NEXTera® ENERGY

DUANE ARNOLD

# Duane Arnold Energy Center
# Regulatory Conference
# Reactor Core Isolation Cooling Pump Trip

**January 7, 2014**

# Nuclear Excellence Model

| | |
|---|---|
| **Vision** | We are a team that delivers consistent excellent performance |
| **Mission** | We will produce energy in a safe, reliable, cost effective way, while caring for our employees, communities and the environment |
| **Values** | Conduct all activities to demonstrate a deep respect for Nuclear Safety<br>Live the Safety Guiding Principles<br>Be a Self-Improving Culture & Learning Organization<br>Maximize the time spent on Prevention and Detection to minimize / eliminate Correction activities<br>Foster a work environment where we are the employer of choice |
| **Core Principles** | Operationally Focused<br>Passion for Excellence<br>Engaged Leaders<br>Standardized Processes<br>Responsive to Stakeholders<br>Effective Workforce Planning<br>Engaged Employees<br>Effective Long-Range Planning<br>Strong Teamwork<br>Strong Ownership & Accountability<br>Effective Supervisors<br>Worklife Balance |
| **Strategic Focus Areas** | **Operational Excellence**<br> <br>**Organizational Effectiveness**<br> <br>**Generation Reliability**<br> <br>**Effective Business & Financial Performance**<br> |

NEXTera ENERGY NUCLEAR FLEET



NEXTera ENERGY DUANE ARNOLD

# PDC

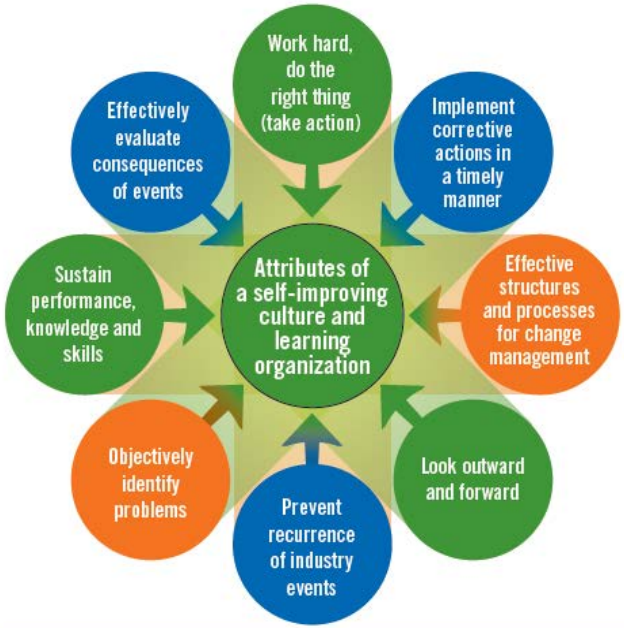
"Do the job right the first time"

**Value**

Maximize the time spent on
Prevention and Detection
to minimize / eliminate Correction activities

NEXTera ENERGY NUCLEAR FLEET

# SIC/LO




**Value**

Be a Self-Improving Culture
& Learning Organization

NEXTera ENERGY NUCLEAR FLEET



NEXTera ENERGY DUANE ARNOLD

# Attendees

- Richard Anderson, Site Vice President
- Tom Gordon, Assistant Operations Manager
- Anil Julka, Fleet Risk and Reliability Manager
- Mike Davis, Site Licensing/EP Manager
- Larry Lee, ERIN Engineering
- Jeff Pladsen, Reactor Operator
- Jim Petro, Fleet Licensing Director

# Agenda

- Opening Remarks – Rich Anderson
- Performance Deficiency – Rich Anderson
- Root Cause Evaluation – Tom Gordon
- Corrective Actions – Tom Gordon
- Operations Response to RCIC Trip – Tom Gordon
- Risk Significance – Anil Julka
- Closing Remarks – Rich Anderson

# Opening Remarks

**Rich Anderson**
**Site Vice President**



NEXTera ENERGY DUANE ARNOLD

# Opening Remarks

- **RCIC is an important contributor to our accident mitigation capability**
  - Operability of all safety systems must always be understood and continually assessed
- **Risk Significance of August 2013 Event**
- **New Information Will be Discussed Today**
  - Operator knowledge and use of procedures to operate RCIC in manual
  - NextEra Energy (NEE) perspectives on risk significance and some identified inaccuracies in SPAR model along with their relative importance

# Event Summary

- **On June 21, 2013, the Control Room Operators noted RCIC turbine speed indicator was indicating 1200 RPM with the system in standby**
  - Condition Report initiated
  - Immediate operability determination was not performed because the speed indicator is not safety related, and is used for indication only
- **Work Request initiated to calibrate the speed indicator**
  - Work scheduled to coincide with next RCIC surveillance test on August 22, 2013 to minimize unavailability of RCIC
- **On August 22, 2013, troubleshooting of speed indicator commenced in accordance with Work Request**
  - Troubleshooting was stopped when expected response was not obtained
- **Subsequent quarterly surveillance test commenced on August 22, 2013 and the RCIC pump tripped on over-speed**

# Performance Deficiency

- **Performance Deficiency**
  - Failure to perform an immediate operability determination in accordance with site procedures on June 21, 2013, when a RCIC system turbine speed indicator in the main control room was found degraded.

# Causal Evaluation and Corrective Actions
# Operations Response to RCIC Trip

**Tom Gordon**

**Assistant Operations Manager**



NEXTera ENERGY DUANE ARNOLD

# Cause Analysis

- **Root Cause 1 –** The RCIC voltage regulator dropping resistor in the RCIC governor power supply failed due to previously unknown resistor material changes made by the manufacturer that reduced performance margins in the given application. This resulted in overheating and ultimate failure

- **Root Cause 2 –** Screenings of the Condition Report and Work Request failed to correctly assess RCIC

# Immediate and Interim Corrective Actions

- **Immediate Actions**
  - On August 23, 2013, the dropping resistor in the RCIC governor power supply was replaced and the RCIC system was declared operable on August 24, 2013
  - The past operability evaluation determined that the RCIC system was inoperable from June 21, 2013 through August 24, 2013
- **Interim Actions**
  - Actions are in place to check the output voltage of the dropping resistor on a weekly basis in order to verify its condition
  - Maintenance actions have been implemented to replace the dropping resistor every three months

# Corrective Actions

- **Sustainable Corrective Actions**
  - The RCIC governor power supply will be modified to provide 50% margin to thermal aging and provide monitoring of output to detect any failures
  - Immediate Operability Determination (IOD) process revised to provide guidance for a peer review of IOD's associated with the top ten significant SSC's
    - An IOD work sheet will be utilized during the screening process for the top ten risk significant SSCs
    - A new automatic generated report of the previous 24 hour Condition Reports along with IOD notes transmitted to key management team members for daily review
    - Weekday Operations alignment meeting reviews previous 24 hour Condition Report IODs with Operations Shift Manager (OSM)

# Operations Response to RCIC Trip

- This part of the presentation will focus on the procedures used to manually operate RCIC and the successful operation of RCIC in the simulator, this discussion focuses on station blackout which encompasses a loss of feed water transient
- Two separate success paths with procedural guidance exists
  - Manual control of RCIC turbine speed by throttling Motor Operator trip/throttle valve MO-2405 at control room panel 1C04 (RCIC control panel)
  - Locally operate the RCIC turbine in accordance with Severe Accident Management Procedure (SAMP) 703. This procedure is specifically directed for use upon Station Blackout (SBO) conditions in the Emergency Management Guideline (EMG)

# Operations Response to RCIC Trip
# Use of MO-2405

- An operating crew was placed in the simulator to respond to an unknown transient. An SBO concurrent with High Pressure Cooling Injection (HPCI) system unavailable and a RCIC governor control system failure was demonstrated
  - Alarm Response Procedure (ARP) 1C04C provides RCIC trouble shooting guidance which lead to throttling MO-2405 instead of fully opening the valve
  - Conduct of Operations procedure requires Operators to take manual control when automatic controls fail
  - Human Performance Aid added to all throttle valve control room ‘cane handles’ to physically indicate in which direction valves can be throttled
  - When placed in an SBO with failure of RCIC speed control logic the operators demonstrated that throttling MO-2405 was their first action to recover RCIC
  - See video demonstration on use of MO-2405, this video depicts a separate crew, the purpose of which is to demonstrate the ease of use of MO-2405 for RCIC control and the lack of a distracting environment during SBO conditions

# Operations Response to RCIC Trip
# Use of SAMP-703 and MO-2404 RCIC Steam Supply Isolation Valve

- During the same scenario:
  - The panel operators informed the Control Room Supervisor (CRS) that normal speed control of RCIC was not working and manual control of MO-2405 trip throttle valve was being used to control turbine speed. The simulator set up intentionally prevented this from being successful to demonstrate that the OSM would order SAMP-703
  - The Operations Shift Manager (OSM) declared SBO Emergency Action Level (EAL) and implemented the use of CR-01 checklist which directed use of EMG's. Once in EMG's the OSM followed the guidance provided to implement SAMP-703, local manual control of RCIC. SAMP-703 ordered at 13 minutes into transient. Scenario is successfully terminated
  - SAMP-703 is part of the non-licensed operating training program and is reviewed bi-annually in Licensed Operator Requalification
  - Multiple operators were directed to walk through the performance of SAMP-703, including wait times for valve manipulations, accessing components in a locked High Radiation Area, etc
  - All walkthroughs, including appropriate briefings were completed within the time necessary to commence RCIC injection prior to vessel water level reaching top of active fuel

# Operations Response to RCIC Trip

- Operator Actions
  - License Reactor Operators are highly trained on the systems and components they control
  - Operators are constantly trained and evaluated on off-normal response of systems and components
  - Procedure guidance exists for operators to take manual control of a single valve to control RCIC turbine speed, as demonstrated by presented video
  - A viable alternate success path exist via SAMP-703 which is specifically directed under SBO conditions
  - In both success paths, it has been demonstrated that RCIC system injection occurred before top of active fuel was reached

# PRA and Risk Significance

**Anil Julka**

**Nuclear Risk and Reliability Manager**



NEXTera ENERGY DUANE ARNOLD

# Process for Comparing NRC and NextEra Energy (NEE) Results

- SPAR used to evaluate significance comparing NRC and NEE assumptions
- NEE (with ERIN support) developed SPAR model that emulates NRC assumptions (difficult without having detailed cutsets from NRC evaluation)
- PRA staff developed new human error probability (HEPs) evaluations based on existing procedures, training and simulator observations to specifically address actions related to this performance deficiency.
- Results were GREEN using DAEC PRA model that conforms to RG 1.200 rev 2
- NEE SPAR model adjusted to more accurately reflect the most significant DAEC PRA model inputs and DAEC operations inputs impacting the calculation of risk for this performance deficiency and to appropriately reflect the as-built, as operated plant

# MANUAL RECOVERY OF RCIC THROTTLING MO-2405 FROM CONTROL ROOM

- NRC assumed no procedure directed use of valve MO-2405, the RCIC turbine stop valve, to manually control RCIC speed. This assumption significantly skews the results high
- NEE version of the SPAR model calculations conservatively credits a probability of 0.1 for recovery of RCIC via manual operation of MO-2405 from the Main Control Room. This is an order of magnitude below the calculated HEP = 0.01
- Key factors credited in HEP:
  - The ARP Directly Leads to Operator Manipulating MO-2405
  - OP-AA-100-1000, Conduct Of Operations Requires Manual Control of non-functioning Automatic Controls
  - Human Performance Aid on Handle Indicates Valve Can Be Throttled
  - Operators Are Experienced In Throttling MO-2405 – Surveillance Procedure
  - Simulator Verification That Operators Will First Throttle MO-2405

# Manual Recovery of RCIC Throttling Turbine Steam Supply Valve MO-2404 from RCIC Room

- As previously discussed by operations, SAMP-703 provides explicit direction on how to manually start RCIC without electric power. RCIC is manually controlled at the RCIC Room.

- Conservatively, this action is not credited in the NEE SPAR Model – instead this action is subsumed by crediting the simpler and less time consuming control room action of throttling MO-2405 (previous slide). This is appropriate given the potential for the high dependency on manual operation of MO-2405 from the control room for this specific performance deficiency, e.g. both actions use similar cues for initiating their respective actions

# Credit for CRD During Loss of Feedwater (LOF)

- NRC SPAR model does not credit high pressure (HP) Reactor Pressure Vessel (RPV) makeup using CRD pumps during a LOF event
- The DAEC PRA model supports that CRD system alone using 1 of 2 pumps can successfully provide high pressure makeup to avoid core damage
- NEE SPAR Model conservatively updated to require 2 of 2 CRD pumps for success
  - One CRD pump is running and continues to run upon LOF
  - Second pump is manually started if needed [per EOP1]

# Connection Between Loss of Offsite Power and EDG HVAC

- NRC model generically assumes LOOP results in EDG HVAC failure and requires operator recovery (open doors) but this does not represent how the DAEC EDG system functions
- DAEC EDG HVAC is dependent on EDG operation NOT on offsite power
- Sensitivity analysis was performed showing ~25% decrease in CDF if the NRC SPAR model LOOP-EDG HVAC dependency was corrected, but adjustments to SPAR were not made since not needed to justify GREEN given the previous adjustments

# Fire PRA

- Credit for throttling MO-2405 reduces fire risk to GREEN

# ΔCDF Results

- NRC results are from NRC Inspection Report dated November 14, 2013
- NEE Inputs and assumptions are very conservative, as such providing significant margin to address modeling uncertainties.

| ΔCDF | | | |
|---|---|---|---|
| Model | Delta CDF (64 Days) | | |
| | Internal Events | Fire | Total |
| SPAR – NRC Inputs | 1.6E-06 | 1.9E-6 | 3.5E-06 |
| SPAR – NEE Inputs | 1.14E-07 | 1.93E-07 | 3.07E-07 |

## LERF results would be similarly reduced to Green

**The results differ significantly primarily due to no credit for CRD availability and the simplicity of RCIC recovery actions.**

# Closing Remarks

**Rich Anderson**

**Site Vice President**



NEXTera ENERGY DUANE ARNOLD