

2.4.11 Boron Concentration Measurement System

Design Description

1.0 System Description

The boron concentration measurement system (BCMS) measures the boron concentration in the chemical and volume control system (CVCS).

The BCMS has the following safety-related function:

- Sends boron concentration measurement signals to the signal conditioning and distribution system (SCDS).

2.0 Arrangement

2.1 The location of the BCMS equipment is as listed in Table 2.4.11-1—Boron Concentration Measurement System Equipment.

3.0 Mechanical Design Features

3.1 Equipment identified as Seismic Category I in Table 2.4.11-1 can withstand seismic design basis loads without a loss of safety function(s).

4.0 I&C Design Features, Displays, and Controls

4.1 The BCMS provides output signals to the recipients listed in Table 2.4.11-2—Boron Concentration Measurement System Output Signals.

4.2 Class 1E BCMS equipment listed in Table 2.4.11-1 can function when subjected to electromagnetic interference (EMI), radio-frequency interference (RFI), electrostatic discharges (ESD), and power surges.

4.3 Locking mechanisms are provided on the BCMS cabinet doors. BCMS cabinet doors that are not closed are indicated on the PICS operator workstations in the MCR.

4.4 The BCMS is designed so that safety-related functions required for an anticipated operational occurrence (AOO) or postulated accident (PA) are performed in the presence of the following:

- Single detectable failures within the BCMS concurrent with identifiable but non-detectable failures.
- Failures caused by the single failure.
- Failures and spurious system actions that cause or are caused by the AOO or PA requiring the safety function.

5.0 Electrical Power Design Features

5.1 Equipment designated as Class 1E in Table 2.4.11-1 are powered from the Class 1E division as listed in Table 2.4.11-1 in a normal or alternate feed condition.

6.0 Environmental Qualifications

6.1 Equipment designated as harsh environment in Table 2.4.11-1 can perform their function under normal environmental conditions, anticipated operational occurrences, and accident and post-accident environmental conditions.

6.2 Equipment designated as mild environment in Table 2.4.11-1 can perform their function under normal environmental conditions, anticipated operational occurrences, and accident and post-accident environmental conditions.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.4.11-3 lists the BCMS ITAAC.

Table 2.4.11-1—Boron Concentration Measurement System Equipment
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| Description | Tag Number⁽¹⁾ | Location | Seismic Category | IEEE Class 1⁽²⁾ | Environment |
|--|---------------------------------|----------------------|-------------------------|-----------------------------------|--------------------|
| Boron Concentration Sensor Division 1 | 30KBA34CQ857A | Fuel Building | I | 1 ^N 2 ^A | Harsh |
| Boron Concentration Sensor Division 2 | 30KBA34CQ857B | Fuel Building | I | 2 ^N 1 ^A | Harsh |
| Boron Concentration Sensor Division 3 | 30KBA34CQ858B | Fuel Building | I | 3 ^N 4 ^A | Harsh |
| Boron Concentration Sensor Division 4 | 30KBA34CQ858A | Fuel Building | I | 4 ^N 3 ^A | Harsh |
| Temperature Sensor Division 1 | 30KBA34CT857A | Fuel Building | I | 1 ^N 2 ^A | Harsh |
| Temperature Sensor Division 2 | 30KBA34CT857B | Fuel Building | I | 2 ^N 1 ^A | Harsh |
| Temperature Sensor Division 3 | 30KBA34CT858B | Fuel Building | I | 3 ^N 4 ^A | Harsh |
| Temperature Sensor Division 4 | 30KBA34CT858A | Fuel Building | I | 4 ^N 3 ^A | Harsh |
| Boron Concentration Measurement Conditioning Cabinets Division 1 | 30CLE23 | Safeguard Building 1 | I | 1 ^N 2 ^A | Mild |
| Boron Concentration Measurement Conditioning Cabinets Division 2 | 30CLF23 | Safeguard Building 2 | I | 2 ^N 1 ^A | Mild |
| Boron Concentration Measurement Conditioning Cabinets Division 3 | 30CLG23 | Safeguard Building 3 | I | 3 ^N 4 ^A | Mild |

**Table 2.4.11-1—Boron Concentration Measurement System Equipment
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| Description | Tag Number ⁽¹⁾ | Location | Seismic Category | IEEE Class 1 ⁽²⁾ | Environment |
|--|---------------------------|----------------------|------------------|----------------------------------|-------------|
| Boron Concentration Measurement Conditioning Cabinets Division 4 | 30CLH23 | Safeguard Building 4 | I | 4 ^N 3 ^A | Mild |

1. Equipment tag numbers are provided for information and are not part of the design certification.
2. ^N denotes the division the equipment is normally powered from. ^A denotes the division the equipment is powered from when alternate feed is implemented.

Table 2.4.11-2—Boron Concentration Measurement System Output Signals

| Item # | Output Signal | Recipient | # Divisions |
|---------------|---------------------------------|------------------|--------------------|
| 1 | Boron Concentration Measurement | SCDS | 4 |

**Table 2.4.11-3—Boron Concentration Measurement System ITAAC
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| Commitment Wording | | Inspections, Tests, Analyses | Acceptance Criteria |
|--------------------|---|--|---|
| 2.1 | The location of the BCMS equipment is as listed in Table 2.4.11-1. | An inspection of the location of the as-built BCMS equipment will be performed. | The BCMS equipment listed in Table 2.4.11-1 is located as listed in Table 2.4.11-1. |
| 3.1 | Equipment identified as Seismic Category I in Table 2.4.11-1 can withstand seismic design basis loads without a loss of safety function(s). | <p>a. Type tests, analyses, or a combination of type tests and analyses will be performed on the equipment identified as Seismic Category I in Table 2.4.11-1 using analytical assumptions, or under conditions, which bound the Seismic Category I design requirements.</p> <p>b. An inspection will be performed of the as-built equipment identified as Seismic Category I in Table 2.4.11-1 to verify that the equipment, including anchorage, are installed in a condition bounded by the tested or analyzed condition.</p> | <p>a. Test/analysis reports conclude that the equipment identified as Seismic Category I in Table 2.4.11-1 can withstand seismic design basis loads without a loss of safety function(s).</p> <p>b. Inspection reports conclude that the equipment identified as Seismic Category I in Table 2.4.11-1, including anchorage, are installed in a condition bounded by the tested or analyzed condition.</p> |
| 4.1 | The BCMS provides output signals to the recipients listed in Table 2.4.11-2. | A test will be performed to verify that the BCMS provides output signals to the recipients listed in Table 2.4.11-2. | The BCMS provides output signals to the recipients listed in Table 2.4.11-2. |
| 4.2 | Class 1E BCMS equipment listed in Table 2.4.11-1 can perform its safety function when subjected to EMI, RFI, ESD, and power surges. | Type tests or type tests and analyses will be performed to demonstrate that the Class 1E BCMS equipment listed in Table 2.4.11-1 can perform its safety function when subjected to EMI, RFI, ESD, and power surges. | Equipment identified as Class 1E in Table 2.4.11-1 can perform its safety function when subjected to EMI, RFI, ESD, and power surges. |

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| Commitment Wording | | Inspections, Tests, Analyses | Acceptance Criteria |
|---------------------------|--|---|--|
| 4.3 | <p>Locking mechanisms are provided on the BCMS cabinet doors. BCMS cabinet doors that are not closed are indicated on the PICS operator workstations in the MCR.</p> | <p>a. A test will be performed to verify that the locking mechanisms on the BCMS cabinet doors operate properly.</p> <p>b. A test will be performed to verify that BCMS cabinet doors that are not closed are indicated on the PICS operator workstations in the MCR.</p> | <p>a. The locking mechanisms on the BCMS cabinet doors operate properly.</p> <p>b. BCMS cabinet doors that are not closed are indicated on the PICS operator workstations in the MCR.</p> |
| 4.4 | <p>The BCMS is designed so that safety-related functions required for an AOO or PA are performed in the presence of the following:</p> <ul style="list-style-type: none"> ● Single detectable failures within the BCMS concurrent with identifiable but non-detectable failures. ● Failures caused by the single failure. ● Failures and spurious system actions that cause or are caused by the AOO or PA requiring the safety function. | <p>A failure modes and effects analysis will be performed on the BCMS at the level of replaceable modules and components.</p> | <p>A report concludes that the BCMS is designed so that safety-related functions required for an AOO or PA are performed in the presence of the following:</p> <ul style="list-style-type: none"> ● Single detectable failures within the BCMS concurrent with identifiable but non-detectable failures. ● Failures caused by the single failure. ● Failures and spurious system actions that cause or are caused by the AOO or PA requiring the safety function. |
| 5.1 | <p>Equipment designated as Class 1E in Table 2.4.11-1 are powered from the Class 1E division as listed in Table 2.4.11-1 in a normal or alternate feed condition.</p> | <p>a. Testing will be performed by providing a test input signal in each normally aligned division.</p> <p>b. Testing will be performed by providing a test input signal in each division with the alternate feed aligned to the divisional pair.</p> | <p>a. The test input signal provided in the normally aligned division is present at the respective Class 1E equipment identified in Table 2.4.11-1.</p> <p>b. The test input signal provided in each division with the alternate feed aligned to the divisional pair is present at the respective Class 1E equipment identified in Table 2.4.11-1.</p> |

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| | Commitment Wording | Inspections, Tests, Analyses | Acceptance Criteria |
|-----|--|---|--|
| 6.1 | <p>Equipment designated as harsh environment in Table 2.4.11-1 can perform their function under normal environmental conditions, anticipated operational occurrences, and accident and post-accident environmental conditions.</p> | <p>a. Type tests or type tests and analysis will be performed to demonstrate the ability of the equipment designated as harsh environment in Table 2.4.11-1 to perform their function under normal environmental conditions, containment test conditions, anticipated operational occurrences, and accident and post-accident environmental conditions.</p> <p>b. An inspection will be performed of the as-built equipment designated as harsh environment in Table 2.4.11-1 to verify that the equipment, including the associated cables, wiring, and terminations located in a harsh environment, are bounded by the type test or combination of type tests and analyses.</p> | <p>a. EQDPs conclude that the equipment designated as harsh environment in Table 2.4.11-1 can perform their function under normal environmental conditions, containment test conditions, anticipated operational occurrences, and accident and post-accident environmental conditions, including the time required to perform the listed function.</p> <p>b. A report exists and concludes that the equipment designated as harsh environment in Table 2.4.11-1, including the associated cables, wiring, and terminations located in a harsh environment, are bounded by the type test or combination of type tests and analyses.</p> |

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| | Commitment Wording | Inspections, Tests, Analyses | Acceptance Criteria |
|-----|---|---|---|
| 6.2 | <p>Equipment designated as mild environment in Table 2.4.11-1 can perform their function under normal environmental conditions, anticipated operational occurrences, and accident and post-accident environmental conditions.</p> | <p>a. Type tests or type tests and analysis will be performed to demonstrate the ability of the equipment designated as mild environment in Table 2.4.11-1 to perform their function under normal environmental conditions, anticipated operational occurrences, and accident and post-accident environmental conditions.</p> <p>b. An inspection will be performed of the as-built equipment designated as mild environment in Table 2.4.11-1 to verify that the equipment, including the associated cables, wiring, and terminations located in a mild environment, are bounded by the type test or combination of type tests and analyses.</p> | <p>a. EQDPs conclude that the equipment designated as mild environment in Table 2.4.11-1 can perform their function under normal environmental conditions, anticipated operational occurrences, and accident and post-accident environmental conditions, including the time required to perform their function.</p> <p>b. A report exists and concludes that the equipment designated as mild environment in Table 2.4.11-1, including the associated cables, wiring, and terminations located in a mild environment, are bounded by the type test or combination of type tests and analyses.</p> |