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Title

# E3S Case Chapter 8: Electrical Power

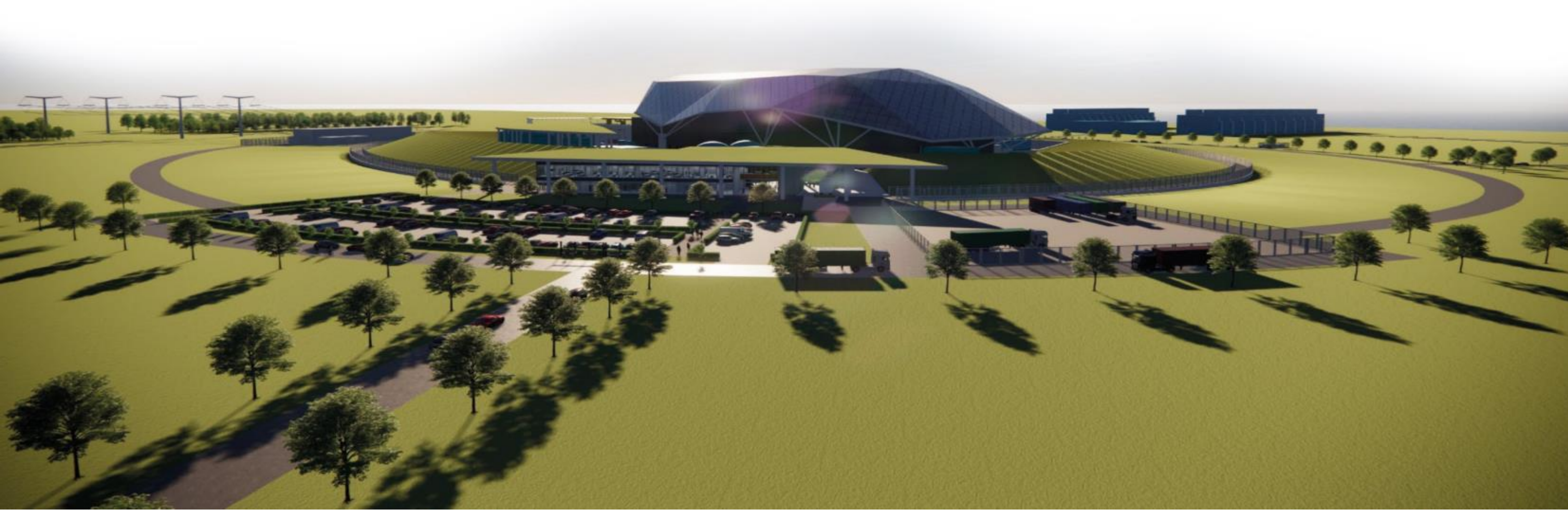

## Executive Summary

This chapter of the Environment, Safety, Security, and Safeguards (E3S) Case presents the electrical systems of the Rolls-Royce Small Modular Reactor (RR SMR). The report outlines the arguments and preliminary evidence available at the Preliminary Concept Definition (PCD) design stage to underpin the high-level Claim that the RR SMR electrical systems are designed and substantiated to achieve functional and non-functional safety requirements and reduce risks to As Low As Reasonably Practicable (ALARP).

The high-level principles and design rules that inform the electrical systems architecture are presented. A high-level overview of the electrical sub-systems architecture and the functions they deliver is also provided.

The full suite of evidence to underpin the Claim is still in development that will be reported in future revisions of the E3S Case, including requirements definition and traceability to the Fault Schedule, detailed design definition for each system presented (and additional electrical systems not covered in this revision), and ultimately verification evidence to support substantiation of safety requirements.



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# 8.0 Introduction

## 8.0.1 Introduction to Chapter

Chapter 8 of the Rolls-Royce Small Modular Reactor (RR SMR) Environment, Safety, Security & Safeguards (E3S) Case forms part of the Pre-Construction Safety Report (PCSR) and is a supporting reference to the Generic Environment Report (GER) and Generic Security Report (GSR), as defined in E3S Case Chapter 1: Introduction, Reference [1].

Chapter 8 presents the overarching summary and entry point to the design information for the Electrical Power Systems of the RR SMR, as defined at Reference Design (RD) 5 level of design maturity.

## 8.0.2 Scope

The electrical systems and sub-systems within the scope of this chapter is presented in Section 8.10 (Appendix A), including those that are within scope but excluded from this revision due to design immaturity.

For the Electric, Control & Instrumentation System (EC&I) [E01] (referred to as the 'Electrical Systems' in this report), the scope covers the Grid Transmission System [A] and the Electrical Power System [B]. It also includes the sub-systems Generator Transmission Main Connection [MS], Lighting Systems [XQ] and the Earthing & Lightning Protection System [XF], noting these are of limited maturity in this report.

For the Generic Design Assessment (GDA), only the safety classified aspects of these systems are covered in the E3S Case, i.e. Safety Class 1, 2, and 3 systems. The E3S Categorisation & Classification scheme for RR SMR is outlined in E3S Chapter 3: E3S Objectives & Design Rules, Reference [2].

***Design/Programme Maturity***

RR SMR design information presented in this revision of the PCSR is largely based on the design definition at the end of Preliminary Concept Definition (PCD), which is an interim design stage representing RD5 level of design maturity.

At PCD, the report covers the high-level design rules and principles that are being developed into safety requirements to inform the design of the electrical systems, including the key design principles for the cabling system and cable route. A high-level overview of the Electrical Power System [B] sub-systems architecture and the functions they deliver is also provided, with a limited overview of the Grid Transmission System [A].

As the design develops beyond PCD, further evidence will be generated (see Section 8.0.3), including definition of safety categorised functional requirements and non-functional system requirements, further design development and definition of electrical systems and sub-systems to achieve requirements, and ultimately substantiation of requirements.

## 8.0.3 Claims, Arguments, Evidence Route Map

The Chapter level Claim for E3S Case Chapter 8: Electrical Power is:

***Claim 8: The RR SMR Electrical Systems are designed and substantiated to achieve functional and non-functional safety requirements, and reduce risks to As Low As Reasonably Practicable (ALARP)***

A decomposition of this Claim into Sub-Claims, Arguments, and link to the relevant Tier 2 Evidence will be presented in future revision of this report. The complete suite of evidence to underpin the Claims in the E3S Case will be generated through the RR SMR design and E3S Case programme and documented in the Claims-Arguments-Evidence (CAE) Route Map, Reference [3], described further in E3S Case Chapter 1: Introduction, Reference [1].

## 8.0.4 Applicable Regulations, Codes & Standards

***Statutory Regulations***

The following relevant United Kingdom (UK) statutory regulations are identified for the Electrical Systems:

1. Electrical Safety, Quality and Continuity Regulations 2002 (as amended)
2. The Building Regulations 2000 (as amended) for England and Wales
3. The Electricity at Work Regulations 1989 (as amended)
4. The Supply of Machinery (Safety) Regulations 1992 (as amended)
5. The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002
6. The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996
7. Construction (Design and Management) Regulations 2015

### *Codes and Standards*

The Electrical Power Systems summarised in this report are designed in accordance with the codes, standards and legislation outlined in Table 8.0-1.

**Table 8.0-1: Electrical Power Systems Codes and Standards**

| Title of the Code/Standard/Legislation | Code/Standard Reference |
|---|---|
| Rotating electrical machines | International Electrotechnical Commission (IEC) 60034 |
| Power transformers | IEC 60076 |
| High-voltage switchgear and control gear | IEC 62271 |
| Low-voltage switchgear and control gear | IEC 60947 |
| Semiconductor converters | IEC 60146-1-1: 2009 |
| Instrumentation systems important to safety – Electrical penetration assemblies in containment structures | IEC 60772:2018 |
| Uninterruptible Power Systems (UPS) | IEC 62040 |
| Protection against lightning | IEC 62305 |
| Requirements for electrical installations. Institution of Engineering and Technology (IET) Wiring Regulations (UK) | British Standard (BS) 7671 |
| Safety of machinery - General principles for design – Risk assessment and risk reduction | International Organization for Standardization (ISO) 12100 |
| Safety of machinery - Safety-related parts of control systems | ISO 13849 |
| Safety of machinery. Electrical equipment of machines | European Standard adopted as a British Standard (EN) 60204 |
| Electromagnetic compatibility (EMC) | IEC 61000 |
| Nuclear power plants - Electrical systems - General requirements | IEC 63046 |
| Nuclear power plants - Electrical power systems - Electrical power systems analysis | IEC 62855 |
| Nuclear power plants - Instrumentation and control systems important to safety - Requirements for electrical supplies | IEC 61225 |
| Nuclear facilities - Electrical equipment important to safety - Qualification | IEC/IEEE 60780-323 |

| Title of the Code/Standard/Legislation | Code/Standard Reference |
|---|---|
| Recommended Practices for Seismic Qualification of Electrical Equipment of the Safety System for Nuclear Generating Stations | IEC 60980 |
| Nuclear power plants - Instrumentation and control systems important to safety – Separation | IEC 60709 |

## 8.1 Description of Electrical System

The Electrical Systems for RR SMR include the grid connection, site wide electrical distribution, turbine-generator control, monitor and protection functions and emergency power supplies.

The key functions of the Electrical Systems are:

1. To transmit electrical power from the main generator to the grid connection point
2. To supply electrical power to site loads (i.e., any Structures, Systems and Components (SSCs) that require electrical power to provide a safety function during all plant states)

To achieve these functions, the Electrical Systems comprise:

1. Conductors (i.e., cables and busbars) to transmit power
2. Power transformers to step-up and step-down voltages throughout the site
3. Switching equipment (circuit breakers, fuses, and isolators) to configure the power system and to prevent hazardous conditions such as overcurrent or earth fault
4. Backup generators to supply power to essential loads during loss of other supplies
5. Energy storage systems to supply short-term power demands of essential equipment and
6. Control & Instrumentation (C&I) to control, monitor and protect the electrical equipment

The Electrical Systems also provide functions relating to equipotential bonding, earthing, lightning protection and lighting.

The architecture of the Electrical Systems is determined primarily by non-functional requirements e.g., requirements for reliability and availability of the system for both power export and site power supplies, see Section 8.1.

At PCD, the nature and extent of the site electrical loads and their requirements for the reliability and availability of power supplies to them are still in development. As such, the current architecture is based on available load information and standard architectures from the International Atomic Energy Agency (IAEA) and Relevant Good Practice (RGP) and Operating Experience (OPEX) of existing nuclear plants.

A series of Single Line Diagrams (SLDs) representing the key Electrical Power Systems [B] has been developed, illustrated in Section 8.11 (Appendix B), including:

1. Key SLD Electrical Power System, Reference [4]
2. Unit Board BBA01 SLD, Reference [5]
3. Unit Board BBA02 SLD, Reference [6]
4. Unit Board BBA03 SLD, Reference [7]

## 8.2 General Principles & Design Approach

Early in the design process, a set of design rules was established to inform the early electrical systems architecture and performance development. As the design progresses, the design rules will be aligned to the E3S Design Principles, Reference [8], and developed into non-functional system requirements through relevant Dynamic Object-Oriented Requirements System (DOORS) modules for each system.

Some of the key aspects of the design rules are expected to include (not exhaustive):

1. Independent and diverse electrical systems for each level of Defence in Depth (DiD) to reduce the potential for Common Cause Failure (CCF) (the five levels of DiD for the RR SMR are described in E3S Case Chapter 3: E3S Objectives & Design Rules, Reference [2])

2. Appropriate levels of redundancy in the design of electrical systems, including sufficient redundancy to meet the single failure criterion for Class 1 systems

3. Physical segregation between redundant trains, or different safety classes within a train

4. Electrical separation to ensure a highly classified system is not compromised by a system of a lower classification

5. Electrical systems are classified corresponding to the categorised safety functions they perform, in accordance with the E3S Categorisation & Classification methodology described in E3S Case Chapter 3: E3S Objectives & Design Rules, Reference [2]

6. Electrical systems are qualified to achieve their safety requirements

7. Electrical systems are initiated automatically without the need for operator intervention

8. Electrical systems important to safety are designed to be fail-safe

9. Design includes minimal complexity and supports the concept of modularisation

10. The Availability, Reliability and Maintainability (ARM) of an electrical system is equivalent to (or higher than) its dependent loads

11. The design facilitates Examination, Maintenance, Inspection & Testing (EMIT) without having a significant detrimental impact on availability

12. Technology and equipment selection for the electrical systems considers protection from obsolescence and

13. Design considers the 60-year life of the RR SMR and ageing management, such as increased design margins

## 8.3 Off-site Power Systems

### 8.3.1 Grid Transmission System & Generator Transmission Main Connection

The primary purpose of the Grid Transmission System [A] is to import and export power from the RR SMR to an external grid. Two off-site power connections are intended in the design, a primary connection for the import/export of power and an auxiliary connection for redundancy.

The primary and secondary connections are single 400kV connections and will interface with the Generator Transmission Main Connection [MS] and the Station Transformer [BCT] within the Power Transmission System [B]. This is shown on the SLD in Figure 8.10-1.

The Grid Transmission System [A] and the Generator Transmission Main Connection [MS] are currently in development, the safety requirements and architecture will be reported in a future revision of the E3S Case as evidence is developed in line with the CAE Route Map, Reference [3].

# 8.4 Onsite Power Systems

## 8.4.1 Normal Onsite Power Supply

***Overview***

Normal onsite power for Design Basis Conditions (DBC) DBC-1 and DBC-2 is provided by the High Voltage (HV) Electrical Supply Systems [BB/BC], comprising:

1. HV Auxiliary Power Transformers [BBT/BCT], each with a single winding input and dual winding output. The Unit Transformer [BBT] derives supplies from the Main Generator [MKA] or main grid connection. The Station Transformer [BCT] derives its supplies directly from the auxiliary grid connection and

2. 11 kV Electrical Supply System [BBA], comprising three Unit Boards that are normally supplied by the Unit Transformer [BBT]. This can also be supplied by the Station Transformer [BCT] if the main generator or main grid connection are unavailable. The system will power the largest loads, such as the Reactor Coolant Pumps, in addition to providing the normal power supplies to all other 11 kV switchboards and to auxiliary transformers to supply the 0.4 kV systems.

The SLDs for the HV Electrical Supply System [BB] are illustrated in Section 8.11 (Appendix B). Further details will be reported in a future revision of the E3S Case as the HV Electrical Supply System [BB] design develops.

## 8.4.2 Standby AC Power Supply

***System & Equipment Functions***

The Standby Alternating Current (AC) Power Supply comprises the HV Essential Supply System [BD], including the switchgear, cable/busbar systems, generator sets, transformers and control and protections equipment.

The Standby AC Power Supply provides backup power to SSCs during DBC-3 Loss of Off-site Power (LOOP) fault conditions, for which it will form part of the overall Safety Measure that delivers the Fundamental Safety Functions (FSFs) of Control of Reactivity (CoR), Control of Fuel Temperature (CoFT) and Confinement of Radioactive Material (CoRM).

The following sub-systems are currently defined for the Standby AC Power Supply:

1. 11 kV Essential Supply System [BDA], comprising two Unit Emergency Boards downstream of the Unit Boards, which will supply the safety systems in abnormal and faulted conditions. In the event of a LOOP fault coincident with a loss of Main Generator [MKA], the Standby AC Power Source [BDV] can supply the Unit Emergency Boards. The two divisions are independent and segregated to minimise the potential for CCF.
2. High Voltage Power Generation System [BDV] – is the two onsite Standby AC Power Sources, which will power safety systems in the event of a LOOP fault. They will be connected to the two Unit Emergency Boards to power essential loads, with power also distributed to the Low Voltage Electrical Supply Systems [BK/BL]. The Standby AC Power Sources [BDV] are independent and segregated from one another to minimise the potential for CCF

***Design Basis***

Postulated Initiating Events (PIEs) for LOOP are currently being derived in the Fault Schedule, which is presented in E3S Case Chapter 15: Safety Analysis, Reference [9]. These will be based on the durations and Initiating Event Frequencies (IEFs) specified in E3S Case Chapter 2: General Site Characteristics, Reference [10], including:

1. Short term LOOP of 2 hours duration, with an IEF of 5 x 10-2/year

2. Medium term LOOP of 24 hours duration, with an IEF of 5 x 10-3/year and

3. Long term LOOP of 168 hours duration, with an IEF of 5 x 10-5/year

Specific safety-categorised functional requirements derived from the Fault Schedule and non-functional system requirements derived from the E3S Principles (as outlined in Section 8.1) will be reported in a future revision of the E3S Case as evidence is developed in line with the CAE Route Map, Reference [3].

The Standby AC Power Supply is expected to supply emergency power to Safety Class 2 SSCs, as such, it is currently baselined as a Safety Class 2 system in line with the Categorisation & Classification methodology outlined in E3S Case Chapter 3: E3S Objectives & Design Rules, Reference [2].

### 8.4.3 Alternate AC Power Supply

***System & Equipment Functions***

The requirement for an Alternate AC Power Supply that is independent to the Standby AC Power Source is currently being explored, to provide backup power to SSCs during DBC-4 Station Blackout (SBO) fault conditions.

Given the passive nature of the safety systems currently identified for an SBO fault (such as the Emergency Core Cooling System (ECCS)), significant electrical loads are not anticipated. The need for an Alternate AC Power Supply will therefore be determined as the design develops.

Provision within the Electrical Power System [B] architecture has been made for one or more alternate power sources through the Low Voltage Alternate Supply System [BL]. If needed, the design of this system will be developed, and further details will be reported in a future revision of the E3S Case as evidence is developed.

Provision is also made within the Electrical Power System [B] architecture for temporary power connection points to give additional flexibility in supplying power during loss of power events.

### 8.4.4 Uninterruptible Power Supply

***System and Equipment Functions***

The UPS for the RR SMR currently comprises the following systems, including Low Voltage (LV) switchgear, cable systems, inverters, batteries and battery chargers:

1. Uninterruptible AC Supply System [BM]

2. LV Direct Current (DC) Main Supply System [BP]

3. LV DC Electrical Supply Systems for Safety Services [BQ/BR]

The system provides backup power to SSCs demanded during LOOP and SBO fault conditions, including Reactor Island Control & Protection Systems [JY], such as the Hardwired Diverse Protection System (DPS) and the Reactor Protection System (RPS), as well as other essential equipment such as fire alarms and radiation monitors.

***Design Basis***

PIEs for SBO are currently being derived in the Fault Schedule, which is presented in E3S Case Chapter 15: Safety Analysis, Reference [9]. Specific safety categorised functional requirements derived from the Fault Schedule and non-functional system requirements derived from the E3S Principles (as outlined in Section 8.1) will be reported in a future revision of the E3S Case as evidence is developed in line with the CAE Route Map, Reference [3].

Classification of the UPS is still to be undertaken in line with the Categorisation & Classification methodology outlined in E3S Case Chapter 3: E3S Objectives & Design Rules, Reference [2], with classification aligned to the classification of the system it supplies.

# 8.5 Electrical Equipment, Cables & Raceways

## 8.5.1 Key Design Principles

The power station and associated works cabling system provide the infrastructure that enables the transfer of electrical power and C&I signals between all plant and equipment, including plant cables, C&I cables, and earthing cables.

Specific design principles for the cabling system and cable route are being developed and are expected to include principles such as:

1. All cabling shall last the design life of the plant without replacement
2. Cabling system shall be arranged to facilitate inspection
3. HV and LV cable distribution system shall be designed to allow installation of an additional 30% cables, including a provision on the design of cable ducts, racking and trays, to allow in service inspection/replacement of damaged cables
4. Cable route shall minimise power cable sizes by reducing inter-cable heating, and consequential derating
5. Cable route will separate C&I and power cables
6. Minimisation of installed cable route lengths
7. Cable routes shall ensure the cables they support can fulfil their post-accident safety functions
8. Bulk cable routes shall not pass-through plant areas, personnel access routes or through other areas subject to high levels of pedestrian traffic
9. Cables shall be routed to avoid harsh environments such as areas of high temperature, high radiation, or areas subject to chemical exposure, or be designed to withstand the environment in which they are located
10. Cables within one safety division shall be segregated and electrically independent from cables of other safety divisions
11. Segregation shall be provided between all safety class 1 and safety class 2 divisions
12. Non-safety circuits shall remain separated from safety circuits and
13. Where cables of one safety division are to be routed within another safety division then additional protective measures shall be provided. Instances of cable routing through other divisions shall be minimised

## 8.6 Earthing, Lightning Protection & Electromagnetic Compatibility

### 8.6.1 Earthing

The RR SMR Electrical Systems will feature earthing and isolation points, the requirements for which will be informed by the design in addition to regulations and standards. This includes a need for fixed earthing and isolation points across the Electrical System. The location and number of these earthing and isolation points will be dictated by the safety rules and the hazards presented by the system when carrying out maintenance and other work activities.

Manual isolation of equipment is expected in addition to the ability to detect faulty equipment and automatically isolate said equipment while notifying operators of the fault. The automatic removal of faulty equipment from the active plant supports the operational goals based on the availability of the RR SMR.

Electrical operation and maintenance studies will be used to inform requirements, including the need for and location of earthing and isolation points. Hazard identification studies will be undertaken to challenge and verify suitable controls are in place for the different operating modes, switchboard configurations and abnormal operating scenarios.

### 8.6.2 Earthing and Lightning Protection System

At PCD, the Earthing and Lightning Protection System [XF] is still in development.

### 8.6.3 Electromagnetic Compatibility

At PCD, the overall approach to ensuring electromagnetic compatibility is still in development.

# 8.7 Main Equipment Types

## 8.7.1 Introduction

This section is intended to cover details of the main equipment types such as transformers, switchgear, batteries and power converters. At this issue of the E3S Case, example information is provided for transformers, with similar information to follow for other equipment types in future revisions of the E3S Case as evidence is developed.

## 8.7.2 Transformers

The RR SMR site will incorporate a range of transformers that have varied physical properties from large oil-filled power transformers to smaller distribution transformers.

Smaller, cast resin distribution transformers typically have exposed conductors at ground level. The transformers will require segregation in their own fire rated room, with access control and interlocks to prevent access until the circuit is deenergised and earthed. Fire detection and suppression equipment may be used to protect adjacent equipment and the integrity of any building they are located in.

Larger oil filled transformers will require segregation and appropriate blast protection with controlled access. The larger power transformers shall be fitted with on-load tap changing equipment and expected to undergo on-load tap changes as the safer method of carrying out this maintenance work.

The design will maximise the use of installed condition monitoring equipment on power transformers to support predictive and preventative maintenance processes to maintain availability. HV and LV switchgear will include appropriate protection and segregation, with a clear set of operating procedures.

# 8.8 Conclusions

## 8.8.1 ALARP in Design Development

The design of the Electrical Power System [B] is being developed in accordance with the systems engineering design process, which includes alignment to RGP & OPEX, design to codes and standards according to the safety classification, and a systematic optioneering process with down-selection of design options based on assessment against relevant E3S criteria (as described in E3S Case Chapter 1: Introduction, Reference [1]).

At PCD, key design decisions to inform the Electrical Power System [B] design development in line with reducing risks to ALARP include:

1. Optioneering of the Standby AC Power Supply architecture has resulted in two redundant divisions each powered by a single power source for the baseline design, on the basis that it aligns to RGP & OPEX for Class 2 systems on other Pressurised Water Reactor (PWR) designs and it aligns to the Class 2 two-train safety systems that it will supply power to during a LOOP (e.g., High-Pressure Injection System (HPIS)). Additional options for power source arrangements, such as dual redundant power sources for each division or an additional Class 3 'spare' power source, remain open with further optioneering and down-selection as the design matures. Technology options for the Standby AC Power Supply power sources also remain open at PCD, with options including diesel generators, gas turbine generators and generators using low emissions fuel being explored; and

2. The architecture of the UPS to supply the Reactor Island C&I systems has been developed to ensure appropriate redundancy and resilience to faults. The selected design option ensures that every essential RR SMR system will be given its own battery-backed supply if required, with no sharing of batteries across different classified C&I systems or other essential systems. This follows RGP and OPEX from the E3S Principles and electrical codes and standards and aligns to electrical systems in other PWR designs. The Reactor Safety C&I and the essential switchboards will also incorporate 50% dual parallel redundant batteries, to provide further resilience and ensure that failure in one division will still allow loads to be supplied.

## 8.8.2 Conclusions

Preliminary evidence is presented to support the overall claim that 'The RR SMR Electrical Systems are designed and substantiated to achieve functional and non-functional safety requirements, and reduce risks to ALARP, which contributes to the overall E3S objective to protect people and the environment from harm, and the demonstration that risks are reduced ALARP.

The full suite of underpinning evidence will be developed in line with CAE Route Map and reported in future revisions of the E3S Case. For the Electrical Systems, this will include assigned safety categorised functional requirements and non-functional system requirements, associated architecture to meet requirements including design decisions supporting ALARP, and ultimately the verification activities/evidence to support substantiation of the requirements.

### 8.8.3 Assumptions & Commitments on Future Dutyholder/Licensee

None identified at this revision.

## 8.9 References

[1] RR SMR Report, SMR0004294/001, “E3S Case Chapter 1: Introduction,” March 2023.

[2] RR SMR Report, SMR0004589/001, “E3S Case Chapter 3: E3S Objectives & Design Rules,” March 2023.

[3] RR SMR Report, SMR0002155/001, “E3S Case Route Map,” March 2023.

[4] RR SMR Report, SMR0001400/001, “Key Single Line Diagram: Electrical Power System,” July 2022.

[5] RR SMR Report, SMR0001401/001, “Unit Board BBA01 Single Line Diagram,” July 2022.

[6] RR SMR Report, SMR0001402/001, “Unit Board BBA02 Single Line Diagram,” July 2022.

[7] RR SMR Report, SMR0001403/001, “Unit Board BBA03 Single Line Diagram,” July 2022.

[8] RR SMR Report, SMR0001603/001, “Environment, Safety, Security and Safeguarding Design Principles,” August 2022.

[9] RR SMR Report, SMR0003977/001, “E3S Case Chapter 15: Safety Analysis,” March 2023.

[10] RR SMR Report, SMR0004542/001, “E3S Case Chapter 2: Generic Site Characteristics,” March 2023.

# 8.10 Appendix A: SSCs in Scope of Chapter 8

Table 8.10-1 lists those SSCs that are within the scope of Chapter 8, and the section of the report in which they are addressed.

**Table 8.10-1: SSCs in Scope of PCSR**

| RDS-PP | SSC | Section Addressed within Chapter 8 |
|---|---|---|
| A | Grid Transmission System | Section 8.3.1 |
| AC | Interface to Grid Transmission System | |
| B | Power Transmission System | Section 8.4.1 |
| BB/BC | HV Electrical Supply Systems 1 & 2 | |
| BD | HV Essential Supply System | Section 8.4.2 |
| BF | LV Electrical Main Supply System for Process Equipment | TBC |
| BG | LV Electrical Main Supply System for Non-Process Equipment | |
| BK | LV Essential Supply System | Section 8.4.3 |
| BL | LV Alternate Supply System | |
| BM | Uninterruptible AC Supply System | Section 8.4.4 |
| BP | LV DC Electrical Main Supply System | |
| BQ/BR | LV DC Electrical Supply Systems 1 & 2 for Safety Services | |
| MS | Generator Transmission Main Connection | Section 8.3.1 |
| XF | Earthing and Lightning Protection System | Section 8.6 |
| XQ | Lighting Systems | This functionality was broken out under a standalone system code after PCD, so this system is listed for completeness, but there are no specific references to the XQ system in this issue of the E3S Case Chapter 8 |

# 8.11 Appendix B: Single Line Diagrams

## 8.11.1 Single Line Diagrams for Electrical Power System [B]

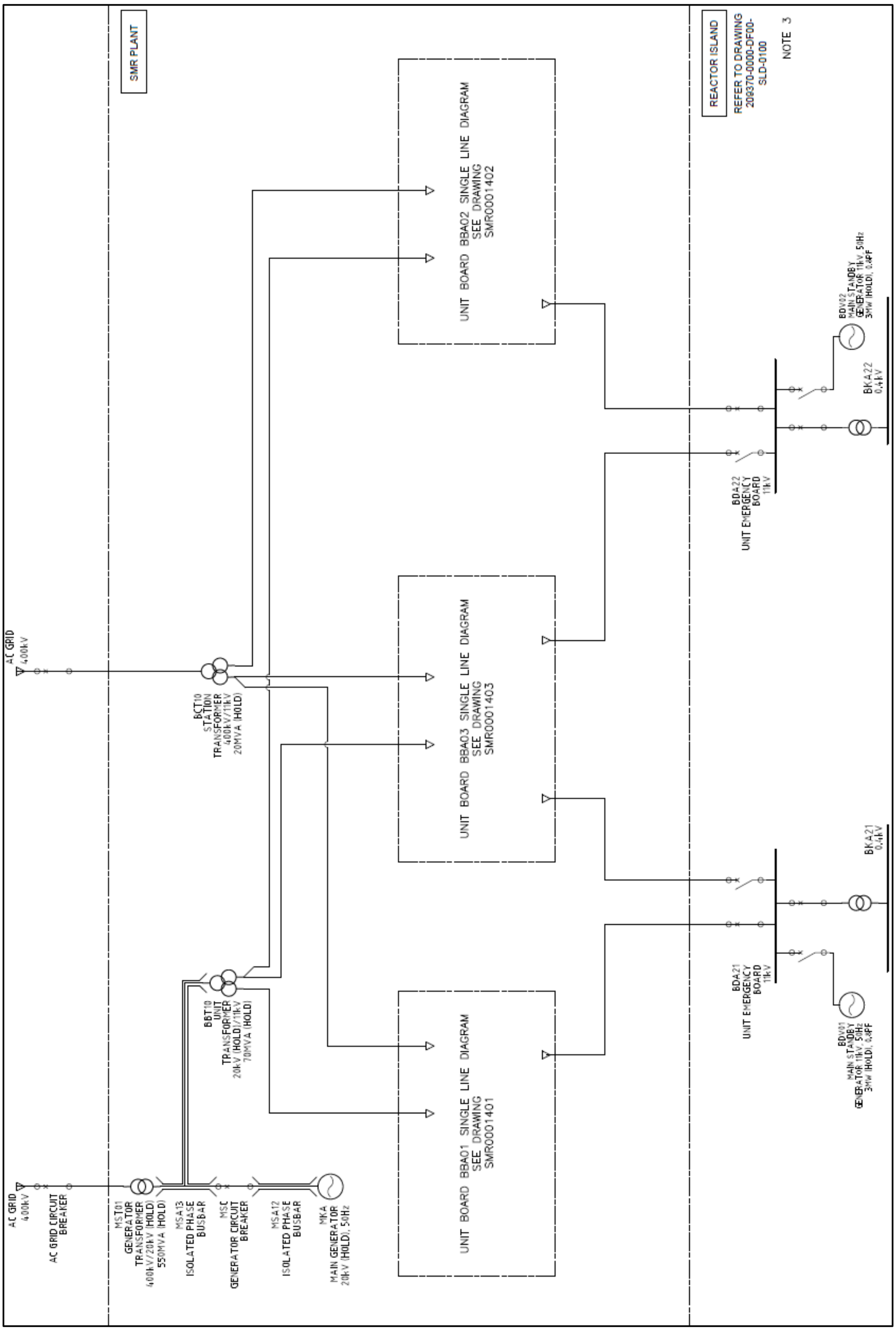


**Figure 8.10-1: Key Single Line Diagram for Electrical System**

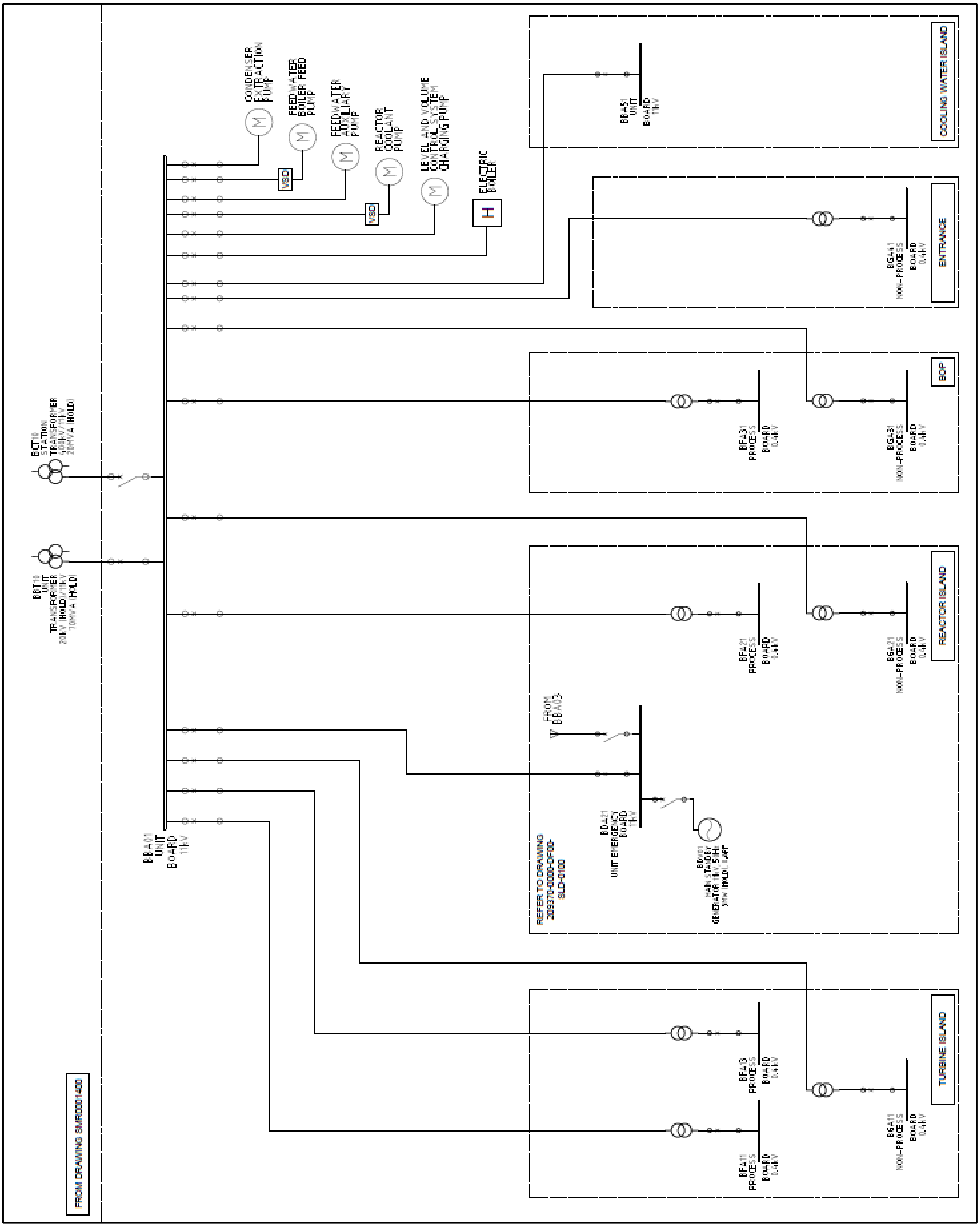


**Figure 8.10-2: Single Line Diagram for BBA01**

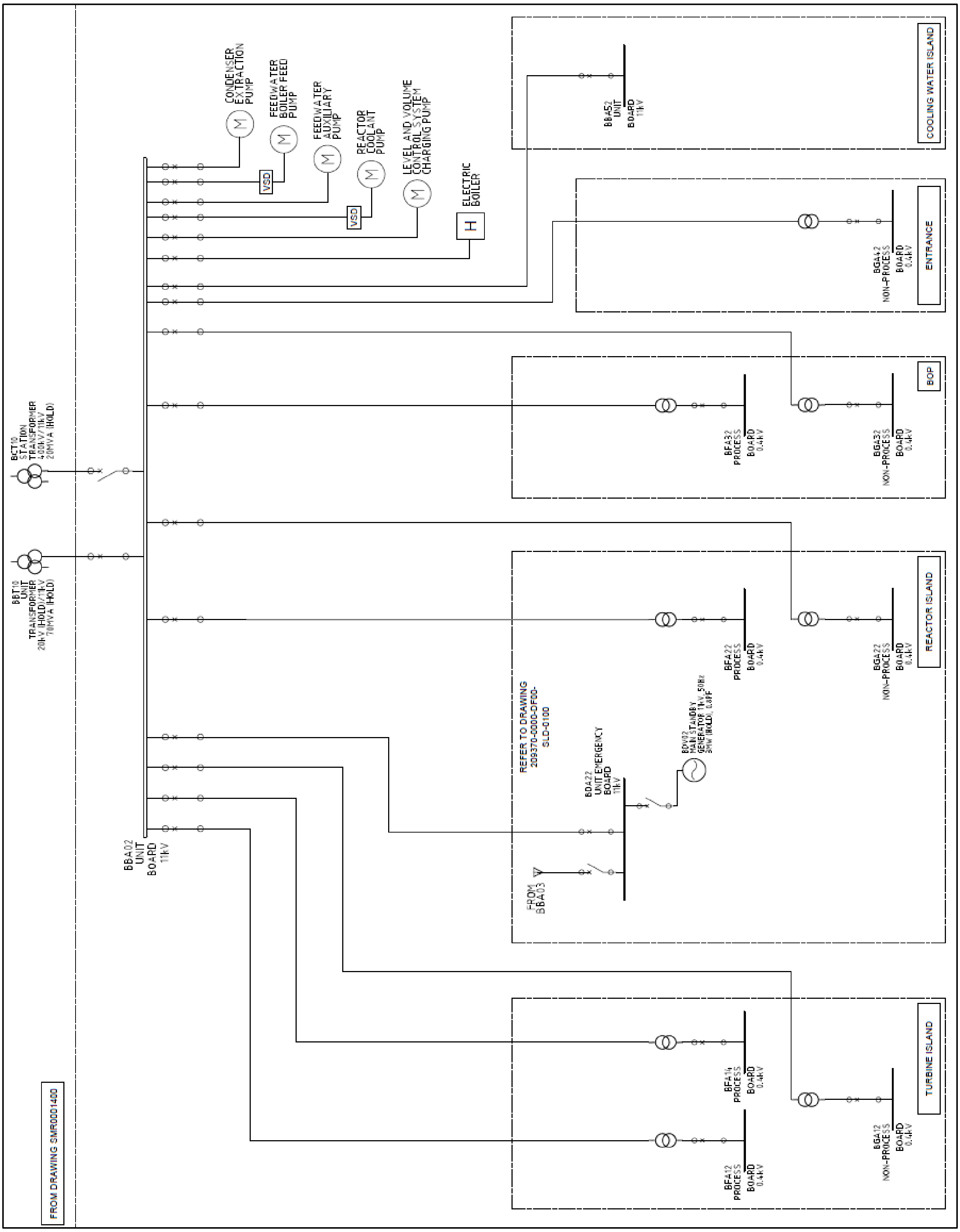


**Figure 8.10-3: Single Line Diagram for BBA02**

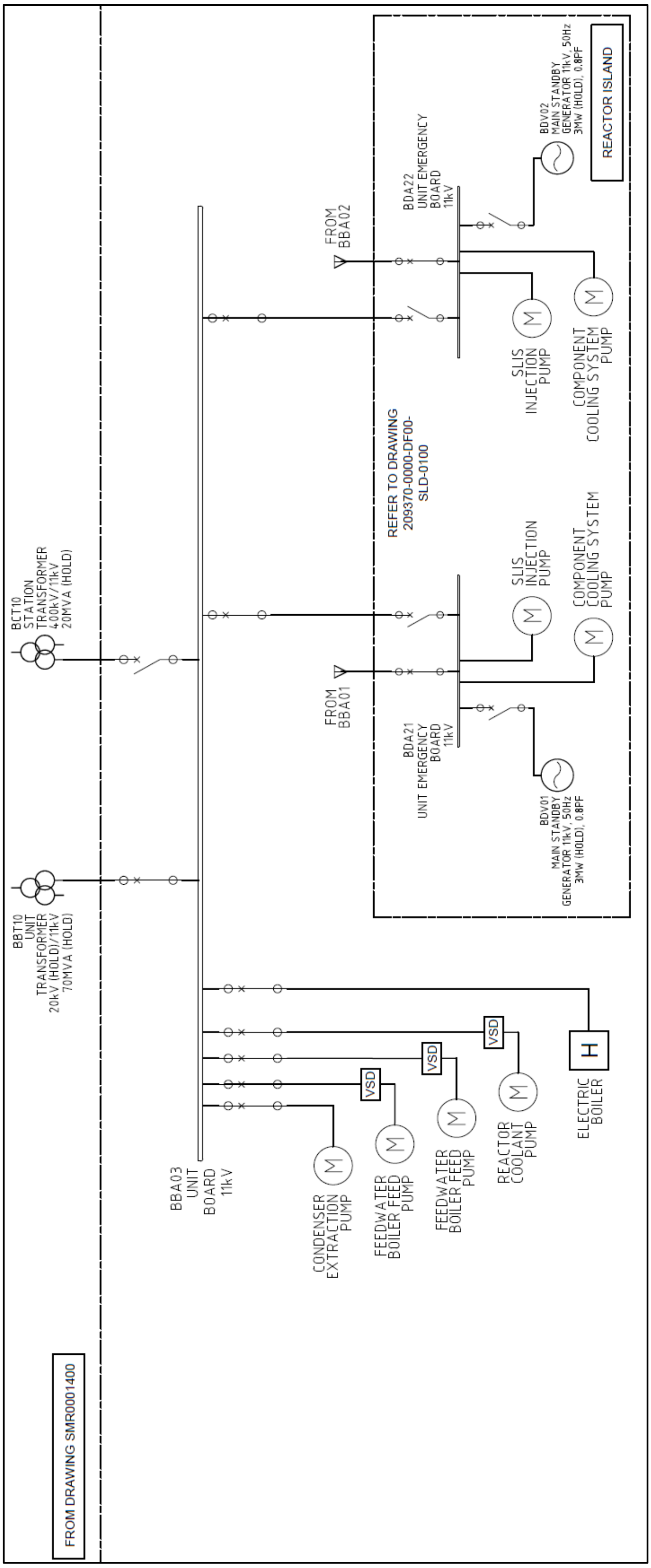


**Figure 8.10-4: Single Line Diagram for BBA03**

# 8.12 Acronyms and Abbreviations

| | |
|---|---|
| AC | Alternating Current |
| ALARP | As Low As Reasonably Practicable |
| ARM | Availability, Reliability and Maintainability |
| BS | British Standard |
| CAE | Claim, Argument, Evidence |
| C&I | Control and Instrumentation |
| CCF | Common Cause Failure |
| CoFT | Control of Fuel Temperature |
| CoR | Control of Reactivity |
| CoRM | Confinement of Radioactive Material |
| DBC | Design Basis Condition |
| DC | Direct Current |
| DiD | Defence in Depth |
| DOORS | Dynamic Object-Oriented Requirements System |
| DPS | Diverse Protection System |
| DSEAR | The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002 |
| E3S | Environmental, Safety, Security and Safeguards |
| EC&I | Electric, Control & Instrumentation System |
| ECCS | Emergency Core Cooling System |
| EMC | Electromagnetic Compatibility |
| EMIT | Examination, Maintenance, Inspection and Testing |
| EN | European Standard adopted as a British Standard |
| FSF | Fundamental Safety Function |
| GDA | Generic Design Assessment |
| GER | Generic Environmental Report |
| GSR | Generic Security Report |

| | |
|---|---|
| HPIS | High-Pressure Injection System |
| HV | High Voltage |
| IAEA | International Atomic Energy Agency |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronic Engineers |
| IEF | Initiating Event Frequency |
| IET | The Institution of Engineering and Technology |
| ISO | International Organization for Standardization |
| LOOP | Loss of Offsite Power |
| LV | Low Voltage |
| OPEX | Operating Experience |
| PCD | Preliminary Concept Definition |
| PCSR | Pre-Construction Safety Report |
| PIE | Postulated Initiating Events |
| PWR | Pressurised Water Reactor |
| RD | Reference Design |
| RDS-PP | Reference Designation System for Power Plants |
| RGP | Relevant Good Practice |
| RPS | Reactor Protection System |
| RR SMR | Rolls-Royce Small Modular Reactor |
| SBO | Station Blackout |
| SLD | Single Line Diagram |
| SSC | System, Structure, Component |
| UK | United Kingdom |
| UPS | Uninterruptable Power Supply |