

**Response to**

**Request for Additional Information No. 19, Revision 0**

**07/09/2008**

**U. S. EPR Standard Design Certification**

**AREVA NP Inc.**

**Docket No. 52-020**

**SRP Section: 09.05.03 - Lighting Systems**

**Application Section: 9.5.3**

**EE Branch**

**Question 09.05.03-1:**

The staff finds that the applicant did not address the features related to effectiveness of control room lighting systems to support reliable human performance including evaluation with respect to the criteria specified in NUREG-0700. Address the staff's concern.

**Response to Question 09.05.03-1:**

In addition to the illumination levels for the main control room (MCR) lighting provided in U.S. EPR FSAR Tier 2, Section 9.5.3, the following features are provided for the MCR lighting to support reliable human performance in accordance with the guidance provided in NUREG-0700:

- To provide lighting uniformity, the level of illumination does not vary greatly over a given work station.
- Supplemental lighting is provided for personnel performing specialized visual tasks in areas where fixed illumination is not adequate.
- Task area luminance ratios provided in NUREG-0700 are not exceeded.
- Shadows are avoided.
- Glare is minimized so it does not interfere with readability of displays, labels, or indicators.
- Reflectance levels are in accordance with NUREG-0700.
- Surface colors are recognizable under both emergency lighting and special emergency lighting.
- Ambient illumination does not degrade the visibility of video display units or computer monitors.
- Colored ambient illumination is not used.
- There is no light source (direct or reflected) in the immediate surrounding area of video display units or computer monitors.

As described in U.S. EPR FSAR Tier 2, Section 18.7.5 the human factors engineering and control room design teams use a style guide for design of human system interface features, which includes issues such as lighting, to support reliable human performance.

**FSAR Impact:**

The U.S. EPR FSAR will not be changed as a result of this question.

**Question 09.05.03-2:**

Discuss special feature to be included in areas containing rotating equipment to eliminate the risk of stroboscopic effect caused by flicker.

**Response to Question 09.05.03-2:**

Stroboscopic effects caused from light flicker will be considered in the detailed layout of the lighting fixtures in relation to rotating equipment. Design considerations include:

- Using lamps with low flicker indexes.
- Using electronic ballasts having high-frequency or rectangular wave characteristics.
- Staggering lighting on alternate phases of the three-phase power supply to provide light pattern overlap.

The principal objective is to provide a safe working environment, in which the lighting system does not contribute to undesirable effects from light flicker. Other safety precautions such as equipment guards and shrouds will also be considered. Recommendations of ANSI/IESNA RP-7-01<sup>1</sup> will be considered in the detailed lighting layout.

**FSAR Impact:**

The U.S. EPR FSAR will not be changed as a result of this question.

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<sup>1</sup> ANSI/IESNA RP-7-01, "Recommended Practice for Lighting Industrial Facilities," Illuminating Engineering Society of North America, 2001.

**Question 09.05.03-3:**

Provide typical luminance ranges for normal lighting in all areas/rooms of the plant that are required for control and maintenance of equipment and plant access routes during normal plant operations.

**Response to Question 09.05.03-3:**

The typical illumination levels for normal lighting in plant areas and rooms required for control and maintenance of equipment and plant access routes during normal operations are provided in Table 9.5.3-3-1.

**Table 9.5.3-3-1—Nominal Illumination Levels**

| <b>Plant Area</b>                               | <b>Nominal Illumination Level<br/>(Foot-Candles)</b> |
|---|--|
| Emergency Power Generator Buildings             | 50   |
| Fuel Handling Building                          | 50   |
| Radiological Waste Processing Building          | 50   |
| Nuclear Auxiliary Building                      | 20   |
| Reactor Building                                | 50   |
| Safeguard Building (exception MCR, TSC and RSS) | 50   |
| Main Control Room                               | -----  |
| Operator's Workstation                          | 100  |
| SICS Panels                                     | 50   |
| Remote Shutdown Station                         | 100  |
| Technical Support Center                        | 100  |
| Turbine Building                                | 50   |
| Engineered Safety Features Equipment Rooms      | 50   |
| Count Room                                      | 100  |
| Laboratories                                    | 100  |
| Stairways and Corridors                         | 10   |
| HVAC Equipment Areas                            | 10   |
| Normal Exterior Areas                           | 5  |

**FSAR Impact:**

The U.S. EPR FSAR will not be changed as a result of this question.

**Question 09.05.03-4:**

FSAR, Rev. 0, Section 9.5.3.2.2 states that the emergency lighting system provides lighting in plant areas primarily containing safety-related equipment. Identify the areas besides MCR and RSS where the emergency lighting will be utilized.

**Response to Question 09.05.03-4:**

A response to the question will be provided by September 15, 2008.

**Question 09.05.03-5:**

FSAR, Rev. 0, Section 9.5.3.3 states that lighting fixtures located in the MCR and RSS are Seismic Category Criteria II. The staff finds that the lighting fixtures located in the vicinity of safety-related equipment in other areas may not be supported adequately so that they may adversely impact the safety-related equipment when subjected to seismic loading of a safe shutdown earthquake. Address the staff's concern.

**Response to Question 09.05.03-5:**

U.S. EPR structures, systems and components (SSC) that do not perform a safety-related function, but can fail under seismic loading and prevent or reduce the functional capability of a Seismic Category I SSC or cause incapacitating injury to main control room (MCR) occupants during or following a safe shutdown earthquake (SSE), are classified as Seismic Category II.

U.S. EPR SSC classified as Seismic Category II are designed to withstand SSE seismic loads without incurring a structural failure that permits deleterious interaction with any Seismic Category I SSC or results in an injury to MCR occupants.

U.S. EPR FSAR Tier 2, Section 9.5.3.3 will be changed to indicate, "Lighting fixtures located in the MCR and RSS, and also those located within close proximity of safety-related systems or components outside of the MCR and RSS, are classified Seismic Category II."

**FSAR Impact:**

U.S. EPR FSAR, Tier 2, Section 9.5.3.3 will be revised as described in the response and indicated on the enclosed markup.

**Question 09.05.03-6:**

Discuss the mounting (Seismic Category Criteria) requirements of battery pack emergency lighting fixtures.

**Response to Question 09.05.03-6:**

U.S. EPR structures, systems and components (SSC) seismic classification described in U.S. EPR FSAR Tier 2, Section 3.2.1 requires that SSCs which perform no safety-related function and could, if they failed under seismic loading prevent or reduce the functional capability of a Seismic Category I SSC, or cause incapacitating injury to main control room (MCR) occupants during or following a safe shutdown earthquake (SSE), be classified as Seismic Category II.

U.S. EPR SSCs which are classified as Seismic Category II are designed to withstand SSE seismic loads without incurring a structural failure that permits deleterious interaction with any Seismic Category I SSC or that could result in injury to MCR occupants.

Battery pack emergency lighting fixtures will be classified as described in U.S. EPR FSAR Tier 2, Section 3.2.1. For example, egress lighting fixtures located within close proximity to safety-related systems or components if they failed under seismic loading will be classified as Seismic Category II.

**FSAR Impact:**

The U.S. EPR FSAR will not be changed as a result of this question.

**Question 09.05.03-7:**

FSAR, Tier 2, Revision 0, Section 9.5.3.3 states that lighting fixtures in the MCR and RSS are Seismic Category Criteria II. Provide basis for Seismic Category Criteria II instead of Seismic Category Criteria I.

**Response to Question 09.05.03-7:**

The plant lighting system is non-safety-related. The Seismic Category II classification for the lighting fixtures located in the main control room (MCR) and remote shutdown station (RSS) meets the guidance provided in RG 1.29. Seismic Category II components are designed to withstand safe shutdown earthquake (SSE) seismic loads without incurring a structural failure that permits deleterious interaction with any Seismic Category I structures, systems and components (SSC) or that could result in injury to MCR occupants.

**FSAR Impact:**

The U.S. EPR FSAR will not be changed as a result of this question.



**Question 09.05.03-8:**

Adequate lighting is needed in areas requiring manual actions during an SBO event where emergency lighting is not installed. Provide a description of the available lighting to be provided (i.e. portable lighting) for this situation.

**Response to Question 09.05.03-8:**

The term station blackout (SBO) refers to a complete loss of alternating current (AC) electric power to the non-safety-related and safety-related switchgear buses. An SBO does not include loss of available AC power to buses fed by station batteries through inverters or by alternating AC sources specifically provided for SBO mitigation. The Class 1E uninterruptible power supply system (EUPS) and the station blackout diesel generators (SBODG) power lighting systems during an SBO event.

There are no identified areas in the U.S. EPR where manual actions are required during an SBO event where emergency lighting is not installed. At the onset of an SBO event, the special emergency lighting, which is powered by the EUPS batteries, maintains main control room (MCR) lighting for manual operator action in the MCR. Escape routing lighting provides illumination for the safe evacuation of personnel from plant rooms and buildings in areas such as stairwells, corridors, rooms, building exit ways and doors. The SBODGs automatically start on a loss of voltage on their associated non-safety-related buses (31BBH and 32BBH), and require no local operator action.

When failure of the emergency diesel generators is confirmed, indicating an SBO event, the SBODGs are manually aligned to their assigned emergency power supply system (EPSS) buses from the MCR within ten minutes from the onset of the SBO event. Alignment of the SBODGs to the EPSS buses restores power to the emergency lighting system and MCR lighting is restored to normal operation with both the emergency lighting and special emergency lighting systems illuminated. The EPSS buses that are restored by the SBODGs also support emergency lighting throughout plant areas as described in U.S. EPR FSAR Tier 2, Section 9.5.3.2.2.

EPSS bus restoration provides the capability to restore the EUPS battery chargers. If the battery chargers require manual realignment (refer to U.S. EPR FSAR Tier 2, Section 8.3.2.1.1.1), the emergency lighting powered by the restored EPSS buses provides the necessary lighting at the battery chargers to perform this task. The restoration of normal power supply system (NPSS) buses 31BBH and 32BBH and the supported motor control centers restores emergency lighting in the Switchgear Building area where the SBODGs are located to support operators monitoring SBODG performance.

In addition to information provided in U.S. EPR FSAR Tier 2, Section 8.4, the following items demonstrate that SBO mitigation efforts have adequate lighting for the limited operator action (in the MCR) and limited additional operator action outside the MCR to mitigate the SBO event:

- Emergency feedwater (EFW) pumps and valves use for SBO mitigation are either in the correct alignment for the event (e.g., EFW storage pool cross connect valves for pump suction), automatically controlled or manually operated from the MCR.

- Steam generator pressure is automatically maintained with the main steam relief train isolation and control valves.
- Reactor coolant pump stand still seal system isolation is automatically aligned.
- Chemical and volume control system letdown is manually isolated from the MCR.
- Heating, ventilation and air conditioning systems used for SBO event mitigation are aligned—Switchgear Building (for SBODG), Safeguard Buildings and reactor pit area cooling are manually aligned from the MCR.
- Containment isolation valves operated for SBO mitigation are manually operated from the MCR as appropriate.
- Reactor coolant system isolation for inventory losses (e.g., reactor coolant system sampling and pressurizer degas flow line) is manually performed from the MCR.

While the use of portable lighting is not anticipated for SBO event mitigation activities, portable lights are provided for the fire brigade as indicated in RG 1.189 and are available for use if necessary.

**FSAR Impact:**

The U.S. EPR FSAR will not be changed as a result of this question.

**Question 09.05.03-9:**

Section 9.5.3.5, "References" is incomplete. Illuminating Engineering Society of North America (IESNA) and IEEE Std. 384 should be included in Section 9.5.3.5

**Response to Question 09.05.03-9:**

The following references will be added to U.S. EPR FSAR Tier 2, Section 9.5.3.5:

2. IESNA HB-9, "Lighting Handbook Reference & Application – 9<sup>th</sup> Edition," Illuminating Engineering Society of North America, 2000.
3. IEEE Std 384-1992, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits," Institute of Electrical and Electronics Engineers, 1992.

The third sentence of the first paragraph of U.S. EPR FSAR Tier 2, Section 9.5.3.3 will be changed to add, "which is based on IESNA HB-9 (Reference 2)".

The second sentence of the fifth paragraph of U.S. EPR FSAR Tier 2, Section 9.5.3.3 will be changed to add, "(Reference 3)".

**FSAR Impact:**

U.S. EPR FSAR, Tier 2, Section 9.5.3.3 and 9.5.3.5 will be revised as described in the response and indicated on the enclosed markup.

**Question 09.05.03-10:**

FSAR, Tier 2, Section 9.5.3.1 states that isolation is provided for lighting systems powered from Class 1E sources by a Class 1E isolation device located at the MCC feed to the distribution panel. It is not clear to the staff whether a series of circuit breakers/fuses or single circuit breaker/fuse will be used. Provide clarification. Address how the requirements of RG 1.75 will be met. Revise Tier 1, Section 2.5.9 to include ITAAC reference for this item.

**Response to Question 09.05.03-10:**

A response to this question will be provided by September 15, 2008.

**Question 09.05.03-11:**

FSAR, Tier 2, Section 9.5.3.2.2 states that EPSS Division 2 and Division 3 power the emergency lighting system to provide approximately 67 percent of the MCR and RSS lighting. Section 9.5.3.2.3 states that EUPS Division 2 and division 3 power special emergency lighting to provide approximately 33 percent of the illumination in the MCR and RSS. Section 9.5.3.3 states that MCR and RSS workstations are illuminated to at least 50 foot-candles during normal operation when lighting is provided by the emergency lighting and special emergency lighting systems. The special emergency lighting system provides at least 10 foot-candles illumination in the MCR and RSS workstations for two hours when powered from the EUPS.

- (a) Is normal lighting (supplied by non-Class 1E power system) provided in the MCR and RSS?
- (b) What is the total illumination level in MCR and RSS?
- (c) Confirm that MCR and RSS workstations (seated operator station, reading, writing and data recording) are illuminated to 100 foot-candles (NUREG-0700) .
- (d) Explain the relationship of percentages and actual foot-candles (Explain how 67 percent and 33 percent corresponds to 50 foot-candles and 10 foot-candles respectively).

**Response to Question 09.05.03-11:**

- (a) Main control room (MCR) and remote shutdown station (RSS) lighting is provided by the emergency lighting system, which is powered by the emergency power supply system (EPSS), and the special emergency lighting system which is powered by the Class 1E uninterruptible power supply system (EUPS). The power supply for both these lighting systems is from a Class 1E power supply. There is not a non-Class 1E power supply that provides "normal" MCR or RSS lighting for ambient lighting during normal operating conditions.
- (b) The operator's stations in the MCR and the RSS have nominal illumination levels of 100 foot-candles.
- (c) The MCR and RSS workstations (seated operator station, reading, writing and data recording) are illuminated to 100 foot-candles.
- (d) The emergency lighting system provides approximately 67 percent of the normal illumination while the special emergency lighting system provides the remaining 33 percent. Both systems are normally in operation, providing the normal MCR and RSS lighting. During a loss of AC power, the special emergency lighting provides a minimum illumination of 10 foot-candles in accordance with NUREG-0700 recommendations for emergency lighting. As indicated with the above ratios, the special emergency lighting is expected to provide greater illumination than the minimum recommended.

U.S. EPR FSAR Tier 2, Section 9.5.3.3 will be changed to indicate, "The MCR and RSS workstations are illuminated to at least 100 foot-candles and the safety-related panels (e.g., safety information and control system panels as described in Section 7.1.1.3.1) are illuminated to at least 50 foot-candles during normal operation when lighting is provided by the emergency lighting and special emergency lighting systems."

U.S. EPR FSAR Tier 1, Section 2.5.9.3.3 will be changed to indicate, “The emergency lighting and special emergency lighting sub-systems provide illumination at the MCR and RSS workstations and safety-related panels.”

The commitment wording in U.S. EPR FSAR Tier 1, Table 2.5.9-1—Lighting System Inspections, Tests, Analyses and Acceptance Criteria, item 3.3 will be changed to indicate, “The emergency lighting and special emergency lighting sub-systems provide illumination at the MCR and RSS workstations and safety-related panels.”

U.S. EPR FSAR Tier 1, Table 2.5.9-1 acceptance criteria will be changed to indicate,

“a. The emergency lighting and special emergency lighting sub-systems provide at least 100 foot-candles illumination at the MCR workstations and at least 50 foot-candles at the safety-related panels.”

“b. The emergency lighting and special emergency lighting sub-systems provide at least 100 foot-candles illumination at the RSS workstations.”

**FSAR Impact:**

U.S. EPR FSAR, Tier 2, Section 9.5.3.3, Tier 1, Section 2.5.9.3.3 and Tier 1, Table 2.5.9-1 will be revised as described in the response and indicated on the enclosed markup.

**Question 09.05.03-12:**

FSAR Tier 2, Revision 0, Section 9.5.3 contains no design description of panel lighting in the MCR (Refer to NUREG-0700) at the safety-related panels. Provide a design description of panel lighting in the MCR or provide a technical basis for not doing so.

**Response to Question 09.05.03-12:**

The U.S. EPR main control room (MCR) consists of operator workstations (operator computer terminals), a limited number of safety information and control system (SICS) panels and plant overview panels from the process information and control system (PICS). The operator workstations are PICS screen based workstations, eliminating the need for the operator to move locations and operate equipment from a different location in the MCR. The SICS panels are the safety-related panels in the MCR. Plant overview panels are non-safety-related monitors that do not require lighting.

The emergency lighting and special emergency lighting systems provide the lighting in the MCR. This lighting is normally illuminated from these systems and is provided for normal and emergency operations in all areas in the MCR including the SICS panels. The SICS panels are provided with at least 50 foot-candle illumination from the emergency lighting and special emergency lighting systems.

**FSAR Impact:**

The U.S. EPR FSAR will not be changed as a result of this question.

**Question 09.05.03-13:**

Include the following in FSAR, Tier 1, Section 2.5.9 and revise Table 2.5.9-1 or provide a justification for not including the following: (1) The control room emergency and special emergency lighting system is electrically independent and physically separated, and (2) DC self-contained sealed-beam units provides illumination levels equal to or greater than those recommended by the IESNS in those areas of the plant required for power restoration and/or recovery from fire, for at least 8 hours.

**Response to Question 09.05.03-13:**

The electrical independence and physical separation between the emergency lighting and the special emergency lighting is in accordance with IEEE Std 384-1992<sup>1</sup>. Approximately 50 percent of the overall lighting in the main control room (MCR) from the emergency lighting and special emergency lighting systems is supplied from Division 2 emergency power supply system (EPSS) and Class 1E uninterruptible power supply system (EUPS), respectively. The other 50 percent of the overall lighting in the MCR from the emergency lighting and special emergency lighting is supplied from Division 3 EPSS and EUPS, respectively. Electrical independence and physical separation is provided between the Division 2 and Division 3 components and circuits. Electrical independence and physical separation is not needed between emergency lighting and special emergency lighting systems since these lighting systems are both powered from Class 1E power sources and they are powered from systems in the same division. Adequate lighting remains in service in the MCR if there is a loss of power from one division (e.g., both the emergency lighting and special emergency lighting from Division 2). If there is a loss of power from one division, the emergency lighting and special emergency lighting systems powered from the unaffected division provide adequate lighting. The approximate percentage of lighting provided in the MCR and RSS by each lighting system and division is shown in Table 9.5.3-13-1—MCR and RSS Lighting Power Sources.

**Table 9.5.3-13-1—MCR and RSS Lighting Power Sources**

| Power Source               | Approximate Lighting Percentage |     |
|----------------------------|---------------------------------|-----|
|                            | MCR                             | RSS |
| Emergency Lighting         |                                 |     |
| Div 2 EPSS                 | 34                              | 34  |
| Div 3 EPSS                 | 34                              | 34  |
| Special Emergency Lighting |                                 |     |
| Div 2 EUPS                 | 16                              | 16  |
| Div 3 EUPS                 | 16                              | 16  |
| Total                      | 100                             | 100 |

<sup>1</sup> IEEE Std 384-1992, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits," Institute of Electrical and Electronics Engineers, 1992.



U.S. EPR FSAR Tier 1, Section 2.5.9 will be changed to indicate,

- 3.5 Eight-hour battery pack emergency lighting fixtures provide illumination for post-fire shutdown activities performed by operators outside the MCR or RSS where emergency diesel generator backed lighting is not credited.

The commitment wording in U.S. EPR FSAR Tier 1, Table 2.5.9-1, will be changed to add item 3.5, "Eight-hour battery pack emergency lighting fixtures provide illumination for post-fire shutdown activities performed by operators outside the MCR or RSS where emergency diesel generator backed lighting is not credited." The inspection, test or analysis section for item 3.5 will indicate, "A test will be performed." the acceptance criteria will indicate, "Eight-hour battery pack emergency lighting fixtures provide at least one foot-candle for post-fire shutdown activities performed by operators outside the MCR or RSS where emergency diesel generator backed lighting is not credited."

**FSAR Impact:**

U.S. EPR FSAR, Tier 1, Section Section 2.5.9 and Tier 1, Table 2.5.9-1 will be revised as described in the response and indicated on the enclosed markup.

**Question 09.05.03-14:**

FSAR, Tier 1, Section 2.5.9, Subsection 2.1 states that lighting fixtures in the MCR are Seismic Category II and can withstand seismic design basis loads without affecting plant safety function. Section 9.5.3.3 states that lighting fixtures in the MCR and RSS are Seismic category criteria II. Modify Tier 1, Section 2.5.9, Subsection 2.1 and Table 2.5.9-1 to address lighting system in the MCR and RSS instead of lighting fixtures in the MCR only.

**Response to Question 09.05.03-14:**

U.S. EPR FSAR Tier 1, Section 2.5.9.2.1 will be changed to indicate, "Lighting fixtures in the MCR and RSS are Seismic Category II and can withstand seismic design basis loads without affecting plant safety functions."

The commitment wording in U.S. EPR FSAR Tier 1, Table 2.5.9-1—Lighting System Inspections, Tests, Analyses and Acceptance Criteria, item 2.1 will be changed to indicate, "Lighting fixtures in the MCR and RSS are Seismic Category II and can withstand seismic design basis loads without affecting plant safety functions."

Subpart (a.) in U.S. EPR FSAR Tier 1, Table 2.5.9-1 acceptance criteria will be changed to indicate, "A report exists and concludes that the MCR and RSS lighting fixtures are installed as designed."

Subpart (b.) in U.S. EPR FSAR Tier 1, Table 2.5.9-1 acceptance criteria will be changed to indicate, "A report exists and concludes that the MCR and RSS lighting fixtures can withstand seismic design basis loads without affecting plant safety functions."

**FSAR Impact:**

U.S. EPR FSAR Tier 1, Section 2.5.9 and Tier 1, Table 2.5.1-1 will be revised as indicated in the response to the question and shown in the attached FSAR markup.

**Question 09.05.03-15:**

FSAR, Tier 1, Table 2.5.9-1, Item 3.2, under Acceptance Criteria, RSS appears twice. First RSS should be changed to MCR.

**Response to Question 09.05.03-15:**

The first section in the acceptance criteria of U.S. EPR FSAR Tier 1, Table 2.5.9-1—Lighting System Inspections, Tests, Analyses and Acceptance Criteria, item 3.2 will be changed to indicate, “The special emergency lighting system provides lighting in the MCR and is powered from the EUPS.”

**FSAR Impact:**

U.S. EPR FSAR, Tier 1, Table 2.5.9-1 will be revised as described in the response and indicated on the enclosed markup.

**Question 09.05.03-16:**

From Section 9.5.3.2.2, it is not clear to the staff where eight hour battery pack emergency lighting units are used. RG 1.189 recommends 8-hour battery pack emergency lighting should be provided in areas needed for operation of safe shutdown equipment and access and egress routes thereto. Explain how you meet above recommendation or provide justification for not meeting RG 1.189 recommendation. Your explanation should include the areas where 8-hour battery pack emergency lighting will be provided.

**Response to Question 09.05.03-16:**

See the response to Question 09.05.01-20 regarding the use of battery powered lights with respect to RG 1.189 conformance.

U.S. EPR FSAR Tier 2, Section 9.5.3.2.2 will be revised to indicate, "Refer to Section 9.5.1 for use and location of emergency lighting for fire fighting and operator actions."

**FSAR Impact:**

U.S. EPR FSAR, Tier 2, Section 9.5.3.2.2 will be revised as described in the response and indicated on the enclosed markup.

**Question 09.05.03-17:**

Section 9.5.3.4 states that the escape route lighting and battery pack emergency lighting units are inspected and tested periodically. Identify the program which will address inspection and testing requirements.

**Response to Question 09.05.03-17:**

Routine maintenance and initial and periodic field testing of escape route lighting and battery pack emergency lighting units is performed to verify the units are capable of supporting egress and operational activities for the required time, accounting for anticipated environmental conditions, battery conditions and bulb life. Periodic testing of escape route lighting will meet the guidance of NFPA 101-2006<sup>1</sup> for periodic testing of emergency lighting equipment. Eight hour battery pack emergency lighting fixtures will be periodically tested to meet the guidance of RG 1.189. A testing program that meets the recommendations as developed by the Electric Power Research Institute for emergency battery lighting unit maintenance will verify the operation of the eight hour batteries and lighting units to perform their function.

U.S. EPR FSAR Tier 2, Section 9.5.3.4 will be changed to add, "Periodic testing of escape route lighting is in accordance with the guidance of NFPA 101-2006 (Reference 4) for periodic testing of emergency lighting equipment. Eight hour battery pack emergency lighting fixtures are periodically tested to meet the guidance of RG 1.189."

U.S. EPR FSAR Tier 2, Section 9.5.3.5 will be changed to add, "4. NFPA 101-2006, "Life Safety Code – 2006 Edition," National Fire Protection Association, 2005."

**FSAR Impact:**

U.S. EPR FSAR, Tier 2, Section 9.5.3.4 and Tier 2, Section 9.5.3.5 will be revised as described in the response and indicated on the enclosed markup.

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<sup>1</sup> NFPA 101-2006, "Life Safety Code – 2006 Edition," National Fire Protection Association, 2005.

# U.S. EPR Final Safety Analysis Report Markups

## 2.5.9 Lighting System

### 1.0 Description

The lighting system (LGT) includes the emergency lighting and special emergency lighting sub-systems. The non-safety-related functions provided by these two sub-systems include providing main control room (MCR) and remote shutdown station (RSS) lighting for normal and off normal operation.

### 2.0 Mechanical Design Features, Electrical and Seismic Classifications

9.5.3-14

2.1 Lighting fixtures in the MCR and RSS are Seismic Category II and can withstand seismic design basis loads without affecting plant safety functions.

### 3.0 Electrical Considerations

3.1 Emergency lighting in the MCR and RSS is powered from the emergency power supply system (EPSS).

9.5.3-11

3.2 Special emergency lighting in the MCR and RSS is powered from the Class 1E uninterruptible power supply system (EUPS).

3.3 The emergency lighting and special emergency lighting sub-systems ~~combined~~ provide ~~at least 50 foot-candles~~ illumination at the MCR and RSS workstations and safety-related panels.

3.4 The special emergency lighting system provides at least ten foot-candles illumination at the MCR and RSS workstations.

3.5 Eight-hour battery pack emergency lighting fixtures provide illumination for post-fire shutdown activities performed by operators outside the MCR or RSS where emergency diesel generator backed lighting is not credited.

9.5.3-13

### 4.0 Inspection, Tests, Analyses and Acceptance Criteria

4.1 Table 2.5.9-1—Lighting System Inspections, Tests, Analyses and Acceptance Criteria provides the ITAAC for the LGT.

**Table 2.5.9-1 Lighting System Inspections, Tests, Analyses and Acceptance Criteria (2 Sheets)**

|     | <b>Commitment <u>Wording</u></b>   | <b>Inspection, Test or Analysis</b>  | <b>Acceptance Criteria</b>   |
|-----|--|--|--|
| 2.1 | <p>Lighting fixtures in the MCR and RSS can withstand seismic design basis loads without affecting plant safety functions.</p> | <p>a. An inspection will be performed.<br/>b. Type testing, analysis, or a combination of type testing and analysis will be performed.</p> | <p>a. A report exists and concludes that the MCR and RSS lighting fixtures are installed as designed.<br/>b. A report exists and concludes that the MCR and RSS lighting fixtures can withstand seismic design basis loads without affecting plant safety functions.</p> |
| 3.1 | <p>Emergency lighting in the MCR and RSS is powered from the EPSS.</p>   | <p>A test will be performed.</p>   | <p>The emergency lighting system provides lighting in the MCR and is powered from the EPSS.<br/>The emergency lighting system provides lighting in the RSS and is powered from the EPSS.</p>   |
| 3.2 | <p>Special emergency lighting in the MCR and RSS is powered by the EUPS.</p>   | <p>A test will be performed.</p>   | <p>The special emergency lighting system provides lighting in the RSS and MCR and is powered from the EUPS.<br/>The special emergency lighting system provides lighting in the RSS and is powered from the EUPS.</p>   |

9.5.3-14

9.5.3-15,  
9.5.3-11



**Table 2.5.9-1 Lighting System Inspections, Tests, Analyses and Acceptance Criteria (2 Sheets)**

|     | <b>Commitment <u>Wording</u></b>  | <b>Inspection, Test or Analysis</b> | <b>Acceptance Criteria</b>   |
|-----|---|-------------------------------------|--|
| 3.3 | The emergency lighting and special emergency lighting sub-systems <del>combined</del> provide <del>at least 50 ft-candles</del> illumination at the MCR and RSS workstations <u>and safety-related panels</u> .                   | A test will be performed.           | <p>a. The emergency lighting and special emergency lighting sub-systems provide at least <del>50 ft-</del><u>100 foot-candles illumination</u> at the MCR <del>operator</del>-workstations <u>and at least 50 foot-candles at the safety-related panels</u>.</p> <p>b. The emergency lighting and special emergency lighting sub-systems provide at least <del>50 ft-</del><u>100 foot-candles illumination</u> at the RSS <del>operator</del>-workstations.</p> |
| 3.4 | The special emergency lighting system provides at least ten foot-candles illumination at the MCR and RSS workstations.  | A test will be performed.           | The special emergency lighting system provides at least ten foot-candles at the MCR operator workstation when it is the only MCR lighting system in operation. The special emergency lighting system provides at least ten foot-candles at the RSS operator workstation when it is the only RSS lighting system in operation.  |
| 3.5 | <u>Eight-hour battery pack emergency lighting fixtures provide illumination for post-fire shutdown activities performed by operators outside the MCR or RSS where emergency diesel generator backed lighting is not credited.</u> | <u>A test will be performed.</u>    | <u>Eight-hour battery pack emergency lighting fixtures provide at least one foot-candle for post-fire shutdown activities performed by operators outside the MCR or RSS where emergency diesel generator backed lighting is not credited.</u>  |

9.5.3-11



9.5.3-13



**9.5.3.2.1 Normal Lighting**

The normal lighting system provides lighting in plant buildings and site areas to support normal operation and plant maintenance activities. The system lighting distribution panels are supplied from the non-Class 1E normal power supply system (NPSS). The NPSS provides a source of interruptible power during normal plant operation. In the event power is lost from the NPSS, normal lighting is lost until NPSS power is restored. The normal lighting fixtures are distributed with the emergency lighting system fixtures in areas served.

**9.5.3.2.2 Emergency Lighting**

The emergency lighting system provides lighting in plant areas primarily containing safety-related equipment. The system is supplied with interruptible power from the EPSS and the NPSS. EPSS supply to emergency lighting is emergency diesel generator (EDG) backed. SBODG alignment to EPSS buses will also restore emergency lighting. Emergency lighting fixtures powered from the EPSS are normally illuminated and provide lighting for normal operation, control and maintenance of safety-related equipment used for implementing plant safe shutdown, and ~~firefighting~~ fire fighting.

Emergency lighting fixtures powered by the NPSS provide SBODG backed lighting in the switchgear building to support station blackout operations.

The emergency lighting system combines with the normal lighting to provide illumination levels that support operation and maintenance activities during normal operation. The amount of lighting provided by the emergency lighting system is determined by the amount of safety-related equipment in the area being served, with a higher percentage of lighting being supplied by the emergency lighting system in areas that have safety-related equipment.

EPSS Division 2 and Division 3 power the emergency lighting system to provide approximately 67 percent of the MCR and RSS lighting. During abnormal conditions that result in a loss of offsite power to the EPSS buses, MCR lighting from the emergency lighting system is interrupted until power is restored by the EDGs or SBODGs.

9.5.3-16

~~Battery pack emergency lighting fixtures are fixed, self-contained sealed beam units with eight hour battery packs. The batteries are charged from the NPSS during normal operation. The lighting fixtures provide lighting for operation of safety-related equipment for implementing plant safe shutdown, firefighting, and access routes to the MCR and RSS. Refer to Section 9.5.1 for use and location of emergency lighting for fire fighting and operator actions.~~

**9.5.3.2.3 Special Emergency Lighting**

EUPS Division 2 and Division 3 powers special emergency lighting to provide approximately 33 percent of the illumination in the MCR and RSS. The system provides lighting during normal operation and sufficient lighting during abnormal operation.

The EUPS system provides an uninterruptible source of power to the special emergency lighting fixtures while the EDGs are starting and connecting to the EPSS buses. In the event of a sustained loss of power to the emergency lighting system, the EUPS system provides a two hour power supply.

**9.5.3.2.4 Escape Route Lighting**

Escape route lighting provides illumination for safe evacuation of personnel from plant rooms and buildings when normal lighting is lost.

The fixtures are self-contained battery-backed sealed beam units maintained in a charged condition by the NPSS. The battery-backup automatically provides power during power interruption for at least 90 minutes following loss of normal power. The fixtures are installed in plant traffic areas such as stairwells, corridors, and building exit ways.

**9.5.3.2.5 Security Lighting**

Security lighting requirements in support of the physical security plan are described in Section 13.6.

**9.5.3.3 Safety Evaluation**

The plant lighting system is non-safety related. However, emergency lighting and special emergency lighting provide illumination for operations during anticipated operational occurrences; egress lighting is provided by escape route lighting for the safe evacuation of plant personnel during conditions where normal lighting is de\_energized. The special emergency lighting system powered from the EUPS system provides the minimum illumination levels, as indicated in NUREG-0700 (Reference 1) which is based on IESNA HB-9 (Reference 2), in the MCR and RSS for emergency operations. The two hour EUPS duration permits MCR operator response actions, including restoring normal offsite power, starting the EDGs, or aligning the SBODGs to the EPSS during station blackout conditions. EDG and SBODG supply to the EPSS restores emergency lighting in the MCR and plant areas containing safety-related equipment.

9.5.3-9

A single failure will not prevent the plant lighting systems from providing sufficient lighting throughout the plant areas. Table 9.5.3-1—Plant Lighting Failure Modes and

Effects Analyses, demonstrates plant lighting capability during single component failure.

9.5.3-5

Lighting fixtures located in the MCR and RSS, and also those located within close proximity of safety-related systems or components outside of the MCR and RSS, are classified Seismic Category Criteria-II.

Emergency lighting and special emergency lighting circuits to lighting fixtures in the MCR and RSS are routed through Seismic Category Criteria-I cable raceways or conduits.

Normal, emergency, and special emergency lighting circuits are fed from their respective lighting panels and are physically separated from each other. Lighting circuits are electrically isolated from Class 1E circuits by the use of isolation devices and separation distance as indicated in IEEE Std 384-1992 (Reference 3). Where required when separation distances cannot be met, the circuits will be separated by a barrier. Additionally, where normal, emergency, and special emergency lighting circuits share common areas, lighting circuits are color coded so that the lighting circuits are readily distinguishable.

9.5.3-9

The MCR and RSS workstations are illuminated to at least 50100 foot-ftcandles and the safety-related panels (e.g., safety information and control system panels as described in Section 7.1.1.3.1) are illuminated to at least 50 foot-candles during normal operation when lighting is provided by the emergency lighting and special emergency lighting systems.

9.5.3-11

The special emergency lighting system provides at least 10 ftfoot-candles illumination in the MCR and RSS workstations for two hours when powered from the EUPS.

**9.5.3.4 Inspection and Testing Requirements**

- Plant lighting fixtures are continuously energized and require no periodic testing. Visual inspections are periodically performed to detect and replace faulty lighting equipment.

9.5.3-17

- Escape route lighting and battery pack emergency lighting units are periodically inspected and tested to verify proper operation including battery capacity and integrity of the charging mechanism. Periodic testing of escape route lighting is in accordance with the guidance of NFPA 101-2006 (Reference 4) for periodic testing of emergency lighting equipment. Eight-hour battery pack emergency lighting fixtures are periodically tested to meet the guidance of RG 1.189.

**9.5.3.5 References**

1. NUREG-0700, "Human-System Interface Design Review Guidelines," Revision 2, U.S. Nuclear Regulatory Commission, May 2002.

9.5.3-9

2. IESNA HB-9, "Lighting Handbook Reference & Application – 9th Edition," Illuminating Engineering Society of North America, 2000.
3. IEEE Std 384-1992, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits," Institute of Electrical and Electronics Engineers, 1992.

4. NFPA 101-2006, "Life Safety Code – 2006 Edition," National Fire Protection Association, 2005.

9.5.3-17