Containment and Balance of Plant Reviewer Final Integrated Plan Checklist for Orders EA-12-049 and EA-12-051 Safety Evaluations

Reactor Core Cooling Strategies – Core Cooling and reactor coolant system (RCS) Makeup (if applicable) (safety evaluation (SE) Sections 3.2.1.1 and 3.2.1.2) (North Anna Power Station, Units 1 and 2 (North Anna) Final Integrated Plan (FIP) Sections 2.3.1, 2.3.2, and 2.3.3)

Provide a brief description of the Phase 1, 2 and 3 core cooling and RCS makeup (if applicable) strategies respectively.

Reactor Core Cooling Strategies – Flooding Variation (if applicable) (SE Sections 3.2.2)

Provide a brief description of the Phase 1, 2 and 3 core cooling and RCS makeup (if applicable) flooding strategies respectively if different from strategy described earlier.

Reactor Core Cooling Strategies – Plant SSCs (SE Section 3.2.3.1.1) (North Anna FIP Section 2.3.4)

1. Turbine Driven Auxiliary Feedwater Pump/Reactor Core Isolation Cooling Pump (North Anna FIP Section 2.3.4.1)

   Explain pump control during an extended loss of alternating current power (ELAP) and backup air, power, and/or manual operation.

2. Steam Generator atmospheric dump valves (ADVs), boiling water reactor (BWR) safety relief valves (SRVs) (North Anna FIP Section 2.3.4.2)

   Explain valve control during an ELAP and backup air, power, and/or manual operation.

3. Additional permanent equipment (e.g. installed charging pumps, diesel driven fire pumps, diesel fuel oil transfer pumps, Residual heat removal/component cooling water (RHR/CCW) pumps used for Phase 3, etc.) used during any phase (including Phase 3) of an ELAP (Note: connections or water sources do not need to be discussed here because they are explained later) (North Anna FIP Section 2.3.4.X)

   Explain equipment control during an ELAP and backup air, power, and/or manual operation.

4. Discuss how the above equipment is robust (e.g., location and protection) from all applicable hazards and is expected to be available during an ELAP event consistent with Nuclear Energy Institute (NEI) 12-06, Section 3.2.1.3. Include references to any documents developed specifically to support the FLEX strategy that are not part of the current design-basis (e.g., an engineering calculation/evaluation demonstrating robustness).

Reactor Core Cooling Strategies – FLEX Pumps and Water Supplies (SE Section 3.2.3.5)
(North Anna FIP Section 2.3.10)

Staff Conclusion: Based on the staff's review of the FLEX pumping capabilities at [Plant X], as described in the above hydraulic analyses and the FIP, the licensee has demonstrated that its [pre-staged] FLEX pumps should perform as intended to support core cooling [and RCS makeup] during an ELAP caused by an external event, consistent with NEI 12-06, Section 11.2.

Information needed to support conclusion:

1. FLEX Pump(s) (North Anna FIP Sections 2.3.10.1, 2.3.10.2, 2.3.10.3)

    a. List the capacity of portable pumps to supply the flow identified in the hydraulic analyses including:
        i. Pump motive force (i.e., diesel or electric)
        ii. Sizing
        iii. Net positive suction head (NPSH)
        iv. Suction lift and/or booster pumps
    b. Ensure current revision of hydraulic analysis is placed on E-Portal.
    c. Briefly discuss storage location.
    d. If pump is pre-staged, describe location and protection from all applicable external hazards (i.e. how robust IAW NEI 12-06 definition). Reference any documents developed specifically to support the FLEX strategy that are not part of the current design basis (e.g., an engineering change document demonstrating robustness).
    e. Discuss National Strategic Alliance of FLEX Emergency Response (SAFER) Response Center NSRC equipment (Phase 3) pump capacities and how they meet flow requirements described earlier.
    f. Briefly discuss water supplies (detailed discussion in SE Section 3.10)

2. Other FLEX equipment such as diesel-powered air compressors.

    a. List the capacity of portable FLEX equipment to supply air, including:
        i. Motive force (i.e., diesel or electric)
        ii. Sizing
    b. Ensure current revision of sizing calculation is placed on E-Portal.
    c. Briefly discuss storage location.
    d. If equipment is pre-staged, describe location and protection from all applicable external hazards (i.e. how robust IAW NEI 12-06 definition). Reference any documents developed specifically to support the FLEX strategy that are not part of the current design basis (e.g., an engineering change document demonstrating robustness).

3. Discuss how the analysis above is consistent with NEI 12-06 Section 11.2 and how the FLEX equipment discussed is capable of supporting the core cooling (and RCS makeup if applicable) strategy and is expected to be available during an ELAP event.

Spent Fuel Pool Cooling Strategies – (SE Sections 3.3.1, 3.3.2, and 3.3.4) (North Anna FIP Sections 2.4.1, 2.4.2, and 2.4.3)

Provide a brief description of the Phase 1, 2 and 3 spent fuel pool (SFP) strategies respectively. Include discussion of hose deployment timeline.

Spent Fuel Pool Cooling Strategies – Plant SSCs (SE Section 3.3.4.1.1) (North Anna FIP Section 2.4.4)

1. Identify permanent plant equipment only (e.g., Fuel Handling Building, installed pumps)

2. Discuss venting of the SFP area to cope with the temperature, humidity, and condensation from the boiling in the SFP.

3. Describe the availability of water sources for Phase 1; Phase 2 and 3 water sources discussed SE Section 3.10.

4. Discuss how the above equipment is robust (e.g., location and protection) from all applicable hazards and is expected to be available during an ELAP event consistent with NEI 12-06, Section 3.2.1.3. Reference any documents developed specifically to support the FLEX strategy that are not part of the current design-basis (e.g., an engineering calculation/evaluation demonstrating robustness). Furthermore, discuss how the above establishes a ventilation path to cope with temperature, humidity and condensation from evaporation and/or boiling of the SFP in accordance with (IAW) with NEI 12-06 Tables C-3 and D-3.

Spent Fuel Pool Cooling Strategies – Thermal-Hydraulic Analyses (SE Section 3.3.4.2) (North Anna FIP Section 2.4.6)

1. Describe and reference thermal-hydraulic analyses including:

    a. Time to Boil
    b. Time to Boil to a specified point above top of active fuel
    c. Heat loads considered, both nominal and maximum
    d. Required makeup rate

2. Discuss how the above analysis is consistent with NEI 12-06, Section 3.2.1.6.

Spent Fuel Pool Cooling Strategies – FLEX Pumps and Water Supplies (SE Section 3.3.4) (North Anna FIP Section 2.4.7)

1. FLEX Pump(s) (if not already described)

    a. List the capacity of portable pumps to supply the flow identified in the hydraulic analyses including:
        i. Pump motive force (i.e., diesel or electric)
        ii. Sizing
        iii. NPSH

iv. Suction lift and/or booster pumps

b. Ensure current revision of hydraulic analysis is placed on E-Portal.
c. Briefly discuss storage location.
d. If pump is pre-staged, describe location and protection from all applicable external hazards (i.e. how robust IAW NEI 12-06 definition). Reference any documents developed specifically to support the FLEX strategy that are not part of the current design basis (e.g., an engineering change document demonstrating robustness).
e. Discuss NSRC equipment (Phase 3) pump capacities and how they meet flow requirements described earlier.

2. A brief description of water supplies (detailed discussion in SE Section 3.10).

3. Discuss how the analysis above is consistent with NEI 12-06 Section 11.2 and how the FLEX equipment discussed is capable of supporting the SFP cooling strategy and is expected to be available during an ELAP event.

Pressurized-water reactor (PWR) Large Dry Containment Cooling Strategies – (SE Sections 3.4.1, 3.4.2 and 3.4.3) (North Anna FIP Sections 2.5.1, 2.5.2, and 2.5.3)

Provide a brief description of the Phase 1, 2 and 3 containment cooling strategies respectively.

PWR Large Dry Containment Cooling Strategies – Plant SSCs (SE Section 3.4.4.1.1) (North Anna FIP Section 2.5.4)

1. Containment Building

    a. Describe construction and volume of structure.
    b. Discuss design temperature and pressure limits.

2. Additional permanent equipment not already described used during any phase (including Phase 3) of an ELAP (e.g. containment spray pumps, containment coolers, RHR/CCW pumps used for Phase 3, etc.) Note: connections and water sources do not need to be discussed here because they are explained later.

    Explain equipment control during an ELAP and backup air, power, and/or manual operation.

3. Discuss how the above structures and equipment are robust (e.g., location and protection) from all applicable hazards and are expected to be available during an ELAP event consistent with NEI 12-06, Section 3.2.1.3. Include references to any documents developed specifically to support the FLEX strategy that are not part of the current design basis (e.g., an engineering calculation/evaluation demonstrating robustness).

PWR Large Dry Containment Cooling Strategies – Plant Instrumentation (SE Section 3.4.4.1.2) (North Anna FIP Section 2.5.5)

Describe the key containment parameter indications credited for all phases of the strategy and associated power sources.

PWR Large Dry Containment Cooling Strategies – Thermal-Hydraulic Analyses (SE Section 3.4.4.2) (North Anna FIP Section 2.5.6)

1. Describe, reference, and place on E-Portal the thermal-hydraulic analyses.

2. Discuss the following:

    a. Analysis inputs (RCS leakage)
    b. Maximum containment temperature and pressure for calculated duration

3. Discuss how the analysis above shows that there is significant margin before a containment pressure or temperature limit would be reached.

PWR Large Dry Containment Cooling Strategies – FLEX Pumps and Water Supplies (SE Section 3.3.4.3) (North Anna FIP Section 2.5.7)

1. Onsite and NSRC FLEX Pump(s) (if not already described in the core cooling or SFP cooling sections)

    a. List the capacity of portable pumps to supply the flow identified in the hydraulic analyses including:
        i. Pump motive force (i.e., diesel or electric)
        ii. Sizing
        iii. NPSH
        iv. Suction lift and/or booster pumps
    b. Ensure current revision of hydraulic analysis is placed on E-Portal.
    c. Briefly discuss storage location.
    d. If pump is pre-staged, describe location and protection from all applicable external hazards (i.e. how robust IAW NEI 12-06 definition). Reference any documents developed specifically to support the FLEX strategy that are not part of the current design basis (e.g., an engineering change document demonstrating robustness).
    e. Discuss NSRC equipment (Phase 3) pump capacities and how they meet flow requirements described earlier.

2. A brief description of water supplies (detailed discussion in SE Section 3.10).

3. Discuss how the analysis above is consistent with NEI 12-06 Section 11.2 and how the FLEX equipment discussed is capable of supporting the containment cooling strategy and is expected to be available during an ELAP event.

BWR Containment Cooling Strategies (SE Sections 3.4.1, 3.4.2 and 3.4.3)
Provide a brief description of the Phase 1, 2 and 3 containment cooling strategies respectively. (2.5.1, 2.5.2, and 2.5.3)

BWR Containment Cooling Strategies – Plant SSCs (SE Section 3.4.4.1.1)

1. Containment Type/Building
    a. Describe construction and volume of structure.
    b. Discuss design temperature and pressure limits.

2. Additional permanent equipment not already described used during any phase (including Phase 3) of an ELAP (e.g. reactor core isolation cooling (RCIC) Pumps, High Pressure Coolant Injection Pumps, Standby Gas Treatment System, Hydrogen Igniters (Mark III), suppression pool venting, etc.) Note: connections and water sources do not need to be discussed here because they are explained later.

    Explain equipment control during an ELAP and backup air, power, and/or manual operation.

3. Discuss how the above structure and equipment are robust (e.g., location and protection) from all applicable hazards and are expected to be available during an ELAP event consistent with NEI 12-06, Section 3.2.1.3 and Section 3.2.2.15. Include references to any documents developed specifically to support the FLEX strategy that are not part of the current design-basis (e.g., an engineering calculation/evaluation demonstrating robustness).

BWR Containment Cooling Strategies – Plant Instrumentation (SE Section 3.4.4.1.2)

Description of the key containment parameter indications credited for all phases of the strategy and associated power sources. (2.5.5)

BWR Containment Cooling Strategies – Thermal-Hydraulic Analyses (SE Section 3.4.4.2)

1. Describe, reference, and place on E-Portal the thermal-hydraulic analyses.

2. Discuss the following:

    a. Analysis inputs (i.e., pump seal leakage)
    b. Suppression Pool venting system if used to maintain containment parameters within limits
    c. Maximum containment temperature and pressure for calculated duration

3. Discuss how the analysis above shows that there is significant margin before a containment pressure or temperature limit would be reached.

BWR Containment Cooling Strategies – FLEX Pumps and Water Supplies (SE Section 3.4.4.3)

1. Onsite and NSRC FLEX Pump(s) (if not already described in the Core Cooling or SFP Cooling sections)

a. List the capacity of portable pumps to supply the flow identified in the hydraulic analyses including:
    i. Pump motive force (i.e., diesel or electric)
    ii. Sizing
    iii. NPSH
    iv. Suction lift and/or booster pumps
b. Ensure current revision of hydraulic analysis is placed on E-Portal.
c. Discuss storage location.
d. If pump is pre-staged, describe location and protection from all applicable external hazards (i.e. how robust IAW NEI 12-06 definition). Reference any documents developed specifically to support the FLEX strategy that are not part of the current design basis (e.g., an engineering change document demonstrating robustness).
e. Discuss NSRC equipment (Phase 3) pump capacities and how they meet flow requirements described earlier.

2. A brief description of water supplies (detailed discussion in SE Section 3.10).

3. Discuss how the analysis above is consistent with NEI 12-06 Section 11.2 and how the FLEX equipment discussed is capable of supporting the containment cooling strategy and is expected to be available during an ELAP event.

Ice Condenser Containment Cooling Strategies – Section 3.4 (SE Sections 3.4.1, 3.4.2 and 3.4.3)

Provide a brief description of the Phase 1, 2 and 3 containment cooling strategies respectively.

Ice Condenser Containment Cooling Strategies – Plant SSCs (SE Section 3.4.4.1.1)

1. Containment Type/Building

    a. Describe construction and volume of structure.
    b. Discuss design temperature and pressure limits.

2. Additional permanent equipment not already described used during any phase (including Phase 3) of an ELAP (e.g. Hydrogen Igniters, Containment Air Recirculation Fans and Hydrogen Skimmer Fans, etc.) Note: connections and water sources do not need to be discussed here because they are explained later

    Explain equipment control during an ELAP and backup air, power, and/or manual operation.

3. Discuss how the above structure and equipment are robust (e.g., location and protection) from all applicable hazards and are expected to be available during an ELAP event consistent with NEI 12-06, Section 3.2.1.3 and Section 3.2.2.15. Include references to any documents developed specifically to support the FLEX strategy that are not part of the current design-basis (e.g., an engineering calculation/evaluation demonstrating robustness).

Ice Condenser Containment Cooling Strategies – Plant Instrumentation (SE Section 3.4.4.1.2)

Description of the key containment parameter indications credited for all phases of the strategy and associated power sources.

Ice Condenser Containment Cooling Strategies – Thermal-Hydraulic Analyses (SE Section 3.4.4.2)

1. Describe, reference, and place on E-Portal the thermal-hydraulic analyses.

2. Specific discussion includes:
    a. Analysis inputs (RCS leakage)
    b. Maximum containment temperature and pressure for calculated duration

3. Discuss how the analysis above shows that there is significant margin before a containment pressure or temperature limit would be reached.

Ice Condenser Containment Cooling Strategies – FLEX Pumps and Water Supplies (SE Section 3.4.4.3)

1. Onsite and NSRC FLEX Pump(s) (if not already described in the Core Cooling or SFP Cooling sections)

    a. List the capacity of portable pumps to supply the flow identified in the hydraulic analyses including:
        i. Pump motive force (i.e., diesel or electric)
        ii. Sizing
        iii. NPSH
        iv. Suction lift and/or booster pumps
    b. Ensure current revision of hydraulic analysis is placed on E-Portal.
    c. Discuss storage location.
    d. If pump is pre-staged, describe location and protection from all applicable external hazards (i.e. how robust IAW NEI 12-06 definition). Reference any documents developed specifically to support the FLEX strategy that are not part of the current design basis (e.g., an engineering change document demonstrating robustness).
    e. Discuss NSRC equipment (Phase 3) pump capacities and how they meet flow requirements described earlier.

2. A brief description of water supplies (detailed discussion in SE Section 3.10).

3. Discuss how the analysis above is consistent with NEI 12-06 Section 11.2 and how the FLEX equipment discussed is capable of supporting the containment cooling strategy and is expected to be available during an ELAP event.

Planned Deployment of FLEX Equipment Mechanical Connections – Section 3.7.3.1 (Mechanical Connection Points)

1. Phase 2 and 3 Core Cooling - Portable/pre-staged FLEX pumps

    a. Primary and alternate pump staging location (North Anna FIP Sections 2.3.2, and 2.3.5.1-2.3.5.3)
    b. Primary and alternate suction and discharge connection points (i.e. Emergency condensate storage tank (ECST), AFW system, main feedwater system, safety injection (SI) system, etc.) (North Anna FIP Sections 2.3.2, and 2.3.5.1-2.3.5.3)
        i. Describe system location and protection from all applicable external hazards (i.e. how robust IAW NEI 12-06 definition). Reference any documents developed specifically to support the FLEX strategy that are not part of the current design-basis (e.g., an engineering analysis demonstrating robustness).
        ii. Describe flow path diversity
    c. Description of hose route(s) (North Anna FIP Sections 2.3.2, and 2.3.5.1-2.3.5.3)
    d. Reference any procedures used in connecting portable/pre-staged FLEX Pumps.

2. Phase 2 and 3 RCS Makeup (PWR only) - Portable/pre-staged FLEX pumps

    a. Primary and alternate pump staging location (North Anna FIP Sections 2.3.2, and 2.3.5.4-2.3.5.6)
    b. Primary and alternate suction and discharge connection points (i.e. refueling water storage tanks (RWST), SI system, etc.) (North Anna FIP Sections 2.3.2, and 2.3.5.1-2.3.5.3)
        i. Describe system location and protection from all applicable external hazards (i.e. how robust IAW NEI 12-06 definition). Reference any documents developed specifically to support the FLEX strategy that are not part of the current design-basis (e.g., an engineering analysis demonstrating robustness).
        ii. Describe flow path diversity
    c. Describe hose route(s) (North Anna FIP Sections 2.3.2, and 2.3.5.1-2.3.5.3)
    d. Reference any procedures used in connecting portable/pre-staged FLEX pumps.

3. Phase 2 and 3 Spent Fuel Cooling - Portable/pre-staged FLEX pumps

    a. Primary and alternate pump staging location (if not already discussed). (North Anna FIP Sections 2.4.2, and 2.4.4.1- 2.4.4.4)
    b. Primary and alternate suction and discharge connection points (i.e. SFP cooling system, RHR, RWST, etc.). (North Anna FIP Sections 2.4.2, and 2.4.4.1- 2.4.4.4)

4. Phase 2 and 3 Containment Cooling (if not already discussed) - Portable/pre-staged FLEX pumps

    a. Primary and alternate pump staging location.
    b. Primary and alternate suction and discharge connection points (i.e. RWST, Containment Spray etc.).
        i. Describe system location and protection from all applicable external hazards (i.e. how robust IAW NEI 12-06 definition). Reference any

documents developed specifically to support the FLEX strategy that are not part of the current design-basis (e.g., an engineering analysis demonstrating robustness).

ii. Describe flow path diversity

c. Describe hose route(s) (North Anna FIP Sections 2.4.2, and 2.4.4.1- 2.4.4.4)

d. Reference any procedures used in connecting portable/pre-staged FLEX pumps.

5. Discuss how the design and location of the primary and alternate connection points, as described in the above, assure that at least one of the connection points should likely be available to support core, SFP, and containment cooling via a portable pump during an ELAP caused by an external event, consistent with NEI 12-06 Section 3.2.2.17.

Fueling of FLEX Equipment - Section 3.7.6 (North Anna FIP Section 2.9.5)

1. Diesel fuel oil transfer strategy (i.e., will FLEX equipment be stored fueled, how permanent diesel-driven plant equipment will be refueled, etc.)

2. Emergency diesel generator fuel oil storage and day tanks if used (North Anna FIP Section 2.3.4.2)

    a. Describe location and protection from all applicable external hazards (i.e. how robust IAW NEI 12-06 definition). Include references to any documentation not part of the current design-basis (e.g., an engineering calculation/evaluation demonstrating robustness).

3. Demonstrate that the volume from on-site protected fuel oil sources are sufficient until replenishment from off-site sources (e.g., existing fuel oil contractors)

4. Fuel oil quality

    a. On-site tanks (e.g., Existing Fuel Oil Chemistry program) (North Anna FIP Section 2.9.5)
    b. Portable equipment (e.g., refueling trailer, generators, pumps)
        i. E.g., Electric Power Research Institute templates (North Anna FIP Section 2.18.7)

5. FLEX fuel oil transfer equipment

    a. Storage
    b. Deployment
    c. Transfer pump capacity and reference calculation

6. Based on the above information, discuss that the diesel-powered FLEX equipment will be refueled to ensure uninterrupted operation to support the licensee's FLEX strategies.

Equipment Operating Conditions - Section 3.9.1.1 (Loss of Ventilation and Cooling)

1. Identify rooms in which FLEX equipment will be operating (e.g., existing installed equipment, pre-staged equipment, portable equipment, including but not limited to turbine-driven auxiliary feedwater (TDAFW), RCIC, ADVs).

2. Discuss how equipment remains operable during ELAP event with loss of ventilation and cooling with reference to ventilation calculations.

3. Describe actions to reduce temperatures (e.g., portable fans, opening doors, etc.) based on the expected temperature response.

4. Discuss procurement specifications for portable FLEX equipment for max high temperature.

5. Discuss how the information above ensures that essential plant equipment required to support the FLEX mitigation strategy should perform the required functions at the expected temperatures as a result of loss of ventilation during an ELAP event IAW NEI 12-06 Section 3.2.2.10.

Equipment Operating Conditions - Section 3.9.1.2 (Loss of Heating)

1. Identify rooms in which FLEX equipment will be operating (e.g., existing installed equipment, pre-staged equipment, portable equipment).

2. Discuss how equipment remains operable during ELAP event with loss of ventilation and heating with reference to ventilation calculations.

3. Discuss procurement specifications for portable FLEX equipment for max low temperature.

4. Discuss any hose/tank freezing and/or boron precipitation concerns and precautions.

5. Discuss how the information above ensures that station equipment required to support the FLEX mitigation strategy should perform the required functions at the expected temperatures as a result of loss of heating during an ELAP event IAW NEI 12-06 Sections 3.2.2.12 and 8.3.2.

Personnel Habitability - Section 3.9.2

1. Main Control Room
    a. Time vs. temperature response during an ELAP with reference to ventilation calculation
    b. Describe actions to reduce temperatures (e.g., portable fans, opening doors, etc.) based on the expected temperature response.
2. Spent Fuel Pool Area
    a. Time to SFP boil, and timing of manual actions to establish vent path (if not already discussed)

b. Identify either FLEX actions in SFP area are completed prior to SFP boiling including reference to procedures or explain how personnel habitability concerns are addressed post SFP boiling.

3. Other Plant Areas

    a. TDAFWP/RCIC Room
        i. Max temperature expected in room during ELAP compared to when operators are expected to enter room, including reference to ventilation calculation.
        ii. Duration of manual actions in room (e.g., continuous or short-term)
        iii. Describe actions to reduce temperatures (e.g., portable fans, opening doors, establish periodic temperature monitoring, etc.) based on the expected temperature response.
        iv. Available options to provide protection to operators (e.g., ice vests, shifts/rotation of staff, etc.)
    b. ADV Room
        i. Same as TDAFWP/RCIC Room
    c. Switchgear room
        i. Same as TDAFWP/RCIC Room
    d. Additional areas
        i. Such as manual operation of valves to realign flowpaths.

4. Describe how the information above is consistent with NEI 12-06, Section 3.2.2.11 such that station personnel can safely enter and perform the necessary actions to support the FLEX mitigation strategy, during an ELAP event.

Water Sources - Section 3.10

1. All Phases of Steam Generator Makeup (PWR only)

    a. Describe the construction, volume and protection from all applicable external hazards (i.e. how robust IAW NEI 12-06 definition). Reference any documents developed specifically to support the FLEX strategy that are not part of the current design basis (e.g., an engineering calculation demonstrating robustness).
    b. Describe timeline that demonstrates that the robust water source in each phase is sufficient until the next water source is available (e.g., CST has enough volume in order to deploy and stage FLEX pump with suction from UHS).

2. All Phases of RCS Makeup (Same information as SG makeup)

3. All Phases of SFP makeup (Same information as SG makeup)

4. All Phases of Containment Cooling (Same information as SG makeup)

5. Discuss how the information above is consistent with NEI 12-06 Sections 3.2.2.5 such that robust, adequate water sources should be available during an ELAP.