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Prairie Island Nuclear Generating Plant
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10 CFR Part 50
Section 50.46

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

PRAIRIE ISLAND NUCLEAR GENERATING PLANT
Docket Nos. 50-282 License Nos. DPR-42
50-306 DPR-60

Corrections to ECCS Evaluation Models

Attached is a report of corrections to the Prairie Island Nuclear Generating Plant (PINGP) Emergency Core Cooling System (ECCS) Evaluation Models. This report is being submitted in accordance with the provisions of 10 CFR 50, Section 50.46.

The applicable corrections noted in Attachment 1 have been applied to Prairie Island's current ECCS analyses of record, and all analyses were found to be in compliance with the applicable acceptance criteria (Attachment 2). Since all analyses remain in compliance, no reanalysis is required or planned. Note that the attachments were prepared by Westinghouse but modified by the NMC Nuclear Analysis Department (pen and ink changes) during the review and approval process for applicability to Prairie Island.

In this letter we have made no new Nuclear Regulatory Commission commitments. Please contact Jack Leveille (651-388-1121, Ext. 4142) if you have any questions related to this letter.

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c: Regional Administrator - Region III, NRC
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Attachments:
1. ECCS Evaluation Model Changes and Errors
2. Large & Small Break LOCA Peak Clad Temperature (PCT) Margin Utilization Sheets

A001

ATTACHMENT 1

ECCS EVALUATION MODEL CHANGES AND ERRORS

NOTRUMP - MIXTURE LEVEL TRACKING/REGION DEPLETION ERRORS

Background

Several closely related errors have been discovered in how NOTRUMP deals with the stack mixture level transition across a node boundary in a stack of fluid nodes. Firstly, when the mixture level attempts to transition a node boundary in a stack of fluid nodes, it can occasionally have difficulty crossing the interface (i.e. level hang). When a mixture level hang occurs at a node boundary, this leads to situations where the flow for a given time step is reset and becomes inconsistent with the matrix solution of the momentum equation for an excessive period of time. This results in local mass/energy errors being generated. In addition, it was discovered that the code was not properly updating metal node temperatures as a result of the implementation of the nodal region depletion logic which can be incurred when a fluid node empties or fills. It is noted that several aspects of these errors, namely mixture level tracking and flow resets, are not directly tied to erroneous coding; rather, they are a direct result of modeling choices made and documented in the original code development/licensing. These errors affect all code versions up to and including NOTRUMP Version 37.0. These error corrections were determined to contain both Discretionary and Non-Discretionary Change aspects in accordance with Sections 4.1.1 and 4.1.2 of WCAP-13451.

Affected Evaluation Model

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

The nature of this error leads to a bounding 13°F increase of the calculated PCT for all standard EM applications. Plant specific PCT impacts will be assessed where required.

References

1. NSBU-NRC-00-5972, "NRC Report for NOTRUMP Version 38.0 Changes", (Non-Proprietary), June 30, 2000.

INADEQUATELY DIMENSIONED CORE REFLUX FLOW LINK ERROR IN NOTRUMP

Background

An error has been discovered which results in the termination of the NOTRUMP code when attempting to model more than 12 active core nodes. The problem results from an inadequately defined maximum number of core reflux flow links in the code externals. The nature of the error is such that code execution can not be performed when attempting to model more than 12 core nodes due to compiler options selected. This problem only exists in the NOTRUMP Version 37.0 code. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1985 Westinghouse Small Break LOCA Evaluation Model

Estimated Effect

The nature of this error leads to no PCT impact for all EM applications due to the core modeling assumed in these models (i.e. <= 12 core nodes).

NOTRUMP CORE HEAT TRANSFER ERROR

Background

An error has been discovered in NOTRUMP which results in either a code abort or the usage of invalid steam table properties and/or heat transfer correlations in the core region under certain conditions. The problem results from the steam cooling core heat transfer correlation attempting to pass sub-cooled properties to steam property routines. Since the property routines do not perform input validity checking, this can result in erroneous properties being returned/utilized by the correlation. This error can only occur when complete subcooling of the core cladding occurs in conjunction with core uncovery. This error affects all code versions up to and including NOTRUMP Version 37.0. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1985 Westinghouse Small Break LOCA Evaluation Model

Estimated Effect

The nature of this error leads to no PCT impact for all standard EM applications due to the lack of this type of core uncovery process.

WCOBRA/TRAC GAP INPUT ERROR IN SECY UPI/BELOCA EM ANALYSES

Background

A survey of current SECY UPI, Best Estimate LBLOCA analyses and LBLOCA test simulations utilizing WCOBRA/TRAC identified an error in the application of the affected evaluation models. The error was in the specification of horizontal channel connections (gaps), which should be from lower numbered to higher numbered channel. The survey showed that only a few analyses contained this error. This error was determined to be a Non-Discretionary change in accordance with Section 4.1.2 of WCAP-13451.

KCH ~~Potentially~~ Affected Evaluation Models

SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model

~~1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model~~

KCH ~~1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection~~

Estimated Effect

For SECY UPI EM analyses, a plant specific analysis was performed for a representative plant, correcting the errors in gap numbering and resulted in a small benefit in reflood PCT. Four other SECY analyses were found to have the same error. Since the error correction was found to be a slight benefit and is considered negligible, the current analyses are conservative and an estimated effect of 0°F PCT impact is being assessed to all of the affected SECY UPI analyses.

~~For Best Estimate LBLOCA analyses, three analyses were found to have the error, but since it appeared for only one gap in the upper head, the impact was judged to be negligible. An estimated effect of 0°F PCT impact is being assessed to these plants.~~

KCH

~~For Best Estimate LBLOCA test simulations, input decks for two tests were found to have this error. Correction of the error resulted in no impact on the methodology conclusions derived from these tests. Thus, there is no PCT impact to report.~~

KCH

KCH ~~The survey found no errors in the application of the 1999 Best Estimate EM for UPI plants~~.

GEDM INTERFACE ERROR

Background

A discrepancy between the inputs for the neutronics model and the way the code used the inputs was discovered that impacted the calculated gamma redistribution factors. This issue was determined to be a Non-Discretionary change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model

KEH ~~1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model~~
~~1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection~~

Estimated Effect

It was determined that the error only concerns the neutronic input, which is not used in the code uncertainty/bias calculations, but only in plant calculations. A typical value of error in terms of the relative power is 0.001% or less than 0.01°F in peak average fuel temperature. This is well within the steady state tolerance criteria, such that estimated impact of the effect of this error on plant calculations is 0°F. The current code version corrects this error.

DROP DIAMETER PLOT TAPE STORAGE ERROR

Background

It was discovered the droplet diameter variable stored in the plot file contained a wrong value. This issue was determined to be a Non-Discretionary change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model

~~1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model~~

KCH ~~1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection~~

Estimated Effect

There is no impact on analysis results, since the drop diameter edit output is not used in the calculation of PCT. A work around is available for old versions of the code. The current code version corrects this error. There is no PCT impact as a result of this error.

RADIATION HEAT TRANSFER TO VAPOR PHASE ERROR

Background

It was determined that the radiation heat transfer was set to zero when the void fraction in a channel exceeded 0.9999. This issue was determined to be a Non-Discretionary change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model

~~1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model~~

KEN ~~1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection~~

Estimated Effect

Evaluations indicate that the single phase vapor heat transfer regime can occur during blowdown heatup, refill, and reflood. This error has negligible impact on existing analyses during the blowdown heatup and refill phases, since the single phase vapor heat transfer mode occurs only briefly in the blowdown heatup and refill. In reflood, single phase vapor conditions occur primarily during the downcomer boiling period for plants with late reflood PCTs. Under those conditions, the radiation heat transfer can account for approximately 20% of the total clad-to-vapor heat transfer. However, these conditions are nearly adiabatic, such that the effect can be considered negligible. The current code version corrects this error. There is no PCT impact as a result of this error.

PAD 4.0 IMPLEMENTATION

Background

The Westinghouse Performance Analysis and Design Model (PAD) is used to generate fuel-related input data for use in LOCA licensing calculations. As documented in Reference 1, the Safety Evaluation Report for Version 4.0 of the PAD model was issued by the US NRC on April 24, 2000. Use of PAD Version 4.0 is considered to represent a Discretionary Change and will be implemented on a forward-fit basis, in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

~~1981 Westinghouse Large Break LOCA Evaluation Model~~

KCk ~~1981 Westinghouse Large Break LOCA Evaluation Model with BART~~

~~1981 Westinghouse Large Break LOCA Evaluation Model with BASH~~

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model

~~1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model~~

KCk ~~1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection~~

Estimated Effect

The implementation of PAD Version 4.0 with respect to Appendix K Large Break LOCA and Small Break LOCA analyses will be handled on a forward-fit basis and is assigned a PCT estimate of 0°F for 10 CFR 50.46 reporting purposes.

References

1. WCAP-15063-P-A Revision 1, with Errata, "Westinghouse Improved Performance Analysis and Design Model (PAD 4.0)", J. P. Foster and S. Sidener, July 2000.

IMPROVED CODE I/O AND DIAGNOSTICS, AND GENERAL CODE MAINTENANCE

Background

Various changes in code input and output format have been made to enhance usability and help preclude errors in analyses. This includes both input changes (e.g. more relevant input variables defined and more common input values used as defaults) and input diagnostics designed to preclude unreasonable values from being used, as well as various changes to code output which have no effect on calculated results. In addition, various blocks of coding were rewritten to eliminate inactive coding, optimize the active coding, and improve commenting, both for enhanced usability and to facilitate code debugging when necessary. These changes were determined to be Discretionary Changes in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

~~1981 Westinghouse Large Break LOCA Evaluation Model~~

KCK ~~1981 Westinghouse Large Break LOCA Evaluation Model with BART~~

~~1981 Westinghouse Large Break LOCA Evaluation Model with BASH~~

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

The nature of these changes leads to an estimated PCT impact of 0 °F.

ACCUMULATOR LINE RESISTANCE USED IN SECY UPI EM ANALYSES

Background

As a result of an audit of a plant specific SECY UPI EM analysis, it was noted that the accumulator line resistance used in the analysis was an average value. Investigation into the basis for this selection revealed that the approved EM WCAP-10924-P-A (Reference) specified that a maximum value was used in the analyses. Later guidance issued for Best Estimate analyses recommended the use of average values, without specifying that it was applicable for SECY. This later recommendation was incorporated into some SECY UPI EM analyses as well. Investigation of the impact of a change from maximum to average accumulator line resistance was conducted, as discussed below. This error in the application of the model was determined to be a non-Discretionary change in accordance with Section 4.1.2 of WCAP-13451. For reasons discussed below, Westinghouse has determined that future SECY UPI EM analyses could use either average or maximum, and this is considered a Discretionary change in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model

Estimated Effect

Appendix H of the reference briefly discusses the selection of maximum value of accumulator line resistance for SECY UPI analyses. The Appendix includes some sensitivity studies, but no single effect sensitivities to accumulator line resistance. Section 3-3-2-8 provides further discussion and states that changes in the accumulator parameters (including line resistance) are evidenced by changes in accumulator water delivery. Effects of changes in accumulator water delivery are overshadowed by the conservative nature of ECC bypass calculated by WCOBRA/TRAC. In addition, other accumulator parameters such as water volume and gas pressure are set to nominal values, as discussed in Section 5-2. Use of average line resistance is in keeping with these other choices. More recent work for two-loop UPI plants using the Best Estimate model has shown that the sensitivity to changes in accumulator line resistance is small (less than ± 5°F for ±20% change in line resistance). From this, it is determined that although the original EM intended to use maximum accumulator line resistance, a change to use of average value is judged to be a small effect compared to the overall conservatism calculated in ECC bypass. Thus, it is concluded that it is acceptable to use either maximum or average accumulator line resistance in the SECY UPI EM and an estimated PCT impact of 0°F is assessed as a result of this report.

Reference:

1. WCAP-10924-P-A, Volume 2, Revision 2, Addendum 1, "Westinghouse Large-Break LOCA Best Estimate Methodology, Volume 2: Application to Two-Loop PWRs Equipped With Upper Plenum Injection, Addendum 1: Responses to NRC Questions," December, 1988.

ATTACHMENT 2

Large & Small Break LOCA Peak Clad Temperature (PCT) Margin Utilization Sheets

Westinghouse LOCA Peak Clad Temperature Summary For SECY UPI Large Break

Plant Name: Prairie Island ~~Unit 2~~ Units 1 + 2 KEK
Utility Name: Northern States Power
Revision Date: 2/23/01

Analysis Information

EM:	SECY UPI WC/T	Analysis Date:	03/95	Limiting Break Size:	Cd = 0.4
FQ:	2.4	FdH:	1.77		
Fuel:	OFA	SGTP (%):	15		
Notes:	Zirlo™, SGTP Evaluated up to 25%				

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	2180	1,2	(a)
MARGIN ALLOCATIONS (Delta PCT)			
A. PRIOR PERMANENT ECCS MODEL ASSESSMENTS			
1 . Fixed Heat Transfer Node Assignment Error/Accumulator Water Injection Error (1995 Report)	-175	3	
2 . 1-D Transition Boiling Heat Transfer Error (1997 Report)	59	5	
3 . Vessel Channel DX Error (1997 Report)	-14	5	
4 . Input Consistency (1997 Report)	-66	5	
5 . No Items for 1996 & 1998 Reports	0	4,6	
6 . Accumulator Line Pressurizer Surge Line Data / Plant Specific Accumulator Level & Line Volume / Plant Specific Restart Error: Reanalysis	113	7	(b)
B. 10 CFR 50.59 SAFETY EVALUATIONS			
1 . Sensitivity Study for Steam Generator Tube Plugging Increase to 25%	52	8	
C. 2000 10 CFR 50.46 MODEL ASSESSMENTS (Permanent Assessments of PCT Margin)			
1 . Modeling Updates and Unheated Conductor Input Corrections (plant specific)	-147	8	(c)
D. TEMPORARY ECCS MODEL ISSUES*			
1 . None	0		
E. OTHER			
1 . None	0		
LICENSING BASIS PCT + MARGIN ALLOCATIONS	PCT = 2002		

* It is recommended that these temporary PCT allocations which address current LOCA model issues not be considered with respect to 10 CFR 50.46 reporting requirements.

References:

1 . 95NS-G-0021, "Updated UPI LBLOCA," March 24, 1995.

2 . WCAP-13919, Addendum 1, "Prairie Island Units 1 and 2 WCOBRA/TRAC Best Estimate UPI Large Break LOCA Analysis Engineering Report Addendum 1: Updated Results," December 1996.

3 . NSP-96-202, "Northern States Power Company Prairie Island Units 1 and 2 10 CFR 50.46 Annual Notification and Reporting," February 20, 1996.

4 . NSP-97-201, "Northern States Power Company Prairie Island Units 1 and 2 10 CFR 50.46 Annual Notification and Reporting," April 17, 1997.

Plant Name: Prairie Island ~~Unit 2~~ Units 1 + 2 KEH

Utility Name: Northern States Power

Revision Date: 2/23/01

5 . NSP-98-012, "Northern States Power Company Prairie Island Units 1 and 2 10 CFR 50.46 Annual Notification and Reporting for 1997," February 27, 1998.

6 . NSP-99-010, "Northern States Power Company Prairie Island Units 1 and 2 10 CFR 50.46 Annual Notification and Reporting for 1998," April 29, 1999.

7 . NSP-00-005, "Northern States Power Company Prairie Island Units 1 and 2 10 CFR 50.46 Annual Notification and Reporting for 1999," February 2000.

8 . NSP-00-057, "Northern States Power Company Prairie Island Units 1 and 2 LOCA Evaluation of 25% SGTP with Other Modeling Updates," December 11, 2000.

Notes:

(a) P-bar-HA increased from 1.57 to 1.59

(b) Reanalysis for all listed issues

(c) Reanalysis for both issues

Westinghouse LOCA Peak Clad Temperature Summary For Small Break

Plant Name: Prairie Island ~~Unit 2~~ Units 1 + 2 KEH
Utility Name: Northern States Power
Revision Date: 2/23/01

Analysis Information

EM:	NOTRUMP	Analysis Date:	07/93	Limiting Break Size:	6 inch
FQ:	2.8	FdH:	2		
Fuel:	OFA	SGTP (%):	25		
Notes:	Zirlo™ (14X14)				

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	1195	1	(a)
MARGIN ALLOCATIONS (Delta PCT)			
A. PRIOR PERMANENT ECCS MODEL ASSESSMENTS			
1 . Effect of SI in Broken Loop (Plant Specific)	21	4	(b,c)
2 . Effect of Improved Condensation Model (Plant Specific)	4	4	(b)
3 . Plant-Specific Assessment to Rebaseline Limiting Case	218	4,6	(d,e,f)
4 . Annular Pellets Misapplication (1998 Report)	39	1,6	
5 . All Other Items in Reference 2 Except A.1 & A.2	0	6	(f)
6 . No Items for 1999 Report	0	7	
B. 10 CFR 50.59 SAFETY EVALUATIONS			
1 . MFW Temperature	3	3	
2 . AFW Flow Reduction to 180 gpm	0	5	
C. 2000 10 CFR 50.46 MODEL ASSESSMENTS (Permanent Assessments of PCT Margin)			
1 . SBLOCA Accumulator Water Level (plant specific misapplication)	25	8	
2 . NOTRUMP Mixture Level Tracking / Region Depletion Errors	13	9	
D. TEMPORARY ECCS MODEL ISSUES*			
1 . None	0		
E. OTHER			
1 . None	0		
LICENSING BASIS PCT + MARGIN ALLOCATIONS	**PCT =** 1518		

* It is recommended that these temporary PCT allocations which address current LOCA model issues not be considered with respect to 10 CFR 50.46 reporting requirements.

References:

1 . WCAP-13920, "Small Break Loss-of-Coolant Accident Engineering Report for the Prairie Island ZIRLO™ Fuel Upgrade," November 1993 (Includes Update NSD-SAE-ESI-97-522).

2 . Annual Reports for 1993 through 1997 (NSP-94-204, NSP-95-202, NSP-96-202, NSP-97-201, NSP-98-012).

3 . NSP-97-504, "Northern States Power Company Prairie Island Units 1 and 2, Feedwater Temperature Increase/Net RCS Heat Input Addition Program, Transmittal of Final Safety Evaluation," September 23, 1997.

4 . NSP-98-031, " SBLOCA Evaluation for Elimination of AFW Flow for Prairie Island Units 1 and 2," September 8, 1998.

Plant Name: Prairie Island ~~Unit 2~~ Units 1 + 2 KEH
Utility Name: Northern States Power
Revision Date: 2/23/01

5 . NSP-98-046, " SBLOCA Evaluation for AFW Flow Reduction for Prairie Island Units 1 and 2 - Final," November 3, 1998.

6 . NSP-99-010, "Northern States Power Company Prairie Island Units 1 and 2 10 CFR 50.46 Annual Notification and Reporting for 1998," April 29, 1999.

7 . NSP-00-005, "Northern States Power Company Prairie Island Units 1 and 2 10 CFR 50.46 Annual Notification and Reporting for 1999," February 2000.

8 . 00NS-G-0019/CAB-00-126, "Northern States Power Company Prairie Island Units 1 and 2, Prairie Island Unit 2 Cycle 20 LOCA Reload Confirmation & Final Fuel Rod Design Report", March 28, 2000.

9 . NSP-00-025, "Northern States Power Company Prairie Island Units 1 and 2 10 CFR 50.46 Appendix K (BART/BASH/NOTRUMP) EM Mid-Year Notification and Reporting for 2000," July 5, 2000.

Notes:

(a) Annular pellet sensitivity study result.

(b) Plant-specific assessments for the effects that were originally estimated for these two items in NSP-93-222.

(c) Also includes the effect of relocation of the break location to the midplane of the cold leg (see WCAP-10054-P-A, Addendum 2, Revision 1). The original estimate (NSP-93-222) did not include this effect.

(d) Value requested by customer pending completion of Westinghouse investigation. Rebaseline study includes newer code versions, COSI condensation model and select input changes (e.g. more conservative power shape, solid fuel pellets).

(e) At the request of NSP, this line item was included in the 1998 50.46 section of the PCT Sheet and has been subsequently rolled into the Prior Permanent Section, consistent with the original request. This represents a deviation from Westinghouse's normal approach.

(f) The estimated effects of previous code changes (through the -19 °F accumulated as of 1997 Annual Report NSP-98-012) are superceded by the Items A.1, A.2 & A.3 plant-specific calculations performed to rebaseline the limiting case (1438 - 1195 = 21 + 4 + 218), originally summarized in the 1998 Report (NSP-99-010).