Duane Arnold Energy Center (DAEC) Loss of Offsite Power (LOOP) Due to Derecho

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DAEC Overview

BWR/4 -

An early BWR/4, the "B" loop of RHR is half of RHR (B+D pumps)

Mark I Containment

HPCI (3,100 gpm) & RCIC (425 gpm)

Core Spray and RHR

Rated Thermal Power 1,912 MW(t)

Rated Net Electric Power ~615 MW(e)

368 Fuel Bundles in the Core

SRVs setpoints:

 1 SRV 1,110 psig
 2 SRVs 1,130 psig

 1 SRV 1,120 psig
 2 SRVs 1,140 psig

Two safety valves (SVs) discharge directly to the DW airspace at the RPV pressure of 1,240 psig

DAEC Plant Status - Monday August 10th, 2020

- DAEC was operating at ~80% power due to coasting down to end of cycle (EOC). This power was selected to limit the cycling of a turbine control valve (TCV4) that would have occurred around ~84% power
- 2. Diesel Driven Fire Pump (DFP) is inoperable due to maintenance
- 3. LPCI B train was inoperable due to testing prior to the event, it was not being tested during the event and was available for use if needed
- 4. Two control rods are fully inserted to suppress a fuel leaker
- 5. Dry cask storage campaign under way in the spent fuel pool; time to boil is 64 hours



Initial conditions:

Power= 80.2% RTP Gross Electric power = 493.5 MWe RPV water level = +189.5" RPV pressure = 1,009.57 psig

SP Temperature = 83.7 °F DW Pressure = 0.5 psig SC Pressure = 0 psig DW Temperature = ~123 °F

DAEC Plant Status - Monday August 10th, 2020

- 11:38 A severe Thunderstorm watch is declared
- DAEC entered the Abnormal Operating Procedure (AOP) for Severe Weather and began performing their preparation actions
- 12:02 The Watch is upgraded to a Severe Thunderstorm Warning
- Shift Manager (SM) directed that fuel handling be placed in a safe condition and secured



August 10, 2020 Monday 12:30-12:35

- 12:30 Multiple alarms received due to grid issues
- 12:35 Grid perturbation occurs which causes the Emergency Diesel Generators (EDGs) to start but not tie on. The EDGs remain running
- Wind speeds > 100 mph with onsite peaks between 100 mph & 130 mph



August 10, 2020 Monday 12:35-12:49

- 12:49 Loss of offsite power due to sustained strong winds (> 100 mph) causes:
- Generator load reject, tripping the turbine and causing the Reactor to scram
- EDGs tie onto the safety buses A and B
- Recirculation pumps trip due to loss of power



August 10, 2020 Monday 12:49-12:51

- ♦ 12:49 All control rods fully insert
- RPV pressure rises quickly causing 2 SRVs to lift on low-low Set when pressure rose above 1,055 psig and initiation of an SRV on its setpoint (1,110 psig)
- 12:49 Ops enters EOP-1 on low level (+170" and lowering). RPV pressure 960 psig and steady. RPV Water level +135 and slowly lowering
- 12:50 Ops directed an initial level control band of 135" to 211"
- 12:51 RPV water level lowers to L2 (+119.5") due to loss of feedwater



August 10, 2020 Monday 13:00 - 24:00

- Continued Cooldown
- Level maintained high to facilitate natural circulation, in accordance with plant procedures.
- **Restored Systems to facilitate plant reliability:**
 - Reactor Water Cleanup System
 - Fuel Pool Cooling System
 - Well Water to keep pressure applied to the Fire System
 - General Service Water for equipment cooling
 - Set up DAEC Switchyard for emergent repairs

August 11, Tuesday

- O2:30 Ops established cold shutdown conditions using SDC
- 11:26 The 161kV Vinton line is restored to the switchyard restoring off-site power
- ♦ 12:15 Startup transformer is reenergized from offsite power
- 13:12 Safety Bus A is reenergized from off-site power
- 13:34 Safety Bus B is reenergized from off-site power
- ♦ 16:00 The NOUE is terminated

- Storm damage found on roof of the North FLEX building. FLEX function maintained by South FLEX Building equipment
- Forced draft Cooling towers severely damaged

August 17, 2020 Tuesday 12:49

 All six off-site power lines are restored



Interstate Transmission Company's (ITC) Off Site Heroes



Restoration of DAEC Off Site Power



DAEC - LOOP Insights

ESW Availability following the increase in dP of the strainer:

- The ESW strainer did not start "clogging" until the Torus Cooling was maximized later in the day with the operation of the HPCI System:
 - DAEC procedures required that maximizing of Torus Cooling with the operation of HPCI
 - This was also done to maintain the Torus under EOP-2 required temperatures
- The ESW system dPs remained low throughout the event
- The high strainer dP came into existence after shutdown cooling was placed in service