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DATE OF MEETING

07/01/2003

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Docket Number(s)	50-269, 50-270, 50-287
Plant/Facility Name	OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3
TAC Number(s) (if available)	MB8086, MB8087, MB8088
Reference Meeting Notice	JUNE 6, 2003
Purpose of Meeting (copy from meeting notice)	TO DISCUSS DEFENSE-IN-DEPTH AND DIVERSITY  ANALYSIS ASSOCIATED WITH DIGITAL UPGRADE  OF RPS/ESPS

NAME OF PERSON WHO ISSUED MEETING NOTICE

L. N. OLSHAN

TITLE

PROJECT MANAGER

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DLPM

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PDII-1

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# ***Oconee Nuclear Station***

## ***RPS/ES D<sup>3</sup> Analysis***

***July 1, 2003***

- ❖ Introductions
- ❖ Licensing interactions
- ❖ RPS/ES D<sup>3</sup> analysis
- ❖ Manual Operator Response Times
- ❖ Leak Detection Capability
- ❖ Applicability of LBB for RCS Piping
- ❖ 50.46 Single Failure Assumption
- ❖ Closing Remarks

- ❖ Duke appreciates the unique nature of this submittal
  - Initial meeting with staff on March 7, 2002
  - Working closely with lead reviewer
  - Followed established guidance
  - Analysis submitted on March 20, 2003
- ❖ NRC response needed as input into design of RPS/ES digital upgrade
  - Eliminates need for diverse LPI actuation feature



## ***RPS/ES D<sup>3</sup> Analysis***

### **RPS/ES D<sup>3</sup> Analysis**

- ❖ Summary of Methodology
- ❖ Analysis Results
  - Diverse Design Features Credited
  - Operator Actions Credited
- ❖ Conclusions

## **Summary of Methodology**

- ❖ Duke used new replacement SG T/H analysis methodologies that are currently under NRC review (non-LOCA PCT scope)
  - Extensions of existing NRC-approved methodologies currently in UFSAR
  - Codes: RETRAN-3D, VIPRE-01, RELAP5/MOD2-B&W, FATHOMS, SIMULATE, LOCADOSE
- ❖ SBLOCA analyzed by FANP using RELAP5/MOD2/B&W
- ❖ LBLOCA addressed by leak detection and low probability (otherwise need diverse actuation of Low Pressure Injection System)

## **Summary of Methodology (cont.)**

### **Transients and Accidents Considered**

Control rod bank withdrawal at zero power

Boron dilution at full power

Locked rotor

Turbine trip

Control rod ejection

Small steam line break

Large break LOCA

Loss of offsite power

Control rod bank withdrawal at full power

Loss of coolant flow

Dropped control rod

Steam generator tube rupture

Large steam line break

Small break LOCA

Loss of main feedwater

Main feedwater line break

## **Summary of Methodology (cont.)**

### **Assumptions**

- Typical conservative initial conditions
- No loss of offsite power
- No single failures
- Integrated Control System (ICS) in automatic
- Realistic core power distribution (SBLOCA only)
- Realistic core flood tank initial conditions (SBLOCA only)
- Realistic operator actions and times
- Credit for AMSAC (trip turbine and start EFW on loss of main feedwater)
- Credit for existing Diverse Scram System (DSS) at 2450 psig RCS pressure
- Credit for Automatic Feedwater Isolation System (AFIS) on low SG pressure
- Pre-existing SG tube leakage at administrative limit



## **Summary of Methodology (cont.)**

### **Acceptance Criteria**

- ❖ Offsite dose limits based on R. G. 1.183
  - Large steam line break 25 rem TEDE (EAB & LPZ)
  - Loss of flow 2.5 rem TEDE (EAB & LPZ)
  - Control Room 5 rem TEDE
- ❖ RCS overpressure limit is 3250 psia (ASME Service Level C), same as ATWS acceptance criterion for B&W plants (Note: 3000 psig error in submittal)
- ❖ Reactor Building overpressure limit is 125 psi based on 98% of ultimate strength (design pressure is 59 psig)

## **Summary of Methodology (cont.)**

### **Results Categories**

- ❖ 1 – RPS and ESPS not actuated / no adverse impact
- ❖ 2 – Event terminated by DSS actuation / no adverse impact
- ❖ 3 – Event bounded by another event
- ❖ 4 – Analysis required and results show acceptance limits are met
- ❖ 5 – Acceptance limits not met / fail diversity and defense-in-depth

## **Analysis Results**

### **Category 1 – RPS and ESPS Not Actuated / No Adverse Impact**

- ❖ Dropped control rod
  - ❖ Steam generator tube rupture
  - ❖ Small steam line break (for RCS pressure response and offsite doses)
- The UFSAR analysis does not credit automatic RPS or ESPS actuation

## **Analysis Results (cont.)**

### **Category 2 – Event Terminated by DSS Actuation / No Adverse Impact**

- ❖ Control rod bank withdrawal at zero power
  - ❖ Turbine trip
  - ❖ Loss of main feedwater
  - ❖ Loss of offsite power
  - ❖ Main feedwater line break
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- The DSS mitigates the event when RCS pressure reaches 2450 psig

## **Analysis Results (cont.)**

### **Category 3 – Event Bounded by Another Event / No Adverse Impact**

- ❖ Boron dilution at full power (bounded by control rod bank withdrawal)
- ❖ Control rod ejection containment response and dose results (bounded by LOCA)
  - Manual actuation of HPIS at 5 minutes credited
  - Manual actuation of RBCS and RBS at 8 minutes credited
- ❖ SBLOCA containment response and doses (bounded by LOCA)
  - Manual actuation of RBCS and RBS at 8 minutes credited

## **Analysis Results (cont.)**

### **Category 4 – Analysis Required and Acceptance Criteria Met**

- ❖ Control rod bank withdrawal at full power
  - No cladding failures, so offsite doses are not significant
  - RCS and Reactor Building pressure limits not challenged
- ❖ Loss of coolant flow (four-pump coastdown)
  - 26.0% cladding failure and 2.14% fuel melt
  - Radiological doses bounded by two-pump coastdown
  - RCS and Reactor Building pressure limits not challenged

## **Analysis Results (cont.)**

### **Category 4 – Analysis Required and Acceptance Criteria Met (cont.)**

- ❖ **Loss of coolant flow (two-pump coastdown)**
  - 26.6% cladding failure and 2.46% fuel melt
  - RCS and Reactor Building pressure limits not challenged
  - Radiological doses
    - EAB boundary = 2.0 rem TEDE (2.5 rem is limit)
    - LPZ boundary = 0.4 rem TEDE (2.5 rem is limit)
    - Control Room = 1.2 rem TEDE (5 rem is limit)

## **Analysis Results (cont.)**

### **Category 4 – Analysis Required and Acceptance Criteria Met (cont.)**

#### **❖ Large steam line break**

- 34.0% cladding failure and 4.75% fuel melt
- RCS pressure limit is not challenged
- Peak containment pressure is 44 psig
- Radiological doses
  - EAB boundary = 4.4 rem TEDE (25 rem is limit)
  - LPZ boundary = 0.9 rem TEDE (25 rem is limit)
  - Control Room = 3.4 rem TEDE (5 rem is limit)



## **Analysis Results (cont.)**

### **Category 4 – Analysis Required and Acceptance Criteria Met (cont.)**

- ❖ Locked rotor
  - No cladding failures, so offsite doses are not significant
  - RCS and Reactor Building pressure limits not challenged
  
- ❖ Small steam line break
  - Peak containment pressure is 45 psig
  - Manual actuation of RBCS and RBS credited at 8 minutes

## **Analysis Results (cont.)**

### **Category 4 – Analysis Required and Acceptance Criteria Met (cont.)**

#### **❖ Small-break LOCA**

- Reactor manually tripped by the operator at 2 minutes
- Reactor coolant pumps manually tripped by the operator at 2 minutes
- HPI and LPI manually started by the operator at 5 minutes
- Peak cladding temperature is limited to around 1000°F
- RCS pressure limit not challenged

## **Analysis Results (cont.)**

### **Category 5 – Acceptance Limits Not Met**

#### **❖ Large-break LOCA**

- Crediting manual start of HPI and LPI at 5 minutes is not early enough to maintain a coolable geometry
- LBLOCA does not meet the diversity and defense-in-depth requirements
- A diverse actuation of LPI is required if LOCA within the scope of the D<sup>3</sup> study
- LOCA addressed by leak detection and low probability – not required to meet diversity and defense-in-depth requirements.

## **Conclusions**

- ❖ Diversity and defense-in-depth demonstrated for all events except large-break LOCA
- ❖ Existing diverse plant systems credited for automatic mitigation
  - DSS
  - AMSAC
  - AFIS
  - ICS

## **Conclusions (cont.)**

- ❖ New manual operator action times credited
  - Manual reactor trip at 2 minutes (SBLOCA)
  - Manual start of HPI and LPI at 5 minutes (SBLOCA, REA)
  - Manual start of RBCS and RBS at 8 minutes (SBLOCA, REA)
- ❖ Acceptance criteria met (except for LBLOCA)
  - Diverse actuation of LPI required for LBLOCA with failure of ESPS
  - Leak detection and low probability justification to preclude LBLOCA



# ***Operator Response Times***

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## **Process Used to Develop Times**

- ❖ Table Top Discussion Using 3 SROs involved with EOP and familiar with other timing validations
- ❖ Scenario analysis to develop operator response times based on previously validated times and operator judgment
- ❖ Structured approach for transient mitigation prior to reactor trip (memory)
- ❖ Immediate operator actions after reactor trip (memory)
- ❖ Symptoms check and parallel actions (manual action response times based on previous validations)



## ***Leak Detection Capability***

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- ❖ **Oconee's capability and methods are similar to others in nuclear industry**
  - Sump Level Monitoring
  - Radioactive Particulate Monitoring
  - Radioactive Gaseous Monitoring
  - Other means, e.g., RCS leakage calc, RCS makeup flow, LDST level monitoring



# Use of LBB for RCS Piping

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- ❖ Submittal not requesting additional LBB approval of RCS piping
  - Previously approved in SER dated December 12, 1985
  
- ❖ Oconee RCS has Inconel welds
  
- ❖ PWSCC issue is generic, the industry through EPRI is working toward quantifying the effect, if any, of PWSCC on LBB analyses



- ❖ SWCMF is not a single failure based on NRC endorsed guidelines for licensing digital upgrades.
- ❖ NRC RIS 2002-22 endorsed EPRI TR-102348 Rev.1
  - D<sup>3</sup> analysis is considered a beyond design basis concern
  - Recognizes the likelihood of a common case software failure in a high quality digital system is significantly below that of a single active hardware failure



## ❖ Closing Remarks