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# ERVIA CCS PRE-FEED STUDY

## Power Generation & Electrical Systems Philosophy - Cork

MDE1234-RPS-01-CX-RP-Z-0012
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# Contents

Holds ..... iii
Glossary ..... iv
References ..... v

**1 INTRODUCTION AND SCOPE ..... 1**
1.1 Project Background ..... 1
1.2 Scope ..... 1

**2 APPLICABLE REGULATIONS AND STANDARDS ..... 2**

**3 ELECTRICAL POWER REQUIREMENTS ..... 4**
3.1 Central Processing Facility (CPF) ..... 4
3.1.1 Estimated Total Electrical Demand ..... 5
3.1.2 Power Supply to the CPF ..... 5
3.1.3 Main Electrical Infrastructure ..... 6
3.1.4 Back-up Generator ..... 7
3.1.5 Uninterruptable Power Supply (UPS) ..... 7
3.2 Jetty ..... 7
3.2.1 Power Supply to the Jetty ..... 7
3.2.2 Uninterruptable Power Supply (UPS) ..... 7
3.3 Remote Installations ..... 8
3.3.1 Power Supply to Valve Installation & Pigging Installations ..... 8
3.3.2 Uninterruptable Power Supply (UPS) ..... 8
3.4 Lighting ..... 9
3.4.1 Emergency Lighting ..... 9
3.5 Small Power/General Services/power to Buildings and external areas ..... 9
3.6 Electrical Services to HVAC Equipment ..... 10
3.7 Fire & Gas Detection & Prevention ..... 10
3.8 Lightning Protection ..... 10
3.9 Earthing and Bonding ..... 10
3.10 Hazardous Areas ..... 10

## Tables

Table 2-1 Applicable Regulations, Standards & Codes of Practice ..... 2
Table 3-1 Summary of Main Electrical Loads ..... 5
Table 3-2 Lighting General Criteria ..... 9

## Figures

Figure 3-1 CPF site indicating jetty and location of Long Point 220kV Substation (high-lighted) ..... 4
Figure 3-2 Local Electricity Grid ..... 4
Figure 3-3 $CO_2$ Pipeline gathering network indicating locations of Valve Installation and Pigging Installations ..... 8

## Appendices

Appendix A Building Electrical Layouts

# Holds

| HOLDS | Description | Responsibility |
|---|---|---|
| **1.** | Configuration of electrical grid connection to be confirmed following formal application process with ESB Networks. | FEED |

# Glossary

| Term | Definition |
|---|---|
| CIBSE | Chartered Institution of Building Services Engineers |
| MCC | Motor Control Centre |
| Form 3 | Form of internal subdivision of the busbars, functional units and external cable terminals within switchgear assemblies according to IEC 61439. Form 3: Busbars are separated from the functional units and the functional units are separated from each other. |
| Form 4 | Form of internal subdivision of the busbars, functional units and external cable terminals within switchgear assemblies according to IEC 61439. Form 4: Busbars are segregated from the functional units and terminals. Functional units are segregated from each other. |
| BMS | Building Management System |
| HVAC | Heating Ventilation and Air Conditioning |
| MCC | Motor Control Centre |
| ONAN | Oil Natural Air Natural |
| CCS | Carbon Capture and Storage |
| CPF | Central Processing Facility |
| CCGT | Combined Cycle Gas Turbine |
| FEED | Front End Engineering Design |
| ATEX | Atmospheres Explosible |
| ESB | Electricity Supply Board |
| MV | Medium Voltage |
| LV | Low Voltage |
| LED | Light Emitting Diode |
| UPS | Uninterruptible Power Supply |
| IT | Information Technology |
| XPLE | Crossed linked polyethylene |
| SWA | Steel Wire Armoured |
| PVC | Poly Vinyl Chloride |
| CCTV | Closed-Circuit Television |
| VSD | Variable Speed Drives |
| ICSS | Integrated Control and Safety System |
| ETCI | Electro Technical Council of Ireland |
| EPD | Explosion Protection Document |

# References

1. MDE1234-RPS-02-CX-DR-Z-AG0100-S3-P01 Constraints Mapping - Gas Transmission & Electricity Networks Cork
2. MDE1234-RPS-01-CX-RP-Z-0003 Process & Utilities Design Philosophy – Cork
3. MDE1234-RPS-01-CX-RP-Z-0011 Process Safety Design Basis – Cork
4. MDE1234-BEC-03-CX-SH-Z-SH0003 Electrical Load List

# 1 INTRODUCTION AND SCOPE

## 1.1 Project Background

Ervia is assessing how Carbon Capture and Storage (CCS), located close to large-scale $CO_2$ emitters can play a role in reducing Ireland's $CO_2$ emissions. A technical feasibility study on the potential for large-scale CCS in Ireland was completed by Ervia in 2020.

The general location of Aghada Power Station in County Cork was selected as a potential site for a Central Processing Facility (CPF) for liquefaction, storage, and export of $CO_2$ overseas via a new marine jetty. The CPF will cater for $CO_2$ captured at 3 emitter locations (Whitegate Power Station, Irving Oil Whitegate Refinery and Aghada CCGT). A new $CO_2$ gas pipeline gathering network will transport $CO_2$ from the emitters to the CPF.

Ervia has appointed RPS / Bechtel to carry out a Pre-FEED study that involves a detailed assessment of the key CPF, pipeline and storage infrastructure necessary to condition, compress, transport and store liquid $CO_2$ at Cork harbour for subsequent loading onto ships for export. (Note: The scope of this project does not include the carbon capture facilities at each emitter).

Additionally, the new marine jetty in Cork will also be used for import of liquid $CO_2$. This scenario considers the regasification of liquid $CO_2$ at Cork for transport via pipeline to the Inch terminal which is the link to indigenous offshore permanent storage at the depleted Kinsale Head Gas Field.

## 1.2 Scope

This document sets out the overall electrical design philosophy for the Central Processing Facility (CPF), jetty and pipeline installations.

# 2 APPLICABLE REGULATIONS AND STANDARDS

All electrical systems will be designed to be safe, fit for intended design-purpose, flexible and reliable.

The electrical systems will be designed to comply with all relevant regulations and guidelines including current versions of the documents listed in Table 2-1 below.

**Table 2-1 Applicable Regulations, Standards & Codes of Practice**

| Ref. | Standard |
|---|---|
| 1 | I.S. 10101 : National Rules for Electrical Installations |
| 2 | ET201 : Code of Practice for the Design, Selection and Erection of Low Voltage Switchboards for Industrial / Commercial Applications. |
| 3 | ET204 : Code of Practice for Control Systems Involving Programmable Electronic Products and Systems. |
| 4 | ET206 : Management of Electrical Safety at Work. |
| 5 | Safety, Health and Welfare at Work Act. |
| 6 | Safety, Health and Welfare at Work (Construction) Regulations. |
| 7 | Safety, Health and Welfare at Work (General Application) Regulations. |
| 8 | CIBSE Design Guidelines. |
| 9 | I.S. Codes of Practice (BS Codes in absence of relevant IS codes). |
| 10 | EC Directives governing CE marking. |
| 11 | EN 62271-1 (2011) High-voltage switchgear and controlgear Part 1: Common Specifications. |
| 12 | EN 62271-100 (2013) High-voltage switchgear and controlgear Part 100: Alternating current circuit-breakers. |
| 13 | EN 62271-101 (2006) High-voltage switchgear and controlgear Part 101: Synthetic testing. |
| 14 | EN 62271-102 (2014) High-voltage switchgear and controlgear Part 102: Alternating current disconnectors and earthing switches. |
| 15 | EN 62271-103 (2015) High-voltage switchgear and controlgear Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV. |
| 16 | EN 60255-1 (2010) Measuring relays and protection equipment - Part 1: Common requirements. |
| 17 | EN 61869-1 (2009) Instrument transformers General requirements. |
| 18 | EN 61869-2 (2012) Instrument transformers Additional requirements for current transformers. |
| 19 | EN 61869-3 (2013) Instrument transformers. Additional requirements for inductive voltage transformers. |
| 20 | IEC 60060-1 (2010) High-voltage test techniques – Part 1: General definitions and test requirements |
| 21 | IEC 61439-1 (2020) Low-voltage switchgear and controlgear assemblies. |
| 22 | 2014/30/EU Electromagnetic compatibility (EMC) Directive |
| 23 | I.S. 3217 (2013) Emergency Lighting and Amendment 1 (2017) |
| 24 | I.S. 62305 Protection against lightning |

| Ref. | Standard |
|---|---|
| **25** | Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (15th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) (Typically referred to as 'The ATEX Workplace Directive'). |
| **26** | Directive 2014/34/EU of the European Parliament and the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (recast). (Typically referred to as 'The ATEX Equipment Directive'). (Repeals Directive 94/9/EC). |

# 3 ELECTRICAL POWER REQUIREMENTS

## 3.1 Central Processing Facility (CPF)

The CPF site is located directly adjacent to Aghada 220kV substation which is serving the adjoining CCGT generation plant (see Figure 3-1).

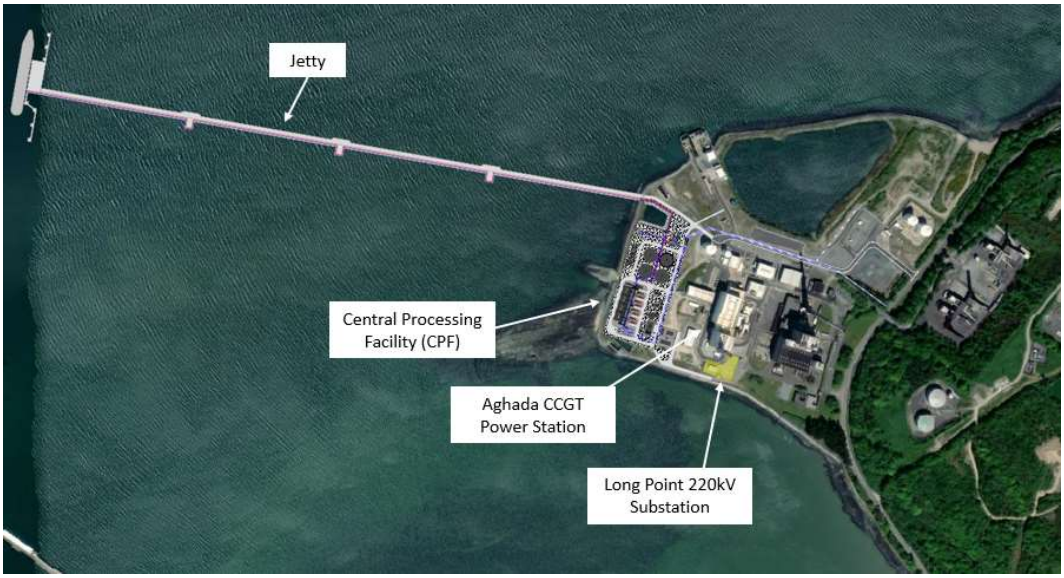



**Figure 3-1 CPF site indicating jetty and location of Long Point 220kV Substation (high-lighted)**

There are no known electrical services within the CPF site area, which will have any significant impact on the construction. The local electrical grid is indicated on constraints mapping (Ref. 01).

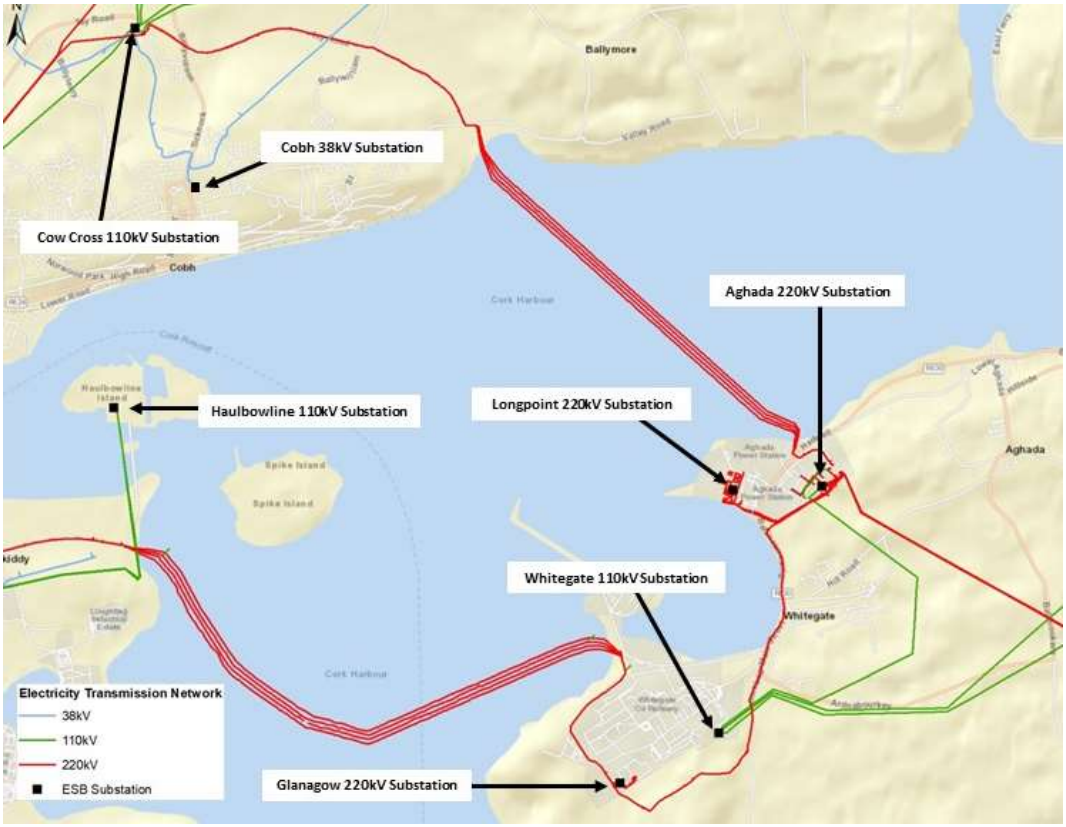



**Figure 3-2 Local Electricity Grid**

### 3.1.1 Estimated Total Electrical Demand

Based on the preliminary electrical design loads, the estimated maximum electrical demand for the site will be 19.1 MVA.

A detailed electrical load list, with estimated connected and operating loads for all main equipment, has been compiled (Ref. 04). A summary of the main electrical loads is given on Table 3-1 below.

**Table 3-1 Summary of Main Electrical Loads**

| Item | Description | Estimated Operating Load (kVA) |
|---|---|---|
| 1 | Refrigeration Compressors (8 no) | 16,000 |
| 2 | $CO_2$ Export Pump | 600 |
| 3 | BOG Compressors (2 no) | 800 |
| 4 | Sea Water Pumps (2 no) | 500 |
| 5 | Air compressor | 200 |
| 6 | Refrigeration Compressor Aftercoolers (6 no) | 600 |
| 7 | Lube oil Pumps (6 no) | 200 |
| 8 | HVAC Equipment | 100 |
| 9 | Lighting / Small Power | 100 |
| | **Total** | **19,100** |

### 3.1.2 Power Supply to the CPF

As indicated above, the maximum electrical demand for the CPF site is estimated to be approximately 19.1 MVA. It would not be feasible to provide this level of power by means of on-site generation, for reasons of capacity and reliability. Therefore, the design philosophy assumes that power supply to the site will be provided from ESB Networks / Eirgrid electricity network.

This is a very significant load, and will require direct connection from ESB / Eirgrid High Voltage network. (38kV, 110kV, or 220kV).

In normal circumstances, ESB Networks will require a formal grid connection application to be submitted, before definite advice on grid connection (point of connection, routing, voltage, cost etc) can be provided. As no formal discussions have yet taken place with ESB Networks, the following assumptions regarding grid connection for the CPF site have been made, based on experience of similarly sized projects [HOLD 1]:

- Supply to site will be taken from the existing 220kV Long Point substation, as it is located directly adjacent to the site. This is likely to have spare capacity as it serves the adjacent Aghada CCGT power station which is rated for 430MW.
- A dedicated on-site 220kV substation will be required to facilitate the incoming power supply to the site.
- The incoming supply will be dual / redundant with 2 no 19MVA transformers (Primary voltage 220kV, secondary voltage 6.6kV, with all MV equipment on site, consequentially rated for 6.6kV). While the MV voltage on site would normally be 20kV, 6.6kV is being chosen in this instance, as there are a number of items of equipment with very large load requirements, (e.g. 8No refrigeration compressors @ 2MVA each) and these will need to be fed directly at 6.6kV.
- The 220kV substation on site will be designed and built to standard ESB Networks details. This will have 220kV switchgear, along with metering and protection equipment on the ESB Networks side. The ESB Networks 220kV switchgear may be Air Insulated (external) or Gas Insulated (internal). Air

insulated type switchgear is less expensive, but requires more space. The final decision in this regard will require liaison with ESB Networks [HOLD 1].

- The customer side of the substation will contain 2 no 19.1 MVA transformers (located externally), which will feed into a main 6.6kV switchboard (containing dual incomers, and a bus coupler, to facilitate the dual incoming supplies, and to provide for full redundancy on the main electrical infrastructure.

A preliminary layout for electrical equipment within the substation building at the CPF is included in Appendix A.

### 3.1.3 Main Electrical Infrastructure

The main electrical infrastructure at the CPF will include:

- 2 no 19.1 MVA 220kV /6.6kV ONAN transformers. Oil will be environmentally friendly natural esters oil.
- 6.6kV main switchboard located in main MV switchroom, on customer side of main substation.
- 6.6kV MCC panel located in MV switchroom in main control building (this will be sized to feed and control all items with direct 6.6kV supply (main compressors etc)
- 6.6kV / 400V unit substation located in main LV switchroom in control building) This will contain a dry type transformer (nominally rated for 2MVA) and 400V switchboard (nominally rated for 3000A)
- 400V 'Process' MCC panel located in LV switchroom in main control building (this will be sized to feed and control all 'process related' equipment, other than those items requiring 6.6kV supply.
- 400V 'HVAC' MCC/BMS panel located in LV switchroom in main control building (this will be sized to feed and control all 'HVAC' equipment,
- Fully rated back-up generator along with Synchronisation panel and G10 protection. (See Section 3.1.4 below).
- UPS unit (see Section 3.1.5 below).
- Local distribution boards will be provided as required to serve all electrical building services in each area (lighting, small power, sockets etc)

6.6KV switchboards and MCCs will be modular metal clad type, with withdrawable circuit breakers.

All main 400V switchboards and MCC panels will be Form 4, with plug in type circuit breakers.

Local distribution boards will be Form 3 type, wired to terminals.

Energy analysers will be provided on all main electrical panels and will be capable of being networked to a central and remotely accessible monitoring system.

Surge arrestors will be provided on main distribution boards also on downstream boards as appropriate.

The MCC panel(s) will contain all starters, overloads, and controls to serve all HVAC fans, pumps etc. VSDs where required will also be inbuilt into the MCCs.

All 6.6kV power distribution cabling will consist of 3 core Al/XLPE/SWA/LSF cables installed on galvanised ladder (provided with covers) for extra mechanical protection.

All 400V power distribution cabling will consist of 4 core Cu/XLPE/SWA/LSF cables installed on galvanised ladder and tray. Suitably sized earth cables will be installed with all power cables.

Suitably sized earth cables will be installed with all power cables.

A preliminary layout for electrical equipment within the Central Control Room building at the CPF is included in Appendix A.

### 3.1.4 Back-up Generator

All electrical equipment which are classed as 'essential services' (Ref. 002) will be served by a dedicated 'Essential Services' switchboard located in the LV switchroom. This switchboard will have auto change-over facilities to automatically start and control the generator in the event of power failure. A G10/ synchronisation panel will also be provided to allow the generator to run in parallel with the mains if and as required. (e.g. to allow for testing the generator without switching off the mains supply)

The generator will be provided with a dedicated oil tank, sized for 72 hours at full load.

### 3.1.5 Uninterruptable Power Supply (UPS)

A UPS system will be installed to provide a guaranteed power supply for critical equipment (IT and Control Equipment).

Preliminary 'critical load' details have been identified (Ref. 002) which indicate a UPS load of approximately 30kW.

The UPS system will consist of 2 no 30kW UPS units (for redundancy) each with a separate by-pass panel, and each serving a dedicated UPS distribution board.

All equipment will be located in the LV switchroom, which will be temperature controlled.

## 3.2 Jetty

### 3.2.1 Power Supply to the Jetty

Based on the preliminary electrical design loads, the estimated maximum electrical demand for the jetty will be 1.2 MVA. (including 1MVA allowance for shore supply to Ship). Power to the jetty will be supplied from the CPF.

The main electrical infrastructure at the jetty will include:-

- 6.6kV power supply cable fed from main 6.6kV switchboard;
- Local 6.6kV switchboard in Jetty area which in turn will serve;
- 6.6KV circuit breaker for future 'shore to ship' supply;
- 6.6kV circuit breaker feeding local 6.6kV/ 400V unit substation;
- 6.6kV / 400V unit substation located in jetty control building) This will contain a dry type transformer (nominally rated for 400 kVA) and 400V switchboard (nominally rated for 630A);
- 400V 'Process' MCC panel located in Jetty control building (this will be sized to feed and control all 'process related' equipment, located in the jetty area;
- 400V 'HVAC' MCC/BMS panel located in LV switchroom in main control building (this will be sized to feed and control all 'HVAC' equipment; and
- Local distribution board(s) will be provided as required to serve all electrical building services in each area (lighting, small power, sockets etc).

A preliminary layout for electrical equipment within the Jetty Control Room building on the jetty is included in Appendix A.

### 3.2.2 Uninterruptable Power Supply (UPS)

A small local UPS unit (nominally 5kVA) will be provided to back up critical electrical equipment in the Jetty Area.

## 3.3 Remote Installations

There will be four installations on the $CO_2$ gathering network as listed below and indicated on Figure 3-3:

1. Valve Installation
2. Whitegate Pig Launching Installation
3. Aghada Pig Launching Installation
4. Inch Pig Receiving Installation

**Figure 3-3 $CO_2$ Pipeline gathering network indicating locations of Valve Installation and Pigging Installations**

The electrical power demands at each of these facilities will be similar, with primary electrical loads including operation of electrically motorised valves, lighting, and space heating for the electrical & instrumentation kiosk at each site. These installations will be unmanned.

### 3.3.1 Power Supply to Valve Installation & Pigging Installations

The estimated maximum electrical demand for these installations will be approximately 15kVA. Small separate ESB Networks supplies will be provided to the following areas:

- Valve installation (at Ballinookera): Small separate ESB Networks supply (nominally 3 phase, 20 kW); and
- Pigging installations (at Whitegate, Aghada and Inch Terminal): Small separate ESB Networks supply (nominally 3 phase, 20 kW).

### 3.3.2 Uninterruptable Power Supply (UPS)

A small local plug-in type UPS (nominally 2kVA) will be provided at each of the above remote locations as back up for critical electrical equipment.

## 3.4 Lighting

Lighting will be provided to all areas in accordance with the following general criteria.

**Table 3-2 Lighting General Criteria**

| Area | Type of Light Fitting | Lighting Level (lux) | Switching |
|---|---|---|---|
| Admin Areas | Recessed modular light fittings | 500 | PIRs with manual override |
| Corridors/Toilets/ Circulation Areas | To be discussed with Architect – depending on finishes/design | 300 | PIRs |
| Plant Areas (internal) | Surface mounted vapour proof fittings | 200 | PIRs with manual override |
| Plant Areas (external) | Surface mounted vapour proof fittings or floodlights as appropriate | 30 | Time clock / photo cell with manual override |
| External Areas/Car Parks | Lighting columns/building mounted floodlights as appropriate | 10-15 | Time clock / photo cell with manual override |

All light fittings will be energy efficient LED type.

The use of PIR/daylight sensors as listed above will greatly reduce the lighting energy consumption.

Wiring to all lighting circuits will be carried out using PVC cables in metal trunking and conduit internally, and XLPE/SWA/PVC cables in ducts externally. Final connection to all fittings will be via ‘klik’ socket and flex.

### 3.4.1 Emergency Lighting

Emergency lighting will be provided in accordance with IS3217. It is proposed that that an addressable automatically monitored system will be provided as this will eliminate the need for regular manual testing.

## 3.5 Small Power/General Services/power to Buildings and external areas

Adequate quantities of general-purpose sockets and small power outlets will be provided as required throughout the facility:

- **Admin Areas** – 230 twin switched sockets. Quantity and location of sockets will be suitable for room purpose; and
- **Plant Areas** – 110V, 230V, and 400V sockets at regular intervals for maintenance and cleaning purposes.

Spur outlets will be provided as required for miscellaneous equipment such as electric doors, door, insectocutors, CCTV cameras, etc.

Wiring to all general services circuits will be carried out using PVC cables in metal trunking and conduit or XLPE/SWA/PVC cables on tray as the case pertains.

## 3.6 Electrical Services to HVAC Equipment

Wiring, as required, will be provided to all HVAC plant and controls. Power and control wiring will be on separate segregated cableways.

Local isolators will be provided adjacent to all items of plant.

The electrical installation will include for all wiring associated with the following systems being provided by others.

Fire suppression to IT room (equipment supplied and installed by Mechanical Contractor, but wiring by Electrical Contractor).

A HVAC MCC panel will be provided in the plantroom electrical room to facilitate power and control of all HVAC motors, and other miscellaneous mechanical equipment. It is envisaged that all motors >5kW will be provided with VSDs to assist with commissioning, and to provide a more energy efficient installation. VSDS will be located in the MCC panel(s).

A BMS system including BMS panel, instruments, software, front end PC, and associated commissioning will be provided to control all HVAC equipment (heating, cooling, ventilation, plumbing).

## 3.7 Fire & Gas Detection & Prevention

A Fire & Gas system will be an integral part of the Integrated Control and Safety System (ICSS) for the CPF, Jetty and pipeline installations. Details of the system are included in the Process Safety Design Basis (Ref. 003).

## 3.8 Lightning Protection

A lightning risk assessment shall be carried out at each location (CPF, Jetty and pipeline installations) in accordance with IS 62305. Lightning protection in the form of surge protection and lightning conductors shall be provided at each location as required.

## 3.9 Earthing and Bonding

Earthing and bonding will be provided in accordance with ETCI requirements. A main earth bar will be provided adjacent to MDB1 with local earth bars located throughout the facility. Equipotential bonding will be provided to the following:

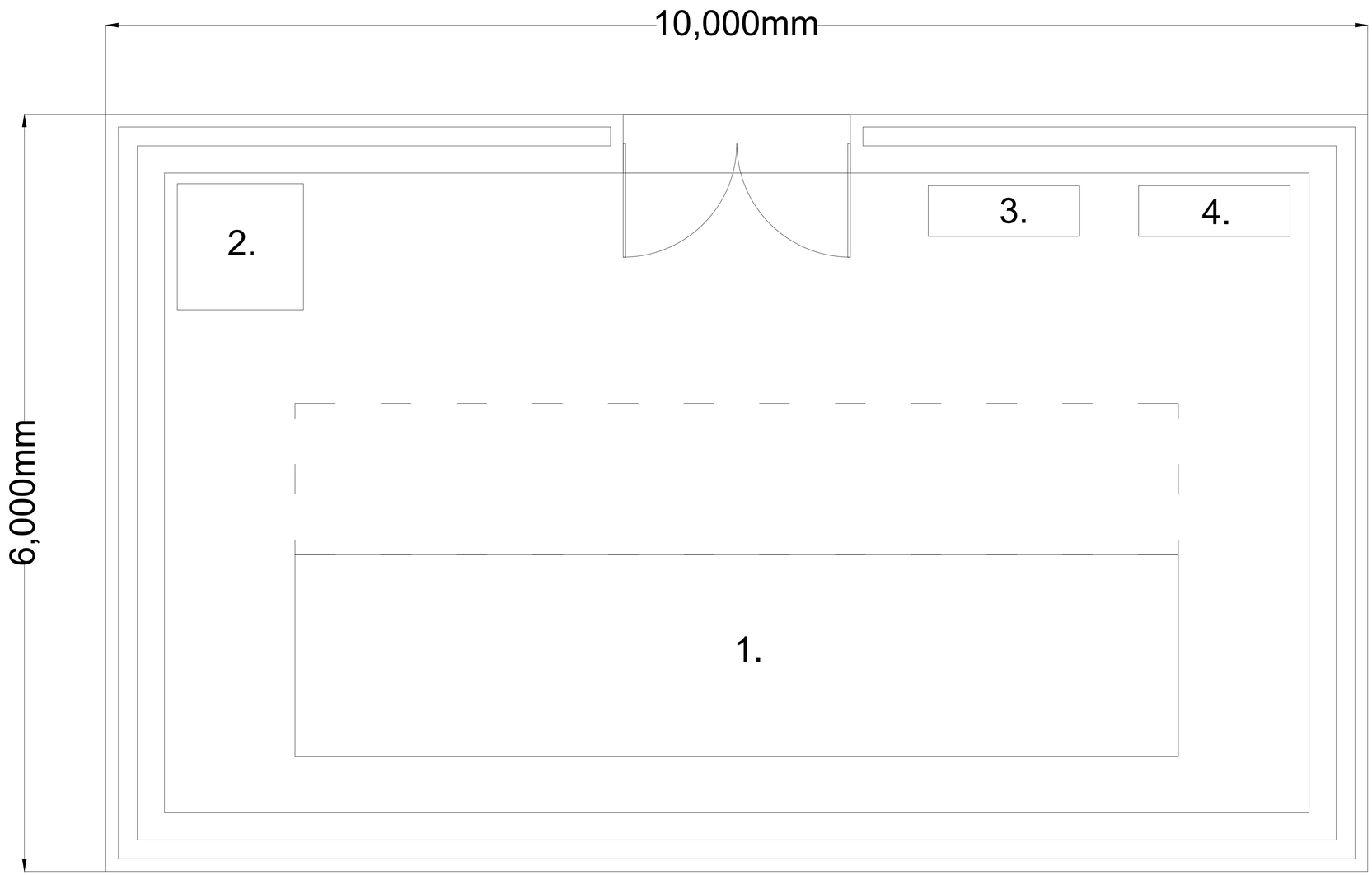
- Exposed metallic equipment and frames;
- Ductwork; and
- Pipework.

## 3.10 Hazardous Areas

Based on the information available during the preliminary design stage, it is not envisaged that there will be any ATEX zones within the facility

A full hazardous area assessment and EPD (Explosion Protection Document) will need to be provided as part of the detailed design stage of the project.

# Appendix A
# Building Electrical Layouts




NOTE:

DASHED LINE INDICATES AREA TO ALLOW FOR WITHDRAWING OF CIRCUIT BREAKERS.

LEGEND:

1. Main MV Switchboard (MVSB1)
   - 7m x 1.6m
2. Battery Charging Panel
   - 1m x 1m
3. Remote Switching Panel
   - 1.2m x 0.4m
4. LV DB
   - 1.2m x 0.4m

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Model File Identifier

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| Scale | N.T.S @ A1<br>N.T.S @ A3 |
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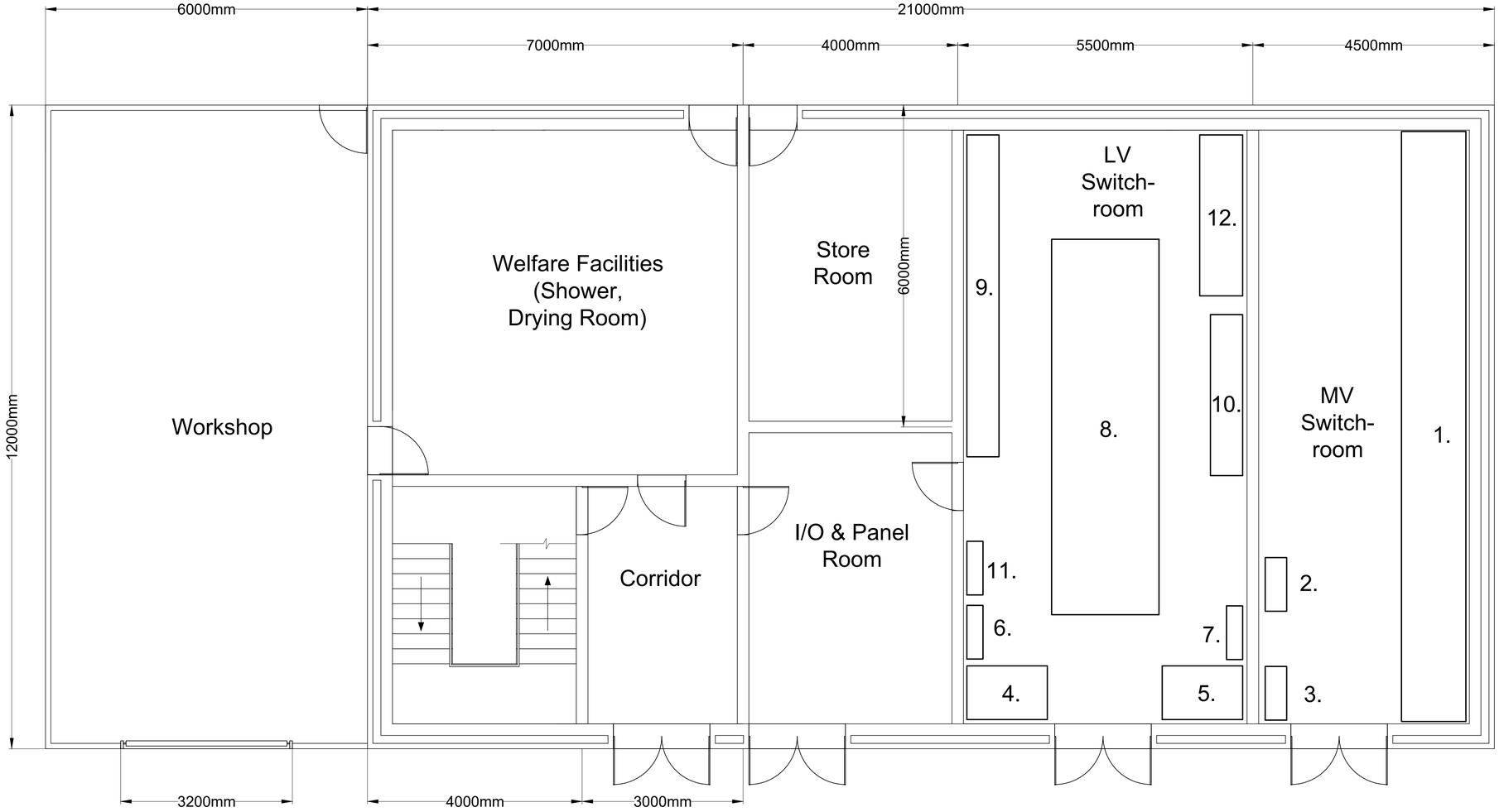
| Title | ERVIA SUB-STATION<br>ELECTRICAL ROOM & EQUIPMENT |
| File Identifier | MDE1234-RPS-01-XX-DR-Z SK0005 |
| Status | S3 |
| Rev | P01 |




LEGEND:

1. MVSB2 (MCC1301A/B)
   - 11m x 1.2m
2. Battery Panel
   - 1m x 0.4m
3. Remote Switching Panel
   - 1m x 0.4m
4. UPS 'A'
   - 1.5m x 1m
5. UPS 'B'
   - 1.5m x 1m
6. UPS-DBA
   - 1.5m x 0.3m
7. UPS-DBB
   - 1.5m x 0.3m
8. MDBI (SWGR 1401A/B)
   - 7m x 2m
9. MCC Panel Process (MCC 1401)
   - 6m x 0.6m
10. MCC Panel HVAC (MCC 1402)
    - 3m x 0.6m
11. Local DB
    - *1.5m x 0.3m (assumed)*
12. EMDBI (MCC 1501)
    - 3m x 0.8m

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Client

ervia

European Commission

General Notes

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(iv) Information including topographical survey, geotechnical investigation and utility detail used in the design have been provided by others.

(v) All Levels refer to Ordnance Survey Datum, Malin Head.

| Rev | Date | Drn | Chk | Amendment / Issue | App |
|---|---|---|---|---|---|
| P01 | S3 | JN | AB | Issue for Review & Comment | CB |

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BECHTEL

BECHTEL ENERGY INC.

Model File Identifier

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|---|---|
| Scale | N.T.S @ A1<br>N.T.S @ A3 |
| Created on | 10.05.2022 |
| Sheets | 01 of 01 |

Project: ERVIA CCS PRE-FEED STUDY

Title: Central Control Room
ELECTRICAL ROOM & EQUIPMENT

| File Identifier | Status | Rev |
|---|---|---|
| MDE1234-RPS-01-XX-DR-Z SK0006 | S3 | P01 |

LEGEND:

1. MV RMV
   - 1.2m x 0.8m
2. Transformer T3
   - 1m x 1.2m
3. MDB3
   - 2.4m x 0.6m
4. MCC Panels
   - 2.4m x 0.6m
5. Local DB
   - 1.2m x 0.4m

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Client

ervia

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| Rev | Date | Drn / Chk | Amendment / Issue | App |
|---|---|---|---|---|
| P01 | S3 | NL / AP | Issue for Review & Comment | CB |

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Model File Identifier

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|---|---|
| Scale | N.T.S @ A1<br>N.T.S @ A3 |
| Created on | 10.05.2022 |
| Sheets | 01 of 01 |
| Project | ERVIA CCS PRE-FEED STUDY |
| Title | Jetty Control Room<br>ELECTRICAL ROOM & EQUIPMENT |
| File Identifier | MDE1234-RPS-01-XX-DR-Z SK0007 |
| Status | S3 |
| Rev | P01 |