

## ArevaEPRDCPEm Resource

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**From:** WILLIFORD Dennis (AREVA) [Dennis.Williford@areva.com]  
**Sent:** Friday, August 02, 2013 2:11 PM  
**To:** Snyder, Amy  
**Cc:** Mitra, Sikhindra; ANDERSON Katherine (EXTERNAL AREVA); DELANO Karen (AREVA); LEIGHLITER John (AREVA); ROMINE Judy (AREVA); RYAN Tom (AREVA); PANNELL George (EXTERNAL AREVA); HOTTLE Nathan (AREVA)  
**Subject:** Response to U.S. EPR Design Certification Application RAI No. 564 (6901), FSAR Ch. 8, Supplement 3  
**Attachments:** RAI 564 Supplement 3 Response US EPR DC.pdf

Amy,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to the one question in RAI No. 564 on December 19, 2012. AREVA NP submitted Supplement 1 to the response on June 28, 2013 to provide a technically correct and complete response to Question 08.02-8. Supplement 2 response was sent on July 16, 2013 to provide a revised final response to Question 08.02-8 to address NRC staff comments.

The attached file, "RAI 564 Supplement 3 Response US EPR DC.pdf," provides a revised final response to Question 08.02-8 to include additional FSAR changes and associated text that were inadvertently omitted in the response provided in Supplement 2. Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to Question 08.02-8.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to Question 08.02-8.

The following table indicates the pages in the response document, "RAI 564 Supplement 3 Response US EPR DC.pdf" that contain AREVA NP's final response to the subject question.

Question #	Start Page	End Page
RAI 564 — 08.02-8	2	7

This concludes the formal AREVA NP response to RAI 564, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

***Dennis Williford, P.E.***  
***U.S. EPR Design Certification Licensing Manager***  
***AREVA NP Inc.***

7207 IBM Drive, Mail Code CLT 2B  
Charlotte, NC 28262  
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Email: [Dennis.Williford@areva.com](mailto:Dennis.Williford@areva.com)

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**From:** WILLIFORD Dennis (RS/NB)  
**Sent:** Tuesday, July 16, 2013 4:53 PM  
**To:** Amy.Snyder@nrc.gov  
**Cc:** Mitra, Sikhindra; ANDERSON Katherine (External AREVA NP INC.); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); PANNELL George (External AREVA NP INC.); HOTTLE Nathan (EP/PE)  
**Subject:** Response to U.S. EPR Design Certification Application RAI No. 564 (6901), FSAR Ch. 8, Supplement 2

Amy,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to the one question in RAI No. 564 on December 19, 2012. AREVA NP submitted Supplement 1 to the response on June 28, 2013 to provide a technically correct and complete response to Question 08.02-8.

The attached file, "RAI 564 Supplement 2 Response US EPR DC.pdf," provides a revised final response to Question 08.02-8 to address NRC staff comments. Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to Question 08.02-8.

The following table indicates the pages in the response document, "RAI 564 Supplement 2 Response US EPR DC.pdf" that contain AREVA NP's final response to the subject question.

Question #	Start Page	End Page
RAI 564 — 08.02-8	2	7

This concludes the formal AREVA NP response to RAI 564, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

***Dennis Williford, P.E.***  
***U.S. EPR Design Certification Licensing Manager***  
***AREVA NP Inc.***

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**From:** WILLIFORD Dennis (RS/NB)

**Sent:** Friday, June 28, 2013 7:35 PM

**To:** [Amy.Snyder@nrc.gov](mailto:Amy.Snyder@nrc.gov)

**Cc:** Mitra, Sikhindra; ANDERSON Katherine (External AREVA NP INC.); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); PANNELL George (External AREVA NP INC.); HOTTLE Nathan (EP/PE)

**Subject:** Response to U.S. EPR Design Certification Application RAI No. 564 (6901), FSAR Ch. 8, Supplement 1

Amy,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to the one question in RAI No. 564 on December 19, 2012. We received some general NRC staff feedback on our Advanced Response at the DCWG meeting on April 16<sup>th</sup>, received written comments via e-mail on April 24<sup>th</sup>, and also discussed further at the DCWG meeting on June 19, 2013. We believe that we have addressed all NRC staff concerns.

Attached please find AREVA NP Inc.'s final response to the subject request for additional information (RAI). The attached file, "RAI 564 Supplement 1 Response US EPR DC.pdf," provides a technically correct and complete final response to the one question in RAI No. 564.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 564, Question 08.02-8.

The following table indicates the respective pages in the response document, "RAI 564 Supplement 1 Response US EPR DC.pdf," that contain AREVA NP's response to the subject question.

Question #	Start Page	End Page
RAI 564 — 08.02-8	2	7

This concludes the formal AREVA NP response to RAI 564, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

**Dennis Williford, P.E.**  
**U.S. EPR Design Certification Licensing Manager**  
**AREVA NP Inc.**

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**From:** WILLIFORD Dennis (RS/NB)  
**Sent:** Wednesday, December 19, 2012 10:43 AM  
**To:** 'Snyder, Amy'  
**Cc:** DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WILLS Tiffany (CORP/QP); NOXON David (RS/NB)  
**Subject:** Response to U.S. EPR Design Certification Application RAI No. 564 (6901), FSAR Ch. 8

Amy,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 564 Response US EPR DC.pdf," provides a schedule since a technically correct and complete response to the question cannot be provided at this time.

The following table indicates the respective pages in the response document, "RAI 564 Response US EPR DC.pdf," that contain AREVA NP's response to the subject question.

Question #	Start Page	End Page
RAI 564 — 08.02-8	2	2

The schedule for a technically correct and complete response to the single question is provided below.

Question #	Response Date
RAI 564 — 08.02-8	April 30, 2013

Sincerely,

**Dennis Williford, P.E.**  
**U.S. EPR Design Certification Licensing Manager**  
**AREVA NP Inc.**

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**From:** Snyder, Amy [<mailto:Amy.Snyder@nrc.gov>]

**Sent:** Friday, November 23, 2012 3:56 PM

**To:** ZZ-DL-A-USEPR-DL

**Cc:** Kang, Peter; Anderson, James; Mitra, Sikhindra; Segala, John; ArevaEPRDCPEm Resource

**Subject:** U.S. EPR Design Certification Application RAI No. 564 (6901), FSAR Ch. 8

Attached please find the subject request for additional information (RAI). A draft of the RAI was provided to you on October 17, 2012, and on October 29, 2012 you informed us that the RAI is clear and no further clarification is needed. As result, no change is made to the draft RAI. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAI question that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30-day period so that the staff can assess how this information will impact the published schedule.

Thank You,

Amy

Amy Snyder, U.S. EPR Design Certification Lead Project Manager

Licensing Branch 1 (LB1)

Division of New Reactor Licensing

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**Hearing Identifier:** AREVA\_EPR\_DC\_RAIs  
**Email Number:** 4638

**Mail Envelope Properties** (554210743EFE354B8D5741BEB695E6561E6469)

**Subject:** Response to U.S. EPR Design Certification Application RAI No. 564 (6901),  
FSAR Ch. 8, Supplement 3  
**Sent Date:** 8/2/2013 2:11:18 PM  
**Received Date:** 8/2/2013 2:11:39 PM  
**From:** WILLIFORD Dennis (AREVA)

**Created By:** Dennis.Williford@areva.com

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MESSAGE	8397	8/2/2013 2:11:39 PM
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**Options**

**Priority:** Standard  
**Return Notification:** No  
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**Sensitivity:** Normal  
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**Recipients Received:**

**Response to**

**Request for Additional Information 564, Supplement 3**

**Issue Date: 11/23/12**

**Application Title: U. S. EPR Standard Design Certification - Docket Number 52-020**

**AREVA NP Inc.**

**Docket No. 52-020**

**Review Section: 08.02 - Offsite Power System**

**Application Section: 08.02**

**EEB Branch**

**Question 08.02-8:**

On July 27, 2012, the NRC issued Bulletin 2012-01, "Design Vulnerability in Electric Power System," (Agencywide Documents Access and Management System (ADAMS) Accession Number ML12074A115) to all holders of operating licenses and combined licenses for nuclear power reactors requesting information about the facilities' electric power system designs, in light of the recent operating experience that involved the loss of one of the three phases of the offsite power circuit (single-phase open circuit condition) at Byron Station, Unit 2 to verify compliance with applicable regulations and to determine if further regulatory action is warranted.

In order to verify the applicants of new reactors have addressed the design vulnerability identified at Byron in accordance with the requirements specified in General Design Criterion (GDC) 17, "Electric Power Systems," in Appendix A, "General Design Criteria for Nuclear Power Plants," and the design criteria for protection systems under 10 CFR 50.55a(h)(3), please provide the following information:

- Describe the protection scheme design for important to safety buses (31-34BDA) to detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on credited offsite power circuits.
- If the important to safety buses are not powered by offsite power sources during at power condition, explain how the surveillance tests (e.g., SR 3.8.1.1) are performed to verify that a single-phase open circuit condition or high impedance ground fault condition on an off-site power circuit is detected.
- Describe the plant operating procedures including off-normal operating procedures, specifically calling for verification of the voltages on all three phases of the ESF buses.

**Response to Question 08.02-8:****Item 1:**

The four Class 1E Emergency Power Supply System (EPSS) Buses 31-34BDA of the U.S. EPR design are powered from two, 25 MVA, 3-winding Emergency Auxiliary Transformers (EAT), 30BDT01 and 30BDT02. The three windings of each EAT are connected Wye; the primary, high-voltage side neutral is solidly grounded, and the two secondary, low-voltage side neutrals are each high-impedance grounded. Although each EAT has the capacity and capability to power all four EPSS buses (31-34BDA) under all design basis conditions, the normal operating configuration is for each EAT secondary winding to power a single EPSS bus.

The EATs are powered by dedicated off-site feeds that are not used for powering normal operation plant loads such as RCPs, Main Feedwater Pumps, etc. The Normal Auxiliary Transformers (NATs) supply the normal operations plant loads and have their own dedicated off-site power feeds. The U.S. EPR electrical system configuration also assures that should a loss of phase occur on one of the off-site feeds, the emergency buses and associated safety equipment powered by the second off-site feed are unaffected.

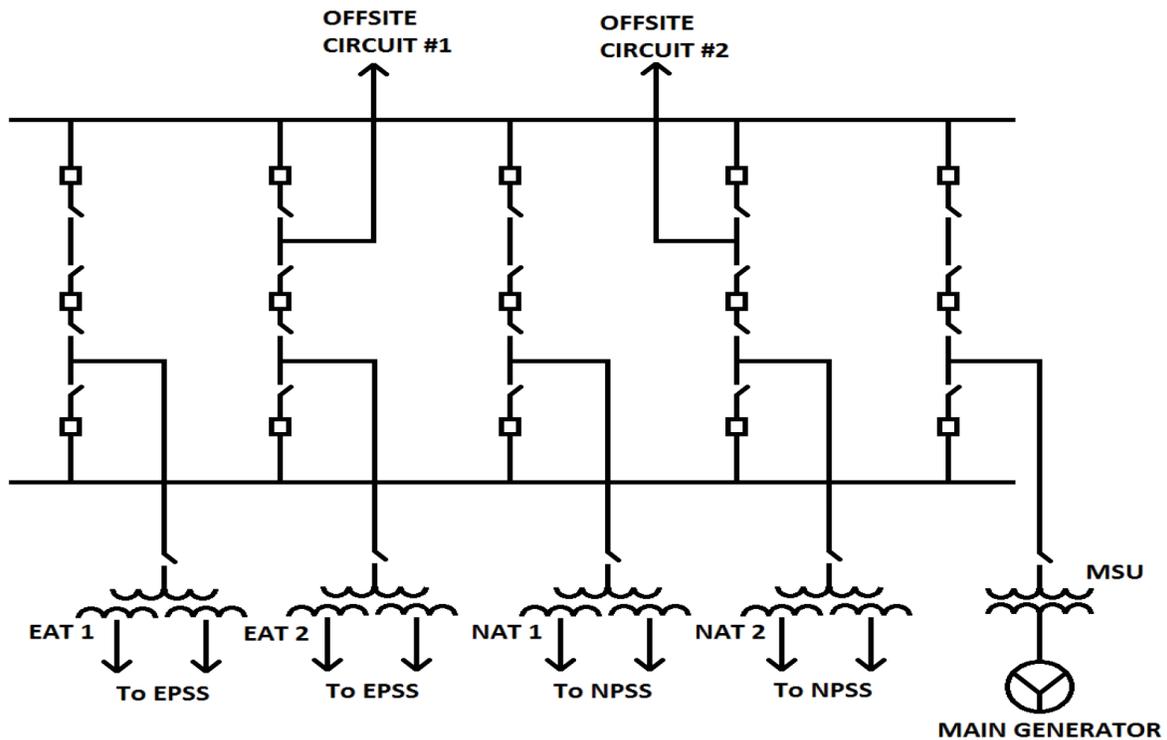
The U.S. EPR electrical system off-site power supply design provides a stable, dedicated and voltage regulated power source for the Emergency Buses. This configuration presents a somewhat unique relaying design challenge when trying to monitor for loss of a single off-site power supply phase due to the light loading of the EATs during normal at-power operation. This normal

operating configuration maintains the EATs very lightly loaded, roughly estimated at 5 to 8 MVA each.

The AREVA electrical design group is participating in nuclear industry efforts to provide an effective design solution to address NRC Bulletin 2012-01. The electrical design group is also performing analyses of the U.S. EPR electrical system using ETAP in order to determine how best to monitor the EATs during normal plant operation to provide:

1. A reliable indication to operators of the loss of power supply phase to either of the EATs.
2. A continuous monitoring scheme which will also provide a reliable means for ensuring that the plant meets the GDC 17 requirements for off-site power with regard to continued compliance with plant technical specifications during plant operation.

### Overview U.S. EPR Offsite Power Supply Design for the EATs



### Key Inputs and Assumptions for the Analysis

- Plant Loads are in steady state.
- One EAT is modeled to demonstrate the analysis methodology; the analysis will be applied to the other EAT during Detailed Design of the U.S. EPR.
- Maximum load condition on the EATs is assuming a single EAT powers all four Emergency Power Supply System (EPSS) buses (31-34BDA) with accident loads operating.
- Minimum load condition on the EATs is assuming the other EAT is carrying the major process system load (e.g., CCW, ESW, SCWS, etc.).
- The offsite grid connections are modeled using the minimum and maximum short circuit contribution used for the U.S. EPR design certification ETAP load flow model.
- The analysis should be performed assuming a loss of a single phase in combination with a high impedance ground fault.
- Since the EATs/NATs utilize an OLTC on the primary side, the three-winding EATs/NATs are effectively two two-winding transformers in a single enclosure.

### Overview of Analysis

- A model was created using ETAP Version 12.0N with guidance from NEI's Consideration of Scenarios for the Open Phase Analysis (Draft 5).
- The model consists of a single EAT with consideration given to loading on the EAT and the impacts of the offsite power sources.
- The static model is used for the U.S. EPR.
- The Phase, Sequence, and Percent Unbalance has been analyzed for voltage and current on the high-side of the EAT.

### Overview of Analysis Results

- Ground-Fault (e.g., solid or high-impedance): The analysis shows the presence of high current on the high-side of the EATs, when compared to minimum and maximum load. The U.S. EPR will consider single line-to-ground faults when performing normal overcurrent protection/coordination studies.
- Open-Phase, High-Side Impact: The analysis performed indicates that a ratio of zero sequence voltage to zero sequence current ( $V_0/I_0$ ) is a potential parameter which is characteristic of an open-phase on the high-side of the EATs. For the U.S. EPR, the sequence components of the current and voltage will be analyzed further for telling signatures of an open-phase on the high-side of the EATs.
- Open-Phase, Low-Side Impact: Preliminary analyses indicate the U.S. EPR degraded grid logic is likely to be initiated on the low-side EPSS buses (31-34BDA), when an open-phase occurs on the EAT high-side.

AREVA will incorporate the use of state of the art digital relaying using voltage and current inputs for monitoring the off-site power feeds to the EATs in the U.S. EPR electrical system design. The relaying scheme will also incorporate design features that filter out potential spurious operation while providing a phase voltage monitoring capability and a reliable loss of

phase alarm system for operations personnel in the control room. The design will be developed by considering operating experience from the U.S. operating fleet and worldwide operating reactors that have implemented various designs for loss of phase monitoring systems that will vary depending on their specific electrical system configurations.

AREVA commits to providing continuous monitoring of the power supply feeds to the EATs in order to address the vulnerabilities described in NRC bulletin 2012-01. The design will use commercially available state of the art non-safety related digital relaying. The monitoring system design will provide alarm functions to the operators, phase voltage monitoring, and will incorporate breaker interface design features. In order to incorporate the automatic trip function, operating reactor loss of phase monitoring system performance must prove reliable enough to support a decision to convert from just alarming to the automatic trip function.

This particular electrical system fault monitoring function presents a unique design challenge with regard to off-site power reliability when considering implementation of the automatic trip function for this very low frequency event. The potential for inadvertent loss of off-site power due to a spurious actuation caused by the phase monitoring system must be carefully considered. Spurious alarms would cause some operational challenges but can be easily dealt with, on the other hand a spurious loss of off-site power can also be dealt with but it could cause actual challenges to reactor safety systems which must be critically evaluated from an overall reactor safety perspective. The alarm indication(s) for an open-phase will be bounded by the automatic actions of the PS to respond to a degraded grid/loss voltage. The relay may not initiate any automatic actions for an open-phase, but the PS ultimately will.

GDC 17 states: An onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety. The safety function for each system (assuming the other system is not functioning) shall be to provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

The onsite electric power supplies, including the batteries, and the onsite electric distribution system, shall have sufficient independence, redundancy, and testability to perform their safety functions assuming a single failure.

Electric power from the transmission network to the onsite electric distribution system shall be supplied by two physically independent circuits (not necessarily on separate rights of way) designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. A switchyard common to both circuits is acceptable. Each of these circuits shall be designed to be available in sufficient time following a loss of all onsite alternating current power supplies and the other offsite electric power circuit, to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded. One of these circuits shall be designed to be available within a few seconds following a loss-of-coolant accident to assure that core cooling, containment integrity, and other vital safety functions are maintained.

Provisions shall be included to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear

power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies.

The U.S. EPR electrical system off-site power supply design as previously approved by NRC in SER ML090780504, dated August 20, 2009, incorporates design features which are unique relative to current operating plants:

- Each EAT has an independent off-site power feed
- The EATs only supply Safety Loads
- Each EAT has an OLTC on the high side to regulate Emergency Bus voltage
- Each EAT can power all four divisions of Safety Equipment
- A fast transfer scheme is incorporated into the design to transfer safety loads to the unaffected EAT should a fault occur in an EAT or a bus fault.
- Additionally, the existing degraded voltage monitoring system for the emergency buses will provide additional protection for the phase voltage condition based on results of the ETAP system analysis described above.

The preferred methods for providing automatic actions by the Phase Monitoring system for the U.S. EPR would be to initiate the fast transfer of Safety Loads by tripping the affected EAT. The August 20, 2009 SER states: "In Request for Additional Information (RAI) 11, Question 08.03.01-1, The Staff asked the applicant how the automatic fast transfer scheme works and how it prevents transfer into a faulted bus. The Staff also asked the applicant to elaborate on a single failure vulnerability of the transfer scheme between the motive (ac) and control power (dc) within the affected divisions. In an October 15, 2008, response, the applicant provided details on how the fast transfer between the EPSS buses to an alternate EAT initiates, and explained that the single point vulnerabilities that can affect the fast transfer are limited to those that will affect only a single division. Based on the applicant's detailed explanation of the fast transfer scheme, the staff finds that transfer to a faulted bus would be prevented. The applicant also explained that a similar transfer scheme is used for the NPSS busses, but it uses a supervised design that allows transfer to occur if it is within the phase angle limit or if it moves into the phase angle limit during the fast transfer enable window. The Staff confirmed that in Revision 1 of the design certification application, U.S. EPR FSAR Tier 2, Section 8.3.1.1.1 was revised, as committed in the RAI response, to eliminate the phrase "that results in a loss of voltage at a BDA bus." The purpose was to remove a limitation on the meaning of faulted bus to include more than the simple loss of voltage. The staff confirmed that Revision 1 of US EPR FSAR, dated May 29, 2009, contains the changes as committed in the RAI response. Accordingly, The Staff finds that the applicant has adequately addressed this issue, and it is, therefore, resolved."

This design approach will prevent unintended separation from the off-site power source due to a false indication from the Phase Monitoring System. Additionally, an interlock function will be incorporated such that if a safety injection SI signal is present coupled with a short time delay, to be determined in the detailed design, an automatic separation from the faulted off-site feed can be initiated by the phase monitoring system. The short time delay filter combined with the low frequency of SI initiation should minimize the potential for spurious separation from off-site power if a SI signal is initiated coincident with a Phase Monitoring System alarm.

Implementation of these design features will ensure continued compliance with GDC 17, and as accepted in the NRC SER ML090780504, August 20, 2009.

An ITAAC has been added to U.S. EPR FSAR Tier 1, Section 2.5.5 to address the Phase Monitoring System testing prior to plant startup.

Additional information on the offsite power system is provided in U.S. EPR FSAR Tier 2, Section 8.2.1.1. and 8.2.2.4.

Detection of an open phase and/or high impedance ground fault condition in the offsite circuits connected to the plant requires site specific information associated with the switchyard and the offsite power grid connections. Therefore, to address RAI 564, the COL item in U.S. EPR FSAR Tier 2 Section 8.2.1.1 and U.S. EPR FSAR Tier 2 Table 1.8-2 (Item 8.2-1) has been revised to specifically address and reference NRC Bulletin 2012-01. In addition, a COL item has been added to Section 8.2.2.4 and Table 1.8-2 (Item 8.2-9) for incorporation of a phase monitoring system for the two required GDC17 independent offsite power supplies to address and reference NRC Bulletin 2012-01.

**Item 2:**

The four 6.9kV EPSS buses are always powered by the EATs via at least two offsite circuits.

**Item 3:**

Specifics regarding operating procedure phase voltage monitoring are the responsibility of the combined license (COL) applicant (Refer to U.S. EPR FSAR Tier 2, Section 13.5). The AREVA open phase monitoring system design will incorporate the capability for operators to monitor the phase voltages of the off-site power supplies to the EATs and it will provide an alarm to alert operators to the loss of a phase in one of the off-site power feeds.

**FSAR Impact:**

U.S. EPR FSAR Tier 1, Section 2.5.5 and Table 2.5.5-1, and Tier 2, Sections 8.1.4.1, 8.2.1.1, 8.2.2.4, and 8.2.3, and Tables 1.8-2 and 8.2-1 were revised and incorporated in U.S. EPR FSAR Revision 5 as described in the response and indicated on the enclosed markups.

# U.S. EPR Final Safety Analysis Report Markups



**Table 1.8-2—U.S. EPR Combined License Information Items**  
**Sheet 20 of 40**

Item No.	Description	Section
8.1-2	A COL applicant that references the U.S. EPR design certification will identify site-specific loading differences that raise EDG or Class 1E battery loading, and demonstrate the electrical distribution system is adequately sized for the additional load.	8.1.3
8.2-1	<u>A COL applicant that references the U.S. EPR design certification will provide site-specific information regarding the offsite transmission system and connections to the station switchyard; including consideration of NRC Bulletin 2012-01 to address detection, notification, and clearing of an open single phase condition or high impedance ground fault in the offsite circuits.</u> <del>A COL applicant that references the U.S. EPR design certification will provide site-specific information regarding the offsite transmission system and their connections to the station SWYD.</del>	8.2.1.1
8.2-2	A COL applicant that references the U.S. EPR design certification will provide site-specific information for the switchyard layout design.	8.2.1.2
8.2-3	A COL applicant that references the U.S. EPR design certification will provide site-specific information that identifies actions necessary to restore offsite power and use available nearby power sources when offsite power is unavailable.	8.2.2.7
8.2-4	A COL applicant that references the U.S. EPR design certification will provide a site-specific grid stability analysis.	8.2.2.4
8.2-5	A COL applicant that references the U.S. EPR design certification will provide site-specific information for the protective devices that control the switchyard breakers and other switchyard relay devices.	8.2.1.2
8.2-6	A COL applicant that references the U.S. EPR design certification will provide site-specific information for the station switchyard equipment inspection and testing plan.	8.2.2.5
8.2-7	A COL applicant that references the U.S. EPR design certification will provide site specific information regarding the communication agreements and protocols between the station and the transmission system operator, independent system operator, or reliability coordinator/authority. Additionally, the applicant will provide a description of the analysis tool used by the transmission system operator to determine, in real time, the impact that the loss or unavailability of various transmission system elements will have on the condition of the transmission system to provide post-trip voltages at the switchyard. The information provided will be consistent with information requested in NRC generic letter 2006-02.	8.2.1.1



**Table 1.8-2—U.S. EPR Combined License Information Items**  
**Sheet 22 of 41**

Item No.	Description	Section
8.2-9	A COL applicant that references the U.S. EPR design certification will describe essential elements of a program for the operation and surveillance testing of the Phase Monitoring System for the GDC 17 off-site power feeds to address NRC Bulletin 2012-01.	8.2.2.4
8.3-1	A COL applicant that references the U.S. EPR design certification will establish procedures to monitor and maintain EDG reliability during plant operations to verify the selected reliability level target is being achieved as intended by RG 1.155.	8.3.1.1.5
8.3-2	A COL applicant that references the U.S. EPR design certification will describe inspection, testing and monitoring programs to detect the degradation of inaccessible or underground power cables that support EDGs, offsite power, ESW and other systems that are within the scope of 10 CFR 50.65.	8.3.1.1.9
8.4-1	A COL applicant that references the U.S. EPR design certification will provide site-specific information that identifies any additional local power sources and transmission paths that could be made available to resupply the power plant following a loss of offsite power (LOOP).	8.4.1.3
8.4-2	A COL applicant that references the U.S. EPR design certification will address the RG 1.155 guidance related to procedures and training to cope with SBO.	8.4.2.6.4
9.1-1	A COL applicant that references the U.S. EPR design certification will provide site-specific information on the heavy load handling program, including a commitment to procedures for heavy load lifts in the vicinity of irradiated fuel or safe shutdown equipment, and crane operator training and qualification.	9.1.5.2.5
9.1-2	A COL applicant that references the U.S. EPR design certification will perform appropriate tests and analyses, which demonstrate that an identified NRC-approved cask can be safely connected to the spent fuel cask transfer facility (SFCTF), and the cask and its adapter meet the criteria specified in Table 9.1.4-1, prior to initial fuel loading into the reactor.	9.1.4
9.2-1	A COL applicant that references the U.S. EPR design certification will provide site specific information for the UHS support systems such as makeup water, blowdown, and chemical treatment (to control biofouling).	9.2.5.2
9.2-2	A COL applicant that references the U.S. EPR design certification will provide site-specific details related to the sources and treatment of makeup to the potable and sanitary water system along with a simplified piping and instrument diagram.	9.2.4.2.1



## 2.5.5 Preferred (Offsite) Power Supply System

### Design Description

#### 1.0 System Description

The preferred (offsite) power system provides the preferred power to the Class 1E emergency power supply system (EPSS) via the emergency auxiliary transformers (EAT) and offsite power to the normal power supply system (NPSS) via the normal auxiliary transformers (NAT) during normal and abnormal operation.

#### 2.0 Arrangement

2.1 Deleted.

#### 3.0 Mechanical Design Features

3.1 Each EAT and NAT has an oil containment system.

3.2 Each EAT and NAT has a deluge fire protection system.

#### 4.0 Electrical Power Design Features

4.1 Each of the two required GDC 17 independent off-site power sources are monitored by a phase monitoring system that provides control room alarm and an automatic breaker control function. Deleted.

4.2 EAT power cables and instrumentation and control circuits are routed separately from NAT power cables and instrumentation and control circuits.

4.3 Each EAT and associated power cables are sized to power the EPSS safety-related and non-safety-related loads.

4.4 Each NAT and associated electrical bus is sized to power the connected NPSS non-safety-related loads.

#### 5.0 Interface Requirements

5.1 At least two independent circuits shall be supplied to the station switchyard by the offsite power transmission system.

5.2 Each offsite power circuit shall be sized to supply the station safety-related and non-safety-related loads during normal and off normal operation.

5.3 Each EAT shall be connected to the switchyard via an independent circuit, sized to supply the four EPSS divisions.

5.4 The maximum transmission system frequency decay rate is bounded by the RCP free coastdown for a complete loss of forced reactor coolant flow analysis due to a loss of offsite power event.



Table 2.5.5-1—Preferred (Offsite) Power Supply System ITAAC

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
2.1	Deleted.	Deleted.	Deleted.
3.1	Each EAT and NAT has an oil containment system.	An inspection will be performed to verify that each as-built EAT and NAT has an oil containment system.	Each EAT and NAT has an oil containment system.
3.2	Each EAT and NAT has a deluge fire protection system.	An inspection will be performed to verify that each as-built EAT and NAT has a deluge fire protection system.	Each EAT and NAT has a deluge fire protection system.
4.1	<u>Each of the two required GDC 17 independent off-site power sources are monitored by a phase monitoring system that provides control room alarm and an automatic breaker control function.</u> <del>Deleted.</del>	<u>A test will be performed to verify that the as-built phase monitoring system provides control room alarm and an automatic breaker control function.</u> <del>Deleted.</del>	<u>The phase monitoring system provides control room alarm and an automatic breaker control function of the each of the two required GDC 17 independent off-site power sources.</u> <del>Deleted.</del>
4.2	EAT power cables and instrumentation and control circuits are routed separately from NAT power cables and instrumentation and control circuits.	An inspection will be performed to verify that as-built EAT power cables and instrumentation and control circuits are routed separately from NAT power cables and instrumentation and control circuits.	The EAT power cables and instrumentation and control circuits are routed separately from NAT power cables and instrumentation and control circuits.
4.3	Each EAT and associated power cables are sized to power the EPSS safety-related and non-safety-related loads.	An inspection and analysis will be performed to verify as-built EAT cables and buses are sized to supply their assigned load requirements.	An equipment sizing analysis concludes EAT cables and buses are sized to supply analyzed load requirements.
4.4	Each NAT and associated electrical bus is sized to power the connected NPSS non-safety-related loads.	An inspection and analysis will be performed to verify as-built NAT cables and buses are sized to supply their assigned load requirements.	An equipment sizing analysis concludes NAT cables and buses are sized to supply analyzed load requirements.



The 12-hour uninterruptible power supply system (12UPS) provides uninterruptible power for non-safety-related Nuclear Island and Turbine Island loads, and instrumentation & control systems. Figure 8.3-6—12-Hour Uninterruptible Power Supply System Single Line Drawing shows system batteries, battery chargers, inverters, and system connections. The 12UPS battery chargers are powered from the SBODGs during loss of power conditions.

The non-Class 1E uninterruptible power supply system (NUPS) provides uninterruptible power for non-safety-related AC and DC Turbine Island loads and DC power to the control rod drive mechanism operating coils in the Nuclear Island. The NUPS batteries, battery chargers, and inverters are shown in Figure 8.3-7—Non-Class 1E Uninterruptible Power Supply System Single Line Drawing. The NUPS battery chargers are powered from the SBODGs during loss of power conditions.

### 8.1.3 Safety-Related Loads

The safety-related loads are normally powered from the PPS and are supplied standby power from the station EDGs. The safety-related AC loads are included in Table 8.3-4—Division 1 Emergency Diesel Generator Nominal Loads, Table 8.3-5—Division 2 Emergency Diesel Generator Nominal Loads, Table 8.3-6—Division 3 Emergency Diesel Generator Nominal Loads, and Table 8.3-7—Division 4 Emergency Diesel Generator Nominal Loads. Safety-related DC and inverter powered AC loads are included in Table 8.3-13—Division 1 Class 1E Uninterruptible Power Supply Nominal Loads, Table 8.3-14—Division 2 Class 1E Uninterruptible Power Supply Nominal Loads, Table 8.3-15—Division 3 Class 1E Uninterruptible Power Supply Nominal Loads, and Table 8.3-16—Division 4 Class 1E Uninterruptible Power Supply Nominal Loads. Safety function performed by safety-related loads is described in the applicable sections of Chapters 5, 6, 7, 8, and 9. A COL applicant that references the U.S. EPR design certification will identify site-specific loading differences that raise EDG or Class 1E battery loading, and demonstrate the electrical distribution system is adequately sized for the additional load.

### 8.1.4 Design Bases

#### 8.1.4.1 Offsite Power System

Station power is provided by a minimum of two offsite transmission lines, each with the capacity and capability to maintain core cooling and containment integrity, as well as other safety-related functions during postulated events. Each offsite source to the EPSS buses is immediately available in the event of a loss of the other offsite power source. To optimize GDC 17 compliance regarding operability of the offsite sources, a digital relay phase monitoring system measures phase voltages and currents at the input (high side) of the EATs and provides information in the control room to alert operators of a degraded condition in any phase of the offsite sources. The phase monitoring system provides alarms for loss of phase and high impedance line faults



that automatically trip the affected EAT upon detection of loss of phase and high impedance line fault. The tripped EAT initiates a fast transfer to maintain offsite power to all four divisions. Additionally, existing control logic in the protection system responds to the tripped EAT to allow the EDGs to supply reliable power to the affected emergency buses.

Physical separation is provided between the two offsite power sources to minimize the possibility of simultaneous failure during normal operations and postulated accident and environmental conditions.

The normal power supply to safety-related and non-safety-related loads is from the switchyard via the station auxiliary transformers. This arrangement permits supplying power to station loads without requiring bus transfers during startup and shutdown operations.

The EAT alignment to the Class 1E divisional buses utilizes no intervening non-Class 1E buses, and Class 1E buses do not share a common winding with the transformers supplying the non-Class 1E switchgear.

The NAT supply to the NPSS provides a normal and alternate offsite power supply to the non-safety-related plant loads.

Each EAT is normally aligned to two EPSS divisions and each serves as the alternate power source for the other two EPSS divisions. Each EAT is sized to provide power to loads in all four EPSS divisions under postulated design basis conditions.

The NATs are sized to provide power to the non-safety-related loads during power plant operations. Both NATs are normally in service. Each NAT is sufficient to power all four of the NPSS trains to allow for NAT maintenance or a transfer of a load due to a NAT failure.

#### **8.1.4.2 Onsite Power System**

The onsite Class 1E distribution system has the capacity and capability to supply power to the safety-related loads to mitigate design basis accident conditions with a concurrent loss of offsite power (LOOP).

The onsite Class 1E distribution system has four redundant divisions. This degree of redundancy maintains power to safety-related loads to complete required safety-related functions in the event of a single failure. Electrical independence and physical separation is provided between redundant onsite Class 1E distribution divisions so a failure in one division does not prevent safety-related function completion.

Each of the four onsite Class 1E distribution divisions consisting of switchgear, load centers, MCCs, batteries and inverters are contained in Seismic Category I structures.



## 8.2 Offsite Power System

### 8.2.1 Description

#### 8.2.1.1 Offsite Power

The offsite power system provides power from the transmission system, via the station switchyard, to the plant Class 1E and non-Class 1E electrical distribution system. The offsite power system includes all transmission lines connected to the switchyard, the switchyard equipment (overhead buses, circuit breakers, disconnect air switches), auxiliary transformers, and ends at the input terminals of the switchgear circuit breakers. The preferred power supply (PPS) is the offsite power from the transmission system to the Class 1E emergency power supply system (EPSS) that is preferred to provide power under accident and post-accident conditions. The offsite transmission system and connections to the station switchyard are site-specific. A COL applicant that references the U.S. EPR design certification will provide site-specific information regarding the offsite transmission system and connections to the station switchyard, including consideration of NRC Bulletin 2012-01 to address detection, notification, and clearing of an open single phase condition or high impedance ground fault in the offsite circuits (Reference 5).

The switchyard has connections to at least two transmission lines. The normally energized transmission lines are physically independent circuits that minimize the likelihood of their simultaneous failure under operating and environmental conditions and postulated events, including transmission tower or transmission line failure. These lines do not cross, and no other transmission lines cross above these two lines. Each offsite power circuit is sized to supply the station safety-related and non-safety-related loads during normal and abnormal operation.

The PPS supplies the station Class 1E EPSS buses from two independent overhead lines between the switchyard and the station transformer area via two emergency auxiliary transformers (EAT). The station remains connected to the offsite power sources during normal plant operation regardless of main generator status, without transferring buses or power sources during startup, full power operation, or shutdown. Each PPS circuit is normally in service through its respective EAT.

Two additional overhead lines provide power to two normal auxiliary transformers (NAT) for the station non-Class 1E normal power supply system (NPSS) buses.

Each auxiliary transformer is provided with two on-load tap changers to maintain the supplied bus voltage at the nominal value during transmission system voltage fluctuations, or voltage changes as a result of changes in bus loading. The reference voltage for the on-load tap changer operation is provided by voltage transformers at the respective bus to which the secondary winding is connected. Momentary bus voltage transients (e.g., motor starting) do not result in tap changers affecting bus



A COL applicant that references the U.S. EPR design certification will provide a site-specific grid stability analysis. The results of the analysis will demonstrate that:

- The PPS is not degraded below a level that will activate EPSS degraded grid protection actions after any of the following single contingencies:
  - U.S. EPR turbine-generator trip.
  - Loss of the largest unit supplying the grid.
  - Loss of the largest transmission circuit or inter-tie.
  - Loss of the largest load on the grid.
- The transmission system will not subject the reactor coolant pumps to a sustained frequency decay of greater than 3.5 Hz/s as bounded by the decrease in reactor coolant system flow rate transient and accident analysis described in Section 15.3.2.

The U.S. EPR is designed to operate within a transmission system operating voltage of  $\pm 10$  percent and not initiate the degraded voltage protection actions as described in Section 8.3.1.1.3. Degraded grid setpoints are provided in Chapter 16, Specification 3.3.1, Table 3.3.1-2. Regulation of the transmission system by the transmission system operator within these limits during normal operation and single contingencies provides sufficient voltage to safety-related loads during design basis events.

The PPS provides two circuits from the transmission system to the Class 1E distribution system through the station switchyard that are sized to supply the maximum expected coincident safety-related and non-safety-related loads during normal and abnormal operations as indicated in IEEE Std 308-2001 (Reference 2) and endorsed by RG 1.32.

[A COL applicant that references the U.S. EPR design certification will describe essential elements of a program for the operation and surveillance testing of the Phase Monitoring System for the GDC 17 off-site power feeds to address NRC Bulletin 2012-01.](#)

#### 8.2.2.5

#### Compliance with GDC 18

Offsite power complies with GDC 18. The offsite power system is designed to permit periodic testing and inspection of the system and components to assess its performance. A COL applicant that references the U.S. EPR design certification will provide site-specific information for the station switchyard equipment inspection and testing plan.

Surge arresters and the lightning protection system are capable of periodic inspection and testing as described in RG 1.204, Section C.2.



3. BTP 8-3, "Stability of Offsite Power Systems," U.S. Nuclear Regulatory Commission, Standard Review Plan, Branch Technical Position, Rev. 3, 2007.
4. BTP 8-6, "Adequacy of Station Electric Distribution System Voltages," U.S. Nuclear Regulatory Commission, Standard Review Plan, Branch Technical Position, Rev. 3, 2007.
5. [NRC Bulletin 2012-01, "Design Vulnerability in Electric Power System," U.S. Nuclear Regulatory Commission, July 2012.](#)



**Table 8.2-1—Offsite Power Failure Modes and Effects Analysis**  
Sheet 2 of 2

Item No.	Component Identification	Function	Failure Mode	Failure Mechanism	Effect On System Safety-Related Function	Remarks
3.	Single transmission line	Receives main generator output during plant operation, provides offsite power to plant loads during plant shutdown.	Loss of single transmission line to switchyard.	Fault or failure on transmission line.	None, system does not have a safety-related function.	Faulted transmission line is isolated by protective relaying. Service to the EATs and NATs is uninterrupted.
4.	PPS circuit from switchyard to EAT	Provides offsite power from the transmission system to the EPSS during normal, accident and post-accident conditions.	Loss of single circuit.	Circuit failure, including ground fault or short circuit. <u>Circuit failure, including open phase, high impedance ground, fault or short circuit.</u>	None, system does not have a safety-related function.	<u>Open phase alarmed in the control room.</u> Faulted circuit is isolated by protective relaying. Affected EPSS switchgear aligned to other EAT source via high speed transfer.
5.	Offsite power circuit from switchyard to NAT	Provides offsite power from the transmission system to the NPSS during normal and off normal conditions.	Loss of single circuit.	Circuit failure, including ground fault or short circuit.	None, system does not have a safety-related function.	Faulted circuit is isolated by protective relaying. Affected NPSS switchgear aligned to other NAT source via high speed transfer.