1D Lungmen Nuclear Power Station (NPS) Station Blackout Considerations (SBO)

1D.1 Introduction

This appendix describes (a) how the Lungmen Nuclear Power Station (NPS) design addresses Station Blackout (SBO) Events; (b) how the Lungmen NPS design complies with 10CFR50.63 SBO requirements; and (c) supporting documentation to these conformances.

1D.2 Discussion

1D.2.1 Station Blackout (SBO) Definition

The definitions of Station Blackout, Alternate AC (AAC) Power Source, and Safe Shutdown given in 10CFR50.02 are provided below:

- Station Blackout

  "Station blackout means the complete loss of alternating current (AC) electric power to the essential and nonessential switchgear buses in a nuclear power plant (i.e., the loss of offsite electric power system concurrent with turbine trip and unavailability of the onsite emergency AC power system). Station blackout does not include the loss of available AC power to buses fed by station batteries through inverters or by alternate AC sources as defined in this section, nor does it assume a concurrent single failure or design basis accident."

- Alternate AC Power Source

  "Alternate AC source means an alternating current (AC) power source that is available to and located at or nearby a nuclear power plant and meets the following requirements:

  (1) Is connectable to but not normally connected to the offsite or onsite emergency AC power systems

  (2) Has minimum potential for common mode failure with offsite power or the onsite emergency AC power sources

  (3) Is available in a timely manner after the onset of station blackout

  (4) Has sufficient capacity and reliability for operation of all systems required for coping with station blackout and for the time required to bring and maintain the plant in safe shutdown (non-design basis accident)"

- Safe Shutdown (SSD)

"Safe shutdown (non-design basis accident (non-DBA)) for station blackout means bringing the plant to those shutdown conditions specified in plant technical specifications as Hot Standby or Hot Shutdown, as appropriate…"

1D.2.2 Plant SBO Design Basis

1D.2.2.1 General SBO Design Basis

- The Lungmen NPS design will mitigate station blackout events as defined in Subsection 1D.2.1.
- The Lungmen NPS design will comply with 10CFR50.63 requirements relative to the loss of all alternating current power sources. The loss of all alternating current is only postulated to occur at one of the Lungmen NPS units.
- During this period the important plant performance characteristics to be considered are maintenance of core cooling and containment integrity.
- The postulated duration of an SBO for Lungmen NPS will be 8 hours or less consistent with Reg. Guide 1.155 and NUMARC 87-00 guidelines.
- The Lungmen NPS design will include and utilize an Alternate AC (AAC) power source to comply with 10CFR50.63 requirements and the recommendations for ALWRs, as defined by the NRC in SECY 90-016.
- The Lungmen NPS design will be consistent with Regulatory Guide 1.155 and NUMARC 87-00 guidelines relative to an AAC power source.
- The Lungmen NPS design AAC power source will supplement and complement the current offsite AC power connections, the onsite normal AC power sources (the unit auxiliary and reserve auxiliary transformers), the onsite emergency AC power sources (EDGs) and the onsite DC power sources.
- Although the Lungmen NPS complies with the SBO rule (10CFR50.63) by the Alternate AC approach, the plant also has the ability to cope with a SBO using an AC independent method by utilizing the Reactor Core Isolation Cooling System (RCIC). The RCIC is described in Subsection 5.4.6 and its capabilities to mitigate an SBO are described in Subsection 19.3.1.2 and 1D.3.

1D.2.2.2 Specific SBO Design Basis

- The Lungmen NPS AAC power source will be the swing emergency diesel generator (EDG).
- The normal design function of the swing EDG will be to act as a standby safety-related power source for the normal divisional emergency diesel generators

- The swing EDG will be capable of being manually configured to provide power to a selected safety-related emergency bus within (to be provided in FSAR) minutes during SBO events.
- The swing EDG will automatically start, accelerate to required speed, reach required voltage and frequency and be ready to accept divisional 1E loads within 20 seconds of the receipt of its start signal.
- The swing EDG will be a diverse, self contained unit (including its auxiliaries) and will be independent of the plant preferred and emergency power sources.
- The target reliability of the swing EDG will be >0.95, as calculated by NSAC-108 methodology.
- The swing EDG will have capacity to supply the required safe shutdown loads.
- The swing EDG will be housed in the auxiliary fuel building which is a Seismic Category 1 structure and will protect the swing EGD from adverse site weather related conditions.
- The swing EDG design will minimize potential for single point failure vulnerability with onsite emergency power sources.
- Adequate pneumatic pressure and water makeup sources will be available throughout the postulated SBO duration.
- The Lungmen NPS design will confine the SBO duration to (to be provided in FSAR) minutes or less with the use of the AAC power source (to be confirmed).
- The swing EDG will be controllable locally or from the MCR.
- Provisions will be made to facilitate the orderly restoration of offsite and onsite power source during the SBO event.
- Quality assurance and control practices applicable to safety-related equipment will be applied to the swing EDG.
- Safety-related requirements will be applied to the swing EDG support components.
- The swing EDG will utilize a separate fuel oil storage tank and transfer system from that of the normal divisional emergency diesel generators.
- The swing EDG will operate during the SBO event without external AC power sources.
- Dual manually operated circuit breakers will separate the swing EDG from the onsite emergency power buses. (to be confirmed)

- The AAC power source will utilize the available station and/or internal batteries for breaker control and initial starting functions.
- The swing EDG Fuel Oil Supply will be periodically inspected and the oil analyzed.
- The swing EDG operation will be subject to plant operation, maintenance and testing procedures.
- All operator actions required during SBO events will be demonstrated by training exercises and will be according to appropriate plant procedures.
- Swing EDG power will be used to restore various selected plant environmental control components (HVAC, chillers, etc.) as soon as possible.
- The swing EDG will not normally be used to provide power connected to the plant loads.
- The swing EDG will be capable of being inspected, tested, and maintained.
- The swing EDG capabilities will be demonstrated prior to shipment, during initial pre-operational test, and periodically during power operation.
- Required plant core cooling and containment integrity during the SBO duration (to be provided in FSAR) minutes will not depend on any AC power sources. (to be confirmed)

1D.2.3 Plant SBO Safety Analysis

1D.2.3.1 Plant Event Evaluations

1D.2.3.1.1 Plant Normal Operation

The normal configuration of the onsite AC power distribution system and its individual power sources are described in Subsections 8.2.1 and 8.3.1. The swing EDG (AAC) system attributes and its interconnections are described in Subsection 8.3.1. Both are shown on Figure 8.3-1.

The normal and alternate preferred AC power sources supply safety-related and non-safety-related loads. Power to these loads are supplied from the unit auxiliary transformers (UATs) units and the reserve auxiliary transformers (RATs).

The swing EDG is designed to supply standby power to any one of the Class 1E 4.16 kV buses.

1D.2.3.1.2 Loss of Offsite Power (LOOP) Events

The Lungmen NPS emergency power sources during Loss of Offsite Power (LOOP) events are the normal divisional emergency diesel generator (EDG) units. These units and their system responses are discussed in Subsection 8.3.1.1.8. However, the swing EDG is available to provide backup emergency power during a LOOP to safety-related loads by manual reconfiguration of the swing EDG and the loads.

1D.2.3.1.3 SBO Events

The swing EDG is the designated AC power source during an SBO event. The swing EDG can supply any of the 4.16 kV Class 1E buses through the realignment of pre-selected breakers during SBO events. The swing EDG will reach operational speed and voltage within 20 seconds of a start signal and will be available for bus connection within (to be provided in FSAR) minutes. Upon a LOOP the swing EDG is automatically or manually started and manually configured by plant operators to a selected 1E bus using appropriate procedures.

1D.2.3.1.4 Other Operational Capabilities

The swing EDG can be used for postulated prolonged SBO scenarios.

The Lungmen NPS design provides for local and main control room operation of the swing EDG. Communication is available between the swing EDG area and the main control room.

1D.2.3.2 Alternative AC Power Source Evaluation

The alternate AC power source (1) is the swing EDG, (2) is provided with an immediate fuel supply that is separate from the fuel supply for other onsite emergency AC power systems, (3) fuel will be sampled and analyzed consistent with applicable standards, (4) is capable of operating during and after a station blackout without any AC support systems powered from the preferred power supply or the blacked-out unit's Class 1E power sources (5) is designed to power a division of Class 1E shutdown loads within (to be provided in FSAR) minutes of the onset of the station blackout, such that the plant is capable of maintaining core cooling and containment integrity (6) will be protected from design basis weather events, (7) will be subject to quality assurance guidelines commensurate with its safety classification, (8) will have sufficient capacity and capability to supply one division of Class 1E loads, (9) will have sufficient capacity and capability to supply the required Class 1E loads used for a safe shutdown, (10) will undergo factory testing to demonstrate its ability to reliably start, accelerate to required speed and voltage and supply power within 20 seconds, (11) will not normally supply power to nuclear safety-related equipment except under specific conditions, (12) will not be a single point single failure detriment to onsite emergency AC power sources, and (13) will be subject to site acceptance testing; periodic preventative maintenance, inspection, testing; operational reliability assurance program goals.

Based on the above, the Lungmen NPS design for the AAC power supply complies with 10CFR50.63, with Regulatory Guide 1.155 and with NUMARC 87-00 and meets the SBO rule.

1D.2.4 Plant Conformance With SBO Requirements

A brief review of the general Lungmen NPS design conformance with various SBO requirements and guidelines is given below. A more complete in-depth and specific review of each of the SBO regulatory requirements or guidelines is given in the enclosed tables (refer to Tables 1D-1 through 1D-3).

1D.2.4.1 10CFR50.63 Requirements

The Lungmen NPS complies with the 10CFR50.63 requirements. Special attention was given to the regulation definition of the SBO event, the event conditions, and the requirement for safe shutdown status. The Lungmen NPS utilizes the AAC power source option and provides an evaluation of the requirements/compliances in Table 1D-1.

1D.2.4.2 New ALWR Requirements (SECY 90-016)

A review of the new ALWR SBO requirements in SECY 90-016 recommendations was conducted. The Lungmen NPS design is in compliance with the ALWR recommendations.

1D.2.4.3 Regulatory Guide 1.155 Guideline Requirements

A review of the Lungmen NPS swing EDG design relative to Sections 3.3.5, 3.3.6, 3.3.7, 3.4 and Appendix A and B of RG 1.155 was conducted. The swing EDG design fully complies with the cited requirements. The use of the swing EDG as an AAC power source in the Lungmen NPS design eliminates the need for a SBO coping analysis by limiting the SBO duration to (to be provided in FSAR) minutes or less. No operator action is required within the initial ten minutes (refer to Table 1D-2).

1D.2.4.4 NUMARC 87-00 Guidelines

A review of the Lungmen NPS swing EDG design relative to the NUMARC SBO guidelines, Subsections 7.1.1 and 7.1.2 and Appendices A and B was conducted. The Lungmen NPS design with swing EDG is consistent with the NUMARC guidelines (refer to Table 1D-3).

1D.2.5 Other SBO Considerations

Several other SBO considerations are identified below for special compliance or consideration.

1D.2.5.1 Plant Technical Specifications

Surveillance and operational requirements are needed for the swing EDG in order to assure its reliability or maintainability. These will be part of the plant maintenance, testing, and inspection procedures. These procedures may in part be covered in the technical specifications.

1D.2.5.2 Design Interface Requirements

The swing EDG has a limited number of design interface requirements. Fuel oil is initially supplied from a local tank, and then transferred from a fuel oil storage tank, both of which are independent of the normal divisional EDG fuel oil tanks. A seven (7) day oil supply for the swing EDG sufficient for shutdown loads will be available onsite. The local swing EDG I&C is powered by the unit itself or supplied from station batteries. Other auxiliary functions are an integral part of the swing EDG unit.

1D.2.5.3 Station Blackout Procedures

Appropriate procedures will include the use of the swing EDG to mitigate the effects of an SBO. The procedures will consider specific instructions for operation actions responses, timing and related matters during SBO events. The operator actions will include power source switching, load shedding, etc.

1D.2.5.4 Equipment Qualification, Testing and Reliability

The swing EDG will be qualified (as a Class 1E AAC power source) for its intended duties and service. Qualification testing, equipment inspections, and reliability data will be made available.

1D.2.5.5 Periodic Surveillance, Testing, Inspection and Maintenance

Reliability assurance program requirements will be established for the swing EDG.

1D.2.5.6 Power and Control Cable Routing

The swing EDG power and control cable routing is physically and electrically separated from other power sources in a similar manner to the other divisional cabling, except that divisional separation is not maintained for some circuits to the other divisional equipment. This is due to the fact that the swing EDG is connectable to any of the safety divisions of either unit but will be connected to only one division at a time. Circuits for which separation is not maintained are normally deenergized so that only one division’s circuits are energized at a given time, thereby preventing a failure within a single division from affecting other divisions.

1D.2.5.7 Plant Battery Recharging

The swing EDG is capable of recharging some of the plant batteries during SBO scenarios while supplying safe shutdown loads depending on which division is being powered.

1D.2.5.8 Plant HVAC Restoration Capabilities

Depending on which division is selected. The swing EDG may be capable of restoring environmental control components during the SBO duration while supplying the safe shutdown loads.

The Main Control Room (MCR) environment will not exceed its design basis temperature even during a prolonged SBO event. With the swing EDG available in (to be provided in FSAR) minutes, MCR HVAC may be restored.

1D.2.5.9 Circuit Breaker Operation

During the alignment of the swing EDG to one of the safety-related buses, at least two breakers will need to be manually closed. (to be confirmed)

The current SBO requirement that at least one emergency bus be powered within (to be provided in FSAR) minutes is achieved by the manual operation of the two breakers between the swing EDG and the selected emergency bus (see Figure 8.3-1).

1D.2.5.10 Swing EDG – Physical Protection Considerations

The swing EDG is housed in the Seismic Category 1 auxiliary fuel building (separate from the building which contains the normal divisional EDGs) above the design flood levels. The building is designed to protect the swing EDG from site related weather conditions.

1D.3 Performance During Station Blackout (SBO) With Failure of Swing Diesel Generator (SDG)

The primary means by which the Lungmen NPS copes with an SBO is use of the swing diesel generator (SDG) as an alternate AC (AAC) power source. The analyses summarized in this subsection show that the Lungmen NPS can withstand an SBO with failure of the SDG without core damage or loss of containment integrity for a period of 8 hours. If AC power is still unavailable beyond this period, core cooling by the RCIC system is assumed to be lost. However, the AC Independent Water Addition (ACIWA) system may be able to prevent core damage.

In addition if it is determined that the AAC power source (SDG) can not be aligned to power a divisional bus within 10 minutes, the RCIC system will be relied upon to cope with the SBO until AC power is available to one of the Class 1E divisional buses.

The key requirements in response to an SBO are to maintain adequate core cooling and integrity of the primary containment vessel (PCV). These issues are treated separately below.

1D.3.1 Core Cooling

The Reactor Core Isolation Cooling system (RCIC) provides water to the reactor vessel during an SBO with failure of the SDG. The flow rate capacity of RCIC by itself is sufficient to keep water over the top of the fuel at all times, thus assuring adequate core cooling. The following areas are considered to assure RCIC functionality during this event:

(1) Reactor monitoring function,

(2) Steam supply to the RCIC turbine,

(3) DC battery capacity,

(4) Water source inventory (condensate storage tank or suppression pool),

(5) RCIC room temperature, and

(6) Control room(s) temperature.

Each of these functions is addressed below.

(1) Reactor Monitoring Function.

The reactor monitoring of vessel water level and pressure is performed using local detectors with main control room (MCR) indication. Instrument power supply is from the station batteries as either DC or constant voltage constant frequency (CVCF) sources.

(2) Steam Supply to the RCIC Turbine.

The reactor vessel is the source of energy for the RCIC turbine which operates the RCIC pump, maintaining vessel water level. The RCIC turbine will isolate (i.e., trip) at low pressure 1.034 MPaG. However, since the operator will be maintaining vessel pressure near 6.619 MPa in accordance with the emergency operating procedure (EOPs), there will be more than adequate RCIC turbine pressure for operation. The RPV pressure will be controlled manually at this level (by opening 1 or more SRVs) below the first SRV setpoint to avoid SRV cycling. SRV operability during SBO is dependent on a DC supply source and a nitrogen supply and these are evaluated in the following discussions. It should be noted that the SRVs will cycle on the spring setpoint if the operator fails to manually control pressure.

(a) Availability of DC Power for SRV Solenoids.

Based on the following evaluation, it is concluded that there is ample DC power for operating SRV solenoids.

The control power for six of the 18 SRVs in the relief mode is taken from the Division I battery. The valves have been considered as part of the load on the Division I battery for purposes of calculating the time the RCIC would be operable during SBO. This engineering evaluation leads to the conclusion that the 4000* ampere hour capacity of the Division I battery is sufficient for 8 hours of coping during SBO with failure of the SDG.

Of the remaining 12 SRVs, 6 have their control for the relief mode power supply on the Division II battery and 6 are on the Division III battery. Each of these batteries have a capacity of 3000* ampere hours. Since Divisions II and III would normally be shut down during an SBO situation with failure of the SDG, these batteries and their associated power distribution equipment would be available to supply power to the SRVs if necessary.

The ambient temperature for Divisions II and III batteries should remain acceptable as there would be very little load on these batteries during SBO. For

* Engineering estimate to be confirmed in FSAR.

this reason, ambient temperature rise due to the lack of HVAC should not be a problem for the batteries and their associated equipment.

Based on the above, Divisions II and III DC supplies should be available on an intermittent basis for use in operating SRVs, as desired. The 6000* ampere hour total capacity of the two batteries would be adequate for many days of operation beyond the no less than 8 hour capability of Division I.

In addition to the relief solenoid on each SRV, the 8 SRVs which are part of the ADS system each have 2 additional solenoids. Each SRV has one ADS solenoid powered by Division 1 and the other ADS solenoid powered by Division 2. Of the 8 SRVs which are ADS valves, 3 of them get power to the relief solenoid from Division 3. Thus the remaining 5 SRVs receive power to the relief solenoid from Division 1 or 2. Control power for each of the ten SRVs which are not used for the ADS function is supplied by one division (four from Division I, three from Division II, and three from Division III). Thus the ability to control reactor pressure is very reliable.

(b) SRV Operability and High Pressure Containment Conditions.

The SRV actuators can open the SRVs without assistance from internal steam pressure when the makeup pneumatic supply is available to maintain the minimum required differential pressure. The SRV accumulators used for the ADS function shall have sufficient pressure and capacity to fully open the SRVs five times at normal drywell pressure and one time at 0.860 MPaA pressure in the containment. Additional gas is available from outside the containment to ensure the pressure control and depressurization function.

The normal supply of N2 gas to the SRVs from the atmospheric control system outside the containment may shut off due to low pressure caused by loss of AC power to the heaters or heating boiler which is used to gasify the liquid N2 supply. However, there is a backup supply of N2 gas from stored bottles at 14.8 to 5.96 MPa (maximum to minimum) pressure which can be used to open the SRVs in the ADS system.

Use of the stored nitrogen bottles requires operator action to manually open a closed supply valve at the valve location. Gas is then fed to the SRV actuators through the DC powered ADS solenoid valves inside the containment automatically. The ADS supply lines from the N2 bottles should also be isolated from the normal N2 supply to other systems by local manual closure of the motor operated crosstie valves which are otherwise inoperable on AC power loss.

* Engineering estimate to be confirmed in FSAR.

The high pressure gas from the N2 bottles is automatically reduced to the normal required pressure by a self-actuated pressure regulating valve. If the SRVs do not open with the pressure supplied by the self-actuated pressure regulating valve [for example, if containment pressure was equal to 0.860 MPa or if somewhat less than the normal required pressure were supplied], the operator could adjust the setpoint of the pressure regulating valve above the normal required pressure at the local station.

The capacity of a group of ten 45 liter high pressure N2 gas bottles at 5.96 MPa minimum pressure is about 16 times that needed to open the 8 ADS SRVs, each of which has an actuator piston volume of 16.4 liters (1000 cubic in). Additionally, there are 10 other N2 bottles that can be valved into service by local manual operation. It is concluded that the ADS valves can be operated to control reactor pressure during SBO.

(3) DC Battery Capacity.

The Division I DC battery will be sized to be capable of operating the RCIC system for 8 hours assuming the expected loading profiles for SBO with failure of the SDG. These loading profiles will assume acceptable battery area environmental conditions and load shedding, when necessary, and will be defined in detail as the Lungmen NPS design progresses.

(4) Water Source Inventory.

The primary water source for the RCIC System is the condensate storage tank (CST) which has been sized to provide sufficient inventory for a minimum of 8 hours operation in an SBO. In the event the CST became depleted, the backup source is the suppression pool. The suction source switches to the suppression pool automatically on high suppression pool level. The RCIC system must be manually overridden to assure that the suction revert to the condensate storage tank to maintain the required inlet temperatures to the RCIC pump.

(5) RCIC Room Temperature.

Failure of the AC power to the room cooling will allow the RCIC room temperature to rise. The Lungmen NPS plant will be designed to prevent the room temperature from reaching the long term equipment design temperature for at least 8 hours. The results of detailed room heatup analysis will be provided in the FSAR.

(6) Control Room Temperatures.

The safety-related equipment required to function during SBO with failure of the SDG and located in the main, lower and computer control rooms will be designed for the maximum operating temperature expected to occur in the event of an SBO. The

Lungmen NPS plant will be designed to prevent the control room temperature from reaching this equipment design temperature for at least 8 hours, starting at the normal room temperature. The results of detailed room heatup analysis will be provided in the FSAR.

1D.3.2 Primary Containment Vessel (PCV) Integrity

Containment pressure and temperature analyses were performed to determine the containment atmospheric conditions after 8 hours of SBO conditions assuming event initiation at 100% thermal power.

Two cases were analyzed to provide comparison of the Lungmen design. The first case was with the AAC power source available and the second case was without the AAC power source available. The analyses looked at the following parameters:

- RPV pressure
- Drywell pressure
- Wetwell airspace pressure
- Drywell temperature
- Wetwell airspace temperature
- Suppression Pool temperature

The assumptions used in the analyses are listed in Table 1D-4. The results of the analyses are shown in Tables 1D-5 and 1D-6 at 0, 2, 4, 6, and 8 hours. Plots showing the results for each of these parameters for both cases can be found on Figures 1D-1 through 1D-8.

The analyses performed assumed the RCIC suction was taken from the condensate storage tank for the first 1.3 hours then transferred to the suppression pool on the high level transfer. RCIC suction was manually transferred back to the CST at 4.4 hours before the Net Positive Suction Head (NPSH) available fell below the NPSH required for the RCIC pump. RCIC suction was from the CST for the remainder of the event. The drywell and wetwell pressure and temperature were calculated to be less than their design basis of 0.411 MPa and 171ºC (drywell), 124ºC (wetwell airspace). The suppression pool temperature exceeds its design value of 97.2ºC after 8 hours. However, the loads resulting from the elevated suppression pool temperatures are easily bounded by the loading combinations experienced during a design basis accident. Therefore, PCV integrity is maintained.

1D.3.3 Operator Actions

For the SBO analysis it was assumed that the loss of normal AC power will lead to indirect turbine trip and reactor scram due to high condenser pressure on loss of circulating water. The subsequent loss of feedwater will cause the RPV to isolate on low water level. Failure of the emergency diesel generators to initiate and failure of the Swing Diesel Generator will leave the RCIC system as the only source of makeup water to the core. The RCIC system will automatically start at level 2 to restore the RPV water level. Operator actions are specified in the EOPs to control the RCIC system and maintain the RPV level between Level 3 and Level 8. For the purposes of the containment analyses it was assumed that RCIC was cycled on and off to maintain water level between levels 4 and 7.

In addition, the operator will be instructed to maintain RPV pressure below the high pressure scram setpoint to avoid SRV cycling by controlling 1 or more SRVs manually. The PCV pressure and temperature will not approach design values for at least 8 hours.

1D.3.4 Recovery Following Restoration of AC Power

All equipment necessary for restoration of power is located external to the primary and secondary containments in the reactor building. With the exception of the control building, all heat generating sources external to secondary containment are shutdown during SBO so that the rooms should be at temperatures which allow restart of the support systems under their automatic or manual modes following restoration of AC power. Temperatures in the control building should be such that restart can be accomplished by the operators from the control room. Also, restart could be initiated from the remote shutdown panel or even by local control at the motor control centers and switchgear. Following restoration of power and initiation of the reactor cooling water system, the ECCS areas of secondary containment will be cooled by their safety grade room coolers so normal operation of the safe shutdown systems could be restored. The turbine building electrical systems and the non-safety-related secondary cooling system provide a backup means of restoring cooling to the ECCS equipment areas within secondary containment.

1D.3.5 Conclusions

The Lungmen NPS plant is being designed to be capable of maintaining core cooling and containment integrity for at least 8 hours following the loss of offsite and onsite AC electrical power including the SDG. This capability assessment follows the general criteria of:

(1) Assuming no additional single failures

(2) Realistic analytical methods and procedures

A summary of the key plant parameters is shown in Table 1D-4.

1D.4 Conclusions

In summary:

- The Lungmen NPS design will utilize a diesel generator (swing EDG) as its Alternate AC (AAC) power source in complying with 10CFR50.63 SBO.

- The Lungmen NPS design complies with 10CFR50.63 and RG 1.155 and is consistent with NUMARC 87-000 guidelines.
- The Lungmen NPS design can successfully prevent or mitigate the consequences of an SBO event.

1D.5 References

1D-1 SECY-90-016, *Evolutionary LWR Certification Issues and Their Relationship to Current Regulatory Requirements*, January 12, 1990.

1D-2 Letter J. Taylor to S. Chilk, *Evolutionary LWR Certification Issues and Their Relationship to Current Regulatory Requirements*, June 26, 1990.

1D-3 10CFR50.63, *Loss of All Alternating Current Power (Station Blackout-SBO)*, July 21, 1988.

1D-4 RG-1.155, *Station Blackout*, July 1988.

1D-5 NUMARC 87-00, *Guidelines and Technical Bases for NUMARC Initiative Addressing Station Blackout at LWRs* Plus Supplemental Questions and Answers, January 4, 1990.

1D-6 10CFR50.2, Definitions.

Table 1D-1 ABWR Design Compliance with 10CFR50.63 Regulations

Requirements	Compliance
§ 10CFR50-63 Loss of all alternating current power.	
§ 50.63 Loss of all alternating current power.	
(a) *Requirements*	
(1) Each light-water-cooled nuclear power plant licensed to operate must be able to withstand for a specified duration and recover from a station blackout as defined in § 50.2. The specified station blackout duration shall be based on the following factors:	The Lungmen NPS design will utilize an alternate AC (AAC) power source to mitigate and recover from station blackout events (defined in 50.2). The AAC power source will be the swing emergency generator (EDG). The swing EDG will be totally independent from offsite preferred and onsite Class 1E sources. A (FSAR) minute interval is used as the Lungmen NPS design basis for the SBO event duration. The AAC power source provides a diverse power source to the plant.
(i) The redundancy of the onsite emergency AC power sources	The Lungmen NPS design swing EDG will have sufficient capacity and capabilities to power the necessary reactor core coolant, control and protective systems including station battery and other auxiliary support loads needed to bring the plant to a safe and orderly shutdown condition (defined in 50.2). The swing EDG supplied will be rated the same as the normal divisional EDGs and be capable of accepting shutdown loads within (FSAR) minutes. The current plant onsite emergency power sources include three (3) independent and redundant EDG divisions which are designed to supply approximately 5 MWe within 1 minute. Additionally, the plant has been designed to accommodate AC power source losses for a period up to 8 hours. The AAC limits the SBO event to (FSAR) minutes.

Table 1D-1 ABWR Design Compliance with 10CFR50.63 Regulations (Continued)

Requirements	Compliance
(ii) The reliability of the onsite emergency AC power sources	The current onsite emergency AC power sources will have the following reliability: DGs…0.975 The swing EDG will have the following reliability: swing EDG…0.95 The above values will be used in the Lungmen NPS-PRA analysis.
(iii) The expected frequency of loss of offsite power	The expected frequency of loss of offsite power assumed was 0.1 events/yr.
(iv) The probable time needed to restore offsite power	The offsite power is expected to be restored within 8 hours.
(2) The reactor core and associated coolant, control, and protection systems, including station batteries and any other necessary support systems, must provide sufficient capacity and capability to ensure that the core is cooled and appropriate containment integrity is maintained in the event of a station blackout for the specified duration. The capability for coping with a station blackout of specified duration shall be determined by an appropriate coping analysis. Utilities are expected to have the baseline assumptions, analyses, and related information used in their coping evaluations available for review.	The AAC power source is capable of providing the necessary core, containment and equipment services (e.g. makeup and cooling water, I&C power, etc.) to bring the reactor to hot shutdown and then to cold shutdown conditions. The AAC will limit the SBO duration to (FSAR) minutes. The current plant design assures that during the (FSAR)-minute interval, the plant core, containment and other safety functions will be maintained without the use or need for AC power. However, the AAC can operate indefinitely. A seven (7) day supply of oil sufficient for shutdown loads is available on site. Subsequent oil deliveries will be provided.

Table 1D-1 ABWR Design Compliance with 10CFR50.63 Regulations (Continued)

Requirements	Compliance
(b) *Limitation of scope* (c) *Implementation* (1) Information Submittal. For each light-water-cooled nuclear power plant licensed to operate after the effective date of this amendment, the licensee shall submit the information defined below to the Director by 270 days after the date of license issuance. (i) A proposed station blackout duration to be used in determining compliance with paragraph (a) of this section, including a justification for the selection based on the four factors identified in paragraph (a) of this section	In addition to the discussion under (a) above, the following is noted. The Lungmen NPS design SBO duration time considerations are consistent with RG1.155 and NUMARC-87-00. Upon loss of offsite power (LOOP) and upon the subsequent loss of all on site AC emergency power sources (three independent and redundant DGs), the swing EDG can be manually connected to any one of the three safety-related (Class 1E) busses by closing two circuit breakers. The alternative AC (AC) power source will automatically start, and within (FSAR) be up to required speed and voltage. It will then manually be connected to a selected IE bus. During the first (FSAR) minutes, the reactor will have automatically tripped, the main steam isolation valves (MSIVs) closed, and the RCIC actuated. The RCIC will automatically control reactor coolant level. Any necessary relief valve operation will also be automatic. Within the (FSAR) minute SBO interval, none of the above actions will require AC power or manual operator actions. The reconfiguration of the swing EDG to pick up the selected Class 1E buses will require manual closure of two circuit breakers. Upon restoration of power to the safety bus(es), the remaining safe shutdown loads will be energized.
(ii) A description of the procedures that will be implemented for station blackout events for the duration determined in paragraph (d)(1)(i) of this section and for recovery therefrom	Appropriate plant procedures will be developed for the Lungmen NPS design. These procedures be integrated/coordinated with the plant EOPs, using the EOP methodology. Procedures will consider instructions for operator actions, responses, timing, and related matters during the SBO event.

Table 1D-1 ABWR Design Compliance with 10CFR50.63 Regulations (Continued)

Requirements	Compliance
(iii) A list of modifications to equipment and associated procedures, if any, necessary to meet the requirements of paragraph (a) of this section, for the specified station blackout duration determined in paragraph (c)(1)(i) of this section, and a proposed schedule for implementing the stated modifications	Modifications to equipment and procedures is not applicable since the use of an AAC source and other SBO considerations are included in the Lungmen NPS design.
(2) Alternate AC source: The alternate AC power source(s), as defined in § 50.2, will constitute acceptable capability to withstand station blackout provided an analysis is performed which demonstrates that the plant has this capability from onset of the station blackout until the alternate AC source(s) and required shutdown equipment are started and lined up to operate. The time required for startup and alignment of the alternate AC power source(s) and this equipment shall be demonstrated by test. Alternate AC source(s) serving a multiple unit site where onsite emergency AC source are not shared between units must have, as a minimum, the capacity and capability for coping with a station blackout in any of the units. At sites where onsite emergency AC sources are shared between units, the alternate AC source(s) must have the capacity and capability as required to ensure that all units can be brought to and maintained in safe shutdown (non-DBA) as defined in § 50.2. If the alternate AC source(s) meets the above requirements and can be demonstrated by test to be available to power the shutdown buses within 10 minutes of the onset of station blackout, then no coping analysis is required.	The Lungmen NPS swing EDG will be automatically initiated upon the loss of offsite power (to be confirmed). The swing EDG will achieve required speed and voltage within 20 seconds. The swing EDG will be manually connected to safe shutdown buses within (FSAR) minutes. These equipment capabilities will be demonstrated 1) by the manufacturer's component tests, 2) by the swing EDG initial startup tests and 3) periodically as part of the operational reliability assurance program. The Lungmen NPS design is a dual unit facility. In the event of Loss of Offsite Power (LOOP) an SBO is only postulated to occur at one of the units. The swing EDG AAC source is available to power shutdown loads within (FSAR) minutes as described above. Therefore, no coping analysis is required (to be confirmed). In addition, the Lungmen NPS is designed with an 8-hour battery to accommodate station blackout without the need for AC power. Also, the three independent emergency diesel generator systems will accommodate one DG out of service, plus a single failure, with the remaining DG capable of bringing the plant to safe shutdown.
(3) Regulatory Assessment:	
(4) Implementation Schedule: (53 FR 23215, June 21, 1988)	

Table 1D-2 ABWR Design Compliance with Regulatory Guide 1.155

Requirements	Compliance
Regulatory Guide 1.155—Station Blackout	
Regulatory Position	
3.3.5 If an AAC power source is selected specifically for satisfying the requirements for station blackout, the design should meet the following criteria: 1. The AAC power source should not normally be directly connected to the preferred or the blacked-out unit's onsite emergency AC power system.	The Lungmen NPS AAC power source is not normally connected to the preferred or the onsite emergency AC power system. Two open circuit breakers separate the swing EDG from the safety-related emergency buses. The AAC power source is also not normally connected to any of the preferred AC power sources or their associated non-safety-related buses.
2. There should be a minimum potential for common cause failure with the preferred or the blacked-out unit's onsite emergency AC power sources. No single-point vulnerability should exist whereby a weather-related event or single active failure could disable any portion of the blacked-out unit's onsite emergency AC power sources or the preferred power sources and simultaneously fail the AAC power source.	The Lungmen NPS design minimizes the potential for a) common cause failures between the preferred sources and the onsite emergency power sources; b) common cause failures between onsite emergency power sources themselves; c) common cause failures between onsite power sources and the AAC power source; and d) common cause failures between preferred sources and the AAC power source. The design also precludes interactions between preferred, onsite emergency, and AAC power systems resulting from weather related events or single failures such that a single point vulnerability will not simultaneously fail both the AAC power source and the onsite emergency or offsite preferred power source(s). This is accomplished by having onsite emergency and the AAC power sources inside weather protected buildings and by maintaining adequate separation between the four power sources. None of the four standby power sources share emergency buses or loads, auxiliary services or instrumentation and controls prior to the recovery actions from the SBO event. These power sources are physically, electrically, mechanically and environmentally separated.

Table 1D-2 ABWR Design Compliance with Regulatory Guide 1.155 (Continued)

Requirements	Compliance
3. The AAC power source should be available in a timely manner after the onset of station blackout and have provisions to be manually connected to one or all of the redundant safety buses as required. The time required for making this equipment available should not be more than 1 hour as demonstrated by test. If the AAC power source can be demonstrated by test to be available to power the shutdown buses within 10 minutes of the onset of station blackout, no coping analysis is required.	The Lungmen NPS AAC design power source will be automatically started (to be confirmed) and reach rated speed and voltage and be available to supply within 20 seconds, and power safety-related loads within (FSAR) minutes for any loss of offsite power sources (LOOP). The design has provisions to assure the timely manual interconnection between the AAC (swing EDG) and any one of the safety-related shutdown buses. The Lungmen NPS AAC design will be demonstrated by test to show that it can be connected to safety-related buses within (FSAR) minutes. Therefore, no coping analysis is required (to be confirmed).
4. The AAC power source should have sufficient capacity to operate the systems necessary for coping with a station blackout for the time required to bring and maintain the plant in safe shutdown.	The Lungmen NPS AAC power source is rated the same as the normal divisional EDGs, which is sufficient capacity to operate the necessary safe shutdown loads.
5. The AAC power system should be inspected, maintained, and tested periodically to demonstrate operability and reliability. The reliability of the AAC power system should meet or exceed 95% as determined in accordance with NSAC-108 (Reference 11) or equivalent methodology.	The Lungmen NPS design includes previsions to demonstrate the operability and reliability of the AAC power source. The swing EDG will be subject to surveillance inspection, testing and maintenance in accordance with the manufacturer's requirements, the maintenance program and with reliability assurance program requirements. The swing EDG will meet or exceed a reliability goal of 0.95 in accordance with NSAC-108 or equivalent methodology.

Table 1D-2 ABWR Design Compliance with Regulatory Guide 1.155 (Continued)

Requirements	Compliance
3.3.6 If a system or component is added specifically to meet the recommendations on station blackout duration in Regulatory Position 3.1, system walk downs and initial tests of new or modified systems or critical components should be performed to verify that the modifications were performed properly. Failures of added components that may be vulnerable to internal or external hazards within the design basis (e.g., seismic events) should not affect the operation of systems required for the design basis accident.	The Lungmen NPS design includes the swing EDG as the AAC power source for SBO mitigation. A test program will be conducted by the manufacturer/equipment vendor to verify the major equipment performance objectives (e.g., start time, rated speed and voltage times, stable voltage outputs, etc.). These tests will be conducted prior to swing EDG installation at the plant site. Prior to plant operation, the AAC power source will be subject to pre-operational testing to demonstrate that the swing EDG will perform its intended function. Periodically, the AAC power source will be tested to assure that the reliability/availability goals are being met and maintained. The Lungmen NPS design safety evaluations take into account potential plant disturbances that could affect AAC power source reliability. These disturbances could occur as a result of internal and external hazards (e.g., floods, fires and harsh environs, respectively). The adverse effects on AAC power source components due to operational hazards will not affect the operations of safety-related systems required for the design basis events. The effects caused by or upon the AAC power source due to operational events (internal and external hazards) are limited since the AAC power source components are physically, mechanically and essentially electrically isolated from the design basis engineered safety features and other power generation systems and components. Design bases accident events may result in the potential degradation of the AAC power source. However, the resulting effects of the AAC will not diminish the current safety system responses and the current event outcomes.

Table 1D-2 ABWR Design Compliance with Regulatory Guide 1.155 (Continued)

Requirements	Compliance
3.3.7 The system or component added specifically to meet the recommendations on station blackout duration in Regulatory Position 3.1 should be inspected, maintained, and tested periodically to demonstrate equipment operability and reliability.	The Lungmen NPS design AAC power source will be capable of being tested, inspected and maintained on a periodic basis. The swing EDG location in the Auxiliary Fuel Building provides easy access to the unit. The access and environmental conditions in the swing EDG area allow physical surveillance, easy maintenance, and testing. The swing EDG will be periodically started, brought up to speed and voltage, and loaded. The swing EDG will be subject to periodic test in order to verify the operability and reliability goals in the plant reliability assurance program.
3.4 Procedures and Training To Cope with Station Blackout Procedures* and training should include all operator actions necessary to cope with a station blackout for at least the duration determined according to Regulatory Position 3.1 and to restore normal long-term core cooling/decay heat removal once AC power is restored.	Appropriate plant procedures will be developed. These procedures will be integrated/coordinated with the plant EOPs, using the EOP methodology. Procedures will consider instructions for operator actions, responses, timing, and related matters during the SBO event.

* Procedures should be integrated with plant-specific technical guidelines and emergency procedures developed using the emergency operating procedure upgrade program established in response to Supplement 1 of NUREG-0737 (Reference 12). The task analysis portion of the emergency operating procedure upgrade program should include an analysis of instrumentation adequacy during a station blackout.

Table 1D-2 ABWR Design Compliance with Regulatory Guide 1.155 (Continued)

	Requirements	Compliance
3.5	Quality Assurance and Specification Guidance for Station Blackout Equipment that is Not Safety-Related Appendices A and B provide guidance on quality assurance (QA) activities and specifications respectively for non-safety-related equipment used to meet the requirements of § 50.63 and not already covered by existing QA requirements in Appendix B or R of Part 50. Appropriate activities should be implemented from among those listed in these appendices depending on whether the non-safety equipment is being added (new) or is existing. This QA guidance is applicable to non-safety systems and equipment for meeting the requirements of § 50.63 of 10CFR50. The guidance on QA and specifications incorporates a lesser degree of stringency by eliminating requirements for involvement of parties outside the normal line organization. NRC inspections will focus on the implementation and effectiveness of the quality controls described in Appendices A and B. Additionally, the equipment installed to meet the station blackout rule must be implemented such that it does not degrade the existing safety-related systems. This is to be accomplished by making the non-safety-related equipment as independent as practicable from existing safety-related systems. The non-safety systems identified in Appendix B are acceptable to the NRC staff for responding to a station blackout.	The Lungmen NPS AAC power source design addresses the quality assurance and equipment specification guidance indicated in Appendices A and B of this guide. The specific responses to Appendices A and B are presented in the following sections in this table.

Table 1D-2 ABWR Design Compliance with Regulatory Guide 1.155 (Continued)

Requirements	Compliance
Appendix A – Quality Assurance	
The QA guidance provided here is applicable to non-safety systems and equipment used to meet the requirements of § 50.63 and not already explicitly covered by existing QA requirements in 10CFR50 in Appendix B or R. Additionally, non-safety equipment installed to meet the station blackout rule must be implemented so that it does not degrade the existing safety-related systems. This is accomplished by making the non-safety equipment as independent as practicable from existing safety-related systems. The guidance provided in this section outlined an acceptable QA program for non-safety equipment used for meeting the station blackout rule and not already covered by existing QA requirements. Activities should be implemented from this section as appropriate depending on whether the equipment is being added (new) or is existing.	The Lungmen NPS AAC power source design is in compliance with the following QA guidelines in 10CFR50.63 as indicated below:
1. Design Control and Procurement Document Control	
Measures should be established to ensure that all design-related guidances used in complying with § 50.63 are included in design and procurement documents, and that deviations therefrom are controlled.	The QA program will comply with this requirement.
2. Instructions, Procedures, and Drawings	
Inspections, tests, administrative controls, and training necessary for compliance with § 50.63 should be prescribed by documented instructions, procedures, and drawings and should be accomplished in accordance with these documents.	The QA program will comply with this requirement.
3. Control of Purchased Material, Equipment, and Services	
Measures should be established to ensure that purchased material, equipment, and services conform to the procurement documents.	The QA program will comply with this requirement.

Table 1D-2 ABWR Design Compliance with Regulatory Guide 1.155 (Continued)

Requirements	Compliance
Appendix A – Quality Assurance	
4. Inspection	
A program for independent inspection of activities required to comply with § 50.63 should be established and executed by (or for) the organization performing the activity to verify conformance with documented installation drawings and test procedures for accomplishing the activities.	The QA program will comply with this requirement.
5. Testing and Test Control	
A test program should be established and implemented to ensure that testing is performed and verified by inspection and audit to demonstrate conformance with design and system readiness requirements. The tests should be performed in accordance with written test procedures; test results should be properly evaluated and acted on.	The QA program will comply with this requirement.
6. Inspection, Test, and Operating Status	
Measures should be established to identify items that have satisfactorily passed required tests and inspections.	The QA program will comply with this requirement.
7. Nonconforming Items	
Measures should be established to control items that do not conform to specified requirements to prevent inadvertent base or installation.	The QA program will comply with this requirement.
8. Corrective Action	
Measures should be established to ensure that failures, malfunctions, deficiencies, deviations, defective components, and nonconformances are promptly identified, reported, and corrected.	The QA program will comply with this requirement.

Table 1D-2 ABWR Design Compliance with Regulatory Guide 1.155 (Continued)

Requirements	Compliance
Appendix A – Quality Assurance	
9. Records	
Records should be prepared and maintained to furnish evidence that the criteria enumerated above are being met for activities required to comply with § 50.63.	The QA program will comply with this requirement.
10. Audits	
Audits should be conducted and documented to verify compliance with design and procurement documents, instructions, procedures, drawings, and inspection and test activities developed to comply with § 50.63.	The QA program will comply with this requirement.

Table 1D-2 ABWR Design Compliance with RG 1.155 (Continued)

Requirements		Compliance
Appendix B—Guidance Regarding Systems/Components		
	Alternate AC Sources	**Lungmen NPS AAC Power Source**
Safety-Related Equipment (Compliance with IEEE-279)	Not required, but the existing Class 1E electrical systems must continue to meet all applicable safety-related criteria.	Existing onsite emergency power sources, buses and loads will continue to meet all applicable safety-related criteria.
Redundancy	Not required.	—
Diversity from Existing EDGs	See Regulatory Position 3.3.4 of this guide.	The Lungmen NPS design will utilize a AAC diverse power source from that of the EDGs. A qualified emergency diesel generator of diverse manufacture will be used as the AAC.
Independence from Existing Safety-Related Systems	Required if connected to Class 1E buses. Separation to be provided by 2 circuit breakers in series	Two breakers separate the onsite emergency power buses from the swing EDG.
Seismic Qualification	Not required.	The swing will be seismically qualified.
Environmental Consideration	If normal cooling is lost, needed for station blackout event only and not for design basis accident (DBA) conditions. Procedures should be in place to affect the actions necessary to maintain acceptable environmental conditions for the required equipment. See Regulatory Position 3.2.4.	The use of the ACC power source will assure that the plant equipment/environment cooling loss will be limited to 10 to 60 minutes (SBO duration). Normal plant cooling loads will be restored after shutdown loads are reestablished. Temperature rise conditions will be limited to minutes rather than hours
Capacity	Specified in § 50.63 and Regulatory Position 3.3.4.	The AAC power source is capable of powering the minimum required shutdown loads.
Quality Assurance	Indicated in Regulatory Position 3.5.	The Lungmen NPS design will be subjected to the quality assurance standards cited in Chapter 17.

Table 1D-2 ABWR Design Compliance with RG 1.155 (Continued)

Requirements		Compliance
Appendix B—Guidance Regarding Systems/Components		
	Alternate AC Sources	**Lungmen NPS AAC Power Source**
Technical Specification for Maintenance, Limiting Condition, FSAR, etc.	Should be consistent with the Interim Commission Policy Statement on Technical Specifications (Federal Register Notice 52 FR 3789) as applicable.	The AAC power source operational and test requirements will be defined by the Plant Maintenance Program and the RAP. They will also be consistent with the Interim Commission Policy Statement on Tech Specs.
Instrumentation and Monitoring	Must meet system functional requirements.	The AAC power source instrumentation, controls and monitoring will be of such number, type and quality to assure that the swing EDG reliability goals are met.
Single Failure	Not required.	—
Common Cause Failure (CCF)	Design should, to the extent practicable, minimize CCF between safety-related and non-safety-related equipment.	The AAC power source will be physically, mechanically and electrically independent of the offsite and onsite power systems.

Table 1D-2 ABWR Design Compliance with RG 1.155 (Continued)

Requirements		Compliance
Appendix B—Guidance Regarding Systems/Components		
	Water Source (Existing Condensate Storage Tank or Alternate)	**SBO Recovery with AAC Power Source**
Safety-Related Equipment (Compliance with IEEE-279)	Not required, but the existing Class 1E systems must continue to meet all applicable safety-related criteria.	The Lungmen NPS design Condensate Storage Tank will provide primary makeup water via the RCIC or HPCF. The suppression pool will serve as the secondary water source. The AAC powered RBCW and RSW pumps will provide heat removal service to the plant systems including chillers and HVAC cooling subsystems.
Redundancy	Not required.	—
Diversity	Not required.	—
Independence from Existing Safety-Related Systems	Ensure that the existing safety functions are not compromised, including the capability to isolate components, subsystems, or piping, if necessary.	The loss of all AC power (SBO) will automatically cause reactor scram, MSIV closure, and initiation of the RCIC. The AAC power source will re-energize the lost shutdown loads (emergency makeup water, heat removal and HVAC services) due to the SBO condition within 10 to 60 minutes. The condensate storage tank will be used during the first ten minutes and throughout the hot shutdown transition period. A significant amount of water is available from the CST (e.g. 2206 m^3). After restoration of power via AAC other plant makeup and cooling water sources will be made available.
Seismic Qualification	Not required.	—
Environmental Consideration	Need for station blackout event only and not for DBA conditions. See Regulatory Position 3.2.4. Procedures should be in place to effect the actions necessary to maintain acceptable environmental conditions for required equipment.	The AAC power source does not need plant service or cooling water for operation. It's a self (air) cooled, self-lubricated and self-controlled machine.

Table 1D-2 ABWR Design Compliance with RG 1.155 (Continued)

Requirements		Compliance
Appendix B—Guidance Regarding Systems/Components		
	Water Source (Existing Condensate Storage Tank or Alternate)	**SBO Recovery with AAC Power Source**
Capacity	Capability to provide sufficient water for core cooling in the event of a station blackout for the specified duration to meet § 50.63 and this regulatory guide.	The Condensate Storage Tank (CST) is capable of providing at least 8 hours of makeup water without replenishment. With the use of the AAC power sources other water sources are readily available for makeup, heat removal, and plant equipment cooling.
Quality Assurance	As indicated in Regulatory Position 3.5.	The Lungmen NPS design's immediate response to an SBO event does utilize a non-safety makeup water source (the CST).
Technical Specifications for Maintenance, Surveillance, Limiting Conditions, FSAR, etc.	Should be consistent with the Interim Commission Policy Statement on Technical Specifications (Federal Register Notice 52 FR 3789) as applicable.	No additional non-safety-related water sources are required during the duration of the 10- to 60-minute SBO event. Use of other sources during cold shutdown activities is optional.
Instrumentation and Monitoring	Must meet system functional requirements.	The makeup water source instrumentation and controls, used during the SBO duration, are safety-related and divisionally separated.
Single Failure	Not required.	—
Common Cause Failure (CCF)	Design should, to the extent practicable, minimize CCF between safety-related and non-safety-related systems.	The primary makeup water source (Condensate Storage Tank) and the secondary makeup water source (Suppression Pool), utilized during the 10 minute SBO duration, are physically, mechanically and environmentally separated from one another.

Table 1D-2 ABWR Design Compliance with RG 1.155 (Continued)

Requirements		Compliance
Appendix B—Guidance Regarding Systems/Components		
	Instrument Air (Compressed Air System)	**SBO Recovery with AAC Power Source**
Safety-Related Equipment (Compliance with IEEE-279)	Not required, but the existing Class 1E systems must continue to meet all applicable safety-related criteria.	Use of Plant Instrument Air/Compressed Air Systems during the 10 minute SBO duration is not required.Safety-related SRV nitrogen gas sources are available during the SBO event and are independent of non-safety air systems.
Redundancy	Not required.	—
Diversity	Not required.	—
Independence from Existing Safety-Related Systems	Ensure that the existing safety functions are not compromised, including the capability to isolate components, subsystems, or piping, if necessary.	The swing EDG stores enough air for 5 starting attempts in safety-related accumulator tanks which are dedicated to the swing EDG. The swing EDG does have a self-contained intake and exhaust system. This is provided by the machine power sources itself.
Seismic Qualification	Not required.	—
Environmental Consideration	Needed for station blackout event only and not for DBA conditions. See Regulatory Position 3.2.4. Procedures should be in place to effect the actions necessary to maintain acceptable environmental conditions for required equipment.	The swing EDG does not require special air or environmental control services before, during or after the SBO event.

Table 1D-2 ABWR Design Compliance with RG 1.155 (Continued)

Requirements		Compliance
Appendix B—Guidance Regarding Systems/Components		
	Instrument Air (Compressed Air System)	**SBO Recovery with AAC Power Source**
Capacity	Sufficient compressed air to components, as necessary, to ensure that the core is cooled and appropriate containment integrity is maintained for the specified duration of station blackout to meet § 50.63 and Regulatory Guide 1.155.	Air service is not required but may be utilized later in the SBO recovery stage to reconfigure plant system to normal operation alignments.
Quality Assurance	As indicated in Regulatory Position 3.3.	Non-safety-related air systems are not utilized during the 10 minute SBO duration.
Technical Specifications for Maintenance, Surveillance, Limiting Conditions, FSAR, etc.	Should be consistent with the Interim Commission Policy Statement on Technical Specifications (Federal Register Notice 52 FR 3789) as applicable.	The swing EDG stores enough air for 5 starting attempts in safety-related accumulator tanks which are dedicated to the swing EDG.
Instrumentation and Monitoring	Must meet system functional requirements.	Plant air system instrumentation, control and monitoring is not required during the 10 minute SBO duration.
Single Failure	Not required.	—
Common Cause Failure (CCF)	Design should, to the extent practicable, minimize CCF between safety-related and non-safety-related systems.	—

Table 1D-2 ABWR Design Compliance with RG 1.155 (Continued)

Requirements		Compliance
Appendix B—Guidance Regarding Systems/Components		
	Water Delivery System (Alternative to Auxiliary Feedwater System, RCIC System, or Isolation Condenser Makeup)	**SBO Recovery with AAC Power Source**
Safety-Related Equipment (Compliance with IEEE-279)	Not required, but the existing Class 1E systems must continue to meet all applicable safety-related criteria.	The Lungmen NPS AAC power source design response during the (FSAR) minute SBO duration does not require additional water makeup sources beyond the CST and/or the Suppression Pool. Later in the SBO recovery sequence, the Lungmen NPS will utilize the normal plant water systems by powering selective divisions with the AAC power source (e.g. reactor building service water and reactor cooling water systems).
Redundancy	Not required.	—
Diversity	Not required.	—
Independence from Existing Safety-Related Systems	Ensure that the existing safety functions are not compromised, including the capability to isolate components, subsystems, or piping, if necessary.	The powering of the normal plant water sources by the AAC power source during SBO will not be inconsistent or contrary with their current DBA design basis.
Seismic Qualification	Not required.	—
Environmental Consideration	Need for station blackout event only and not for DBA conditions. See Regulatory Position 3.2.4. Procedures should be in place to effect the actions necessary to maintain acceptable environmental conditions for required equipment.	The use of the normal plant cooling water systems will not require prior equipment environment controls or cooling. Their operation will be provided concurrently with the powering of water makeup sources.

Table 1D-2 ABWR Design Compliance with RG 1.155 (Continued)

Requirements		Compliance
Appendix B—Guidance Regarding Systems/Components		
	Water Delivery System (Alternative to Auxiliary Feedwater System, RCIC System, or Isolation Condenser Makeup)	**SBO Recovery with AAC Power Source**
Capacity	Capability to provide sufficient water for core cooling in the event of a station blackout for the specified duration to meet § 50.63 and this regulatory guide.	The emergency water makeup sources include the condensate storage tank and the suppression pool inventory.
Quality Assurance	As indicated in Regulatory Position 3.5.	The plant normal makeup water systems are subject to quality assurance evaluations (e.g. CST and the SP).
Technical Specifications for Maintenance, Surveillance, Limiting Conditions, FSAR, etc.	Should be consistent with the Interim Commission Policy Statement on Technical Specifications (Federal Register Notice 52 FR 3789) as applicable.	Emergency water makeup systems are subject to Technical Specifications requirements.
Instrumentation and Monitoring	Must meet system functional requirements.	Instrumentation and controls for normal plant makeup water systems are qualified for their functional services.
Single Failure	Not required.	—
Common Cause Failure (CCF)	Design should, to the extent practicable, minimize CCF between safety-related and non-safety-related systems.	The use of additional plant water makeup systems (post SBO) will not degrade the operation or reliability of the necessary makeup systems (RCIC, HPCF, etc.). The swing EDG has sufficient capacity to power necessary shutdown loads.

Table 1D-3 ABWR Design Compliance with NUMARC 87-00 Guidelines

Requirements	Compliance
7.0 Coping Evaluations	
7.1.1 Coping Methods For purposes of this assessment, coping methods are separated into two different approaches. The first is referred to as the "AC-Independent" approach. In this approach, plants rely on available process steam, DC power, and compressed air to operate equipment necessary to achieve safe shutdown conditions (i.e., Hot Standby or Hot Shutdown, as appropriate) until offsite or emergency AC power is restored. A second approach is called the "Alternate AC" approach. This method is named for its use of equipment that is capable of being electrically isolated from the preferred offsite and emergency onsite AC power sources. Station blackout coping using the Alternate AC power approach would entail a short period of time in an AC-Independent state (up to one hour) while the operators initiate power from the backup source. Once power is available, the plant would transition to the Alternate AC state and provide decay heat removal until offsite or emergency AC power becomes available. The AC power sources used in the Alternate AC power approach would be subject to the Appendix B criteria including electrical isolation requirements in order to assure their availability in the event of a station blackout. Appendix A provides a definition of Alternate AC power sources. Appendix B provides detailed acceptance criteria for an Alternate AC power source.	The Lungmen NPS design utilizes the "Alternate AC (AAC)" approach as defined in Appendix A. The AAC power source will be available to be connected to the core inventory makeup and decay heat removal loads within (FSAR) minutes. The AAC power source is capable of being electrically isolated from the preferred offsite and emergency onsite AC power sources and complies with the Appendix B criteria including electrical isolation requirements. Although compliance with the SBO rule (10 CFR 50.63) is accomplished via the AAC approach, Lungmen NPS also has significant capabilities to cope with an SBO utilizing RCIC for 8 hours with no AC power available.

Table 1D-3 ABWR Design Compliance with NUMARC 87-00 Guidelines (Continued)

Requirements	Compliance
7.1.2 Coping Duration AC-Independent plants must meet the requirements of this methodology for at least four hours (or at least two hours for plants in *both* emergency AC group A and offsite power group P1). Plants using an Alternate AC power source must assess their ability to cope for one hour. However, if an Alternate AC power source can be shown by test to be available within 10 minutes of the onset of station blackout, then no coping assessment is required. Available within 10 minutes means that circuit breakers necessary to bring power to safe shutdown buses are capable of being actuated in the control room within that period.	Lungmen NPS design will demonstrate by test that the AAC swing EDG is capable of being available within (FSAR) minutes of the onset of a SBO event and therefore no formal coping evaluation is necessary or required. (to be confirmed). All actions during the (FSAR) minute period are safety-related and automatic. The Lungmen NPS design provides the operator with the means to reconfigure the electrical distribution system including circuit breakers, and to connect the AAC power source to the necessary shutdown buses and loads within the (FSAR) minute interval.

Table 1D-3 ABWR Design Compliance with NUMARC 87-00 Guidelines (Continued)

Requirements	Compliance
Appendix A — Definitions	
This appendix defines the terminology used throughout the guide. ALTERNATE AC POWER SOURCE. An alternating current (AC) power source that is available to and located at or nearby a nuclear power plant and meets the following requirements: (i) Is connectable to but not normally connected to the preferred or onsite emergency AC power systems (ii) Has minimal potential for common cause failure with offsite power or the onsite AC power sources (iii) Is available in a timely manner after the onset of station blackout (iv) Has sufficient capacity and reliability for operation of all systems necessary for coping with a station blackout and for the time required to bring and maintain the plant in safe shutdown (Hot Shutdown or Hot Standby, as appropriate) (v) Is inspected, maintained, and tested periodically to demonstrate operability and reliability as set forth in Appendix B	The Lungmen NPS AAC power source design will meet the following requirements: (i) The design is connectable to (but not normally connected to) the preferred or onsite emergency AC power sources. Two normally open breakers separate the AAC swing EDG from the safety-related onsite emergency power buses. (ii) The Lungmen NPS design has a minimal potential for common cause failure between preferred power or onsite AC power sources. The Lungmen NPS AAC power source is a diverse power supply to the normal onsite emergency DGs. The AAC power supply is totally independent of the preferred and onsite power sources. The AAC power source automatically starts and is available for loading in 20 seconds. The AAC power supply is connectable to a Class 1E bus through the actuation of two (2) manual operated circuit breakers. The AAC power source is normally electrically, physically, mechanically, and environmentally isolated from the preferred and onsite power sources. The AAC power source is normally used during LOOP and SBO events. However, the swing EDG can be used for a number of operational services (e.g. maintenance backup, etc.). (iii) The Lungmen NPS AAC power source is available in a timely manner after the onset of a SBO event. The AAC power source automatically starts on LOOP, attains required speed and voltage within 20 seconds, and is capable of being connected to shutdown loads within (FSAR) minutes.

Table 1D-3 ABWR Design Compliance with NUMARC 87-00 Guidelines (Continued)

Requirements	Compliance
	(iv) The Lungmen NPS AAC power source is rated the same size as the normal divisional EDGs. The shutdown loads can be powered by a single division. The swing EDG reliability is 0.95. The Lungmen NPS is expected to be in hot shutdown condition in twenty four (24) hours, and in cold shutdown condition in ninety-six (96) hours. The swing EDG, is designed to run for at least 7 days under SBO conditions at rated load. A seven-day fuel supply is available on the site for the swing EDG. (v) The Lungmen NPS AAC power source will be capable of being inspected, maintained and tested periodically to demonstrate its operability and reliability to guidelines set forth in Appendix B.
REQUIRED COPING DURATION. The time between the onset of station blackout and the restoration of offsite AC power to safe shutdown buses.	The Lungmen NPS AAC power source design does not require a formal SBO coping analysis (to be confirmed). The AAC power source will be available to supply shutdown loads within (FSAR) minutes. The current design requirements associated with DBA events assure that the plant will be able to cope with a (FSAR) minute SBO event.
SAFE SHUTDOWN. For the purpose of this procedure safe shutdown is the plant conditions defined in plant technical specifications as Hot Standby or Hot Shutdown, as appropriate.	The Lungmen NPS design will assure safe shutdown plant conditions as defined by the Plant Technical Specifications and the definition in 10CFR50.63.
STATION BLACKOUT. Means the complete loss of alternating current (AC) electric power to the essential and nonessential switchgear buses in a nuclear power plant (i.e., loss of offsite electric power system concurrent with turbine trip and unavailability of onsite emergency AC power system). Station Blackout does not include the loss of available AC power to buses fed by station batteries through inverters or by Alternate AC power sources as defined in this appendix, nor does it assume a concurrent single failure or a design basis accident. At a multi-unit site, station blackout is assumed to occur in only one unit unless the emergency AC power sources are totally shared between the units.	The Lungmen NPS design accommodates the SBO definition and the other definitions defined in 10CFR50.63. The Lungmen NPS design utilizes the current available station batteries throughout the event. The station batteries may be recharged as necessary by the AAC power source.

Table 1D-3 ABWR Design Compliance with NUMARC 87-00 Guidelines (Continued)

Requirements	Compliance
Appendix B—Alternate AC Power Criteria	
This appendix describes the criteria that must be met by a power supply in order to be classified as an Alternate AC power source. The criteria focus on ensuring that station blackout equipment is not unduly susceptible to dependent failure by establishing independence of the AAC system from the emergency and non-Class 1E AC power systems.	
AAC Power Source Criteria	
B.1 The AAC system and its components need not be designed to meet Class 1E or safety system requirements. If a Class 1E EDG is used as an Alternate AC power source, this existing Class 1E EDG must continue to meet all applicable safety-related criteria.	The Lungmen NPS AAC power source is a safety-related swing EDG.
B.2 Unless otherwise provided in this criteria, the AAC system need not be protected against the effects of: (a) Failure or misoperation of mechanical equipment, including (i) fire, (ii) pipe whip, (iii) jet impingement, (iv) water spray, (v) flooding from a pipe break, (vi) radiation, pressurization, elevated temperature or humidity caused by high or medium energy pipe break, and (vii) missiles resulting from the failure of rotating equipment or high energy systems (b) Seismic events	The Lungmen NPS AAC power source is housed in a Seismic Category 1 building (Auxiliary Fuel Building). The AAC power source is physically, mechanically, electrically and environmentally separated from the preferred and onsite power sources. The AAC power source is protected from normal plant and site environmental perturbations (e.g., wind, temperature, etc.).
B.3 Components and subsystems shall be protected against the effects of likely weather-related events that may initiate the loss of offsite power event. Protection may be provided by enclosing AAC components within structures that conform with the Uniform Building Code, and burying exposed electrical cable run between buildings (i.e., connections between the AAC power source and the shutdown buses).	The Lungmen NPS AAC power source is protected against the effects of weather-related events that may initiate the loss of offsite power events. The AAC power source is located above the maximum flood level. The power and control cables from the swing EDG to the shutdown buses are routed separately from the offsite preferred power and control cables to the shutdown buses in the Reactor Building. The Auxiliary Fuel Building design basis capabilities will provide adequate protection for the enclosed equipment in compliance with their equipment design basis requirements.

Table 1D-3 ABWR Design Compliance with NUMARC 87-00 Guidelines (Continued)

Requirements	Compliance
B.4 Physical separation of AAC components from safety-related components or equipment shall conform with the separation criteria applicable for the unit's licensing basis.	The Lungmen NPS AAC power source design maintains physical separation between safety-related components or equipment and the swing EDG by adhering to applicable separation criteria used in the plant licensing basis.
Connectability to AC Power Systems	
B.5 Failure of AAC components shall not adversely affect Class 1E AC power systems.	The Lungmen NPS AAC power source design and its associated components failures will not adversely affect Class 1E AC power systems. Class 1E AC power system failures will not affect AAC power source operability.
B.6 Electrical isolation of AAC power shall be provided through an appropriate isolation device. If the AAC source is connected to Class 1E buses, isolation shall be provided by two circuit breakers in series (one Class 1E breaker at the Class 1E bus and one non-Class 1E breaker to protect the source).	The Lungmen NPS AAC power source is electrically isolated from the Class 1E power sources by two (2) circuit breakers in series. Power to the breakers will be from appropriate DC sources.
B.7 The AAC power source shall not normally be directly connected to the preferred or onsite emergency AC power system for the unit affected by the blackout. In addition, the AAC system shall not be capable of automatic loading of shutdown equipment from the blacked-out unit unless licensed with such capability.	The Lungmen NPS AAC power source will not normally be connected to the preferred or onsite emergency AC power system. However, the swing EDG may be used for other services (e.g. maintenance backup, etc.). The AAC power system will not automatically connect to or load any shutdown equipment on safety-related emergency buses. The AAC power source will automatically start upon occurrence of a LOOP event. It is capable of being manually connected to safety-related buses.
Minimum Potential for Common Cause Failure	
B.8 There shall be minimal potential for common cause failure of the AAC power source(s). The following system features provide assurance that the minimal potential for common cause failure has been adequately addressed.	The Lungmen NPS AAC power source design contains a number of design and operational features which provide assurance of minimal potential for common cause failure.

Table 1D-3 ABWR Design Compliance with NUMARC 87-00 Guidelines (Continued)

Requirements	Compliance
(a) The AAC power system shall be equipped with a DC power source that is electrically independent from the blacked-out unit's preferred and Class 1E power system.	The AAC power system is equipped with sufficient plant or self-contained DC power supplies (separate from the Class 1E DC power supplies) to facilitate successful operation. During normal operation, the plant electrical distribution systems will provide charging power to the plant battery systems.
(b) The AAC power system shall be equipped with an air start system, as applicable, that is independent of the preferred and the blacked-out unit's preferred and Class 1E power supply.	The swing EDG stores enough air for 5 starting attempts is safety-related accumulator tanks which are dedicated to the swing EDG.
(c) The AAC power system shall be provided with a fuel oil supply, as applicable, that is separate from the fuel oil supply for the onsite emergency AC power system. A separate day tank supplied from a common storage tank is acceptable provided the fuel oil is sampled and analyzed consistent with applicable standards prior to transfer to the day tank.	The AAC power supply is equipped with a fuel system separate from that of the DGs. An external fuel supply transfer system will also be provided. A seven (7) day supply of oil for use by the swing EDG to achieve safe shutdown is available on site. The swing EDG oil storage and transfer system is physically and mechanically independent of the DG oil storage and transfer system.
(d) If the AAC power source is an identical machine to the emergency onsite AC power source, active failures of the emergency AC power source shall be evaluated for applicability and corrective action taken to reduce subsequent failures.	The Lungmen NPS AAC power source is an independent and diverse power supply from the onsite emergency DG power sources. The AAC power source is a swing EDG.
(e) No single point vulnerability shall exist whereby a likely weather-related event or single active failure could disable any portion of the onsite emergency AC power sources or the preferred power sources, and simultaneously fail the AAC power source(s).	The Lungmen NPS AAC power source design precludes single point vulnerabilities, weather-related events effects, or single active failures that could disable any portion of the onsite emergency AC power sources or the preferred power sources and simultaneously fail the AAC power source. The AAC power source is physically, mechanically, electrically and environmentally separated from the other plant power systems (e.g. circuit breaker separation, separate oil supplies, separate auto start circuits, etc.).

Table 1D-3 ABWR Design Compliance with NUMARC 87-00 Guidelines (Continued)

Requirements	Compliance
(f) The AAC power system shall be capable of operating during and after a station blackout without any support systems powered from the preferred power supply, or the blacked-out unit's Class 1E power source affected by the event.	The Lungmen NPS AAC power source design does not require preferred or onsite AC power sources to support the operation of the swing EDG unit. The swing EDG and its auxiliary support systems are maintained in their standby status by normal plant power sources. Upon reaching design speed and voltage, the swing EDG operation is supported by a self-powered internal control package. This package assures continued operation without external power or auxiliary service needs.
(g) The portions of the AAC power system subjected to maintenance activities shall be tested prior to returning the AAC power system to service.	The Lungmen NPS AAC power source is capable of being tested and will be periodically tested: (i) To demonstrate its reliability and its availability (ii) To demonstrate that it can be connected to shutdown buses within (FSAR) minutes (iii) To demonstrate the operability after maintenance has been performed on the swing EDG
Availability After Onset of Station Blackout	
B.9 The AAC power system shall be sized to carry the required shutdown loads for the required coping duration determined in Section 3.2.5, and be capable of maintaining voltage and frequency within limits consistent with established industry standards that will not degrade the performance of any shutdown system or component. At a multi-unit site, except for 1/2 shared or 2/3 emergency AC power configurations, an adjacent unit's Class 1E power source may be used as an AAC power source for the blacked-out unit if it is capable of powering the required loads at both units.	The Lungmen NPS AAC power source is designed to provide reliable power to shutdown loads during and after the SBO duration. The swing EDG will maintain supply voltage and frequency within the limits currently required during normal operation, and during loading transients, etc.

Table 1D-3 ABWR Design Compliance with NUMARC 87-00 Guidelines (Continued)

Requirements	Compliance
Capacity and Reliability	
B.10 Unless otherwise governed by technical specifications, the AAC power source shall be started and brought to operating conditions that are consistent with its function as an AAC source at intervals not longer than three months, following manufacturer's recommendations or in accordance with plant-developed procedures. Once every refueling outage, a timed start (within the time period specified under blackout conditions) and rated load capacity test shall be performed.	The Lungmen NPS AAC power source will be started and brought to operating conditions consistent with manufacturer's recommendations, the plant RAP, or in accordance with specific plant developed procedures. The AAC power source is capable of being started and connected to the preferred power source for load capacity testing. Testing procedures based on plant specific RAP objectives will be developed.
B.11 Unless otherwise governed by technical specifications, surveillance and maintenance procedures for the AAC system shall be implemented considering manufacturer's recommendations or in accordance with plant-developed procedures.	Plant specific surveillance and maintenance procedures based on the appropriate manufacturer's/vendor's recommendations, reliability assurance programs, plant maintenance effectiveness programs and plant operational requirements will be provided.
B.12 Unless otherwise governed by technical specifications, the AAC system shall be demonstrated by initial test to be capable of powering required shutdown equipment within one hour of a station blackout event.	The Lungmen NPS AAC power source design will be tested to demonstrate that the swing EDG is capable of powering shutdown equipment within (FSAR) minutes of the SBO event.

Table 1D-3 ABWR Design Compliance with NUMARC 87-00 Guidelines (Continued)

Requirements	Compliance
B.13 The Non-Class 1E AAC system should attempt to meet the target reliability and availability goals specified below, depending on normal system state. In this content, reliability and availability goals apply to the overall AAC system rather than individual machines, where a system may comprise more than one AAC power source. (a) Systems Not Normally Operated (Standby Systems) System reliability should be maintained at or below 0.95 per demand, as determined in accordance with NSAC-108 methodology (or equivalent). (b) Systems Normally operated (Online Systems) Availability: AAC systems normally online should attempt to be available to its associated unit at least 95% of the time the reactor is operating. Reliability: No reliability targets or standards are established for online systems.	The Lungmen NPS AAC power source satisfies the following reliability and availability goal: System reliability will be maintained at or above 0.95 per demand as determined in accordance with NSAC-108 methodology or its equivalent. Periodic testing and maintenance, to assure this reliability, will be performed.

Table 1D-4 Assumptions in RCIC/SBO Analyses

Case A: SBO event with on RHR in suppression pool cooling mode powered by the AAC power source after 30 minutes into the event.

Case B: SBO event without any AC power available (i.e., no RHR suppression cooling available).

For these analyses, the following assumptions are made:

- Initial power level: 100% of rated (3926 MWt).
- Best estimate, ANSI/ANS 5.1, 1979, decay heat.
- Pool initial water level at normal water level.
- Pool initial temperature at 35°C (95°F).
- Wetwell airspace temperature at 35°C (95°F)
- Drywell initial temperature at 57.2°C (135°F).
- Model WW-to-DW vacuum breakers.
- CST water temperature is at site maximum temperature 37.9°C (100.2°F).
- The ultimate heat sink temperature is 29.9°C.

Additional assumptions made to operate the RCIC manually.

- RCIC is on at Level 4.
- RCIC is off at Level 7.

The RCIC will be available at 52 seconds based on the Lungmen PSAR Table 19.3-2 information below.

- at 0.0 s, MSIV closure
- at 4.2 s, Reactor scrammed (Decay heat curve is 4.2 s translated.)
- at 52 s, RCIC injection, Suction from CST
- at 1.3h, RCIC suction switched to suppression pool
- at 4.4h, RCIC suction switched to CST
- at 8.0h, analyses terminated

For SRV operation, the spring set points are used rather than the relief set points.

Table 1D-5 Pressure and Temperature Results (RHR SP cooling available after 30 minutes) (Interpolated)

Pressure						
Time	**RPV**		**DW**		**WW**	
hrs	psia	kPaA	psia	kPaA	psia	kPaA
0.00	1060.00	7308.49	15.50	106.52	15.50	106.52
2.00	974.60	6719.67	16.37	112.87	16.42	113.21
4.00	1004.93	6928.76	17.22	118.74	17.24	118.85
6.00	933.13	6433.72	18.11	124.88	18.17	125.25
8.00	996.10	6867.94	19.09	131.61	19.14	131.95

Temperature						
Time	**DW**		**SC**		**SP**	
hrs	°F	°C	°F	°C	°F	°C
0.00	135.00	57.22	95.00	35.00	95.00	35.00
2.00	144.35	62.42	128.40	53.55	142.49	61.39
4.00	152.66	67.03	153.78	67.65	163.67	73.15
6.00	161.24	71.80	171.61	77.56	179.43	81.91
8.00	170.65	77.03	184.18	84.55	189.77	87.65

Table 1D-6 Pressure and Temperature Results (RHR SP cooling not available) (Interpolated)

Pressure						
Time	**RPV**		**DW**		**WW**	
hrs	psia	kPaA	psia	kPaA	psia	kPaA
0.00	1060.00	7308.49	15.50	106.52	15.50	106.52
2.00	940.68	6485.81	16.44	11.335	16.46	113.50
4.00	952.07	6564.34	17.62	121.48	17.65	121.67
6.00	1086.95	7494.29	19.35	133.40	19.39	133.70
8.00	1087.52	7498.22	21.99	151.59	21.85	150.64

Temperature						
Time	**DW**		**SC**		**SP**	
hrs	°F	°C	°F	°C	°F	°C
0.00	135.00	57.22	95.00	35.00	95.00	35.00
2.00	144.48	62.49	129.81	54.34	149.09	65.05
4.00	156.11	68.95	166.49	74.72	180.97	82.76
6.00	173.20	78.44	198.79	92.66	207.46	97.48
8.00	198.33	92.41	228.83	109.35	233.91	112.17

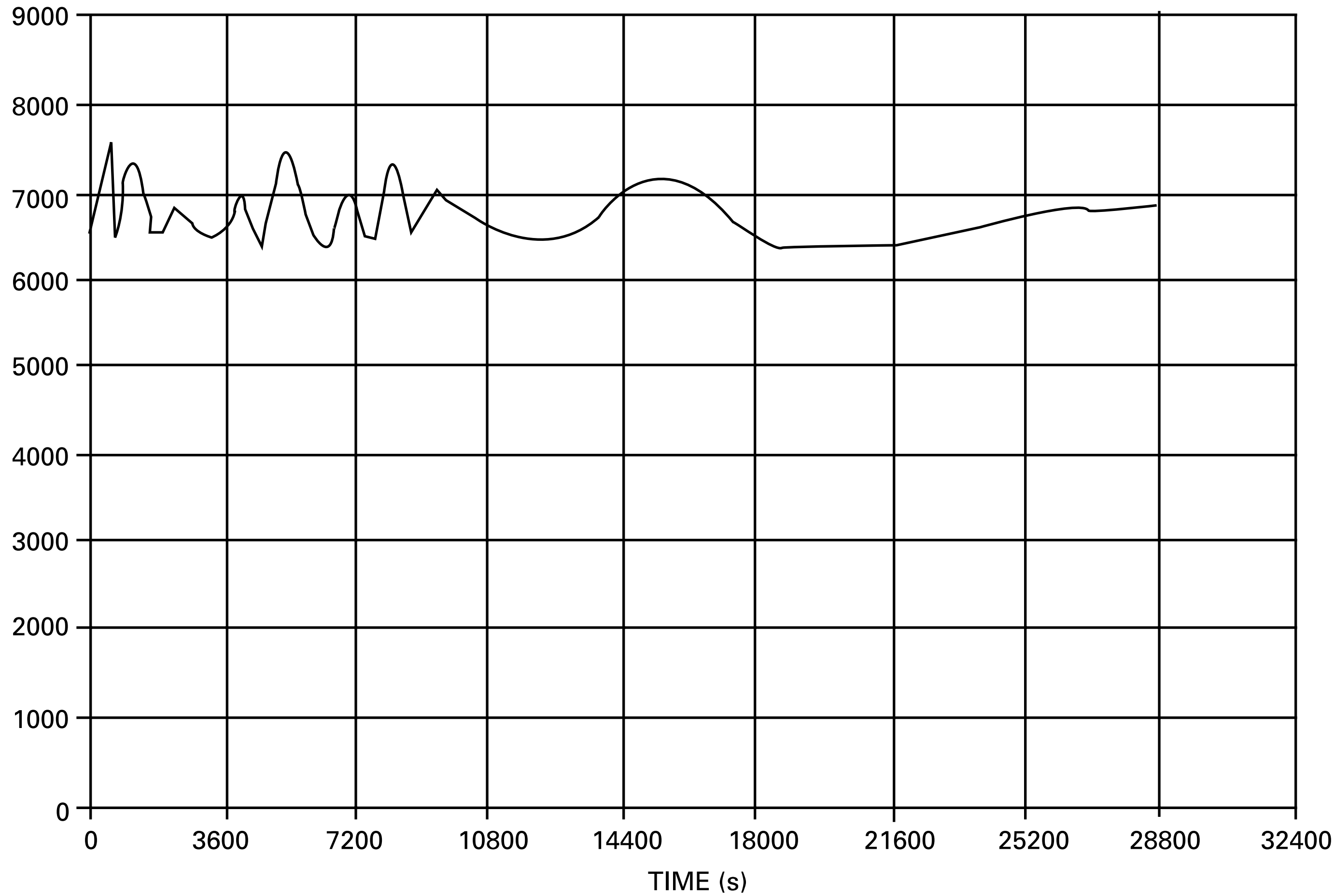

Figure 1D-1 Lungmen NPS RPV Pressure History During SBO Event
(1 RHR Available After 30 Minutes into the Event)

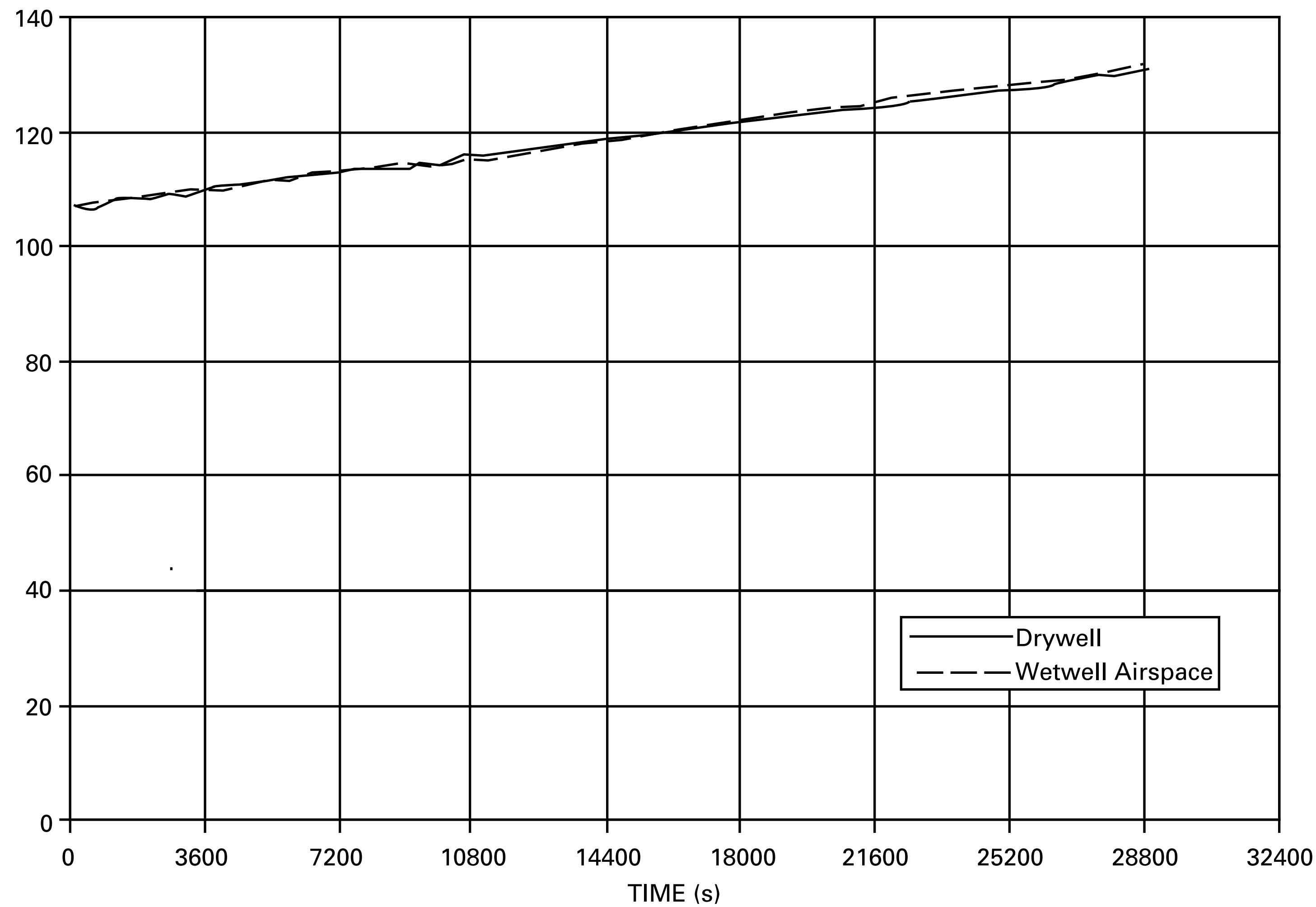

Figure 1D-2 Lungmen NPS Containment Pressure Response to SBO (1 RHR Available After 30 Minutes into the Event)

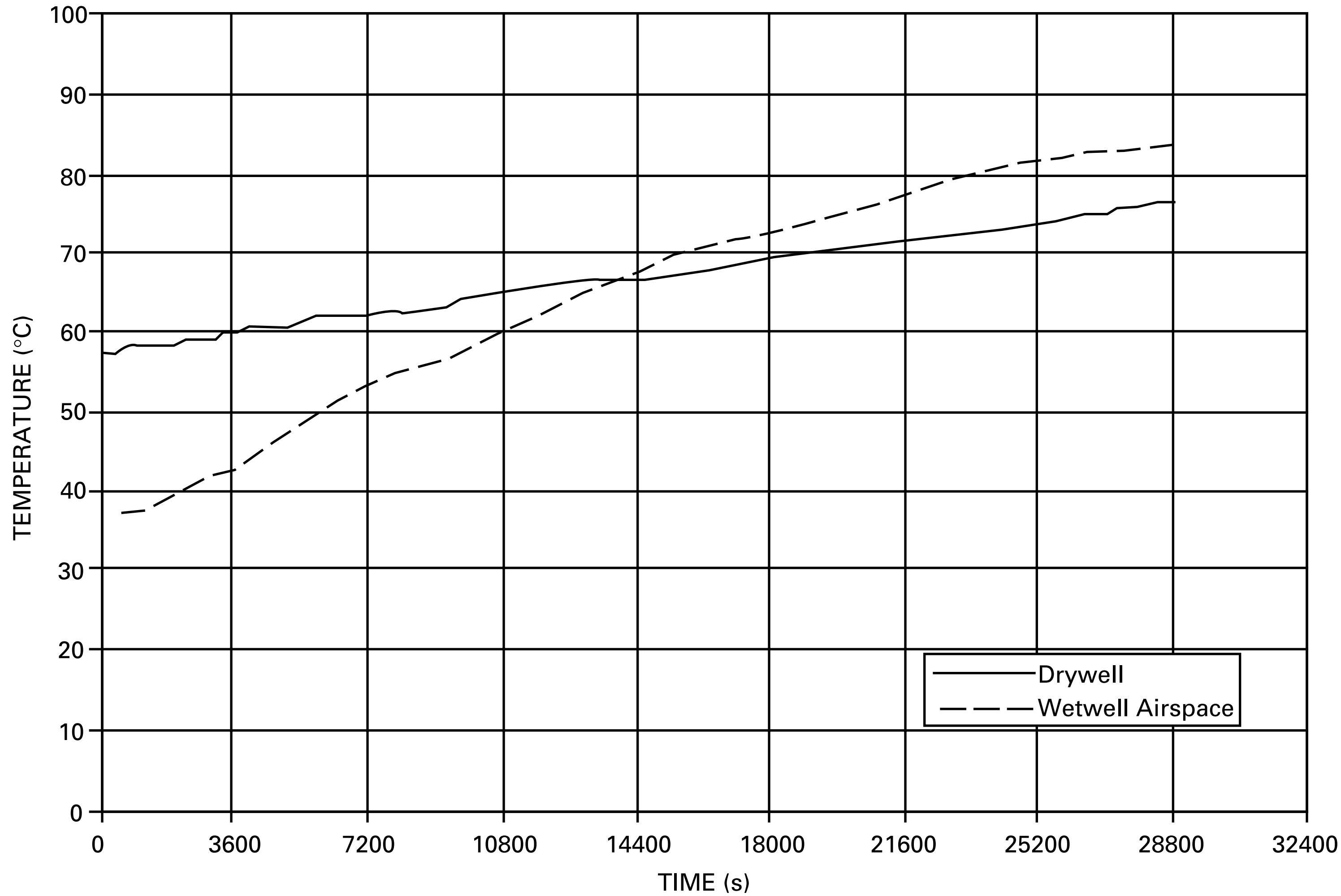

Figure 1D-3 Lungmen NPS Containment Temperature Response to SBO Event (1 RHR Available After 30 Minutes into the Event)

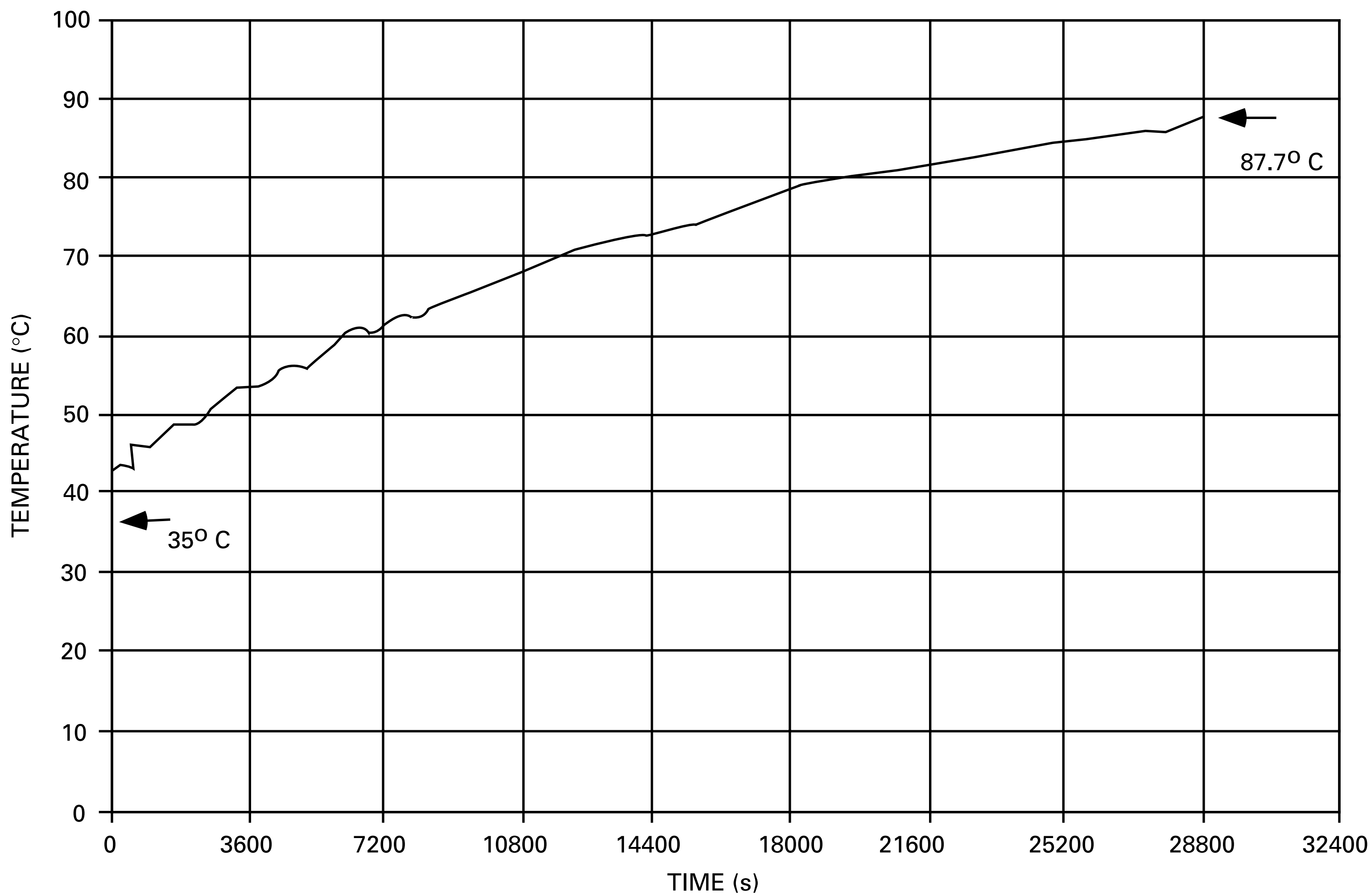

Figure 1D-4 Lungmen NPS Suppression Pool Temperature Response to SBO (1 RHR Available After 30 Minutes into the Event)

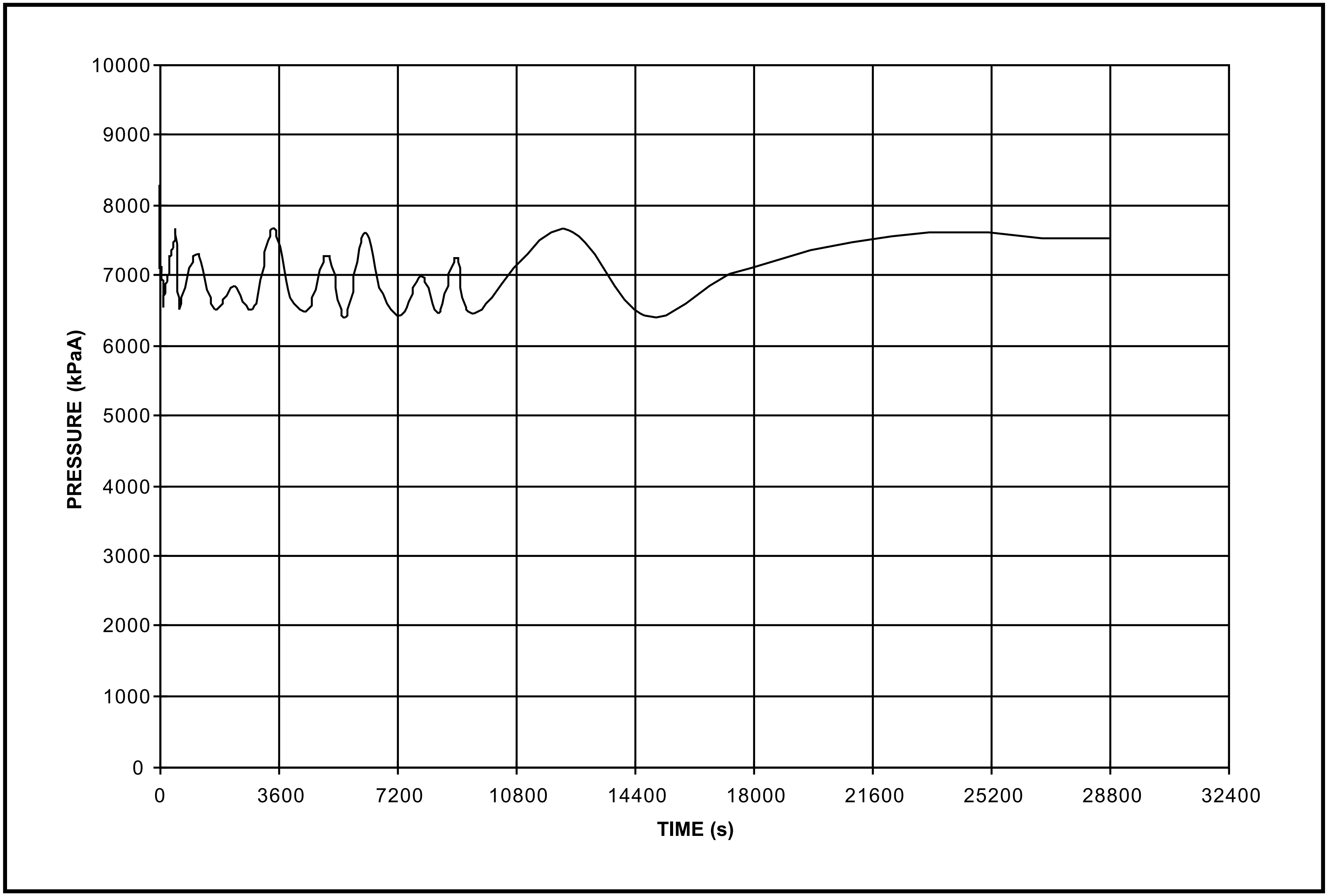

Figure 1D-5 Lungmen NPS RPV Pressure History During SBO Event (No RHR Available)

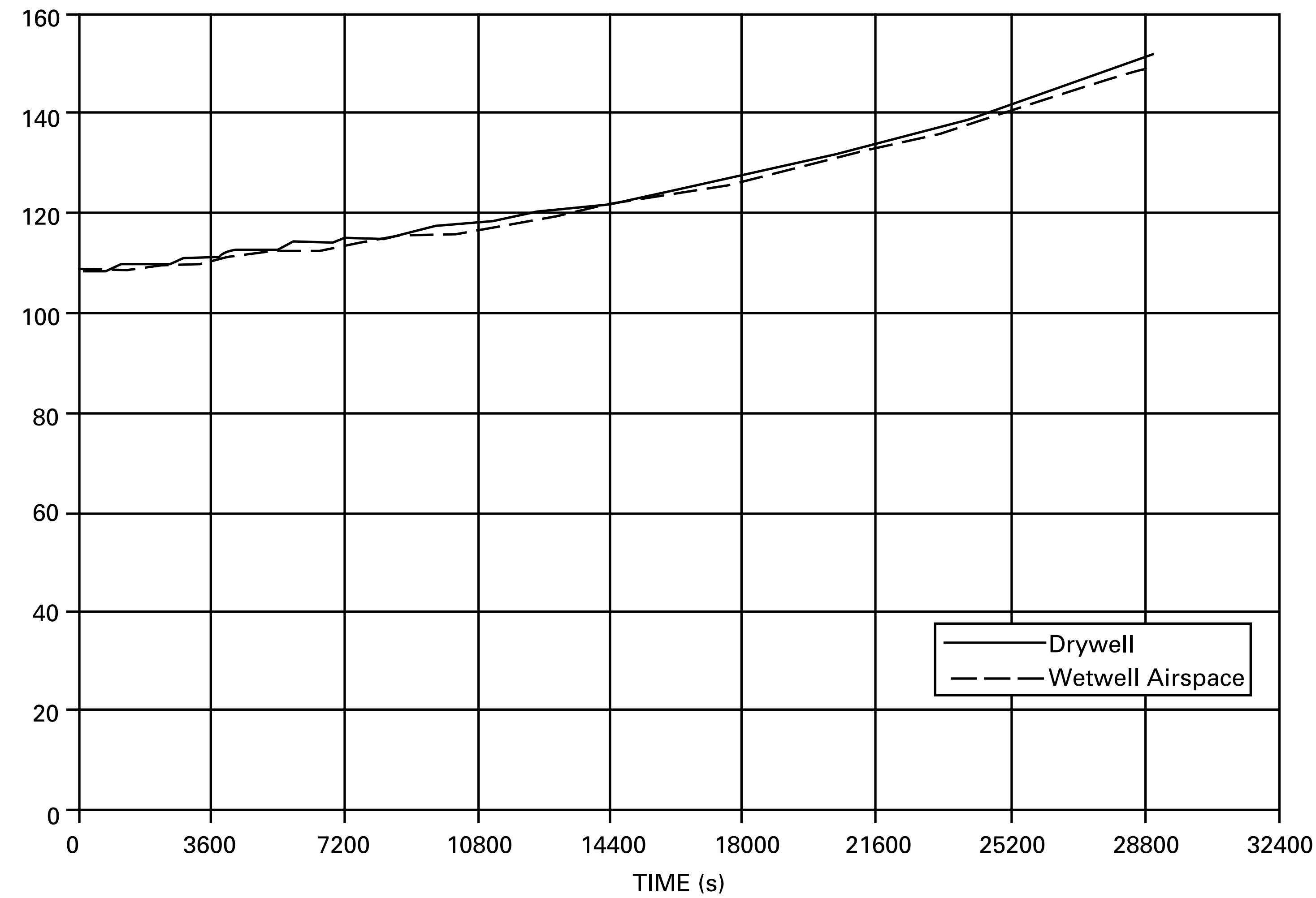

Figure 1D-6 Lungmen NPS Containment Pressure Response to SBO Event (No RHR Available)

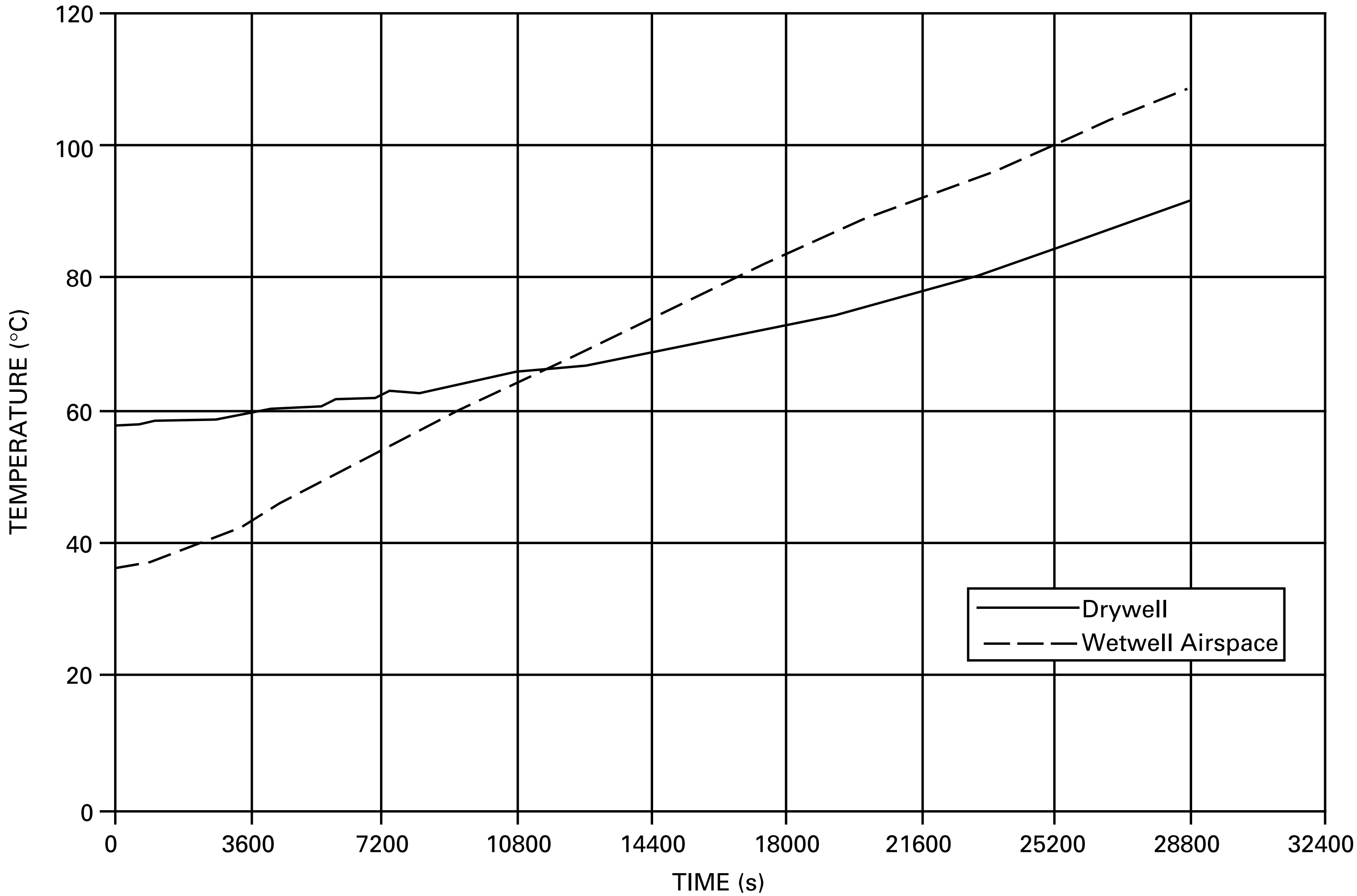

Figure 1D-7 Lungmen NPS Containment Temperature Response to SBO Event (No RHR Available)

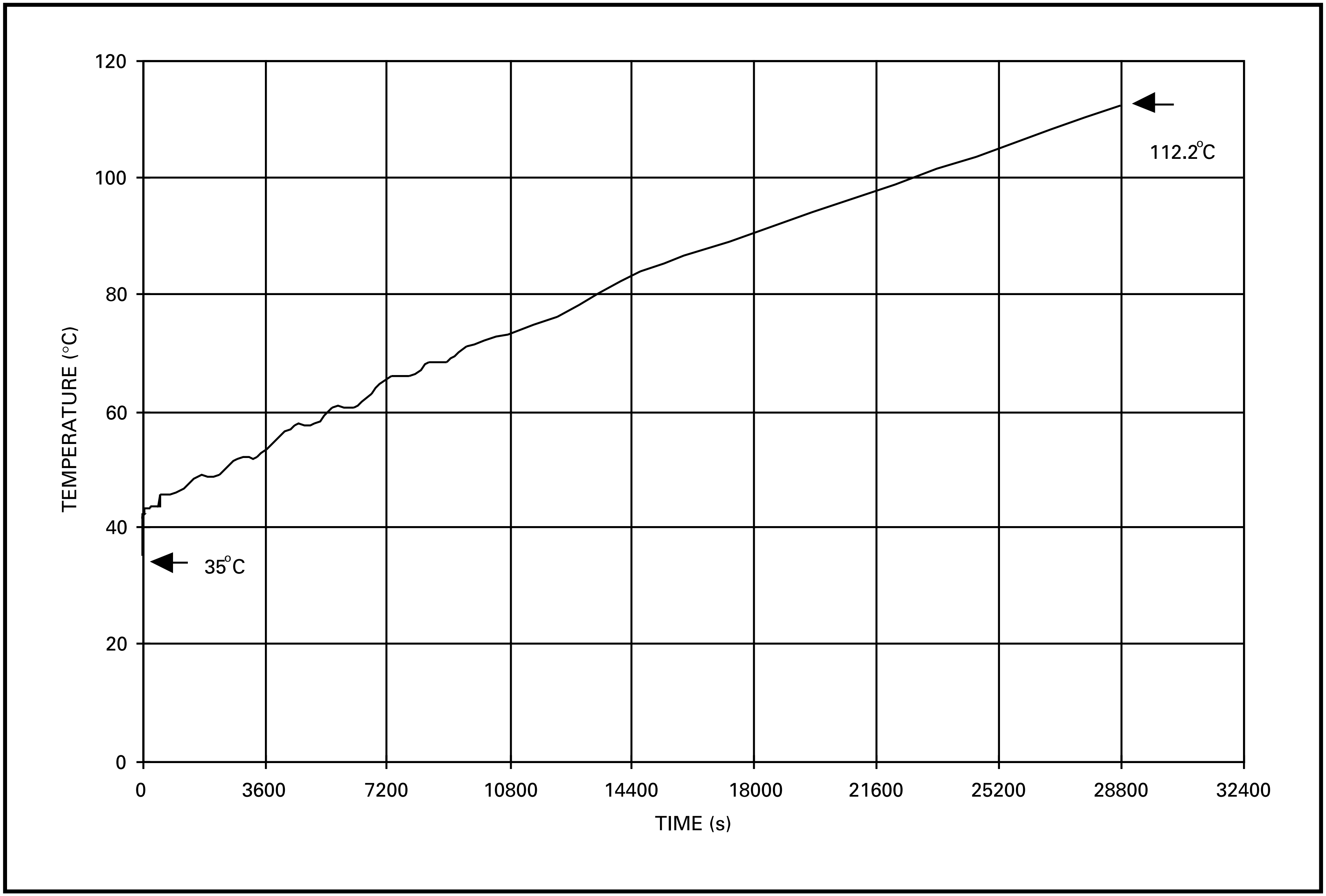

Figure 1D-8 Lungmen NPS Suppression Pool Temperature Response to SBO Event (No RHR Available)