TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT (BFN)

License Amendment Request to Extend the Completion Time
for an Inoperable Diesel Generator
from 7 Days to 14 Days

Rockville, Maryland
June 29, 2010

Agenda

• Introduction	Terry Cribbe
• Revised Technical Specifications (TS) and TS Bases Changes	Dan Green
• BFN Electrical System	Rick Sampson
• Probabilistic Risk Assessment (PRA) Evaluations	Ching Guey
• Closing Remarks	Terry Cribbe

Revised TS and TS Bases Changes

TS 3.8.1, AC Sources - Operating

- New Proposed Required Action B.1
- New Proposed Condition C and Required Action C.1
- Associated TS Bases Changes
- Questions?

Independent Offsite Power Sources

- Robust Offsite Power Distribution System
  - Seven 500kV Lines
  - Two 161kV Lines
  - Six Unit Station Service Transformers (USSTs) (2 per Unit)
  - Two Common Station Service Transformers (CSSTs)

Normal Power Alignment to 4kV Unit Boards

- Unit 1 - USST 1B
- Unit 2 - USST 2B
- Unit 3 - USST 3B

Alternate Power Alignment to 4kV Unit Boards

- Unit 1 - CSSTs via 4kV Start Bus
- Unit 2 - CSSTs via 4kV Start Bus
- Unit 3 - CSSTs via 4kV Start Bus

Normal Power Alignment to 4kV Shutdown Boards

- Unit 1 - 4kV Unit Board Via 4kV Shutdown Bus 1
- Unit 2 - 4kV Unit Board Via 4kV Shutdown Bus 2
- Unit 3 - 4kV Unit Board (Direct Feed)

Alternate Power Alignment to 4kV Shutdown Boards

- Unit 1 - 4kV Unit Board Via 4kV Shutdown Bus 2
- Unit 2 - 4kV Unit Board Via 4kV Shutdown Bus 1
- Unit 3 - 4kV Unit Board (Direct Feed)

Emergency Power Alignment to 4kV Shutdown boards

- The 4kV Bus Tie Board Functions as a Tie Breaker to Provide Additional Functionality (Not Credited in Accident Analysis)
- Not Qualified

4kV System Supplies Entire Plant

- Safety-Related Loads - USSTs 1B, 2B and 3B
- Non-Safety (Balance of Plant) Loads - USSTs 1A, 2A and 3A

4kV Standby Power (If Offsite Power is Lost)

- Unit 1 and Unit 2 Share 4 Diesel Generators (DGs)
- Unit 3 has 4 DGs
- Unit 3 DGs Can Be Aligned (Direct Cross-Tie) to Supply Unit 1/2 4kV Shutdown Boards (Does Not Require the 4kV Bus Tie Board)
- Unit 1/2 DGs Can Be Aligned (Direct Cross-Tie) to Supply Unit 3 4kV Shutdown Boards (Does Not Require the 4kV Bus Tie Board)

Example Unit 1 Alignment - DG A Out of Service

- Utilize DG 3EA as Alternate Supply for 4kV Shutdown Board A via the Tie Breakers on 4kV Shutdown Board A and 3EA
- Utilize DG 3EA as Emergency Supply to 4kV Shutdown Board A via the 4kV Bus Tie Board (Only If Options 1 or 2 Were Not Available - This Option Is Not Qualified)

Example Unit 2 Alignment - DG C Out of Service

- Utilize DG 3EC as Alternate Supply for 4kV Shutdown Board C via the Tie Breakers on 4kV Shutdown Board C and 3EC
- Utilize DG 3EC as Emergency Supply to 4kV Shutdown Board C via the 4kV Bus Tie Board (Only If Options 1 or 2 Were Not Available - This Option Is Not Qualified)

Example Unit 3 Alignment - DG 3EA Out of Service

- Utilize DG A as Alternate Supply for 4kV Shutdown Board 3EA via the Tie Breakers on 4kV Shutdown Board 3EA and A
- Utilize DG 3EB as Emergency Supply for 4kV Shutdown Board 3EA via the 4kV Bus Tie Board (Only If Options 1 or 2 Were Not Available - This Option Is Not Qualified)

DG Loading

- Load Shedding Performed As Necessary to Utilize Alternate Feeds/Alignments
- Loading Monitored In Accordance With Operating Instructions
- Load Restrictions, Where Necessary, On Single Line Drawings As Operating Limit (OPL) Notes
- OPL Notes Referenced in Operating Instructions

BFN Electrical System

- Questions?

PRA Supporting DG 14 Day Completion Time

- Topics Of Interest
  - BFN PRA Upgrade
  - Risk Insights from DG Completion Time Studies

Introduction

- Unit 1 BFN PRA RISKMAN Model Updated in 2006
  - Significant Findings and Observations (F&Os) Found During Peer Review
  - RISKMAN Software Requires More Resources to Understand, Develop and Apply
- PRA Upgrade Began in 2007
  - Model Converted from RISKMAN to CAFTA
  - Every Element of Model Re-Examined
  - Peer Review of Internal Events May 2009
  - Peer Review of Internal Flooding August 2009

Programs/Tools Used for Conversion

Software Package	Version	Description
CAFTA	5.4	Computer Aided Fault Tree Analysis System
PRAQuant	5.0a	PRAQuant Accident Sequence Quantification
FTREX	1.4	Fault Tree Reliability Evaluation eXpert
HRA Calculator	4.0	Human Reliability Analysis Calculator
MAAP	4.0.5	Modular Accident Analysis Program

General Aspects of Upgrade

- New CAFTA Model Integrates All Three Units
  - Allows Evaluation of Risk for All Units for Outage of Common Systems, Structures, and Components
  - Allows Simultaneous Update for Data
- New Calculations Issued for All PRA Elements
- Documentation Developed to Meet Regulatory Guide (RG) 1.200
- PRA Updates Follow Industry PRA Configuration and Control Practices

Initiating Events (IE)

- 101 New Initiators Added to 3-Unit Model
  - 57 Flood Initiators Replaced 7 Previously Modeled
  - 3 Initiators Added for Intake Structure Plugging (1 per Unit)
  - 51 Initiators Added for Various Combinations of AC and DC Electrical Board Failures
- Initiators That Could Affect More than 1 Unit Considered
- Previous Peer Review Findings Resolved
- NUREG/CR-6928 used for Industry IE Frequencies
  - Bayesian Update of Industry IE with Plant Specific Data

Accident Sequences

- IEs Grouped and Evaluated Collectively
- Event Trees Developed for Each Accident Class (e.g., Large LOCA, General Transient, etc.)
- Operations Personnel Interviewed to Reflect Plant Responses

Success Criteria

- All Success Criteria Re-Evaluated for PRA Upgrade
- Realistic Success Criteria Established
  - Existing Safety Analyses Reviewed for Applicability
  - Plant Specific Thermal Hydraulic (T-H) Calculations Performed
- T-H analyses Based on MAAP 4.0.5 runs

Systems Analysis

- All Systems in PRA Re-Evaluated
- Includes All Systems that are
  - Required for Accident Mitigation
  - Systems Supporting Accident Mitigating Systems
- Identified Support System Initiating Events
- Ensured Models are Consistent With As-Built As-Operated Plant
  - System Engineers Reviewed Documentation

Data Analysis

- Freeze Date for Data was January 2008
- Industry Data Based on NUREG/CR-6928
  - Bayesian Updated with Plant Specific Data
- Unavailability Data Based on
  - Maintenance Rule Data
  - System Engineer/Operations Staff Estimates
- Data Will Be Updated Every 4 Years
- Common Cause Failures Accounted for Within Systems

Human Reliability Analysis (HRA)

- HRA Calculator Used to
  - Document and Quantify all Independent Human Error Probabilities
  - Document and Quantify Human Error Probabilities for Dependent Actions
- HRA Performed Developed to Meet RG 1.200

Internal Flooding

- Internal Flooding Was Completely Re-evaluated to Address RG 1.200, Revision 2
- Several Walkdowns Performed to Assess the Impact of Flooding, Spray, and Impingement
- Peer Reviewed in August 2009
- All Findings Resolved

Large Early Release Frequency (LERF) Analysis

- New Containment Event Trees Developed
- New MAAP Analyses Performed to Define Realistic LERF Sequences

Quantification

- Single Fault Tree (for each Unit) Quantified Using CAFTA and FTREX 1.4
- Uncertainty Analysis Performed Quantitatively Using UNCERT
- Sensitivity Studies Performed for Significant Modeling Uncertainties

Modeling for DG Completion Time

- Additional Initiators Added to Evaluate Fires That Could Cause Loss of Offsite Power
- Impact of Extended DG Completion Time On All Units Evaluated for each DG

Summary Of Risk Impact of EDG (Internal Events)

Table 4. Effect on CDF and LERF of 14-Day DG AOT Unavailability				
Case	Base PRA Model	DG Using Unavailability 14-Day AOT	Change	% Change
U1 CDF	6.57E-06	6.67E-06	9.49E-08	1.44%
U2 CDF	6.88E-06	6.95E-06	7.74E-08	1.13%
U3 CDF	7.30E-06	7.53E-06	2.29E-07	3.13%
U1 LERF	2.13E-06	2.14E-06	6.80E-09	0.32%
U2 LERF	2.70E-06	2.71E-06	4.90E-09	0.18%
U3 LERF	1.01E-06	1.02E-06	5.10E-09	0.50%

Summary Of Risk Impact of EDG (Fire-Induced LOOP Events)

Table 5. FIVE Scenarios with Plant Response Bounded by Loss of Offsite Power					
Fire Area / Fire Zone	**Description**	**Frequency**	**Severe Fire Factor**	**Major Fire Frequency**	**New Initiator Name***
16-3 (case 2B)	Control Building - 617' (Control Room)	4.62E-05	0.049	2.26E-06	%xLOOPFRCB
24	4kV Bus Tie Board Room	1.92E-02	0.10	1.92E-03	%xLOOPFRBT
25-3 (case 3B)	Turbine Deck	1.34E-02	0.119	1.59E-03	%xLOOPFRTD
Yard Area (case 2)	Yard Area	5.10E-03	0.25	1.28E-03	%xLOOPFRYD

* There are four new fire initiators per unit (x in the Init Name = unit number)

Summary Of Risk Impact of EDG (Fire-Induced LOOP Events)

Table 6. Effect on CDF and LERF of 14-Day DG AOT Unavailability for Fires Resulting in a LOOP				
Case	Base PRA Model	DG Using Unavailability 14-Day AOT	Change	% Change
U1 CDF	1.22E-06	1.35E-06	1.28E-07	10.44%
U2 CDF	9.92E-07	1.08E-06	8.97E-08	9.05%
U3 CDF	2.26E-06	2.53E-06	2.74E-07	12.14%
U1 LERF	2.25E-07	2.33E-07	7.95E-09	3.54%
U2 LERF	2.03E-07	2.08E-07	4.49E-09	2.21%
U3 LERF	1.83E-07	1.86E-07	3.38E-09	1.85%

Summary Of Risk Impact of EDG (Total Including Internal and Fire)

Table 7. Total Effect on CDF and LERF of 14-Day DG AOT Unavailability				
Case	Base PRA Model	DG Using Unavailability 14-Day AOT	Change	% Change
U1 CDF	7.79E-06	8.01E-06	2.23E-07	2.86%
U2 CDF	7.87E-06	8.03E-06	1.67E-07	2.12%
U3 CDF	9.56E-06	1.01E-05	5.02E-07	5.26%
U1 LERF	2.36E-06	2.37E-06	1.48E-08	0.63%
U2 LERF	2.90E-06	2.91E-06	9.39E-09	0.32%
U3 LERF	1.19E-06	1.20E-06	8.48E-09	0.71%

PRA Conclusions

- BFN PRA Model Significantly Upgraded Since 2006
- Internal Events and Internal Flooding Meet RG 1.200, Revision 2
- Extended DG Completion Time Meets RG 1.177

Probabilistic Risk Assessment

– Questions?

- Closing Remarks