1C ABWR Station Blackout Considerations

The information in this appendix of the reference ABWR DCD, including all subsections and tables, is incorporated by reference with the following departures and supplement.

STD DEP Admin ~~(pages 1C-2 and 1C-3)~~(Table 1C-1 Item (2) and Table 1C-2 Appendix B)

STD DEP 1.8-1 (Table 1C-3)

STD DEP 8.3-1 (Tables 1C-1, 1C-2, 1C-3)

1C.2 Discussion

1C.2.2 Plant SBO Design Basis

1C.2.2.2 Specific SBO Design Basis

STD DEP 1.8-1

STD DEP 8.3-1

~~The plant medium voltage electrical system alternate design description was provided in ABWR Licensing Topical Report NEDO-33335, "Advanced Boiling Water Reactor (ABWR) Plant Medium Voltage Electrical System Design," dated May, 2007. The revised Appendix 1C pages included in the Licensing Topical Report are incorporated by reference.~~

- *The CTG will automatically start, accelerate to required speed, reach required voltage and frequency and be ready to accept PIP loads ~~within two~~*in less than 10 *minutes of the receipt of its start signal.*
- *The CTG will be housed in ~~a~~*an International Building Code (IBC)*~~Uniform Building Code~~ structure which is protected from adverse site weather related conditions.*

1C.2.3 Plant SBO Safety Analysis

1C.2.3.1 Plant Event Evaluations

1C.2.3.1.1 Plant Normal Operation

STD DEP 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 ~~transformer (RAT)~~*transformers (RATs).

*The CTG is designed to supply standby power to the non-Class 1E ~~6.9~~*4.16*kV buses which carry the plant investment protection (PIP) loads. The CTG automatically starts on detection of under voltage on the PIP buses. When the CTG is ready to assume*

load, if the voltage is still deficient, power automatically transfers to the CTG (refer to Figure 8.3-1).

The CTG can also supply standby power to the non-Class 1E ~~6.9~~13.8kV power generation buses which supply ~~feedwater and~~ condensate and condensate booster pumps. These buses normally receive power from the unit auxiliary transformers. ~~and supply power to the plant investment protection (PIP) buses through a cross tie. The cross tie automatically opens on loss of power but~~ Breakers on the CTG buses and power generation buses may be manually reclosed if it is desired to operate a condensate and condensate booster pump from the combustion turbine generator or the reserve auxiliary transformer. ~~which are connectable to the PIP buses~~. This arrangement allows the powering of load groups of non-Class 1E equipment in addition to the Class 1E divisions which may be used to supply water to the reactor vessel (refer to Figure 8.3-1).

1C.2.3.1.3 SBO Events

STD DEP 8.3-1

The CTG is the AC power source during an SBO event. The CTG can supply ~~6.9~~4.16kV Class 1E buses through the realignment of pre-selected breakers during SBO events. The CTG will reach operational speed and voltage in ~~2~~less than 10 minutes and will be available for bus connection within 10 minutes. Upon a LOPP, the CTG is automatically started and configured to non-safety-related PIP loads. Plant operators using appropriate procedures will reconfigure any of the ~~6.9~~4.16 kV Class 1E buses to accept CTG power. Refer to Tier 2 Subsections 8.3.1.1.7 and 9.5.11.

1C.2.3.2 Alternative AC Power Source Evaluation

STD DEP 8.3-1

The alternate AC power source (1) is a combustion turbine generator, (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 units Class 1E power sources (5) is designed to power all of the PIP and/or Class 1E shutdown loads necessary within 10 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 (except seismic and tornado missiles) to the extent that there will be no common mode failures between offsite preferred sources and the combustion turbine generator power source, (7) will be subject to quality assurance guidelines commensurate with its importance to SBO, (8) will have sufficient capacity and capability to supply ~~one division~~ two divisions of Class 1E loads, (9) will have sufficient capacity and capability to supply the required non-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 two~~in less than 10 minutes, (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.

1C.4 COL License Information

1C.4.1 Station Blackout Procedures

The following site-specific supplement addresses COL License Information Item 1.13.

The station blackout procedure(s) will be developed ~~per the schedule and description provided in ABWR Licensing Topical Report NEDO-33297, "Advanced Boiling Water Reactor (ABWR) Procedures Development Plan," dated January, 2007~~consistent with the plant operating procedure development plan in Section 13.5. (COM 1C-1)

Table 1C-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 ABWR 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 a combustion turbine generator (CTG). The CTG will be totally independent from offsite preferred and onsite Class 1E sources. A ten (10) minute interval is used as the ABWR 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 ABWR design CTG 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 CTG supplied will be rated at a ~~minimum of 9~~*minimum of 20 *MWe and be capable of accepting shutdown loads within 10 minutes.* *The current plant onsite emergency power sources include three (3) independent and redundant DG divisions which are designed to supply approximately ~~5~~7.2 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 10 minutes.*

Table 1C-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 ABWR design SBO duration time considerations are consistent with RG1.155 and NUMARC-87-00. Upon loss of offsite power (LOPP) and upon the subsequent loss of all on site AC emergency power sources (three independent and redundant DGs), the CTG can be manually connected to any one of the three safety-related (Class 1E) buses by closing two circuit breakers. The alternative AC (AC) power source will automatically start, and ~~within 2~~* in less than 10 *minutes be up to required speed and voltage. It will then automatically connect to selected PIP buses (non-Class 1E) loads.* *During the first 10 minutes, the reactor will have automatically tripped, the main steam isolation valves (MSIVs) closed, and the RCIC actuated.* *The RCIC system will automatically control reactor coolant level.* *Any necessary relief valve operation will also be automatic.* *Within the 10 minute SBO interval, none of the above actions will require AC power or manual operator actions.* *The reconfiguration of the CTG to pick up the Class 1E buses will require manual closure of two circuit breakers from the control room. Upon restoration of power to the safety bus(es), the remaining safe shutdown loads will be energized.*

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

Requirements	Compliance
(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 ABWR CTG will be automatically initiated upon the loss of power to the PIP buses. The CTG will achieve required speed and voltage ~~within 2~~*in less than 10 *minutes. The CTG will be manually connected to safe shutdown buses within 10 minutes. These equipment capabilities will be demonstrated 1) by the manufacturer's component tests, 2) by the CTG initial startup tests and 3) periodically by the COL applicant as part of his operational reliability assurance program.* ~~*The ABWR design is a single unit plant arrangement design.*~~ On site emergency AC sources are not shared between units. *The CTG AAC source is available to power shutdown loads within 10 minutes as described above. Therefore, no coping analysis is required. In addition, the ABWR 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.*

Table 1C-2 ABWR Design Compliance with RG 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:	*The ABWR AAC power source is not normally connected to the preferred or the onsite emergency AC power system.* ~~*Two*~~At least two *open circuit breakers—one Class 1E and the* ~~*other*~~others *non-Class 1E— separate the CTG 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.* ~~*A*~~At least two *non-Class 1E circuit* ~~*breaker separates*~~breakers separate *the CTG from the PIP buses.*
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.	
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 ABWR AAC design power source will be automatically started and reach rated speed and voltage and be available to supply PIP loads* ~~*within 2*~~in less than 10 *minutes, and safety-related loads within 10 minutes for any loss of preferred offsite power sources (LOPP).* *The design has provisions to assure the timely manual interconnection between the AAC (CTG) and any one or more of the safety-related shutdown buses.* *The ABWR AAC design will be demonstrated by test to show that it can be connected to safety-related buses within 10 minutes. Therefore, no coping analysis is required.*
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 ABWR AAC power source is rated at* at least ~~*9*~~20 *MWe, which is more than sufficient capacity to operate the necessary safe shutdown loads which are less than* ~~*5*~~7.2 *MWe.*

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

Requirements		Compliance
Appendix B - Guidance Regarding Systems/Components		
	Alternate AC Sources	**ABWR AAC Power Source**
Independence from Existing Safety-Related Systems	*Required if connected to Class 1E buses. Separation to be provided by 2 circuit breakers in series (1 Class 1E at the Class 1E bus and 1 non-Class 1E).*	~~*Two*~~At least two *breakers separate the onsite emergency power buses from the CTG. One breaker is Class 1E and the breaker closest to the CTG is non-Class 1E (see Figure 8.3-1).*
	~~Water Source (Existing Condensate Storage Tank or Alternate)~~ **Instrument Air (Compressed Air System)**	**SBO Recovery with AAC Power Source**

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

Requirements	Compliance
Appendix A — Definitions	
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	*(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 CTG from the safety-related onsite emergency power buses. ~~A single~~*Non-Class 1E *normally open ~~breaker separates~~*breakers separate *the AAC CTG from the non-safety-related PIP buses (preferred power) (see Figure 8.3-1).*
(ii) Has minimal potential for common cause failure with offsite power or the onsite AC power sources	*(ii) The ABWR design has a minimal potential for common cause failure between preferred power or onsite AC power sources. The ABWR 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 ~~two~~*less than 10 *minutes. 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 LOPP and SBO events. However, the CTG can be used for a number of operational services (e.g. maintenance backup, etc.).*
(iii) Is available in a timely manner after the onset of station blackout	*(iii) The ABWR AAC power source is available in a timely manner after the onset of a SBO event. The AAC power source automatically starts on LOPP, attains required speed and voltage ~~within two (2)~~*in less than ten (10) *minutes, and is capable of being connected to shutdown loads within ten (10) minutes.*
(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	

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

Requirements	Compliance
	(iv) The ABWR AAC power source is rated a minimum of ~~9~~20 MWe. The shutdown loads are less than ~~5~~7.2 MWe. The CTG reliability is 0.95. The ABWR is expected to be in hot shutdown condition in twenty four (24) hours, and in cold shutdown condition in ninety-six (96) hours. The CTG is designed to run indefinitely under SBO conditions at rated load. A seven-day fuel supply is available on the site for the CTG.
	(v) The ABWR 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.
Appendix B—Alternate AC Power Criteria	
AAC Power Source Criteria	
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	The ABWR AAC power source is housed in a International Building Code (IBC)~~Uniform Building Code~~ Building (Turbine 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.).
Connectability to AC Power Systems	
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 ABWR AAC power source is electrically isolated from the Class 1E power sources by at least two (2) circuit breakers in series (one Class 1E at the Class 1E buses and at least one non-Class 1E breaker at the CTG bus). Power to the breakers will be from appropriate DC sources.