Prairie Island Nuclear Generating Plant Reactor Core Cooling & Heat Removal FLEX Strategy -Phase 1

December 6, 2012

Purpose

- Describe the Prairie Island baseline capability to provide reactor core cooling and heat removal per NEI 12-06, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide
- This presentation will present our strategy for Phase 1: Cope relying on installed plant equipment
  - This strategy relies on the turbine driven auxiliary feedwater pump, as supplied by the diesel driven cooling water pumps

Following Discussion

- Review NEI 12-06 language
- Auxiliary Feedwater System Design
- Cooling Water System Design
- Emergency Intake Structure Design
- Screenhouse Design
- FLEX Phase 1 strategy for core cooling

NEI 12-06, Coping Phases

- Phase 1: Cope relying on installed plant equipment.
- Phase 2: Transition from installed plant equipment to on-site FLEX equipment.
- Phase 3: Obtain additional capability and redundancy from off-site equipment until power, water, and coolant injection systems are restored or commissioned.

NEI 12-06, Section 3.2.1.1

- Procedures and equipment relied upon should ensure that satisfactory performance of necessary fuel cooling and containment functions are maintained. A simultaneous ELAP and LUHS challenges both core cooling and spent fuel pool cooling *due to interruption of normal ac powered system operations*. (emphasis added)

NEI 12-06, Table 3-2

Safety Function	Method	Baseline Capability
Reactor Core Cooling & Heat Removal (steam generators available)	• AFW/EFW • Depressurize SG for makeup with Portable Injection Source • Sustained Source of Water	• Use of installed equipment for initial coping • Connection of portable pump to feed required SGs • Use of alternate water source to support core heat removal

NEI 12-06, 3.2.1.3

(4) *Normal access* to the ultimate heat sink is lost, but the water inventory in the UHS remains available and robust piping connecting the UHS to plant systems remains intact. The motive force for UHS flow, i.e., pumps, is assumed to be lost with no prospect for recovery. (emphasis added)

(6) Permanent plant equipment that is contained in structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles, are available.

NEI 12-06, Section 3.2.2 (5)

- *"Plant procedures/guidance should ensure that a flow path is promptly established for makeup flow to the steam generator/nuclear boiler and identify backup water sources in order of intended use. Additionally, plant procedures/guidance should specify clear criteria for transferring to the next preferred source of water."*
- "Alternate water delivery systems can be considered available on a case-by-case basis"
- "Finally, when all other preferred water sources have been depleted, lower water quality sources may be pumped as makeup flow using available equipment (e.g., a diesel driven fire pump or a portable pump drawing from a raw water source)."

Normal Access to the UHS

- For Prairie Island, *normal access* to the ultimate heat sink is provided by the 11 and 21 Motor-Driven Cooling Water pumps via the intake traveling screens.
- These non-safeguard pumps are located in the 670' elevation of the plant screenhouse
- Normal access is lost as a result of the ELAP event (i.e., motor driven pumps are unavailable)

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Phase 1 Core Cooling - Overview

- Turbine Driven AFW pumps will provide feedwater supply to the steam generators
- Condensate Storage Tanks (CST) provide water source to AFW pumps, if available
- Diesel Driven Cooling Water (i.e. “Service Water”) pumps provide backup source to AFW pumps
- This strategy provides a highly reliable source of feedwater to the steam generators

Prairie Island Auxiliary Feedwater Design

- Auxiliary Feedwater System (AFW) consists of (per unit)

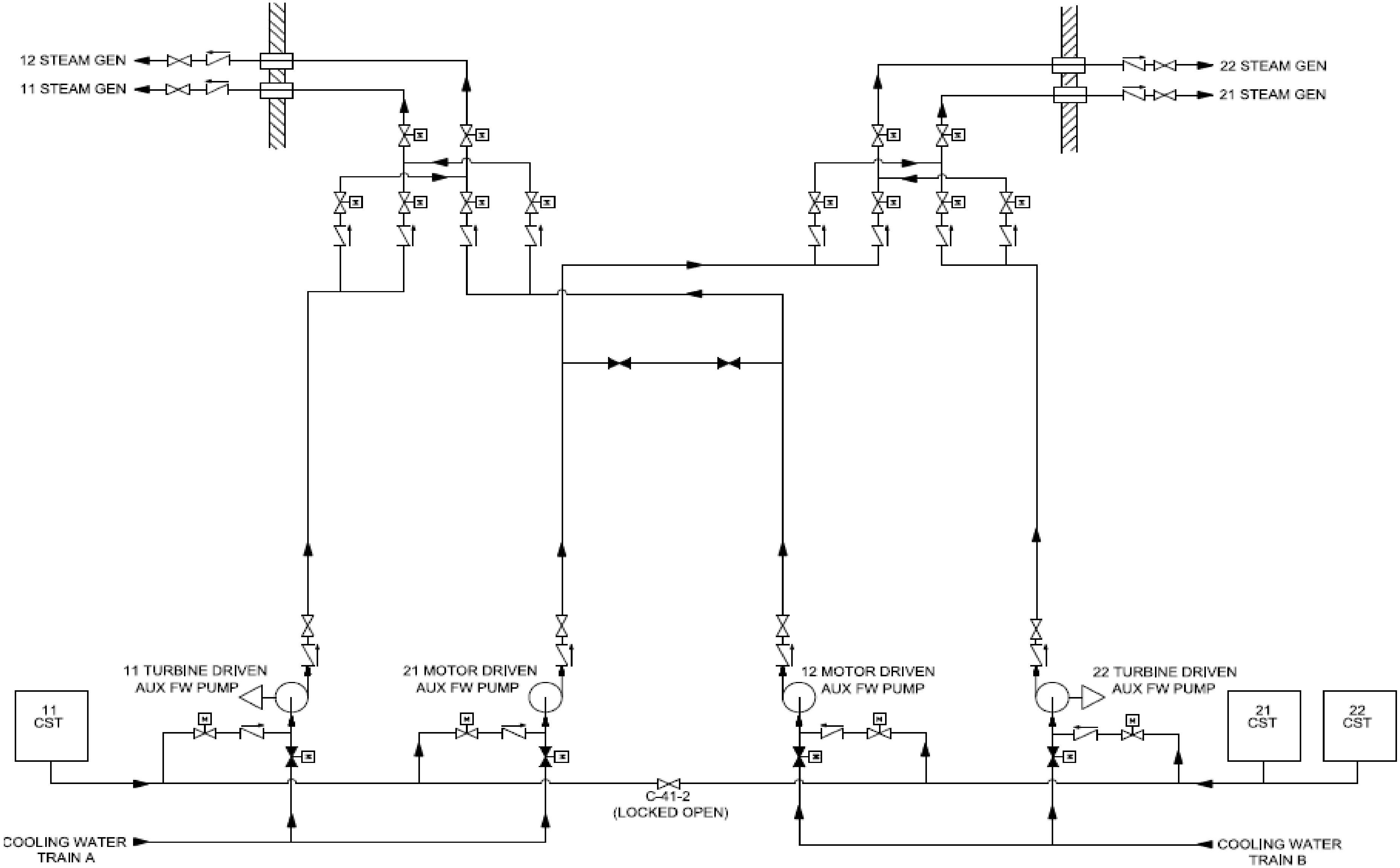
  (System diagram on slide 13)

  - One steam turbine-driven pump
  - One motor-driven pump
  - Each is capable of delivering 100 % of required feedwater to both steam generators
- Turbine-driven AFW pump:
  - Independent of plant AC power sources
  - Supplied steam from both main steam lines of associated unit.

Prairie Island Auxiliary Feedwater Design

- Auxiliary Feedwater System (AFW) water sources are redundant and diverse.
  - Normal source: gravity feed from three cross-connected 150,000 gallon condensate storage tanks (CST).
  - Safety related water supply: Class I Cooling Water System (CL)
  - On postulated loss of normal coolant source (CST), existing procedures direct aligning AFW suction to Cooling Water System

AFW System


12 STEAM GEN
11 STEAM GEN
22 STEAM GEN
21 STEAM GEN
11 TURBINE DRIVEN
AUX FW PUMP
21 MOTOR DRIVEN
AUX FW PUMP
12 MOTOR DRIVEN
AUX FW PUMP
22 TURBINE DRIVEN
AUX FW PUMP
11
CST
21
CST
22
CST
C-41-2
(LOCKED OPEN)
COOLING WATER
TRAIN A
COOLING WATER
TRAIN B

Prairie Island Cooling Water System

- Cooling Water System provides the following functions:

  (System diagram on Slide 18)

  - Suction Source Water Supply
    - AFW pumps
  - Cooling
    - Unit 1 diesel generators
    - Air compressors
    - Component Cooling Water heat exchangers
    - Containment fan-coil units
    - Auxiliary Building unit coolers

Prairie Island Cooling Water System (cont)

- Cooling Water System is a Safety Related system with five pumps feeding a dual-unit shared ring header
- Normal supply is from the Circulating Water (CW) pump bays in the plant screenhouse
- Two horizontal, motor-driven, CL pumps
  - Located at 670' elevation of screenhouse
  - Take a suction on the CW pump bays
  - Provide normal access to the ultimate heat sink

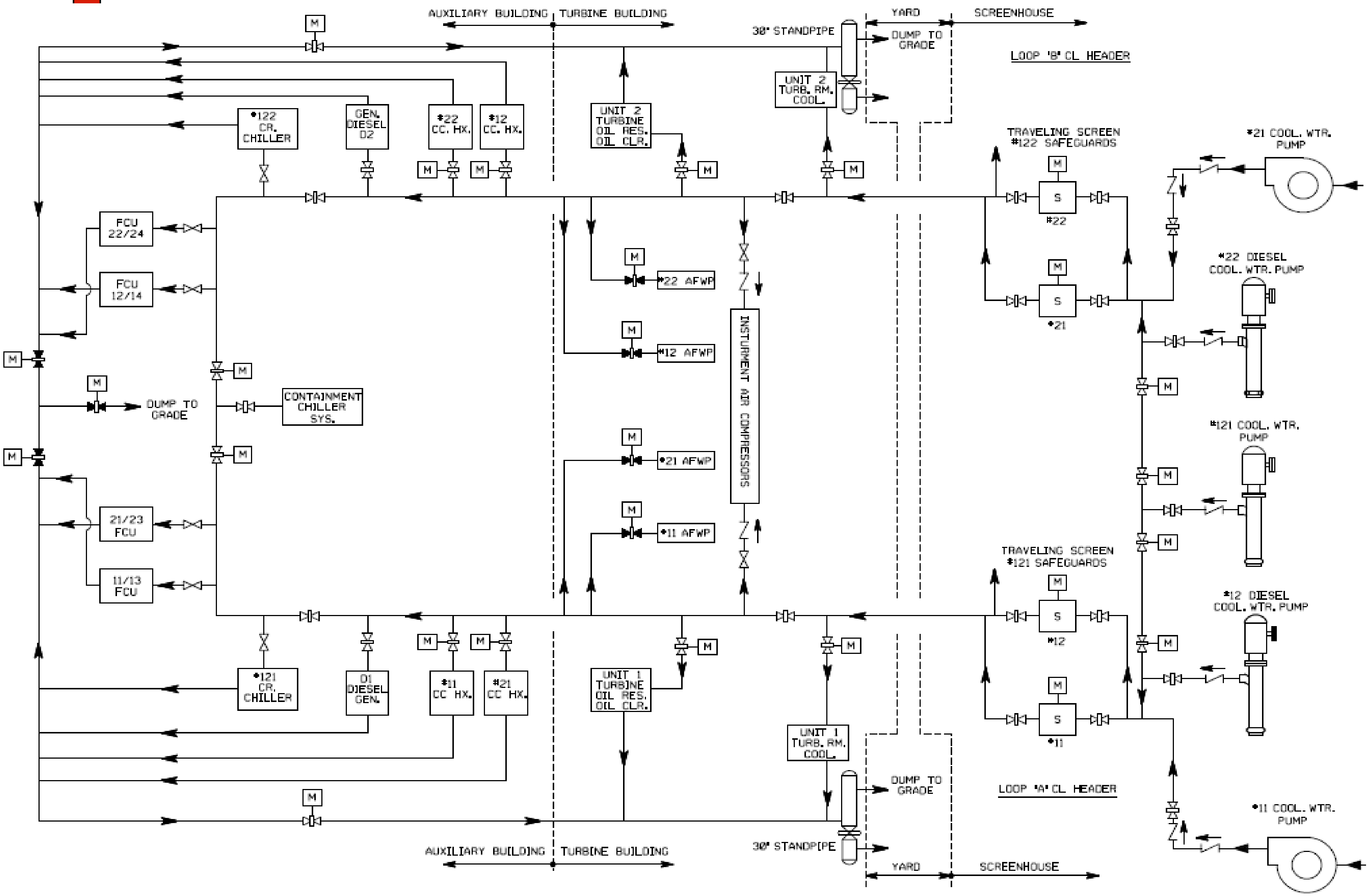
Prairie Island Cooling Water System (cont)

- Three Safety-Related vertical pumps (one motor-driven and two diesel-driven)
  - Housed in a robust structure (695’ elevation of screenhouse)
  - Take a suction on the Emergency Bay
  - Provide the emergency (safeguard) access to the ultimate heat sink.
- Emergency Bay is supplied from:
  - CW pump bays through 2 normally open, gated tunnels or
  - 36-inch emergency cooling water intake line from the ultimate heat sink

Diesel-Driven Cooling Water Pumps

- Diesel driven pumps take suction from the Emergency Bay and discharge to the common discharge header.
- 17,500 gpm each (400 gpm total needed for AFW)
- Independent of plant AC power sources
- Two Auto-Start Signals – 1) Safety Injection, 2) low discharge header pressure
- Can be manually started in Control Room or locally

Cooling Water System



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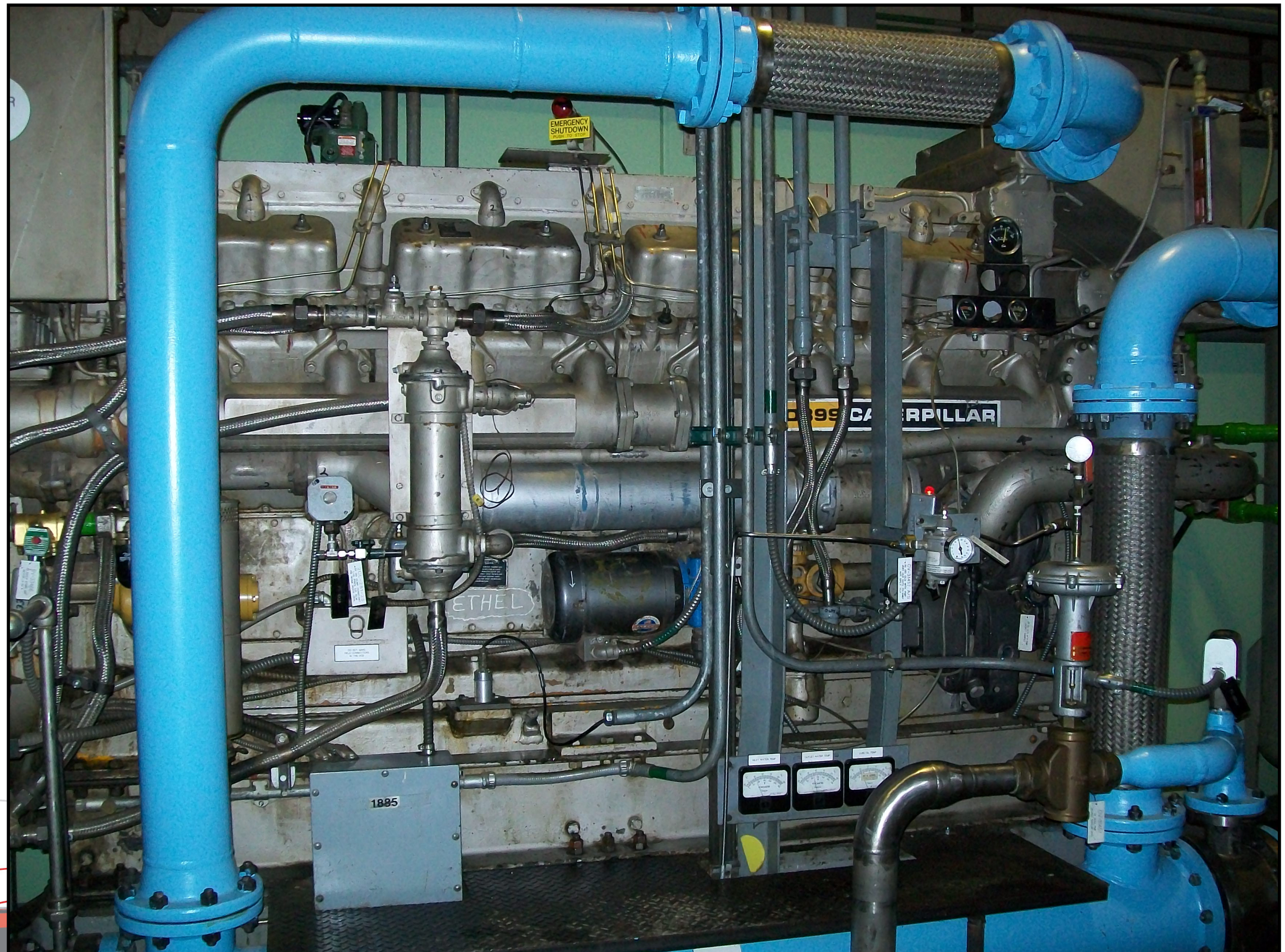
12 and 22 Safeguard DD CL Pumps



121 MD CL Pump

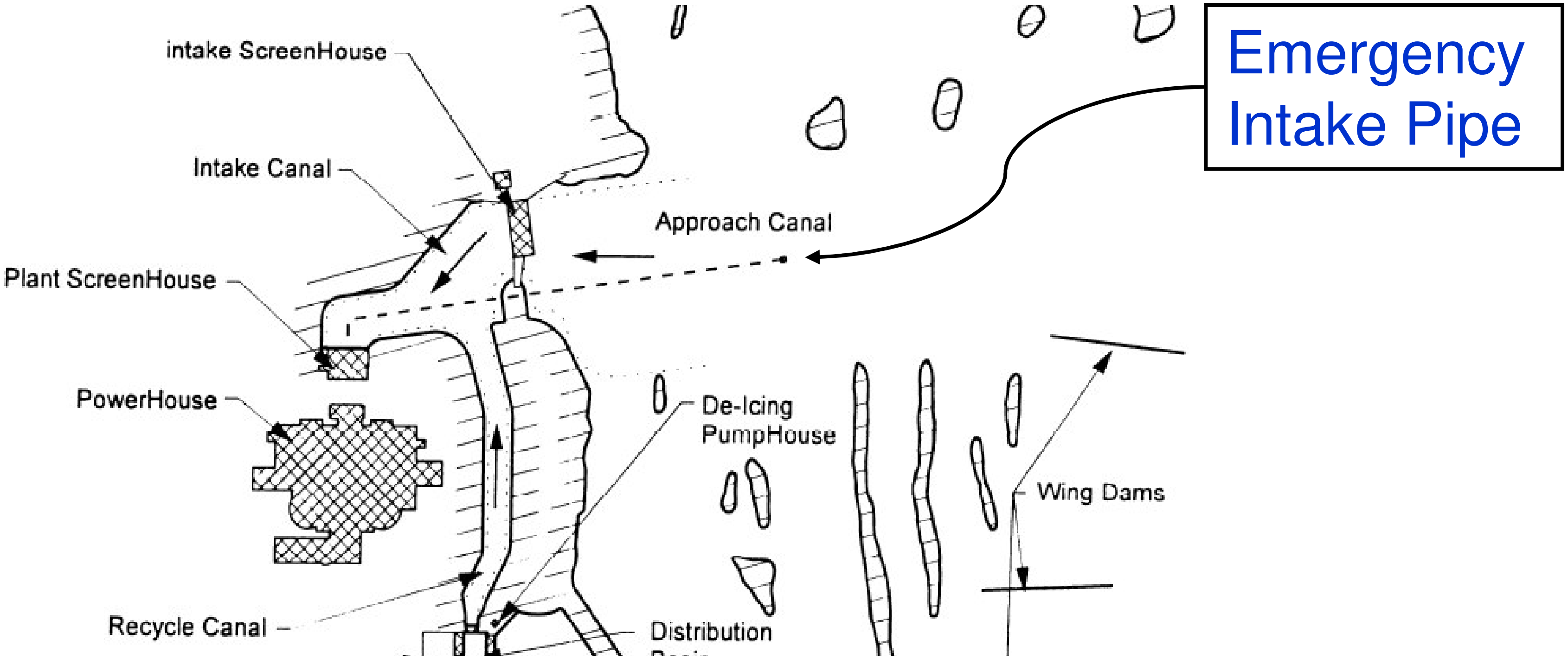
Emergency Cooling Water Intake

- Design Basis
  - Provide cooling water for reactor shutdown cooling after a DBE
  - Assumes
    - CW intake canal is blocked or
    - Dam break at Lock and Dam #3 downstream of the plant
- Source
  - Independent of the normal access to the ultimate heat sink.
  - Connects to a submerged crib in the branch channel of the Mississippi River
  - Consists of a 36” pipe buried approximately 40’ below the circ water intake canal level in a nonliquifiable soil.

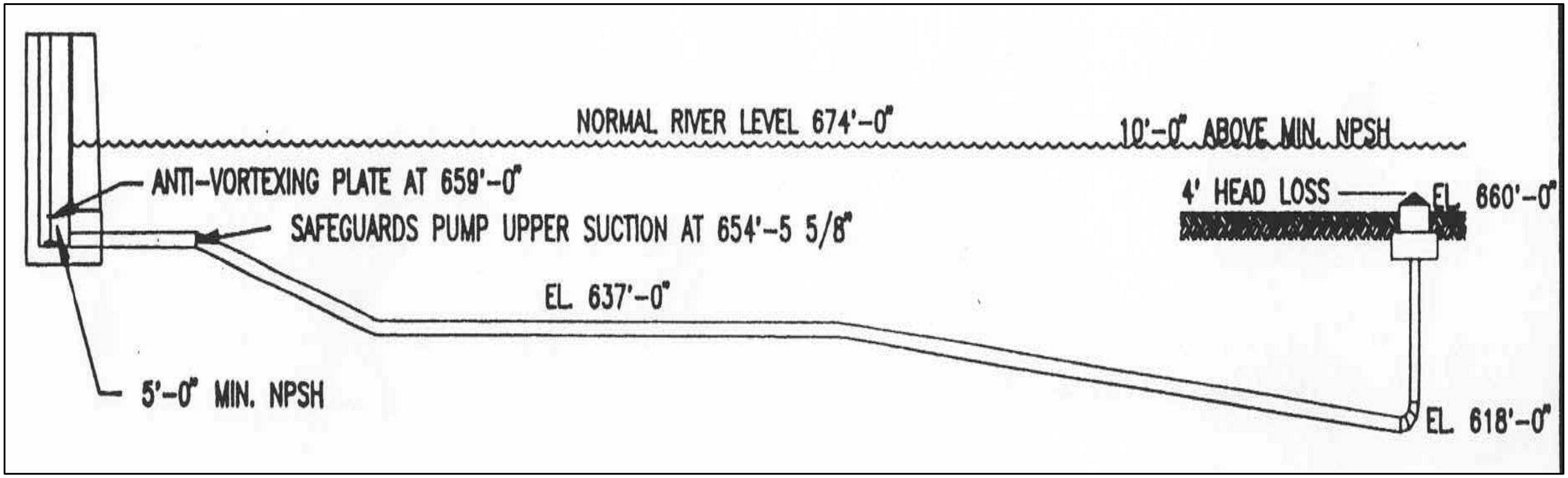
Emergency Cooling Water Intake (cont)

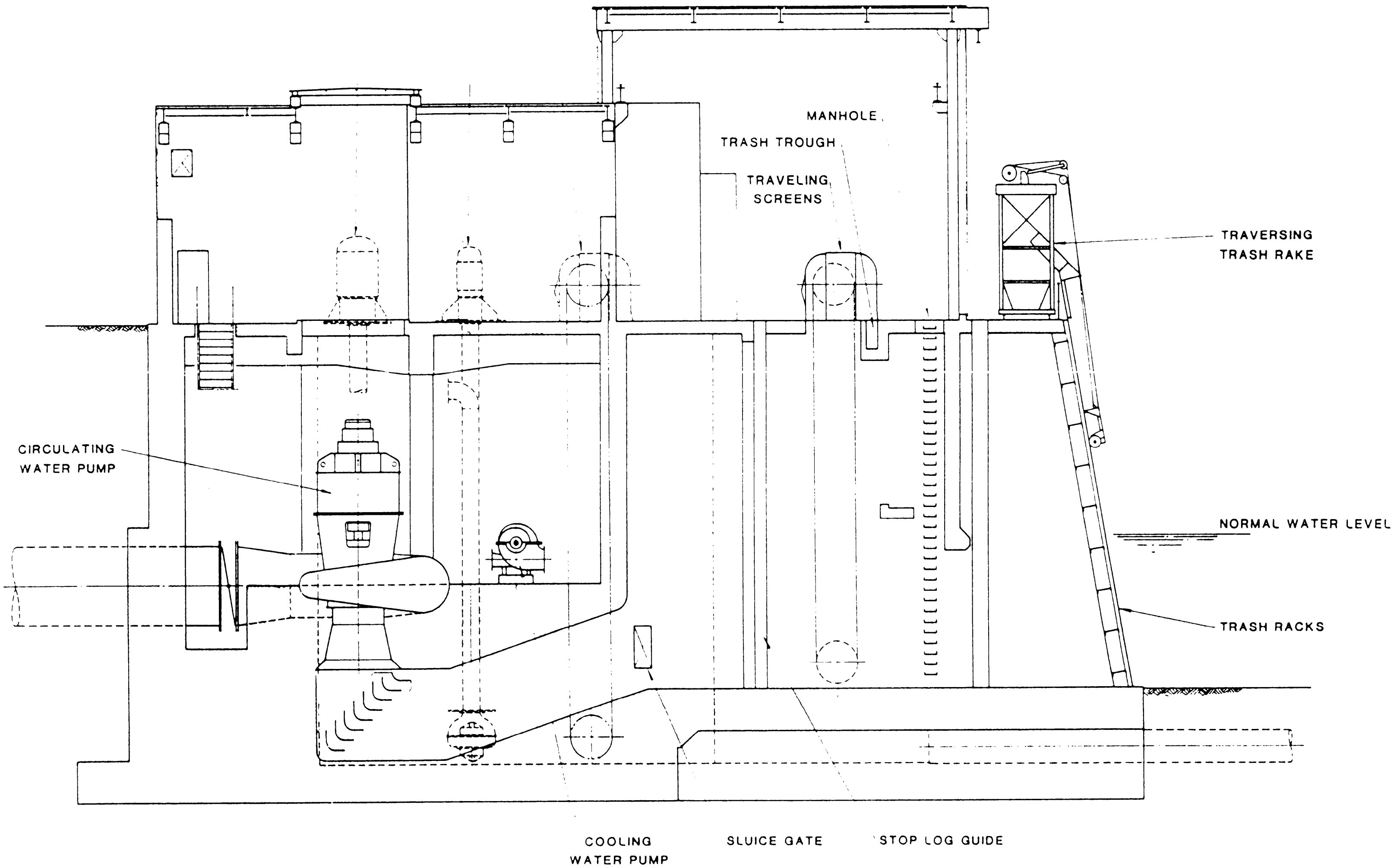
- Intake
  - Class I structure, as is the approach canal which supplies its intake crib.
  - Designed to exclude trash and means are provided for back flushing.

Emergency Intake Pipe

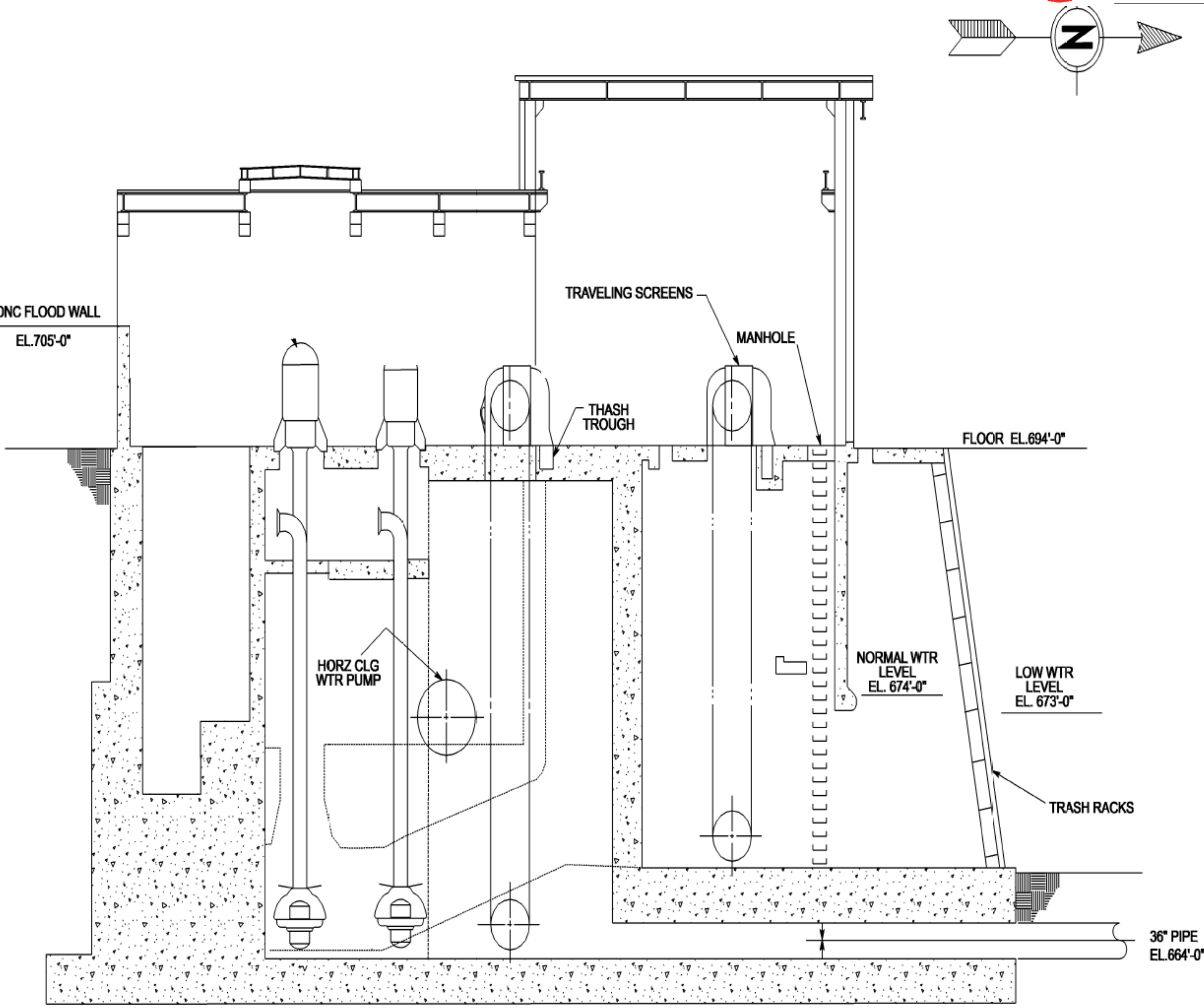


Emergency Pipe Profile





MANHOLE
TRASH TROUGH
TRAVELING SCREENS
TRAVERSING TRASH RAKE
CIRCULATING WATER PUMP
NORMAL WATER LEVEL
TRASH RACKS
COOLING WATER PUMP
SLUICE GATE
STOP LOG GUIDE


CONC FLOOD WALL
EL.705'-0"
TRAVELING SCREENS
MANHOLE
THASH
TROUGH
FLOOR EL.694'-0"
HORZ CLG
WTR PUMP
NORMAL WTR
LEVEL
EL. 674'-0"
LOW WTR
LEVEL
EL. 673'-0"
TRASH RACKS
36" PIPE
EL.664'-0"

Screenhouse Structure

- Screenhouse areas (housing the Cooling Water facilities, equipment and piping) are a Class I structure.
- Structures are analyzed for each of the following conditions;
    1. Normal Operating Conditions
    2. Operational Basis Earthquake Conditions
    3. Design Basis Earthquake Conditions
    4. Tornado Condition
- Screenhouse structure housing the CL equipment is flood protected to the PMF level.

Emergency Intake Maintenance/Testing

- Monthly Backflush of Emergency Bay Intake Pipe
- Approach, Intake, and Discharge Canal Hydrographic Survey
- Diver inspection of emergency intake crib every five (5) years

CL-AFW Flow Path Testing

- The Flow Path, including pumps, valves, and diesel engines, are tested per Prairie Island ASME IST Program

Relationship to FLEX Strategy (NEI 12-06)

AFW Procedure Without AC

- C28.1, AOP3 “Auxiliary Feedwater System Operation when AC Power is Lost” (existing)
  - If/when CSTs inventory is depleted the Cooling Water system is manually aligned to supply AFW
  - Includes step to locally align the Cooling Water Supply to the AFW system
  - Valves needed to perform switchover are located in robust structure (AFW pump room, ground floor of turbine building)

1[2]ECA 0.0, "Loss of all Safeguards Power"

(Step 2) Verify AFW Flow – GREATER THAN 200 GPM

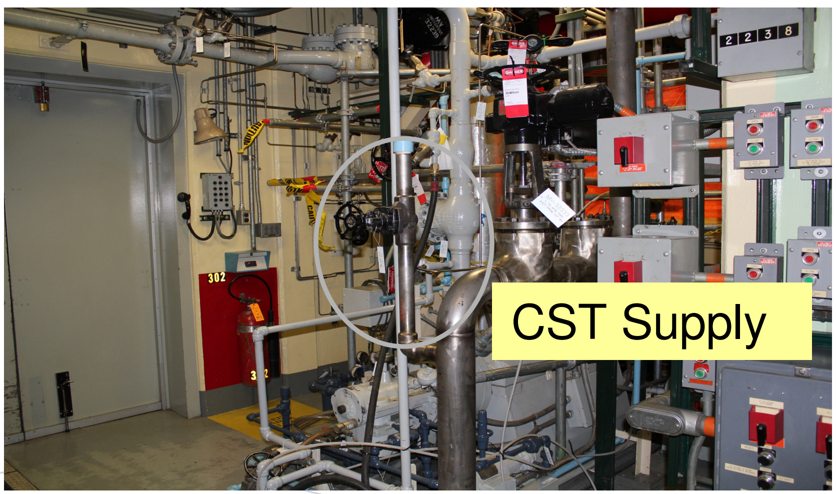
(RNO) Perform the following:

a. Verify TD AFW pump running. IF NOT, THEN manually start TD AFW pump.

IF pump can NOT be started, THEN dispatch personnel to locally start pump per C28.1 AOP3, AUX FEEDWATER SYSTEM OPERATION WHEN AC POWER IS LOST.

AFW Operation per C28.1 AOP3

- **Local operation of Motor Valves to transfer source from CST to Cool Water Supply**



AFW Operation per C28.1 AOP3

- **Dedicated ladders pre-staged in AFW room**

C28.1, AOP3 Training

- Non Licensed Operators
  - Perform local actions
  - Initial classroom and OJT/TPE, as well as continuing training
- Licensed Operators
  - Monitor system, direct local actions in CR
  - Initial classroom and OJT/TPE, as well as continuing training

Core Cooling Strategy – Compliance with NEI 12-06

- Normal access to the ultimate heat sink is lost
  - *Motor driven cooling water pumps lost as a result of the ELAP event*
- Permanent plant equipment that is contained in robust structures are available
  - *Screenhouse structure housing the diesel driven cooling water pumps is robust relative to seismic, flooding, high winds, tornados*

Core Cooling Strategy – Compliance with NEI 12-06 (cont)

- A simultaneous ELAP and LUHS challenges both core cooling and spent fuel pool cooling due to interruption of normal AC powered system operations
  - *Turbine driven AFW and diesel driven cooling water systems operate independent of AC power*
- Plant procedures/guidance should ensure that a flow path is promptly established for makeup to the steam generators.
  - This strategy exists in current plant procedures and within the Operations training curriculum.

Phase 1 Core Cooling Strategy - Summary

- Rely on TD AFW pumps.
- Credit Diesel Driven CL Pumps as water source if/when CSTs are depleted or lost
- This strategy is consistent with Order EA-12-049 and NEI guidance.