Isolation Valve
MSLB	Main Steam Line Break
M&E	Mass and Energy release
N-1	All control rods inserted, most reactive stuck out
NSP	Northern States Power Co.
PI	Prairie Island
RCS	Reactor Coolant System
RSE	Reload Safety Evaluation
SDM	Shut Down Margin
SG	Steam Generator
SI	Safety Injection
TS	Technical Specification

Background

Prairie Island description:

- Westinghouse 2-Loop PWR
- Rated power is 1650 MWth
- West Vantage+ 4.95 w/o U-235
- Gadolinia at 6 and 8 w/o
- West Model 51 steam generators

Prior to 1980, FSAR was licensing basis for Main Steam Line Break (MSLB).

- Vendors responsible for Reload Safety Evaluations (RSE)

In 1980, IE 80-04 issued to address water sources:

- Increased Reactor Coolant System (RCS) flow
- Aux Feedwater flow at runout

<u>Assumption</u>	<u>FSAR</u>	<u>May 1980 Submittal</u>	<u>New Analysis</u>
Break Type	DE @ SG Exit	FSAR	FSAR
Physics Parameters	HZP, EOC	FSAR	FSAR
SDM	2%	FSAR	FSAR
Control Rods	N-1	FSAR	FSAR
Offsite Power	Available	FSAR	FSAR
FW Isolation	10 sec	FSAR	FSAR
FW Enthalpy	50 Btu/lbm	FSAR	405 Btu/lbm
Aux FW Flow	200 gpm	Runout	Runout
SG Level	33%	FSAR	FSAR
RCS Flow	100% of TS Min	110% of TS Min	115% of TS Min
Single Failure	Safeguards Train	FSAR	FSAR
MSIV Closure	10 sec	FSAR	FSAR
Check Valve Closure	Not credited	FSAR	5.5 sec
SI Time	6 sec	FSAR	FSAR
Entrainment	85% M&E	FSAR	WCAP-8822

NSP response (May 1980 Submittal) accepted by NRC.

May 1980 Submittal became part of licensing basis.

In 1982, NSP RSE methods topical submitted.

- Same MSLB assumptions as FSAR except Aux FW at runout
- Utilizes the DYNODE and CONTEMPT codes

DYNODE models primary and secondary systems.

- Simulates pipe breaks
- Computes mass and energy release (M&E)

CONTEMPT models the containment structure.

- Inputs DYNODE mass and energy release (M&E)
- Computes pressure and temperature

* NRC did not approve DYNODE mass and energy (M&E) input into CONTEMPT.

- Review was not completed.
- NSP would therefore verify the previous analysis bounding.

Initially, NSP did not evaluate MSLB containment response:

- Response relatively insensitive to fuel type

Starting in 1987, compared M&E to FSAR.

- Approved to generate M&E
- Gave assurance that FSAR still bounding

Problem Identification

During 1993 several minor problems identified.

- Led to detailed review of MSLB methods.

This review determined:

- Higher RCS flow limiting. (115% Tech Spec min)
 - Previous analysis used 110% Tech Spec min
 - Actual flow is ~111% of Tech Spec min
- SI line volume not conservative for Unit 1
- Higher feedwater enthalpy limiting (found in 1994)
 - FSAR and May 1980 used 50 Btu/lbm
 - 405 Btu/lbm exists at full power

When corrected, May 1980 Submittal M&E exceeded.

Led to reanalysis of MSLB Containment Response, including:

- PI 1 Cycle 16 (just completed)
- PI 2 Cycle 16 (operating)
- PI 1 Cycle 17 (next reload)

New analysis used DYNODE/CONTEMPT link.

- Not approved in the topical.

New Analysis

◆ Problems Corrected

- RCS Flow at 115% of T.S. Min
- SI Line Volumes Modeled for Each Unit
- FW Enthalpy at 405 Btu/lbm (125° FW Temp)

Result -

Table 5

LIMIT 46 psig

PI 1 Cycles 16 & 17

PI 2 Cycle 16

Case A

47.4 psig

47.1 psig

@ 160-200 sec

@160-200 sec

This was Expected.

All Conservative Assumptions were Retained.

(New Analysis)

◆ Remove Some Conservatism

Use Experience From Boric Acid Storage Tank (BAST) Project

- Credit the Closure of the Broken Loop
Non-Return Check Valve
- Model Liquid Entrainment

Minimize Deviations from Licensing Basis

Use Methods that are Not Approved for NSP

Goal : Demonstrate Licensing Basis is Still Conservative

(New Analysis)

◆ Non-Return Check Valves

Not Credited in FSAR and May 1980 Submittal
MSIVs Provide Isolation

- Safety Grade (QA Class I)
- Meet ASME Section XI testing criteria - test valve travel
- Similar to MSIVs - no air cylinder actuator
- Conservative Closure Time of 5.5 seconds

(New Analysis)

◆ Entrainment

Specify Break Exit Quality vs Time in Dynode Code

WCAP-8822 Overview:

- Tranfl0 Code - Break Exit Quality
- Model D SGs - U Tube, Integral Preheater
- Sensitivity Study found:
 - applicable to Model 51 SGs
 - Model Ds have less entrainment
- 1.4 sqft DE Break
 - (PI: 4.6 sqft DE Break)
- WCAP-8822 has been Reviewed by NRC

Results

◆ Case B:

- Errors Corrected
- Credit Taken for Non-Return Check Valves

Result - Table 5

PI 1 Cycles 16 & 17 PI 2 Cycle 16

Case B

46.2 psig
@ 170-200 sec

46.2 psig
@170-200 sec

- Containment Pressure Slightly Over Limit
- Worth of Check Valve = 1 psi

(Results)

◆ Case C:

- Errors Corrected
- Credit Taken for Non-Return Check Valves
- Liquid Entrainment Modeled

Result - Table 5

PI 1 Cycles 16 & 17 PI 2 Cycle 16

Case C 28.7 psig
 @ 12 sec

28.4 psig
@ 12 sec

- Margin of 17 psi to Limit
- Worth of Entrainment Method = 16 psi

(Results)

◆ Case D:

- Errors Corrected
- Credit Taken for Non-Return Check Valves
- Sensitivity Study on Entrainment

Result - Table 5

	PI 1 Cycles 16 & 17	PI 2 Cycle 16
Case D	46.1 psig @ 80 sec	45.9 psig @ 80 sec

- Entrainment Reduction of 37% Required to Reach Limit
- WCAP-8822 Average Uncertainty is 17%
- Provides Confidence in Making Conclusions

Table 5
Results of New Analysis

Containment Design Pressure Limit = 46 psig

	<u>PI 1 Cycles 16 & 17</u>	<u>PI 2 Cycle 16</u>
Case A <i>all errors resolved</i>	47.4 psig @ 160-200 sec	47.1 psig @160-200 sec
Case B <i>check valves</i>	46.2 psig @ 170-200 sec	46.2 psig @170-200 sec
Case C <i>check valves, entrainment</i>	28.7 psig @ 12 sec	28.4 psig @ 12 sec
Case D <i>check valves, 63% entrainment</i>	46.1 psig @ 80 sec	45.9 psig @ 80 sec

Conclusion

- ◆ Current Licensing Basis is FSAR and May 1980 Submittal
- ◆ Problems Corrected
 - Used Unapproved Methods in a Conservative Manner
- ◆ No Reduction in the Margin of Safety
- ◆ No Unreviewed Safety Questions
- ◆ Justification for Continued Operations:

Unit 2 Cycle 16 - operating

Unit 1 Cycle 17 - refueling, startup in mid-June