外部委託業者の募集

References: IO/25/OT/10034121/VML

“PPEN Upgrade for MCPC Stage 2 and ICH&ECH SRO "

（MCPC ステージ 2 および ICH&ECH SRO 向けの PPEN アップグレード）

IO 締め切り 2025 年 12 月 15 日(月)

〇はじめに

本事前情報通知（PIN）は、作業契約の入札授与および実行につながる公開入札調達プロセスの最初のステップです。

この文書の目的は、作業範囲および入札プロセスに関する技術的内容の基本的な概要を提供することです。

〇背景

ITER は平和利用の核融合発電の科学的および技術的な実現可能性の実証を目的とした、国際共同研究開発プロジェクトです。ITER 機構の 7 つのメンバーは、;欧州連合（EURATOM が代表）、日本、中華人民共和国、インド、大韓民国、ロシア連邦、および米国です。

ITER の敷地はフランス南東部のブーシュデュローヌ地区にあり、ITER 本社（HQ）もあるフランス CEA サン・ポール・レ・デュランス に近いところに位置しています。詳細については、ITER のウェブサイト http://www.iter.org を参照して下さい。

〇作業範囲

本調達の範囲は、以下のPPEN SROアップグレードを対象とします：

- PPEN 66kVシステム ステージ2：MCPCステージ2とのサブステーション自動化およびI¥&Cインターフェースを含む10回路。
- PPEN 22kVケーブルの敷設および端末処理：
  - ○ GISスイッチギア室からB15-L1-03 Northまで敷設された8回路の22kVケーブルを再編成し、4回路に変換して新しい構成に従って端末処理を行う。
  - ○ SRO用に、GISスイッチギア室からB15-L1-03 Northの電子サイクロトロン（EC）HCDまでの2回路の新しいケーブルを調達、敷設、端末処理する。
  - ○ GISスイッチギア室からB15-L1-03 Northまで敷設された1回路の22kVケーブルを、B15-L1-03 NorthからB20のイオンサイクロトロン（IC）HCDへ向けて再ルーティングし、端末処理する。
  - ○ SRO用に、GISスイッチギア室からB20のイオンサイクロトロン（IC）HCDおよびB15-L1-03 Northの電子サイクロトロン（EC）HCDまでの3回路の新しいケーブルを調達、敷設、端末処理する。

この調達プロセスはフルターンキー契約であり、単一の部品および労務契約を意味します。契約には以下が

含まれます（ただしこれに限定されません）：

予備設計、最終設計、製造設計、製造、工場受入試験、梱包および輸送、IOサイトへの納入、組立および設置設計、組立および設置、現地受入試験および試運転（PPEN 66kVステージ1システムのI&Cシステムとの統合および22kV I&C適応を含む）、引き渡し。

サービスの全範囲については、添付の技術仕様書ref. DURH6Y v2.1をご参照ください。

〇調達プロセスと目的

目的は、競争入札プロセスを通じて供給契約を落札することです。
この入札のために選択された調達手続きは公開入札手続きと呼ばれます。
オープン入札手順は、次の 4 つの主要なステップで構成されています。

- ステップ 1-事前情報通知（PIN）
  事前情報通知は公開入札プロセスの第一段階です。IO は、関心のある候補企業に対し、以下の概略日程に示された期日までに担当調達担当官に添付の関心表明フォームで以下の情報を提出し、競争プロセスへの関心を示すよう正式に要請します。

  特に注意:
  関心のある候補企業は、IO Ariba の電子調達ツール 「IPROC」 に登録してください（まだ登録していない場合）。手順については、
  https://www.iter.org/fr/proc/overview
  を参照してください。

  Ariba（IPROC）に登録する際には、お取引先様に最低 1 名の担当者の登録をお願いします。この連絡担当者は、提案依頼書の発行通知を受け取り、必要と思われる場合は入札書類を同僚に転送することができます。

- ステップ 2-入札への招待
  関心表明提出後、提案依頼書（RFP）を 「IPROC」 に掲載します。この段階では、担当の調達担当者に関心を示し、かつ IPROC に登録している関心のある候補企業は、RFP が公表された旨の通知を受けることができます。その後、RFP に詳述されている入札説明書に従って提案書を作成し、提出します。

  このツールに登録されている企業のみが入札に招待されます。

- ステップ 3-入札評価プロセス
  入札者の提案は、IO の公平な評価委員会によって評価されます。入札者は、技術的範囲に沿って、かつ、RFP に記載された特定の基準に従って作業を実施するために、技術的遵守を証

明する詳細を提供しなければなりません。

- ステップ 4-落札
  認定は、公開されている RFP に記載されている、コストに見合った最適な価格または技術的に準拠した最低価格に基づいて行われます。

〇概略日程

概略日程は以下の通りです：

マイルストーン	暫定日程
事前指示書（PIN）の発行	2025 年 12 月 3 日
関心表明フォームの提出	2025 年 12 月 15 日
I-Proc での提案依頼書の要求	2025 年 12 月 16 日
入札会議（Teams にて）	2026 年 1 月 15 日
入札提出	2026 年 2 月 5 日
契約授与	2026 年 3 月
契約調印	2026 年 4 月

〇契約期間と実行

ITER機構は2026年の3月ごろに供給契約を授与する予定です。完成までの期間は48か月の予定です。

〇候補

参加は、個人またはグループ/コンソーシアムに参加するすべての法人に開放されます。法人とは、法的権利及び義務を有し、ITER 加盟国内に設立された個人、企業又は機構をいいます。ITER 加盟国は欧州連合(EURATOM メンバー)、日本、中華人民共和国、インド共和国、大韓民国、ロシア連邦、アメリカ合衆国です。

法人は、単独で、またはコンソーシアムパートナーとして、同じ契約の複数の申請または入札に参加することはできません。共同事業体は、恒久的な、法的に確立されたグループ又は特定の入札手続のために非公式に構成されたグループとすることができます。

コンソーシアムのすべての構成員(すなわち、リーダーと他のすべてのメンバー)は、ITER 機構に対して連帯して責任を負います。

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指名されたコンソーシアムのリーダーは、入札段階で、コンソーシアムのメンバーの構成を説明する

予定です。その後、候補者の構成は、いかなる変更も ITER 機構に通知することなく変更してはなりません。かかる認可の証拠は、すべてのコンソーシアムメンバーの法的に授権された署名者が署名した委任状の形式で、しかるべき時期に IO に提出しなければなりません。

どのコンソーシアムメンバーも IPROC に登録する必要があります。

【※　詳しくは添付の英語版技術仕様書「**PPEN Upgrade for MCPC Stage 2 and ICH&ECH of SRO**」をご参照ください。】
ITER 公式ウェブ　http://www.iter.org/org/team/adm/proc/overview からもアクセスが可能です。

「核融合エネルギー研究開発部門」の HP：　http://www.fusion.qst.go.jp/ITER/index.html
では ITER 機構からの各募集（IO 職員募集、IO 外部委託、IO エキスパート募集）を逐次更新しています。ぜひご確認ください。

イーター国際核融合エネルギー機構からの外部委託
に関心ある企業及び研究機関の募集について

＜ITER 機構から参加極へのレター＞

以下に、外部委託の概要と要求事項が示されています。参加極には、提案された業務に要求される能力を有し、入札すべきと考える企業及び研究機関の連絡先の情報を ITER 機構へ伝えることが求められています。このため、本研究・業務に関心を持たれる企業及び研究機関におかれましては、応募書類の提出要領にしたがって連絡先情報をご提出下さい。

china eu india japan korea russia usa
Route de Vinon-sur-Verdon - CS 90 046 - 13067 St Paul Lez Durance Cedex - France

PRIOR INDICATIVE NOTICE (PIN)

OPEN TENDER SUMMARY

IO/25/OT/10034121/VML

for

PPEN Upgrade for MCPC Stage 2 and ICH&ECH of SRO

Prior Indicative Notice annexes:
- Annex I: Expression of Interest Form
- Annex II: Technical Specifications ref DURH6Y v 2.1

IO Contact Persons: Virginie.Michel@iter.org and Andrew.Brown@iter.org

Abstract

The purpose of this summary is to provide prior notification of the ITER Organization's intention to launch a competitive Open Tender process in the coming weeks. This summary provides some basic information about the ITER Organization, the technical scope for this tender, and details of the **PPEN Upgrade for MCPC Stage 2 and ICH&ECH of SRO.**

1 Introduction

This Prior Indicative Notice (PIN) is the first step of an Open Tender Procurement Process leading to the award and execution of a full turnkey Contract.

2 Background

The ITER project is an international research and development project jointly funded by its seven Members being, the European Union (represented by EURATOM), Japan, the People's Republic of China, India, the Republic of Korea, the Russian Federation and the USA. ITER is being constructed in Europe at St. Paul–Lez-Durance in southern France, which is also the location of the headquarters (HQ) of the ITER Organization (IO).

For a complete description of the ITER Project, covering both organizational and technical aspects of the Project, visit www.iter.org.

3 Scope of Supply

The scope of this procurement is to cover the PPEN SRO upgrade underneath:

- PPEN 66kV system Stage 2: ten (10) circuits including Substation Automation and I&C interface with MCPC stage 2.

- PPEN 22kV Cable installation and termination:

  - Eight 22kV circuits/cables laid from GIS switchgear room to B15-L1-03 North need to be reorganised and converted into four circuits and terminated for a new configuration.
  - Two new circuits/cables procurement, installation and termination from 22kVGIS switchgear room to Electron cyclotron (EC) HCD in B15-L1-03 North for SRO.
  - One 22kV circuits/cables laid from GIS switchgear room to B15-L1-03 North need to be redirected from B15-L1-03North to B20 for Ion Cyclotron (IC) HCD and terminated.
  - Three new circuits/cables procurement, installation and terminations from 22kV GIS switchgear room to MV switchgears for Ion Cyclotron (IC) HCD in B20 and Electron cyclotron (EC) HCD in B15-L1-03 North for SRO.

This Procurement process is for a full Turnkey project that means a single parts and labour contract which covers, but not limited to, the Preliminary Design, Final Design, Manufacturing Design, Manufacturing, Factory Acceptance Test, Packing and transportation, Delivery on IO Site, Assembly & Installation Design, Assembly and Installation, Site Acceptance Test and Commissioning (incl. integration with the I&C system of PPEN 66kV Stage 1system and 22kV I&C adaptation) and handover.

For the full scope of services, please see the attached Technical Specifications, ref. DURH6Y v2.1

4 Procurement Process & Objective

The objective is to award a Supply Contract through a competitive bidding process.

The Procurement Procedure selected for this Tender is a so-called **Open Tender** procedure.

The Open Tender procedure is comprised of the following four main steps:

- Step 1- Prior Information Notice (PIN)

The PIN is the first stage of the Open Tender process. The IO formally invites interested Suppliers to indicate their interest in the competitive process by returning to the Procurement Officer in charge the attached "Expression of Interest and PIN Acknowledgement" (Annex I) by the date indicated in the procurement timetable below.

Special attention:

Interested tenderers are kindly requested to register in the IO Ariba e-procurement tool called "I-PROC". You can find all links to proceed along with instruction going to: https://www.iter.org/fr/proc/overview.

When registering in Ariba (I-PROC), suppliers are kindly requested to nominate at least one contact person. This contact person will be receiving the notification of publication of the Request for Proposal and will then be able to forward the Tender documents to colleagues if deemed necessary.

- Step 2 - Invitation to Tender – Request for Proposal (RFP)

The Request for Proposals (RFP) will be published on our digital tool "Iproc" after the submission of Expression of Interest. This stage allows interested bidders who have indicated their interest to the Procurement Officers in charge AND who have registered in IPROC to receive the notification that the RFP is published. They will then prepare and submit their proposals in accordance with the tender instructions detailed in the RFP.

Only companies registered in this tool will be invited to the tender.

- Step 3 – Tender Evaluation Process

Tenderers' proposals will be evaluated by an impartial evaluation committee of the IO. Tenderers must provide details demonstrating their technical compliance to perform the works in line with the technical scope and in accordance with the particular criteria listed in the RFP.

- Step 4 – Contract Award

One Supply Contract will be awarded on the basis of Best Value for Money with a sharing of 60% for the technical offer and 40% for the financial offer according to the evaluation criteria and methodology described in the RFP.

Procurement Timetable

The tentative timetable is as follows:

Milestone	Date
Publication of the Prior Indicative Notice (PIN)	3 December 2025
Submission of expression of interest form	15 December 2025 12:00 CET
Request for Proposal launched on I-PROC	16 December 2025
Tenderers Conference (via teams)	15 January 2026
Tender Submission	5 February 2026

Contract Award	March 2026
Contract Signature	April 2026

5 Quality Assurance Requirements

The Candidate shall have ISO 9001 or shall submit to the IO for approval its "Quality Assurance Program'' in the Tender Submission for the IO's review and acceptance.

6 Contract Duration and Execution

The IO shall award the Contract around March 2026. The Time for Completion is 48 months.

7 Candidature

Participation is open to all legal entities participating either individually or in a grouping/consortium. A legal entity is an individual, company, or organization that has legal rights and obligations and is established within an ITER Member State, being: the European Union (represented by EURATOM), Japan, the People's Republic of China, India, the Republic of Korea, the Russian Federation and the USA.

Legal entities cannot participate individually or as a consortium partner in more than one application or Tender of the same contract. A consortium may be a permanent, legally established grouping, or a grouping which has been constituted informally for a specific Tender procedure. All members of a consortium (i.e. the leader and all other members) are jointly and severally liable to the IO.

In order for a consortium to be acceptable, the individual legal entities included therein shall have nominated a leader with authority to bind each member of the consortium, and this leader shall be authorised to incur liabilities and receive instructions for and on behalf of each member of the consortium.

It is expected that the designated consortium leader will explain the composition of the consortium members in its offer. Following this, the Candidate's composition must not be modified without notifying the IO of any changes. Evidence of any such authorisation shall be submitted to the IO in due course in the form of a power of attorney signed by legally authorised signatories of all the consortium members.

All consortium members shall be registered in I-PROC.

8 Sub-contracting Rules

Subcontracting is limited to 40 % of the contract value and up to level 2.
All sub-contractors who will be taken on by the Contractor shall be declared with the Tender submission in I-PROC. Each sub-contractor will be required to complete and sign forms including technical and administrative information which shall be submitted to the IO by the Tenderer as part of its Tender.

All declared sub-contractors must be established within an ITER Member State in order to participate.

The IO reserves the right to approve (or disapprove) any sub-contractor which was not notified in the Tender and request a copy of the sub-contracting agreement between the Tenderer and its subcontractor(s). Rules on sub-contracting are indicated in the RFP itself.

ANNEX I

EXPRESSION OF INTEREST & PIN ACKNOWLEDGEMENT

To be returned by e-mail to: Virginie.Michel@iter.org with Andrew.Brown@iter.org in cc

Tender reference: **IO/25/OT/10034121/VML**
Description: **PPEN Upgrade for MCPC Stage 2 and ICH&ECH of SRO**
Procurement Officer: **Virginie Michel - Procurement Division ITER Organization**

☐ WE ACKNOWLEDGE HAVING READ THE PIN NOTICE FOR THE ABOVE-MENTIONED TENDER

☐ WE INTEND TO SUBMIT A TENDER

Are you registered in Iproc (only entities registered in iPROC will be invited to tender):

☐ YES

Please indicate your registration number: ……

☐ NO, but we shall register ASAP and before the indicated tender launch date

Please list the users of ARIBA/IPROC that you wish to add as response team for this tender:

Name	E-mail
…	…

Signature:

COMPANY STAMP

Name: .....

Position: .....

Tel: .....

E-mail .....

Date: .....

IDM UID
DURH6Y

VERSION CREATED ON / VERSION / STATUS
29 Oct 2025 / 2.1 / Approved

EXTERNAL REFERENCE / VERSION

Technical Specifications (In-Cash Procurement)

Technical Specification of PPEN Upgrade for MCPC Stage 2 and ICH&ECH of SRO

This Technical Specification covers the following main tasks:PPEN 66kV system Stage 2: ten (10) circuits including Substation Automation and I&C interface with MCPC stage 2 and relevant modifications if applicable.PPEN 22kV Cable installation and termination: -The 22kV cables laid to B15-L1-03 north need to be reorganised and terminated for a new configuration. -Five new circuits/cables installation and terminations from 22kV GIS switchgear room to MV switchgears for Ion Cyclotron(IC) HCD in ...

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1 Preamble

This Technical Specification describes the technical requirements on a Turnkey Procurement for Pulsed Power Electrical Network (PPEN) underneath.

- PPEN 66kV system Stage 2- ten (10) circuits for ECPS power supply of MCPC stage 2.
- PPEN 22kV cable pulling and connection for ECH at B15 North and ICH at B20.

This Technical Specification is to be considered in combination with *General Management Specification for Service and Supply (GM3S)* [AD1] that constitutes a full part of the technical requirements.

In case of conflict or contradicting information and requirements, the content of this Technical Specification supersedes the other document in following order:

- Other applicable documents, codes and standards, listed in Chapter 4 of this technical specification.
- *General Management Specification for Service and Supply (GM3S)* [AD1].
- *General Management Specification for Executing Entities at the ITER Site (GMS)* [AD32].

Referenced documents are not contractual and are provided as information or illustration purposes. In case of doubts, the Contractor or the Supplier shall contact the ITER Organization (IO) to obtain clarifications.

2 Purpose

2.1 Background and system overview

The ITER Organization (IO) is a joint international research and development project of fusion. The seven members of the IO are: the European Union (represented by F4E), Japan, the People's Republic of China, India, the Republic of Korea, the Russian Federation and the USA.
The project aims to demonstrate the scientific and technological feasibility of fusion power for peaceful purpose and to gain necessary data for the design, construction and operation of the first electricity-producing fusion plant. It will also test a number of key technologies, including the heating, control, diagnostic and remote maintenance that will be needed for a full-scale fusion power station.
The ITER site is in the Bouches du Rhône department of France. It includes the Headquarters of the IO and a construction worksite. The construction of the facility is on-going. Further information is available on the IO website: www.iter.org.

2.1.1 Pulsed Power Electrical Network (PPEN) Overview

ITER plant is hierarchically broken-down into ITER elements following *ITER Project breakdown Structure (PBS)* [RD1]. The elements in the scope of this Turnkey Procurement belong to 41.PP-Pulsed Power Electrical Network.
PPEN receives power from the 400kV RTE Grid and distributes power in 66kV and 22kV to the pulsed loads of Coil Power Supply System (CPSS) and Heating & Current Drive (H&CD) systems.
PPEN comprises of following major subsystems:

- PPEN 400kV System.
- PPEN 66kV system and distribution network.
- PPEN 22 kV System and distribution network.

To suppress harmonics generated from the power converters and meet RTE requirement on the power quality at 400kV interface point, following system are also configured and connected to 66kV systems below.

- 66 kV Reactive Power Compensation and Harmonic Filtering (RPC & HF)
- Static Synchronous Compensator (STATCOM).

RPC & HF system reduces the voltage fluctuations by control of reactive power flow and harmonic filtering.
As a complementary system of RPC&HF, STACOM is a shunt-connected reactive compensation device. The study of STATCOM is undergoing.

2.1.2 PPEN 66kV System

The Ex-vessel Coil Power (ECPS) Converters, which are required to supply the TF, PF, CS and VS coils, are procured into two stages:

- Power converter Stage 1: already in commissioning stage, herein referred as MCPC stage 1.
- Power converters Stage 2: are to be procured, herein referred as MCPC stage 2.

In ITER baseline 2024, both MCPC stage 1 and MCPC stage 2 power converters are required for Start of Research Operation (SRO). The coil power supply system shall be fully assembled and commissioned in the Pre-SRO stage and ensured readiness for the Integrated Commissioning I (IC-I) and SRO.

PPEN 66kVsystem are configured and constructed in alignment with the stages of ECPS Converters, Neutral Beam and RPCs in Area 35 as indicated on *Site Plan - ITER Site Map* [RD2].

PPEN 66kV Stage 1:

Thirty (30) 66kV feeders had been installed for PPEN 66kV stage 1 in Area 35 EAST.

- Twenty-two (22) 66kV feeder modules, incl. 66kV power cables, had been installed to distribute pulsed power to TF, PF, CS and VS coils of MCPC Stage 1 located in Building 32 (B32) and & Building (B33).
- Six (6) 66kV RPC&HF feeder modules had been also installed to connect to RPC&HF installed in Area 39 (A39).
- Two (2) 66kV feeder modules had been installed to distribute pulsed power to Heating Neutral Beam (HNB) installed in Building 34 (B34).

All elements of PPEN Stage 1 had been assembled and installed in A35.

PPEN 66kV Stage 2:

Ten (10) 66kV feeder modules, including 66kV components, Substation Automation system and 66kV cables and its accessories, need to be procured and installed to distribute 66kV power to MCPC Stage 2 power converters located at B32 and B33.

The table below indicates all 66kV feeders for ECPS converters units in a staged approach.

Table 2-1 PPEN 66kV feeders in A35

66kV Feeders	Ratings of 66kV Circuit	PPEN customers	Load (MVA)
41PPAF-JA-1001	66kV, 1250A, 31.5kA	TF	61.14
41PPAF-JA-1002	66kV, 1250A, 31.5kA	CS1U-1	63.02
41PPAF-JA-1003[1]	66kV, 1250A, 31.5kA	CS1U-2	63.02
41PPAF-JA-1004	66kV, 1250A, 31.5kA	CS1L-1	63.02
41PPAF-JA-1005[1]	66kV, 1250A, 31.5kA	CS1L-2	63.02
41PPAF-JA-1006	66kV, 1250A, 31.5kA	CS3U-1	63.02
41PPAF-JA-1007[1]	66kV, 1250A, 31.5kA	CS3U-2	63.02
41PPAF-JA-1008	66kV, 1250A, 31.5kA	CS3L-1	63.02
41PPAF-JA-1009[1]	66kV, 1250A, 31.5kA	CS3L-2	63.02
41PPAF-JA-1010	66kV, 1250A, 31.5kA	PF3-1	77.96
41PPAF-JA-1011	66kV, 1250A, 31.5kA	PF3-2	77.96
41PPAF-JA-1012	66kV, 1250A, 31.5kA	PF3-3	77.96
41PPAF-JA-1013	**66kV** [2], 3150A, 31.5kA	TCR #1	ind250/cap125
41PPAF-JA-1014	**66kV** [2], 3150A, 31.5kA	HF#1	-125
41PPAF-JA-2001	66kV, 1250A, 31.5kA	VS1&VS2	63.02
41PPAF-JA-2002[1]	66kV, 1250A, 31.5kA	VS3&VS5	63.02
41PPAF-JA-2003[1]	66kV, 1250A, 31.5kA	VS4&VS6	63.02
41PPAF-JA-2004	66kV, 1250A, 31.5kA	PF2-1	77.96
41PPAF-JA-2005	66kV, 1250A, 31.5kA	PF2-2	77.96
41PPAF-JA-2006	66kV, 1250A, 31.5kA	PF2-3	77.96
41PPAF-JA-2007	66kV, 1250A, 31.5kA	PF4-1	77.96
41PPAF-JA-2008	66kV, 1250A, 31.5kA	PF4-2	77.96
41PPAF-JA-2009	66kV, 1250A, 31.5kA	PF4-3	77.96
41PPAF-JA-2010	66kV, 1250A, 31.5kA	NB H&CD-1	65.20
41PPAF-JA-2011	66kV, 1250A, 31.5kA	NB H&CD-2	65.20
41PPAF-JA-2012	**66kV** [2], 3150A, 31.5kA	TCR #2	ind250/cap-125
41PPAF-JA-2013	**66kV** [2], 3150A, 31.5kA	HF#2	-125
41PPAF-JA-3001	66kV, 1250A, 31.5kA	PF5-1	77.96
41PPAF-JA-3002	66kV, 1250A, 31.5kA	PF5-2	77.96
41PPAF-JA-3003	66kV, 1250A, 31.5kA	PF5-3	77.96
41PPAF-JA-3004	66kV, 1250A, 31.5kA	CS2U-1	63.02
41PPAF-JA-3005[1]	66kV, 1250A, 31.5kA	CS2U-2	63.02
41PPAF-JA-3006	66kV, 1250A, 31.5kA	CS2L-1	63.02
41PPAF-JA-3007[1]	66kV, 1250A, 31.5kA	CS2L-2	63.02
41PPAF-JA-3008	66kV, 1250A, 31.5kA	PF1-1	77.96
41PPAF-JA-3009[1]	66kV, 1250A, 31.5kA	PF1-2	77.96
41PPAF-JA-3010	66kV, 1250A, 31.5kA	PF6-1	77.96
41PPAF-JA-3011[1]	66kV, 1250A, 31.5kA	PF6-2	77.96
41PPAF-JA-3012	**66kV** [2], 3150A, 31.5kA	TCR #3	ind250/-cap125
41PPAF-JA-3013	**66kV** [2], 3150A, 31.5kA	HF#3	-125

[1] PPEN 66kV Stage 2 feeder modules

[2] GL245 had been adopted as per the study in ITER_D_NSB3S6.

2.1.3 PPEN 22kV System

In ITER baseline 2024, 22kV system consists of two subsystems located in B32 and 41MV respectively.
Currently 22kV switchgears in B32 is Gas Insulated Switchgear (GIS)-8DA10 from Siemens. These switchgears had been fully assembled and will supply electrical power to Correction Coil (CC) converters and H&CD systems which are configured for SRO stage. Thirty-six (36) feeders had been installed in B32.

- Nine (9) 22kV feeders for CC converters, incl. 22kV power cables and accessories, had been installed and commissioned to distribute power to CC converters.
- Three (3) 22kV feeders for NB and DNB systems incl. 22kV power cable and accessories will be pulled and terminated by Others. **It is out of the scope of this technical specification.**
- Six (6) 22kV feeders for EC systems incl. 22kV power cable and accessories had been installed and commissioned to distribute power to EC 22kV switchgears located at 15-L1-03-SOUTH.
- Nine (9) 22kV feeders had been laid to 15-L1-03-NORTH. 22kV cables had been terminated in GIS room, but the cable terminations at 15-L1-03-NORTH side haven't been terminated.
- Other feeders as spares

41MV will distribute power to H&CD systems scheduled for DT-1 stage and In-vessel Coil (IVC) power supply located in B13. **The elements of 41MV are out of the scope of this technical specification.**

2.2 Summary of Procurement Scope

This Procurement is to be a full Turnkey project: a single contract which covers, but not limited to, supply the components and materials, labor cost and the Preliminary Design, Final Design, Manufacturing Design, Manufacturing, Factory Acceptance Test, Packing and transportation, Assembly & Installation Design, Assembly and Installation, Site Acceptance Test and Commissioning (incl. integration with the I&C system of PPEN 66kV Stage 1 system) and handover. Refer to Section 8.5 of *ITER Project Management Plan (PMP)* [AD8] for the full lifecycle of activity phases and phase-gates.
This Turnkey Procurement includes the following main tasks:

- PPEN 66kV system Stage 2: ten (10) circuits including Substation Automation and I&C interface with MCPC stage 2 and relevant modifications if applicable.
- PPEN 22kV Cable installation and termination: This part involves new cable installation and terminations from 22kV GIS switchgear room to MV switchgears for Ion cyclotron in B20 and Electron cyclotron in B15-L1-03 North.

  The 22kV cables laid to B15-L1-03 north need to be reorganised and terminated for new configuration. Refer to [23RD3], [RD4] and Appendix 16.2.8 and for details.

By the time of placing this Contract, the main interfaces have been analysed, and the interface constraints or requirements have been addressed in the relevant sections of this Technical Specifications and Interface Control Documents (ICD).
The activities within this procurement are indicated as follows (detailed requirements are provided in Chapter 6 and Chapter 8.

Preliminary Design

- Confirm the electrical components and materials at tender stage. physical and functional interfaces.
- Propose IEDs and confirm the compatibility of the communication between proposed IEDs covered by this Technical Specification and existing HMI (PACiS), IEDs (MiCOM C264P) of PPEN 66kV stage 1 under the same subring inside PPEN 66kV substation container.
- Update IEC 61850 architecture for PPEN 66kV system with the proposed IEDs.
- Develop Preliminary Design according to this Technical Specification and perform Preliminary Design Review (PDR) as per [AD17] and [AD21].

Final Design

- Update Specification of the major components if necessary.
- Develop Substation automation for PPEN 66kV system stage 2, incl. the integration with PACiS and existing IEC61850 network.
- Develop Integration design with PPEN 66kV system stage 1, incl. integration inside PPEN 66kV Substation Container, 66kV switchyard and auxiliary power services.
- Validate Interfaces with MCPC stage 2, incl. HV connection and I&C interfaces and physical interface with ICH SRO in B20 and ECH SRO located in B15-North.
- Justify the design, using relevant methods and tools (calculations with CANECO).
- Complete the Final Design according to the Technical Specifications and related Final Design Review (FDR), as per [AD17] and [AD21].

Manufacturing Design & Preparation

- Refine design definition to a detailed level for the manufacturing execution (manufacturing drawings, fabrication, etc) by the manufacturers or the Suppliers.
- Support IO to update all ICD/IS according to the refined design definition.
- Generate manufacturing Bill of materials, procurement plan and Manufacturing Inspection Plan (MIP).
- Complete the Manufacturing Design according to the Technical Specifications and related Manufacturing Readiness Review (MRR) as per [AD22].

Manufacturing and Delivery

- Execute Manufacturing.

- Develop test programs and perform Factory Acceptance Test (FAT) according to the requirements of this Technical Specification.
- Pack the component and material properly and be ready for storage at the ITER site.
- Perform Delivery Readiness Review (DRR) as per [AD24].
- Management of administrative procedures (customs, export control, transportation)

Assembly & Installation Preparation

- Develop Assembly and Installation design as per as-manufactured technical inputs.
- Develop Installation Procedures for installation.
- Perform Construction Readiness Review (CRR) as per [AD27].

Assembly & Installation Execution

- Transport the material from the Contractor storage area to working area.
- Carry out assembly and installation of the components.
- Organize the French regulatory inspection for its installation work and perform corrections in case of non-conformities identified by the legal inspector.
- Develop Test & Commissioning procedures

Test & Commissioning

- Carry out Test& Commissioning for Site Acceptance Test (SAT).
- Commissioning PPEN 66kV stage 2 and Integration with CODAC and PPEN 66kV system stage 1 Substation automation.
- Perform Construction Completion Readiness or Commissioning Certificate Readiness (CCR) with as-built documentation as per [AD29].
- Handover PPEN 66kV system ready for operation to IO.

The Contractor shall follow IO system development process [AD17] and [AD21] and specific procedures to perform each activity, deliver required deliverables (including the components and documentation) and pass the required control gates to accomplish this Turnkey Contract.

2.3 Responsibilities

2.3.1 IO's Responsibility

IO takes responsibility for the management of interface with interfacing systems, such as MCPC stage 2, H&CD systems, CODAC and so on, with the technical deliverables or inputs from the Contractor or its Supplier(s).
Accordingly, the following items will be supplied by IO:

- Area for storage of components and material delivered to premises.
- Data, items and services defined under IO responsibility in the ICD and corresponding IS.

- IO will provide guidance to the Contractor and its sub-contractor(s) or its Supplier(s) to execute site related physical activities at IO site in compliance to HSE norms.
- Site coordination with interfacing system or facilities, particularly those impacted by the tests or commissioning of other interfacing systems.
- Hand Over Package preparation (HOP) for cable pulling and termination for PPEN clients outside A35, including 66kV cables, 22kV cables and I&C interfacing cables connecting to other plant or system.
- Cost of local transportation of all components and materials from IO storage warehouses in France to ITER site if applicable.

2.3.2 The Contractor's Responsibility

The Contractor shall be responsible for the design developments that meet the requirements described in this Technical Specification, including the Preliminary Design, Final Design, Manufacturing Design, Manufacturing & Inspections, Factory Acceptance Tests, Packing, Delivery, Assembly & Integration Design, Assembly &Installation execution, Integration and Site Acceptance Tests etc.
The design shall be performed in accordance with applicable design codes, QA requirements and standards listed in this Technical Specification. Any deviations and non-conformances shall be done in accordance with requirements of *ITER Quality Assurance Program* [AD5].
The Contractor shall be responsible for a site survey for the cable tray system for the cables being covered by this Technical Specification, and responsible for secondary supports and fixation if needed.

2.4 Work Schedule & Milestones

In accordance with the ITER project overall schedule of Baseline 2024, IO has developed a schedule requirement for this Turnkey Procurement as illustrated in Figure 2-1. The Contractor shall develop its Detailed Work Schedule (DWS) based on this schedule and be responsible of it.
Any deviation from this general schedule should be raised during call for tender stage and agreed before contract being signed.

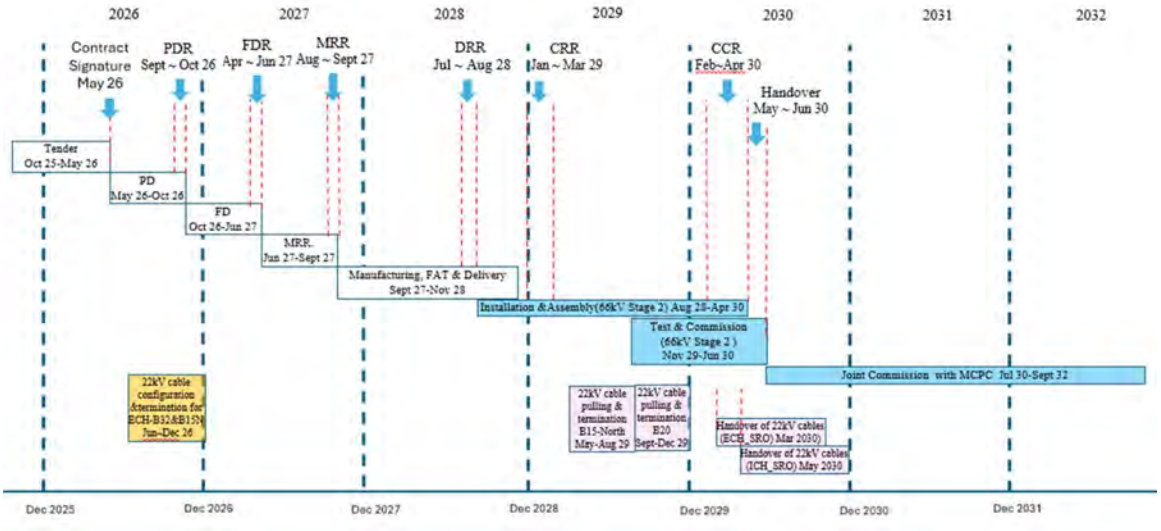


Figure 2-1 Schedule requirement

3 Acronyms & Definitions

3.1 Acronyms

For a complete list of abbreviations and acronyms see ITER Abbreviation ITER_D_2MU6W5. The following acronyms are the main ones relevant to this document.

Table 3-1 List of Abbreviations

Abbreviation	Description
AC	Alternating Current
AIS	Air-insulated switchgear
BOM	Bill Of Material
CC	Correction Coil
CCR	Construction Completion Readiness or Commissioning Certificate Readiness
CID	Configured IED Description
CODAC	Control, Data Access, and Communication
COTS	Commercial-Off-The-Shelf
CRR	Construction Readiness Review
CPSS	Coil Power Supply System
CRO	Contract Responsible Officer
CPSD	Coil Power Supply and Distribution
CTS	Cable Tray System
DC	Direct Current
DCIF	Design Collaboration Implementation Form
DS	Disconnector Switch
DWS	Detailed Work Schedule
ECH	Electron Cyclotron Heating
ECPS	Ex. Vessel Coil Power Supply
EMC	Electro-Magnetic Compatibility
ES	Earth Switch
FAT	Factory Acceptance Test
GIS	Gas-Insulated Switchgear
GMS	General Management Specification for Executing Entities at the ITER Site
GM3S	General Management Specification for Service and Supply
H&CD	Heating & Current Drive
HMI	Human Machine Interface
HNB	Heating Neutral Beam
HOP	Handover Package
HV	High Voltage
I&C	Instrumentation & Control
ICD	Interface Control Documents
ICH	Ion Cyclotron Heating

Abbreviation	Description
IDM	ITER Document Management (system)
IED	Intelligent Electronic Device
ILM	Integrated Materials and Logistics Management Group
IO	ITER Organization
I/O	Input/Output
IS	Interface Sheet
ITER	International Thermonuclear Experimental Reactor
IVC	In-Vessel Coils
LCC	Local Control Cubicle
LV	Low voltage
MCPC	Main Coil Power Converter
MIP	Manufacturing and Inspection Plan
MMS	Manufacturing Message Specification
MQP	Management and Quality Program
MV	Medium Voltage
NCR	Non-conformance Report
NSC	Non-Seismic Category
PCDH	Plant Control Design Handbook
PBS	Plant Breakdown Structure
PIA	Protection Important Activity
PIC	Protection Important Component
PNI	ITER Part Number
PON	Plant Operation Network
PRO	Procurement Responsible Officer
PPEN	Pulsed Power Electric Network
PSH	Plant System Host
QA	Quality Assurance
QARO	Quality Assurance Responsible Officer
RAMI	Reliability, Availability, Maintainability and Inspectability
RPC&HF	Reactive Power Compensation and Harmonic Filter
SAT	Site Acceptance Test
SOA	Sign-off Authority
SRO	Start of Research Operations
STATCOM	Static Synchronous Compensator
TBDM	To Be Defined by Manufacturer
THD	Total Harmonic Distortion
TRO	Technical Responsible Officer
TCN	Time Communication Network
UID	Unique Identifier
WBS	Work Breakdown Structure
WI	Working Instruction
XLPE	Cross-linked polyethylene

3.2 Definitions

Table 3-2 Definitions

Term	Definition
The Contractor	Shall mean an economic operator who have signed the Contract in which this document is referenced. The economic operator can be a single entity, a consortium between several entities and includes their sub-Contractors or Supplier, if any.
The Supplier/ the Sub-Contractor	Refers to any lower-tier member of the Contractor's supply chain.
Works Contractor	Works Contractor covers all construction contractors engaged in executing work on or off the site. It covers all the appointed contractors working under this Turnkey Procurement.
Contract Responsible Officer (CRO)	Refers to the IO staff member who has the responsibility of a contract on the IO's side. The CRO approves most of the deliverables, follow-up the Contractor works… For this contract, the CRO and TRO will be the same IO staff member.
Technical Responsible Officer (TRO)	Refers to the IO staff member who has the technical responsibility of a system on the IO's side. The TRO is the main Contractor's contact person for all technical related topics and is the main approver for technical topics. For this contract, the CRO and TRO will be the same IO staff member
Commercial-Off-the-Shelf (COTS)	Refers to ready-made products or solutions that are available for purchase from vendors and can be used directly by consumer.
Works	Any work being performed under the Contract by the Contractor either at their facility or at the IO site.
I&C System	Refers to the hardware and software required to operate the PPEN equipment. Comprises PPEN plant I&C systems and Central I&C systems and I&C networks.
As-Manufactured	The documents being issued by the entity in charge of offsite Manufacturing to record the accurate representation of the Works they have completed, based on the engineering documents provided as input.
As-built	The updated design documentation by the entity in charge of the design that integrates all the As-Constructed and As-Manufactured documents.

4 Applicable Documents & Codes and Standards

4.1 Applicable Documents (AD) and Reference Documents (RD)

This is the responsibility of The Contractor to identify and request for any documents that would not have been transmitted by IO, including the below list of reference documents. This Technical Specification takes precedence over the referenced documents. In case of conflicting information, this is the responsibility of The Contractor to seek clarification from IO.

Table 4-1 Applicable Documents

Ref	Title	IDM Doc ID
AD1	General Management Specification for Service and Supply (GM3S)	ITER_D_82MXQK
AD2	Project Requirement (PR)	ITER_D_27ZRW8
AD3	SRD-41 (Coil Power Supply and Distribution)	ITER_D_28B6XQ
AD4	ITER site Meteorology	ITER_D_2UT36S
AD5	ITER Quality Assurance Program (QAP)	ITER_D_22K4QX
AD6	Quality Requirements for IO Performers	ITER_D_22MFG4
AD7	Procedure for the management of Deviation Request	ITER_D_2LZJHB
AD8	ITER Project Management Plan (PMP)	ITER_D_2NCR3F
AD9	EDH Part 1: Introduction	ITER_D_2F7HD2
AD10	EDH Part 2: Terminology and Acronyms	ITER_D_2E8QVA
AD11	EDH Part 3: Codes and Standards	ITER_D_2E8DLM
AD12	EDH Part 4: Electromagnetic Compatibility (EMC)	ITER_D_4B523E
AD13	EDH Part 5: Earthing and lightning protection	ITER_D_4B7ZDG
AD14	IO cabling rules	ITER_D_335VF9
AD15	Procedure for Management of Nonconformities	ITER_D_22F53X
AD16	Design Development Procedure	ITER_D_U34DDZ
AD17	ITER System Design Process (SDP) Working Instruction	ITER_D_4CK4MT
AD18	Design Review Procedure	ITER_D_2832CF
AD19	Design Interface Control Procedure	ITER_D_28VNJG
AD20	Sign-Off Authority (SOA) for Project Documents	ITER_D_2EXFXU
AD21	MQP L3 Expected content of System Design deliverables	ITER_D_43S7GL
AD22	MQP L3 Working Instruction for Manufacturing Readiness Review	ITER_D_44SZYP
AD23	Procedure for Identification and Controls of Items	ITER_D_U344WG

Ref	Title	IDM Doc ID
AD24	Working Instruction for the Delivery Readiness Review (DRR)	ITER_D_X3NEGB
AD25	Procedure for Transportation of Components to ITER Site	ITER_D_RY5C6Q
AD26	MQP L3 WI for Construction Preparation (EWP/CWP/IWP)	ITER_D_UYGEDA
AD27	MQP L3 Working Instruction for Construction Readiness Review	ITER_D_QXW4KQ
AD28	MQP L3 Working Instruction for Completion Dossier Preparation	ITER_D_UYUSEE
AD29	WI for Commissioning Certificate Readiness (CCR)	ITER_D_ X8LS3F
AD30	MQP L3 Working Instruction for the Qualification of ITER safety codes	ITER_D_258LKL
AD31	MQP L2 Procedure for the CAD management plan	ITER_D_2DWU2M
AD32	General Management Specification for Executing Entities at the ITER Site	ITER_D_YX55YY
AD33	Risk and Opportunity Management Procedure	ITER_D_22F4LE
AD34	Internal Regulations	ITER_D_27WDZW
AD35	MQP L3 Contractor Safety Management Procedure	ITER_D_Q2GBJF
AD36	Health Protection and Safety General Coordination Plan - ITER Construction Site - volume 0- General Safety Rules	ITER_D_2NUEYG
AD37	Environmental requirements	ITER_D_97WRFP
AD38	MQP L0 ITER Policy on Safety, Security and Environment Protection Management	ITER_D_43UJN7
AD39	MQP L3 Contractor Safety Management Procedure	ITER_D_Q2GBJF
AD40	MQP L2 ITER Site access Procedure	ITER_D_S3893D
AD41	MQP L3 Procedure for Occupational Health and Safety Hazard Identification and Assessment	ITER_D_AJLQRF
AD42	Vehicle Access and Traffic Circulation and Parking on the ITER Site	ITER_D_N3MG3V
AD43	MQP L2 Physical Security Protection Management Procedure	ITER_D_TZYDJH
AD44	ITER Numbering System for Components and Parts	ITER_D_28QDBS
AD45	ITER Function Category and Type for ITER Numbering System	ITER_D_2FJMPY
AD46	Quality Classification Determination	ITER_D_24VQES
AD47	Deviation Request Template	ITER_D_2LRNQP
AD48	ITER Site Permit to Work Procedure	ITER_D_3E8289

Table 4-2 Reference Documents

Ref	Title	IDM Doc ID
RD1	ITER Plant Breakdown Structure (PBS)	ITER_D_28WB2P
RD2	Site Plan - ITER Site Map	ITER_D_37UASM
RD3	ITER_41PPAJ_CBD_001: Cabling Diagram 22kV PPEN Part	ITER_D_NPCDVK
RD4	Proposal of PPEN power supply for ECH/ICH under scenario B	ITER_D_983KRX
RD5	Cleat Analysis for PBS41 PPEN 66kV and 22 kV cables	ITER_D_XEGRXZ
RD6	PPEN Cleats Technical Specification	ITER_D_YN9W4F
RD7	Zone 13 - Construction Design. Infrastructure works. Special foundations. Design report. Area 35 -FRA_FH_RG_6P2008_IN_	ITER_D_THU9XD
RD8	Zone 13 - Construction Design. Infrastructure works. Special foundations. Calculation notes. Area35-FRA_FH_CR_6P2008_IN	ITER_D_THTTU5
RD9	D08- GA drawings of civil work - A35	ITER_D_74ALL4
RD10	D09- GA drawings - cable galleries and cable trays, conduits	ITER_D_74B7KU
RD11	D10- As-built drawing in A35 for the concrete foundations of AC circuits	ITER_D_74FC5W
RD12	D11- As-built drawings in A35 container for the protection and control of AC circuits	ITER_D_74FH6L
RD13	D19- GA drawings of new AC circuits in A35 (incl. protection and control container)	ITER_D_74FJMG
RD14	D20- GA drawings (CBD) of cables/fibres in A35 and cable galleries	ITER_D_74FFNU
RD15	PPEN - 66 kV Bay 1 Functional Diagrams (II). Additional Boxes	ITER_D_33Z97R
RD16	PPEN - 66 kV Bay 2 Functional Diagrams (II). Additional Boxes	ITER_D_33UR8Q
RD17	PPEN - 66 kV Bay 3 Functional Diagrams (II). Additional Boxes	ITER_D_346B9E
RD18	41PPCM-CU-1000 66kV Control & Protection Cubicle -1 Eletrical Wiring Diagram	ITER_D_E79ER9
RD19	Interface Control Document between PPEN (PBS41.PP) and AC/DC Converter	ITER_D_2KSK3W
RD20	Interface Sheet IS-41PPAF-41_66kVConverters-001	ITER_D_GJZ52A
RD21	Interface Sheet IS-41PPAF-41_66kVConverters-002	ITER_D_GJXJNQ
RD22	ITER_41PPAF_CBD_003 66kV Power and I&C Cabling Diagram	ITER_D_WGL2DZ
RD23	Interface Control Document between Pulsed Power Electric Network (PBS 41. PP) and Cable Tray Systems (PBS44)	ITER_D_D7RJM4
RD24	ICD-41-45 Interface Control Document for Coil Power Supply & Distribution (PBS 41) and CODAC (PBS 45)	ITER_D_2NKSW9
RD25	IS-41-45-005 Interface between PHV and CODAC	ITER_D_RRHSLC
RD26	M02_PPEN_S06_Technical_Datasheets	ITER_D_QEY2ST
RD27	M05_PPEN_S06_Manual_Installation	ITER_D_QPGAHK

Ref	Title	IDM Doc ID
RD28	PPEN 22kV Switchgear Layout -FRA_FH_DW_1P2076_EL	ITER_D_DMM5ZC
RD29	Interface Sheet "IS-41. PP-51. HV-001"	ITER_D_3F85YN
RD30	IS-41.PP-52-001_Interface between 22kV Power Supply of PPEN & Electron Cyclotron H&CD system (B15)	ITER_D_3FZXPK
RD31	22 KV AC Cells: Layout and single line diagram	ITER_D_UJ4AAP
RD32	PPEN 66kV Circuit breaker GL100X with FK3-1 functional diagram-ITER_41PPAF-BJ-1100_EWD_01	ITER_D_EJX8F4
RD33	PPEN-66 kV Bay 1 Functional Diagrams disconnector switch and earthing switch-ITER_41PPAF-BJ-1000_EWD_01	ITER_D_ELBUZC
RD34	M02_PPEN_S07CABLE_Technical_Datasheets	ITER_D_P73TUS
RD35	I&C cubicle internal configuration	ITER_D_4H5DW6
RD36	ITER catalogue for I&C products - Cubicles	ITER_D_35LXVZ
RD37	Plant Systems Factory Acceptance Plan for I&C systems	ITER_D_3VVU9W
RD38	SSEN and PPEN Factory Acceptance Tests for IEC61850 systems	ITER_D_3ZS356
RD39	IO cable catalogue	ITER_D_355QX2
RD40	PPEN Input Data for the RAMI Analysis	ITER_D_4ECMHS
RD41	How to guide for computing required number of spare parts	ITER_D_27N358
RD42	In Work CAD Manual for See Electrical V4R2	ITER_D_V3GW3R
RD43	Template for SDR Input Data Package	ITER_D_TWW7AY
RD44	Software Qualification Policy	ITER_D_KTU8HH
RD45	SEE System Design folder (How to) <folder>	ITER_D_2EDQYH
RD46	41.DCIF for PPEN upgrade for MCPC Stage 2 and ICH&ECH SRO Contract	ITER_D_EMWQ34
RD47	CAD Manual 10 - CAD Access and Support	ITER_D_9XJU3X

4.2 Applicable Codes and Standards

The Contractor shall be responsible to procure the relevant Codes and Standards applicable to the scope of this Technical Specifications. The latest applicable versions of Codes and Standards shall be referenced.

Table 4-3 Applicable Codes and Standards

Ref	Title
CS1	NF C13-200: High voltage electrical installations for electrical energy production sites, industrial, commercial, and agricultural sites
CS2	NF C15-100: Low-voltage electrical installations
CS3	NF C18-510: Operations on electrical network and installations and in an electrical environment - Electrical risk prevention
CS4	IEC 60947: Low-voltage switchgear and controlgear
CS5	IEC 60529: Degrees of protection provided by enclosures (IP Code)
CS6	IEC 61000-6-2: Electromagnetic compatibility (EMC) - Part 6-2: Generic standards
CS7	IEC 61000-6-4: Electromagnetic compatibility (EMC) - Part 6-4: Generic standards
CS8	ISO 9001: Quality management
CS9	IEC 60664: LV Insulation coordination
CS10	IEC 60034: Rotating electrical machines
CS11	Eurocode 8: Design of structures for earthquake resistance. General rules, seismic actions, and rules for buildings
CS12	Directive 2014/35/EU- Low Voltage Directive (LVD)
CS13	Directive 2006/42/EC- Machinery Directive
CS14	Directive 2014/30/EU-EMC Directive
CS15	Directive 1999/519/EC-on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)
CS16	EU Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
CS17	EU Directive 2002/96/EC on waste electrical and electronic equipment (WEEE)

Note: **CS1, CS2 and CS3 are French regulatory standards which shall be complied with during full lifecycle of the execution of this Turnkey contract.**

In addition, the component design, manufacturing and test procedures for the circuit breakers, disconnectors, earthing switches, instrumentation transformers, and cables shall comply at least with the codes and standards of relevant chapters.

5 Ambient Conditions

The design climatic conditions must be in accordance with *ITER Site Meteorology* [AD4]. In case there are differences between the values indicated in *SRD-41 (Coil Power Supply and Distribution)* [AD3] and [AD4], the values indicated in [AD3] prevail.

5.1 Environmental Outdoor Conditions at site

The following are the climatic and environmental parameters applicable to electrical equipment located outside:

Site altitude	315 m
Temperature range:	
Absolute maximum	+40ºC
Absolute minimum	-25ºC
Average temperature over 24-hour period:	
Absolute maximum	+35ºC
Absolute minimum	-5ºC
Extreme wind speed (10m above ground)	29m/s (104 km/h)
Relative humidity	
24-hour average	≤ 95%
30-day average	≤ 90%
Ice coating	≤ 10 mm
Snow loads	≤ 150 kg/m2
Insolation	~1000 W/m2 more than 2500hrs/y
Pollution Level (according to IEC 60071-2)	1 (Light)

5.2 Environmental Indoor Conditions at site

As a reference, the following ambient conditions inside 66kV Substation container shall be considered:

Table 5-1 PPEN 66kV Substation container conditions

Containers	Max/Min Temp (ºC)	Relative Humidity (%)
Substation relay room	30/20	60 ± 10
Gallery	40	Not controlled

5.3 System and Components Classifications

The classification of the components is defined as follows, in accordance with [AD3] and *ITER Quality Assurance Program* [AD5]:

- Quality: QC-3
- Seismic class: NSC

The following seismic requirements are in accordance with the ones indicated in *Project Requirements* [AD2] Section 7.4.3.2.
PPEN 66 kV equipment are classified as Non-Seismic Components (NSC). This equipment and its support structures shall be designed to withstand SL-1 earthquakes with 0.05 g peak horizontal and vertical ground acceleration.
The equipment manufacturer shall demonstrate adequately the compliance of the equipment and structures with the acceleration required indicated above.

5.4 Operation Requirements and Restrictions

The substation manufacturer shall confirm that 66 kV switchyard equipment is able to withstand without any damage or malfunction the operation requirements and restrictions described as indicated in [AD3].

5.4.1 Voltage Variations

66 kV and 22kV switchyard equipment shall be designed to operate with a grid rated voltage of 400 kV with a daily and seasonal variation of ±5% corresponding to a nominal range of 380-420 kV.
Other less frequent variations of the incoming 400 kV supply (not including PPEN AC distribution system voltage drop) are possible as indicated in table hereafter.

Table 5-2 PPEN 400kV voltage variation

	Variation	Voltage
1 hour, 1 time per year	-20% to -15 %	320 to 340 kV
1.5 hour, 5 time per year	-15% to -10 %	340 to 360 kV
5 hours, 10 times per year	-10% to -5 %	360 to 380kV
20 minutes, several times per year	+5% to +6 %	420 to 424 kV
5 minutes, a few times per year	+6% to +7 %	424 to428 kV
5 minutes, once every 10 years	+7% to +10%	428 to 440 kV

Note:Some Short period voltage dips (according to RTE network statistics) are observed. These short period voltage dips could be discarded.

The 66 kV and 22kV equipment and cable and accessories shall be designed taking into account the following voltage variations respectively:

Table 5-3 PPEN 66kV voltage variation

Nominal voltage	Nominal voltage range	Nominal voltage range
66 kV	94% - 110%	62 kV to 72 kV
22 kV	90% - 110%	19.8 kV to 24 kV

5.4.2 Frequency Variations

66 kV and 22kV equipment shall be designed to operate with a nominal grid frequency of 50 Hz with a daily and seasonal variation of ±1% corresponding to a nominal range of 49.5-50.5 Hz. Other less frequent variations are possible as indicated in table hereinafter.

Table 5-4 PPEN 66kV&22kV frequency variation

	Variation	Frequency
1 minute, once every 5 to 10 years, exceptionally	-6 to -5 %	47 to 47.5 Hz
3 minutes, once every 5 to 10 years, exceptionally	47.5 to 49 Hz	47.5 to 49 Hz
5 hours continuously, total 100 hours during service life	-2% to -1%	49 to 49.5 Hz
1 hour continuously, total 15 hours during service life	+1% to +2%	50.5 to 51 Hz
15 minutes, 1 to 5 times per year	+2% to +4%	51 to 52 Hz
1 minutes exceptional (transitional regime)	+4% to +10%	52 to 55 Hz

5.4.3 Harmonic Contents

Special attention shall be given to the heating effect of the harmonics. The increased eddy and stray current losses due to harmonic currents shall also be minimized. Any additional losses due to fundamental and high frequency harmonics shall be taken into account.
The harmonic voltage τ_h, expressed as a percentage of the supply voltage, shall not exceed the thresholds given in the following table (compatibility level of harmonic voltage), and the total rate τ_g shall not exceed 4.8% where:

$$\tau_g = \sqrt{\sum_{k=2}^{40} \tau_k^2}$$

The effective value of each harmonic shall be measured in accordance with the standard IEC 61000-4-30, with a time interval of 10 minutes.
In addition, the 66 kV equipment shall be able to support without damage and overheating the following harmonic levels:

Table 5-5 PPEN Harmonic Filtering Requirements

Odd Harmonics: Non multiple of 3			Odd Harmonics: multiple of 3			Even Harmonics		
Order	Harmonic Voltage (%)		Order	Harmonic Voltage (%)		Order	Harmonic Voltage(%)	
	66kV	22kV		66kV	22kV		66kV	22kV
5	2	6	3	2	5	2	1.5	2
7	2	5	9	1	1.5	4	1	1
11	1.5	3.5	15	0.3	0.3	6	0.5	0.5
13	1.5	3	21	0.2	0.2	8	0.4	0.5
17	1	2	> 21	0.2	0.2	10	0.4	0.5
19	1	1.5				12	0.2	0.2
23	0.7	1.5				> 12	0.2	0.2
25	0.7	1.5						
> 25	0.2+0.5(25/h)	0.2+1.3(25/h)						

The maximum total harmonic distortion (THD) that PPEN equipment shall support without damage and overheating as [AD3] are:

- 400kV and 66kV: THD ≤ 3%.
- 22kV: THD ≤ 8%.

6 Scope of Supply and Installation

This chapter defines the scope of this Turnkey Procurement, incl. designs, supply, installation, and test & commissioning, for the PPEN 66kV system stage 2 and 22kV cable installation and termination for SRO HCD system located in B15 North and B20.

6.1 For 66kV Equipment and Components

It includes the ten (10) 66kV outdoor air-insulated feeder modules in A35, connecting to main busbars of each bay by means of flexible aluminium conductor, and 66kV cables and its accessories.

6.1.1 Electrical Equipment per each feeder module

The assembly of each feeder modules is comprised of the following equipment as indicated in Appendix 16.3.1

- One (1) three-pole air-insulated disconnector with associated earthing switch for outdoor installation, manufactured and tested in accordance with IEC 62271-102. Refer Appendix 16.1.2 for the datasheet and and Appendix 16.2.1 for the identifications.
- One (1) three-pole SF6 insulated circuit breaker for outdoor installation, manufactured and tested in accordance with IEC 62271-100. Refer Appendix 16.1.3 for the datasheet and Appendix 16.2.2 for the identifications.
- One (1) three-pole air-insulated earthing switch for outdoor installation, manufactured and tested in accordance with IEC 62271-102. Refer Appendix 16.1.4 for the datasheet and Appendix16.2.3 for the identifications.
- One (1) set of three (3) current transformers with three (3) cores, one core for measurement and two cores for protection, manufactured and tested in accordance with IEC 61869-2. Refer Appendix 16.1.5 for the datasheet and Appendix 16.2.4 for the identifications.
- One (1) set of three-phase, 66 kV aluminium alloy flexible conductor (ASTR 570) for feeder module. Conductors shall be manufactured and tested in accordance with IEC 61089.

6.1.2 Steel Structures

The following structures are to be included in the scope of supply:

- Metal structures for 66 kV feeder modules to support the electrical equipment including 66kV circuit breaker, 66kV disconnector switch, 66kV earthing switch, 66kV current transformer, 66kV cable and terminations, auxiliary power distribution box, 66kV cable earthing boxes etc.

- Anchorages of all the installed equipment, including all necessary material, like screws, bolts, etc.

The dedicated support structure for the different equipment (CB, DS, CT, ES etc) shall be defined taking account of the equipment manufacturer's requirement, and respects the constrains of the anchorages which had been constructed as introduced in Section 7.1.1.

Refer to Appendix 16.3.3 for an indicative representation of the assembly of 66kV Stage 1 components and metallic structures as reference.

6.1.3 Protection and Control Cubicles

The five (5) Protection and Control cubicles for the ten (10) air-insulated 66kV feeder modules will be located inside 66kV substation container.
Each cubicle will accommodate the components for the control and protection of two feeder modules and Ethernet switch. Refer to Appendix 16.1.6 for the datasheet of Protection and Control cubicles and Appendix 16.2.6 for the quantity for the relays and Ethernet switch.
The spaces are reserved for these Protection and Control cubicles for PPEN 66kV Stage 2. Refer Section 7.1.3 and Appendix 16.3.2 for the information.

6.1.4 Auxiliary Power Services

The auxiliary power services situate in 66kV substation container as introduced in Section 7.1.3.2. It consists of following services.

- 400/230 V AC system provides power supply for substation container loads, heating and local lighting of all outdoor equipment, 48 V DC system and 230 V AC UPS.
- 230 V AC UPS system provides power supply for motors of HV switching equipment and auxiliary services inside 66kV substation container.
- 48 V DC system provides power supply for control, communication, and Protection and Control cubicles.

There are spare feeders inside each 400/230VAC distribution boards.

- 41PPAF-BD-1100: four spare F1, F10, F11,F12
- 41PPAF-BD-1200: F1, F9~~F22, F28, F29

Refer to Appendix 16.5.1 for the single line diagram of AC distribution boards.

There are three spare feeders (2x iCH65L C25 2P, 1x iCH65L C32 2P) inside each UPS 230VAC distribution boards as following.

- 41PPAF-BD-2100: 1QF01, 1QF02, 1QF12
- 41PPAF-BD-2200: 2QF01, 2QF02, 2QF12

Refer to Appendix 16.5.2 for the single line diagrams of UPS distribution boards.

There are three spare feeders (iCH65H DC 32 2P) inside each 48VDC distribution boards as following.

- 41PPAF-BD-3100: 1QF01, 1QF02, 1QF12
- 41PPAF-BD-3200: 2QF01, 2QF02, 2QF12

Refer to Appendix 16.5.3 for the single line diagrams.

The Contractor shall validate if these MCB need to be replaced after MRR.

In case of replacement or modification on these spare feeders, the modification and replacement shall be in the scope of supply, and update the related schematics and Single Line Diagrams.

6.1.4.1 Auxiliary power for Protection and Control cubicles

The Contractor shall be responsible for the design, supply and connection of auxiliary powers from the existing auxiliary power services, for Protection and Control cubicles pertaining to the ten (10) 66kV feeder modules.
The Contractor shall validate the cable sizing via CANECO with the loads of selected component and equipment after MRR.

6.1.4.2 Auxiliary power for Sub-distribution boards in field

Ten (10) sub-distribution boards are to be included in the scope of supply as shown in Appendix 16.2.5 These sub-distribution boards distribute auxiliary power to each equipment in the same feeder module, including DS, CB, ES, CT.
Since the ten (10) feeder modules were not in place at PPEN 66kV stage 1 installation stage, the ten (10) sub-distribution panels had been skipped.
The Contractor should reconfigure the auxiliary power network of sub-distribution panel as the permanent configuration indicated in [RD15], [RD16] and [RD17] at Installation stage.
The power consumption of heating and charging motors of each electrical boxes of DS, CB, ES, CT being covered by this Technical Specification are supposed to be similar as the consumption of its equivalent equipment of PPEN 66kV stage 1.
The power consumption of each individual component might deviate from this assumption, then significant deviation might impact the cable sizing. The Contractor shall consider the assumption taken at PPEN 66kV Stage 1 for heater and charging motor and avoid this situation as far as possible.

6.1.5 Cable Trays

Cable trays had been installed for PPEN 66kV stage 1, including cable trays inside the galleries and under 66kV substation container as introduced in Section 7.1.2.
The Contractor needs to investigate if additional cable trays and supports are necessary for PPEN 66kV stage 2 in the shallow trenches and under 66kV substation container.
The Contractor shall be responsible for the design and installation of the secondary cable trays and supports, fixations, outside of the main cable trays which are already constructed by others and seal of the openings after the completion of cable pulling.

6.1.6 Earthing and Lightning Protection System

All earthing cables and fittings pertinent to the ten (10) 66kV feeder modules shall be included in the scope of supply.
The Contractor shall be responsible to earth all equipment and metallic structure to the buried earth system via the pigtails as per NF C13-200. Refer Section 7.1.1 for more details of interfaces in A35.

6.1.7 66kV Cables and Accessories

66 kV insulated cables and accessories, in accordance with the characteristics set out in Section 8.6, for the connection of the 66 kV substation feeder modules to the 66 kV consumers, include the following:

- Single-core 66 kV cable with dry extruded insulation made in cross-linked polyethylene (XLPE).
- Outdoor cable terminations (porcelain insulator type), complete with all their accessories, for the connection to the 66 kV substation feeder modules on the 66 kV AIS supports.
- Outdoor cable terminations (porcelain insulator type), complete with all their accessories, for the connection to the 66 kV consumers located at B32 and B33.
- Supports, clamps, bolts, etc, as required to support the 66 kV cable terminations installed at PPEN 66kV switchyard (A35) and B32&B33 side.
- Supports, bolts, screws, clamps, bolting, tapes and any other material that is necessary for the supporting and fastening of the 66 kV cables in all their length.
- The cable cleats shall meet with the requirement of [RD5] and [RD6].
- The Contractor shall define the bill of materials of cleats corresponding to the characteristics of cleats to be selected.
- The tape shields in 66kV power cables shall be earthed at both ends. Fully equipped boxes for connection and protection of the 66 kV cable shields, as required in accordance with the shield earthing system that is applied.

Refer to Appendix 16.2.7 for the list of the ten (10) circuits regarding cable section per 66kV feeder, cable terminations.

6.1.8 I&C interface cable for MCPC stage 2

The interfacing I&C cables with MCPC Stage 2 power converters in B32 and B33 are defined in [RD21], including the signals for synchronization signal, hardwired wire signals.

Refer Section 16.2.9 for a preliminary list for I&C cables. These I&C cables would be confirmed at FDR.

6.1.9 Other Components included in the Scope of Supply

- Connectors required for the joining of the supplied equipment, including connection to main 66 kV tubular busbar of each bay, the connection to 66kV AC disconnector switches of MCPC stage 2 located at B32 and B33.
- All interconnecting cables and connectors between the supplied equipment components.
- All I&C cables between the supplied equipment (switchyard equipment) and the substation container equipment.
- Interconnecting Fiber Optic cables or patch cords, I&C cables and connectors with the existing 66kV systems if applicable.
- One (1) set of special tools which the Contractor deems necessary for plant maintenance during operation or site erection.
- Spare parts and consumables necessary for substation pre-commissioning, testing, commissioning, and insurance.
- Spare parts necessary to carry out maintenance work (special tools, test and verification equipment, accessories, back-up copies of the source code, maintenance programs, etc)
- Spare parts recommended for five (5) years of operation as option.

6.2 For 22kV Equipment and Components

6.2.1 22kV cables and accessories

There are nine (9) circuits of 22kV cables had been installed between 22kV GIS room located in B32 and B15 North. Further to H&CD upgrade in Baseline 2024, eight (8) circuits must be reconfigured for ECH SRO. One (1) circuit need to be shortened from B15 to B20 for ICH SRO.

The following works shall be included in the scope of supply:

- Rearrange nine (9) triplex cables under the platform of 22kV GIS room and reinstall the window CT as per new configuration [RD3] and [RD4].
- Shorten one (1) circuit and connect them to 22kV switchgears in B20 as defined in [RD4] and Appendix 16.2.8
- Rearrange eight (8) circuits and connect them to 22kV switchgears in B15-L1-03 North as defined in [RD4] and Appendix 16.2.8.

- Five (5) new 22kV circuits will be included in the scope of supply for the connection between PPEN 22kV GIS switchgear located in 32-L1-02 and 22kV AIS located in 15-L1-03 North and B20, including the 22kV cables and accessories listed in Appendix 16.2.8.

  - B15-L1-03 North: Two (2) new circuits consist of 240mm^2 Single-core 22 kV cable with dry extruded insulation made in XLPE.

  - B20: Three (3) new circuits consist of 150mm2 Single-core 22 kV cable with dry extruded insulation made in XLPE.

In addition, the following materials and works shall be included in the scope of supply:

- Plug-in Cable terminals, complete with all their accessories, for the connection to the 22 kV GIS switchgears.
- AIS Cable terminations, complete with all their accessories, for the connection to the 22 kV consumers.
- Supports, bolts, screws, cable cleats, bolting and any other material that is necessary for the supporting and fastening of the 22 kV cables in all their lengths.

  The cable cleats shall meet with the requirement of [RD5] and [RD6].

  The Contractor shall define the bill of materials of cleats corresponding to the cleats to be selected.
- The tape shields and/or armours in power cables shall be earthed at both ends directly. Fully equipped earthing materials for connection and protection of the 22 kV cable shields, as required in accordance with the shield earthing system that is applied.

Refer Section 16.2.8 for more details for 22 kV insulated cables and accessories, in accordance with the characteristics set out in Section 8.6.

6.2.2 Other Components and installation Included in the Supply

- One (1) set of special tools which the Supplier deems necessary for plant maintenance during operation or site erection.
- Spare parts and consumables necessary for cables pre-commissioning, testing, commissioning, and insurance
- Spare parts necessary to carry out maintenance work (special tools, test and verification equipment, accessories, maintenance programs, etc)
- Spare parts recommended for five (5) years of operation as option.

6.3 Services included.

The following services for both 66kV and 22kV system mentioned in Section 6.1and 6.2 shall be in the scope of supply:

- Packing and transport.
- Source code and licensing of all software installed in the supplied equipment.
- Performance of the tests indicated in Sections 8.1.4, 8.2.9, 8.3.3, 8.4.4, 8.5.3 and 8.6.3.
- Supply of the documentation required in Sections 8.1.7, 8.2.10, 8.3.5, 8.4.6, 8.5.4 and 8.6.6.
- Preparation of As-built documentation to include changes on site and/or drawings errors.
- Develop Assembly & Installation procedures and test procedures.
- Supervision and coordination of erection, testing and commissioning, including Site Acceptance Test (SAT).
- Initial regulatory inspection by a third-party legal inspector during Design, assembly&Installation stages..
- Mechanical completion dossier.
- Handover

6.4 Supply and Installation Limits

6.4.1 PPEN 66kV system stage 2

- For the 66kV main busbar side, the limit of supply shall be the connection with the existing 66 kV tubular busbars.
- For the 66kV load side, the limit of supply shall be the connection to the 66kV disconnector switches of MCPC stage 2 located around B32 and B33.
- For the I&C interfacing cables with MCPC stage 2, the limit of supply shall be the terminals of respective Local Control Cubicle (LCC) located inside B32 and B33.
- For IEC 61850 FO network, the limit of supply shall be the connection to 66kV Common Control panel (41PPCM-CU-0001).
- For the cubicle monitoring Ethernet network, the limit of supply shall be the connection to 66kV Communication panel (41PPCM-CU-0002).
- For the LV power cables, the limit of supply shall be the terminals of respective 400/230 V AC distribution boards, 230V AC UPS distribution boards and 48V DC distribution boards located in 66kV substation container.
- For the auxiliary power services for outdoor equipment, the limit of supply shall be the terminal block of the adjacent BP panels.
- The limit of supply for the earth system shall be the connection points of the buried earthing grid.

- For civil works, the limit of supply is the fixation of metallic structure on the anchorages which had been delivered by others.

6.4.2 PPEN 22kV system

- For 22kV GIS switchgear side, the limit of supply shall be the connection of 22kV cables to the cable housings of 22kV GIS switchgears.
- For load sides, the limit of supply shall be the connection to the Connecting bar inside the cable compartment of 22kV AIS switchgears in B15-NORTH and in B20.
- The limit of supply for the earthing of 22kV cables screen shield shall be the connection point of the local earthing systems in 22kV GIS switchgear room, inside B15-NORTH and B20 respectively.

6.5 Equipment and Services Supplied by Others

- Foundations for 66kV equipment and its support structures in A35.

  The Contractor shall respect the constrains of the built foundations and verify if the foundations are strong enough to support the equipment and structures to be supplied by the Contractor. Refer to Section 7.1.1 about the constructed concrete.

- Embedded conduit pipes.

  The buries conduits are already in place for each 66kV feeder module. The Contractor shall install additional buried conduits ONLY if they are required as per the Assembly & Installation design of PPEN 66kV system stage 2.

- Cable trenches and cable trays inside the trenches.

  The Contractor shall be responsible to remove the covers of shallow trenches before pulling cables and restore them after pulling cables.

- PPEN 66kV Lightning protection.
- PPEN 66kV Buried earth system.
- PPEN 66 kV Equipment outdoor lighting.
- Main cable trays inside the cable trench, cable gallery and building not covered by Section 6.1.5.

7 Interfaces

For the scope of works mentioned in Chapter 6, there are interfaces to be considered for the scope of supply of this Turnkey Procurement.

7.1 PPEN 66kV System

The Contractor shall take into account both physical interfaces and functional interfaces, in particular the concrete foundations and cable trays had been constructed by others and compile the design deliverable accordingly for Preliminary Design and Final Design etc. for PPEN 66kV system Stage 2.

7.1.1 Concrete Foundations 66kV Switchyard in A35

The following reference document are provided regarding the concrete foundations located in A35.

- *Zone 13 - Construction Design. Infrastructure works. Special foundations. Design report. Area 35 - FRA_FH_RG_6P2008_IN* [RD7].
- *Zone 13 - Construction Design. Infrastructure works. Special foundations. Calculation notes. Area 35 - FRA_FH_CR_6P2008_IN* [RD8].
- *D08- GA drawings of civil work - A35* [RD9].
- *D10- As-built drawing in A35 for the concrete foundations of AC circuits* [RD11].

7.1.2 Shallow trench, Cable Gallery and Cable Tray

The following reference document are provided regarding the shallow trench in A35, the galleries and cable trays to B32/33.

- *D09- GA drawings - cable galleries and cable trays, conduits* [RD10].
- *D20- GA drawings (CBD) of cables/fibres in A35 and cable galleries* [RD14].

7.1.3 PPEN 66kV Switchyard and Substation Container

7.1.3.1 Layout

The 66kV switchyard had been constructed and the spaces are reserved for the ten (10) circuit of PPEN 66kV Stage 2. The as-built survey is available as follows:

- *D11- As-built drawings in A35 container for the protection and control of AC circuits* [RD12].
- *D19- GA drawings of new AC circuits in A35(incl. protection and control container)* [RD13].

The Contractor shall update and optimize the layout as per the equipment procured for Final Design and Assembly and Installation Preparation.

7.1.3.2 Auxiliary Power Service inside Substation Container

The main auxiliary power services had also been installed inside 66kV substation container as follows:

- Two (2) sets 400/230 V AC switchgear, 3Ph + N + PE (TN-S)
- Two (2) sets 230 V AC UPSs (batteries, battery chargers, inverters, bypass transformer, static and maintenance switches and AC distribution panels)
- Two (2) sets 48 V DC systems (batteries, battery chargers and DC distribution panels)

The Contractor shall be responsible for the connection to the terminal block of LV distribution boards for the power supply of Protection and Control cubicles pertinent to the ten (10) 66kV feeder modules as described in Section 6.1.3.

7.1.3.3 Auxiliary Power Service in 66kv Switchyard

In each 66kV feeder module, one sub-distribution panel is configured to distribute auxiliary power to disconnector switch, earthing switch and current transformer.
Since the ten (10) feeder modules were not in place at PPEN 66kV stage 1 installation stage, the ten (10) sub-distribution panels had been skipped.
The Contractor should reconfigure the auxiliary power network of sub-distribution panel as the permanent configuration indicated in [RD15], [RD16] and [RD17] at Installation stage.
The interface for the auxiliary power connection is the adjacent BP panels of those ten (10) feeder modules.

7.1.4 Interface with existing IEC 61850 Subring

IEC 61850 architecture inside PPEN 66kV substation container is illustrated in following document and Figure 7-1 and Appendix 16.4.1.

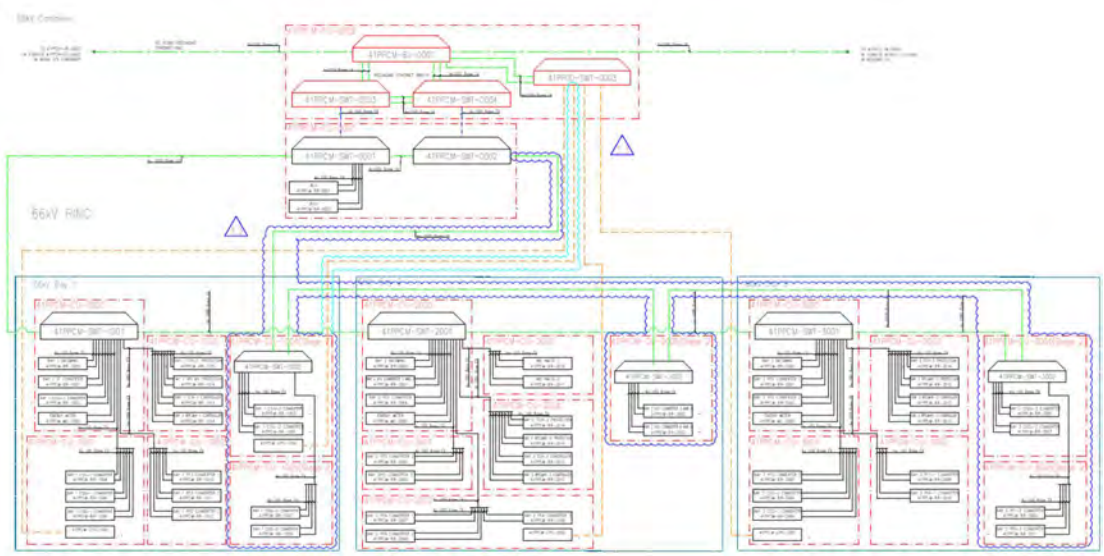


Figure 7-1 IEC61850 Communications Architecture, 66kV. Container Subring

The IEDs of PPEN 66kV Stage 2 are indicative. The new ten IEDs shall be connected to Ethernet switches with multimode fibres and then to communication cubicle (41PPCM-CU-0001) with Single mode FO fibre.
The Contractor shall confirm the IEC 61850 architecture at Preliminary Design.
The Contractor shall be responsible for the intercommunication and interoperability between Substation automation of PPEN 66kV stage 2 with those of PPEN 66kV stage 1, and update HMI (PACiS) accordingly and provide necessary information to integrate those new relays into ITER Central Control System CODAC (IEC61850 addresses, datasets and RCB configured, relays IPs, etc...).

7.1.5 Coil Power Supply & Distribution (PBS41)

PPEN 66kV system deliver pulsed power to MCPC system via insulated 66kV cables.
The power converters of MCPC Stage 2 require signals for phase synchronization and exchange information directly with PPEN via hardwired cabling.
The scope boundaries of MCPC stage 2 and the PPEN 66kV Stage 2 are defined in Interface sheets and Figure 7-2.

- Interface Control Document between PPEN (PBS41.PP) and AC/DC Converters (PBS41.xx) [RD44].
- Interface Sheet IS-41PPAF-41_66kVConverters-001 [RD20].
- Interface Sheet IS-41PPAF-41_66kVConverters-002 [RD21].

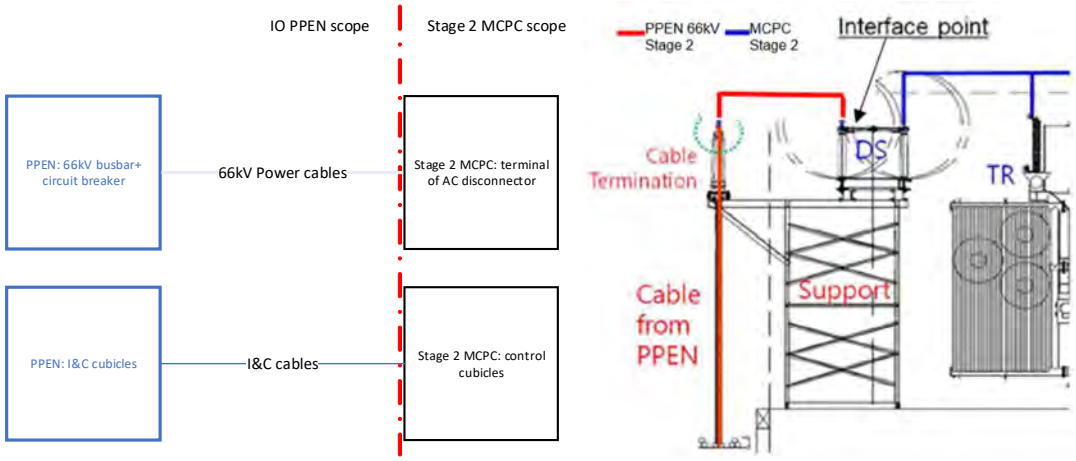


Figure 7-2 Boundary of PPEN and MCPC Stage 2 Power Converter

Supplier of MCPC Stage 2

The Contractor shall also provide technical information of 66kV cables and termination, grounding boxes so that the Supplier of MCPC stage 2 can design the metallic structures for the fixation of 66kV cables and its accessories accordingly.

Then the Supplier of MCPC stage 2 will provide the detailed drawings of the metallic structures after its FDR.

At Assembly and Installation stage, the Contractor shall be responsible to fix 66kV cables and its accessories on the metallics structure of 66kV disconnector switches of MCPC stage 2 with proper cleats and clamps, and then complete 66kV cable termination and connect the 66kV cable termination to the stud or plate of 66kV disconnector switches of MCPC stage 2 with flexible conductors.

For I&C interfaces, the Supplier of MCPC Stage 2 will provide final technical requirements after its FDR. The Contractor shall verify the cable sizes listed in Appendix 16.6 and *ITER_41PPAF_CBD_003 66kV Power and I&C Cabling Diagram* [RD22].

7.1.6 Cable Trays System (CTS, PBS44)

IO PBS 44 (Cable Trays System) is responsible for the appropriate design of the cable trays and management of the cables routed in trays. PBS 44 will provide the requirement for the space allocation of the cable tray for all HV/MV power cables and LV cables in compliance of the CTS requirements.

The selection of the cable trays will take into account segregation and others specific requirement.

PBS44 manages the passages of all HV/MV power cables, LV power cables, I&C cables and FO cables in the scope of supply of this Technical Specification. All cables shall be routed in cable trays and conduits. The material selection and cable routing shall comply with the relevant rules of ITER project.

The Contractor shall provide cable lists including the number of cables, their sizes and the start/end points to PBS 44 for routing LV power cable and I&C cables within A35 and 66kV substation container as well.

The description on the interface is detailed in Interface Control Document (ICD) and relevant Interface Sheet (IS) .

- *Interface Control Document between Pulsed Power Electric Network (PBS 41.PP) and Cable Tray Systems (PBS44)* [RD23].

7.1.7 Control, Data Access and Communication (CODAC, PBS45)

CODAC (PBS 45) system is the central (supervisory) control system for the conventional plant control systems of the ITER I&C architecture. PBS 45 provides the Central I&C network and the I&C Integration Kits as the interface infrastructure for the software and hardware, to ensure communication between CODAC and the Plant systems. The CODAC system provides plantwide data monitoring, alarm handling, error logging, data visualisation, data handling, data storage, global operation state management, operation schedule management, automated pulse execution and plasma control functions for the overall ITER operation.
The following networks that are supplied by CODAC to achieve the communication with and control of PPEN substation:

- The plant operation network (PON) is used to transmit information not used for plasma control.

The relevant interface document with PBS45 are as follows:

- *ICD-41-45 Interface Control Document for Coil Power Supply & Distribution (PBS 41) and CODAC (PBS 45*) [RD24]
- *IS-41-45-005 Interface between PHV and CODAC* [RD25].

7.2 PPEN 22kV system

As specified in Section 6.2, the Contractor shall reconfigure nine (9) circuits and pull 22kV cables for the five (5) new circuits, and connect 22kV cables as listed in Appendix 16.2.8 to 22kV GIS switchgear (Siemens 8DA10) and to AIS switchgears for ECH located in B15 and ICH located inside B20.
For the 22kV cables of the nine circuits which had been laid to B15-North, refer [RD34] for more details of the 22kV cables.
The Contractor shall take into account the interfaces, in particular the constructed facilities and cable trays, in the scope of supply.

7.2.1 22kV GIS switchgear and layout

- *M02_PPEN_S06_Technical_Datasheets* [RD26].
- *M05_PPEN_S06_Manual_Installation* [RD27].
- *PPEN 22kV Switchgear Layout -FRA_FH_DW_1P2076_EL* [RD28].
- Proposal of PPEN power supply for ECH/ICH under scenario B [RD4]

7.2.2 PPEN 22kV interfaces with ECH 22kV switchgear and ICH 22kV switchgear

The following reference document shall be taken into account.

- *Interface Sheet "IS-41. PP-51. HV-001"* [RD29].
- *IS-41.PP-52-001_Interface between 22kV Power Supply of PPEN & Electron Cyclotron H&CD system (B15)* [RD30]
- *22 KV AC Cells: Layout and single line diagram* [RD31].

Both ECH 22kV switchgear and ICH 22kV switchgear are air-insulated switchgear.
The detailed technical document and layout drawings of these 22kV switchgear will be provided by IO PBS51 (ICH) and PBS52 (ECH) after its FDR respectively.
At assembly and Installation stage, the Contractor shall be responsible to connect 22kV cables and cable termination to the 22kV GIS switchgear and the plate of 22kV AIS switchgears at both sides.

7.2.3 PPEN cable gallery and cable trays

In addition to the interface described in Section 7.1.6, a dedicated HOP will be issued by PBS44 for 22kV cable pulling after FDR of this Turnkey Procurement, including cable tray layout, routing report, pulling card etc.

Regarding the cable trays under the false floor of EC switchgear room (15-L1-03 North), the cable trays had been installed for a different configuration in terms of cubicle layout. The Contractor shall be responsible for the rearrange the cable layout if necessary.
Regarding the cable trays inside B20, the cable trays will be designed by IO PBS44 design team.

8 Design Requirements

8.1 66kV Switchyard Equipment

The switchyard equipment included in this specification shall comply with the design requirements described below.
The purpose of the substation description and associated equipment specifications contained in this document and its appendices is to establish the general criteria to be followed by the Contractor.
The Contractor's final design and selection of equipment shall be such that an optimum solution is attained from the points of view of quality, safety, operating costs, maintenance facilities, etc. Preference will be given to simple designs with standardised, proven equipment.
It is the responsibility of the Contractor to ensure that all equipment and installations supplied form a harmonic, functional, complete assembly to facilitate the correct operation, supervision and maintenance of the substation as a whole and of each of its systems and equipment items.
Under the chapter Exceptions to the Specification, the Manufacturer shall include in his tender a detailed list of equipment, systems, works or services that are excluded, indicating the reason for exclusion with reference to the corresponding section of the specification.
The systems and equipment shall be designed for a useful life of 25 years' operation, except for components subject to wear and tear which shall be easily replaceable.

8.1.1 Applicable Codes and Standards

The applicable codes and standards shall be in accordance with the Electrical Design Handbook Part 3: Codes and Standards [AD11]. And the latest version of th standards shall be considered.
The equipment design, manufacturing and test procedures for the circuit breakers, disconnectors, earthing switches and instrumentation transformers shall comply at least with the following codes and standards:

- High-voltage techniques

NF C13-200	High-voltage electrical installation - Requirements
IEC 60060	High-voltage test techniques
IEC 60068	Environmental testing
IEC 60071-2	Insulation Coordination-Application guide
IEC 60270	Partial discharge measurements
IEC 62271-101	High-voltage switchgear and controlgear - Synthetic Testing
IEC 61140	Protection against electric shock - Common aspects for installation and equipment

IEC 61936	Power installations exceeding 1 kV a. c.
IEC 62271-1	High-voltage switchgear and controlgear. Common specifications

- High-voltage circuit breakers

IEC 62771-100	High-voltage switchgear and controlgear. High-voltage alternating current circuit-breakers

- Disconnectors and earth switches

IEC 62271-102	High-voltage switchgear and controlgear - Alternating current disconnectors and earthing switches

- Instrument transformers

IEC 61869-1	Instrument transformers – Part 1 : General requirements
IEC 61869-2	Instrument transformers – Part 2 : Additional requirements for current transformers

8.1.2 General Design Requirements

8.1.2.1 Basic Requirements

The following are the basic parameters for the design of the 66 kV substation:

Type	Air insulated
Earthing system	By means of low earthing resistor, 500/10s
Rated voltage	72.5 kV
Creepage distance	≥ 16 mm/kV
Rated short-duration power frequency withstand voltage (1 min)	
• Phase-to-earth and between phases	140kV
• Across the isolating distance	160kV
Rated lightning impulse withstand voltage (1,2/50 μs)	
• Phase-to-earth and between phases	325kV peak
• Across the isolating distance	375 kV peak
Rated short-time withstand current	31.5kA
Rated peak withstand current	80kA
Rated duration of short-circuit	1s

8.1.2.2 Auxiliary Power Supplies

AC interruptible consumers	400/230 V AC, 50 Hz, single or three-phase, TN-S
UPS consumers	230 V AC single-phase, TN-S
Direct current system	48 V DC (TN)

8.1.2.3 Protection Index

Cabinets and equipment for indoor installation shall be designed to protection class IP31 as a minimum, in accordance with IEC 60529.
Electrical equipment and panels for outdoor installation shall be designed to a Protection class equal to or better than IP55, in accordance with IEC 60529.

8.1.2.4 Safety Measures

The necessary systems shall be provided and measures taken to protect personnel from high voltages. Live parts shall be at a safe distance from the accessible points, or they shall be isolated, shielded or otherwise covered to protect personnel against accidental contact with them.
All metal parts and components that are not live shall be suitably earthed.

8.1.2.5 Minimum Substation Clearances

Safety clearances shall be those stated by NF C13-200 standard and are the following:

Phase to earth clearance:	
• conductor/structure	760 mm
• rod/structure	760 mm
Phase to phase clearance:	
• conductor/conductor	760 mm
• rod/conductor	760 mm
Substation container to live parts	3000 mm
Height of the first insulating parts	2250 mm
Height of the live parts	3300 mm
Working clearance to any possible live parts	3000 mm
Fence clearance to live parts	5000 mm

8.1.3 Specific Design Requirements

In addition to the general requirements specified, the electrical equipment shall comply with the following specific requirements.

8.1.3.1 66kV System Design

The 66kV system design shall take into account the basic parameters indicated in Section 8.1.2 and shall comply with the standards for high-voltage installations.
The general arrangement of the equipment shall be based on the overall plan for the 66 kV layout shown in the Appendix 16.3.1 and Appendix 16.3.2.

8.1.3.2 66kV Circuit Breakers

The 66 kV circuit breakers to be supplied shall have the following design specifications:

Number of poles	3
Installation	Outdoor
Type	Sulphur hexafluoride (SF6) trip free
Rated voltage	72.5 kV
Rated frequency	50 Hz
Earthing system	By means of low earthing resistor
Rated short-duration power frequency withstand voltage (1 min)	
• Phase-to-earth and between phases	140 kV
• Across the isolating distance	160 kV
Rated lightning impulse withstand voltage (1,2/50 μs)	
• Phase-to-earth and between phases	325kV peak
• Across the isolating distance	375 kV peak
Rated short-time withstand current:	31.5 kA
Rated peak withstand current:	80 kA
Rated duration of short-circuit	1 s
Rated current:	≥ 1250 A
First pole factor	1.5
Rated operating sequence	O-0,3s-CO-3min-CO
Rated breaking time for a breaking current equal to the rated short-circuit breaking capacity	≤60ms
Operating mechanism	Motor operated charged spring and Manual operated

Insulator material	Porcelain
Creepage distance	≥ 16 mm/kV

Circuit breakers shall be single-pressure puffer or self-blast suitable for outdoor installations.
The operating mechanism of the three circuit breaker poles shall be based on energy stored by means of a motor-operated charged spring.
The circuit breakers shall be designed for continuous operation at the rated current, and temperature rises shall not exceed the maximum values indicated in table 3 of IEC 62271-1.
The circuit breakers shall be designed so that in the closed position they are able to withstand for 1s, without damage, a through current of a value equal to the rated short-circuit breaking capacity.
In addition, the circuit breakers shall be able to withstand in the closed position, without damage, a peak current value equal to the specified rated short-circuit breaking capacity.
The circuit breakers shall be capable of breaking normal load current should the gas pressure fall to atmospheric value.
The rated short-circuit making current of the circuit breakers shall be as per Section 5.103 of IEC 62271-100.
The circuit breakers shall be able to break an out-of-phase current as per Section 5.105 of IEC 62271-100.
The Manufacturer shall provide an estimated value for these circuit breakers' rated currents, taking into account the capacitive characteristics of these types of loads.
The Sulphur Hexafluoride gas-insulated circuit breakers shall be designed so that the maximum gas loss per year does not exceed 1% of the volume per pole.
The circuit breaker and their associated control cabinet shall be provided with a rating plate fixed in a clearly visible place.
The rating plates shall be made of corrosion resistant material and shall bear at least the data indicated in IEC 62271-100 in indelible lettering.
In addition, a plate showing pressure/temperature characteristics for the SF6 in the circuit breaker at normal, alarm and lockout SF6 pressure/density shall be included.
The Sulphur Hexafluoride gas shall be included in the supply. Likewise, recharging after erection at site shall also form part of the supply.
Each circuit breaker pole shall be equipped with a temperature compensated pressure switch (density meter) to monitor the Sulphur Hexafluoride gas pressure in each circuit breaker pole, with two stage density indications (loss pressure and low-low pressure).
A low-pressure remote indication of each of the three poles pressure switches shall be provided.
In addition, each circuit breaker pole shall be equipped with an SF6 refill device in the event of loss of gas and this device shall impede the gas from escaping when the refill operation is completed.
The drive mechanism for the three poles as well as the control elements shall be housed in a weatherproofed control cabinet (IP55), protected from condensation and attached to the foundation of the pole.
The charging motor of the closing spring and the earthing switch motors shall be powered at a voltage rating of 230 V AC. Circuit breakers and earthing switches shall be capable of correctly opening and closing at any control voltage value comprised between 85% and 110% of nominal supply voltage.

The breaker trip and close coils shall be powered at 48 V DC +10% -30 %.
The power supply circuit of the charging motor for the closing spring, for the closing and first trip circuits and for the second trip circuit power supplies shall be protected by automatic thermal-magnetic circuit breakers.
Closure whilst a spring charging operation is in progress shall be prevented, and release of the springs shall not be possible until they are fully charged.
Each mechanism shall be fitted with two trip coils.
Circuit breakers shall be electrically and mechanically trip free.
The control cabinet (IP55 for outdoor installation) shall have a set of on/off pushbuttons for local electrical control of the breaker. The cabinet shall interconnect the wiring and the remote switching control. It shall be also equipped with a Local – Off – Remote selector switch with key interlock in local and remote position. The selection of Local operation shall inhibit the operation of the breaker for any remote source.
Refer to [RD32] for the typical control for 66kV Circuit breaker as reference.
The circuit breaker operating mechanism shall open and close all three poles simultaneously.
Local manual opening of the breaker must also be possible, in case of insufficient voltage control.
The circuit breakers shall be motorised, and it shall be possible to close them manually using a crank system. During this mode of operation, the command electric circuits must be interrupted.
Auxiliary contacts shall be made of silver, with a rated thermal current of 10A and a minimum inductive circuit rated operating current (breaking capacity) of 1A for 48VDC. At least twenty-four (24) auxiliary contacts (twelve (12) NO and twelve (12) NC) shall be provided for use by control systems.
The circuit breaker shall have optical position indicators linked to the transmission and clearly visible from the floor level.
These contacts must be:

- Independent
- Easily convertible from NO to NC
- Led by cables to the terminal board located in the control cabinet

The control cabinet of all breaker poles shall have a mechanical instrument to indicate the position of the breaker pole (on or off), mechanical indicator of the state of the closing spring (charged or discharged) and an operation counter, easily visible from ground level.

8.1.3.3 Disconnectors and Earthing Switches

66 kV feeder module disconnectors and earthing switches shall have the following design specifications:

Number of poles	3
Installation	Outdoor
Type of disconnectors	Double break

Earthing system	By means of low earthing resistor
Rated voltage	72.5 kV
Rated frequency	50 Hz
Rated short-duration power frequency withstand voltage (1 min)	
• Phase-to-earth and between phases	140 kV
• Across the isolating distance	160 kV
Rated lightning impulse withstand voltage (1,2/50 μs)	
• Phase to earth and between phases	325 kV peak
• Across the isolating distance	375 kV peak
Rated short-time withstand current	
• Disconnectors	31.5 kA
• Earthing switches	31.5 kA
Rated peak withstand current	
• Disconnectors	80 kA
• Earthing switches	80 kA
Rated duration of short-circuit	1 s
Rated continuous operating current:	≥ 1250 A
Operating mechanism	Electric motor and manual operated
Insulator material	Porcelain
Creepage distance	≥ 16 mm/kV

The disconnectors and earthing switches shall be designed to function in continuous operation at rated current without temperature rises in different parts exceeding the maximum values indicated in table 14 of IEC 62271-1.
The disconnectors and earthing switches shall be designed to withstand, without damage, the thermal and mechanical stresses produced by the rated short-circuit current peak value and by the allowable rated short-time current for 1 s, as specified in IEC 62271-102.
The disconnectors and earthing switches shall be designed so that they remain in their normal position, open or closed, even when subjected to act of gravity, to vibrations, relatively significant shocks or accidental forces on the operating mechanism.
Disconnectors and earthing switches shall be motor-operated and provided with manual mechanical operation provision in case of emergency. Local and remote electrical operation shall

also be provided. The mechanisms of the disconnectors and earthing switches shall be interlocked relative to one another, to prevent malfunctioning.
The disconnectors shall be of the air-insulated double break type. Each disconnector shall be combined with an earthing switch, to comprise one unit.
The disconnectors shall be able to make or break the load capacitive currents produced by the connection or disconnection of the different busbar substation parts.

8.1.3.3.1 Construction Details and Accessories

Disconnectors live parts shall be supported by insulators.
Disconnectors and earthing switches shall feature an earthing terminal appropriate for connection to a 120 mm^2 conductor.
Disconnectors shall be equipped with optical indicators that will be mechanically linked to the transmission shaft and clearly visible from the floor level.
Each pole of the disconnectors shall be identified with a rating plate fixed in a clearly visible location.

8.1.3.3.2 Disconnector and Earthing Switch Operation

Disconnectors and earthing switches shall be supplied with their associated control cabinet.
The disconnector and earthing switch operating mechanism shall open and close all three poles simultaneously.
In the control cabinet (IP55 for outdoor installation) shall be equipped with lockable Local/ Remote selector switch. The power supplies indicated in Section 8.1.2.2 will be available at each feeder module to feed the disconnector and earthing switch actuators and their respective controls, the control of the panel, and the space heaters through a dedicated LV distribution panel as illustrated in [RD15], [RD16] and [RD17].
Refer to [RD33] for the typical control of the disconnector switches and earthing switches as reference.
Remote indication of excessive switching time on intermediate position shall be provided.
Protection of the power supply circuit of the driving motor of the disconnector or earthing switch shall be ensured by a two-pole mini circuit breaker and by the set of contactors and thermal relay, with suitable tripping characteristics for motor protection; it shall also include two independent auxiliary contacts, one normally open (NO) and the other normally closed (NC).
If the circuit breaker is tripped (or the thermal relay energised), the NO contact of the circuit breaker of the drive motor of disconnector or earthing switch (or the NC contact of the thermal relay) shall disconnect the control circuit.
Make and break contactors shall comply with IEC 60947-1.
Make and break contactors shall be electrically and mechanically interlocked to one another.
The driving motor shall be powered at a voltage rating of 230 V AC UPS +10%-15%
The disconnectors and earthing switch motor contactors shall be powered at 48 V DC +10% -15%.

Blade control for each of the disconnector or earthing switches shall be equipped with two (2) limit switches for make and break. The limit switch make contact shall disconnect the closing command, while the limit switch break contact shall disconnect the opening command.
The opening and closing commands shall be electrically and mechanically interlocked to one another.
The control cabinet of the disconnectors and earthing switches shall feature a set of Open/Close pushbuttons for local electrical control.
Local operation of the disconnector and earthing switches poles shall also be possible by means of a handle; interlocking between the manual operation device and the control circuit shall be provided. Said interlocking can be achieved in two different ways:

- By the opening of a contact that would block the control circuit upon introduction of the manual operation handle
- By means of a mechanical interlock that prevents insertion of the manual operation handle when electrical control is not blocked

Normally open auxiliary contacts shall close when the disconnector is near the "Closed" position and shall remain open when the disconnector is in the "Open" position or in an intermediate position.
Normally closed auxiliary contacts shall close when the disconnector is near the "Open" position and shall remain open when the disconnector is in the "Closed" position or in an intermediate position.
The NO and NC contacts of each pole shall be wired to the control panel. The control panel shall feature ten (10) contacts, five (5) NO and five (5) NC.
Auxiliary contacts shall be made of silver, with a rated thermal current of 10 A and a minimum inductive circuit rated operating current (breaking capacity) of 1 A for 48 V AC.
In case of failure of remote operation, local operating switches might be necessary. In order to safely maneuver disconnector switches and earthing switches locally, equipotential operating platforms shall be considered in front of the operating mechanism.

8.1.3.4 Current Transformers

Current transformers shall have the following design specifications:

Type	Oil filled-multi core bar primary
Installation	Outdoor
Rated voltage	72.5 kV
Rated frequency	50 Hz
No. of secondary windings	3

Transformation ratio, power output and accuracy class	750/5[3],30 VA, Cl.0,2 1000/5[3], 50 VA, 5P20 1000/5[3], 50 VA, 5P20
Primary winding rated short-duration power frequency withstand voltage (1 min)	140 kV
Primary winding rated lightning impulse withstand voltage (1,2/50 μs)	325 kV peak
Secondary winding power frequency rated withstand voltage	3 kV
Withstand voltage between windings	4.5 kV peak
Rated short-time withstand current	31.5 kA
Rated peak withstand current	80 kA peak
Insulator material	Porcelain
Creepage distance	≥ 16 mm/kV

The current transformers shall be designed so that they do not exceed the temperature rise limits indicated in Section 6.4 of IEC 61869-1.
Current transformers shall be able to withstand, without damage, the thermal and mechanical stresses produced by the specified short-circuit currents.
The instrument current transformers shall not exceed the current and phase shift error limits indicated in Table 201 of IEC 61869-2.
The protection current transformers shall not exceed the current and phase shift error limits and combined error limits indicated in Table 205 of IEC 61869-2.
Current transformers shall comprise one or more magnetic ring circuits placed in air inside an enclosure in which the secondary windings are installed.
The magnetic ring circuits shall be mounted on a metal frame which ensures good electric field distribution.
The magnetic ring circuits shall be carefully secured so that they can withstand the vibrations produced during transport and during operation.
The transformer secondary windings of the three poles shall be connected to a marshalling cabinet (IP55 for outdoor installation) attached to the support structure and supplied with holes to accommodate the connecting cables. The terminals shall preferably be of the nut and bolt type, suitable for connecting cables with ring compression terminals. Facility shall be provided for shorting and earthing the current transformer secondary winding at the terminal box. The star point shall be formed at the marshalling cabinet only. The star points shall be earthed at this point.
The arrangement of the primary winding and secondary winding terminals shall be identified in indelible lettering in respect of polarities and number of secondary windings.

[3] The secondary current could be 5A or 1A, up to the Contractor to choose.

The terminals shall be identified in accordance with that indicated in Table 7 of IEC 61869-1.
Current transformers shall be provided with a rating plate and connection diagram fixed in a clearly visible place. The rating plate shall be made of corrosion resistant material and shall bear at least the data indicated in Sections 6.13.202 of IEC 61869-2 in indelible lettering.
Current transformers shall be provided with two earthing terminals for connecting the earthing conductor, and with terminals for tan delta measurements.

8.1.4 Tests

8.1.4.1 66kV equipment factory verifications and tests

The substation and its components (circuit breakers, disconnectors, earthing switches and current transformers) shall be fully tested in accordance with current edition of the relevant IEC standards and the performance of the tests shall be witnessed by an IO representative (if requested).
The equipment manufacturer shall submit testing procedures, according to applicable IEC standards, for all the tests described in this section. In the event that one of the tests described in this section is not strictly covered by an IEC standard, the equipment manufacturer shall submit testing procedures with their proposal.
All the test procedures shall be reviewed by IO for acceptance before being performed. For each substation equipment item, the equipment manufacturer shall provide the reports for type tests carried out on equipment similar to that of the supply and he shall carry out the routine tests indicated below. The type tests shall be carried out at reputed testing laboratory, the tests must have been carried out during last 5 years.

8.1.4.1.1 Circuit Breakers

Type tests shall be in accordance with section 6 of IEC 62271-100.

- Dielectric tests, in accordance with Section 7.2 of IEC 62271100.
- Measurement of the resistance of the main circuit, in accordance with Section 7.4 of IEC 62271100.
- Temperature rise tests, in accordance with Table 14 of IEC 62271100.
- Short time withstand current and peak withstand current tests, in accordance with Section 7.6 of IEC 62271100.
- Verification of the degree of protection, in accordance with Section 7.7 of IEC 62271100
- Tightness tests, in accordance with Section 7.8 of IEC 62271100.
- Electromagnetic compatibility tests, in accordance with Section 7.9 of IEC 62271100.
- Mechanical operation tests at ambient air temperature, in accordance with Sections 7.101.2.1, 7.101.2.2 and 7.101.2.3 of IEC 62271-100.

- Short circuit current making and breaking tests, in accordance with Sections 7.102, 7.103, 7.104, 7.105 and 7.106 of IEC 62271-100.
- Critical current test, in accordance with Section 7.108.1 of IEC 62271-100.
- Single phase and double earth fault, in accordance with Section 7.108.2 of IEC 62271100.
- Out of phase making and breaking tests, in accordance with Section 7.110 of IEC 62271100.
- Capacitive current switching tests, in accordance with Section 7.111 of IEC 62271100.

The circuit breakers shall be subjected to the following routine tests:

- Dielectric tests on the main circuit, in accordance with Section 8.2 of IEC 62271-100.
- Dielectric test on auxiliary and control circuits, in accordance with Section 8.3 of IEC 62271100.
- Measurement of the resistance of the main circuit, in accordance with Section 8.4 of IEC 62270-100.
- Tightness test, in accordance with Section 8.5 of IEC 62271-100.
- Design and visual checks, in accordance with Section 8.6 of IEC 62271-100.
- Mechanical operating tests, in accordance with Section 8.101 of IEC 62271-100.

8.1.4.1.2 Disconnectors and Earthing Switches

Type tests shall be in accordance with section 7 of IEC 62271-102.

- Dielectric tests, in accordance with Section 7.2 of IEC 62271102.
- Measurement of the resistance of the main circuit, in accordance with Section 7.4 of IEC 62271102.
- Temperature rise tests, in accordance with Section 7.5 of IEC 62271102.
- Short time withstand current and peak withstand current tests, in accordance with Section 7.6 of IEC 62271102.
- Electromagnetic compatibility tests, in accordance with Section 7.9 of IEC 62271102.
- Operating and mechanical endurance tests, in accordance with Section 7.102 of IEC 62271102.
- Operation under severe ice condition test, in accordance with Section 7.103 of IEC 62271-102.

Disconnectors and earthing switches shall be subjected to the following routine tests:

- Dielectric tests on the main circuit, in accordance with Section 8.2 of IEC 62271-102.
- Dielectric test on auxiliary and control circuits, in accordance with Section 8.3 of IEC 62271-102.
- Measurement of the resistance of the main circuit, in accordance with Section 8.4 of IEC 62270-102.
- Design and visual checks, in accordance with Section 8.6 of IEC 62271-102.
- Mechanical operating tests, in accordance with Section 8.101 of IEC 62271-102.

8.1.4.1.3 Current Transformers

Type tests shall be in accordance with Section 7.2 of IEC 61869-2:

- Temperature rise tests.
- Impulse voltage withstand test on primary winding.
- Wet test for outdoor type transformers.
- Tests for Accuracy.
- Short-time current test.

The current transformers shall be subjected to the following routine tests, in accordance with Section 7.3 of IEC 61869-2:

- Power-frequency voltage withstand tests on primary terminals.
- Partial discharge measurement.
- Power-frequency voltage withstand tests between sections.
- Power-frequency voltage withstand tests on secondary terminals.
- Test for Accuracy.
- Verification of terminal markings.
- Determination of the secondary winding resistance (Rct).
- Determination of the secondary loop time constant (Ts).
- Test for rated knee point e.m.f (E_k) and exciting current at E_k.
- Inter-turn overvoltage test.

The current transformers shall be subjected to the following special tests, in accordance with Section 7.4 of IEC 61869-2:

- Measurement of capacitance and dielectric dissipation factor.

8.1.4.2 66 kV equipment tests after installation on site

After installation, and before being put into service, the substation shall be tested in order to check the correct operation and the dielectric integrity of the equipment.
These tests and verifications comprise:

- Dielectric tests on the main circuits
- Dielectric tests on auxiliary circuits
- Measurement of the resistance of the main circuit
- Tightness tests
- Checks and verifications

The Manufacturer and user should agree on a commissioning test procedure for tests on site. Manufacturer shall supervise its implementation on the site.
For dielectric tests on the main circuits, the applicable portions of Section 11.101.2 of IEC 62271-203 are applicable.
For dielectric tests on auxiliary circuits, Section 7.2 of IEC 62271-1 is applicable with the following addition: dielectric tests should be carried out on new wiring. If wiring has to be taken off or if electronic devices are in circuits, these circuits shall not be tested.
For measurement of the resistance of the main circuit, the resistance measured shall be compared with the values of the individual routine tests, taking into account the differences of the two test arrangements (number of devices, contacts and connections, length of conductors, etc.).
For tightness tests, Section 7.8 of IEC 62271-1 is applicable.
The following checks and verifications shall be verified:

- Conformity of the assembly
- Tightness of bolts and connections
- Conformity of the wiring with the diagrams
- Proper function of the electrical and other interlocks
- Proper function of the control, measuring, protective and regulating equipment including heating and lighting
- Mechanical operation checks

The mechanical operation checks and tests shall be carried out according to the relevant standards.
Other instructions for final installation inspection and tests which should be made after the substation has been installed an all connections completed, (reference to Section 11.3.7 of IEC 62271-1), shall be included in the proposal.

8.1.5 Acceptance Criteria for Tests

The acceptance criteria shall be in accordance with the values indicated in Appendix 16.7
The criteria shall be in accordance with the corresponding standards and must not deviate from the data fulfilled by the equipment manufacturer in the certified data sheets defined in Appendix 16.1.
Meeting the criteria included in these acceptance criteria do not exempt the manufacturer from the full compliance with test requirements included in the referenced standards.
Moreover, the equipment manufacturer must send a list indicating all the tests to be performed, with a reference to each associated procedure, indicating the applicable standard and specifying the acceptance criteria, as indicated in Appendix 16.7. This list must be reviewed and accepted by IO.

8.1.6 Technical Guarantees

The Contractor shall guarantee the tender values indicated in the Tender Technical Datasheets as Appendix 16.1.1~Appendix 16.1.5 of this specification.

8.1.7 Documentation

8.1.7.1 Documentation to be supplied with the tender

The following documentation shall be supplied with the tender, as a minimum:

- Description of The Contractor´s quality assurance and quality plan.
- Description of the scope of supply of services, equipment and materials.
- Description of the systems, facilities and equipment comprising the supply.
- Literature and brochures on the equipment and components offered.
- List of components and accessories of the equipment to be supplied, indicating the Manufacturer, type and characteristics.
- Tender Technical Datasheets, attached to this Technical Specification, duly completed.
- Preliminary drawings of the dimensions and physical layout of the switchyard equipment, showing minimum distances to be respected, elevation drawing and plan view.
- Erection and maintenance requirements for the equipment.
- List of special tools
- List of spares and consumables needed for startup and guarantee tests
- Optionally and separately, a price list of spares recommended for a five (5)-year operation, indicating the following for each spare:

- Identification and description
- Equipment to which it belongs
- Minimum quantity recommended
- Unitary prices
- Estimated consumption frequency
- Delivery date

The list of spares shall also include the consumables (grease, oils, joints, etc.) needed for maintenance of equipment during the five (5) years of operation.

- List of references on the supply of equipment identical or similar to that offered.
- Description of the tests offered, indicating the applicable codes and standards.
- Type test certificates of equipment similar to that offered.
- Catalogues of equipment and accessories.

In addition, the Manufacturer shall present a "List of Exceptions" indicating the technical discrepancies between the specifications of the equipment and services offered as opposed to the requirements of this Technical Specification.
All exceptions shall be included in the list aforementioned, indicating justification, and will be numbered with a reference to the corresponding specification sections.
Those exceptions not included in the list of exceptions shall not have contractual validity.

8.1.7.2 Documentation to be supplied during contract execution

The following documents shall be submitted for IO approval. The delivery period is to be agreed before placing the order:

	Maximum delivery period after award
• Certified Tender Technical Datasheets	To be defined
• List of documents indicating delivery periods	To be defined
• Equipment general arrangement, elevation, detailed dimensions and earthing connections requirements	To be defined
• Drawings of auxiliary equipment etc	To be defined
• Detail drawings of equipment and structure earth systems	To be defined
• Schematic and wiring diagrams of the equipment	To be defined
• Manufacturing programme and delivery period	To be defined
• Manufacturing Inspection plan, for approval	To be defined
• Test procedures	To be defined
• Type test certificates	To be defined
• General list of components and accessories for each circuit breaker, surge arrester, disconnector, earthing switch, insulator, current transformer, voltage transformer and connecting device, indicating the Manufacturer, type and characteristics for each	To be defined
• Instruction manuals and literature	To be defined
• Weights and dimensions for transport	To be defined
• Equipment erection drawings and instructions	To be defined
• Painting procedure	To be defined
• Seismic qualification procedures and reports	To be defined
• System and equipment operating and maintenance manuals	To be defined
• Catalogue of spare parts	To be defined

In addition to the documents specifically indicated, The Supplier shall draw up any other documents applicable to the supply covered by this specification that may be required or that may be necessary for defining the substation design, equipment supply, erection tests or startup.

8.2 Substation Automation System (Stage 2)

8.2.1 scope of supply

8.2.1.1 Equipment and components

The Substation automation of PPEN 66kV system stage 1 had been constructed in 66kV substation container, including the bay control unit, transfer busbar control, auxiliary Service Control unit (ASCU) and protection relays for 66kV feeder modules of stage 1.
In the scope of supply of this Technical Specification, the Contractor shall be responsible for the 10 protection relays for the ten (10) feeders corresponding to MCPC stage 2 converters, including design, supply, assembly and installation and test and commissioning.

- Five (5) set of feeder bay protection & control, and monitoring panels.

In addition to the equipment indicated above, the following equipment and services shall be supplied:

- Three (3) Ethernet switches and the F.O. cables that connect these Ethernet switches forming the 66 kV System communication ring.
- Equipment and instruments installed on the front side of the panel and inside it, such as main equipment and all the auxiliary relays, and current and voltage circuit connection and testing terminals
- All software necessary to parameterize the equipment and to obtain and modify relevant information, records and oscillographs both locally and remotely from engineering station
- Internal wiring between equipment and terminals
- Erection and installation inside the panels of all the above-mentioned equipment
- Calculation of setting, parameter implementation, verification and test of the parameterization of the relays and measuring and communication equipment.

8.2.2 Applicable standards

Protection relay and control equipment.

IEC 61850	Communication networks and systems in substations
IEC 60255	Electrical relays
IEC 60447	Basic and safety principles for man-machine interface, marking and identification – Actuating principles
IEC 60073	Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators
IEC 60297	Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482.6 mm (19 in) series
IEC 60870	Telecontrol equipment and systems

IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems
IEEE 829	Software test documentation
IEEE 1588	Standard for A Precision Clock Synchronization Protocol for Networked Measurement and Control systems
EN 50173	Information technology – Generic cabling systems
EN 60793	Optical cables. Product specification
EN60794	Optical fibre cables

In addition to the standards mentioned, the applicable standards in Section 8.1.1shall be taken into account.

8.2.3 Overall Architecture of 66kV Substation Automation System

8.2.3.1 PPEN control architecture

IEC 61850 substation automation system proposed configuration for PBS 41 is based on decentralized architecture and on a concept of bay-oriented, distributed intelligence. Functions are decentralized, object-oriented and located as close as possible to the process.
The main process level information of the substation is stored in distributed database. The typical Substation Automation System (SAS) architecture structure is divided in three levels, i.e. on station level, bay level and process level.
At bay level, the IEDs provide all bay level functions regarding control, monitoring and protection, inputs for status indication and outputs for commands. The IEDs are directly connected to the switchgear and CT/VT without any need for additional interposition or convertors.
Each bay control IED is independent from each other, and its functioning is not affected by any fault occurring in any of the other bay control units of the station.
The data exchange between the electronic devices at bay and substation level take place via the communication infrastructure. It is realized using fibre-optic cables to guarantee disturbance free communication. Data exchange is performed using IEC 61850 supported protocol with a redundant managed switched Ethernet communication backbone infrastructure.
The communication architecture is fault-tolerant Ethernet fiber ring in redundant mode, excluding the links between individual bay IEDs to switch wherein the redundant connections are not envisaged, such that failure of one set of fiber will not affect the normal operation of the SAS. However, upon failure of fibre, it will alarm in SAS. Each fiber optic cable will have spare fibers as future spares.
At station level, the entire substations are controlled and supervised from the CODAC control room from a centralized location. The local supervision & controls of PPEN stations (PACiS) will also be provided to ensure that in case of failure of any of Plant System Host (PSH) is not leaving the substations unattended.
IEDs will monitor & control its respective bays from the bay level equipment at all times.

The station level supervision will contain the station-oriented functions, which cannot be realized at bay level, e.g. alarm list or event list related to the entire substation, gateway for the remote communication.
The process level will be incorporated by direct connection between switchyard equipment defined in this specification, and the BCUs and IEDs.
The time synchronization signal is provided for the synchronization of the entire SAS system through NTP server or WinCC-OA server (2 redundant time synchronization available).

8.2.3.2 66 kV System Control Architecture

The design of the substation control, protection, measuring and communications is based on the standard defined in IEC 61850. The topology of the LAN network set up by the different bay control units and every IED, is based on the IEC 61850.
The substation communication bus is configured like a ring, formed by several switches connected through gigabit links.
Each IED and BCU is connected to the correspondent switch through fiber optic link, 100 Base FX. See architecture diagrams in Figure 7-1.
Every IED will be provided with the correspondent CID file and any other file that can be necessary for the complete configuration of the device and its integration into the network. The CID file will be compiled in XML language according to IEC 61850-6.
Each IED shall be able to receive sample values (SVs), receive/generate GOOSE messages and generate MMS reports. The control, protection, metering and communication systems for the 66 kV AIS PBS 41 shall be integrated in the bay level of all systems with an IEC 61850 supported protocol.
A Sequence of Event Record Application will be reachable by CODAC thru a WinCC-OA server (acting as gateway between IEC61850 protocol and OPC-UA on PON) to determine the cause of undesired events. A list of the relevant events related to the different operating states of the Plant along with the trips/anomalies leading to said events will be provided. CODAC will receive this information with time stamp with 1 ms resolution.
Therefore, the specific equipment, such as control, measure and protection panels, communications and interface panels, will be housed in the 66 kV substation container.
Two (2) feeder module control, protection, measuring and monitoring IED equipment will be installed on each panel, if possible.

8.2.3.2.1 Performance guidelines for IEC 61850 System

Salient Features:
The system architecture shall be based on state-of-the-art client-server technology over Ethernet Local Area Network (LAN) on TCP/UDP protocol Stack. The SAS shall be suitable for centralized collection of data and information.
The SAS shall mainly execute the following tasks:

- Collection of data related to the electrical current, voltage, frequency, consumption etc. and display of the parameters on the respective HMI screens.

- Remote control facility, control command execution shall not be more than one (1) second.
- Management information with facility for generation of reports
- Time synchronization with plant Supervisory Control Data Acquisition (SCADA) system on SNTP as well as with the BCU/IED through communication network
- Time tagged status/event shall be retrieved from the BCU/IED by SAS and the resolution of time tagging of event recording shall not be more than 1 ms.

The SAS design shall be robust and in line with architecture requirement. The SAS system shall be equipped with server software (licensed) with necessary development tools for graphics, database builder, free format report writer etc. in line with IEC 61850 standard.
IEC 61850 SAS server shall have database for archiving information over a long period of time. The historical database shall be provided for displaying charts and reports and shall store data for a minimum period of one (1) year.
Creation of database at system start and maintaining the same during operation shall be considered as essential design factor for proper functioning of the SAS. Purging of old data after user specified time interval shall be considered with prior intimation to the system user.
Storage of all data shall be protected against data corruption when system losses power supply or during any other failures.

System Parameters:
The SAS shall be designed and selected based on the following criteria:

- Open System architecture and database
- Features for checking the healthiness of the system and communication links as well as data integrity for all the required data
- Continuous reliable operation with the hardware of standard type suitable for installation in control room environment in the substation area
- Protection against data corruption and data loss

System level Acceptance Criteria:
The substation system shall meet then following acceptance criteria, which needs to be demonstrated at the time of testing of the system.

System parameters	Acceptance criteria
System availability	≥ 99.9% (calculated over a period of seven working days)
HMI screen refresh time	1 Second
Network bandwidth utilization	10% maximum, five (5) minutes average
Unallocated system auxiliary memory	At least 50% of total capacity
% CPU loading	50% maximum, five (5) minutes average
Time Synchronization	With ITER plant NTP

SAS Performance Requirements:

Supplier have to predict and indicate the worst loading condition and design the system accordingly to meet the performance criteria. The worst case loading conditions have to include the following tasks as a minimum:

- All analog input, scanning and processing is in progress and all the data is being transmitted over the system bus every one second.
- A burst of 50 alarms is generated over a period of 10s.
- One Operator control is generated every 10s
- Data collection for logs/reports is in progress
- Data Collection for historical storage and trend function is in progress.
- Data Collection of fault records is in progress
- All health monitoring functions/diagnostics in progress
- All output devices are in operation with rated performance.
- All data are transferred to the operator workstations.
- The display response time under worst case condition for all display should not be worse than 1 sec. for HMI displays.

8.2.3.2.2 Performance guidelines for Message Types

Fast Speed Messages:
This type of message typically contains a simple binary code containing data, command or simple message, for example Trip, Close, Reclose order, Start, Stop, Block, Unblock, Trigger, Release, State Change etc.

Trip Message:
The Trip is the most important fast message in the substation. Therefore, this message has more demanding requirements compared to all other fast messages. The same performance is expected for interlocking, intertrips and logic discrimination between protection functions.
The Total transmission time performance shall be in the order of half cycle i.e. 10 ms.

Other than Trip Message:
All other fast messages are important for the interaction of the substation automation system with the process. The total transmission time performance expected shall be less than or equal to 100 ms i.e. within 5 cycles.

Medium Speed Messages:
These are a kind of messages where the time at which the message originated is important but transmission time is less critical. The message shall include a time tag set by the sender, and the receiver will normally react after an internal time delay. Normal plant state information's belong to this type of message.
The total transmission time performance shall be less than or equal to 100 ms

Low Speed Messages:

This type of messages includes complex messages that may require being time tagged like auto control functions, event records, setting of set-point values and general presentation of system data.
The total transmission time performance shall be less than or equal to 500 ms

Raw Data Messages:
This data will consist of continuous streams of synchronized data from each BCU/IED, interleaved with data from other BCU/IEDs.

Data type (P1)	Transmission Time (ms) defined by trip time	Resolution (bits) amplitude	Rate (Sample/Sec) Frecuency
Voltage	10	13	480
Current	10	13	480

Data type (M1)	Accuracy Clases and Harmonics	Resolution (bits) amplitude	Rate (Sample/Sec) Frecuency
Voltage	Class 0.5 (IEC 61869-9) Class 0.2 (IEC 61869-9) Up to 5th Harmonics	12	1500
Current	Class 0.5 (IEC 61869-9) Class 0.2 (IEC 61869-9) Up to 5th Harmonics	14	1500

File Transfer Function:
This type of message shall be used to transfer large files of data for recording, information purposes, settings etc. Data must be split into blocks of limited lengths, to allow for other communication network activities.
The transfer time performance should be equal to or greater than 1000 ms. For remote access, the request for file shall have an access control.

Time Synchronization messages:
This type of message is used to synchronize the internal clocks of the BCU/IED's in the substation. The standard BCU/IED synchronizing for control and protection events is:

Time Performance Class	Accuracy (ms)	Resolution (bits) amplitude
T1	+/- 1	Time tagging of events

8.2.3.2.3 Performance guidelines for IEC 61850 Equipment (BCUs/IEDs)

Each BCU/IED shall be capable of supporting at least five simultaneous client-server associations. This number is necessary to support the possible network requirement of one SCADA gateway connection, two redundant HMI connections, and two redundant engineering access connections.

Each BCU/IED shall support five default preloaded buffered reports and five preloaded unbuffered reports. These reports shall be preconfigured and capable of being used without customization. However, the BCU/IED shall also support customization of the reports and data sets.

Each BCU/IED shall have the ability to freely rename data sets, logical devices, and logical nodes. Each BCU/IED shall have the ability to add and remove logical nodes to and from each logical device.

Each BCU/IED shall use specific naming for commonly used information rather than generic data references. Changes to data sets and reporting configuration shall be done via ease-of-use configuration software. The resulting SCL CID file shall be downloaded directly into the BCU/IED as described within the IEC 61850 standard.

Each BCU/IED shall support remote loading of the CID file via Ethernet using standard TCP/IP mechanisms in order to accommodate engineers designing and technicians configuring BCU/IEDs remotely.

It is of utmost importance that the BCU/IEDs should support stations & applications with different data requirements, have the ability to accommodate data that were not recognized to be necessary until contract award, and represent customer specific data and BCU/IED logic values as appropriate logical nodes and data objects. Therefore, flexible configuration of data sets shall be required as well as the ability to create new logical devices, logical nodes, and their contents. To support this, it shall be possible to create different ICD (IED capability description) and CID files that map any and all available BCU/IED data for specific ITER applications. In this way, unique data sets and customer specific names shall be supported. Modifications to the data sets and customer specific names of the BCU/IED shall be done without hardware or firmware changes.

In order to effectively perform the anticipated communication designs, the IEC 61850 GOOSE implementation in each BCU/IED shall support the following requirements:

- Each BCU/IED shall be capable of publishing eight (8) unique GOOSE messages.
- Each BCU/IED shall be capable of subscribing to twenty-four (24) unique GOOSE messages.
- Each BCU/IED shall be capable of monitoring GOOSE message quality.
- Each BCU/IED shall be capable of creating a GOOSE data set that includes both Boolean values and non-Boolean data types, such as analogue values.
- Each BCU/IED shall be capable of accepting and processing data sets from other BCU/IEDs that contain Boolean and non-Boolean data types.
- Each BCU/IED shall support priority tagging of GOOSE messages for optimizing latency through Ethernet switches.
- Each BCU/IED shall support VLAN identifiers to facilitate segregation of GOOSE traffic on the Ethernet network.
- Each BCU/IED shall support preloaded default GOOSE message for use without custom configuration.
- Each BCU/IED shall support custom editing of the data sets published in the GOOSE messages so the user can send what they choose.

- Changes to data sets, GOOSE parameters, GOOSE publication, and GOOSE subscription shall be done via ease-of-use configuration software. The resulting SCL CID file shall be downloaded directly into the BCU/IED as described within the IEC61850 standard.
- The configuration software of the BCU/IED vendor shall import CID, ICD, and substation communications description (SCD) files in order to learn the available GOOSE publications and data sets from other BCU/IEDs. The software shall use this information to configure the BCU/IEDs to subscribe to other vendor's BCU/IEDs and use the data being broadcast.
- BCU/IEDs IP address shall be static and modifiable only through local interface (i.e. not through ACSI configuration).
- BCU/IEDs should record disturbance data in COMTRADE format. All the BCU/IEDs reports should be available for downloading through ACSI (Abstract communication services interface) Services, FTP protocol and USB download.
- Each BCU/IED, while in service, shall allow the user to query it to learn communications diagnostics as well as status and/or error codes of GOOSE messages being sent and received. In order to effectively configure the BCU/IED for use within the network, the ease-of-use configuration software provided with the BCU/IEDs shall be capable of the following requirements:
    - The software shall be capable of importing configuration information about other BCU/IEDs from ICD, CID, or SCD files.
    - The software shall validate the imported information to confirm that it complies with IEC 61850 parameters.
    - The software shall provide error messages describing problems detected in imported files.
    - The software shall support naming BCU/IEDs with up to 16 characters as per ITER naming guidelines.
    - The software shall support review and editing of BCU/IED data sets, GOOSE parameters and report parameters.
    - The software shall support the association of data quality with data elements.
    - The software shall support visible end-user warnings to prevent incorrect data set editing as well as warning when editing a data set that is already in use. In this fashion, the end user can be warned not to disrupt an existing configuration and/or create a data set too large for its intended purpose.
    - The configuration software shall support creation of eight GOOSE publications.
    - The configuration software shall present the user with all available GOOSE messages and support up to 24 subscriptions.
    - The configuration software shall support assigning VLAN and priority tags to GOOSE messages. The configuration software shall present the user with the entire data set for each potential GOOSE subscription and allow the user to browse for necessary data.

- The configuration software shall present the user with the entire data set for each potential GOOSE subscription and allow the user to map data from the incoming datasets into the BCU/IED. When this is done, the software should automatically subscribe to the associated GOOSE message.
- The configuration software shall allow the user to choose message and data validation on incoming GOOSE data set contents.
- The configuration software shall allow the user to directly load the SCL file into the BCU/IED, or export it for storage or remote loading.
- The configuration software shall allow importing and exporting of SCL files without modification of the private regions of the original.
- The configuration software shall create files in XML format that can be modified by XML editors and tools to help resolve conflicts or errors in badly formed files.
- For each BCU/IED, the measured GOOSE transfer time shall be provided with a description of how it was measured.
- IEC 61850-10 defines other metrics to be measured within devices and documented:
  - Maximum clock synchronization error, which should indicate the accuracy of the BCU/IED to synchronize its clock to the NTP time reference.
  - Maximum timestamp delay error, which should indicate the accuracy of the BCU/IED to timestamp the data when the event has occurred.

8.2.4 Equipment of PPEN 66kV system Stage 2

The 66 kV AIS shall be remotely controlled and supervised via CODAC Workstation designed and supplied by others. Additionally, back-up control and monitoring shall be granted at Plant system level from dedicated HMI. Currently PACIS v5.1 acts as the Plant control and supervisory system. Contractor shall configure the new database for Stage 2 integration and quote in the scope the upgrade to EcoStruxure System that shall ensure technical support available for long-term (>20y)..
To integrate the ten (10) feeder modules with the existing Substation automation system, the following equipment shall be included:

8.2.4.1 Protection relays (10 sets)

The protection relays included are:

- Feeder module overcurrent
- Other related with circuit breaker (Aux. supply, coil supervision…)

All protections for downstream consumer outside A35, for example converter transformers, reactors, capacitors, etc. , will be supplied by others.
The trip circuit of the protection shall have duplicate and redundant trip circuits or matrix outputs.

Control circuits including potential and current transformer secondary circuits, DC external cables connected with the function of the protection equipment shall be protected against conductive, electrostatic and electromagnetic influences of transients.
The protection scheme shall be organized to form two protection groups (external and internal) and provisions shall be made for two separate trip coils for each circuit breaker. The two protection groups shall be connected to different secondary of CTs. The Supplier will be responsible to coordinate the characteristics required by his protection to his CTs.
The following relays, with the main protection functions indicated, shall be included in the protection relay panels.

8.2.4.1.1 Multifunction feeder protection

The following characteristics have been selected:

- Installation on 19" horizontal rack
- 48 V DC (+10%/-30%) power supply
- Instrument transformer input modules: 4CT and/or 4VT or more (as required protection function)
- Digital output/input modules with 2 trip and 2 close orders, 8 inputs and 8 outputs, freely configurable by the Contractor
- Communication ports: RS232 and/or USB ports in the front of the relay, to allow the connection for a PC in the rear the relay must have at least one RS485 and one 100 Base FX

The protection, measurement and monitoring functions, and the interface with the screen and alarm LEDs on the front panel, will be included in a single chassis
The following protection functions are available with these types of relays:

- Delayed phase / neutral / earth overvoltage and overcurrent
- Instantaneous phase / neutral / earth overcurrent
- Phase / neutral / auxiliary overvoltage, undervoltage and synchronism check

Every protection function, service or special feature of the relay must be described in the corresponding file, ICD, PICS, PIXIT, MICS and TICS that shall be provided by the Supplier.

8.2.4.1.2 Protection functions

Overcurrent:

Overcurrent protection functions will be used on 66 kV feeders. Each feeder bay shall be provided with phase, earth and neutral residual overcurrent delayed and instantaneous protection functions.
Each protection functions will have the activation for four or more stages.

There shall be a selection of response curves between IEEE, IEC, IAC, I2t, fixed time and configurable curves, as required by the Contractor. The availability of directional overcurrent units is also required.
66 kV back-up overcurrent protection function will be available to send a delayed trip for transformers LV side external faults.

Additionally, the relay shall be able to manage inrush from transformer energization by means of a 2nd or 5th harmonic block.

Thermal overload function:

Thermal time characteristic shall be available to trip the breaker following the application of the overload condition.

Voltage Protection:

Undervoltage, overvoltage and residual overvoltage element shall be available in at least 2 stages with independent definitive time relay.

Extra function

Circuit breaker failure. Upon a failure of the feeder protection breaker to trip upon demand the Feeder relay shall be able to be configured to launch a re-trip and the successive request to trip to the upstream breaker when verification of missed trip of the local breaker elapses.

Internal Control Functions

Programmable logic with signals stored in non-volatile memory.
Flexible controls for functions to be defined by the Contractor, selecting from among physical and virtual inputs.
Lockout possibility in any of the inputs.
Two or more tables of settings which can be automatically selected based on programmed inputs.

Monitoring Functions

Disturbance fast recorder programmable by the Contractor.
Trip circuit monitoring.
Different actuations and state of the protection relay by means of programmable front panel LEDs with settings set in the factory with the capability of being reset.
Relay will be equipped with the necessary I/O card following the design of the already commissioned Feeder cubicle of the Stage 1 which represent the reference for the Stage 2 design.
Availability of 20% I/O spare shall be achieved.

Relay mimic

Relay will be provided and configured with local mimic allowing equipment control. Operator shall be able to analyze the relay log and plant measurement directly on the local screen of the relay and to retrieve records connecting to the relay port using appropriate tool.

CB close order permissive

One (1) undervoltage function 27I will be used as blocking to CB close order on incomer bay, and one (1) undervoltage function 27B will be used as permissive to CB close order on incomer bay. This close order will be blocked if there is no voltage in the 66 kV busbar and the incomer. The synchro-check function 25 is not required.
Interlocks will be configured in the relay following the Stage 1 reference design

Line switch and earth switch O/C permissive

Interlocks for switched will follow the Stage 1 reference design.

Station authority

Relay interlock shall manage the station authority between local control (switchyard and relay mimic) and remote control (CODAC and Plant HMI) following the Stage1 reference design.

8.2.4.1.3 Setting and Parameterization of Protections

The Contractor shall include the preparation of documents related to settings, parameters and programming of protections relay control and measuring equipment on 66 kV bays and the coordination and selectivity of overcurrent protection with the overcurrent setting by others on MCPC Stage 2 converter transformer.
This service shall include at least the following:

- Obtaining of input data for settings that will be provided by the Contractor design, such as external system data, transformer data short-circuit calculations, relay curves or adjustments, with which some type of coordination must be carried out.
- Additional calculations to define the parameter setting.
- Recommendations for setting values, as per protection Supplier and Contractor design.
- Preparation of protection coordination curves.
- Preparation of setting parameter files using the software applicable to the relay.

The Supplier shall send the Contractor design the document containing all the above information and the relay parameterization files to IO for comments and review.
Before the Factory Acceptance Test (FAT) the Supplier shall load the setting parameters file in the relays in order to carry out the relay setting tests.
The Supplier shall include the tests of relay settings, parameterization, and programming of the protection relays, measuring and communications equipment in the workshop by specialized personnel and equipment.
The attendance of the Contractor during the workshop test shall be taken into account.
The relays included in the panels will leave the workshop with the settings installed, if possible with the settings accepted by the Contractor.
The Supplier shall perform the FAT and SAT indicated in Section 8.2.9.

8.2.4.1.4 Plant System HMI and Engineering station

The supply will include the refurbishment of the existing Plant System HMI/Engineering Station installed inside the Cubicle 41PPCH-CU-0003 located in B36. The existing Plant system HMI is based on Pacis V5.1 and runs on a Windows 7 environment in a dedicated Industrial Control Computer.

The scope of supply will include:

- The supply upgrade of the Plant System Control and Supervision system to the latest available technology available (Ecostruxure or similar) fully licensed
- The refurbishment of the existing Industrial Control Computer (last Windows version compatible with the Control and Supervision System shall be installed)
- The implementation of a full Engineering station with the complete set of software tools needed for the configuration, commissioning and troubleshooting of the Stage 1 and Stage 2 architecture including the softare for database and the HMI configuration.
- The upgrade of the existing database and HMI screens for the integration of the Stage 2 relays and the associated Site test.
- The installation of the required tool to create a cybersecurity police and configure the for enhanced security in the PPEN network. The tool shall allow retrieving security logs from any devices in the network connected to the central system and shall allow a centralized administration of the roles, passwords and of the security parameters in general.

A standard license shall be quoted for the full access of the Ecostruxure engineering function. Any limitation shall be declared in the technical Offer.

8.2.4.1.4.1 Performance

The following HMI features are expected:

- IEC61850 edition 2 data acquisition (>100,000 tags, 500 IEC61850 servers, highest constant dataflow, automatic DR extraction etc.)
- Capability for redundancy and scalability
- Configuration tools
- Retrieval of historical data
- Real time monitoring and control function (visualization of electrical SLD and interlocking pages, alarm and events management, visualization of equipment status, sequence of events, analogue trends, customized sequence scripts etc.)
- Cybersecurity
- Web access
- Capability for predictive analysis

- Risk notification available for operators

8.2.4.1.5 Technical characteristics of protection relays

8.2.4.1.6 Protection Relay General Data

The protection relays shall be designed for instrument transformer voltages of 100 V and $100/\sqrt{3}$ AC, and for rated current of 5 A (or 1A). The power supply rated voltage is 48 V DC (+10% - 30%) and the contacts shall be designed to withstand rated voltages of 230 V AC (±10%).
System frequency is 50 Hz.
The protection relays must have screw terminals and the removal of a card or component shall not cause current circuits to open or voltage circuits to short-circuit. Output contacts which are N/O must functionally remain the same after removal of their cards.
The protection relays must not have test boxes or tools. The voltage and current circuit tests shall be carried out on plug-in, short-circuitable terminals included in protection panel.

8.2.4.1.7 Technology

Main protection relays are digital, multifunctional and programmable with microprocessor-based technology.

Electromechanical control must be used in every auxiliary relay. The will be devoted to multiply actuations, signals and tripping and lockout functions. If a protection relay has to be analogue or static without digital technology, its correct operation shall be substantiated by demonstrable experience.
All the protection relays shall be digital and programmable from the local man-machine interface.
The performance of a complete functional test shall be possible even during normal service.
Each relay shall include continuous self-monitoring, diagnosis, event recording and fault reporting.
The protection relays will perform supervision of all parts of the relay hardware, firmware and software and shall have a documented life of not less than two (2) years.
It shall be possible to connect protection relays via communication bus for data settings and extraction, communicating directly with the centralized control system.
The protection relays of the transformers shall be connected in a communication network of the IEC 61850 station bus type. The setting of the relays, data analysis (alarms, trips, disturbance records, etc.) and faults/events recording shall be accessible through the central station bus.
The protection relays shall not include remote measurement and control functions.

8.2.4.1.8 Communication

The protection relays must have at least the following communication ports: in the front of the panel RS232 and/or USB communication ports to allow the connection for a PC. In the rear the device must have at least one (1) RS485 communications port and one (1) 100BaseFX.

8.2.4.1.9 Fast Disturbance and Sequential Events Report Record

All protection relays using numerical control technology shall have event information file, record units.
Synchronization shall be through network (SNTP).
Every signal of every relay, as well as all alarms or recordings shall be time tagged in the protection relays or IEDs with 1 ms resolution and transferred to SAS to events recording.
Remote handling of the protective relay records must be possible via the communication network.
The disturbance channels and their triggering sources shall be user configurable. Oscillography analysis shall be provided in the engineering workstation for optimum results. The protection relays shall provide voltage and current vectors at the time of trigger initiation and also voltage and current waveform recording.

8.2.4.1.10 On-screen Measurements

All protection relays shall have current and voltage measurement indication which will reach the relay. Readings shall be easily accessible to non-specialist personnel.

8.2.4.1.11 Software

All the software developed for and applicable to the protection relays shall be supplied, especially for changing settings and for reading, printing and managing the protective relay records. The necessary software will be installed in the engineering workstation.

8.2.4.1.12 Obsolescence management

Control and Protection relay of the Stage 1 are equipped with CPU270 boards in end-of-commercialization phase since 2018. Similarly, Pacis V5.1 is installed on site and was declared in obsolescence on the 1st of July 2022.

For the Stage 2 equipment in the scope of this specification the latest technology is requested.

Availability of spares and technological support shall be ensured for at least 20 years of operation. Contactor shall analyse any constraint due to the integration of the latest relay technology, that shall be in Active Phase of production, in the existing relay architecture.

Contractor shall additionally perform the Overall I&C obsolescence risk assessment of the existing PPEN I&C architecture. Contractor shall collect information from Manufacturers about obsolescence since design phase and include in the scope the system upgrades needed to ensure long term operation of the Plant (>20years) with available spare parts and technological support. Any partial refurbishment or full replacement of the existing Stage1 equipment shall be evaluated and included to achieve this target.

8.2.4.1.13 Spare part

Contractor shall include 20% spare part for each relay model installed.

8.2.4.1.14 Cybersecurity

The following cybersecurity targets shall be achieved to ensure robust cybersecurity and meet IT compliance standards with a comprehensive solution:

- Implementation of a cybersecurity policy
- Configuration of the security of devices
- Retrieval of security logs of the substation, plant or industrial environment
- Centralized administration of user accounts and roles

A security plan shall be issued for approval and implementation.

8.2.4.1.15 Other services

The protection relay Supplier shall ask the Contractor for basic data on the equipment and electrical system which he considers necessary so that the relays are duly adjusted and enabled for the function to be carried out.
The Supplier of the relays must provide the ICD file of every supplied device, also the PICS, PIXIT, MICS and TICS, every one must comply with the standard defined in the IEC 61850.

8.2.4.2 **Ethernet switches**

One (1) Ethernet switch shall be included inside the protection panels that house the feeders protection relays for PPEN 66kV stage 2. At least, they shall have 4 ports of 1000BaseLX and 16 ports of 100BaseFX.

8.2.4.2.1 General

The Ethernet switches shall be fully managed, modular, specifically designed to operate reliably in electrically harsh substation environment for mission critical, real time control application. The switches shall be packaged in a galvanized steel enclosure with industrial grade DIN, Panel or 19”rack mount mounting options.
This datasheet is applicable for both kind of switch requirements.

8.2.4.2.2 Data Sheet

8.2.4.2.3 Ethernet Ports

- Gigabit Ethernet ports and Fast Ethernet ports – Copper and/or fiber optic
- Two port modules for flexibility and easy configurations
- Non-blocking, store and forward switching
- Supports many types of fiber (Single mode/Multimode)
- Accepts multiple connector types (ST, MTRJ, LC, and SC)
- Many different fiber port options (like 9/19/32 ports) managed Ethernet switch

8.2.4.2.4 Security features

- Supports multi-level user passwords
- Enable/disable ports (local & remote), AMC based port security
- Port based network access control (802.1x)
- VALN (802.1Q) to segregate and secure network traffic
- SNMP v3 authentication and 56-bit encryption

8.2.4.2.5 Environment

- Immunity to EMI and heavy electrical surges meeting IEC61850-3
- -40 ºC to +85ºC operating temperatures without any cooling/heating mechanism
- Galvanized steel enclosure

8.2.4.2.6 OS features

- Simple plug & play operation-automatic learning, negotiation and cross over detection
- Rapid spanning tree network fault recovery: It should allow the creation of fault tolerant ring and mesh ethernet networks

- Quality of service (802.1P) for real time traffic
- VLAN (802.1Q) with double tagging
- Link aggregation (802.3AD)
- Port configuration, status, statistics, mirroring, and security locally as well as from remote
- SNTP time synchronization (client and server): It should automatically synchronize the internal clock of all devices on the network. It should allow for correlation of time stamped events for troubleshooting

8.2.4.2.7 Switch Management Tools

- Telnet and CLI management interfaces
- SNMP v1/v2/v3 (56 bit encryption)
- Remote monitoring (Web based management)
- Diagnostics with logging and alarms facility

8.2.4.2.8 Power Supply

- Supply range: 36-72V DC
- Fully integrated dual redundant power supply
- Screw or pluggable terminal blocks available
- Terminal blocks for maintenance free connections
- CSA/UL 60950 safety approved to +85 ºC

8.2.4.2.9 Ethernet Switches inside Substation container

Hirschmann switches of MAR1030 serial had been used adopted in 66kV substation container.

8.2.4.3 **Other equipment included in protection and control panels**

8.2.4.3.1 Trip and lockout relays (86)

Auxiliary trip and lockout relays with fast acting, robust contacts associated with the protection relays shall be supplied, which shall comply with the following requirements:

- Electromechanical relay with fast-trip coil (8 ms) and electrical reset by pushbutton
- Minimum of 8 robust contacts N/O and 8 contacts N/C

8.2.4.3.2 Test blocks

For monitoring, isolation and secondary current injection testing of protection relays, each protection relay panel shall be furnished with test blocks that assured the automatic short

circuiting in the current transformer circuit. The test block will be complemented with the multifinger test plug.

8.2.4.3.3 Automatic Circuit Breakers and Disconnectors Control Power Supplies

To establish the separation of protection relays and actuation redundancies, separate controls will be required for the protection relays and for the common control of auxiliary relays which are multipliers of positions of circuit breakers, disconnecting switches, etc.
Two-pole thermal-magnetic circuit breakers with two auxiliary contacts shall be used.

8.2.4.3.4 Auxiliary relays

Each of the protection and control relay panels shall be furnished with the auxiliary relay types and quantities required.
Bistable auxiliary relays will be used to multiply of disconnector switch, earthing switch and circuit breaker status (closed and open position)
Auxiliary relays for SAS commands.

8.2.5 Fiber Optic

Fiber optic cables shall have the following characteristics:

- Multimode fiber optic cable
- Core / cladding dimensions (µm): 62.5 / 125
- Attenuation (dB/km): 3.50 / 1.00 (@ 850 /1300 nm)
- Bandwidth (MHz-km): > 200 / 500 (@ 850 /1300 nm)
- Applicable code: EN 50173
- Other requirements: EN 18700, EN 60794-3, CEI 794-2

8.2.6 Communication panels

The substation shall be provided with the following internal communication for system LAN IEC 61850 into the substation container:

- Communications channels for the SAS data communications

Telecommunication cabinets and fiber optic patch panel/termination panels shall be supplied.

8.2.7 Protection and Control panels construction details

The design of the Protection and Control Panels have to be in accordance with *I&C cubicle internal configuration* [RD35] and *ITER catalogue for I&C products - Cubicles* [RD36].

For conventional and interlock controls: Type Spacial SF, height 47 U / 2200mm, width 800 mm, depth 800mm.

8.2.7.1 General features

- Structure: top and bottom frame, vertical uprights.
- Degree of protection IP54 according to IEC 60529.
- Resistance to mechanical impact: IK10 according to IEC 62262 (IK08 for the transparent doors).
- Configuration reference: NSYSFRSTVA

8.2.7.2 Technical description of the standard configuration

- Front Securit® glazed door with 180° hinges (right) and locking system by key N°405.
- Rear plain door with 180° hinges (right) and locking system by key N°405.
- 1 Removable roof mounted with 2 cable gland plate type FL21 (one with 25 cables entries Ø5 to Ø26 and one with 7 cables entries Ø8 to Ø 60) on lateral one at the left side and other one at the right side.
- 1 pair of 2 standard side panels screwed on with captive screws.
- 1 standard fan 473m3/h mounted on the bottom of the rear door.
- 1 outlet grille mounted on the top of the rear door.
- 4 19” uprights front and rear chassis.
- 2 vertical trim strips on the front 19” upright.
- Cable tray mounted at left.
- 1 cable gland plate 3 parts mounted on the bottom of rack.
- 1 plinth 100mm joint.
- 1 set of 4 feet adjustable joint.
- 1 set of 4 lifting eyes (not mounted).
- 1 earthing braid for claddings joint.
- 2 earthing strips: ref. NSYASTAEEC1UN and NSYASTAEECS.
- 1 able support on the lateral framework NSYASTCFS98.
- 1 front plate and 1 DIN rail ref NSYASTCRTM3UD and NSYASTR19DIN (mounted on the 19’’ uprights).
- 1 digital thermostat 1U ref.: NSYASTCRTM1UVTD.
- Contact door at the front and rear door (mounted).
- 1 Monitoring and sensors joint (not wired) inside the enclosure.
- Painted with epoxy-polyester resin, Afnor.2550 (blue) for decontamination.
- Document support inside the front door.

8.2.7.3 Additional requirements

8.2.7.3.1 General

The distribution of equipment installed on the front panel shall be proposed and carried out by the Supplier with the Contractor's approval. Internal distribution shall be such that the protective relays and associated terminals are accessible for examination or replacement without interference from other components.
The Supplier shall prepare drawings of the equipment dimensions and arrangement and submit them for approval by the Contractor before beginning any manufacturing activities.
The hanger bolts shall be removable, and the bolts holes shall be sealed with a threaded cap.
The panels shall be supplied completely equipped with all components assembled and wired in the factory. However, fragile components that require special packing to prevent damage shall be disassembled for transport.
All fixings shall be made of cadmium plated or passivated iron at fixture points and of brass when good electrical contact necessary.
All non-metallic components – such as terminals, cable trenches, brackets, etc, shall be made non-hygroscopic halogen-free material.

8.2.7.3.2 Protection Relay and Control Bay Panels

The panels shall be enclosed and furnished with a pivoting rack at the front and a 100 mm support frame.
The front of the pivoting rack shall be protected with a steel profile door with polycarbonate window made of halogen free material.
Both the door and the pivoting rack shall be equipped with an adjustable retention mechanism to prevent collision with the adjacent panel.
On the back wall of the panel there shall be vertical or horizontal profiles for fixing auxiliary relays and instruments, terminal strips, and cable fixing rack for offsite connection (included in the supply). Cable entry shall be through the bottom of the panel.
Gaps not covered by relays shall be covered with plates of different heights which facilitate any subsequent extension or replacement at the Plant.
All protective relays will be installed in dust-proof cubicles, of standard modular 19'' rack design, following IEC 60297.

8.2.7.4 Instruments and components

All equipment and components shall operate correctly in the environmental conditions specified.
All equipment and components used shall have suitable characteristics and their location shall facilitate maintenance without having to interrupt the operation of any adjacent equipment.
Each panel shall be supplied with a lamp for interior lighting, controlled by the door, powered by 230 V AC and protected by circuit breakers with differential protection.

Each panel shall also be fitted with a heating resistor.
Each panel shall be supplied with a 16 A 230 V AC outlet protected by circuit breakers with differential protection.

8.2.7.5 Earthing

A 30 mm x 5 mm copper bar shall be screwed along each panel to which all non-current carrying metal parts will be electrically connected.
The earth shall be bare copper.
The earth bar sections shall be joined together with at least two screws.
There shall be a clamp-on terminal on both ends to the panel earth bar, fixed with at least two screws.
The doors shall be connected to earth using at least 6 mm2 flexible or braided wire.

8.2.7.6 Wiring

Internal wiring shall be in accordance with the requirements indicated in Section 13.

8.2.8 Name plate requirements

Regarding the control, protection, measuring and communication panel and subpanels, each one shall be supplied with a main nameplate fixed to the top of the front panel, bearing the designation indicated in the front panel drawings and in accordance with their corresponding manufacturing standard. These plates shall include the code identification given in the project. They shall be fixed to the panel by means of stainless-steel screws. The use of glues or adhesives is not permitted.
The relays and other elements located in the front of each pivoting rack shall be furnished with a tag clearly indicating their function and the equipment protected. The designation shall be in accordance with the list of materials to be supplied by the Supplier and approved by the Contractor. These nameplates shall be of stainless steel of 1.5 mm thickness with matt or satin finish and engraved with black lettering. They shall be fixed to the panel by means of stainless-steel screws.
Other nameplates shall also be fixed alongside each component installed into the panel. The designation shall be that indicated in the aforementioned list of materials. Each of these nameplates shall also bear the identification of the device used in the internal wiring. These plates shall be of stainless steel of 1.5 mm thickness with engraved black lettering. They shall be fixed.
The Supplier shall provide also labels, nameplates, instruction and warning plates on all equipment necessary for the identification and safe operation of auxiliary equipment.

8.2.9 Tests

All the panels shall be subject to the shop tests and verifications addressed below.
The cable entry gaps and the panel dimensions shall be checked in accordance with the general dimension drawings.
The correct location of the relays shall be checked against the approved physical layout drawings.
The relays characteristics –type, brand, etc.- shall be checked against the approved list of materials.
Internal wiring continuity shall be checked in accordance with the panel control wiring diagrams and internal wiring diagrams.
An insulation and dielectric strength test shall be carried out on the wiring in accordance with IEC 61439. Necessary steps shall be taken to ensure that no equipment damage is caused during this test (protection relays, auxiliary relays, etc).
The earthing of all non-current carrying metal parts shall be checked.
The panels shall be completely wired, tested and inspected at factory.
Protection relays functional and settings tests shall be carried out by the Contractor. Relays must leave the factory already adjusted, if possible with the parameters accepted by the Contractor prior to the final tests.
IEDs shall be tested in accordance with the conformance and quality tests indicted in IEC 61850-10 and IEC 61850-4 Section 7.
For test classified in the applicable standards as type tests, the certified test report will be submitted.

8.2.9.1 Type tests

Type tests shall be in accordance to the various parts of IEC 60255, IEC 61000 and IEC 60068 for:

TEST	Description
IEC 60068-2-1	Cold Temperature
IEC 60068-2-2	Dry Heat
IEC 60068-2-30	Humidity (Damp heat, Cyclic)
IEC 60255-5	Dielectric Strength
IEC 60255-5	HV Impulse
IEC 60255-11	Voltage dips, short interruptions, variations and ripple on auxiliary power supply port
IEC 60255-21	Vibration, shock, bump and seismic tests on measuring relays and protection equipment
IEC 60255-22, IEC 61000-4-4	Electrical disturbance tests

TEST	Description
IEC 60255-25	Electromagnetic emission tests
IEC 61000-4-2	ESD
IEC 61000-4-3	Radiated RFI
IEC 61000-4-4	Burst (Fast Transient)
IEC 61000-4-5	Surge
IEC 61000-4-6	Induced (conducted) RFI
IEC 61000-4-8	Magnetic Field
IEC 61000-4-29 & 11	Voltage Dips & Interrupts
IEC 61000-4-12	Damped Oscillatory
IEC 61000-4-16	Mains Frequency Voltage
IEC 61000-4-17	Ripple on DC Power Supply
IEC 61000-4-23	Test methods for protective devices for HEMP and other radiated disturbances

8.2.9.2 Routine tests: On Factory Acceptance Tests (FAT)

The Factory Acceptance Tests (FAT) occur at the completion of the manufacturing phase of plant system procurement and are the first stage of the validation activity. These tests are intended to check the conformity of the plant system delivered by the supplier before it is shipped to IO in Cadarache.

8.2.9.2.1 Plant system I&C FAT objectives

Plant system I&C factory acceptance tests (FAT) are intended to check the conformity of plant system I&C procurements with IO requirements and mainly PCDH requirements, in order to ensure that the plant system I&C are integrable before they enter into IO SAT. Plant system I&C FAT is a part of the plant system FAT.
The Factory Acceptance Tests (FAT) will verify that the IEC61850 Substation Automation System (SAS) functions are as per the approved design and technical specification.

8.2.9.2.2 Scope of tests

The FAT tests have been divided into relevant sections to perform the tests systematically. Upon successful verification of the tests in each section, pertinent forms and test results will be completed and signed for acceptance by the ITER or its representative.
The Plant system I&C components to be tested are the cubicles with their embedded hardware and software.
The I&C FAT shall check the compliance of the Plant system I&C to specifications in the following areas:

- Mechanical and electrical configuration of I&C cubicles
- Controller's hardware and software
- Plant system configuration
- Plant system I&C functions
- Performance
- Documentation

Some items of the scope might not be applicable to some procurements.
The I&C FAT doesn't aim to test the correctness of the functional process-related logic implemented in the Plant System I&C. This will be tested by the Plant System Responsible Officer.
Device Conformance testing is mandatory to ensure IEC 61850 compliance of the device as per standard.
The details of the factory acceptance requirements should be defined and agreed with the suppliers during the detailed engineering phase however it is included a minimum in this specification.

8.2.9.2.3 Factory Acceptance Test (FAT)

- Operational and Pre-FAT tests
  Before FAT, vendor have to perform operational & pre-FAT test and submit the report for initial verification and send the notification for witnessing the FAT.
- Notification for the readiness to test
- The minimum FAT tests that have to be performed are:
  - Pre Power on checks
  - Power on checks
  - Hardware Tests
  - Functional tests
  - Parametric Test/Conformance Tests
  - Power Failure and Auto restart test
  - Testing of interlocks
- Integrated Testing of the overall PPEN system

The FAT protocol shall be submitted as a document and shall be included in I&C Deliverables. After the FAT has been successfully verified, the System Acceptance document will be signed by representatives from ITER and manufacturer.

8.2.9.2.4 Test environment and tools

The interface to the plant instrumentation and actuators is disconnected or simulated by test equipment. The environmental conditions are those of the supplier's factory.
The **test environment** consists of:

- Simulators for field physical devices (sensors, actuators, equipment)
- Test Data Set
- Stubs (e.g. data for external interfaced plant systems)
- Network probes
- —
- Configured compatible CPUs

The **test equipment's** consists of:
To conduct the test procedures outlined in this document, the following equipment's are required to be arranged the system supplier.

- Digital Multimeter
- 3 Phase current and voltage injection kit
- Protocol Analyser (if required)
- Any other equipment's necessary for the test.

The Factory Acceptance Tests (FAT) have to be in accordance with the ITER documents [RD37] and [RD38].

8.2.9.3 **On Site Acceptance Test (SAT)**

Following the FAT in the Contractor premises, the I&C equipment will be shipped together with the plant system to Cadarache. I&C shipment units are the cubicles.
These cubicles will be installed on site in Cadarache.
Then, the following actions will be undertaken by IO:

- SCC cubicles will be connected to LCC cubicles (if necessary)
- LCC cubicles will be networked (if necessary)
- The cubicles will be connected to infrastructure network hutches supplied by IO,
- Mini-CODAC will be reinstalled in a convenient location for testing but using the IO network infrastructure
- Test tools will be installed
- Power supplies will be connected (not powered on)

The PS supplier will crosscheck the cabling and will power the cubicles.

Then the FAT campaigns will be re-done to confirm that there has been no damage during transportation.
The information about FAT campaigns is included in [RD37].

The On-Site Acceptance Tests have to be in accordance with the ITER document [RD37].

The full SAT e is in the scope of the Contractor and will include communication and 100% signal test with the Local Plant HMI and CODAC.

All software and hardwired interlock shall be verified for controls.

The protection test will be performed by means of secondary injection following procedure once measuring equipment have been validated with primary injection.

SAT procedure shall be prepared in advance and submitted for approval to IO. It will not be allowed to start tests on site without approved procedures for testing.

The site/commissioning test (SAT) should be categorized under following categories:

- Site Start up tests
- Calibration and Configuration checks
- Pre Commissioning tests
- Trial Operation tests
- Availability test
- System handover and Final acceptance

Availability test have to include and guarantee the availability of the system to 99.9%. The test should be performed for certain number of days after trial operation tests are succesfully completed.
The availability test have to be expressed as percentage, which will be calculated as (100% x (test duration time - accumulated test outage time / test duration time)).
The system handover to the ITER for operation can start after the successful site/commissioning tests. A handover certificate will be issued by the ITER. Final Acceptance of the system will take place after the succesful completion of availability tests.
It has to be guaranteed on site that the I&C systems will be in service with the final settings loaded into the I&C devices, correctly programmed with the parameters obtained in the calculations after revising them during the tests and verified by the Contractor team.
In the case of later adjustments on site, the definitive setting load will be carried out on the I&C devices. This implies the review of the setting documents and files, as well as part of some tests, if any were performed.

8.2.10 Documentation

8.2.10.1 Documentation to be supplied with the tender

- Detailed description of control, protection and metering systems
- One-line diagram of the substation protection and metering systems
- Control system architecture diagram
- A “List of Pre-FAT, FAT and SAT tests” shall be presented for verification and approval by representatives of ITER

In addition, the Supplier shall present a “List of Exceptions” indicating the technical discrepancies between the specifications of the equipment and services offered as opposed to the requirements of this Technical Specification.

8.2.10.2 Documentation to be supplied during contract execution

The following documents shall be submitted for IO approval. The delivery period is to be agreed before placing the order:

Document type	Maximum delivery period after award
One-line diagrams of protection and metering systems	To be defined
Precision calculations and sketches of protection and metering systems and current and voltage transformers	To be defined
Control system architecture	To be defined
Lists of control system signals	To be defined
Control system hardware manuals	To be defined
Lists of I&C cables	To be defined
Recommended drawings of I&C cable routes	To be defined
List of materials and components of the control, protection, metering and communications panels	To be defined
Final setting parameters and test recording (oscillography, fault report and data logger) extract from each relay	To be defined
Test procedures	To be defined
Routine test reports and protocols	To be defined
Type test certificates	To be defined

In addition to the documents specifically indicated, the Supplier shall draw up any other documents applicable to the supply covered by this specification that may be required or that may be necessary for defining the substation I&C design, equipment supply, erection tests or startup.

8.2.10.3 Final documentation (I&C Deliverables)

8.2.10.3.1 Plant system I&C function and architecture

It shall include a high-level functional analysis (D1A), a detailed functional breakdown with functional links and the characterization of functions (D1B), and the physical architecture with separation of conventional, interlock and safety controls (D1C).

8.2.10.3.2 Plant system I&C boundary definition

Definition shall be made regarding to physical and functional boundaries to other plant systems and central systems, including boundaries between conventional, interlock and safety I&C.

8.2.10.3.3 Plant systems I&C physical and functional integration plan

It shall take into account distribution of functions between plant and central systems as well as between plant systems.

8.2.10.3.4 Plant system P&IDs, mechanical and electrical drawings related to I&C detailed design

I&C cables will be listed with the rest of 66 kV system cables. They will include type, start point and end point.

8.2.10.3.5 Plant system controller(s) computational and signal IO performance requirements and physical configuration requirements

8.2.10.3.6 List of physical input and output signals (I/O)

List of physical I/O of the I&C controllers and signal conditioning units.

8.2.10.3.7 Boolean logic diagram for equipment interlocking

Boolean logic diagram for relay interlocking shall be produced. The interlocking diagram shall be reflected in a dedicated HMI screen for real time analysis.

8.2.10.3.7 List of the variables handled by the plant system I&C controllers

This includes plant internal variables as well as all variables exchanged via networks (grouped by network/function). Separate by type of controller (conventional, interlock, safety).

8.2.10.3.8 Physical configuration of plant I&C within I&C cubicles

It shall include intra-rack and external cabling connections (includes networks).

8.2.10.3.9 Detailed description of plant system state machines (PSOS)

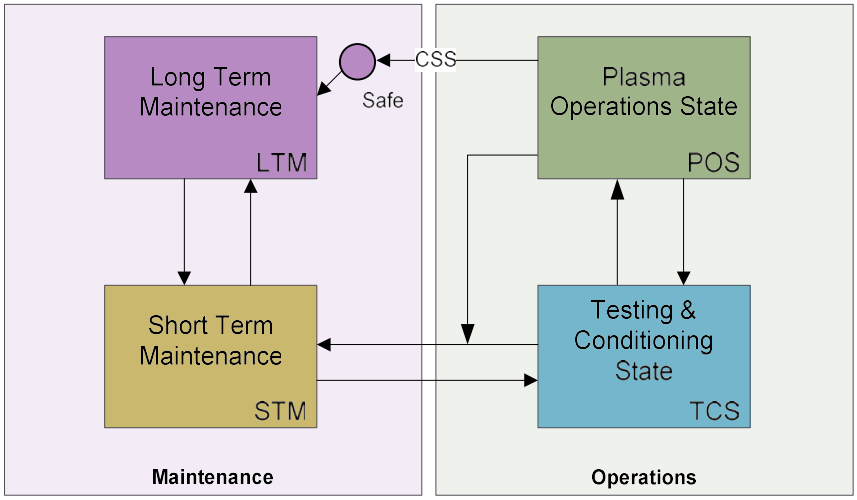
PSOS shall be described with all states, transitions, procedures and state variables. Documentation in standard prescribed graphical format. The 66 kV System state machines diagram shall be made according to the following:

Global operational states

The ITER machine shall always be in one of four well defined Global Operational States. These states are briefly described the table below. The following sections break down each state into sub-states and the stages of the pulse and run sequences are defined and described.

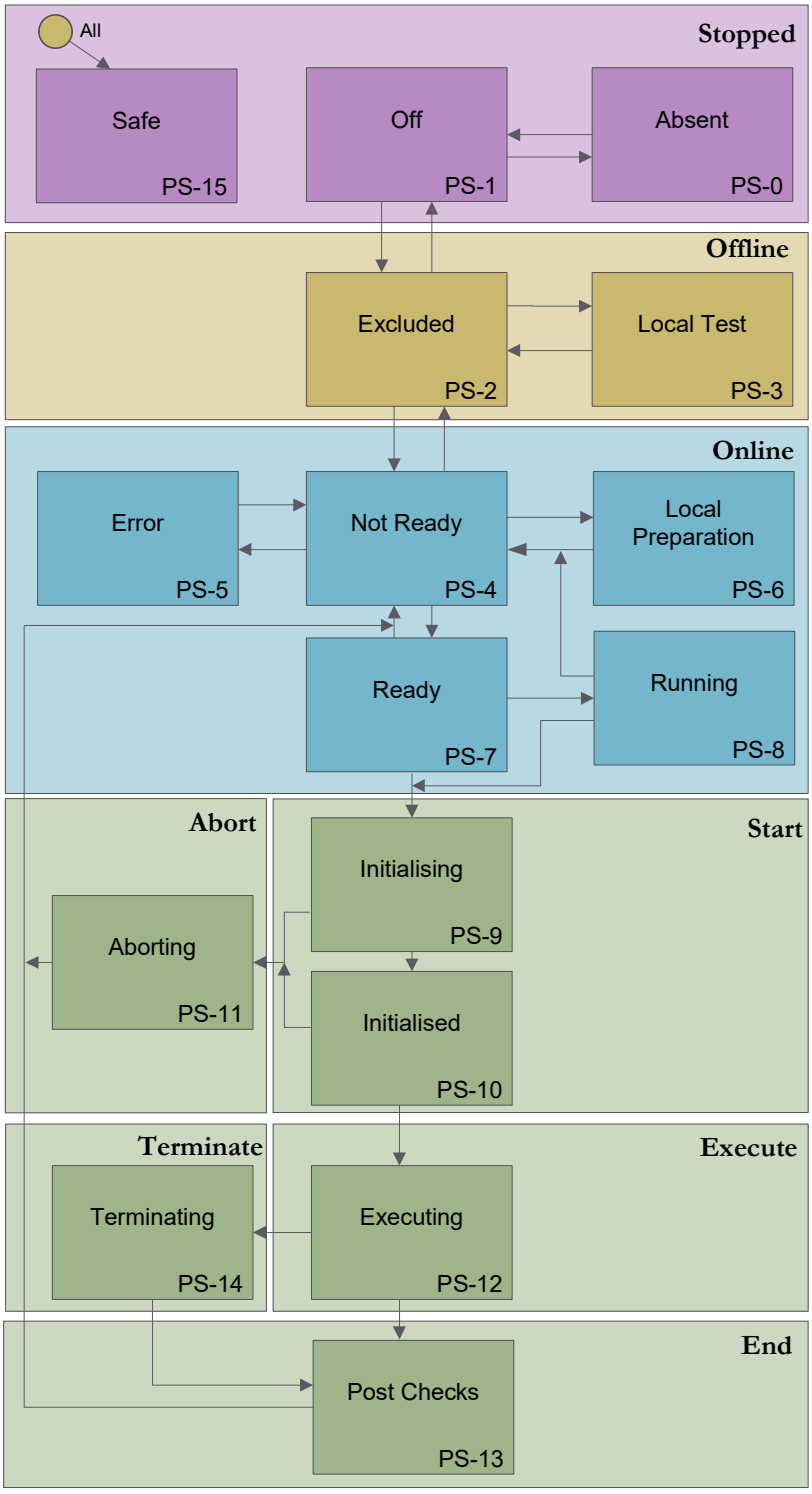
Long Term Maintenance (LTM)	This state is used for long term maintenance or upgrade, after a significant nuclear decay period. Decay heat is passively removed. Coil excitation and any power injection by an additional heating system to the Tokamak is prohibited. All safety locks, shutters and isolation breakers are set to safe.
Short Term Maintenance (STM)	This state may be scheduled or unscheduled following a failure. The vessel is evacuated; all magnets are at zero or reduced current but are cooled. Decay heat removal may be taking place, if appropriate. Safety locks, shutters and isolation breakers are removed from certain systems to permit testing.
Testing & Conditioning State (TCS)	In this state the sub-set of systems required for test runs are ready (with no-plasma). Other systems are excluded. Cooling systems are in low-flow. Runs include operations such as glow discharge cleaning, without the presence of the magnetic field, or baking. TF and PF coil excitation tests may be performed. Additional heating system tests such as NBI ion source conditioning, RF dummy load tests, and fueling system tests are allowed – however there cannot be any Tokamak plasma. There is very limited access and no in-vessel or major ex-vessel maintenance may be performed. However minor ex-cryostat component maintenance and trouble shooting may be authorised. Safety locks, shutters and isolation breakers are removed from many systems to permit test and conditioning runs.
Plasma Operation State(POS)	This is the state waiting for, during the countdown, execution and end of a plasma pulse, including IC wall conditioning. The TF field is on.Safety locks, shutters and isolation breakers are removed from all systems to permit plasma pulse operation.

The permitted transitions (and necessary authorizations) between Global Operational States are shown in the following figure.



Plant Common Operational States

The plant Common Operational States (COS) and sub-states of plant systems are shown in the figure below. The COS is a state property that implements simple and synthetic state information applicable to each plant system so that they can be managed by the CODAC Supervisory Control System in a coherent way.



A plant system will have its own internal states and transitions, which may not map uniquely to one Common Operational State, however they always report the COS to the CODAC systems and follow the indicated transitions.

8.2.10.3.10 Additional documentation

The Supplier shall include the following documentation at Manufacturing Readiness Review:

- Operator manuals
- Product manuals
- Logic diagrams
- Guaranteed technical design parameters
- Calculation of power supplies
- Assembly drawings

8.3 Substation Structures

The metallic structures shall be included in the scope of supply of the Contractor or the equipment manufacturers to support the supplied equipment and materials.

8.3.1 Applicable Codes and Standards

- NF EN 1990:2003 Structural Eurocodes – Basis of structural design
- NF EN 1990:2003/A1:2011 Structural Eurocode – Basis of structural design Amendment A1
- NF EN 1990 /NA French National Annex (NF P 06-100-1/A1/NA:2007)
- NF EN 1991-1-1: 2003 Eurocode 1 – Actions on structures. Densities, selfweight, imposed load for buildings
- NF EN 1991-1-4: 2008 Eurocode 1 – Actions on structures. Wind actions
- NF EN 1991-1-4 /NA French National Annex (NF P 06-114-1/NA:2008)
- NF EN 1991-1-5:2004 Eurocode 1 – Actions on structures. Thermal actions
- NF EN 1991-1-5 /NA French National Annex (NF P 06-115-1/NA:2008)
- NF EN 1993-1-1:2005 Eurocode 3 – Design of steel structures
- NF EN 1993-1-1 /NA French National Annex (NF P 22-311-1/NA:2013)
- NF EN 1998-1:2005 Eurocode 8 – Design of structures for earthquake resistance. General rules, seismic actions and rules for buildings
- NF EN 1998-1 /NA French National Annex (NF P 06-030-1/NA:2013)
- NF EN 10080:2005 – Steels for the reinforcement of concrete – Weldable reinforcing steel General
- NF EN ISO 683-1:2018 – Heat treatable steels, alloy steels and free-cutting steels
- NF EN 10210-1:2006 – Hot finished structural hollow sections of non-alloy and fine grain steels
- NF EN 10219:2006 – Cold formed welded structural hollow sections of non-alloy and fine grain steels
- NF EN 287 Qualification test of welders
- NF EN 1090-2 Execution of steel and aluminium structures – Part 2- Technical requirements for steel structures
- NF EN 1179 Zinc and zinc alloys – Primary zinc
- NF EN 10020 Steel Grade Definitions and Classifications
- NF EN 10021 General technical delivery requirements for steel products

- • NF EN 10025 Hot rolled product of structural steels – Technical delivery conditions
- NF EN 10029 Hot rolled steel plates 3mm thick or above – Tolerances on dimensions, shape and mass
- NF EN 10034 Structure steel I and H sections – Tolerances on shape and dimensions
- NF EN 10055 Iron and steel – Hot rolled bars or merchant bars and sections for general purposes – Tolerances on shape and dimensions
- NF EN 10056-1 Iron and steel – Hot rolled unequal leg angles – Dimensions
- NF EN 10056-2 Structure steel equal and unequal leg angles – Tolerances on shape and dimensions
- NF EN 10058 Hot rolled flat steel bars for general purposes – Dimensions and tolerances on shape and dimensions
- NF EN 10060 Hot rolled round steel bars for general purposes – Dimensions and tolerances on shape and dimensions
- NF EN 10204 Metallic products – Type of inspection documents
- NF EN 10279 Hot rolled steel channels – tolerances on shape, dimensions and mass
- NF EN 14399 High strength structure bolting assembling for preloading
- NF EN 20273 Fasteners – Clearance hole for bolts and screws
- NF EN 26157-1 Fasteners – Surface discontinuities – Part 1 – Bolts, screws and studs for general requirements
- NF EN ISO 898-1 Mechanical properties of fasteners made in carbon steel and alloy steel – Part 1- Bolts, screws and studs
- NF EN ISO 1461 Hot dip galvanized coatings on fabricated iron and steel articles –Specification and test methods
- NF EN ISO 2063 Thermal spraying metallic and other inorganic coatings and their alloys
- NF EN ISO 2560 Welding consumables – covered electrodes for manual metal arc welding and fine grain steels - Classification
- NF EN ISO 3269 Fasteners – Acceptance inspection
- NF EN ISO 4014 Hexagon head bolts – Product grades A and B
- NF EN ISO 4017 Hexagon head screws – Product grades A and B
- NF EN ISO 4032 Hexagon regular nuts – Product grades A and B
- • NF EN ISO 4035 Hexagon chanfered thin nuts – Product grades A and B

- NF EN ISO 4759 Tolerances for fasteners
- NF EN ISO 6157-2 Fasteners – Surface discontinuities – Part 2 nuts
- • NF EN ISO 7091 Plain washers – Normal series – Product grade C
- • NF EN ISO 7093-1 Plain washers – Large series – Product grade A
- • NF EN ISO 9013 Thermal cutting – Classification of thermal cuts – Geometrical product specification and quality tolerances
- NF EN ISO 10484 Widening test on nuts
- NF EN ISO 10485 Cone proof load test on nuts
- NF EN ISO 14175 Welding consumables – Gases and gas mixture for fusion welding and allied processes
- NF EN ISO 14341 Welding consumable – Wire electrodes and deposits for gas shielded metal arc welding of non-alloy and fine grain steels classification
- NF EN ISO 14713 Zinc coatings guidelines and recommendations for the protection against corrosion of iron and steel in structures
- NF EN ISO 15607 Specification and approval of welding procedures for metallic materials
- NF EN ISO 17632 Welding consumables – Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine grain steels - Classification

Regarding the geometrical characteristics, The steel products used shall be in accordance with the Standards below (non-exhaustive):

- HEA and HEB NF EN 10034 / NF A 45-201
- IPE NF EN 10034 / NF A 45-205
- UAP NF A 45-255
- UPN NF EN 10279 / NF A 45-202
- Equal wings brackets angle iron NF EN 10056-2 / NF A 45-009
- Unequal wings brackets angle iron NF EN10056-1 / NF EN 10056-2
- Round iron NF EN 10055 / NF EN 10060
- Flat bar NF EN 10055 / NF EN 10058
- Medium and Heavy plates NF EN 10029

8.3.2 Design Requirements

8.3.2.1 Seismic and safety classification of the structure

This structure has no safety requirements, so is included into non-seismic class NSC.
The definition for NSC seismic class structures includes the following:

NSC – non-seismic category. No seismic requirements for safety.

Class NSC applies for civil work structures without safety requirements; these structures shall be designed for the conventional earthquake action, as defined in the applicable French national seismic regulation.

8.3.2.2 Mechanical and Chemical Characteristics

The steel grade S355 JR, J0 or J2 quality has guarantee characteristics.
The mechanical characteristics and the limits of the chemical composition shall be in accordance with defined values of NF EN 10025 standard.

8.3.2.3 **Weldability**

The S355 steel shall be weldable, if the mechanical and chemical characteristics are in accordance with the NF EN 10025 standard.

8.3.2.4 **Galvanizing ability**

The steel must have the ability to galvanizing. This is mainly due to:

- Chemical composition
- Cleanliness of the surface
- Product design

Chemical composition: The steel in the presence of certain phosphorus and silicon contents generates not only a matt or marbled surface appearance but also weakening its resistance to shocks.
The supplier shall ensure that the steel meets the requirements of NF A 35503 standard.
Surface conditions: The galvaniser performs a cleaning of the pieces to be galvanized with solutions that generally, only allow the elimination of iron oxides and soluble cutting oil.
Therefore, the supplier shall provide to the galvaniser products free of traces of welding slag, any kind of oil, lime, felt marking, glued labels, paint, non-stick welding products etc.
Furthermore, the surface of the elements constituting the structure shall be free of:

- Rolling defects,
- Machining defects (scratches, smudges of any kind, etc.)
- Excessive corrosion, flaws, porosity, etc.

All parts which are the subject of an assembly by bolting shall be delivered unassembled to the galvaniser who undertakes their processing element by element.

8.3.2.5 **Cutting**

Cutting parts (rods and plates) shall be performed, depending on the nature of the profile, with shear, mechanical saw or with a thermal process. The use of blowtorch and any non-guided Oxygen cutting means shall be prohibited. Cutting profiles with high inertia shall be performed with mechanical saw.
The edges of the cut pieces must submit regular lines, clear-cut throughout their thickness and free from cracks, rips, lack of material, regardless of the process used. All smudges shall be removed.
The presence of cracks or rips shall cause the disposal of the piece.
Oxygen cutting surfaces shall respect a minima the criteria for overall quality 3 defined by NF EN ISO 9013 standard on:

- Flatness defects,
- Ruggedness,
- Edge fusion,
- Number of scours and dimensions,
- Conditions for oxides removal.

Cutting plates and cover plates with entrant angles requires fillet radius least equal to the thickness of the sheet but not less than 10 mm.
Tolerances:

- - On bars length: ± 2 mm
- - On the plates: + 0 + 2 mm
- On assembled elements (beams, legs, supports): ± 5 mm

8.3.2.6 **Folding**

Folded steel plates that have cracks shall be discarded .

Cold folding:

The cold folding shall be limited to the folding angles less than or equal to 90 º.

Conditions of cold folding steel plates shall conform to the provisions or annexes of standards for products used (NF EN 10025). All necessary measures must be taken to prevent hardening of the metal in the angle of folding .

The tolerance on fobs folding angle shall be + -1 º.

Hot folding:

When the design of the part requires smaller folding radius, the steel plates may be heat folded. In this case, the bending radius is at least equal to half the steel plate thickness.

The tolerance on the bend angle gussets shall be + -1 º.

Bending of profiles with high inertia:

Feet of the main structures and sometimes the main chords of the beams are profiles with high inertia (H, I, U, high angle section).

For these elements the supplier shall establish bending procedures.

8.3.2.7 Drilling

Tracing and drilling holes shall permit, on site and with bolts, an accurate mounting of all the elements of the structure out, and the interchangeability of components corresponding to same type structures.

This operation must be very careful. The holes need not be oval, except those for which this form is explicitly specified on execution plans.

The drill holes diameter shall be consistent with the H13 average series of NF EN 20273 standard except otherwise provided on the plans. They shall be free of smudges.

8.3.2.8 Authorized limits for punching

Punching should not bring embossed deformation. The punches used must be in perfect condition.

The use of worn or damaged punches shall be prohibited.

The diameter of a punched hole should be substantially constant throughout the thickness of the piece. This property is characterized by the body punching which is the difference between the diameters of the entry and exit hole of the punch. It must be less than the tenth thickness punched with a maximum of 1.2 mm.

For parts having a thickness greater than 14 mm, the holes with diameter upper than 25 mm shall not be punched, but drilled.

8.3.2.9 Welding

The elements may be assembled by electric arc welding according to one or more following methods:

a) Arc welding with coated electrodes

b) Arc welding with active gas shield and consumable electrode MAG process

c) Arc welding with cored wire (with active gas shield)

d) Arc welding with cored wire (gasless)

It is possible to practice a, b, c and d processes in manual mode and only b, c and d processes in automatic mode.

Whatever the welding process, it is essential to work under shelter, protected from drafts, and to ensure that the parts shall be free of moisture.

The weld implemented by these means must possess mechanical and chemical properties as close as possible of assembled products. They must not decrease locally the galvanizing ability of the frames.

The deposited metal shall be as close as possible to the welded material (NF EN ISO 14341), the supplier will make available certificates of filler products.

It is necessary to pay attention to the silicon content of the filler materials which may be detrimental to good performance of galvanizing.

Before use, the coated electrodes (NF EN ISO 2560) and flux-cored wire (NF EN ISO 17632) shall be retained and steamed if necessary according to the supplier's recommendations.

The judicious choice of gas (NF EN ISO 14175) must limit projections related to welding.

However, the supplier shall ensure that the gas does not lead to unacceptable defects.

The welders must be qualified in accordance with NF EN 287, and the supplier must be able to produce associate certificates.

Special provisions

Surfaces and edges located up to 50 mm of the location of a weld must be smooth, uniform and free from cracks, rust, loose flakes, oil, grease, paint or other contaminating materials may have harmful effects on the strength or quality of the welds.

The welds shall be treated as a first pass cord if they are greater than 25 mm. Otherwise they shall be eliminated.

When assembling or mounting method requires the use temporary elements attached by fillet welds, they shall be removed without damaging the principal element.

Cold folded parts can receive weld if suitable distance conditions are met.

Alignment conditions are given in NF EN 1090-2 standard.

For lattice structures with flat bars, these assemblies shall be made with flat profiles welded endwise on the angle, or UAP wing of an angle. All of these welds shall be reversed upside down and looping.

For lattice structures with angle irons, if these ones are welded on UAP wing or another angle iron, the welder shall ensure the flatness of the contact surfaces of lattice and frames. Welds shall be continuous and curled at the ends.

Welding should be systematically circumvented and closed to be impervious. This arrangement avoids acid penetration during galvanizing

Inspections, type and frequency

Visual and dimensional: 100%.

8.3.2.10 **Bolts**

Bolts, screws and nuts shall meet mechanical, dimensional and appearance characteristics.

Mounting structures requires the implementation of general purpose bolts and controlled clamping.

The use of bolts or screws in unprotected steel shall be prohibited with the exception of parts made entirely in stainless steel.

The protection against corrosion must be achieved by hot galvanizing.

General purpose bolting:

Unless otherwise specified, the bolts shall be carbon steel according to NF EN 20898 standard. The bolting products used shall be in accordance with the Standards below:

	Screw	Nuts
Matter	NF EN 20898	
Mechanical characteristics	NF EN 20898	
Dimensional features	NF EN 24014	NF EN 24032
Test method	NF EN 20898	
Marking	NF EN 20898	
Surface flaws	NF EN 26157-1	NF EN 6157-2

The number of bolts for the structures assembly shall be limited. Therefore controls shall be carried out with great care and made 100% on the dimensional characteristics, the surface states and marking. Mechanical tests shall include hardness testing. Compliance certificate shall be provided.

Controlled tightening bolts:

The screws used shall be grade 8.8 or 10.9. Associated nuts shall be respectively grade 8 or 10 regarding NF EN 14399-1 and NF EN 14399-3 standards. Appearance, marking, mechanical and dimensional characteristics, and associated controls are specified in NF EN 14399-1, 14399-2, 14399-3, 14399-5 and 14399-6 standards.

8.3.2.11 **Galvanization**

Galvanization shall be performed following dry method process which comprises parts preheating after fluxing and before immersion.

Bath characteristics (temperature, composition) and coating characteristics shall be consistent with NF EN ISO 1461 standard.

Zinc ingots used for galvanizing shall conform to the NF EN 1179 standard.

The bath zinc content at the temperature of 450 ° C should be at least equal to 98.5%.

The minimum mass of deposited zinc shall be in accordance with the following table:

Nature of material to be galvanized	Minimum coating mass on the sample		Minimum coating mass on each individual type of product sample	
	g/m^2	Thickness (µm)	g/m^2	Thickness (µm)
Steel Thickness _ 5mm	500	70	450	63
Nuts and bolts with threads Ø > 9mm	375	52	300	42

The zinc coating shall be free of discontinuities and defects which can be prejudicial for use of the finished product (drips, drops, tears, adhering slags, troublesome thicknesses).

The deposited zinc mass shall be checked with the magnetic measurement method (nondestructive).

The adherence shall be such that the product can withstand normal handling without cracking or chipping.

Adherence control of the zinc coating on steel which is in accordance with standard NF A 35503 must be made by the galvaniser with the cross-hatch test defined in paragraph 6.4 of NF EN ISO 1461 standard.

Continuity of the coating shall be checked with immersion emersion in sulphate copper test according NF EN ISO 1461 standard.

Reconditioning of surfaces with point defects after galvanizing shall be acceptable in the circumstances described in paragraph 6.3 NF EN ISO 1461 standard with the following processes.

• Thermal sprayings, with zinc filler metal, in accordance with NF EN ISO 2063 standard.

• Application of zinc rich paint with generally acceptable proportions of 88 % minimum for an organic binder and 80 % for a silicate binder.

8.3.3 Tests

The steel structure shall be fully tested in accordance with current edition of the NF EN 10025:2005 standards. The tests are as follows:

- Chemical composition, in accordance with Section 7.2.2 of NF EN 10025:2005
- Tensile test, in accordance with Section 7.3.1 of NF EN 10025:2005
- Impact test, in accordance with Section 7.3.2 of NF EN 10025:2005

8.3.4 Technical Guarantees

The Contractor shall guarantee the tender values indicated in the Technical Datasheets corresponding to Appendix 16.1.10 of this specification.

8.3.5 Documentation

8.3.5.1 Documentation to be supplied with the tender

The following documentation shall be supplied with the tender, as a minimum:

- Description of The Contractor's quality assurance and quality control programme
- Description of the scope of supply of services and materials
- Tender Technical Datasheets, attached to this Technical Specification, duly completed
- Preliminary drawings of the geometry of the steel structure
- Description of the tests offered, indicating the applicable codes and standards

8.3.5.2 Documentation to be supplied during contract execution

The following documents shall be submitted for IO approval. The delivery period is to be agreed before placing the order:

	Maximum delivery period after award
• Certified Tender Technical Datasheets	To be defined
• List of documents indicating delivery periods	To be defined
• Certified general layout and dimension drawings of the steel structure	To be defined
• Manufacturing Inspection plan, for approval	To be defined

	Maximum delivery period after award
• Test procedures	To be defined
• Weights and dimensions for transport	To be defined
• Seismic qualification procedures and reports	To be defined

8.3.5.3 **Final Manufacturing Dossier**

Within 1 month after completion of the supply, the Supplier shall deliver a final manufacturing dossier comprising the following documents:

- Execution drawings
- Steel grade certificates of used steel parts
- Bolts certificates
- Zinc ingots certificates
- Filler welding products certificates
- Completed Inspection Points Programme
- Penetrant testing certificates
- Adherence control certificates
- Continuity tests certificates
- This document should be duly signed and stamped by the supplier on all points and by the supplier on all points witnessed and shall serve as a record of the inspection activities
- Copy of all procedures subject to approval
- Copy of the quality certificates, reception reports, test reports, test protocols, certificates required by the mandatory regulations, etc., that the Inspection Points Programme indicates as to be issued at each corresponding point
- Documented reports of any major deviation that may occur
- A major deviation is one which modifies the Supplier standards, the specifications or a document approved by IO, or is generated during final testing.
- Supplier’s Final Quality Certificate

8.4 Substation Cables

8.4.1 Scope of Supply

The scope of supply of this specification includes the following cables:

- OHL conductors indicated in Appendix 16.3.1.
- LV power cables, to be defined after Final Design.
- I&C cables, to be defined after Final Design.
- I&C interface cables with MCPC stage 2 are indicated in Appendix 16.2.9.

The cable code shall follow IO cable catalogue [RD39].

8.4.2 Applicable Codes and Standards

NF C13-200	High Voltage Electrical Installation - Requirements
NF C15-100	Low voltage electrical installation
NF C15-500	Determination of cross-sectional area of conductors and selection of protective devices with software
NF C30-202 (HD 361)	System for cable designation
NF C32-013 (IEC 60228)	Conductors of insulated cables
NF C32-070	Insulated cables and flexible cords for installations - Classification tests on cables and cords with respect to their behaviour to fire
NF C32-076 (EN 50200)	Method of test for resistance to fire of unprotected small cables (20mm) for use in emergency circuits
NF C32-102.13 (HD 22.13)	Rubber insulated cables of rated voltages up to and including 450/750 V - Single and multi-core flexible cables, insulated and sheathed with cross linked polymer and having low emission of smoke and corrosive gases
NF C32-310	Insulated cables and flexible cords for installation. Fire resistant (class CR1) cables and flexible cords for rated voltage up to and including 0.6/1 kV
NF C32-323	Insulated cables and flexible cords for installations. Halogen-free 0.6/1 kV cables with improved characteristics in the case of fire, type C1, with cross-liked synthetic insulation and with extruded synthetic protective sheath.

EN 50182	Conductors for overhead lines. Round wire concentric lay stranded conductors
EN 50266-2-4	Common test methods for cables under fire conditions - Test for vertical flame spread of vertically-mounted bunched wires or cables: Procedures - Category C
EN 50266-2	Common test methods for cables under fire conditions - Test for vertical flame spread of vertically-mounted bunched wires or cables: Procedures
EN 50267-2-1 (IEC 60754-1)	Common test methods for cables under fire conditions - Tests on gases evolved during combustion of materials from cables: Procedures - Determination of the amount of halogen acid gas
EN 50267-2-2 (IEC 60754-2)	Common test methods for cables under fire conditions - Tests on gases evolved during combustion of materials from cables: Procedures - Determination of degree of acidity of gases for materials by measuring pH and conductivity
EN 50267-2-3	Common test methods for cables under fire conditions - Tests on gases evolved during combustion of materials from cables: Procedures - Determination of degree of acidity of gases for cables by determination of the weighted average of pH and conductivity
EN 50341-1	Overhead electrical lines exceeding AC 45 kV. Part 1: General requirements. Common specifications
HD 308	Identification of cores in cables and flexible cords
HD 627-7M	Multicore and multipair cables for installation above and below ground
IEC 60183	Guide to the selection of high-voltage cables
IEC 60228	Conductor of insulated cables
IEC 60245	Rubber insulated cables. Rated voltages up to and including 450/750 V
IEC 60287	Electric cables - Calculation of the current rating
IEC 60331	Tests for electric cables under fire conditions - Circuit integrity
IEC 60332	Test on electric cables under fire conditions
IEC 60332-1-2	Tests on electric and optical fibre cables under fire conditions: Test for vertical flame propagation for a single

	insulated wire or cable - Procedure for 1 kW pre-mixed flame
IEC 60332-2-1	Tests on electric and optical fibre cables under fire conditions: Test for vertical flame propagation for a single small insulated wire or cable - Apparatus
IEC 60332-3-24	Tests on electric and optical fibre cables under fire conditions - Test for vertical flame spread of vertically-mounted bunched wires or cables - Category C
IEC 60811	Common test methods for insulating and sheathing materials of electric cables
IEC 61034-2	Measurement of smoke density of cables burning under defined conditions - Test procedure and requirements
IEC 61089	Round wire concentric lay overhead electrical stranded conductors

8.4.3 Design Requirements

8.4.3.1 Overhead line conductor

The overhead conductor proposed for the ten (10) 66 kV feeder modules is the following:

- Overhead Conductor: ASTER 570
- Designation (EN 50182): 570 – AL4
- Circuit: Simple
- Section: 570.22 mm2
- Outer diameter: 31.05 mm
- Weight: 1.574 kg/m
- Current: 1237 A at 30ºC ambient temperature

8.4.3.2 LV, Control and Instrumentation Cables

All LV, control and instrumentation cables will be designed for fixed installation in trays, to be located in inspection troughs, inside steel tubing, above ground or in PE conduits embedded in concrete.

All LV, control and instrumentation cables between the embedded conduits and the electrical boxes, panels, should be well protected either by cable trays with covers or by flexible conduits against UV light. Otherwise, these cables shall be UV-resistant.

Flexible conductors class 5 or class 2 shall be used, according to IEC 60228 and depending on the application.
All cables shall pass flame spread and fire tests in accordance with NF C32-070 (classified C1), and IEC 60332-1 for individual cables or single conductors or in accordance with IEC 60332-3 for layered cables.
The cable insulation and jacketing shall be made of materials with a reduced emission of smoke according to IEC 61034, and zero halogen content during combustion and with a low toxicity and corrosion index according to NF C32-323 and IEC 60754.
All cables outer jacket shall be identified at least with the name of the manufacturer, the type of cable, the section, and the isolation voltage. The data shall be legible and indelible and made to last during the rated life of the cable. The data shall be in accordance with the provisions of the applicable standards.
For all types of cables, the oxygen index shall be 30 to 35.
PVC shall not be used in cable manufacture.
Sizing and installation of all LV cables shall comply with NF C15-100.
All cable will be sized based upon the following reference conditions:

- Maximum conductor temperature 90 ºC (under normal operation)
- Maximum conductor temperature 130 ºC (under emergency overload conditions)
- Maximum conductor temperature 250 ºC (under short-circuit conditions)
- Air temperature 30 ºC. In addition to this, cables will be sized according to the ambient conditions stated in Section 5.1.
- Soil temperature 20 ºC.

The cables shall be single-core or multicore, depending on the application.
Cable splices shall be prohibited unless protected by junction boxes specifically intended for that purpose.
Cables or wires being spliced together shall be of the same cable manufacture.
The splices shall use only materials specifically approved for the expected operating environment.
Power cables shall be fixed to the supports. Clamps for single-core alternating current cables shall be made of non-magnetic material.
Control and instrumentation cable shields are earthed at the transmitting end only.
Switchyard I&C cables shall be shielded for protection against 66 kV electrical field.
A preliminary list for outdoors control cable cross sections are listed in Appendix 16.6 with reference to PPEN 66kV Stage 1 and interfaces with MCPC Stage 1. These cables should be updated and verified after Final Design stage.

8.4.3.2.1 Low Voltage Power Cables

The low voltage power cables shall have a rated insulation voltage of 0.6/1 kV, XLPE insulation.
Low voltage cables shall comply with IEC 60502-1. Low voltage power cables do not have cable shield.
Cable size shall be the following:

- Multi-core cables ≤ 70 mm^2
- Single-core cables > 70 mm^2

Conductors:

The conductors shall be made of compact round cord consisting of annealed copper wires, whose characteristics shall comply with those specified for conductors in the IEC 60228 standard, and whose physical, mechanical and electrical characteristics shall comply with standards IEC 60502-1 and IEC 60502-2 (copper resistivity, mechanical and electrical tests).
Cables with section >10 mm^2 shall be class 2. Cables with section ≤ 10 mm^2 could be class 5 or 2.

Insulation:

The insulation shall be cross-linked polyethylene (XLPE) and will consist of a continuous and compact homogeneous mixture around each conductor, perfectly adhering and free of lumps and other defects.

Semiconductor Layer on the Insulation:

A semiconductor strip, similar to the semiconductor layer on the conductor, shall be applied on the insulation.

External Jacket:

The jacket will be oil resistant and UV resistant, with zero halogen content and shall ensure that flames and fire do not spread, according to IEC 60332-3.

8.4.3.2.2 Control Cables

Control cables (48 V DC and secondaries of instrument transformers) shall be multi-core and shall have a rated insulation voltage of 450/750 V. Cables shall comply with IEC 60245.
Analogue signals and digital signals shall be carried using different cables.

Conductors:

The conductors shall be made of compact round cord consisting of annealed copper wire, with or without jacketing, whose characteristics shall comply with those specified for Class 5 conductors in standard IEC 60228.

Insulation:

The insulation shall be cross-linked polyethylene (XLPE), without halogen emission.

Fabrication of Cable and Shield:

The insulated conductors shall be wired and stranded together.

Fills shall be used to give the assembly cylindrical shape. The filling material shall be compatible with the jacket insulation, non-hygroscopic and flame retardant.
All control and measurement cables shall be shielded by an overall metal screen.

External Jacket:
The jacket material shall not produce halogen emissions, shall be oil resistant and UV resistant, and shall ensure that flames and fire do not spread, according to IEC 60332-3.

8.4.3.2.3 Instrumentation Cables

The instrumentation cables shall have a rated insulation voltage of 300/500 V and comply with HD 627-7M.
Instrumentation cables shall in any event comply with the requirements of the manufacturer of the instruments to which they are connected.
Analogue signals and digital signals shall be carried using different cables.

Conductors
The conductors shall be made of flexible copper cords, Class 5, according to IEC 60228.

Insulation
The insulation shall be cross-linked polyethylene (XLPE), without halogen emission.
In places where temperatures above 250ºC are expected, the compensation cables for temperature measurement (thermocouples or RTDs) shall have mineral insulation.

Fabrication of Cable and Shield

- Multicore cables

  The insulated cables will be wired together in accordance with HD 627-7M.

  An overall shield and drain wire shall be applied on the wired conductors, in accordance with HD 627-7M.

- Multipairs and multiple ternary cables for RTDs

  Conductors from each triplet or pair shall be stranded together to reduce as much as possible the signal mistakes caused by noise induced by the other conductors in the same cable.

  Multipairs and multiple ternary cables shall have an individually shield per pair and an overall shield.

  Multipairs and multiple ternary cables shall be twisted 20 turn per meter.

  The fabrication of the cable in terms of joining conductors, single shield and drain wire, collective shield and drain wire shall be made according to HD 627-7M.

External Jacket

The jacket material shall not produce halogen emissions, shall be oil resistant and UV resistant, and shall ensure that flames and fire do not spread, according to IEC 60332-3.

8.4.4 Tests

The cables shall be subject to factory tests in accordance with the relevant standards to test the design and general qualities of the cables as below:

- Routine tests on each drum of cables
- Sampling tests: Acceptance tests on drums chosen at random for acceptance of the lot
- Type tests on each type of cable
- Type test protocols certificates shall be accepted, except in the case of flammability test that the performance of the test shall be necessary.

8.4.4.1 Routine Tests & Factory acceptance test

The following tests shall be carried out on representative samples of LV power cables in accordance with IEC 60502-1.

- Conductor resistance measurement (IEC 60502-1, clause 15.2)
- Voltage test (IEC 60502-1, clause 15.3)

The following tests shall be carried out on representative samples of control cables in accordance with IEC 60245-1, Table 3.

- Measurement of the conductor D.C. resistance.
- Power frequency voltage test.
- Insulation resistance measurement.

Instrumentation cables will be subjected to the following routine tests on each drum of cables:

- Measurement of the Ohm resistance of the conductors
- Power frequency withstand test
- Measurement of insulation resistance
- Mutual capacity test
- Capacity disequilibrium test

8.4.4.2 Type Tests

Each type of cable shall also be subject to the following additional type tests:

- Flammability test on finished cables as per the requirements of IEC 60332-3-24
- Smoke generation by sheath under fire as per IEC 61034-1 and IEC 61034-2
- Halogen generation by outer sheath under fire as per IEC 60754-1
- Corrosivity test as per IEC 60754-2

8.4.5 Technical Guarantees

The Contractor shall guarantee the tender values indicated in the Technical Datasheets corresponding to Appendix 16.1.9 of this specification.

8.4.6 Documentation

8.4.6.1 Documentation to be supplied with the tender

The following information shall be supplied with the tender, as a minimum:

- Complete description of the scope
- Detailed list of the cables to be supplied, including description and sketch of the transversal section of each type of cable
- Datasheets, included as Appendix 16.1.9 to this Technical Specification, correctly completed
- Catalogues and technical brochures of the cables offered, giving cable construction details and characteristics
- Cable current ratings for different types of installation, including derating factors for ambient temperature, grouping, etc.
- Description of the tests offered, indicating the standard applied
- Type test certificates on all specified cables and terminals.

In addition, The Contractor or the Supplier shall present a “List of Exceptions” containing the technical discrepancies between the characteristics of the cables and terminals offered and what is required by this Technical Specification, those established in applicable codes and standards and the documents attached.
All exceptions shall be included in this list, indicating their justification and they shall be listed referencing the corresponding sections of this Specification.
The exceptions not included in the List of Exceptions shall not be contractually valid.

8.4.6.2 Documentation to be supplied during contract execution

The following documents shall be submitted for IO approval. The delivery period is to be agreed before placing the order:

	Max delivery period from date of award
• Certified Technical Datasheets of the Proposal	To be defined
• OHL and cable sizing	To be defined
• Lists of cables	To be defined
• List of documents with delivery schedule	To be defined
• Manufacturing programme and delivery schedule	To be defined
• Manufacturing Inspection plan, for approval	To be defined
• Test procedures, for approval	To be defined
• Equipment test certificates, reports and protocols	To be defined
• Installation manual	To be defined
• Commissioning, operating and maintenance instructions manual	To be defined

8.5 Connecting Devices

The scope of supply of this specification includes the connection devices.
The detailed design should be defined after the MRR gate review according to the manufacturing data of 66kV equipment.

8.5.1 Applicable Codes and Standards

IEC 61284 Overhead lines - Requirements and tests for fittings

8.5.2 Design Requirements

Connecting devices shall be outdoor installation, screw-type with independent tightening torque on each side, permitting easy installation and removal without requiring special tools.

The bolting shall ensure constant pressure on the connecting devices throughout their temperature range. To this end, the material of the bolting selected shall have a thermal expansion coefficient similar to that of the connecting devices or be used with lock washers of the "Belleville" type or similar.

Bolting shall be made of bronze or aluminum alloy, depending on the material of the connecting device, or preferably of stainless steel. Cadmium-coated steel bolting shall not be accepted.

Connecting devices shall be supplied complete, including the full complement of bolts, nuts and washers required both for assembling the elements that make up the devices and for securing the latter to terminals, insulators, etc.

In no case shall the hottest spot temperature of the connecting device exceed that reached by the elements that it connects, no matter what the level of current running through them.

Complete and detailed instructions for the assembly of the connecting devices shall be delivered with the supply. This information shall include at least the following:

- Treatment of contact surfaces
- Bolt tightening torques

8.5.3 Tests

Sample test shall be made on connecting devices taken at random from batches offered for acceptance.

- Verification of dimensions and finish of the connecting pieces
- Mechanical tests
- Thermal fatigue test
- Galvanizing test
- Radio interference measurement

8.5.4 Documentation

The Contractor or the Supplier shall deliver the following documentation with the tender:

- Certified drawings of each type of connection device, indicating the following characteristics:

  -Maximum allowable current.

  -Material of the connection device, composition.

  -Material of the connection device screws, nuts and bolts.

  -Dimensions and details of the connection device, giving the details of the connected parts.

  -Maximum allowable stress.

- Certified drawings of general dimensions of the various different types of fittings, including maximum supported stresses and weights
- Instructions for storing the equipment on site

8.6 66kV Cables, 22kV cables and accessories

8.6.1 Applicable Codes and Standards

The applicable codes and standards shall be in accordance with the Electrical Design Handbook Part 3: Codes and Standards [AD11].

The equipment design, manufacturing and test procedures shall comply at least with the following codes and standards:

NF C13-200	High Voltage Electrical Installation - Requirements
NF C32-070	Insulated cables and flexible cords for installations – Classification tests on cables and cords with respect to their behaviour to fire
NF C33-226	Isolated cables and accessories for energy networks – cables with rated voltages between 6/10(12) kV and 18/30(36) kV insulated with XLPE with a fixed gradient, for energy distribution networks
NF C32-323	Insulated cables and cords for installations - Fire retardant Halogen free rigid cable 0,6/1 kV, with cross-linked synthetic insulation and with extruded synthetic protective sheath and with improved performances in case of fire
IEC 60183	Guide to the selection of high-voltage cables
IEC 60228(NF EN 60228)	Conductors of insulated cables
IEC 60229	Tests on cable oversheaths which have a special protective function and are applied by extrusion
IEC 60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um =1,2 kV) up to 30 kV (Um =36 kV)
IEC 60230	Impulse tests on cables and their accessories
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60840	Power cables with extruded insulation and their accessories for rated voltages above 30 kV (Um = 36 kV) up to 150 kV (Um = 170 kV)
IEC 60287	Electrical cables. Calculation of the current rating
IEC 60332-1	Tests on electric cables under fire conditions – Part 1: Test on a single vertical insulated wire or cable

IEC 60811	Common test methods for insulating and sheathing materials of electric cables
IEC 60885	Electrical test methods for electric cables
IEC 60754	Test on gases evolved during combustion of materials from cables
IEC 61034	Measurement of smoke density of cables burning under defined conditions
NF EN 60754	Test on gases evolved during combustion of materials from cables
IEC 61034	Measurement of smoke density of cables burning under defined conditions
IEC 61442	Test methods for accessories for power cables with rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV
EN 50267-2-2	Common test methods for cables under fire conditions. Test on gases evolved during combustion of material from cables. Part 2-2: Procedures. determination of degree of acidity of gases for materials by measuring ph and conductivity
NF EN 50181	Plug-in type bushings above 1 kV up to 52 kV and from 250 A to 2,50 kA for equipment other than liquid filled transformers

8.6.2 Design Requirements

8.6.2.1 Characteristics of 66kV and 22kV Cables

8.6.2.1.1 Characteristics of 66kV cables

The following service conditions shall be taken into consideration for the design of the 66 kV cable:

System rated voltage	66 kV
Maximum system voltage under normal operating conditions	72.5 kV
Rated power frequency withstand voltage	140 kV (1 min)
Rated lightning impulse withstand voltage	325 kV peak
Rated frequency	50 Hz
Number of phases	3

Neutral grounding	Earthed through a resistor that limits the current to 500 A for 10 s
Maximum symmetrical current of the three-phase short-circuit	31.5 kA for 1 second
Rated peak withstand current	80 kA peak

The cable must fulfil the basic design requirements indicated below.

Basic testing standards	IEC 60840
Rated voltages (Uo/U/Um)	36/66/72.5 kV
Rated frequency	50 Hz
Maximum admissible temperature in the conductor under normal operation	90ºC
Maximum admissible temperature in the conductor under short-circuit conditions (maximum time of 5 seconds)	250ºC
Test voltage at power frequency	90 kV (30 min)
Lightning impulse withstand voltage	325 kV peak

The life of the cables shall be of at least 25 years.
The cables shall be single-core, made of copper and with radial field. The insulation shall be dry and made in extruded cross-linked polyethylene (XLPE) for 36/66/72.5 kV (U_0/U/Um).
The design of the cables shall include means to prevent water penetration in the cable, both in the longitudinal direction, under the metallic cover, and in the radial direction.
The portions of the cables exposed to direct sunlight must be sunlight resistant or mechanically shielded from sunlight.

Conductor:
The conductor shall be formed by a round compact cord or round segmented cord formed by annealed class 2 copper wires, as per IEC 60228.

Semiconductive layer on the conductor:
A semiconductive layer shall be applied on the copper conductor by simultaneous extrusion with the insulation. This layer shall be adequate to prevent the formation of ionised air in contact with the insulation.

Insulation:
The insulation shall be made in cross-linked polyethylene (XLPE), zero halogen content, applied by extrusion simultaneously with the semiconductive layers. It shall have a reduced emission of

smoke during combustion according to IEC 61034 and a low toxicity and corrosion index as per IEC 60754.

Semiconductive layer on the insulation:
The insulation shall have an adequate semiconductive layer to obtain a homogenous distribution of the electrical field between the insulation and the metallic screen.

Longitudinal protection tape against water penetration:
Over the semiconductive layer described above there shall be an air-spaced sheathing to prevent the longitudinal penetration of water in the cable.

Metallic screen:
Over the air-spacer sheathing for longitudinal protection against water there shall be a metallic screen of the cable with an adequate section to withstand the service conditions and operation requirements and restrictions that are specified at the beginning of Section 8.6.2.1.1 and aforementioned requirements respectively.
For the design of the screen, it shall be taken into account that the phase-to-ground short circuit current is limited to 500 A/10s through earthing transformers.

Outer cover:
The outer cover shall be made in red colour polyethylene (PE) with zero halogen content during combustion. It shall be flame-retardant, as per NF C32-070 (classified C1) and IEC 60332-1. Also, it shall have a reduced emission of smoke according to IEC 61034 during combustion and a low toxicity and corrosion index as per NF C32-323 and IEC 60754
A conductive layer shall be applied on the exterior cover. This layer shall be thick enough to allow the verification test of its integrity to be performed satisfactorily.
Since at both ends side, 66kV will be installed outside the cable gallery, 66kV will be exposed directly to direct sunlight with insolation of 1000W/m2 more than 2500hrs/y as indicated in Section 5.1. 66kV cable should be capable to withstand this insolation during its service life. Otherwise, the cables shall be mechanically shielded from sunlight.
The cover shall have the following data printed on it for the sake of identification:

- Manufacturer name
- Rated voltages
- Type of insulation, XLPE
- Material and section of the conductor in mm2
- Material of the cover
- Accumulated length in one metre intervals
- Year of manufacturing

8.6.2.1.2 Characteristics of 22kV cables

The 22 kV cable, including its accessories, shall be used to connect the 22 kV cable terminals to the 22 kV GIS switchgears and the 22 kV consumers.

The following service conditions shall be taken into consideration for the design of the 22 kV cable:

System rated voltage	22 kV
Maximum system voltage under normal operating conditions	24 kV
Rated power frequency withstand voltage	50 kV (1 min)
Rated lightning impulse withstand voltage	125 kV peak
Rated frequency	50 Hz
Number of phases	3
Neutral grounding	Earthed through a transformer that limits the current to 500 A for 10 s
Maximum symmetrical current of the three-phase short-circuit	40 kA for 1 second
Rated peak withstand current	100 kA peak

The cable must fulfil the basic design requirements indicated below.

Basic testing standards	IEC 60502-2
Rated voltages (U_0/U/Um)	12/20/24 kV
Rated frequency	50 Hz
Maximum admissible temperature in the conductor under normal operation	90ºC
Maximum admissible temperature in the conductor under short-circuit conditions	250ºC
Test voltage at power frequency (routine test)	42 kV (5 min)

Lightning impulse withstand voltage	125 kV peak

The life of the cables shall be of at least 25 years.
The cables shall be single-core made in copper and with radial field. Their insulation shall be dry and made in extruded cross-linked polyethylene (XLPE) for 12/20/24kV (U0/U/Um).
The design of the cables shall include means to prevent water penetration into the cable, both in the longitudinal direction, under the metallic cover, and in the radial direction.
The portions of the cables exposed to direct sunlight shall be sunlight resistant or mechanically shielded from sunlight.

Conductor:
The conductor shall be formed by a round compact cord or round segmented cord formed by annealed class 2 copper wires, as per IEC 60228 ((NF EN 60228)).

Semiconductive layer on the conductor:
A semiconductive layer shall be applied on the copper conductor by simultaneous extrusion with the insulation. This layer shall be adequate to prevent the formation of ionised air in contact with the insulation.

Insulation:
The insulation shall be made in cross-linked polyethylene (XLPE), zero halogen content, applied by extrusion simultaneously with the semiconductive layers. It shall have a reduced emission of smoke during combustion according to IEC 61034 and a low toxicity and corrosion index as per IEC 60754.

Semiconductive layer on the insulation:
The insulation shall have an adequate semiconductive layer to obtain a homogenous distribution of the electrical field between the insulation and the metallic screen.

Longitudinal protection tape against water penetration:
Over the semiconductive layer described above there shall be an air-spaced sheathing to prevent the longitudinal penetration of water in the cable.

Metallic screen:
Over the air-spacer sheathing for longitudinal protection against water there shall be a metallic screen of the cable with an adequate section to withstand the service conditions and operation requirements and restrictions that are specified at beginning of Section 8.6.2.1.2 and aforementioned requirements respectively.
For the design of the metallic screen it shall be taken into account that the phase-to-ground short circuit current is limited to 500 A/10s through earthing transformers.

Outer cover:
The outer cover shall be made in red colour polyethylene (PE) with zero halogen content during combustion. It shall be flame-retardant, as per NF C32-070 (classified C1) and IEC 60332-1.

Also, it shall have a reduced emission of smoke according to IEC 61034 during combustion and a low toxicity and corrosion index as per NF C32-323 and IEC 60754.
A conductive layer shall be applied on the exterior cover. This layer shall be thick enough to allow the verification test of its integrity to be performed satisfactorily.
The cover shall have the following data printed on it for the sake of identification:

- Manufacturer name
- Rated voltages
- Type of insulation, XLPE
- Material and section of the conductor in mm2
- Material of the cover
- Accumulated length in one metre intervals
- Year of manufacturing

8.6.2.2 Cable Accessories

8.6.2.2.1 66kV Cable Accessories Requirements

The accessories of the cables shall comply with the basic design requirements that are indicated below:

Basic testing standards	IEC 60840
Rated voltages (U_0/U/Um)	36/66/72.5 kV
Rated frequency	50 Hz
Test voltage at power frequency	90 kV (30 min)
Lightning impulse withstand voltage	325 kV peak
Rated peak withstand	80 kA peak
Creepage distance	16 mm/kV

The life of the cable accessories shall be of at least 20 years.

Cable Terminations:
The cable-terminations shall be for outdoor use (porcelain insulator type), manufactured by the same Supplier as of the 66 kV cable, unless the Supplier justifies the compatibility with the cable.
The Contractor or the Supplier shall coordinate the mechanical, thermal and electrical interfaces related with the design and assembly of the terminations with the Suppliers of the equipment to be connected.
Additionally, the design of the connections shall allow the performance of the required site tests.

Splices:

The single-core cable of each phase shall be of a single section. Thus, no splices are allowed.

8.6.2.2.2 22kV Cable Accessories Requirements

The accessories of the cables shall comply with the basic design requirements that are indicated below:

Basic testing standards	IEC 60502-4
Rated voltages (U_0/U/Um)	12/20/24 kV
Rated frequency	50 Hz
Test voltage at power frequency	48 kV (5 min) or 54 kV (15 min)
Lightning impulse withstand voltage	125 kV peak
Rated peak withstand	40 kA
Creepage distance	100 kA peak

The life of the cable accessories shall be of at least 20 years.

Cable Terminations:
The cable-terminations shall be inside-cone plug-in system for plug sizes 3 according to EN 50181 for indoor purpose to connect the cable to the 22 kV GIS switchgear inside Building 32.
The cable-terminations shall be for indoor purpose to connect the cable to the 22 kV consumers, manufactured by the same manufacturer as that of the 22 kV cable, unless the Supplier justifies that those from a different manufacturer are compatible with the cable.
The Contractor or the Supplier(s) shall coordinate the mechanical, thermal and electrical interfaces related with the design and assembly of the terminations with Client systems.
Additionally, the design of the connection shall allow the performance of the required site tests.

Splices:
The single-core cable of each phase shall be of a single section. Thus, no splices are allowed.

8.6.2.2.3 Connection and Protection Boxes for 66kV Cable Shields

The tape shields in power cables shall be earthed at both ends.
Link boxes for protection and connection of the cable shields shall be supplied with adequate elements for the connection and disconnection of the earthing the metallic support of the terminals and the cable shields
The boxes shall allow the verification of the integrity and efficiency of the outer cover of the cables by means of a specific test when the cables are not powered.
The boxes must be able to withstand the short-circuit current specified in Section 8.6.2.1.1 for 66kV cables.
The degree of protection of the boxes shall be IP55, as per IEC 60529.

8.6.2.3 Requirements of the cable installation

As part of the cable system engineering and design services, the Contractor shall define, amongst others, the following final characteristics of the cable facilities:

- Layout of the cables in the ends
- Types of laying along the run
- Fixation cable on the cable try or on supports.
- Earthing system for screens
- Cable supports and fastening
- One single-pole cable shall be installed per phase without splices.

In areas with frequent passage of personnel, the maximum values of the electrical and magnetic fields shall be limited to 5 kV/m and 100 μT respectively, in accordance with *European Directive 1999/519/CE* [CS15].
Outdoor sections of cables shall be supported and fastened at regular intervals by means of adequate cleats or clamps to prevent movements due to thermal cycles caused by operation, electrodynamic stresses, etc. The short-circuit currents specified in Section 8.6.2.1.1and Section 8.6.2.1.2 must be taken into consideration for the design of the supports and the fastening of the cables.
All metallic elements used to support or fasten cables must be electrically earthed.
The cable support and fastening from the point where they come out of the earth up to their connection to the cable terminals located in the equipment shall be done in such a way that no stresses are transmitted to the other end.
After cable pulling, the Contractor shall be responsible to seal the opening properly after cable pulling.

8.6.2.4 Anchoring

The 66 kV and 22kV cable and anchoring accessories shall be designed to withstand SL-1 earthquakes with a 0.05 g peak horizontal and vertical ground acceleration applied on the centre of gravity, as it is indicated in Section 5.3.

8.6.3 Tests

The components shall be fully tested in accordance with current edition of the relevant IEC standards and the performance of the tests shall be witnessed by an IO representative (if requested).
The manufacturer shall submit testing procedures, according to applicable IEC standards, for all the tests described in this section. In the event that one of the tests described in this section is not strictly covered by an IEC standard, the manufacturer shall submit testing procedures with their proposal. All the test procedures shall be reviewed by IO for acceptance before being performed.
For each equipment item, the manufacturer shall provide the reports for type tests carried out on equipment similar to that of the supply and he shall carry out the corresponding routine tests. The type tests shall be carried out at reputed testing laboratory; the tests must have been carried out during last 5 years.
The following types of tests shall be considered:

- Routine tests on each drum of cable
- Tests on cable samples
- Type tests on each type of cable
- Electrical tests after installation

8.6.3.1 Routine tests

The following routine tests shall be performed on each length of manufactured 66 kV cable and on the main insulation of each prefabricated accessory, in accordance with clause 9 of standard IEC 60840 for 66kV cables and clause 16 of standard IEC 60502-2 for 22kV cables.

- Measurement of the electrical resistance of conductors
- Partial discharge test
- Voltage test
- Electrical test on oversheath of the cable

Additionally, the dimensions of the accessories and the location of their components shall be verified in accordance with the approved drawings.

8.6.3.2 Tests on cable samples

The following tests shall be carried out on representative samples of 66 kV cables of the production units respectively. Tests shall be performed in accordance with Clause 10 of IEC 60840.

- Verification of the conductor

- Measurement of the electrical resistance of the conductor and the metallic screen
- Measurement of the thickness of the insulation and the oversheath
- Measurement of the thickness of the metallic sheath
- Measurement of the diameter of the conductor and of the exterior diameter of the cable
- Hot set test for XLPE insulation
- Measurement of the capacitance
- Water penetration test

The following tests shall be carried out on representative samples of 22kV cables of the production units respectively. Tests shall be performed in accordance with Clause 17 of IEC 60502-2.

- Verification of the conductor
- Measurement of the thickness of the insulation and of the oversheath
- Measurement of the thickness of sheath.
- Measurement of the diameter of the conductor and of the exterior diameter of the cable
- Voltage test
- Hot set test for XLPE insulation

8.6.3.3 Type tests on cable systems

Certificates of the type tests performed shall be allowed for the type tests on the cables and accessories. Tests shall be in accordance with Clause 12 of the IEC 60840 for 66kV cables and accessories and in accordance with clause 18 of IEC 60502-2 for 22kV cables and accessories. Additionally, the following flammability type test shall be submitted:

- Flammability tests on finished cables as per the requirements of NF C32-070 (classified C1) and IEC-60332-1.
- Smoke generation by sheath under fire as per IEC 61034. Halogen-free cables shall meet the requirements of light transmission of minimum 90% after 15 minutes.
- Halogen generation by outer sheath under fire as per EN 50267-2-2. It will just be required for halogen-free cables a maximum value of 0.5%.
- Corrosivity test as per IEC 60754-2. It will just be required for halogen-free cables: ph > 4.3 and conductivity ≤ 10 µs/mm.

8.6.3.4 Electrical tests after installation

The following tests shall be performed once the installation of the 66 kV cable and accessories has been completed:

- DC voltage test of the oversheath, in accordance with Clause 16.1 of IEC 60840
- AC voltage test of the insulation, in accordance with Clause 16.2 of IEC 60840

The following tests shall be performed once the installation of the 22 kV cable and accessories has been completed:

- DC voltage test of the oversheath, in accordance with clause 20.1 of IEC 605022
- AC voltage test of the insulation, in accordance with clause 20.2 of IEC 605022

8.6.4 Acceptance Criteria for Tests

These criteria shall be in accordance with the corresponding standards and must not deviate from the data fulfilled by the equipment manufacturer in the certified data sheets defined in Appendix 16.1.7 and 16.1.8.
The acceptance criteria shall be in accordance with the values indicated in Appendix 16.7.
Meeting the criteria included in these acceptance criteria do not exempt the manufacturer from the full compliance with test requirements included in the referenced standards.
Moreover, the manufacturer must send a list indicating all the tests to be performed, with a reference to each associated procedure, indicating the applicable standard and specifying the acceptance criteria, as indicated in Appendix 16.7. This list must be reviewed and accepted by IO.

8.6.5 Technical Guarantees

The manufacturer or the supplier shall guarantee the tender values indicated in the technical datasheets corresponding to Appendix 16.1.7 and 16.1.8 of this specification.

8.6.6 Documentation

8.6.6.1 Documentation to be supplied with the tender

The following documentation shall be supplied with the tender, as a minimum:

- Tender Datasheets and Requirements, included as Appendix 16.1.7 and 16.1.8, duly completed
- Preliminary drawing of main dimensions of the cable accessories
- Documentation and brochures on the cables and accessories offered

- List of accessories and special tools
- Recommended spares, in accordance with that established in the purchasing conditions
- List of references of the supply of equipment identical or similar to that offered
- Manufacturing schedule and delivery dates
- Description of the tests offered, indicating the standard applicable
- Certificates of the type tests of the cables and their accessories
- Estimated list of the spare parts recommended for five (5) years of operation, with the following information for each spare part
  - Identification and description
  - Equipment where it belongs
  - Minimum quantity recommended
  - Unitary prices
  - Estimated consumption frequency
  - Delivery date
  - The list of spares shall also include the consumables (grease, oils, joints, etc.) needed for maintenance of equipment during the five (5) years of operation

In addition, the Supplier shall present a "List of Exceptions" indicating the technical discrepancies between the specifications of the equipment and services offered as opposed to the requirements of this Technical Specification.
All exceptions shall be included in the aforementioned list, indicating justification, and will be numbered with a reference to the corresponding specification sections.
Those exceptions not included in the list of exceptions shall not have contractual validity.

8.6.6.2 Documentation to be supplied during contract execution

The following documents shall be submitted for IO approval. The delivery period is to be agreed before placing the order:

	Max delivery period from date of award
• Certified Tender Datasheets	To be defined
• List of documents with delivery schedule	To be defined

	Max delivery period from date of award
• Certified dimension drawings of the cable accessories, including the layout of their components and details of the cable terminations and the flanges for coupling to the equipment	To be defined
• Cable construction and dimensions drawing	To be defined
• Certified drawings of the general layout of the cable: cable support and fastening; grounding of the cable screens and of the metallic parts of the support and the cable fastening elements, and spaces for maintenance	To be defined
• Calculation justifying the cable supports and fastening	To be defined
• Manufacturing and delivery programme	To be defined
• Manufacturing Inspection Points (MIP)	To be defined
• Test procedures	To be defined
• Test reports and protocols	To be defined
• Instruction manuals and descriptive brochures	To be defined
• Dimensions and weight for transport	To be defined

8.7 Other requirements

8.7.1 Reliability, Availability, Maintainability, Inspectability (RAMI)

For the RAMI analysis performed, it has been considered the following failure rate (failures rate/h) as indicated in the table of PPEN input data for the RAMI analysis [RD40]:

- Disconnectors $0.2 \cdot 10^{-6}$
- Circuit Breakers $4 \cdot 10^{-6}$
- Current Transformer $0.3 \cdot 10^{-6}$
- Control & Protection $1.5 \cdot 10^{-6}$
- Connections & Auxiliaires $0.4 \cdot 10^{-6}$
- Control & protection $1.5 \cdot 10^{-6}$
- Cables (1000 meters) $2 \cdot 10^{-6}$

The equipment manufacturer shall indicate the failure rate of the equipment.
In case that these failure rates are greater than the values aforementioned, it shall be clearly stated by the Contractor, or the manufacturer and IO shall send and official confirmation for the acceptance of these values.
The final equipment acceptance will be subjected to IO approval of the equipment failure rate.

8.7.2 Tagging, Labelling and CE Marking

8.7.2.1 Tagging

The IO CRO shall be responsible to provide to the Contractor a list of pre-assigned functional references (FR) to each unit in the kick-off stage.
In addition to the function references specified in Appendix 16.2, the Contractor shall liaise with the IO CRO to determine the applicable ITER Part Number (PNI).
The Contractor is responsible to assign FR for the detailed components with the support of the IO, following *Procedure for Identification and Controls of Items* [AD23] and *ITER Numbering System for Components and Parts* [AD44].

8.7.2.2 Labelling

According to [AD1] Section 9.2, all components supplied by the Contractor shall be physically labelled with the minimum contents of the Product label as specified in below table:

Table 8-1 : Labelling Requirements

Label	By whom	When	Lifecycle	Mandatory contents	Additional information	Note
Product	Contractor name	After production	Permanent	1) Title of Product, 2) Manufacture Part Number 3) PNI 4) SN 6) Quality Class	1) Other Ref. Num. 2) Dimensions 3) Weight 4) Supplier 5) Production Date (MM/YYYY) 6) CE marking	PNI to be provided by IO.
Shipping	Contractor name	After packaging	Temp.	1) Title of crate 2) Contract Number, etc. 3) Shipping/Crate Num. 4) Supplier Ref. Num. 5) Manufacture Part Number 6) PNI 7) SN 8) From (CON-M) / To 10) Net / gross weight 11) Responsibility 12) Packing Date (MM/YYYY).	1) Dimensions, 2) Other Ref. Num. 3) Quantity in the crate	For PNI as mentioned above. Accompanying signs, e.g. sign of handling precaution during transportation.

8.7.2.3 CE Marking

CE Markings shall be implemented in accordance with European and French legislation [CS12]~ CS17].
The list of products for which the CE marking may be applicable is available on the following web-site: https://ec.europa.eu/growth/single-market/ce-marking/manufacturers_en.
Comprehensive guidance on the implementation of EU product rules can be found in the so-called Blue Guide: https://ec.europa.eu/docsroom/documents/18027/

8.7.3 Electrical Requirements

The MCPC stage 2 shall be designed in conformance with guidance given in:
ITER Electrical Design Handbook (EDH),

- EDH Part 1: Introduction [AD9]
- EDH Part 2: Terminology and Acronyms [AD10]
- EDH Part 3: Codes and Standards [AD11]
- EDH Part 4: Electromagnetic Compatibility (EMC) [AD12]
- EDH Part 5: Earthing and lightning protection [AD13]
- IO Cabling Rules [AD14]

8.7.4 Earthing Requirements

PPEN components and systems shall include appropriate earthing as specified in EDH Part 5: Earthing and lightning protection [AD13].
Equipment earthing shall be installed in compliance with the applicable French codes and standards (Norme Français, NF), and the European Directives.
The earthing conductors, including the downlead conductor for outdoor equipment, shall be fixed properly with clamps.
The earthing conductors on the floor shall be protected from damage with covers.
The equipotential platform of disconnector switches and earthing switches in front of its operating mechanism shall be connected by embedded earthing system as well.

8.7.5 Spare Parts for five years operation and maintenance

RAMI results shall be taken as prime consideration in the defining of the list of critical spares. The spare part is recommended to follow RAMI analysis and guideline in *How to guide for computing required number of spare parts* [RD41].
Except the spare parts listed in Appendix 16.2 and the necessary spare parts for test and commissioning up to the handover of this turnkey contract, the Contractor shall propose a spare part list for 5 years of operation and maintenance according to its experience. This spare part list will be an option of the scope of supply.
The Contractor and the Supplier shall inform IO of any risk regarding components' obsolescence and make all pertinent recommendations to eliminate that risk.

8.7.6 Design analysis and modelling

The design analysis shall be undertaken using the following software programs,

- Caneco BT (https://www.ige-xao.com/fr/fr/caneco-bt/) shall be used for low voltage electrical distribution.
- See System Design (SSD), See Cabling Manager, See Electrical Expert (SEE) [RD42] (www.ige-xao.com) shall be used for production of multidiscipline diagrams, including, detailed electrical circuit diagrams, cabling diagrams, cable routings and terminations. Refer to [RD45] to How-to folder for SEE System Design.
- ETAP (https://etap.com/) shall be used to for 66kV &22kV analysis, and update PPEN models according the engineering data of PPEN 66kV stage 2 and 22kV feeders for ICH/ECH SRO.
- CATIA (www.dassault.com) shall be used for 3D space allocation of equipment and hangers, routing of Busbars and cable trays. Refer *to CAD Manual 10 - CAD Access and Support* [RD47] for the details regarding the process and tools.
- The analysis program available from ANSYS shall be used for electromechanical analysis (see http://www.ansys.com/products/electromagnetics) and for structural analysis (see http://www.ansys.com/products/structural-mechanics).

- The analysis program available from Reliasoft shall be used for RAMI and FMECA analysis (see https://www.hbkworld.com/en/products/software/reliability/blocksim-system-reliability-availability-maintainability-ram-analysis-software).
- The use of other software programs can be accepted, if found advantageous, in agreement with IO. All input information used in the design analysis and modelling shall be made available to IO and shall be submitted to IO with the design analysis and modelling.
-

8.7.7 Electromagnetic Compatibility

All equipment supplied shall comply with European Directive 2004/108/EC and IEC 61000 for EMC with respect to both the emission and immunity of such equipment.
It shall also be considered *Electrical Design Handbook, Part 4: Electromagnetic compatibility* [AD12].

8.7.8 Identification

The identification shall be in accordance with the requirements established in *ITER numbering system (for parts/components)* [AD44] and ITER function category and Type for *ITER Numbering System* [AD45].

9 Contract Execution Requirement

9.1 Phase-Gate reviews

The activity phases and the associated gate reviews is inherited from *ITER Project Management Plan (PMP)* [AD8] that apply to the contract are shown in Figure 9-1.

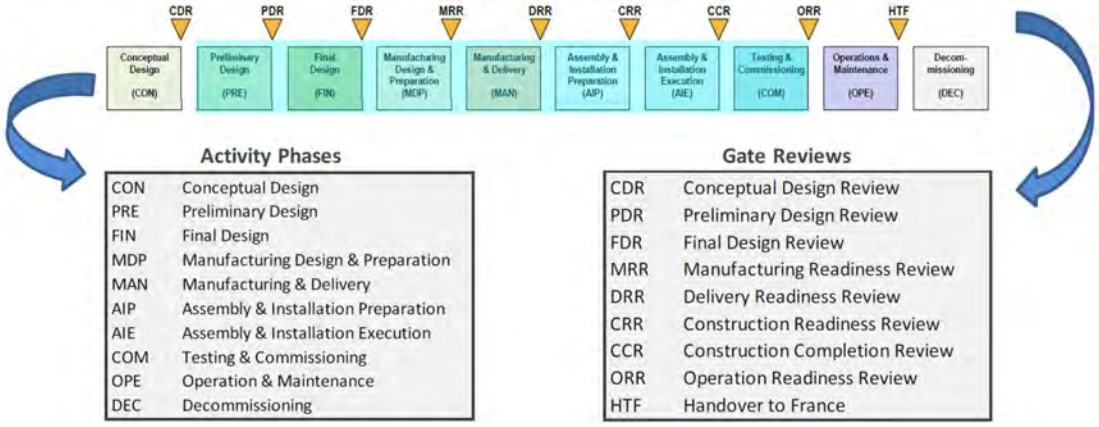


Figure 9-1 Activity Phases and their Phase-Gates

The Contractor will take the responsibility of performing the activities from Preliminary Design, Final Design, Manufacturing Design & Preparation and Assembly& Installation Preparation, Assembly & Installation Execution, Test & Commissioning for the equipment or components covered by this Technical Specification.

The Contractor shall follow the design processes specified in [AD16], [AD17] to complete the activities and pass the corresponding gate reviews, as required by *Design Review Procedure* [AD18].

All gate reviews are Hold Points. Principally, the Contractor shall get the authorization to proceed to the next phase.

The Contractor shall also develop a schedule for their activities covering all the tasks within the turnkey contract and submit it for review and approval. The schedule shall show all the key activities and tasks to cover their full scope, including but not limited to:

- Milestones
- Gates
- Design and analysis activities
- Procurement and sub-contracting activities if any
- Manufacturing Preparation, Manufacturing
- Factory Acceptance Tests
- Packing & Delivery
- Site assembly & installation preparation and installation activities
- Site Acceptance Tests preparations and SAT tests.

- Integration with PPEN 66kV Stage 1 Substation automation.

The schedule for documentation deliverables is not required to show in the schedule as this is covered under the Document Schedule. During all the control stages (in particular the design stages), the Contractor shall support IO to update the interfaces with other systems, following *Design Interface Control Procedure* [AD19]:

- Respect the interface constraints and ensure the design meet the interface requirements.
- Update the interface sheet by providing up to date information as design matures.

All the document deliverables shall be managed in compliance with the following requirements:

- all documents' deliverables shall be uploaded into IDM with original format (word, excel, etc), and respect *Sign-off Authority* [AD20].
- the design analysis shall be provided.
- all CAD deliverables shall be managed following CAD working instructions.

9.2 Preliminary Design (PRE)

The key activities, input and output for this stage are defined in the following table:

Table 9-1 Preliminary Design Activity Phase: inputs, outputs and objectives

Preliminary Design Activity Phase (PRE)	
Phase Inputs	• Technical specifications covering consolidated Technical/Engineering data produced by IO. • Forward Workplan (Design Plan and DPP for the PRE phase)

Main Objectives:
 	
To achieve the Allocated Baseline [AD16] [AD17] [AD21]
	• To produce the documents for 41PP scope and maturity relevant for the PRE phase as indicated in the DPP in order to achieve the Allocated Baseline for this scope.
	• To refine the Conceptual Design or inputs in order to confirm the technical feasibility and the robustness of schedule. Evidence is given in:
	  ○ An update of the Design Description (DD) with detailed set of schematics and component definition
	  ○ An update of the System Load Specification (if applicable).
	  ○ An update of the definition justification documents, referring to a first consistent set of justification notes demonstrating that the technical objectives of the systems requirements will be met (analyses, return of experience, tests, simulations) and that manufacturability, transfer, assembly and qualification/start-up of the system have been addressed
	• Support analysis and calculations
	• To complete Interface specifications (assumptions, ranges, actual data) once the level of detail of the design allows the production of Interfaces Sheets (IS) and relevant CMMs and room book,
	• To re-assess the technical risks of the selected solution and provide mitigation plan before going to the detailed design (Risk/Hazard Analysis Report, RAMI Analysis Report)
	• To check that the proposed design solution definition still meets the RQs (DCM/VCM for SRD and s-SRD)
	• Provide documents required according to [AD21].

Phase Outputs (Maturity Level)	System Design with the preliminary design maturity: • General architecture (Functional: FBS, Physical PBS-GBS) is consolidated and the main (or critical) components described adequately. • All the Interface Requirements shall be defined. • 3D model / System Layout Drawing shall be updated if needed. • Justification documentation, including verification plan are prepared

This Phase is terminated with the approval of the Close-out Report of the Preliminary Design Review (PDR), giving the Authorization-to-Proceed(ATP) to the next activity phase (Final Design).

9.3 Final Design (FIN)

The key activities, input and output for this stage are defined in the following table:

Table 9-2 Final Design Activity Phase: inputs, outputs and objectives

Final Design Activity Phase (FIN)	
Phase inputs	• Technical/Engineering data produced during the PRE phase • Forward Workplan (Design Plan and DPP for the FIN phase)
Main Objectives: To achieve the Production Baseline [AD16] [AD17] [AD21]	• To produce the documents for 41PP scope and maturity relevant for the FIN phase as indicated in the DPP in order to achieve the Production Baseline for this scope. • To refine the design to a level where the final definition of the product (PBS element) is sufficiently complete to allow starting the manufacturing design & preparation phase (subsystem/component specifications are detailed enough to be "understandable" by the manufacturer) – in particular the Engineering-BOM and a preliminary Manufacturing-BOM are available • To verify the concrete through analysis and calculations • To update all ICD/IS according to refined design definition • To have a complete and approved CMM (under config branch) for PPEN 66kV stage 2. • To build a complete set of justifications demonstrating that: o Component specifications and design are justified (supporting analyses, return of experience, tests and explanations) o The specification of the qualification process is fixed (test objectives, logical sequencing, expected results, etc.) • To develop documentation covering the following aspects of the system manufacturability, on-site delivery, assembly/installation, commissioning, operation and maintenance of the system
Phase Outputs (Maturity Level)	• Complete definition of the system (DDD, diagrams, 3D models (DM/CM), drawings, component lists, etc) • Detailed definition of the composing PBS elements (i.e. Functional References) ready for manufacturing/detailed design. • Full set of justification documents (including DCM, Structural Integrity Reports, etc)

	• Plans for next phases (manufacturing, installation, commissioning, operation and maintenance)

This Phase is closed with the approval of the Close-out Report of the Final Design Review (FDR), giving the Authorization-to-Proceed (ATP) to the next activity phase (Manufacturing Design and Preparation).

9.4 Manufacture Design, Preparation and Manufacturing

Table 9-3 Manufacturing Design & Preparation Activity Phase: inputs, outputs and objectives

Manufacturing Design & Preparation Activity Phase (MDP)	
Phase inputs	• Detailed definition of the composing PBS elements ready for manufacture studies, • Forward Workplan (Design Plan and DPP for the MDP phase)
Main Objectives To achieve the Production Baseline [AD22]	• To produce the documents for the considered scope and maturity relevant for the MDP phase as indicated in the Design Plan. • To refine the design definition (Manufacturing Design) to a detailed level for the workshop execution (manufacturing drawings, fabrication, factory assembly and test description, data sheet for COTS, Manufacturing and Controls procedures, Weld Plan, tooling, trainings, materials certificates, tagging procedure) • To generate Manufacturing-Bill of Materials (M-BOM) and deliverable list. • To generate Manufacturing Implementation Plan (MIP). • To build a complete set of justifications demonstrating that: o Manufacturing design is compliant with the Manufacturing requirements (Compliance Matrices DCM/VCM), o Manufacturing Design is justified (supporting analyses, return of experience, tests and explanations), o Component Qualification is finalized. o Manufacturing processes are qualified.
Phase Outputs (Maturity Level)	Manufacturing design: • Manufacturing Inspection Plan • Detailed definition of the composing products/equipments and their identification following[AD23] ready for procurement (for COTS) or actual fabrication. • Detailed definition of the welded joints (welding maps…) • Material certificates. • Manufacturing Procedures,Tagging procedures • Factory Acceptance Test Plan and procedures[4] • Qualified manufacturing, coating and assembly processes and tools • Qualification of operators • FAT report: Test results performed according to FAT procedure approved in the Final Design Review • Document to describe the transport and delivering procedures • and the certifications for the commercial components (if any) Requirements for the preservation of the product and its qualification over the product lifecycle.

[4] The FAT plan (indicating the test items, test pre-requisite and test criteria) shall be developed and fully approved at this stage. However, the test procedures can be approved before the FAT execution.

This Phase is closed with the approval of the Close-out Report of the Manufacturing Readiness Review (MRR), giving the Authorization-to-Proceed (ATP) to the next activity phase (Manufacturing).
After the MRR, The Contractor shall follow the procurement plan to procure the necessary raw materials and COTS, and the manufacturing implementation plan to perform the manufacturing activities.
MIP is required and Section 8.4.2 of [AD1] shall be followed. If considered convenient, instead of a single MIP, several MIPs can be produced.
MIPs shall list all operations that are critical from a quality point of view. As such, QARO and TRO reserve the rights to request for MIP revision if any activity considered critical is not listed in MIPs. MIPs shall be approved by the IO.

9.5 Factory Acceptance Test (FAT)

Detailed test procedures and acceptance criteria of the FAT shall be proposed by the Contractor and the Suppliers during the manufacturing design and approved by the IO. The following sections list the minimum tests to be performed on the key components in the FAT.
The tests shall be sufficient to demonstrate the performance of the components can be guaranteed during the normal operation and accidental events.

9.5.1 66kV Circuit breaker

The following factory acceptance tests for 66kV circuit breaker shall follow the latest IEC 62271-100.

- Dielectric tests on the main circuit, in accordance with Section 8.2 of IEC 62271-100.
- Dielectric test on auxiliary and control circuits, in accordance with Section 8.3 of IEC 62271100.
- Measurement of the resistance of the main circuit, in accordance with Section 8.4 of IEC 62270-100.
- Tightness test, in accordance with Section 8.5 of IEC 62271-100.
- Design and visual checks, in accordance with Section 8.6 of IEC 62271-100.
- Mechanical operating tests, in accordance with Section 8.101 of IEC 62271-100.

Refer to Appendix 16.7 for the acceptance criteria.

9.5.2 66kV Disconnector and earthing switch

The following factory acceptance tests for 66kV circuit breaker shall follow the latest IEC 62271-102.

- Dielectric tests on the main circuit, in accordance with Section 8.2 of IEC 62271-102.
- Dielectric test on auxiliary and control circuits, in accordance with Section 8.3 of IEC 62271-102.
- Measurement of the resistance of the main circuit, in accordance with Section 8.4 of IEC 62270-102.
- Design and visual checks, in accordance with Section 8.6 of IEC 62271-102.
- Mechanical operating tests, in accordance with Section 8.101 of IEC 62271-102.

Refer to Appendix 16.7 for the acceptance criteria.

9.5.3 66kV Current transformer

The current transformers shall be subjected to the following routine tests, in accordance with Section 7.3 of IEC 61869-2:

- Power-frequency voltage withstand tests on primary terminals.
- Partial discharge measurement.
- Power-frequency voltage withstand tests between sections.
- Power-frequency voltage withstand tests on secondary terminals.
- Test for Accuracy.
- Verification of terminal markings.
- Determination of the secondary winding resistance (*R*ct).
- Determination of the secondary loop time constant (*T*s).
- Test for rated knee point e.m.f (E_k) and exciting current at E_k.
- Inter-turn overvoltage test.

The current transformers shall be subjected to the following special tests, in accordance with Section 7.4 of IEC 61869-2:

- Measurement of capacitance and dielectric dissipation factor.

9.5.4 Substation Automation

For protection and control cubicles, please refer to Section 8.2.9.2 for details of FAT.

9.5.5 Connecting devices

Sample test shall be made on connecting devices taken at random from batches offered for acceptance.

- Verification of dimensions and finish of the connecting pieces
- Mechanical tests
- Thermal fatigue test
- Galvanizing test
- Radio interference measurement

9.5.6 66kV&22kV cable and accessories

The following tests shall be carried out on representative samples of 66 kV cables and 22kV cables of the production units respectively. Tests shall be performed in accordance with Clause 10 of IEC 60840 for 66kV cables and Clause 17 of IEC 60502-2 for 22kV cables.
Refer to Section 8.6.3.2 for the FAT.

9.5.7 LV power cables, control cables and Instrument cables

For LV power cables, control cables and instrument cables, please refer to Section 8.4.4.1for details of FAT.

9.6 Packing, Delivery and Preservation

The Contractor is responsible for packing, transportation, site preservation and management of administrative procedures (customs, export control…), with the support from the IO.
The Contractor shall be responsible for clearly labelling the components as per *Procedure for Identification and Controls of Items* [AD23].
The Contractor shall ensure that the components to be delivered are safely and properly packaged conditioned and handled during transport. The Contractor or the supplier is encouraged to use shock absorbers and accelerometers to ensure proper handling and performance during transportation.

Transportation of the components shall be carried out by the Contractor to address as follows.

ITER Organization
Route de Vinon sur Verdon
13067 St Paul lez Durance, France.

The Contractor shall be responsible for delivering the components to the ITER Site and is encouraged to take an appropriate insurance policy coverage against risk of loss or damage to the components during the transport.
Prior to each delivery, the Contractor shall follow *Working Instruction for the Delivery Readiness Review (DRR)* [AD24].

The Contractor shall also follow the Pre-transportation Preparation and Transportation Process Control in accordance with *Procedure for Transportation of Components to ITER Site* [AD25] and prepare following document accordingly.

- Contractor Release Note
- Delivery Report.
- Detailed Package & Packing List.

In case the components need to be stored in IO storage facilities for certain duration before assembly & Installation, the Contractor shall support IO TRO to provide following document for storage and preservation to the IO ILM.

- Equipment Storage and Preservation Requirements Form.

Transportation activities shall not occur until the approval of the Contractor Release Note by the IO TRO and approval of the Delivery Report by the IO ILM.

9.7 Assembly and Installation Preparation and Execution

The Contractor is responsible for planning, site coordination, assembly and installation execution for the components covered by this Technical Specification at ITER worksite.
The process of Assembly & Installation includes:

- Receiving EWPs (technical documentation issued for construction purposes) Assembly & Installation design deliverables via HOP [AD26].
- Reviewing and packaging EWPs into IWPs.
- The receipt and review of IWPs issued by the Works Contractor for execution.

During these processes supporting tasks are undertaken. These include.

- Constructability Reviews
- Hazard Identification and Risk Assessment (HIRA) for the scope of work in IWPs
- Construction Readiness Reviews (CRR)[AD27].

Before the assembly & installation, an CRR shall be organized to check the readiness of the installation (drawings and procedures) and approve the installation activities.
After the assembly and installation, a Construction Completion Review or Commissioning Certificate Readiness (CCR) shall be organized to approve the installation and allow the SAT activities.

9.7.1 Assembly and Installation design

The Contractor shall minimize the installation effort needed on site by design the system in a way that most of the components are pre-assembled (and tested) in the factory.
In the design stage, the Contractor shall perform the Assembly & Installation design to identify the installation activities on site, the required workflow and the duration.
The Assembly & Installation design has to be approved by the IO before going to the manufacturing stage.

9.7.2 Assembly and installation Execution

Section 13 of [AD1] (Additional general requirements for working at the ITER site) applies to the site installation activities in the scope of this Turnkey contract.
The Contractor shall prepare Mechanical Completion Dossier(MCD) as per *MQP L3 Working Instruction for Completion Dossier* [AD28].

9.7.3 Inspection after installation

The IO will issue the third-party regulatory inspections on the components after the installation and before the SAT, and the Contractor/the Supplier is responsible to correct the system in case of non-compliances.

A handover certificate will be issued after CCR being approved successfully.

9.8 Testing & Commissioning for Components and SAT preparation

After the completion of the assembly & installation activities of the main components, there will be the following activities:

- Components test (mechanical and electrical tests)
- Instrumentation and Control test

9.8.1 Component Test

The following tests (shown in Table 9-4) shall be performed for each main component of the converters, and dummy load to verify the equipment satisfies the functional requirements as a minimum, as well as the acceptance criteria.

Table 9-4 : Summary Component Tests

Equipment	Test Items	Acceptance Criteria	Applicable Standard and its sub-clause
66kV Circuit breaker	Measurement of the resistance of the main circuit	Appendix 16.7	IEC 62271-100, 8.4
	Visual check		IEC 62271-100, 8.6
	Mechanical operating tests		IEC 62271-102, 8.101
	Other tests recommended by the manufacturer		
66kV disconnector switch and Earthing switch	Measurement of the resistance of the main circuit	Appendix 16.7	IEC 62271-102, 8.4
	Visual check		IEC 62271-102, 8.6
	Mechanical operating tests		IEC 62271-102, 8.101
	Other tests recommended by the manufacturer		
66kV Current transformer	Visual check and verification	Appendix 16.7	
	Verification of terminal markings		IEC 61869-1, 7.3.6
	Test for Accuracy		IEC 61869-2, 7.3.5
	Power-frequency voltage withstand tests on primary terminals		IEC 61869-1, 7.3.1
	Power-frequency voltage withstand tests between sections of primary		IEC 61869-1, 7.3.3

Equipment	Test Items	Acceptance Criteria	Applicable Standard and its sub-clause
	and secondary windings and on Secondary windings		
	Power-frequency voltage withstand tests on secondary terminals		IEC 61869-1, 7.3.4
66kV cable and accessories	DC voltage test of the oversheath	Appendix 16.7	IEC 60840, 16.1
	AC voltage test of the insulation		IEC 60840, 16.2
22kV cable and accessories	DC voltage test of the oversheath	Appendix 16.7	IEC 60502-2, 20.1
	AC voltage test of the insulation		IEC 60502-2, 20.2

9.8.2 Instrumentation and Control test

9.8.2.1 Description

These tests are carried out to verify that the hardware & software of local/remote control can operate as required by the design specification and integrate with the interfaced systems.
Testing of the control function:

- All voltage and current transducers shall be tested and calibrated.
- All digital and analogue command signal transmissions and control circuit response shall be tested and calibrated.
- All tests and calibration data for the instrumentation signals shall be recorded.

Testing of protection and interlock function:

- All interlock and protection signals shall be tested and calibrated.
- All the I/O of interlock shall be tested individually.
- The interlock and protection function test of the protection and control relay shall be performed by operating the equipment remotely and locally, a verification and validation matrix shall be provided to ensure the test coverage.
- All tests and calibration data for protection signals shall be recorded.

The Contractor shall be responsible for integration of PPEN 66kV stage 1 and stage 2, including the integration of HMI of Stage 1 and Stage 2.
Integration control test with CODAC:

- All signals including analogue signals and digital signals acquired from local instrumentation shall be transmitted to CODAC.
- All control signals or commands from the CODAC shall be sent to the controller.

- The exchange of signals and commands between CODAC and the controller shall be tested one by one according to the signals list.

IO central team or IO Subcontractor (GTD) is responsible for CODAC. Integration control test with CODAC will be organised along with PPEN 66kV stage 2 I&C test.

9.8.2.2 Acceptance Criteria

All analogue and digital signals exchanged between the electrical operating mechanisms, protection relays, HMI and CODAC, operate as required by the design specification.
The Contactor shall ensure the experienced engineers with sufficient technical competences be ready to provide the support at the requested time. Section 13 of [AD1] (Additional general requirements for working at the ITER site) applies to the site commissioning activities in the scope of this turnkey contract.

10 Location for Scope of Work Execution

The design, manufacture, FAT and delivery are to be performed outside of ITER site. The in-person meetings can be organized in the ITER office area or the venues of the Contractor, the supplier and the Subcontractor.
The installation and assembly, SAT and commissioning and test are to be performed at the ITER construction site.

As part of the work is to be performed in the ITER construction area, please refer to Section 13 of [AD1] for detailed requirements and instructions and [AD32] as well.

11 IO Documents & IO Free issue items

11.1 IO Documents : Technical Input Documentation

Under this scope of work, IO will deliver the following documents.

Table 11-1 : IO Documentation

Ref.	Title	Doc ID	Expected date
1	All IDM reference documents mentioned in Section 4.1	NA	Immediate
2	3D context models for PPEN 66kV area in A35		Upon request

11.2 Free issue items

No free issue is expected from the IO.

12 Deliverables and Schedule Milestones

12.1 Schedule for delivery

The schedule for the Turn-key contract milestones is specified in the following **Table 12-1**.

Table 12-1 : Schedule for Deliverables

Schedule Milestones	Deliverables**	Acceptance criteria	Expected Time (T0*+x month)
KOM	Documentation package submission	Documents accepted by IO CRO	T0+1
PDR	Completion of Preliminary Design documentation package	Preliminary Design Review Deliverables accepted by IO CRO	T0+5
FDR	Completion of Final Design documentation package	Final Design Review Deliverables accepted by IO CRO	T0+13
MRR	Completion of Manufacturing Design documentation package	Manufacturing Design Review Deliverables accepted by IO CRO	T0+16
Manufacturing and FAT	Completion of the manufacturing of components Completion of the Factory Acceptance Test	MIP reports signed by IO FAT reports accepted by IO CRO	T0+26
DRR	Completion of Delivery Readiness Review	Delivery Readiness Review Deliverables accepted by IO CRO	T0+27
CRR	Completion of the Construction Readiness Review	Final Design Review Deliverables accepted by IO CRO	T0+32
Assembly &Installation	Completion of the assembly and installation of all elements in the Contractor's scope	Relevant MIPs signed by IO	T0+45
CCR	Completion of the Construction Completion Readiness	Construction Completion Readiness Deliverables accepted by IO CRO	T0+47
SAT	Completion of the Stage 2 components Site Acceptance Test (incl. integration with I&C system of PPEN 66kV stage 1)	All SAT reports accepted by IO CRO	T0+53
Handover to IO	Completion Review with the as-built deliverables	MCD accepted by IO CRO and Final Acceptance Certificates issued to the Contractor.	T0+54

* T0 = Contract Signature date.

** the detailed list of deliverables is available in Appendix 16.8 of this document.

12.2 List of deliverable documentation

The Contractor and its supplier shall provide the IO with the material, documents and data required in the application of this technical specification, *Expected content of System Design deliverables* [AD21], *Template for SDR Input Data Package* [RD43] and any other requirement derived from the application of the Turn-key contract.
The deliverables are to be provided in accordance Chapter 6 and Chapter 8 of this technical specification. The final list must be agreed by the IO and each document approved by the IO before the respective Contract gate, as defined in Chapter 9.
IO has prepared the deliverable document list, as Appendix 16.8, in consistent with *MQP L3 Expected content of System Design deliverables* [AD21].

13 Quality Assurance Requirements

Quality Requirements shall be in accordance with *Quality Requirements for IO Performers* [AD6]. For this purpose, The Contractor and the Suppliers carrying out contracts placed under this turnkey contract shall be in compliance with the QA requirements under the relevant ITER QA classification as per *Quality Classification Determination* [AD46]" and shall have an IO approved QA Program or an ISO 9001 accredited quality system, complemented with the above mentioned requirements.

Prior to commencement of the works, The Contractor shall submit a Quality Plan for IO approval in accordance with [AD6].

The Contractor's Quality Plan shall describe the organization for tasks, roles and responsibilities of workers involved in, any anticipated subcontractors, and give details of who are the independent checkers of the activities. The Quality Plan shall be sent to the IO CRO who will upload it in IDM with the relevant IO QARO as a reviewer. After considering any comments in IDM, the IO RO will inform his approval/disapproval to The Contractor CRO. Quality Plans shall be produced by the Contractor and submitted to the IO for acceptance, unless otherwise agreed between the Parties, to describe how they will implement the ITER Procurement Quality Requirements.

Manufacturing and Inspection Plans (MIP) are used to monitor Quality Control and acceptance tests and must be produced by each Supplier and Subcontractor and submitted to the IO for acceptance and mark-up of any IO interventions, unless otherwise agreed between the Parties. It should be noted that interventions additional to those required in the Technical Specification may be included on the MIP by IO if justified.

When a deviation to an IO specified requirement is anticipated, The Contractor shall discuss it with the IO CRO as appropriate for that ITER work activity. If the proposed deviation is considered beneficial, in accordance with *Procedure for the Management of Deviation Request* [AD7], a Deviation Request shall be submitted to IO for a decision using *Deviation Request Template* [AD47].

When a non-conformity is identified, The Contractor shall inform the IO CRO immediately or as soon as practically possible, of the nature of the non-conformity, taking into account requirements and process described in *Procedure for Management of Nonconformities* [AD15]. If needed, immediate actions shall be applied, to segregate a nonconforming item or work in order to ensure safety. After confirmation of agreement on categorization, The Contractor shall issue a Non-Conformance Report using the IO NCR Database.

Documentation developed as the result of the work shall be retained by the Contractor or a supplier/subcontractor for a minimum of five (5) years and then may be discarded at the direction of the IO.

IO will monitor implementation of the Contractor's Quality Plan. Where necessary, IO will assess the adequacy and effectiveness of the quality management system specified in the Quality Plan through inspections or audit. Where condition adverse to quality is identified, the Contractor shall eliminate discovered findings.

The use of computer software to perform a safety basis task activity such as analysis and/or modelling, etc. shall be reviewed and approved by the IO prior to its use in accordance with

Q*uality Assurance for ITER Safety Codes Procedure* [AD30] . Where applicable, *Software Qualification Policy* [RD44] shall be taken into consideration to ensure quality and integrity of software prior to application.

14 Safety requirements

No specific safety requirement related to PIC and/or PIA applies.

15 Special Management requirements

15.1 Electrical requirements for on-site activities.

CERTIFICATION is mandatory for:

- Performing any WORK ACTIVITIES on or in the VICINITY of electrical NETWORKS or INSTALLATIONS;
- Supervising any WORK ACTIVITIES on or in the VICINITY of electrical NETWORKS or INSTALLATIONS;
- Unsupervised access to ROOMS WITH ACCESS RESERVED for ELECTRICIANS

In view that the working areas are categorized as HTA for 22kV system or HTB for 66kV system, the Contractor's personnel shall be accredited with electrical certification as per the French Labor code and NF C 18-510.

15.2 CAD design requirements

For this contract where CAD design tasks are involved, [AD1] GM3S section 6.2.2.2 applies with the below specific requirements.
All diagrams, models and drawings are subject to *MQP L2 Procedure for the CAD management plan* [AD31].
The Contractor shall exchange CAD data relevant for the design and associated interfaces with the IO in the CAD software and related versions indicated in the latest revision of the ITER CAD Manual in [RD46] released by the Design Office of the IO. CAD data may be exchanged in other formats if compatible with the IO software and if agreed by the IO through the Design Collaboration Implementation Form (DCIF) associated to this turnkey contract-Design Collaboration Implementation Form (DCIF) [RD46].
The Contractor shall ensure that all CAD Data (Schematics, Models and Drawings) prepared by the Contractor, or its Suppliers comply with the requirement as [RD46]for the Design activities covered by this Technical Specification.

15.3 Risk Management

The Contractor/the Suppliers shall, within 90 (ninety) calendar days of the entry into force of the contract, draw up and submit to the IO, for information, a plan for managing risks associated with implementing the turnkey contract (hereinafter referred to as the "Risk Plan"). The Risk Plan will be consistent with *Risk and Opportunity Management Procedure*[AD33].
The Contractor shall process risks which may impinge on the successful execution of the contract directly in the Project Risk Register, in accordance with [AD33].

15.4 Environment, Safety and Health and Security

The Contractor shall ensure that its personnel, Suppliers and Subcontractors observe all applicable environment, safety and health and security provisions for work on the ITER Site in Cadarache, as well as specific requirements set out in this Technical Specification.
Any activity by the Contractor personnel or its Suppliers and Subcontractors at the ITER Site shall be subject to *Internal Regulations* [AD34] and *MQP L3 Contractor Safety Management Procedure* [AD35].
Any activity by the Contractor personnel or its Suppliers and Subcontractors on the ITER Construction Site shall be subject to *Health Protection and Safety General Coordination Plan - ITER Construction Site - volume 0- General Safety Rules* [AD36] and resulting procedures. Any additional applicable provisions regarding environment, safety and health and Security, as well as Project Control and Site Coordination, shall be communicated by the IO to The Contractor at least 30 (thirty) calendar days in advance of the activities to be performed at the ITER Site.

For all entities working on Site, the following documents shall apply for work on the ITER Construction Site:

- *Environmental requirements* [AD37]
- *ITER Policy on Safety, Security and Environment Protection Management* [AD38]
- *Contractor Safety Management Procedure* [AD39]
- *ITER Site access Procedure* [AD40]
- *Procedure for Occupational Health and Safety Hazard Identification and Assessment* [AD41]
- *Vehicle Access and Traffic Circulation and Parking on the ITER Site* [AD42]
- *Physical Security Protection Management Procedure* [AD43]
- *ITER* Site Permit to Work Procedure[AD48]

The Contractor personnel and its Suppliers and Subcontractors on the ITER Construction Site shall be subject to *General Management Specification for Executing Entities at the ITER Site* [AD32], which collects in a consistent manner existing requirements already applicable, as well as requirements in the field of Project Control and Site Coordination.

16 Appendices

Appendix Number	Appendix Name
16.1	**Technical Datasheets for tender**
16.1.1	66 kV Substation General Datasheet
16.1.2	66kV Disconnector with single Earthing switch Datasheet
16.1.3	66kV Circuit Breakers Datasheet
16.1.4	66kV Earthing Switch Datasheet
16.1.5	66kV Current Transformers Datasheet
16.1.6	Control and Protection Panel Datasheet
16.1.7	66kV Cable and Accessories Datasheet
16.1.8	22kV Cable and Accessories Datasheet
16.1.9	LV, Control cables and OHL conductor Datasheet
16.1.10	Metallic structure Datasheet
16.2	**Identification and Bill of Material**
16.2.1	66kV Disconnector Switch and Earthing Switch
16.2.2	66kV Circuit Breakers
16.2.3	66kV Earthing Switch
16.2.4	66kV Current Transformer
16.2.5	LV Distribution Panel(BP)
16.2.6	Control &Protection cubicle
16.2.7	66kV Cable and Accessories
16.2.8	22kV Cable and Accessories
16.2.9	Interface I&C cables with MCPC stage 2 (ON HOLD)
16.3	**PPEN 66 kV &22kV drawing**
16.3.1	66 kV Switchyard Layout
16.3.2	PPEN 66kV Stage 1 Equipment drawing

Appendix Number	Appendix Name
16.3.4	PPEN 22kV GIS layout
16.4	**I&C Documentation**
16.4.1	PPEN 66 kV I&C Architecture
16.4.2	Typical I/O signal list (for reference only)
16.4.3	Protection & Control Cubicle Schematic (for reference only)
16.5	**Substation Auxiliary Services One Line Diagram**
16.5.1	Single Line Diagram-AC 400V/230V
16.5.2	Single Line Diagram-UPS AC 230V
16.5.3	Single Line Diagram-DC 48V
16.6	**PPEN 66kV system LV Cable Definition**
16.7	**Acceptance Criteria for tests**
16.7.1	66kV Disconnector Switch and Earthing Switch
16.7.2	66kV Circuit Breakers
16.7.3	66kV Current Transformer
16.7.4	66kV Cable and Accessories
16.7.5	22kV Cable and Accessories
16.8	**List of Documentation Deliverables**

16.1 Technical Datasheets for Tender

The equipment manufacturer shall fulfil the "OFFERED" column without leaving any blank space.
In the column "REQUIRED" there are indicated the main characteristics/requirements that the equipment must comply.
In the "REQUIRED" column, there will be stated, by using the acronym "TBDM", all the values that shall be defined and fulfilled by the manufacturer based on the equipment to be supplied.

16.1.1 66kV Substation General Datasheet

GENERAL FEATURES	UNIT	REQUIRED	OFFERED
Type		Air Insulated	
Testing and manufacturing standards		IEC 62271-100	
Earthing system		Low resistor	
Rated voltage	kV	72.5	
Rated frequency	Hz	50	
Rated busbar current Main busbar Transfer busbar Feeder busbar	 A A A	 2500 2500 1250	
Rated short-time withstand voltage (r.m.s)	kA/s	31.5/1	
Rated peak withstand voltage (peak)	kA	80	
Creepage distance	mm/kV	≥ 16	
Rated insulation level a) Rated short-duration power frequency withstand voltage (1 min) - Phase to earth and between phases - Across the isolating distance b) Rated lightning impulse withstand voltage (1.2/50µs) - Phase to earth and between phases (peak) - Across the isolating distance (peak)	 kV kV kV kV	 140 160 325 375	
Insulator material	kV	Porcelain	

16.1.2 66kV Disconnector and Earthing switch Datasheet

FEATURES	UNIT	REQUIRED	OFFERED
General Requirements			
Number of units:	Set	10	
Manufacturer	-	TBDM	
Type of disconnectors	-	Double break	
Structure and Type	-	Three column &horizontal rotary	
Place of manufacturer	-	TBDM	
Testing and manufacturing standard	-	IEC 62271-1 IEC 62271-102	
Installation	-	Outdoor	
Insulator material	-	Porcelain	
Creepage distance	mm/kV	≥16	
Static mechanical terminal loads			
- Straight load	N	TBDM	
- Cross load	N	TBDM	
- Vertical Force	N	TBDM	
Electrical data			
Rated voltage	kV	72.5	
Rated frequency	Hz	50	
Rated current	A	1250	
Rated short-time withstand current (r.m.s)			
- Disconnectors	kA/s	31.5/1	
- Earthing switch	kA/s	31.5/1	
Rated peak withstand current			
- Disconnectors	kA	80	
- Earthing switch	kA	80	
Rated insulation level			
a) Rated short-duration power frequency withstand voltage (1 min)			
- Phase to earth and between phases	kV	140	
- Across the isolating distance (peak)	kV	160	
b) Rated lightning impulse withstand voltage (1.2/50 µs)			
- Phase to earth and between phases (peak)	kV	325	
- Across the isolating distance (peak)	kV	375	
Disconnector interlocking type		Mechanical and Electrical	
Construction			
Mass	kg	TBDM	
Mass of fluid for interruption	kg	TBDM	

FEATURES	UNIT	REQUIRED	OFFERED
Insulator material	-	Porcelain	
Color of insulator	-	TBDM	
Operating Mechanism			
Rated voltage for driving motor	V	230 AC UPS (+10% to -15%)	
Rated supplied voltage for control	V	DC 48 +10%/-15%	
Operation mechanism type	-	TBDM	
Operation mode	-	Three-pole operation	
Operating mechanism	-	Electric motor & Manual	
Degree of protection (IP) of mechanism box	-	IP54	
Material of mechanism box	-	Stainless steel	
Auxiliary contacts of Disconnector and Earthing switch - Disconnectors - Earthing switch	-	 8NO+8NC 8NO+8NC	
Opening time	s	TBDM	
Closing time	s	TBDM	
Average opening speed	m/s	TBDM	
Average closing speed	m/s	TBDM	
Mechanical endurance		M1 or M2	
Power frequency voltage test on auxiliary & control circuits	kV	1	
Tests			
a) Type Tests			
Dielectric tests - Short-duration power frequency withstand voltage (1 min) - Lightning impulse voltage test (1.2/50μs)		 CERTIFIED CERTIFIED	
Measurement of the resistance of the main circuit		CERTIFIED	
Temperature rise tests		CERTIFIED	
Short time withstand current and peak withstand current tests		CERTIFIED	
Electromagnetic compatibility (EMC) tests		CERTIFIED	
Operation under severe ice condition tests		CERTIFIED	
Operating and mechanical endurance tests		CERTIFIED	
b) Routine Tests			
Measurement of the resistance of the main circuit		REQUIRED	
Dielectric test on auxiliary and control circuits - Short-duration power frequency withstand voltage(1 s)		 REQUIRED	
Measurement of the resistance of the main circuit		REQUIRED	
Design and visual checks		REQUIRED	
Mechanical operating tests		REQUIRED	

16.1.3 66kV Circuit Breaker Datasheet

FEATURES	UNIT	REQUIRED	OFFERED
General Requirements			
Number of units	Set	10 (three-pole)	
Manufacturer	-	TBDM	
Type	-	TBDM	
Place of manufacture	-	TBDM	
Testing and manufacturing standards	-	IEC 62271-1 IEC 62271-100	
Installation	-	Outdoor	
Number of interrupting units per pole	-	1	
Cooling method	-	Natural	
Arc extinction method	-	SF6	
Number of poles	-	3	
Temperature rise at the hottest point of the circuit breaker	-	IEC 62271-1 Table 3	
SF6 Characteristics - Rated pressure - Maximum operating pressure - Minimum closing pressure	 bar bar bar	 TBDM TBDM TBDM	
SF6 gas humidity - Acceptance Value - Long-time running allowable value	 µL/L µL/L	 ≤150 ≤300	
Relative leakage rate	%/year	≤1	
Purity of SF6 gas	%	99.8	
Electrical data			
Rated voltage	kV	72.5	
Rated frequency	Hz	50	
Rated current	A	≥1250	
Rated short-time withstand current (r.m.s)	kA/s	31.5/1	
Rated peak withstand current (peak)	kA	80	
First pole factor	-	1.5	
Rated insulation level a) Rated short-duration power frequency withstand voltage (1 min) - Phase to earth and between phases - Across the isolating distance b) Rated lightning impulse withstand voltage (1.2/50 µs) - Phase to earth and between phases (kV peak) - Across the isolating distance (kV peak)	 kV kV kV kV	 140 160 325 375	
Rated short-circuit breaking current - AC component - DC component of the rated short-circuit breaking current - Degree of asymmetry	 kA/s kA %	 31.5/1 >9.6 >26.1	
Transient recovery voltage related to the short circuit breaking current	kV	TBDM	
Transient recovery voltage variation	kV/µs	TBDM	
Rated out-of-phase making current	kA	TBDM	
Rated out-of-phase breaking current	kA	TBDM	

FEATURES	UNIT	REQUIRED	OFFERED
Rated small inductive breaking current	A	TBDM	
Rated short-circuit making current	A	TBDM	
Rated capacitive switching current	A	TBDM	
Restrike performance	-	C1 or C2	
Electrical endurance classification	-	M2	
Construction			
Mass	kg	TBDM	
Mass of fluid for interruption	kg	TBDM	
Insulator material	-	Porcelain	
Color of insulator	-	TBDM	
Operating Mechanism			
Type of mechanism	-	Spring-charged	
Operation mode	-	Three-pole operation	
Degree of protection (IP) of mechanism box	-	IP54	
Material of mechanism box	-	Stainless steel	
Mechanical endurance class	-	M2	
Rated operating sequence	-	O-0.3s-CO-3min-CO	
Close coil: - Rated supplied voltage - Minimum admissible supplied voltage, in percentage of the rated supplied voltage - Maximum admissible supplied voltage, in percentage of the rated supplied voltage - Consumption - Surge current of each coil - Steady-state current of each coil	 V % % W A A	 DC 48 85% 110% TBDM TBDM TBDM	
Trip coil: - Number of coils - Rated supplied voltage - Minimum admissible supplied voltage, in percentage of the rated supplied voltage - Maximum admissible supplied voltage, in percentage of the rated supplied voltage - Consumption - Surge current of each coil - Steady-state current of each coil	 V % % W A A	 2 DC 48 70% 110% TBDM TBDM TBDM	
Rated time Value - Opening time - Break time - Closing time - Open-close time - Reclosing time - Close-open time - Pre-insertion time	 ms ms ms ms ms ms ms	 TBDM ≤60ms TBDM TBDM TBDM TBDM TBDM	
Difference between the closing and opening time of main contacts	ms	TBDM	
Average opening speed	m/s	TBDM	
Average closing speed	m/s	TBDM	
Opening disagreement	ms	TBDM	
Closing disagreement	ms	TBDM	

FEATURES	UNIT	REQUIRED	OFFERED
Heater (if applicable) - Voltage - Consumption	 V W	 TBDM TBDM	
Auxiliary Contact - Quantity - Breaking capacity		 8NO+8NC TBDM	
Tests			
Type Tests			
Dielectric tests		CERTIFIED	
Radio interference voltage tests		CERTIFIED	
Measurement of the resistance of the main circuit		CERTIFIED	
Temperature rise tests		CERTIFIED	
Short time withstand current and peak withstand current tests		CERTIFIED	
Verification of the degree of protection		CERTIFIED	
Tightness test		CERTIFIED	
Mechanical operation tests at ambient temperature		CERTIFIED	
Short circuit current making and breaking tests		CERTIFIED	
Capacitive current switching tests		CERTIFIED	
Out of phase making and breaking tests		CERTIFIED	
Short line fault tests		CERTIFIED	
Routine Tests			
Dielectric tests on the main circuit		REQUIRED	
Dielectric test on auxiliary and control circuits		REQUIRED	
Measurement of the resistance of the main circuit		REQUIRED	
Tightness tests		REQUIRED	
Design and visual checks		REQUIRED	
Mechanical operating tests		REQUIRED	

16.1.4 66kV Earthing Switch Datasheet

FEATURES	UNIT	REQUIRED	OFFERED
General Requirement			
Number of units	Set	10 (three-pole)	
Manufacturer	-	TBDM	
Type of earthing switches	-	TBDM	
Structure and Type	-	Single column vertical open	
Place of manufacturer	-	TBDM	
Testing and manufacturing standard	-	IEC 62271-1 IEC 62271-102	
Installation	-	Outdoor	
Insulator material	-	Porcelain	
Creepage distance	mm/kV	≥16	
Static mechanical terminal loads - Straight load - Cross load - Vertical Force	 N N N	 TBDM TBDM TBDM	
Electrical data			
Rated voltage	kV	72.5	
Rated frequency	Hz	50	
Rated current	A	50	
Rated short-time withstand current	kA/s	31.5/1	
Rated peak withstand current (peak)	kA	80	
Rated insulation level a) Rated short-duration power frequency withstand voltage (1 min) - Phase to earth and between phases - Across the isolating distance (peak) b) Rated lightning impulse withstand voltage (1.2/50 μs) - Phase to earth and between phases (peak) - Across the isolating distance (peak)	 kV kV kV kV	 140 160 325 375	
Construction			
Mass	kg	TBDM	
Mass of fluid for interruption	kg	TBDM	
Insulator material	-	Porcelain	
Color of insulator	-	TBDM	
Operating Mechanism			
Rated voltage for driving motor	V	230 AC UPS (+10% to -15%)	
Rated supplied control voltage	V	DC48 +10%-15%	
Operation mechanism type	-	TBDM	
Operation mode	-	Three-pole operation	
Operating mechanism	-	Electric motor operated/ Manual operated	
Degree of protection (IP) of mechanism box	-	IP54	
Material of mechanism box	-	Stainless steel	

FEATURES	UNIT	REQUIRED	OFFERED
Interlock type	-	Mechanical and Electrical	
Opening time	s	TBDM	
Closing time	s	TBDM	
Average opening speed	m/s	TBDM	
Average closing speed	m/s	TBDM	
Mechanical endurance		M1	
Power frequency voltage test on auxiliary and control circuits	kV	1	
TESTS			
Type Tests			
Dielectric tests		CERTIFIED	
Measurement of the resistance of the main circuit		REQUIRED	
Temperature rise tests		CERTIFIED	
Short time withstand current and peak withstand current tests		CERTIFIED	
Electromagnetic compatibility (EMC) tests		CERTIFIED	
Operation under severe ice conditions		CERTIFIED	
Operating and mechanical endurance tests		CERTIFIED	
Routine Tests			
Dielectric tests on the main circuits		REQUIRED	
Dielectric test on auxiliary and control circuits		REQUIRED	
Measurement of the resistance of the main circuit		REQUIRED	
Design and visual checks		REQUIRED	
Mechanical operating tests		REQUIRED	

16.1.5 66kV Current Transformer Datasheet

FEATURES	UNIT	REQUIRED	OFFERED
General Requirement			
Manufacturer	-	TBDM	
Type	-	Outdoor, Single phase, oil-immersed,	
Testing and manufacturing standard	-	IEC 61869-1 IEC 61869-2	
Installation	-	Outdoor	
Insulator material	-	Porcelain	
Creepage distance	mm/kV	≥16	
Technical data			
Rated voltage	kV	72.5	
Rated frequency	Hz	50	
Number of secondary windings	-	3	
Transformation ratio for measurement	A	750/5(or 750/1)	
Accuracy class - 1st secondary winding	-	 30 VA, Cl.0,2	
Transformation ratio for protection	A	1000/5-5 (or 1000/1-1)	
Output and accuracy class - 2nd secondary winding - 3rd secondary winding		 50 VA, 5P20 50 VA, 5P20	
Rated short-time withstand current (r.m.s)	kA/s	31.5/1	
Rated peak withstand current (peak)	kA	80	
Transformer temperature rise for a primary current equal to the rated continuous thermal current and with a load equal to the accuracy load, with a power factor of 1 (ºC)		TBDM	
Winding insulation class		TBDM	
Insulation level - Primary winding rated short-duration power frequency withstand voltage - Primary winding rated lightning impulse withstand voltage (1.2/50 µs) (peak) - Secondary winding rated power frequency withstand voltage - Withstand voltage between windings (peak)	 kV kV kV	 140 325 3 4.5	
Partial discharge - Partial discharge initiation voltage (peak) - Partial discharge extinction voltage (peak) - Partial discharge intensity - Phase and earth Um - Phase and earth Um/1.2$Um/\sqrt{3}$	 kV kV pC pC	 TBDM TBDM ≤10 ≤5	
Response in transient operating conditions - Rated short-circuit symmetrical current factor, Kssc - Dimensioning factor for the rated transient operating conditions, Ktd - Admissible time for the accuracy limit, tal - Time for maximum flow, tmax - Assigned time constant of the secondary loop, Ts	 - - ms ms ms	 TBDM TBDM TBDM TBDM TBDM	

FEATURES	UNIT	REQUIRED	OFFERED
- Resistance of the secondary winding at 75ºC, Rct	Ω	TBDM	
- Admissible fault in the accuracy limit condition	%	TBDM	
Dielectric dissipation factor tanδ (%)			
- For 10kV	%	≤0.4	
- For Um/$\sqrt{3}$	%	≤0.4	
- For(0.5 ~ 1) Um/$\sqrt{3}$, tanδ incremental	%	≤0.1	
Transmitted overvoltage peak value limits	kV	≤1.6	
Other Technical Data			
Limi t of temperature rise			
- Top oil	K	55	
- Winding	K	65	
- Connection of Primary winding	K	50	
Transformer Insulating oil			
- Insulating oil Grade	-	TBDM	
- Breakdown voltag	kV	≥45	
- tanδ (90°C)	-	≤0.5	
- Water content	%	≤20	
- Total hydrocarbon	µL/L	≤10	
- H2	µL/L	≤50	
- C2H2	µL/L	0	
Insulation of the secondary windings	kV	3	
Mass	kg	TBDM	
Service life	year	20	
Static mechanical terminal loads			
- Straight load	N	TBDM	
- Cross load	N	TBDM	
Marshalling box for three phases Current transformer			
Material	-	Stainless steel	
Degree of protection (IP)	-	IP55	
Tests			
Type Tests			
Temperature-rise test		CERTIFIED	
Short-time current test		CERTIFIED	
Lightning impulse voltage test on primary terminals		CERTIFIED	
Impulse voltage withstand test on primary terminals		CERTIFIED	
Wet test for outdoor type transformers		CERTIFIED	
Chopped impulse voltage withstand test on primary terminals		CERTIFIED	
Transmitted overvoltage test		CERTIFIED	
Test for accuracy		CERTIFIED	
Verification of the degree of protection by enclosures		CERTIFIED	
Mechanical tests		CERTIFIED	
Routine Tests			
Power-frequency withstand test on primary terminals		REQUIRED	
Partial discharge measurement		REQUIRED	
Power-frequency withstand test between sections of secondary windings		REQUIRED	
Power-frequency withstand test on secondary terminals		REQUIRED	
Test for Accuracy		REQUIRED	

FEATURES	UNIT	REQUIRED	OFFERED
Verification markings		REQUIRED	
Determination of the secondary winding resistance		REQUIRED	
Insulation oil characteristic test		REQUIRED	
Test for rated knee point e.m.f. and exciting current at rated knee point e.m.f.		REQUIRED	
Inter-turn overvoltage test		REQUIRED	
Measurement of capacitance and dielectric dissipation factor tanδ (%)		REQUIRED	

16.1.6 Protection and Control Panel Datasheet

FEATURES	UNIT	REQUIRED	OFFERED
Control & Protection Panel			
Manufacturer	-	Schneider Electric	
Model	-	NSYSFRSTVA	
Quantity	set	5	
Manufacturing and testing standards	-	IEC 61850 IEC 60255 IEC 61000	
Insulation level: Power frequency withstand voltage Impulse test voltage 1.2 x 50 µs (peak)	 kV kV	 TBDM TBDM	
Degree of protection	-	IP54	
Characteristics of the enclosure: - Material - Thickness (mm) - Surface finish - Dimensions (W x H x D) - Finish colour	 - - - mm -	 See Section 8.2.7 See Section 8.2.7 Epoxy-Poliester Resin 2200x800x800 Afnor. 2550 (blue)	
Type of internal wiring		TBDM	
Cross Sections cables: - CT circuits - VT circuits - Control 48V DC - Circuits 230 V AC		 ≥2.5 mm^2 ≥2.5 mm^2 ≥1.5 mm^2 ≥1.5 mm^2	
Control & Protection Relay			
General: Protection function Manufacturer Model (compatible with existing MiCOM C264P in 66kV container) Quantity Digital Inputs Digital Outputs Analog Inputs(4~20mA) Num. of Current Measurement channels (0-5A -or 0-1A) Num of Voltage measurement chanel (0-100/√3 V) Ports Front Rear Synchronization mode Manufacturing and testing standards	- - - - set	Digital Multifunction 50-51-50N-51N-27B Schneider Electric TBDM 10 set+2 spare 64 16 20 4 4 1xRS485/1USB 1xRS485+ 2x100BaseFX NTP TBDM	
Auxiliary Control Equipment			
Trip & Lockout Relay (86)			

FEATURES	UNIT	REQUIRED	OFFERED
Type	-	TBDM	
Quantity	set	10	
Response time	-	TBDM	
Contacts na/nc	-	TBDM	
Test Blocks			
Type(s)	-	TBDM	
Quantity	-	TBDM	
Miniature Circuit Breaker (48v Dc)			
Quantity/Type	-	TBDM	
Quantity/Type	-	TBDM	
Quantity/Type	-	TBDM	
Auxiliary Relays			
Quantity/Type	-	TBDM	
Quantity/Type	-	TBDM	
Quantity/Type	-	TBDM	
Differential Circuit Breaker (230 V AC)			
Quantity/Type	-	TBDM	
Socket			
Quantity/Type	-	TBDM	
Ethernet Switches			
Manufacturer	-	TBDM	
Model	-	TBDM	
Quantity		3	
Support RSTP,STP	-	STP	
Number of ports (at least)	- -	4x1000BaseLX 16x100BaseFX	
Aux Power supply	-	48 V DC (redundant)	

16.1.7 66kV Cable and Accessories Datasheet

FEATURES	UNIT	REQUIRED	OFFERED
Cables			
General data			
Manufacturer	-	TBDM	
Place of manufacture	-	TBDM	
Basic testing standard	-	IEC 60840	
Manufacturer reference	-	TBDM	
Rated section	mm^2	240 300	
Number of conductors per phase - 240 mm^2 - 300 mm^2		 2 2	
Total length of the cables to be supplied - 240 mm^2 - 300 mm^2	 m m	 9215 2360	
Rated frequency of the 66 kV system	Hz	50	
Rated voltages of cables (Uo/U/Um)	kV	36/66/72.5	
Test voltages: - Power frequency voltage test (30 min) - Test voltage at lightning impulse (peak)	 kV kV	 90 325	
Maximum admissible temperature in the conductor under normal operation	ºC	90	
Maximum admissible temperature in the conductor under short-circuit operation (maximum duration 5 seconds	ºC	250	
Ampacity of the copper conductors three single-core cable, with XLPE insulation, based on 35ºC ambient air temperature. Cables in air, with trefoil formation and sheath bonded at two ends and 90ºC, A: - 240 mm^2 - 300 mm^2	 A A	 610 695	
Emergency operating conditions with an overload of 10% over the maximum admissible current during continuous operation and with an initial conductor temperature of 90ºC and in the worst installation conditions: For 240 mm^2: - Current, - Maximum admissible duration of the overload, - Maximum admissible accumulated duration per year, - Maximum temperature of the conductor,	 A h h ºC	TBDM	
For 300 mm^2: - Current, - Maximum admissible duration of the overload - Maximum admissible accumulated duration per year - Maximum temperature of the conductor,	 A h h ºC		
Maximum short-circuit current in the conductor, based on the maximum admissible temperature during normal operation, for a duration of: 1 second	kA	31.5	
Maximum resistance at 50 Hz at the maximum admissible temperature of the conductor during normal operation,	Ω/km	TBDM	
Maximum equivalent reactance per phase at 50 Hz,	Ω/km	TBDM	

FEATURES	UNIT	REQUIRED	OFFERED
Capacitance between the conductor and the screen,	µF/km	TBDM	
Capacitive load current per phase and km of cable under normal operating conditions (66/√3 kV),	A/km	TBDM	
Electrical dissipation factor (tg δ) measured at rated voltage U0		TBDM	
Cable wave impedance,	Ω	TBDM	
Screen grounding system	-	2 ends	
Maximum induced voltage in the screens during an external symmetrical three-phase short-circuit of 31.5 kA, V	V	TBDM	
Losses in the three phases at rated voltage and current, with the maximum service current and with the conductor at the maximum admissible temperature during normal operation.			
- In the conductors,	kW/km	TBDM	
- Dielectric,	kW/km	TBDM	
- In the screens,	kW/km	TBDM	
- Total,	kW/km	TBDM	
Diameters of the cables			
- Rated diameter of the conductor	mm	TBDM	
- Rated diameter on the insulation	mm	TBDM	
- Rated exterior diameter	mm	TBDM	
Minimum curvature radius of the cables		TBDM	
- During installation	mm		
- In the final installation,	mm		
Approximate weight of the cable,	kg/m	TBDM	
Dimensions and weights of the drums			
- Number of drums	-	TBDM	
- Diameter	m	TBDM	
- Approximate weight	kg	TBDM	
- Normal length of the cable per drum	m	TBDM	
Minimum installation temperature	ºC	TBDM	
Separation between identification marks	mm	TBDM	
External colour of the cable	-	Black	
Protection against longitudinal water penetration	-	Required	
Protection against radial water penetration	-	Required	
Maximum admissible tensile stress	N	TBDM	
Maximum admissible tangential stress	N	TBDM	
Maximum admissible strain	mm/m	TBDM	
Thermal strain,	mm/m ºC	TBDM	
Conductor			
Material	-	Copper	
Composition (no. of leads and diameter, mm)	-	TBDM	
Cladding of the leads	-	TBDM	
Class of conductor, in accordance with IEC 60228	-	Class 2	
Rated section, mm2			
- 240 mm^2	mm^2	240	
- 300 mm^2	mm^2	300	
Maximum resistance with direct current at 20º	Ω/km	TBDM	
Internal semi-conductive layer			
Material	-	TBDM	
Manufacturing process	-	TBDM	
Insulation			

FEATURES	UNIT	REQUIRED	OFFERED
Material	-	XLPE, low smoke zero halogen	
Nominal thickness	mm	TBDM	
Manufacturing process	-	TBDM	
Maximum dielectric stress calculated with the rated voltage (Uo) - On the internal semiconductive layer - On the external semiconductive layer	 kV/mm kV/mm	TBDM	
Maximum dielectric stress calculated with lightning impulse voltage: - On the internal semiconductive layer - On the external semiconductive layer	 kV/mm kV/mm	TBDM	
External semiconductive layer			
Material	-	TBDM	
Manufacturing process	-	TBDM	
Shield			
Material	-	TBDM	
Construction	-	TBDM	
Nominal thickness	mm	TBDM	
Section	mm^2	TBDM	
Exterior cover			
Material	-	PE, low smoke	
Nominal thickness	mm	TBDM	
Additives	-	TBDM	
Conductive layer on the cover	-	REQUIRED	
Type of sunlight protection in ends: - Sunlight /UV resistant - Mechanically shielded from sunlight	 	 REQUIRED REQUIRED	
Accessories Of the Cables			
General data			
Manufacturer	-	TBDM	
Installation	-	Outdoor	
Place of manufacture	-	TBDM	
Basic testing standard	-	IEC 60840	
Rated voltages (Uo/U/Um)	kV	36/66/72.5	
Test voltages: - Power frequency voltage test (30 min) - Test voltage at lightning impulse, peak	 kV kV	 90 325	
Rated peak withstand	kA	80	
Creepage distance	kV/mm	≥16	
Cable terminations			
Type of cable termination	-	Pre-moulded porcelain insulator type	
Model	-	TBDM	
Material of terminal or stud	-	Cooper	
Diameter of terminal or stud	-	30/50 IEC 60840	
Insulator - Applicable standard - Anti-Cantilever bending torque	 - N.m	 IEC 60168 TBDM	

FEATURES	UNIT	REQUIRED	OFFERED
Stress cone - Material - Type	 - -	 TBDM Pre-moulded	
Type of Insulation oil	-	TBDM	
Amount to the supplied - 240 mm^2 - 300 mm^2	 set set	 96 24	
Approximate weight	kg	TBDM	
Height	mm	TBDM	
Rated current	A	Not less than cable connected	
Short circuit current	kA/s	Not less than cable connected	
Connection Boxes and Screen Protection			
Manufacturer	-	TBDM	
Model	-	TBDM	
Material of the connection box	-	Stainless steel	
Plate of cable penetration	-	Dismantlable	
Protection class, as per IEC 60529	-	IP55	
DC withstand voltage	kV/min	20	
Impulse withstand voltage	kV	40	
Sheath voltage limiter (SVL)		Yes, TBDM	
Amount to the supplied	set	22	
Cleats (including intermediate restrain if applicable)			
Manufacturer	-	TBDM	
Model	-	TBDM	
Standard	-	IEC 61914	
Operating temperature	-	-25°C to +60°C	
Cable arrangement	-	In triplet	
Material	-	Stainless steel Low Smoke & Fume (LSF) Liners, Zero halogen (LSOH) and phosphorus free.	
Size of cables	mm	TBDM	
Peak short circuit current	kA	≥60	
Quantity (Sufficient for cable fixation on the supports)	set	TBDM	
Tests On Cables and Accessories (As Per IEC 60840)			
Routine tests			
Cable testing			
Partial discharges test		REQUIRED	
Insulation voltage test		REQUIRED	
Electrical test on over-sheath of the cable		REQUIRED	
Tests on accessories			
Appearance and relevant inspection		REQUIRED	
Partial discharges test		REQUIRED	
Insulation voltage test		REQUIRED	

FEATURES	UNIT	REQUIRED	OFFERED
Pressure test for insulator		REQUIRED	
Tests on cable samples			
Verification of the conductor		REQUIRED	
Measurement of the electrical resistance of the conductor and the metallic screen		REQUIRED	
Measurement of the thickness of the insulation and the over-sheath		REQUIRED	
Measurement of the thickness of the metallic sheath		REQUIRED	
Measurement of the diameters on the insulation and on the exterior of the cable		REQUIRED	
Hot set test for XLPE insulation		REQUIRED	
Measurement of the capacitance		REQUIRED	
Water penetration test		REQUIRED	
Test on components of cables with a longitudinally applied metal foil (if applicable)		REQUIRED	
Type tests			
Certificates of the type tests on the cables with their accessories		CERTIFICATE	
Bending test		CERTIFICATE	
Partial discharge test after bending test		CERTIFICATE	
Tan δ measurement		CERTIFICATE	
Heating cycle voltage test		CERTIFICATE	
Lightning impulse voltage test followed by power frequency voltage test		CERTIFICATE	
Partial discharge test after lightning impulse voltage test		CERTIFICATE	
Examination		CERTIFICATE	
Resistivity of semi-conducting screens		CERTIFICATE	
Check of cable construction		CERTIFICATE	
Mechanical properties of insulation before and after ageing		CERTIFICATE	
Mechanical properties of overseaths before and after ageing		CERTIFICATE	
Ageing tests on pieces of complete cable		CERTIFICATE	
Pressure test at high temperature on overseaths		CERTIFICATE	
Hot set test for XLPE insulation		CERTIFICATE	
Water penetration test		CERTIFICATE	
Shrinkage test for XLPE insulation		CERTIFICATE	
Flammability type tests			
Flame retardance test for finished cable as per NF C32.070 (classified C1) and IEC 60332-1		CERTIFICATE	
Burning smoke density test for finished cable as per IEC 61034		CERTIFICATE	
Burning corrosion test for finished cable as per IEC 60754-2		CERTIFICATE	
Halogen generation by outer sheath under fire as per EN 50267-2-2		CERTIFICATE	
Electrical tests after the installation			
DC voltage test of the over-sheath		REQUIRED	
AC voltage test of the insulation		REQUIRED	

16.1.8 22kV Cable and Accessories Datasheet

FEATURES	UNIT	REQUIRED	OFFERED
Cables			
General data			
Manufacturer	-	TBDM	
Place of manufacture	-	TBDM	
Basic testing standard	-	IEC 60502-2	
Manufacturer reference	-	TBDM	
Rated section	mm^2 mm^2	150 240	
Number of conductors per phase - 150 mm^2 - 240 mm^2	 - -	 1 1	
Total length of the cables to be supplied, m - 150 mm^2 - 240 mm^2		 4950 3900	
Rated frequency of the 22 kV system	Hz	50	
Rated voltages of cables (Uo/U/Um)	kV	12/20/24	
Test voltages: - Power frequency voltage test (5 min) - Test voltage at lightning impulse peak	 kV kV	 42 125	
Maximum admissible temperature in the conductor under normal operation	ºC	90	
Maximum admissible temperature in the conductor under short-circuit operation (maximum duration 5 seconds)	ºC	250	
Ampacity of the copper conductors three single-core cable, with XLPE insulation, based on 35ºC ambient air temperature. Cables in air, with trefoil formation and sheath bonded at two ends and 90ºC: - 150 mm^2 - 240 mm^2	 A A	 465 630	
Emergency operating conditions with an overload of 10% over the maximum admissible current during continuous operation and with an initial conductor temperature of 90ºC and in the worst installation conditions: For 150 mm^2: - Current, - Maximum admissible duration of the overload, - Maximum admissible accumulated duration per year, - Maximum temperature of the conductor For 240 mm^2: - Current - Maximum admissible duration of the overload - Maximum admissible accumulated duration per year	 A h h ºC A h h	 TBDM TBDM TBDM TBDM TBDM TBDM TBDM	
Maximum short-circuit current in the conductor, based on the maximum admissible temperature during normal operation, for a duration of: 1 second	kA	40	
Maximum resistance at 50 Hz at the maximum admissible temperature of the conductor during normal operation	Ω/km	TBDM	
Maximum equivalent reactance per phase at 50 Hz,	Ω/km	TBDM	

FEATURES	UNIT	REQUIRED	OFFERED
Capacitance between the conductor and the screen	µF/km	TBDM	
Capacitive load current per phase and km of cable under normal operating conditions (22/√3 kV),	A/km	TBDM	
Electrical dissipation factor (tg δ) measured at rated voltage Uo	-	TBDM	
Cable wave impedance,	Ω	TBDM	
Screen grounding system	-	2 ends	
Maximum induced voltage in the screens during an external symmetrical three-phase short-circuit of 40 kA	V	TBDM	
Losses in the three phases at rated voltage and current, with the maximum service current and with the conductor at the maximum admissible temperature during normal operation.			
- In the conductors,	kW/km	TBDM	
- Dielectric,	kW/km	TBDM	
- In the screens,	kW/km	TBDM	
- Total	kW/km	TBDM	
Diameters of the cables			
- Rated diameter of the conductor	mm	TBDM	
- Rated diameter on the insulation	mm	TBDM	
- Rated exterior diameter	mm	TBDM	
Minimum curvature radius of the cables			
- During installation	mm	TBDM	
- In the final installation	mm	TBDM	
Approximate weight of the cable	kg/m	TBDM	
Dimensions and weights of the drums			
- Number of drums	-	TBDM	
- Diameter	m	TBDM	
- Approximate weight	kg	TBDM	
- Normal length of the cable per drum	m	TBDM	
Minimum installation temperature	ºC	TBDM	
Separation between identification marks	mm	TBDM	
External colour of the cable	-	Black	
Protection against longitudinal water penetration	-	Required	
Protection against radial water penetration	-	Required	
Maximum admissible tensile stress	N	TBDM	
Maximum admissible tangential stress	N	TBDM	
Maximum admissible strain	mm/m	TBDM	
Thermal strain	mm/m ºC	TBDM	
Conductor			
Material	-	Copper	
Composition (no. of leads and diameter, mm)	-	TBDM	
Cladding of the leads	-	TBDM	
Class of conductor, in accordance with IEC 60228	-	Class 2	
Rated section,			
- 150 mm^2	mm^2	Required	
- 240 mm^2	mm^2	Required	
Maximum resistance with direct current at 20ºC	Ω/km	TBDM	
Internal semi-conductive layer			
Material	-	TBDM	

FEATURES	UNIT	REQUIRED	OFFERED
Manufacturing process	-	TBDM	
Insulation			
Material	-	XLPE, , low smoke zero halogen	
Nominal thickness	mm	TBDM	
Manufacturing process	-	TBDM	
Maximum dielectric stress calculated with the rated voltage (Uo) - On the internal semiconductive layer - On the external semiconductive layer	 kV/mm kV/mm	 TBDM TBDM	
Maximum dielectric stress calculated with lightning impulse voltage: - On the internal semiconductive layer - On the external semiconductive layer	 kV/mm kV/mm	 TBDM TBDM	
External semiconductive layer			
Material	-	TBDM	
Manufacturing process	-	TBDM	
Shield			
Material	-	TBDM	
Construction	-	TBDM	
Nominal thickness,	mm	TBDM	
Section,	mm^2	TBDM	
Exterior cover			
Material		PE, low smoke	
Nominal thickness,	mm	TBDM	
Additives	-	TBDM	
Conductive layer on the cover	-	REQUIRED	
Type of sunlight protection in ends: - Sunlight/ UV resistant - Mechanically shielded from sunlight	 	 REQUIRED REQUIRED	
22kV Accessories of the cables			
General data			
Manufacturer	-	TBDM	
Place of manufacture	-	TBDM	
Basic testing standard		IEC 60502-4	
Rated voltages (Uo/U/Um)	kV	12/20/24	
Test voltages: - Power frequency voltage test, (1 min / 5min) - Test voltage at lightning impulse, peak	 kV kV	 48 / 54 125	
Rated peak withstand	kA	100	
Creepage distance	kV/mm	≥16	
Cable terminations for the 22 kV GIS switchgear (Siemens 8DA10)			
Manufacturing standard	-	IEC 60502	
Model	-	TBDM	
Size	-	3	
Amount to the supplied - 150 mm^2 - 240 mm^2	 - -	 36 6	
Approximate weight	kg	TBDM	

FEATURES	UNIT	REQUIRED	OFFERED
Height	mm	TBDM	
Rated current	A	Not less than cableconnected	
Cable terminations for the 22 kV consumer side (Schneider PIX24)			
Manufacturing standard	-	IEC 60502	
Model - 150mm2 (NKT Cables) - Others	 - -	 NKT TI24 TBDM	
Amount to the supplied B15-L1-L03-North: - 150 mm^2 (NKT Cables) - 240 mm2 B20: - 150 mm^2 (NKT Cables) - 150 mm^2		 24 6 3 9	
Approximate weight	kg	TBDM	
Height	mm	TBDM	
Rated current	A	Not less than cable connected	
Cleats (including intermediate restrain if applicable)			
Manufacturer	-	TBDM	
Model	-	TBDM	
Standard	-	IEC 61914	
Operating temperature	-	-25°C to +60°C	
Cable arrangement	-	In triplet	
Material	-	Stainless steel Low Smoke & Fume (LSF) Liners, Zero halogen (LSOH) and phosphorus free.	
Size of cables	mm	TBDM	
Peak short circuit current	kA	≥86	
Quantity (Sufficient for cable fixation on the supports)	set	TBDM	
Tests on cables and accessories (as per IEC 60502-2)			
Routine tests			
Cable testing			
Measurement of the electrical resistance of conductors	REQUIRED		
Partial discharges test	REQUIRED		
Voltage test	REQUIRED		
Tests on accessories			
Verification of dimensions	REQUIRED		
Partial discharges test	REQUIRED		
Insulation voltage test	REQUIRED		
Tests on cable samples			
Verification of the conductor	REQUIRED		
Measurement of the electrical resistance of the conductor and the metallic screen			

FEATURES	UNIT	REQUIRED	OFFERED
Measurement of the thickness of the insulation and the oversheath	REQUIRED		
Measurement of the thickness of sheath.	REQUIRED		
Measurement of the diameters on the insulation and on the exterior of the cable	REQUIRED		
Hot set test for XLPE insulation	REQUIRED		
Voltage test	REQUIRED		
Measurement of the capacitance	REQUIRED		
Water penetration test	REQUIRED		
Type tests			
Certificates of the type tests on the cables with their accessories	CERTIFICATE		
Flammability type tests			
Flammability test as per NF C32.070 (classified C1) and IEC 60332-1	CERTIFICATE		
Smoke generation by sheath under fire as per IEC 61034	CERTIFICATE		
Halogen generation by outer sheath under fire as per EN 50267-2-2	CERTIFICATE		
Corrosivity test as per IEC 60754-2	CERTIFICATE		
Electrical tests after the installation			
DC voltage test of the oversheath	REQUIRED		
AC voltage test of the insulation	REQUIRED		

16.1.9 LV, Control cables and OHL conductor Datasheet

CHARACTERISTICS	UNIT	REQUIRED	OFFERED
Power Cables (Repeat for each composition)			
Manufacturer	-	TBDM	
Manufacturing and testing standards	-	See Section 8.4.2	
Outer diameter	mm	TBDM	
Conductor: - Material - Section - Resistance to 20ºC	 - mm^2 Ω/m	 Cu See Appendix 16.6 TBDM	
Insulation - Material - Thickness	 - mm	 XLPE TBDM	
Routine and type tests as per IEC	-	See Section 8.4.4	
Control Cables (Repeat for each composition)			
Manufacturer	-	TBDM	
Manufacturing and testing standards	-	See Section 8.4.2	
Outer diameter	mm	TBDM	
Conductor Material Section Resistance to 20ºC	- - mm^2 Ω/m	 Cu See Appendix 16.6 TBDM	
Insulation Material Thickness	 - mm	 XLPE TBDM	
Shield Material Thickness	 - mm	 TBDM TBDM	
Routine and type tests as per IEC		See Section 8.4.4	
OHL Conductor			
Manufacturer	-	TBD	
Manufacturing and testing standards	-	IEC 61089	
Outer diameter	mm	31.05	
Section	mm^2	570.22	
Almelec Conductor	-	ASTER 570	
Designation	-	570-AL4	
Weight	kg/m	1.574	
Current (at 30ºC ambient and conductor temperature of 85ºC)	A	1237	
Num. of strands	-	61	
Diameter of single wire	mm	3.45	
Nominal tensile force	kN	185.33	
DC resistance	Ω/km	0.0585	
Elastic coefficient	N/mm^2	54000	
Expansion coefficient	/K	2.3E-5	
Routine and type tests as per IEC	-	IEC 61089	
Service life	years	30	
OHL Tubular Conductor (installed in A35 at PPEN 66kV Stage 1, for reference only)			
Manufacturer	-	Hubei Xinghe Electric New Material Co., Ltd	
Manufacturing and testing standards	-	EN 515, EN 573	
Outside/inside diameter Φ	mm	100/90	

CHARACTERISTICS	UNIT	REQUIRED	OFFERED
Section	mm2	1492	
Material	-	Aluminium Alloy tubular conductor	
Type of alloy	-	Mg-Al-Si alloy series (6063G)	
State of alloy	-	T6	
Density of alloy	g/cm^3	2.69~2.73	
Thermal conductivity coefficient	W/(m*K)	209	
Temperature coefficient of linear expansion	/℃	23.4×10^{-6}	
Minimum conductivity	S/m	55	
Aluminum busbar resistivity at 20℃	Ω.m	0.03	
Temperature coefficient of resistance	/℃	4.1×10^{-3}	
Minimum ultimate strength σb	N/mm^2	215	
Minimum yield strength σ0.2	N/mm^2	170	
Minimum elongation rate δ	%	8	
Elasticity modules	N/mm^2	6.9×10^4	
Permissible highest heating temperature	℃	150~200	
Permissible tolerance of outer diameter	mm	-0.7	
Permissible tolerance of thickness	mm	±0.7	
Conductor surface requirements	-	Cationic oxidation treatment	
Thickness tolerance	mm	0.5	
Weight	kg/m	4.03	
Current carrying capacity(at 30ºC ambient and tubular conductor temperature of 85ºC)	A	3123	
Rated short time withstand current (r.m.s)	kA/s	50/1	
Rated dynamic current (Peak)	kA	125	
Service life	years	30	

16.1.10 Metallic Structure Datasheet

FEATURES	REQUIRED	OFFERED
General Requirement		
Steel type:	S355JR	
Testing and manufacturing standards	NF EN 10025	
Chemical Composition (Product Analysis)		
Deoxidized steel type	Rimmed steel not allowed	
Carbon content	≤0.27%	
Silicon content	≤0.60%	
Manganese content	≤1.70%	
Phosphorus content	≤0.045%	
Sulfur content	≤0.045%	
Nitrogen content	≤0.014%	
Copper content	≤0.60%	
Tensile Test		
Minimum Yield strength ReH. Nominal thickness of the product，e≤16mm	355Mpa	
Minimum Yield strength ReH. Nominal thickness of the product，16<e≤40mm	345 Mpa	
Minimum Yield strength ReH. Nominal thickness of the product，40<e≤63mm	335Mpa	
Minimum Yield strength ReH.	325Mpa	

FEATURES	REQUIRED	OFFERED
Nominal thickness of the product，63<e≤80mm		
Minimum Yield strength ReH. Nominal thickness of the product，80<e≤100mm	315Mpa	
Minimum Yield strength ReH. Nominal thickness of the product，100<e≤150mm	295Mpa	
Minimum Yield strength ReH. Nominal thickness of the product，150<e≤200mm	285Mpa	
Minimum Yield strength ReH. Nominal thickness of the product，200<e≤250mm	275Mpa	
Tensile strength Rm. Nominal thickness of the product，e<3mm	510-680 Mpa	
Tensile strength Rm. Nominal thickness of the product，3<e≤100mm	470-630 Mpa	
Tensile strength Rm. Nominal thickness of the product，100<e≤150mm	450-600 Mpa	
Tensile strength Rm. Nominal thickness of the product，150<e≤250mm	450-600 Mpa	
% Min. Elongation after fracture. L0= 80 mm, nominal thickness, e<1mm	14%	
% Min. Elongation after fracture. L0= 80 mm, nominal thickness, 1<e≤1.5mm	15%	
% Min. Elongation after fracture. L0= 80 mm, nominal thickness, 1.5<e≤2mm	16%	
% Min. Elongation after fracture. L0= 80 mm, nominal thickness, 2<e≤2.5mm	17%	
% Min. Elongation after fracture. L0= 80 mm, nominal thickness, 2.5<e≤3mm	18%	
% Min. Elongation after fracture. L0=5.65√S0mm，nominal thickness, 3<e≤40mm	22%	
% Min. Elongation after fracture. L0=5.65√S0mm，nominal thickness, 40<e≤63mm	21%	
% Min. Elongation after fracture. L0=5.65√S0mm，nominal thickness, 63<e≤100mm	20%	
% Min. Elongation after fracture. L0=5.65√S0mm，nominal thickness, 100<e≤150mm	18%	
% Min. Elongation after fracture. L0=5.65√S0mm，nominal thickness, 150<e≤250mm	17%	
Impact Test		
% Min. Impact energy value (J), nominal thickness of the product, e≤150mm. Temperature 20°C	27%	
% Min. Impact energy value (J), nominal thickness of the product 150<e≤250mm. Temperature 20°C	27%	

16.2 Identification and Bill of Material

In this section, the identifications of main components are listed.
Unless specified in the lists, spare components are not listed. The Contractor or the manufacturers shall provide the necessary spare parts for the installation, commission and test.
The special tools, if any, shall be provided by the Supplier.

16.2.1 66kV Disconnector Switch and Earthing Switch

Bay	Circuit	Disconnector Switch combined with Single Erathing Switch (3-phases) 72.5kV, 31.5kA/1s		The Mechanisms				Metallic structure for HV Disconnector switch and earthing switch
		TTT code	Quantity (set)	DS/ES	Designation	TTT code	Quantity (set)	Quantity (set)
66kV Bay #1	Feeder-03	41PPAF-JU-1103	1	DS	Disconnector	41PPAF-BJ-1103	1	1
				ES	Earthing switch	41PPAF-BJ-1133	1	
	Feeder-05	41PPAF-JU-1105	1	DS	Disconnector	41PPAF-BJ-1105	1	1
				ES	Earthing switch	41PPAF-BJ-1135	1	
	Feeder-07	41PPAF-JU-1107	1	DS	Disconnector	41PPAF-BJ-1107	1	1
				ES	Earthing switch	41PPAF-BJ-1137	1	
	Feeder-09	41PPAF-JU-1109	1	DS	Disconnector	41PPAF-BJ-1109	1	1
				ES	Earthing switch	41PPAF-BJ-1139	1	
66kV Bay #2	Feeder-02	41PPAF-JU-2102	1	DS	Disconnector	41PPAF-BJ-2102	1	1
				ES	Earthing switch	41PPAF-BJ-2132	1	
	Feeder-03	41PPAF-JU-2103	1	DS	Disconnector	41PPAF-BJ-2103	1	1
				ES	Earthing switch	41PPAF-BJ-2133	1	
66kV Bay #3	Feeder-05	41PPAF-JU-3105	1	DS	Disconnector	41PPAF-BJ-3105	1	1
				ES	Earthing switch	41PPAF-BJ-3135	1	
	Feeder-07	41PPAF-JU-3107	1	DS	Disconnector	41PPAF-BJ-3107	1	1
				ES	Earthing switch	41PPAF-BJ-3137	1	
	Feeder-09	41PPAF-JU-3109	1	DS	Disconnector	41PPAF-BJ-3109	1	1
				ES	Earthing switch	41PPAF-BJ-3139	1	
	Feeder-11	41PPAF-JU-3111	1	DS	Disconnector	41PPAF-BJ-3111	1	1
				ES	Earthing switch	41PPAF-BJ-3141	1	
In total			**10**				**20 sets**	**10 sets**

16.2.2 66kV Circuit Breaker

Bay	Circuit	66kV Circuit breaker(3-phases) 72.5kV, 31.5kA/1s		The Mechanisms		Metallic structure for HV Circuit Breakers
		TTT code	Quantity (set)	TTT code	Quantity (set)	Quantity (set)
66kV Bay #1	Feeder-03	41PPAF-JA-1103	1	41PPAF-BJ-1003	1	1
	Feeder-05	41PPAF-JA-1105	1	41PPAF-BJ-1005	1	1
	Feeder-07	41PPAF-JA-1107	1	41PPAF-BJ-1007	1	1
	Feeder-09	41PPAF-JA-1109	1	41PPAF-BJ-1009	1	1
66kV Bay #2	Feeder-02	41PPAF-JA-2102	1	41PPAF-BJ-2002	1	1
	Feeder-03	41PPAF-JA-2103	1	41PPAF-BJ-2003	1	1
66kV Bay #3	Feeder-05	41PPAF-JA-3105	1	41PPAF-BJ-3005	1	1
	Feeder-07	41PPAF-JA-3107	1	41PPAF-BJ-3007	1	1
	Feeder-09	41PPAF-JA-3109	1	41PPAF-BJ-3009	1	1
	Feeder-11	41PPAF-JA-3111	1	41PPAF-BJ-3011	1	1
Spare		41PPAF-JA-	1	41PPAF-BJ-	1	
In total			11		11	10

16.2.3 66kV Earthing Switch

Bay	Circuit	Earthing Switch(3-phases) 72.5kV, 31.5kA/1s		The Mechanisms		Metallic structure for HV Earthing Switch
		TTT code	Quantity (set)	Quantity (set)	Quantity (set)	Quantity (set)
66kV Bay #1	Feeder-03	41PPAF-JT-1003	1	41PPAF-BJ-1023	1	1
	Feeder-05	41PPAF-JT-1005	1	41PPAF-BJ-1025	1	1
	Feeder-07	41PPAF-JT-1007	1	41PPAF-BJ-1027	1	1
	Feeder-09	41PPAF-JT-1009	1	41PPAF-BJ-1029	1	1
66kV Bay #2	Feeder-02	41PPAF-JT-2002	1	41PPAF-BJ-2022	1	1
	Feeder-03	41PPAF-JT-2003	1	41PPAF-BJ-2023	1	1
66kV Bay #3	Feeder-05	41PPAF-JT-3005	1	41PPAF-BJ-3025	1	1
	Feeder-07	41PPAF-JT-3007	1	41PPAF-BJ-3027	1	1
	Feeder-09	41PPAF-JT-3009	1	41PPAF-BJ-3029	1	1
	Feeder-11	41PPAF-JT-3011	1	41PPAF-BJ-3031	1	1
In total			10		10	

16.2.4 66kV Current Transformer

Bay	Circuit	Current transformer 72.5kV, 31.5kA/1s		CT Marshalling box		Metallic structure for 66kV Earthing Switch
		TTT code	Quantity (pcs)	TTT code	Quantity (pcs)	Quantity(set)
66kV Bay #1	Feeder-03	41PPAF-TC-1103	3	41PPAF-BJ-1403	1	1
	Feeder-05	41PPAF-TC-1105	3	41PPAF-BJ-1405	1	1
	Feeder-07	41PPAF-TC-1107	3	41PPAF-BJ-1407	1	1
	Feeder-09	41PPAF-TC-1109	3	41PPAF-BJ-1409	1	1
66kV Bay #2	Feeder-02	41PPAF-TC-2102	3	41PPAF-BJ-2402	1	1
	Feeder-03	41PPAF-TC-2103	3	41PPAF-BJ-2403	1	1
66kV Bay #3	Feeder-05	41PPAF-TC-3105	3	41PPAF-BJ-3025	1	1
	Feeder-07	41PPAF-TC-3107	3	41PPAF-BJ-3027	1	1
	Feeder-09	41PPAF-TC-3109	3	41PPAF-BJ-3029	1	1
	Feeder-11	41PPAF-TC-3111	3	41PPAF-BJ-3031	1	1
Spare		41PPAF-TC-	3	-	-	
In total			33		10	10

16.2.5 LV Distribution Panel(BP)

Bay	Circuit	Marshalling box	
		TTT code	Quantity (pcs)
66kV Bay #1	Feeder-03	41PPAF-BP-1003	1
	Feeder-05	41PPAF-BP-1005	1
	Feeder-07	41PPAF-BP-1007	1
	Feeder-09	41PPAF-BP-1009	1
66kV Bay #2	Feeder-02	41PPAF-BP-2002	1
	Feeder-03	41PPAF-BP-2003	1
66kV Bay #3	Feeder-05	41PPAF-BP-3005	1
	Feeder-07	41PPAF-BP-3007	1
	Feeder-09	41PPAF-BP-3009	1
	Feeder-11	41PPAF-BP-3011	1
In total			10

16.2.6 Protection and Control Cubicle

Bay	Circuit	Pr&C Cubicle		IED /Ethernet Switch/PLC		
		TTT code	Qty.	Description	Qty. (set)	TTT code
66kV Bay #1	Feeder-03/Feeder-05	41PPCM-CU-1004	1	-Feeder IEC 61850 protection and control IED	2	41PPCM-BR-1003 41PPCM-BR-1005
				-Compatible Ethernet Switch for IEC 61850 network	1	41PPCM-SWT-1002
				Cubicle monitoring PLC	1	41PPCM-CPU-1004
	Feeder-07/ Feeder-09	41PPCM-CU-1005	1	-Feeder IEC 61850 protection and control IED	2	41PPCM-BR-1007 41PPCM-BR-1009
66kV Bay #2	Feeder-02/ Feeder-03	41PPCM-CU-2005	1	-Feeder IEC 61850 protection and control IED	2	41PPCM-BR-2002 41PPCM-BR-2003
				- Compatible Ethernet Switch for IEC 61850 network	1	41PPCM-SWT-2002
66kV Bay #3	Feeder-05 /Feeder-07	41PPAF-CU-3004	1	-Feeder IEC 61850 protection and control IED	2	41PPCM-BR-3005 41PPCM-BR-3007
				- Compatible Ethernet Switch for IEC 61850 network	1	41PPCM-SWT-3002
	Feeder-09/ Feeder-11	41PPAF-CU-3005	1	-Feeder IEC 61850 protection and control IED	2	41PPCM-BR-3009 41PPCM-BR-3011
Spare				-Feeder IEC 61850 protection and control IED	2	
In total			5		IED: 12 sets Ethernet Switch: 3 sets PLC: 1 set	
Common						
Fiber Optic cable or patch cords	Multimode			50/125 µm, 3.0/1.0 dB/km, 2x100 Base FX, L=2m	6	
				50/125 µm, 3.0/1.0 dB/km, 2x100Base FX, L=10m	4	
	Monomode			9/125 µm, 3.50 / 1.00 dB/km, 2x1000base LX, L=15m	6	
Ethernet CAT.5e				L=10m	1	

16.2.7 66kV cable and Accessories

66 kV Consumer	Rated Power(MVA)	From	To	Cable TTT code	Num. of Cables and Section (mm^2)	Cable Length Estimated(m)	Num. of Cable Terminations	Num. of cable Cleat
CS1-U Converter 2	63.02	41PPAF-JA-1003	41C1CU-JU-1302	41PPAF-CAP-0079 41PPAF-CAP-0082	3 x (1x240) 3 x (1x240)	660 660	6 6	As needed
CS1-L Converter 2	63.02	41PPAF-JA-1005	41C1CL-JU-1102	41PPAF-CAP-0097 41PPAF-CAP-0100	3 x (1x240) 3 x (1x240)	665 665	6 6	As needed
CS3-U Converter 2	63.02	41PPAF-JA-1007	41C3CU-JU-1102	41PPAF-CAP-0109 41PPAF-CAP-0112	3 x (1x240) 3 x (1x240)	550 550	6 6	As needed
CS3-L Converter 2	63.02	41PPAF-JA-1009	41C3CL-JU-1102	41PPAF-CAP-0121 41PPAF-CAP-0124	3 x (1x240) 3 x (1x240)	690 690	6 6	As needed
VS3/5 Converter	63.02	41PPAF-JA-2002	41V1VC-JU-0005 41V1VC-JU-0011	41PPAF-CAP-0060 41PPAF-CAP-0063	3 x (1x240) 3 x (1x240)	460 420	6 6	As needed
VS4/6 Converter	63.02	41PPAF-JA-2003	41V1VC-JU-0013 41V1VC-JU-0015	41PPAF-CAP-0066 41PPAF-CAP-0093	3 x (1x240) 3 x (1x240)	610 565	6 6	As needed
CS2-U Converter 2	63.02	41PPAF-JA-3005	41C2CU-JU-1102	41PPAF-CAP-0264 41PPAF-CAP-0267	3 x (1x240) 3 x (1x240)	510 510	6 6	As needed
CS2-L Converter 2	63.02	41PPAF-JA-3007	41C2CL-JU-1102	41PPAF-CAP-0276 41PPAF-CAP-0279	3 x (1x240) 3 x (1x240)	500 500	6 6	As needed
PF1 Converter 2	77.96	41PPAF-JA-3009	41P1CU-JU-1102	41PPAF-CAP-0288 41PPAF-CAP-0291	3 x (1x300) 3 x (1x300)	570 570	6 6	As needed
PF6 Converter 2	77.96	41PPAF-JA-3011	41P6CU-JU-1102	41PPAF-CAP-0300 41PPAF-CAP-0303	3 x (1x300) 3 x (1x300)	610 610	6 6	As needed

	Cable Length Estimated (m)	Num. of Cable Terminations		Cable connection box for screen earthing		Cable Cleat
		66 kV AIS side	66 kV consumers side	Without SVL (66kV AIS side)	With SVL (66kV consumers side)	
Single-core cable 240 mm^2	**9,215**	48	48	8	10	As needed
Single-core cable 300 mm^2	**2,360**	12	12	2	2	As needed
Sub-total	**11,575**	**120**		**10**	**12**	

16.2.8 22kV Cable and Accessories

22 kV Consumer	Rated Power (MVA)	From	To	Cable TTT code	Num. of Cables and Section(mm²)	Cable Length Estimated(m)	Num. of Cable Terminations		Cable Cleat
							GIS (Size 3)	Consumer	
IC H&CD-1	6.77	41PPAJ-CU-1004	51HVSW-CU-0100	41PPAJ-CAP-7045	3 x (1x150)	3x550	3	3	As needed
IC H&CD-2	6.77	41PPAJ-CU-2007	51HVSW-CU-0200	41PPAJ-CAP-7003	3 x (1x150)	3x550	3	3	As needed
IC H&CD-3	6.77	41PPAJ-CU-3011	51HVSW-CU-0300	41PPAJ-CAP-7006	3 x (1x150)	3x550	3	3	As needed
IC H&CD-4	6.77	41PPAJ-CU-1008	51HVSW-CU-0400	41PPAJ-CAP-1231[5]	3 x (1x150)	3x70[5]	3	3[7]	As needed
EC H&CD-7	14.13	41PPAJ-CU-1006	52HVSG-CU-1101	41PPAJ-CAP-0011[6] 41PPAJ-CAP-0175[6]	3 x (1x150) 3 x (1x150)	0 0	3 3	3[7] 3[7]	As needed
EC H&CD-8	14.13	41PPAJ-CU-1007	52HVSG-CU-2101	41PPAJ-CAP-0025[6] 41PPAJ-CAP-0178[6]	3 x (1x150) 3 x (1x150)	0 0	3 3	3[7] 3[7]	As needed
EC H&CD-9	14.13	41PPAJ-CU-2004	52HVSG-CU-3101	41PPAJ-CAP-0042[6] 41PPAJ-CAP-0100[6]	3 x (1x150) 3 x (1x150)	0 0	3 3	3[7] 3[7]	As needed
EC H&CD-10	14.13	41PPAJ-CU-2005	52HVSG-CU-4101	41PPAJ-CAP-7000	3 x (1x240)	3x650	3	3	As needed
EC H&CD-11	14.13	41PPAJ-CU-2006	52HVSG-CU-5101	41PPAJ-CAP-0103[6] 41PPAJ-CAP-0106[6]	3 x (1x150) 3 x (1x150)	0 0	3 3	3[7] 3[7]	As needed
EC H&CD-12	14.13	41PPAJ-CU-3012	52HVSG-CU-6101	41PPAJ-CAP-7009	3 x (1x240)	3x650	3	3	As needed

Cable to be supplied	Cable Length Estimated (m)	Num. of Cable Terminations to be supplied		Cable Cleat
		GIS side (Inside-cone plug-in Size 3)	22 kV consumers side AIS	
Single-core cable 240 mm²	3900	6	6	As needed
Single-core cable 150 mm²	4950	36	NKT cables: 27 (TI24 Recommended) New cables: 9 set	As needed
Sub-total	**8850**	**42**	**42**	

[5] 41PPAJ-CAP-1231 have been laid up to building 15-L1-03 North. This triplet cables have to be shorten and rerouted to B20. 210m is the estimated length to be routed from cable gallery to ICH 22kV cubicle (51HVSW-CU-0400) located inside B20.

[6] 41PPAJ-CAP-0011, 0175, 0025, 0178, 0042, 0100, 0103, 0106 had been laid to B15-L1-03 North. The 22kV cables at 22kV GIS room need to be redirected as per [RD4] and cable termination need to be redone at 22kV GIS side, and new indoor terminations needs to be done for the AIS switchgears-Schneider Electric PIX24.

[7] These cables are manufactured by NKT cable. The indoor termination -TI24 fabricated by the same manufacturer-NKT is recommended.

16.2.9 Interface I&C cables[8] with MCPC stage 2 (ON HOLD)

As specified in Section 7.1.5, the Supplier of MCPC Stage 2 will provide final technical requirements on the interface signals after its FDR.
A preliminary list underneath is provided for tender purpose ONLY. The Contractor shall verify the cable size and update these I&C interface accordingly before placing the purchase order for these I&C cables. For the preliminary BOM of I&C cable, please refer to Appendix 16.6.

Functional Reference	Segregation Code	Part Number	From Component	From Component Description	From Location	To Component	To Component Description	To Location
41C2CU-CAS-0212	NS	MS0514LN	41PP00-BD-0001	Distribution Board	32-L1-01	41C2CL-CU-1201	CS2L-2 Converter: Conventional Cubicle	32-L1-01
41C2CU-CAS-0211	NS	MS0514LN	41PP00-BD-0001	Distribution Board	32-L1-01	41C2CU-CU-1201	CS2U-2 Converter: Conventional Cubicle	32-L1-01
41C1CL-CAS-0222	NS	MS0514LN	41PP00-BD-0001	Distribution Board	32-L1-01	41C1CL-CU-1201	CS1L-2 Converter: Conventional Cubicle	32-L1-01
41C1CU-CAS-0142	NS	MS0514LN	41PP00-BD-0001	Distribution Board	32-L1-01	41C1CU-CU-1201	CS1U-2 Converter: Conventional Cubicle	32-L1-01
41C3CU-CAS-0209	NS	MS0514LN	41PP00-BD-0001	Distribution Board	32-L1-01	41C3CU-CU-1201	CS3U-2 Converter: Conventional Cubicle	32-L1-01
41P6CU-CAS-0008	NS	MS0514LN	41PP00-BD-0002	Distribution Board	32-L1-01	41P6CU-CU-1203	PF6-2 Converter: Conventional Cubicle	32-L1-01
41C3CL-CAS-0209	NS	MS0514LN	41PP00-BD-0002	Distribution Board	32-L1-01	41C3CL-CU-1201	CS3L-2 Converter: Conventional Cubicle	32-L1-01
41P1CU-CAS-0007	NS	MS0514LN	41PP00-BD-0002	Distribution Board	32-L1-01	41P1CU-CU-1203	PF1-2 Converter: Conventional Cubicle	32-L1-01
41V1VC-CAS-0301	NS	MS0514LN	41PP00-BD-0003	Distribution Board	33-L1-01	41V1VC-CU-1301	VS1-3 Converter: Conventional Cubicle	33-L1-01
41V1VC-CAS-0300	NS	MS0514LN	41PP00-BD-0003	Distribution Board	33-L1-01	41V1VC-CU-1501	VS1-5 Converter: Conventional Cubicle	33-L1-01
41V1VC-CAS-0299	NS	MS0514LN	41PP00-BD-0004	Distribution Board	33-L1-01	41V1VC-CU-1401	VS1-4 Converter: Conventional Cubicle	33-L1-01
41V1VC-CAS-0298	NS	MS0514LN	41PP00-BD-0004	Distribution Board	33-L1-01	41V1VC-CU-1601	VS1-6 Converter: Conventional Cubicle	33-L1-01

[8] This cable list is a preliminary list. HOP will be provided after FDR, including the routing report.

Technical Specifications

Functional Reference	Segregation Code	Part Number	From Component	From Component Description	From Location	To Component	To Component Description	To Location
41PPCM-CAS-0105	NS	MS0412LN	41PPCM-CU-3005	66 kV Feeder Protection Cubicle	35-HV2-02	41PP00-BD-0002	Distribution Board	32-L1-01
41PPCM-CAS-0074	NS	MS0412LN	41PPCM-CU-1004	66 kV Feeder Protection Cubicle	35-HV2-02	41PP00-BD-0001	Distribution Board	32-L1-01
41PPCM-CAS-0075	NS	MS0412LN	41PPCM-CU-1005	66 kV Feeder Protection Cubicle	35-HV2-02	41PP00-BD-0001	Distribution Board	32-L1-01
41PPCM-CAS-0103	NS	MS0412LN	41PPCM-CU-3004	66 kV Feeder Protection Cubicle	35-HV2-02	41PP00-BD-0001	Distribution Board	32-L1-01
41PPCM-CAS-0097	NS	MS0412LN	41PPCM-CU-2005	66 kV Feeder Protection Cubicle	35-HV2-02	41PP00-BD-0004	Distribution Board	33-L1-01
41PPCM-CAS-0080	NS	MS0412LN	41PPCM-CU-1005	66 kV Feeder Protection Cubicle	35-HV2-02	41PP00-BD-0002	Distribution Board	32-L1-01
41PPCM-CAS-0106	NS	MS0412LN	41PPCM-CU-3005	66 kV Feeder Protection Cubicle	35-HV2-02	41PP00-BD-0002	Distribution Board	32-L1-01
41PPCM-CAS-0071	NS	MS0412LN	41PPCM-CU-1004	66 kV Feeder Protection Cubicle	35-HV2-02	41PP00-BD-0001	Distribution Board	32-L1-01
41PPCM-CAS-0104	NS	MS0412LN	41PPCM-CU-3004	66 kV Feeder Protection Cubicle	35-HV2-02	41PP00-BD-0001	Distribution Board	32-L1-01
41PPCM-CAS-0107	NS	MS0412LN	41PPCM-CU-2005	66 kV Feeder Protection Cubicle	35-HV2-02	41PP00-BD-0003	Distribution Board	33-L1-01
41P6CU-CAS-0005	NS	MS0714LN	41P6CU-CU-2201	PF6-2 Converter: Fast Interlock Cubicle	32-L1-01	41PP00-BD-0002	Distribution Board	32-L1-01
41P1CU-CAS-0004	NS	MS0714LN	41P1CU-CU-2202	PF1-2 Converter: Slow Interlock Cubicle	32-L1-01	41PP00-BD-0002	Distribution Board	32-L1-01
41P1CU-CAS-0005	NS	MS0714LN	41P1CU-CU-2201	PF1-2 Converter: Fast Interlock Cubicle	32-L1-01	41PP00-BD-0002	Distribution Board	32-L1-01
41P6CU-CAS-0004	NS	MS0714LN	41P6CU-CU-2202	PF6-2 Converter: Slow Interlock Cubicle	32-L1-01	41PP00-BD-0002	Distribution Board	32-L1-01
41V1VC-CAS-0296	NS	MS1414LN	41V1VC-CU-2601	VS1-6 Converter: Interlock Cubicle	33-L1-01	41PP00-BD-0004	Distribution Board	33-L1-01
41C3CL-CAS-0207	NS	MS1414LN	41C3CL-CU-2201	CS3L-2 Converter: Interlock Cubicle	32-L1-01	41PP00-BD-0002	Distribution Board	32-L1-01

Technical Specifications

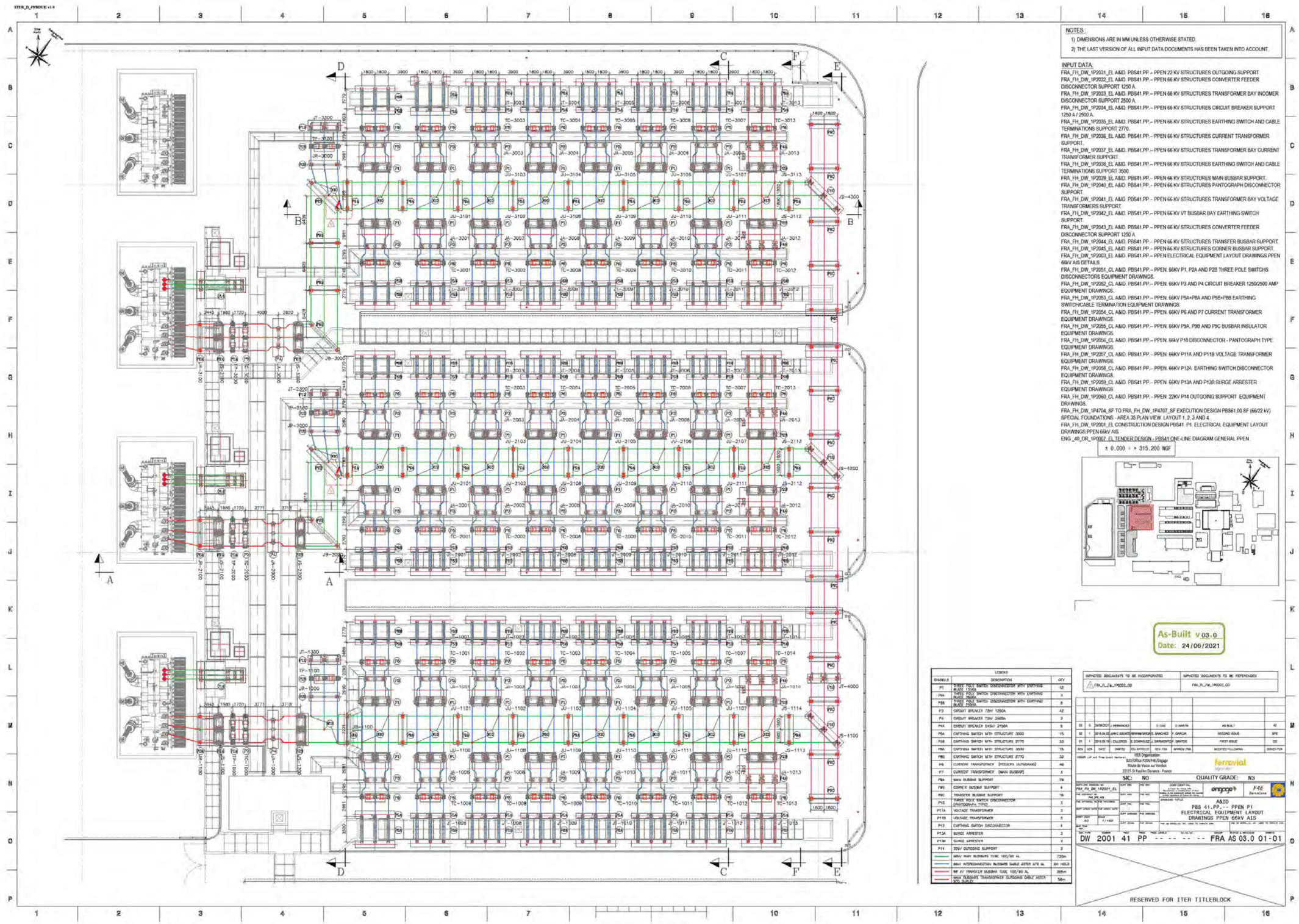
Functional Reference	Segregation Code	Part Number	From Component	From Component Description	From Location	To Component	To Component Description	To Location
41V1VC-CAS-0292	NS	MS1414LN	41V1VC-CU-2501	VS1-5 Converter: Interlock Cubicle	33-L1-01	41PP00-BD-0003	Distribution Board	33-L1-01
41C2CU-CAS-0207	NS	MS1414LN	41C2CU-CU-2201	CS2U-2 Converter: Interlock Cubicle	32-L1-01	41PP00-BD-0001	Distribution Board	32-L1-01
41V1VC-CAS-0290	NS	MS1414LN	41V1VC-CU-2301	VS1-3: Interlock cubicle	33-L1-01	41PP00-BD-0003	Distribution Board	33-L1-01
41C1CL-CAS-0219	NS	MS1414LN	41C1CL-CU-2201	CS1L-2 Converter: Interlock Cubicle	32-L1-01	41PP00-BD-0001	Distribution Board	32-L1-01
41C1CU-CAS-0139	NS	MS1414LN	41C1CU-CU-2201	CS1U-2 Converter: Interlock Cubicle	32-L1-01	41PP00-BD-0001	Distribution Board	32-L1-01
41C2CL-CAS-0207	NS	MS1414LN	41C2CL-CU-2201	CS2L-2 Converter: Interlock Cubicle	32-L1-01	41PP00-BD-0001	Distribution Board	32-L1-01
41V1VC-CAS-0290	NS	MS1414LN	41V1VC-CU-2301	VS1-3: Interlock cubicle	33-L1-01	41PP00-BD-0003	Distribution Board	33-L1-01
41C1CL-CAS-0219	NS	MS1414LN	41C1CL-CU-2201	CS1L-2 Converter: Interlock Cubicle	32-L1-01	41PP00-BD-0001	Distribution Board	32-L1-01
41C1CU-CAS-0139	NS	MS1414LN	41C1CU-CU-2201	CS1U-2 Converter: Interlock Cubicle	32-L1-01	41PP00-BD-0001	Distribution Board	32-L1-01
41C2CL-CAS-0207	NS	MS1414LN	41C2CL-CU-2201	CS2L-2 Converter: Interlock Cubicle	32-L1-01	41PP00-BD-0001	Distribution Board	32-L1-01
41V1VC-CAS-0294	NS	MS1414LN	41V1VC-CU-2401	VS1-4 Converter: Interlock Cubicle	33-L1-01	41PP00-BD-0004	Distribution Board	33-L1-01
41C3CU-CAS-0205	NS	MS1414LN	41C3CU-CU-2201	CS3U-2 Converter: Interlock Cubicle	32-L1-01	41PP00-BD-0001	Distribution Board	32-L1-01

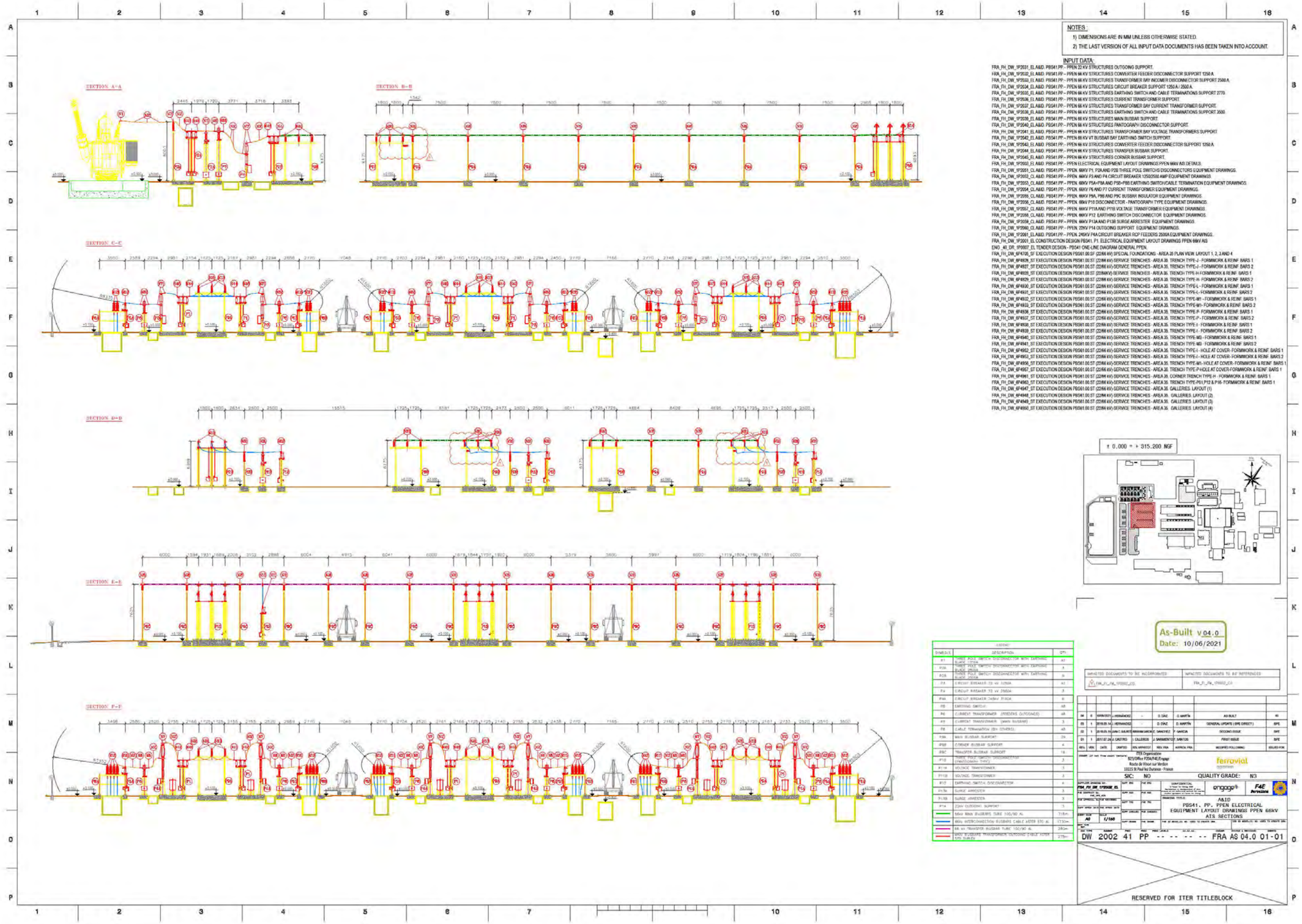
16.3 PPEN 66 kV &22kV drawing

All these detailed drawings are for reference and shall be updated at FDR and CRR stage as per the component or material selected by the Contractor.

16.3.1 66kV switchyard Layout

PPEN 66kV switchyard layout is based on the components of PPEN 66kV Stage 1 equipment. The layouts are provided for reference only.

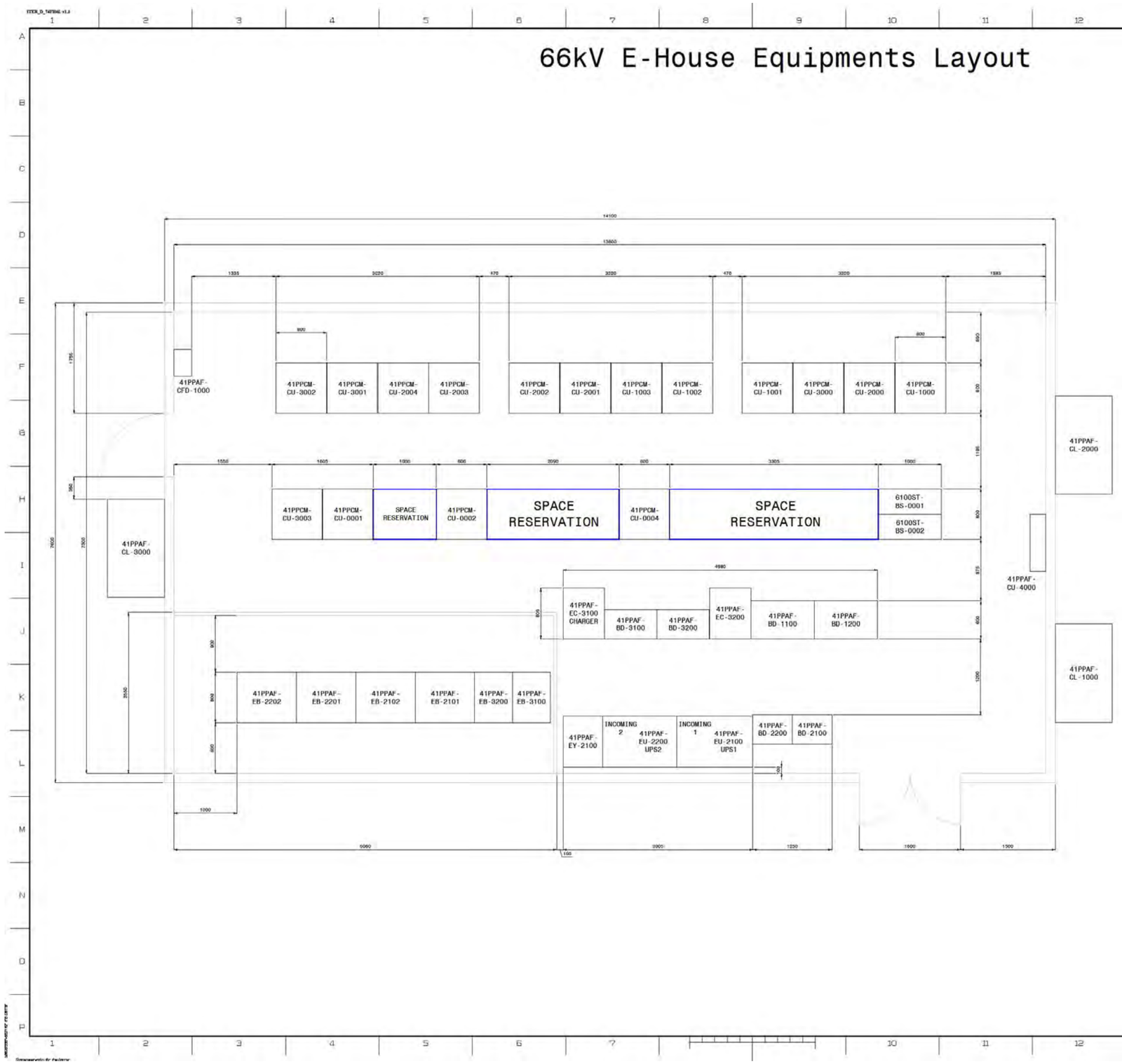

NOTES:
1) DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2) THE LAST VERSION OF ALL INPUT DATA DOCUMENTS HAS BEEN TAKEN INTO ACCOUNT.
INPUT DATA:
FRA_FH_DW_1P2031_EL A&D. PBS41.PP – PPEN 22 KV STRUCTURES OUTGOING SUPPORT.
FRA_FH_DW_1P2032_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES CONVERTER FEEDER DISCONNECTOR SUPPORT 1250 A.
FRA_FH_DW_1P2033_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES TRANSFORMER BAY INCOMER DISCONNECTOR SUPPORT 2500 A.
FRA_FH_DW_1P2034_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES CIRCUIT BREAKER SUPPORT 1250 A / 2500 A.
FRA_FH_DW_1P2035_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES EARTHING SWITCH AND CABLE TERMINATIONS SUPPORT 2770.
FRA_FH_DW_1P2036_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES CURRENT TRANSFORMER SUPPORT.
FRA_FH_DW_1P2037_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES TRANSFORMER BAY CURRENT TRANSFORMER SUPPORT.
FRA_FH_DW_1P2038_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES EARTHING SWITCH AND CABLE TERMINATIONS SUPPORT 3500.
FRA_FH_DW_1P2039_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES MAIN BUSBAR SUPPORT.
FRA_FH_DW_1P2040_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES PANTOGRAPH DISCONNECTOR SUPPORT.
FRA_FH_DW_1P2041_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES TRANSFORMER BAY VOLTAGE TRANSFORMERS SUPPORT.
FRA_FH_DW_1P2042_EL A&D. PBS41.PP – PPEN 66 KV VT BUSBAR BAY EARTHING SWITCH SUPPORT.
FRA_FH_DW_1P2043_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES CONVERTER FEEDER DISCONNECTOR SUPPORT 1250 A.
FRA_FH_DW_1P2044_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES TRANSFER BUSBAR SUPPORT.
FRA_FH_DW_1P2045_EL A&D. PBS41.PP – PPEN 66 KV STRUCTURES CORNER BUSBAR SUPPORT.
FRA_FH_DW_1P2003_EL A&D. PBS41.PP – PPEN ELECTRICAL EQUIPMENT LAYOUT DRAWINGS PPEN 66kV AIS DETAILS.
FRA_FH_DW_1P2051_CL A&D. PBS41.PP – PPEN. 66kV P1, P2A AND P2B THREE POLE SWITCHS DISCONNECTORS EQUIPMENT DRAWINGS.
FRA_FH_DW_1P2052_CL A&D. PBS41.PP – PPEN. 66kV P3 AND P4 CIRCUIT BREAKER 1250/2500 AMP EQUIPMENT DRAWINGS.
FRA_FH_DW_1P2053_CL A&D. PBS41.PP – PPEN. 66kV P5A+P8A AND P5B+P8B EARTHING SWITCH/CABLE TERMINATION EQUIPMENT DRAWINGS.
FRA_FH_DW_1P2054_CL A&D. PBS41.PP – PPEN. 66kV P6 AND P7 CURRENT TRANSFORMER EQUIPMENT DRAWINGS.
FRA_FH_DW_1P2055_CL A&D. PBS41.PP – PPEN. 66kV P9A, P9B AND P9C BUSBAR INSULATOR EQUIPMENT DRAWINGS.
FRA_FH_DW_1P2056_CL A&D. PBS41.PP – PPEN. 66kV P10 DISCONNECTOR - PANTOGRAPH TYPE EQUIPMENT DRAWINGS.
FRA_FH_DW_1P2057_CL A&D. PBS41.PP – PPEN. 66kV P11A AND P11B VOLTAGE TRANSFORMER EQUIPMENT DRAWINGS.
FRA_FH_DW_1P2058_CL A&D. PBS41.PP – PPEN. 66kV P12A EARTHING SWITCH DISCONNECTOR EQUIPMENT DRAWINGS.
FRA_FH_DW_1P2059_CL A&D. PBS41.PP – PPEN. 66kV P13A AND P13B SURGE ARRESTER EQUIPMENT DRAWINGS.
FRA_FH_DW_1P2060_CL A&D. PBS41.PP – PPEN. 22kV P14 OUTGOING SUPPORT EQUIPMENT DRAWINGS.
FRA_FH_DW_1P4704_SF TO FRA_FH_DW_1P4707_SF EXECUTION DESIGN PBS61.00.SF (66/22 kV) SPECIAL FOUNDATIONS - AREA 35 PLAN VIEW LAYOUT 1, 2, 3 AND 4.
FRA_FH_DW_1P2001_EL CONSTRUCTION DESIGN PBS41. P1. ELECTRICAL EQUIPMENT LAYOUT DRAWINGS PPEN 66kV AIS.
ENG _40_DR_1P0007_EL TENDER DESIGN - PBS41 ONE-LINE DIAGRAM GENERAL PPEN.
± 0.000 = + 315.200 NGF
As-Built v 03.0
Date: 24/06/2021
SIC: NO
QUALITY GRADE: N3
AS1D
PBS 41.PP_-- PPEN P1
ELECTRICAL EQUIPMENT LAYOUT
DRAWINGS PPEN 66kV AIS
DW 2001 41 PP -- -- -- -- FRA AS 03.0 01-01
RESERVED FOR ITER TITLEBLOCK


SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
SECTION F-F
NOTES :
1) DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2) THE LAST VERSION OF ALL INPUT DATA DOCUMENTS HAS BEEN TAKEN INTO ACCOUNT.
INPUT DATA:
± 0.000 = + 315.200 NGF
As-Built v 04.0
Date: 10/06/2021
SIC: NO
QUALITY GRADE: N3
A&ID
PBS41. PP. PPEN ELECTRICAL
EQUIPMENT LAYOUT DRAWINGS PPEN 66KV
AIS SECTIONS
DW 2002 41 PP -- -- -- -- -- FRA AS 04.0 01-01
RESERVED FOR ITER TITLEBLOCK

16.3.2 66kV Substation Container layout

PPEN 66kV Substation Container had been constructed with spaces reserved for protection & control cubicles for PPEN 66kV Stage 2 equipment. The layout is provided for reference.

66kV E-House Equipments Layout



Panel Code	Description	QTY	Dimension (HxWxD)mm	Weight (kg)
41PPCM-CU-3002	66kV Feeders Control & Protection Panel	1	2200x800x800	520
41PPCM-CU-3001	66kV Feeders Control & Protection Panel	1	2200x800x800	520
41PPCM-CU-2004	66kV Feeders Control & Protection Panel	1	2200x800x800	520
41PPCM-CU-2003	66kV Feeders Control & Protection Panel	1	2200x800x800	520
41PPCM-CU-2002	66kV Feeders Control & Protection Panel	1	2200x800x800	520
41PPCM-CU-2001	66kV Feeders Control & Protection Panel	1	2200x800x800	520
41PPCM-CU-1003	66kV Feeders Control & Protection Panel	1	2200x800x800	520
41PPCM-CU-1002	66kV Feeders Control & Protection Panel	1	2200x800x800	520
41PPCM-CU-1001	66kV Feeders Control & Protection Panel	1	2200x800x800	520
41PPCM-CU-3000	66kV Incoming and Feeder Control & Protection Panel	1	2200x800x800	520
41PPCM-CU-2000	66kV Incoming and Feeder Control & Protection Panel	1	2200x800x800	520
41PPCM-CU-1000	66kV Incoming and Feeder Control & Protection Panel	1	2200x800x800	520
41PPCM-CU-3003	66kV Feeders Control & Protection Panel	1	2200x800x800	450
41PPCM-CU-0001	66kV Common Control Panel	1	2200x800x800	450
41PPCM-CU-0002	66kV Communication Cubicle	1	2200x800x800	450
41PPCM-CU-0004	RPH3 Cubicle	1	2200x800x800	
6100ST-BS-0001	400/230 Vac Cubicle	1	2200x1000x400	
6100ST-BS-0002	400/230 Vac Cubicle	1	2200x1000x400	
41PPAF-EC-3100	DC System 1 Charger Unit	1	1900x650x804	380
41PPAF-BD-3100	DC System 1 Distribution Board	1	2000x826x465	200
41PPAF-BD-3200	DC System 2 Distribution Board	1	2000x826x465	200
41PPAF-EC-3200	DC System 2 Charger Unit	1	1900x650x804	380
41PPAF-BD-1100	400/230V AC Switchgear Busbar 1000	1	2200x1000x600	450
41PPAF-BD-1200	400/230V AC Switchgear Busbar 2000	1	2200x1000x600	450
41PPAF-EY-2100	UPS 1 & 2 Bypass Panel	1	1900x627x804	
41PPAF-EU-2200	UPS 2 Charger/Inverter	1	1900x1175x804	890
41PPAF-EU-2100	UPS 1 Charger/Inverter	1	1900x1202x804	
41PPAF-BD-2200	UPS 2 Distribution Board	1	2000x626x465	200
41PPAF-BD-2100	UPS 1 Distribution Board	1	2000x626x465	200
41PPAF-EB-2202	UPS 2 Battery Panel 2	1	2200x940x800	950
41PPAF-EB-2201	UPS 2 Battery Panel 1	1	2200x940x800	950
41PPAF-EB-2102	UPS 1 Battery Panel 2	1	2200x940x800	950
41PPAF-EB-2101	UPS 1 Battery Panel 1	1	2200x940x800	950
41PPAF-EB-3200	DC System 2 Battery Panel	1	2200x600x800	650
41PPAF-EB-3100	DC System 1 Battery Panel	1	2200x600x800	650
41PPAF-CL-1000	HVAC Unit 1	1	2100x1554x900	400
41PPAF-CL-2000	HVAC Unit 2	1	2100x1554x900	400
41PPAF-CL-3000	HVAC Unit 3	1	2100x1554x900	400
41PPAF-CFD-1000	Fire Detection Control Panel	1	580x420x133	25
41PPAF-CU-4000	HVAC Main Panel	1	950x900x250	50

*NOTE
1. Dimensions are in mm unless otherwise stated.
2. This GA drawing was newly created as per site survey result.
3. Input document : M10_PPEN_811_Drawings(Q7N6W3)
   Document(66kV E-HOUSE_880C-KEH020-C600-TM_v1C, PDF page 4/28)

KEPCO ENGINEERING & CONSTRUCTION CO., INC.
As-Built
Date : 29/11/2022

SITE LOCATION
AREA35 CONTAINER

DRAWING TITLE
66kV E-House Equipments Layout

41 PP

01 | 000 | W

16.3.3 PPEN 66kV Stage 1 Equipment drawing

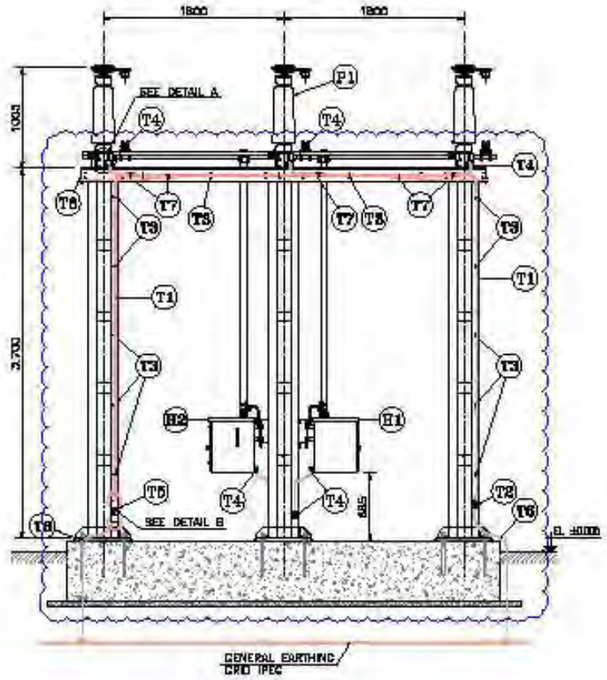
The following PPEN 66kV Stage 1 equipment drawings of feeder module are provided **for reference only**.

- P1-Three-pole disconnector switch with Earthing switch (72.5 kV, 1250A)
- P3-Circuit breaker 72.5 kV, 1250A
- P5A/B+P8A/B-Earthing switch with structure 3500/2770
- P6-Current transformer

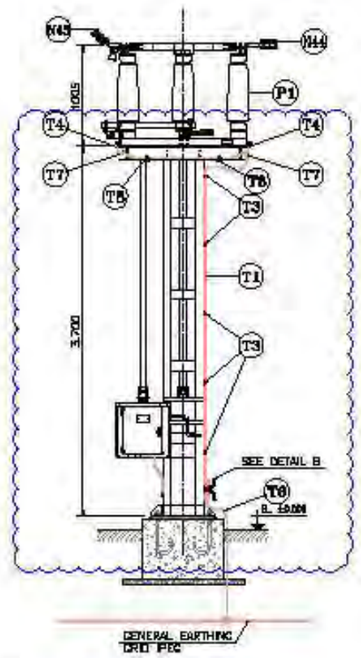
The Contractor shall develop the relevant design in accordance with the manufacturer's inputs after MRR

ITER_D_5MHKTG v1.0

FRONT VIEW



SIDE VIEW



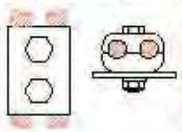
BILL OF MATERIALS

ITEM	DESCRIPTION	PART NUMBER	MANUFACTURER
	EQUIPMENT		
P1	SWITCH DISCONNECTOR WITH EARTHING SWITCH (ACCORDING TO ITER_D_QEYFR7)	S3CT	ALSTOM
	EARTH		
T1	BARE COPPER CONDUCTOR, SECTION 1X150mm²	–	–
T2	EARTHING CLAMP FOR 2 BARE COPPER CONDUCTORS	1208–1515	AUXIME
T3	EARTHING CLAMP FOR 1 BARE COPPER	1228–15	AUXIME
T4	COMPRESSION STUD FOR BARE COPPER CONDUCTOR SECTION 150mm²/M14	2A 3D–M 14	CEMBRE
T5	TWIN WINGS EARTH CLAMP	2CLPAR 120–240	MALTEP
T6	BARE COPPER CONDUCTOR, SECTION 1X185mm²		
T7	CRIMP C-TYPE CRC–14	–	SOFAMEL
T8	St/Zn CLAMP CONNECTOR 6–10mm	–	DEHN
N44	ASTER 300 CONDUCTOR – DISCONNECTOR (S3CT–1250A) 0°	[illegible]	TBEA
N45	ASTER 570 CONDUCTOR – DISCONNECTOR (S3CT–1250A) TERMINAL FLAT 45°	[illegible]	TBEA
	FITTINGS		
H1	MOTOR OPERATING MECHANISM BOX FOR DISCONNECTOR SWITCH (ACCORDING TO ITER_D_QEYFR7)		ALSTOM
H2	MOTOR OPERATING MECHANISM BOX FOR EARTHING SWITCH (ACCORDING TO ITER_D_QEYFR7)		ALSTOM

NOTE:

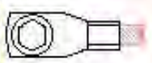
1. FOR EQUIPMENT LAYOUT SEE FRA_FH_DW_1P2001_EL
2. FOR ANCHORING DETAILS TO THE FOUNDATION SEE CIVIL DRAWINGS INDICATED IN INPUT DATA OF THE COVER SHEET
3. FOR ANCHORS INFORMATION BETWEEN ELEMENTS REFER TO SHEET 11 OF THIS DOCUMENT
4. FOR ANCHORING OF MECHANISM BOX SEE SHEET 11 & 12 OF THIS DOCUMENT
5. FOR EARTHING CONNECTIONS DETAIL TO IPEG, SEE EARTHING DRAWINGS INDICATED IN THE INPUT DATA OF THE COVER SHEET.
6. MEASUREMENTS INDICATED HEREIN ARE IN mm UNLESS OTHERWISE STATED

DETAIL ITEM T2



DETAIL ITEM T3

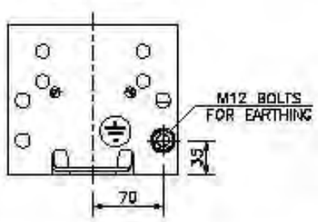
DETAIL ITEM T4



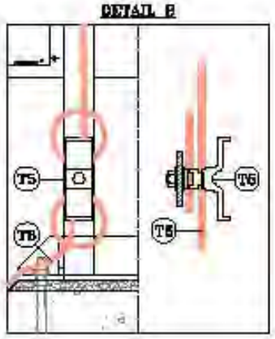
DETAIL ITEM T7

DETAIL ITEM T8

DETAIL "A"
LOWER BASE
SCALE 1/5



DETAIL B



SUPPLIER DRAWING NO.
FRA_FH_DW_1P2051_EL

ISSUER(if not from Joint Venture)
ITER Organization
B23/Office P204/F4E/Engage
Route de Vinon sur Verdon
13115 St Paul lez Durance
France

ferrovial agroman

REV.	VER.
01	2

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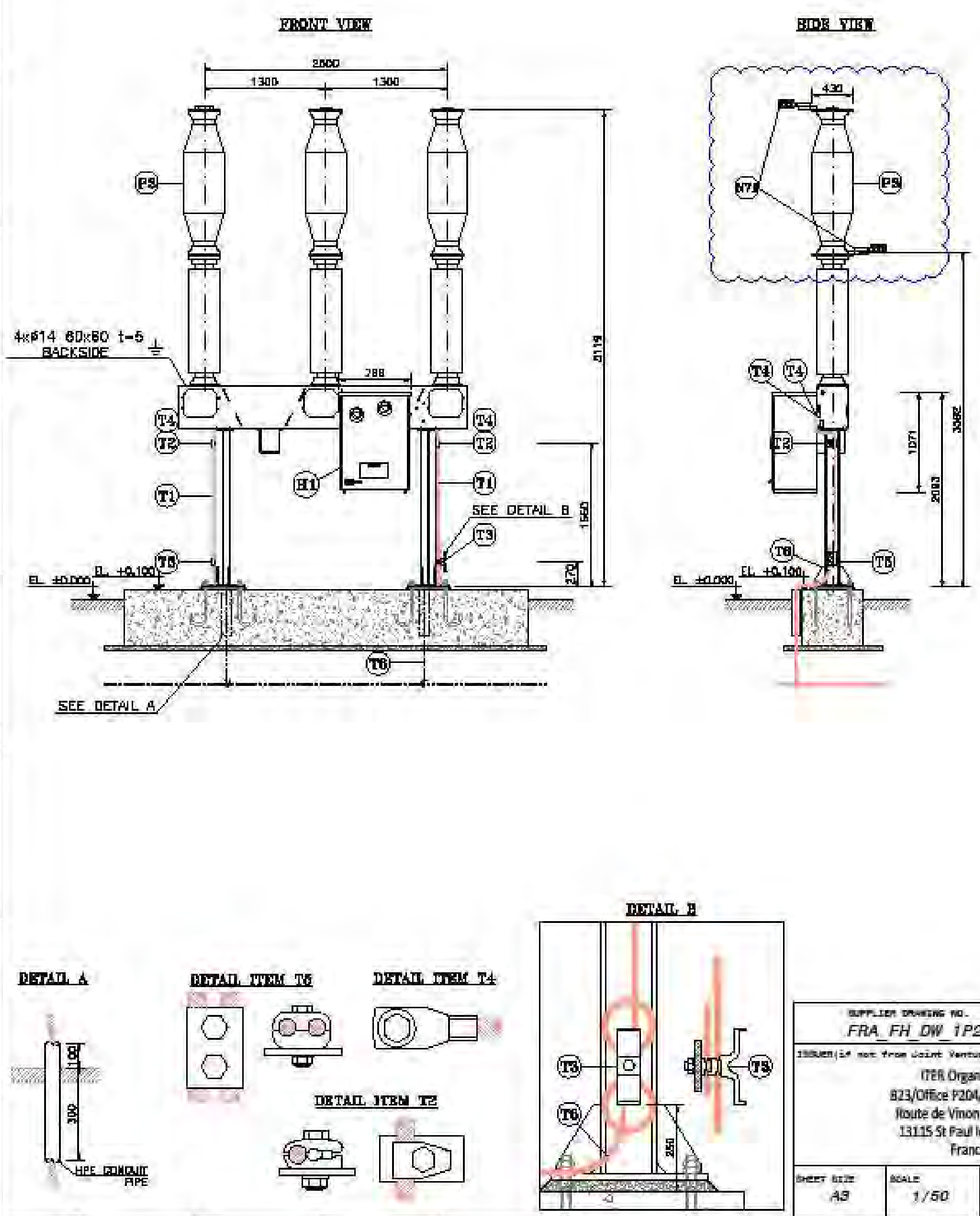
engage

F4E Barcelona

DRAWING TITLE
A&ID
PBS 41.PP.-- PPEN
66KV P1 THREE POLE SWITCHS DISCONNECTORS
S3CT 72.5KV 1250A

SHEET SIZE	SCALE	DOC TYPE	NUMBER	PBS1	PBS2	PBS3 LEVELS	AA.AA.AA.	ISSUER	STATUS & REVISION	SHEETS
A3	1/50	DW	2051	41	--	-- -- --	-- --	FRA	AS 01.202	-14

ITER_D_5H3C2J v1.0



BILL OF MATERIALS

ITEM	DESCRIPTION	PART NUMBER	MANUFACTURER	QUANT
	EQUIPMENT			
P3	CIRCUIT BREAKER THREE POLE(ACCORDING TO ITER_D_QEYFR7)	GL100X	ALSTOM	3
	EARTH			
T1	BARE COPPER CONDUCTOR. SECTION 150mm²	–	–	7.5m
T2	EARTHING CLAMP FOR 1 BARE COPPER CONDUCTOR SECTION RANGE 121–185 mm² UPON STRUCTURE	122B–15	AUXIME	2
T3	TWIN WINGS EARTH CLAMP	2CLPAR 120–240	MALTEP	1
T4	COMPRESSION STUD FOR BARE COPPER CONDUCTOR SECTION 150mm²/M14	2A 30–M 14	CEMBRE	2
T5	EARTHING CLAMP FOR 2 BARE COPPER CONDUCTOR SECTION RANGE 121–185 mm² UPON STRUCTURE	1208–1515	AUXIME	1
T6	BARE COPPER CONDUCTOR. SECTION 185mm²	–	–	4m
N71	ASTER 570–CIRCUIT BREAKER TERMINAL FLAT 0°	SL–64–130X125–N71	TBEA	6
	FITTINGS			
H1	MOTOR OPERATING MECHANISM BOX (ACCORDING TO ITER_D_QEYFR7)	FK3–4/018/02	ALSTOM	1

NOTE:

1. FOR EQUIPMENT LAYOUT SEE FRA–FH–DW–1P2D01–EL.
2. FOR ANCHORING DETAILS TO THE FOUNDATION SEE CIVIL DRAWINGS INDICATED IN INPUT DATA OF THE COVER SHEET.
3. FOR ANCHORS INFORMATION BETWEEN ELEMENTS REFER TO SHEET 7 OF THIS DOCUMENT.
4. FOR EARTHING CONNECTION DETAILS TO IPEG, SEE EARTHING DRAWINGS INDICATED IN INPUT DATA OF THE COVER SHEET.
5. TIGHTENING TORQUE FOR PRIMARY CONNECTION AND EQUIPMENT SEE SHEET 8.
6. EQUIPMENT DETAIL REFER TO SHEET 5 OF THIS DOCUMENT.
7. EARTHING CONNECTION OF THE MECHANISM BOX IS MADE THROUGH THE BASE FRAME
8. MEASUREMENTS INDICATED HEREIN ARE IN mm UNLESS OTHERWISE STATED

SUPPLIER DRAWING NO.: FRA_FH_DW_1P2052_EL

REV.: 01 VER.: 2

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ISSUER (if not from Joint Venture): ITER Organization, 823/Office F204/F4E/Engage, Route de Vinon sur Verdon, 13115 St Paul lez Durance, France

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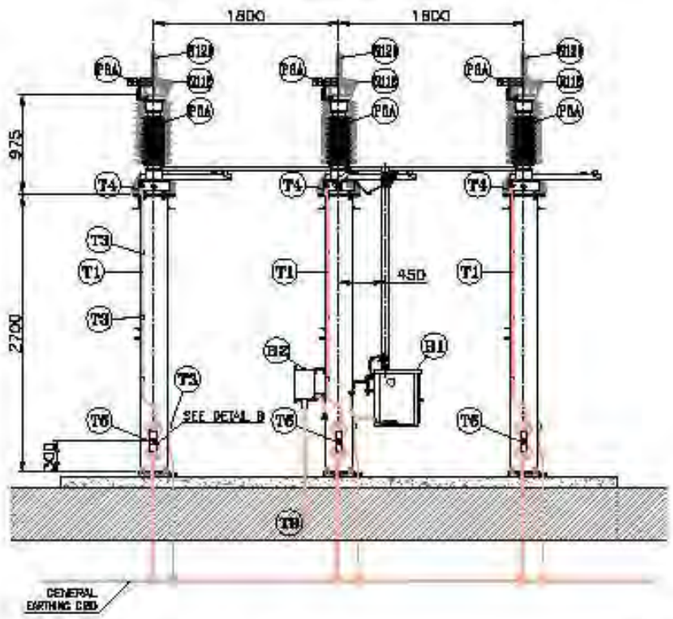
DRAWING TITLE: A&ID PBS 41.PP.-- PPEN 66kV P3 CIRCUIT BREAKER 1250 AMP, DRAWINGS

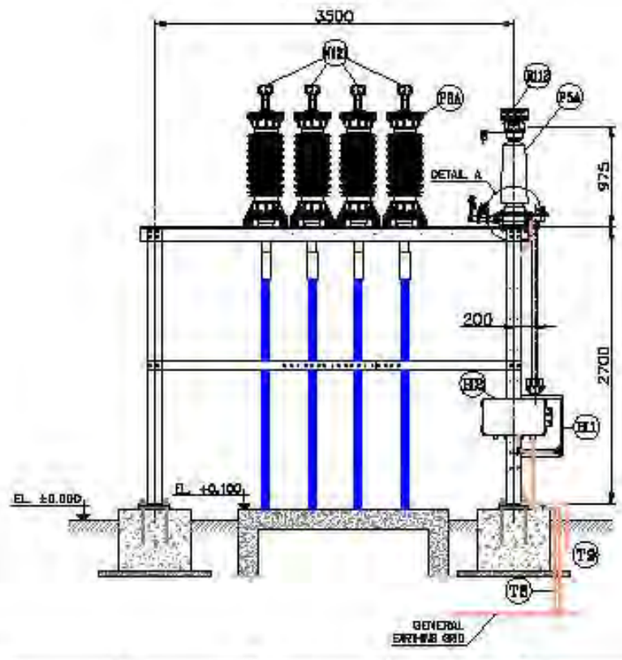
SHEET SIZE	SCALE	DOC TYPE	NUMBER	PBS1	PBS2	PBS3 LEVELS	AA.AA.AA.	ISSUER	STATUS & REVISION	SHEETS
A3	1/50	DW	2052	41	--	-- --	--	FRA	AS	01.202-09

ITER_D_5E6RDA v1.0

FRONT VIEW



SIDE VIEW



DETAIL "A"
LOWER BASE

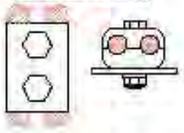
BILL OF MATERIALS

ITEM	DESCRIPTION	PART NUMBER	MANUFACTURER	QUANT
	EQUIPMENT			
P5A	EARTHING SWITCH (ACCORDING TO ITER_D_QEYFR7)	STA-72.5KV	ALSTOM	3
	EARTH			
T1	BARE COPPER CONDUCTOR SECTION 1x150mm²	–		8.5m
T2	EARTHING CLAMP FOR 2 BARE COPPER CONDUCTORS SECTION 150mm² UPON STRUCTURE	1208-1515	AUXIME	1
T3	EARTHING CLAMP FOR 1 BARE COPPER CONDUCTORS SECTION 150mm² UPON STRUCTURE	1228-15	AUXIME	9
T4	COMPRESSION STUD FOR BARE COPPER CONDUCTOR SECTION 150mm²/M14	2A 30-N 14	CEMBRE	5
T5	CONICAL PLASTIC ANCHOR RIBBED FOR BOLT ø12 mm, L=35	–	–	6
T6	EARTH ACCESSORY WITH DOUBLE WINGED SECTION 185mm²	2CLAM 120-240	MALTEP	1
T7	COPPER GROUND CONNECTOR FOR COPPER CABLE TO BAR, BOLT 1/2", FOR CONDUCTOR 300 – 500 KCMIL / 150 –240 MM2.	GB34	BURNDY	6
T8	BARE COPPER CONDUCTOR. SECTION 185mm²	–	–	4.5m
T9	66KV EARTHING BOX CONNECTION TO EARTHING NETWORK BARE COPPER CONDUCTOR. SECTION 150mm²	–	–	1
P8A	OUTDOOR TERMINATION FEV 72-P PORCELAIN INSULATOR	–	–	(SEE NOTE 8)
N112	ASTER 570 CONDUCTOR – EARTHING SWITCH (STA) TERMINAL FLAT 90° (CONVERTER FEEDER) (SEE NOTE 7)	TL-570-STA66-N112	TBEA	3
N121	66 KV CABLE TERMINAL – 90° ASTER 570 CONDUCTOR (SEE NOTE 8)	TL-570/35-N121	TBEA	(SEE NOTE 8)
	FITTINGS			
H1	MECHANISM BOX (ACCORDING TO ITER_D_QEYFR7)	–	–	1
H2	EARTHING BOX BHX-01/JDX-01	–	–	1

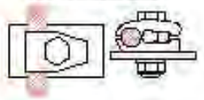
NOTES:

1. FOR EQUIPMENT LAYOUT SEE FRA_FH_DW_1P2001_EL.
2. FOR ANCHORING DETAILS TO THE FOUNDATION SEE CML DRAWINGS INDICATED IN INPUT DATA OF THE COVER SHEET.
3. FOR ANCHORS INFORMATION BETWEEN ELEMENTS REFER TO SHEET 6 OF THIS DOCUMENT.
4. MEASUREMENTS INDICATED HEREIN ARE IN mm UNLESS OTHERWISE STATED.
5. FOR GROUNDING INFORMATION OF THE CABLE SCREENS SEE SHEETS 8 TO 11.
6. FOR OUTPUT TO RPC OR TCR IS REPLACED BY N12.
7. FOR OUTPUT TO RPC OR TCR IS REPLACED BY N111.
8. QUANTITY DETERMINING THE NUMBER OF CONDUCTORS PER PHASE

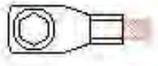
DETAIL ITEM T2



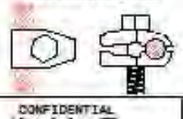
DETAIL ITEM T3



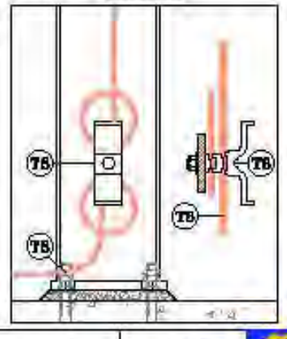
DETAIL ITEM T4



DETAIL ITEM T7



DETAIL B



SUPPLIER DRAWING NO. FRA_FH_DW_1P2053_EL		03	2	CONFIDENTIAL	engage	F4E Barcelona
		REV.	VER.			

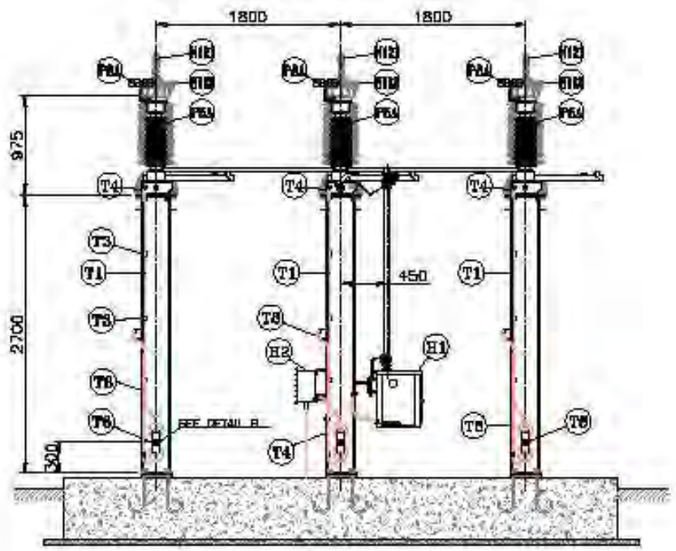
ISSUER(if not from Joint Venture)
ITER Organization
B23/Office P204/F4E/Engage
Route de Vinon sur Verdon
13115 St Paul lez Durance
France

DRAWING TITLE
A&ID
PBS 41.PP.-- PPEN
66kV P5A+P8A EARTHING SWITCH/CABLE TERMINATION
EARTHING SWITCH 2800mm GALLERY SOUTH OF THE BAY

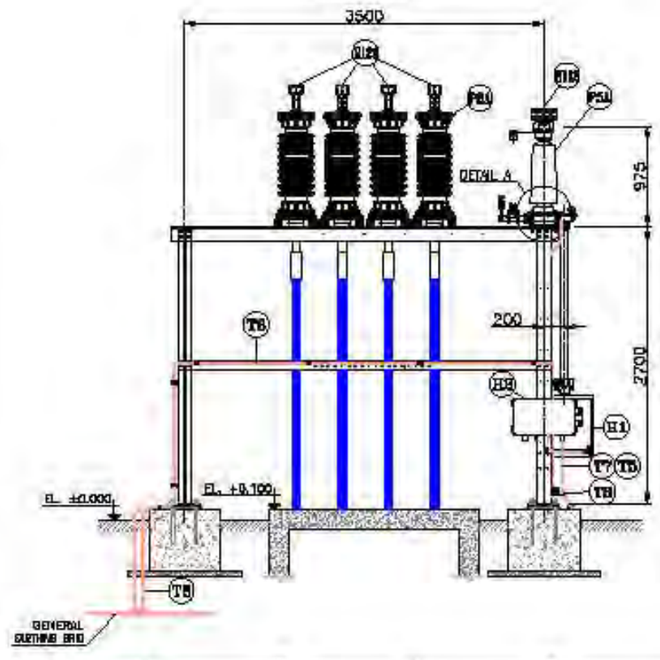
SHEET SIZE	SCALE	DOC TYPE	NUMBER	PBS	PBS	PBS LEVELS				AA.AA.AA.	ISSUER	STATUS & REVISION	SHEETS
A3	1/50	DW	2053	41	--	--	--	--	--	--	FRA	AS 03.202	-20

ITER_D_5E6RDA v1.0

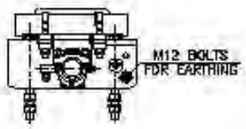
FRONT VIEW



SIDE VIEW



DETAIL "A"
LOWER PART



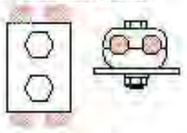
BILL OF MATERIALS

ITEM	DESCRIPTION	PART NUMBER	MANUFACTURER	QUANT
	EQUIPMENT			
P5A	EARTHING SWITCH (ACCORDING TO ITER_D_QEYFR7)	STA-72.5KV	ALSTOM	3
	EARTH			
T1	BARE COPPER CONDUCTOR SECTION 1x150mm²	–		8.5m
T2	EARTHING CLAMP FOR 2 BARE COPPER CONDUCTORS SECTION 150mm² UPON STRUCTURE	1208-1515	AUXIME	1
T3	EARTHING CLAMP FOR 1 BARE COPPER CONDUCTORS SECTION 150mm² UPON STRUCTURE	1228-15	AUXIME	9
T4	COMPRESSION STUD FOR BARE COPPER CONDUCTOR SECTION 150mm²/M14	2A 30-M 14	CEMBRE	5
T5	CONICAL PLASTIC ANCHOR RIBBED FOR BOLT ø12 mm, L=35	–	–	5
T6	EARTH ACCESSORY WITH DOUBLE WINGED SECTION 185mm²	2CLPAR 120-240	MALTEP	1
T7	COPPER GROUND CONNECTOR FOR COPPER CABLE TO BAR, BOLT 1/2", FOR CONDUCTOR 300 – 500 KCMIL / 150 –240 MM2.	GB34	BURNDY	5
T8	BARE COPPER CONDUCTOR. SECTION 185mm²	–	–	4.5m
T9	66kV EARTHING BOX CONNECTION TO EARTHING NETWORK BARE COPPER CONDUCTOR. SECTION 150mm²	–	–	1
P8A	OUTDOOR TERMINATION FEV 72-P PORCELAIN INSULATOR	–	–	(SEE NOTE 8)
N112	ASTER 570 CONDUCTOR – EARTHING SWITCH (STA) TERMINAL FLAT 90° (CONVERTER FEEDER) (SEE NOTE 7)	TL-570-9B15-N112	TBEA	3
N121	66 KV CABLE TERMINAL – 90° ASTER 570 CONDUCTOR (SEE NOTE 8)	TL-570/30-N121	TBEA	(SEE NOTE 8)
	FITTINGS			
H1	MECHANISM BOX (ACCORDING TO ITER_D_QEYFR7)	–	–	1
H2	EARTHING BOX BHX-01/JDX-01	–	–	1

NOTES:

1. FOR EQUIPMENT LAYOUT SEE FRA_FH_DW_1P2001_EL.
2. FOR ANCHORING DETAILS TO THE FOUNDATION SEE CIVIL DRAWINGS INDICATED IN INPUT DATA OF THE COVER SHEET.
3. FOR ANCHORS INFORMATION BETWEEN ELEMENTS REFER TO SHEET 6 OF THIS DOCUMENT.
4. MEASUREMENTS INDICATED HEREIN ARE IN mm UNLESS OTHERWISE STATED.
5. FOR GROUNDING INFORMATION OF THE CABLE SCREENS SEE SHEETS 8 TO 11.
6. FOR OUTPUT TO RPC OR TCR IS REPLACED BY N12.
7. FOR OUTPUT TO RPC OR TCR IS REPLACED BY N111.
8. QUANTITY DETERMINING THE NUMBER OF CONDUCTORS PER PHASE

DETAIL ITEM T2



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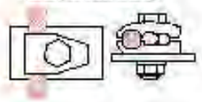
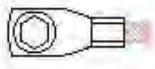
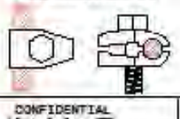


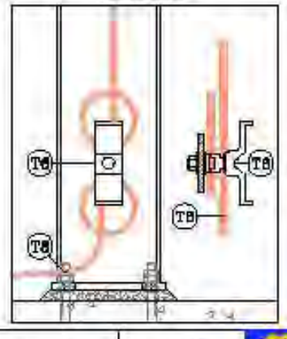
DETAIL ITEM T4



DETAIL ITEM T7



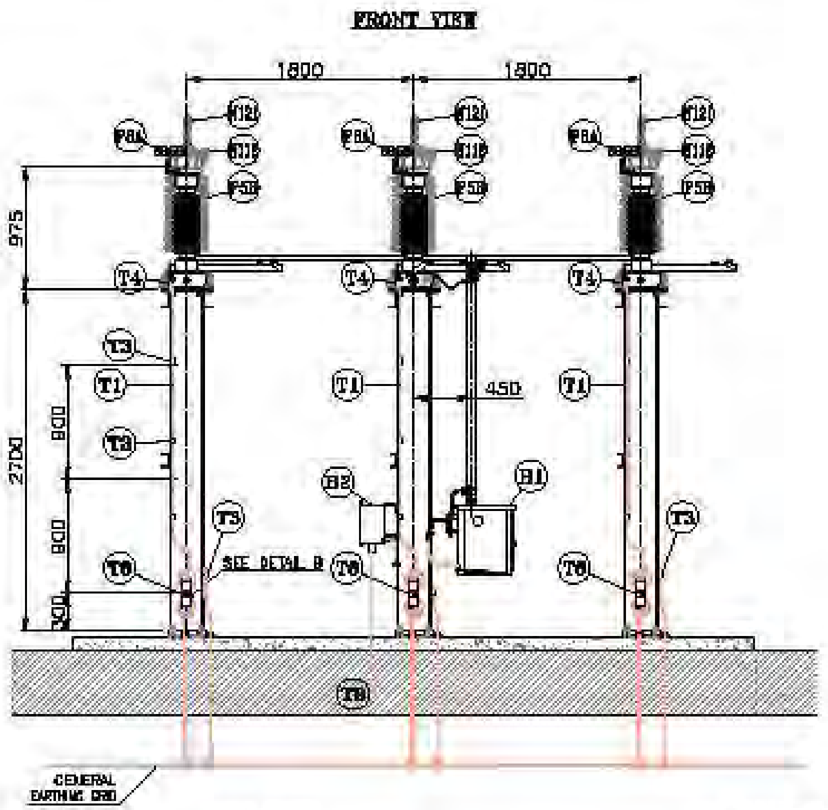
DETAIL B

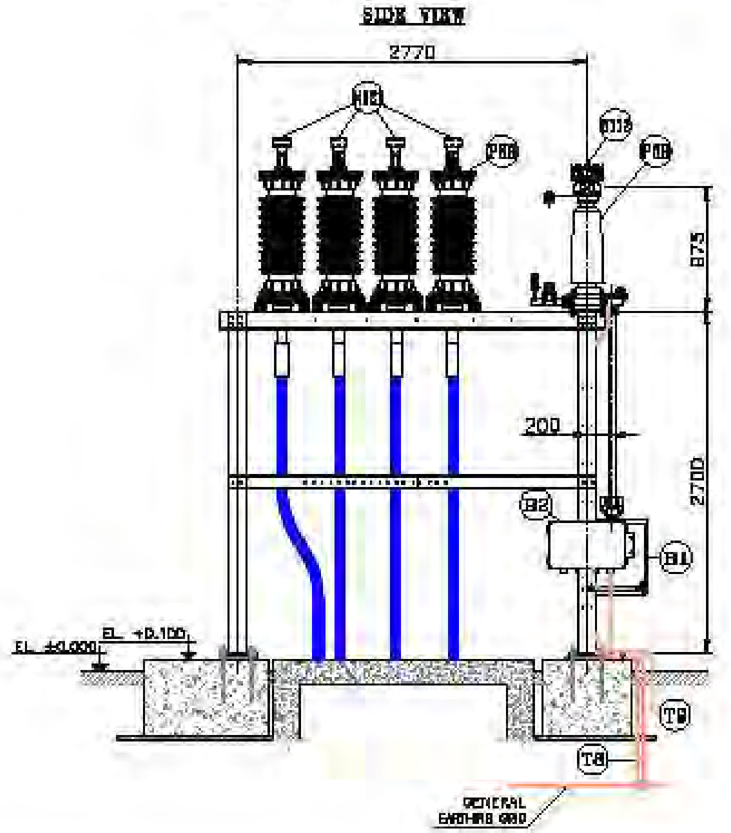


SUPPLIER DRAWING NO. FRA_FH_DW_1P2053_EL		03	2	CONFIDENTIAL	engage	F4E Barcelona
ISSUER(if not from Joint Venture)		REV.	VER.		
ITER Organization B23/Office P204/F4E/Engage Route de Vinon sur Verdon 13115 St Paul lez Durance France	fernovial agroman			DRAWING TITLE A&ID PBS 41.PP.-- PPEN 66kV P5A+P8A EARTHING SWITCH/CABLE TERMINATION EARTHING SWITCH 2800mm GALLERY NORTH OF THE BAY		

SHEET SIZE	SCALE	DOC TYPE	NUMBER	PBS	PBS2	PBS3 LEVELS	AA.AA.AA.	ISSUER	STATUS & REVISION	SHEETS
A3	1/50	DW	2053	41	--	-- -- -- -- --		FRA	AS 03.203-20	

ITER_D_5E6RDA v1.0



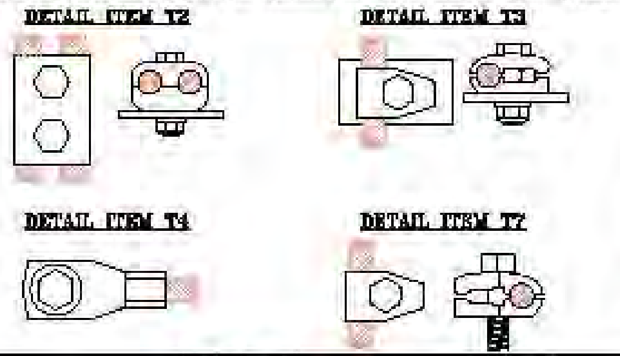


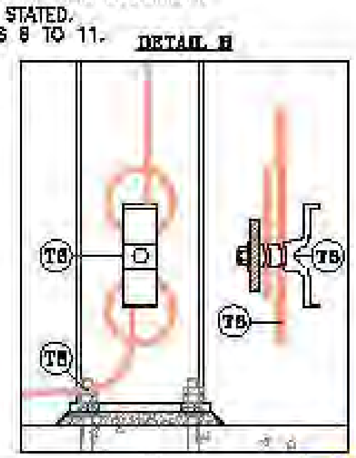
BILL OF MATERIALS

ITEM	DESCRIPTION	PART NUMBER	MANUFACTURER	QUANT
	EQUIPMENT			
P5A	EARTHING SWITCH (ACCORDING TO ITER_D_QEYFR7)	STA–72.5KV	ALSTOM	3
	EARTH			
T1	BARE COPPER CONDUCTOR SECTION 1x150mm²	–		8.5m
T2	EARTHING CLAMP FOR 2 BARE COPPER CONDUCTORS SECTION 150mm² UPON STRUCTURE	1208–1515	AUXIME	1
T3	EARTHING CLAMP FOR 1 BARE COPPER CONDUCTORS SECTION 150mm² UPON STRUCTURE	1228–15	AUXIME	9
T4	COMPRESSION STUD FOR BARE COPPER CONDUCTOR SECTION 150mm²/M14	2A 30–M 14	CEMBRE	5
T5	CONICAL PLASTIC ANCHOR RIBBED FOR BOLT ø12 mm. L=35	–	–	6
T6	EARTH ACCESSORY WITH DOUBLE WINGED SECTION 185mm²	BOLPAR 120–240	MALTEP	1
T7	COPPER GROUND CONNECTOR FOR COPPER CABLE TO BAR, BOLT 1/2", FOR CONDUCTOR 300 – 500 KCMIL / 150 –240 MM2.	GB34	BURNDY	6
T8	BARE COPPER CONDUCTOR. SECTION 185mm²	–	–	4,5m
T9	66kV EARTHING BOX CONNECTION TO EARTHING NETWORK BARE COPPER CONDUCTOR. SECTION 150mm²	–	–	1
P8A	OUTDOOR TERMINATION FEV 72–P PORCELAIN INSULATOR	–	–	(SEE NOTE 8)
N112	ASTER 570 CONDUCTOR – EARTHING SWITCH (STA) TERMINAL FLAT 90° (CONVERTER FEEDER) (SEE NOTE 7)	TL-570-40X16-N112	TBEA	3
N121	66 KV CABLE TERMINAL – 90° ASTER 570 CONDUCTOR (SEE NOTE 8)	TL-570/30-N121	TBEA	(SEE NOTE 8)
	FITTINGS			
H1	MECHANISM BOX (ACCORDING TO ITER_D_QEYFR7)	–	–	1
H2	EARTHING BOX BHX–01/JDX–01	–	–	1

NOTES:

1. FOR EQUIPMENT LAYOUT SEE FRA_FH_DW_1P2001_EL.
2. FOR ANCHORING DETAILS TO THE FOUNDATION SEE CIVIL DRAWINGS INDICATED IN INPUT DATA OF THE COVER SHEET.
3. FOR ANCHORS INFORMATION BETWEEN ELEMENTS REFER TO SHEET 8 OF THIS DOCUMENT.
4. MEASUREMENTS INDICATED HEREIN ARE IN mm UNLESS OTHERWISE STATED.
5. FOR GROUNDING INFORMATION OF THE CABLE SCREENS SEE SHEETS 8 TO 11.
6. FOR OUTPUT TO RPC OR TCR IS REPLACED BY N12.
7. FOR OUTPUT TO RPC OR TCR IS REPLACED BY N111.
8. QUANTITY DETERMINING THE NUMBER OF CONDUCTORS PER PHASE.

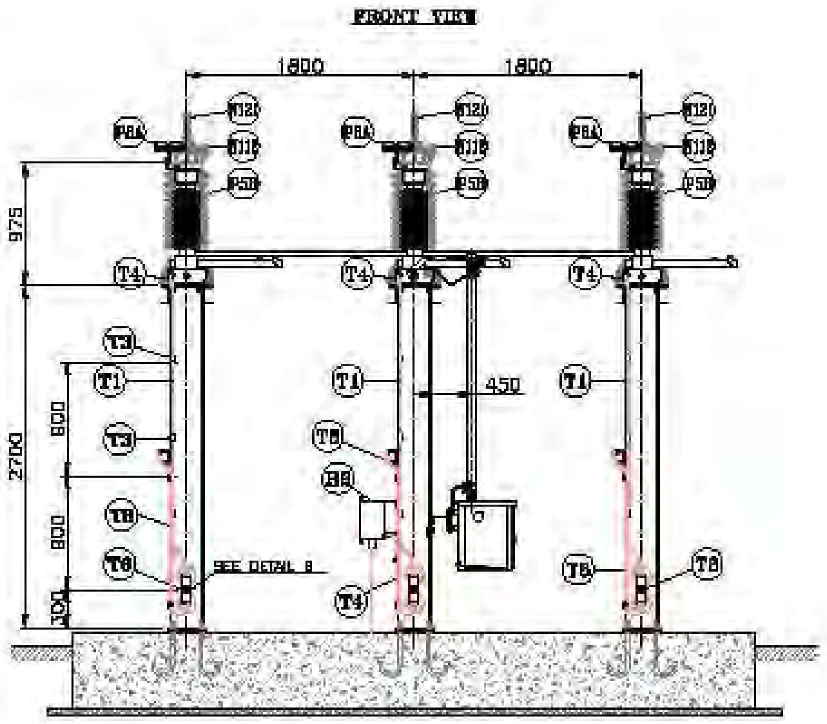


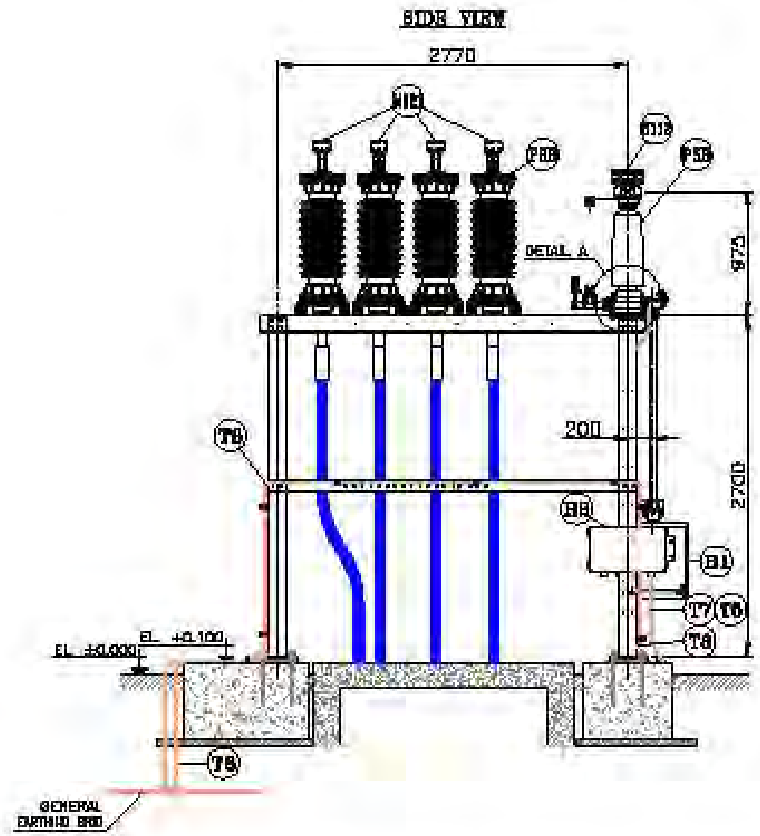


SUPPLIER DRAWING NO. FRA_FH_DW_1P2053_EL	03 (REV.)	2 (VER.)	CONFIDENTIAL	engage / F4E Barcelona
ISSUER (if not from Joint Venture): ITER Organization, 823/Office F204/F4E/Engage, Route de Vinon sur Verdon, 13115 St Paul lez Durance, France — ferrovial agroman			DRAWING TITLE: A&ID PBS 41.PP.-- PPEN 66kV P5B+P8B EARTHING SWITCH/CABLE TERMINATION EARTHING SWITCH 2050mm GALLERY SOUTH OF THE BAY	

SHEET SIZE	SCALE	DOC TYPE	NUMBER	PBS1	PBS2	PBS3 LEVELS	AA.AA.AA.	ISSUER	STATUS & REVISION	SHEETS
A3	1/50	DW	2053	41	--	-- --	--	-- FRA	AS 03.204	20

ITER_D_5E6RDA v1.0



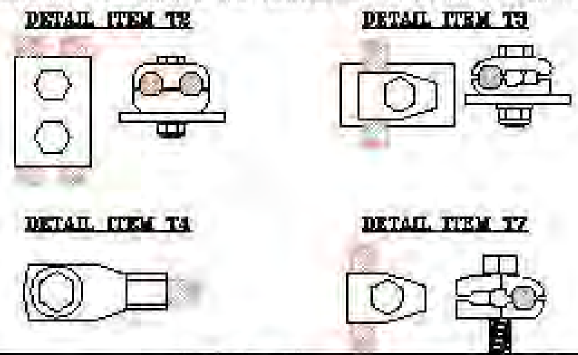


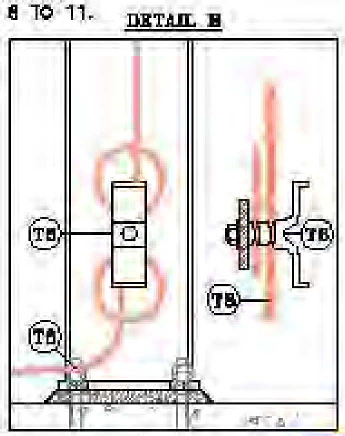
BILL OF MATERIALS

ITEM	DESCRIPTION	PART NUMBER	MANUFACTURER	QUANT
	EQUIPMENT			
P5A	EARTHING SWITCH (ACCORDING TO ITER_D_QEYFR7)	STA–72.5KV	ALSTOM	3
	EARTH			
T1	BARE COPPER CONDUCTOR SECTION 1x150mm²	–		8.5m
T2	EARTHING CLAMP FOR 2 BARE COPPER CONDUCTORS SECTION 150mm² UPON STRUCTURE	1208–1515	AUXIME	1
T3	EARTHING CLAMP FOR 1 BARE COPPER CONDUCTORS SECTION 150mm² UPON STRUCTURE	1228–15	AUXIME	9
T4	COMPRESSION STUD FOR BARE COPPER CONDUCTOR SECTION 150mm²/M14	2A 30–M 14	CEMBRE	5
T5	CONICAL PLASTIC ANCHOR RIBBED FOR BOLT ø12 mm, L=35	–	–	8
T6	EARTH ACCESSORY WITH DOUBLE WINGED SECTION 185mm²	ECLPAR 120-240	MALTEP	1
T7	COPPER GROUND CONNECTOR FOR COPPER CABLE TO BAR, BOLT 1/2", FOR CONDUCTOR 300 – 500 KCMIL / 150 –240 MM2.	GB34	BURNDY	8
T8	BARE COPPER CONDUCTOR. SECTION 185mm²	–	–	4,5m
T9	66kV EARTHING BOX CONNECTION TO EARTHING NETWORK BARE COPPER CONDUCTOR. SECTION 150mm²	–	–	1
P8A	OUTDOOR TERMINATION FEV 72–P PORCELAIN INSULATOR	–	–	(SEE NOTE 8)
N112	ASTER 570 CONDUCTOR – EARTHING SWITCH (STA) TERMINAL FLAT 90° (CONVERTER FEEDER) (SEE NOTE 7)	TL-570-90X15-N112	TBEA	3
N121	66 KV CABLE TERMINAL – 90° ASTER 570 CONDUCTOR (SEE NOTE 6)	TL-570/30-N121	TBEA	(SEE NOTE 8)
	FITTINGS			
H1	MECHANISM BOX (ACCORDING TO ITER_D_QEYFR7)	–	–	1
H2	EARTHING BOX BHX–01/JDX–01	–	–	1

NOTES:

1. FOR EQUIPMENT LAYOUT SEE FRA_FH_DW_1P2001_EL.
2. FOR ANCHORING DETAILS TO THE FOUNDATION SEE CIVIL DRAWINGS INDICATED IN INPUT DATA OF THE COVER SHEET.
3. FOR ANCHORS INFORMATION BETWEEN ELEMENTS REFER TO SHEET 8 OF THIS DOCUMENT.
4. MEASUREMENTS INDICATED HEREIN ARE IN mm UNLESS OTHERWISE STATED.
5. FOR GROUNDING INFORMATION OF THE CABLE SCREENS SEE SHEETS 8 TO 11.
6. FOR OUTPUT TO RPC OR TCR IS REPLACED BY N12.
7. FOR OUTPUT TO RPC OR TCR IS REPLACED BY N111.
8. QUANTITY DETERMINING THE NUMBER OF CONDUCTORS PER PHASE.



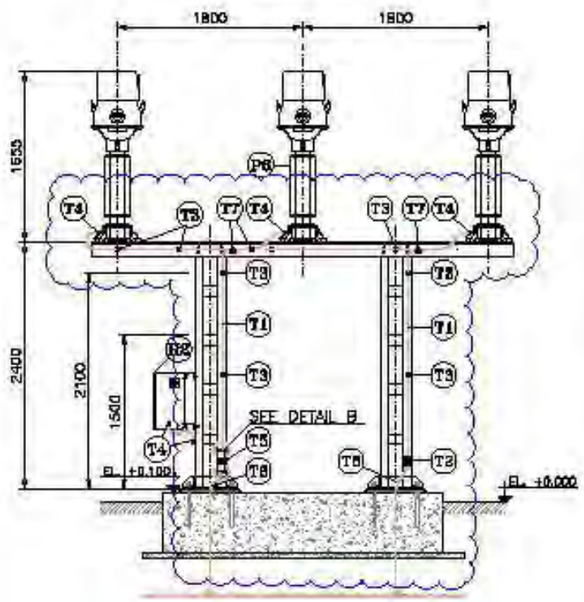


SUPPLIER DRAWING NO. FRA_FH_DW_1P2053_EL	03 (REV.)	2 (VER.)	CONFIDENTIAL	engage	F4E Barcelona
ISSUER (if not from Joint Venture): ITER Organization, B23/Office P204/F4E/Engage, Route de Vinon sur Verdon, 13115 St Paul lez Durance, France — ferrovial agroman			DRAWING TITLE: A&ID PBS 41.PP.-- PPEN 66kV P58+P88 EARTHING SWITCH/CABLE TERMINATION EARTHING SWITCH 2050mm GALLERY NORTH OF THE BAY		

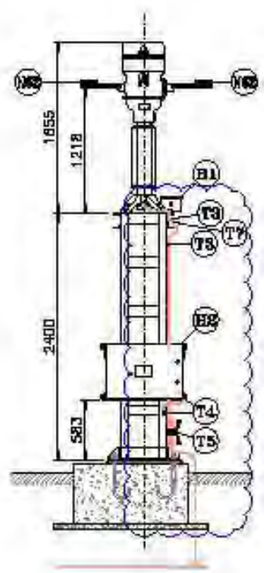
SHEET SIZE	SCALE	DOC TYPE	NUMBER	PBS1	PBS2	PBS3 LEVELS		AA.AA.AA.		ISSUER	STATUS & REVISION	SHEETS
A3	1/50	DW	2053	41	--	--	--	--	--	FRA	AS	03.205-20

ITER_D_5H3C7Y v1.0

FRONT VIEW



SIDE VIEW



BILL OF MATERIALS

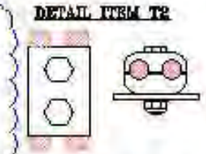
ITEM	DESCRIPTION	PART NUMBER	MANUFACTURER	QUANT
	EQUIPMENT			
P6	CURRENT TRANSFORMER (ACCORDING TO ITER_D_QFDJ7R V02.0)	KGSK72.5	TRENCH CHINA NWB (SHANGHAI) CO. LTD.	3
	EARTH			
T1	BARE COPPER CONDUCTOR. SECTION 150mm²	–	–	8.5m
T2	EARTHING CLAMP FOR 2 BARE COPPER CONDUCTORS SECTION 150mm² UPON STRUCTURE	1208–1515	AUXIME	4
T3	EARTHING CLAMP FOR 1 BARE COPPER CONDUCTORS SECTION 150mm² UPON STRUCTURE	1228–15	AUXIME	4
T4	COMPRESSION STUD FOR BARE COPPER CONDUCTOR SECTION 150mm²/M10	2A 30–M14	CEMBRE	5
T5	TWIN WINGS EARTH CLAMP	2CLAM 120-240	MALTEP	1
T6	BARE COPPER CONDUCTOR. SECTION 185mm²	–	–	4m
N62	ASTER 570 DUPLEX CONDUCTOR – CURRENT XMER TERMINAL FLAT 0° (CONVERTER FEEDER) SEE NOTE 7	SL-9A-15R10-N62	TBEA	6
	FITTINGS			
H1	TERMINAL BOX (ACCORDING TO ITER_D_QFDJ7R)			1
H2	MARSHALLING CUBICLE (ACCORDING TO ITER_D_QFDJ7R)			1

NOTE:

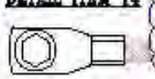
1. FOR 66KV EQUIPMENT LAYOUT SEE FRA_FH_DW_1P2001_EL.
2. FOR ANCHORING DETAILS TO THE FOUNDATION SEE CIVIL DRAWINGS. INDICATED IN INPUT DATA OF THE COVER SHEET.
3. FOR ANCHORS INFORMATION BETWEEN ELEMENTS REFER TO SHEET 10.
4. FOR EARTHING CONNECTION DETAILS TO IPEG, SEE EARTHING DRAWINGS INDICATED IN INPUT DATA OF THE COVER SHEET.
5. FOR CONNECTION DETAILS SEE FRA_FH_DW_1P420B_EL.
6. MEASUREMENTS INDICATED HEREIN ARE IN mm UNLESS OTHERWISE STATED
7. FOR OUTPUT TO RPC OR TCR IS REPLACED BY:
   N6 ASTER 570 DUPLEX CONDUCTOR – CURRENT XMER TERMINAL FLAT 0° (QTY=3)
   N61ASTER 570 DUPLEX CONDUCTOR – CURRENT XMER TERMINAL FLAT 45°(QTY=3)

DETAIL ITEM T7

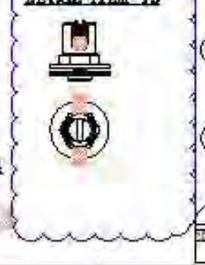
DETAIL ITEM T2



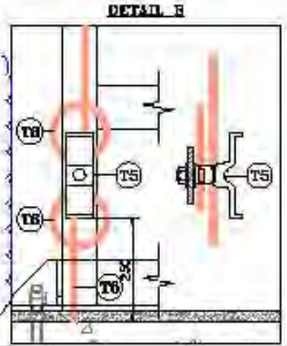
DETAIL ITEM T4



DETAIL ITEM T3



DETAIL B

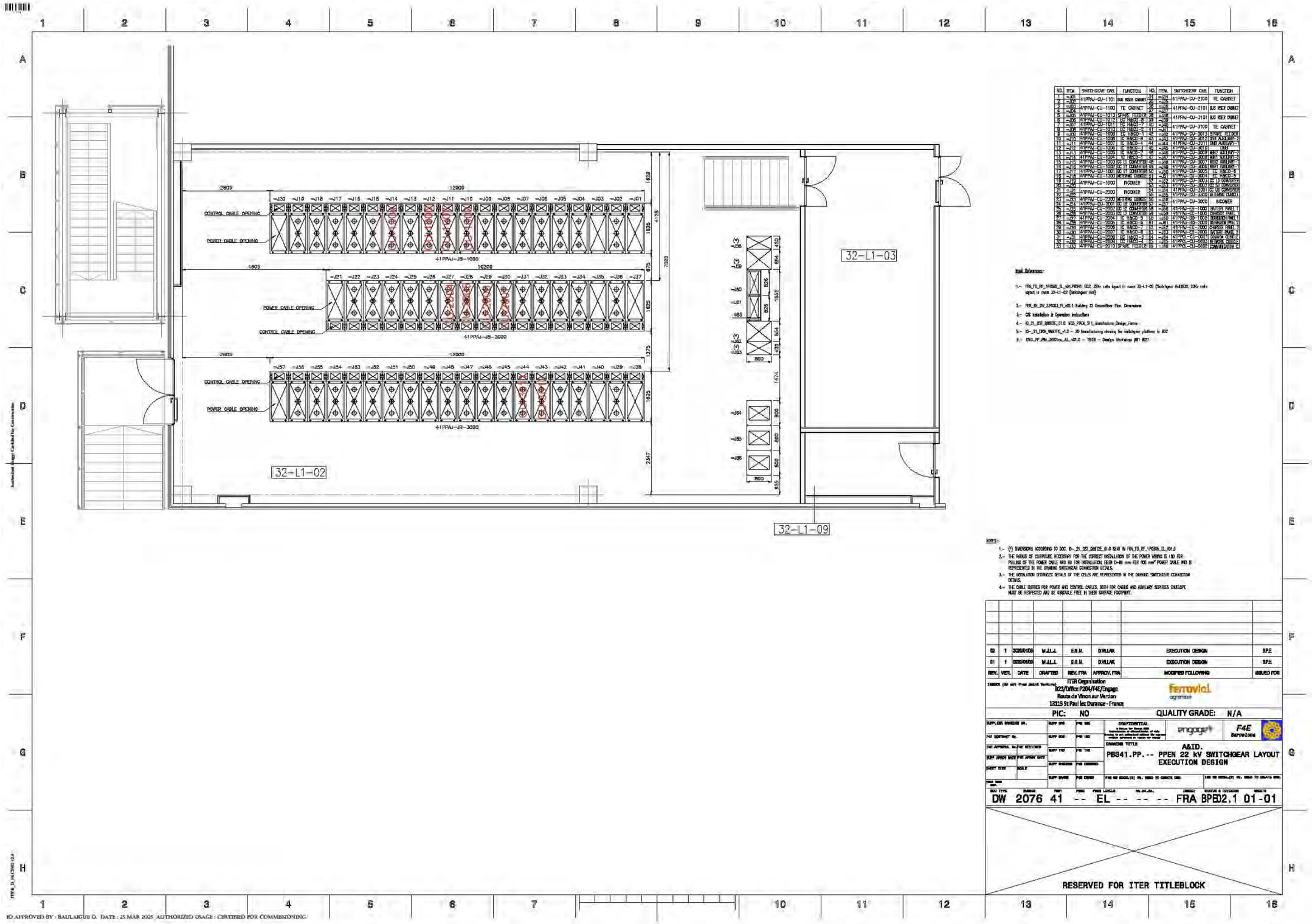


SUPPLIER DRAWING NO.		01	2	CONFIDENTIAL	engage	F4E Barcelona
FRA_FH_DW_1P2054_EL		REV.	VER.			
ISSUER(if not from Joint Venture)		DRAWING TITLE				
ITER Organization B23/Office P204/F4E/Engage Route de Vinon sur Verdon 13115 St Paul lez Durance France	ferrovial agroman	A&ID PBS 41.PP.-- PPEN 66kV P6 CURRENT TRANSFORMER CURRENT TRANSFORMER - FEEDERS OUTGOINGS				

SHEET SIZE	SCALE	DOC TYPE	NUMBER	PBS	FBS	FBS LEVEL6	AA.AA.AA.	ISSUER	STATUS & REVISION	SHEETS
A3	1/50	DW	2054	41	--	-- -- -- -- --		FRA	AS 01.202-11	

16.3.4 PPEN 22kV GIS layout

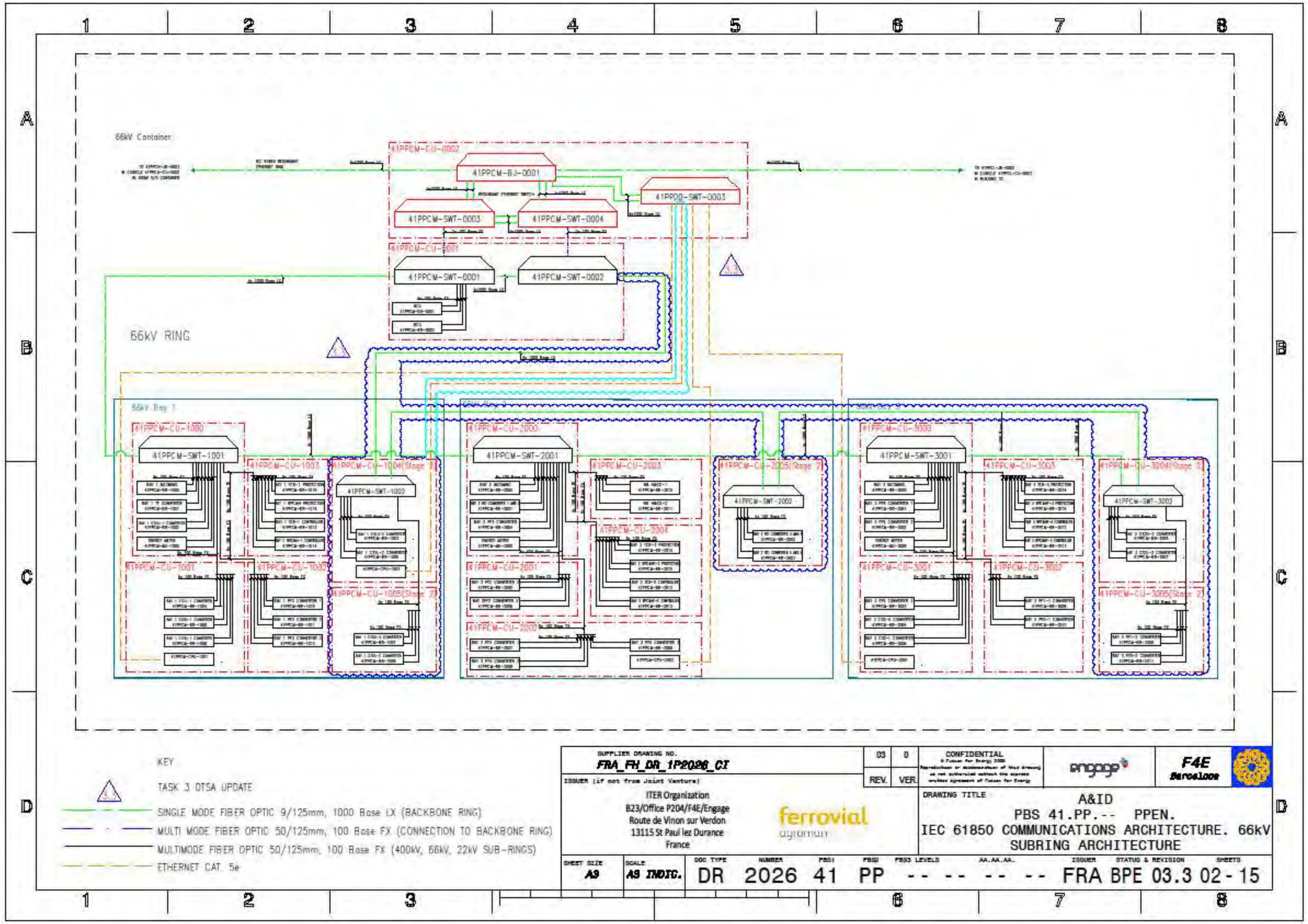
22kV GIS switchgears had been installed in 22kV GIS switchgear room (32-L1-02). The layout [RD28] of 22kV GIS switchgear room is for reference.
The nine (9) circuits of 22kV cables which had been laid to B15-L1-03 will need to reconnected to the 22kV GIS switchgears as highlighted in this layout on the next page.


32-L1-02
32-L1-03
32-L1-09
41PPAJ-JB-1000
41PPAJ-JB-2000
41PPAJ-JB-3000
CONTROL CABLE OPENING
POWER CABLE OPENING
12000
10200
RESERVED FOR ITER TITLEBLOCK

16.4 I&C documentation

16.4.1 PPEN 66kV I&C architecture

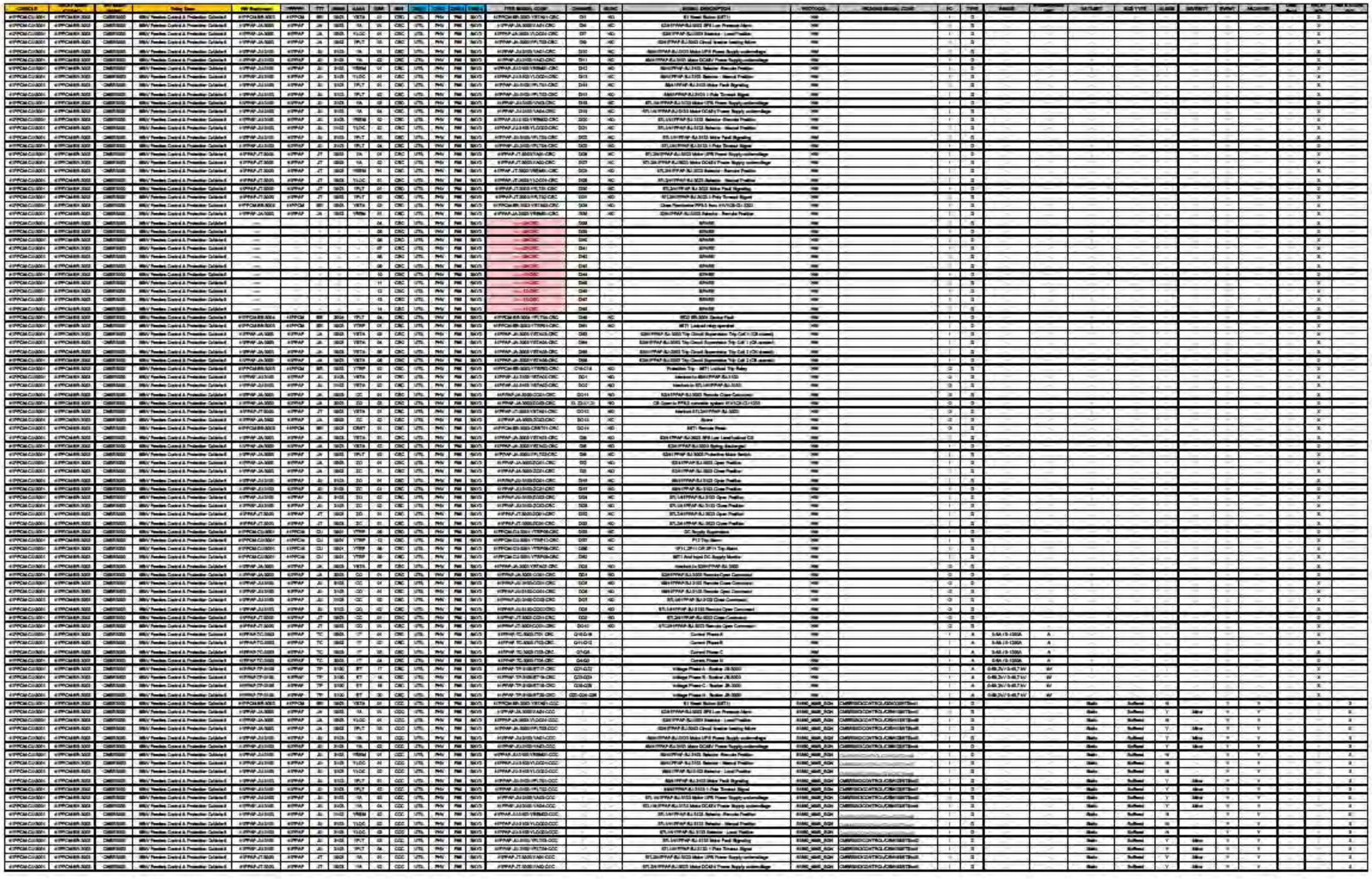
IEC 61850 subring are constructed with the protection & control relays of PPEN 66kV stage 1. Considering the existing switches has no sufficient ports for the connection of protection &control relays of PPEN 66kV stage 2, new switches will be necessary for connecting the 10 relays to IEC 61850 network.
Appendix 16.2.6 is a preliminary configuration of I&C cubicles with protection & control relays, Ethernet switches and PLC. It might be optimized in future in the design phases in terms of Ethernet switch. Then the Contractor shall update the architecture according to its proposal accordingly as of Preliminary Design.


66kV Container
41PPCM-CU-0002
41PPCM-GJ-0001
41PPCM-SWT-0003
41PPCM-SWT-0004
41PPCM-CU-0001
41PPCM-SWT-0001
41PPCM-SWT-0002
66kV RING
66kV Bay 1
41PPCM-CU-1000
41PPCM-SWT-1001
41PPCM-CU-1003
41PPCM-CU-1004(Stage 2)
41PPCM-SWT-1002
41PPCM-CU-1001
41PPCM-CU-1002
41PPCM-CU-1005(Stage 2)
41PPCM-CU-2000
41PPCM-SWT-2001
41PPCM-CU-2003
41PPCM-CU-2004
41PPCM-CU-2005(Stage 2)
41PPCM-SWT-2002
41PPCM-CU-2001
41PPCM-CU-2002
41PPCM-CU-3000
41PPCM-SWT-3001
41PPCM-CU-3003
41PPCM-CU-3004(Stage 2)
41PPCM-SWT-3003
41PPCM-CU-3001
41PPCM-CU-3002
41PPCM-CU-3005(Stage 2)
KEY
TASK 3 OTSA UPDATE
SINGLE MODE FIBER OPTIC 9/125mm, 1000 Base LX (BACKBONE RING)
MULTI MODE FIBER OPTIC 50/125mm, 100 Base FX (CONNECTION TO BACKBONE RING)
MULTIMODE FIBER OPTIC 50/125mm, 100 Base FX (400kV, 66kV, 22kV SUB-RINGS)
ETHERNET CAT. 5e
SUPPLIER DRAWING NO.
FRA_FH_DR_1P2026_CI
03
0
REV.
VER.
CONFIDENTIAL
ISSUER (if not from Joint Venture)
ITER Organization
B23/Office P204/F4E/Engage
Route de Vinon sur Verdon
13115 St Paul lez Durance
France
ferrovial agroman
engage
F4E
Barcelona
DRAWING TITLE
A&ID
PBS 41.PP.-- PPEN.
IEC 61850 COMMUNICATIONS ARCHITECTURE. 66kV
SUBRING ARCHITECTURE
SHEET SIZE
A3
SCALE
A3 INDIC.
DOC TYPE
DR
NUMBER
2026
PBS1
41
PBS2
PP
PBS3 LEVELS
-- -- -- --
AA.AA.AA.
ISSUER
FRA
STATUS & REVISION
BPE 03.3
SHEETS
02 - 15

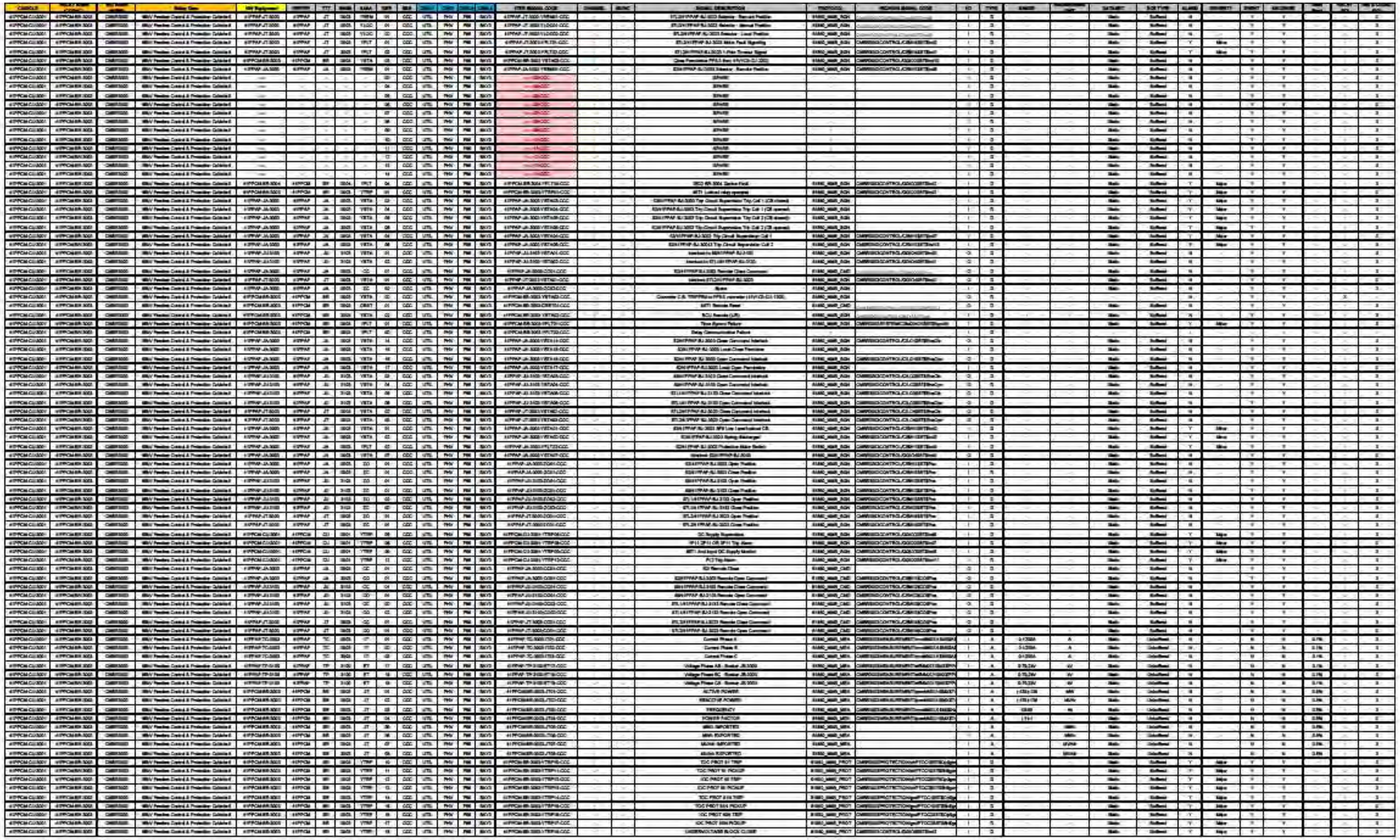
16.4.2 Typical I/O signals of one feeder.

One typical IO signal listed for one feeder is provided for reference only. The Contractor shall develop its own signal list at FDR and update it as per the manufacturing design at manufacturing phase onwards.

Technical Specifications



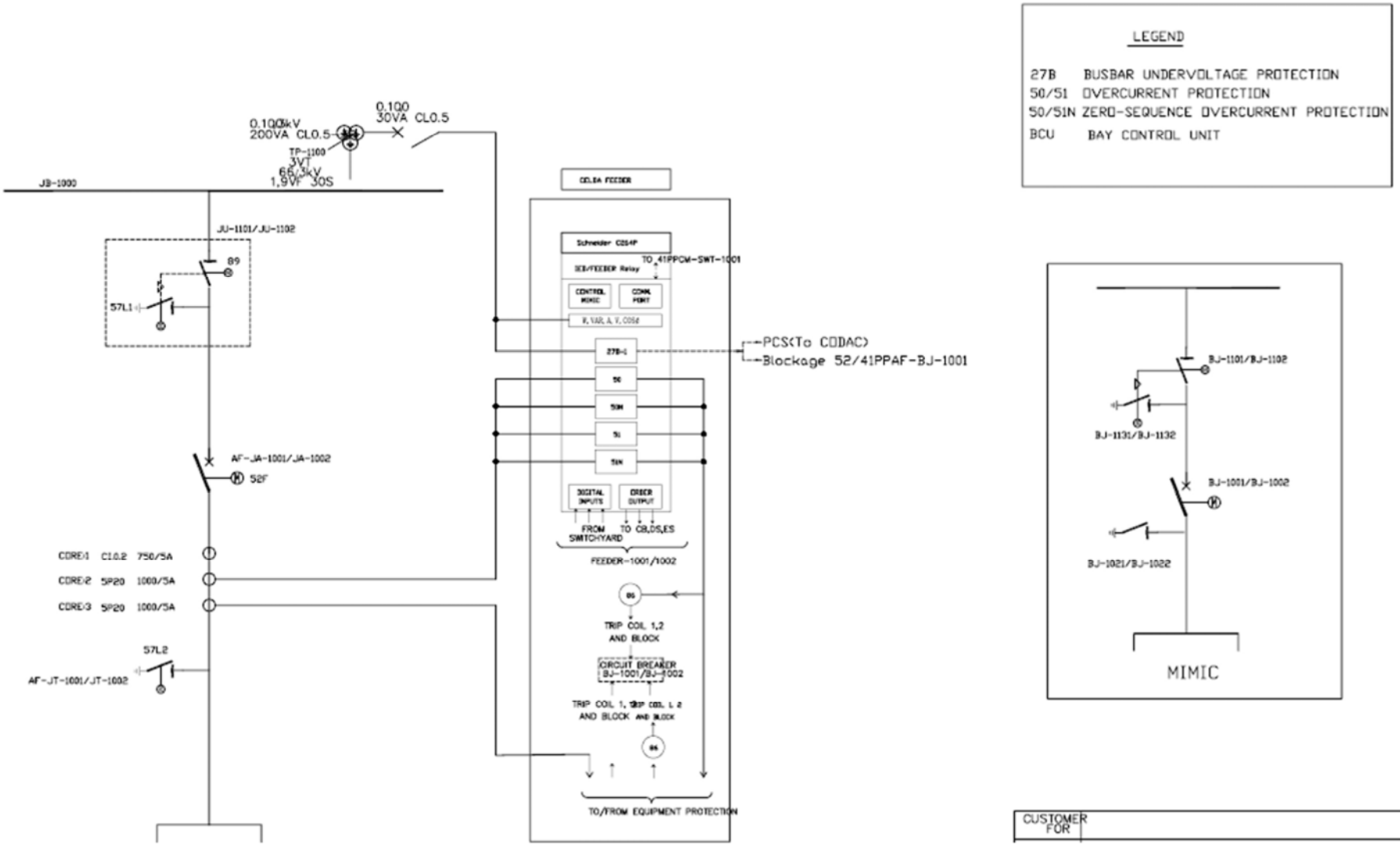
Technical Specifications

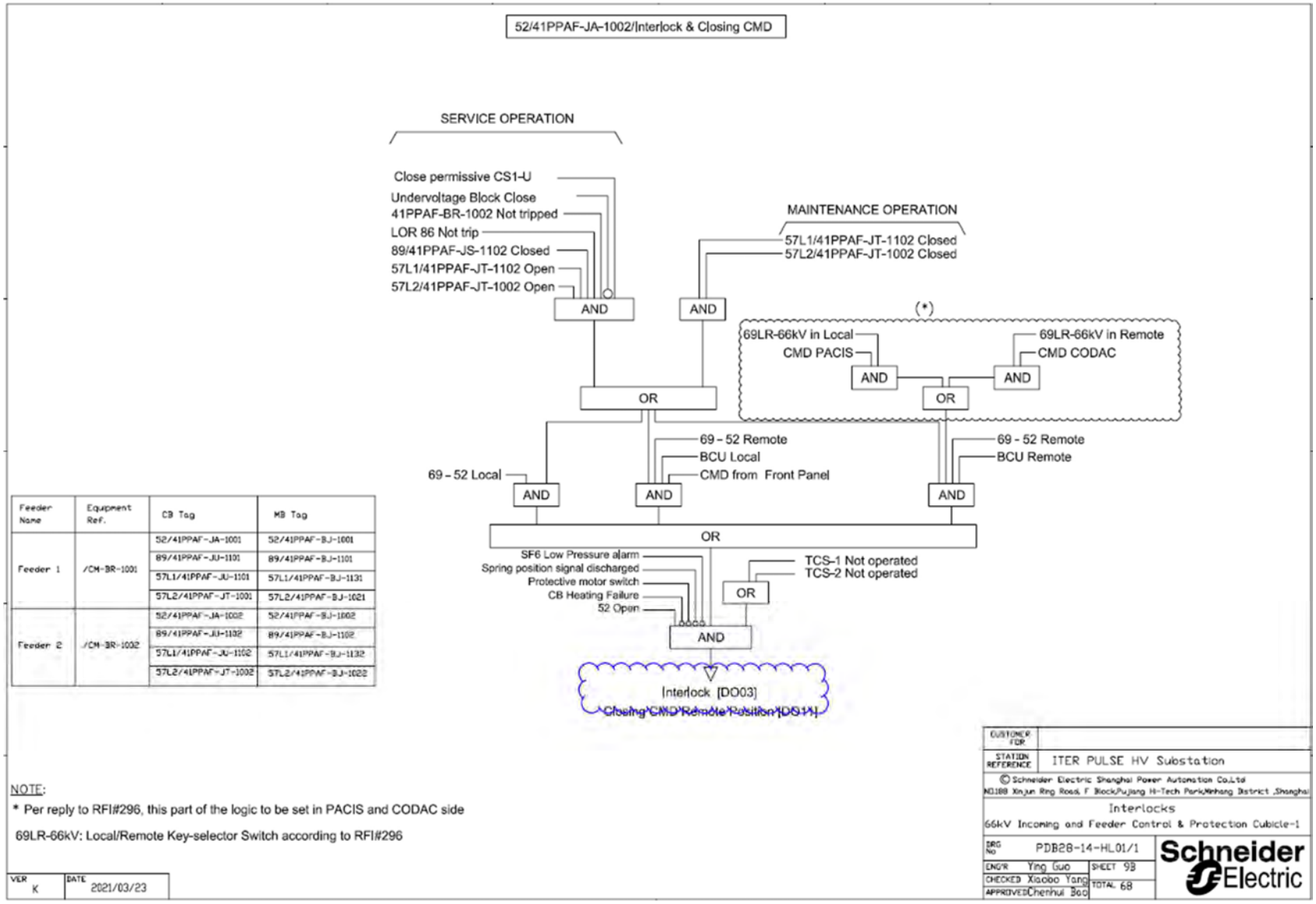


16.4.3 Protection & Control Cubicle Schematic (for reference ONLY)

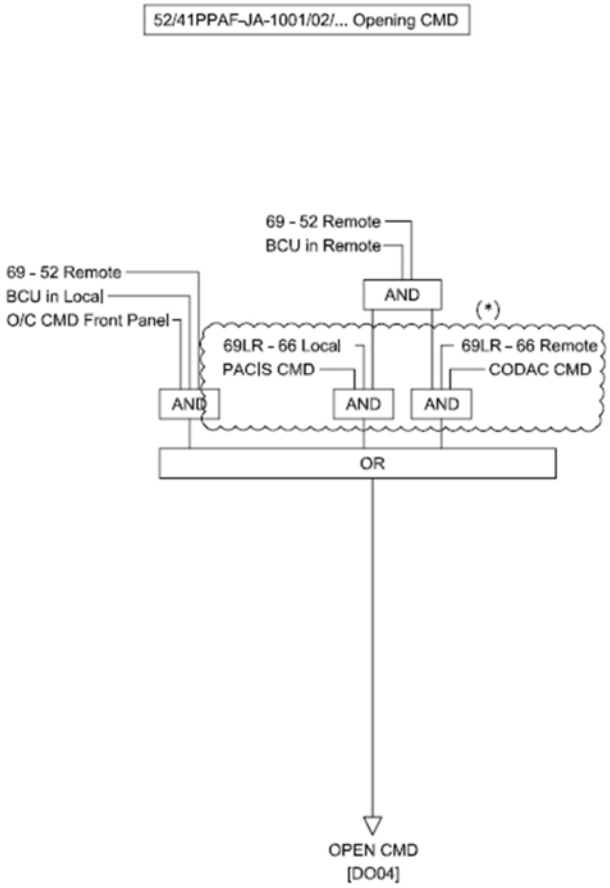
A typical schematic for one I&C cubicles 41PPCM-CU-3001 is provided for reference only.
Each Protection &Control cubicles shall accommodate the control circuit for two feeders on the same 66kV busbar.
Principally, the Contractor and the Supplier shall follow the control logics as shown on following pages extracted from [RD18].
The Contractor and the Supplier shall develop the Assembly & Installation design as per the as-manufactured drawing of 66kV outdoor equipment.

Technical Specifications




52/41PPAF-JA-1002/Interlock & Closing CMD
SERVICE OPERATION
Close permissive CS1-U
Undervoltage Block Close
41PPAF-BR-1002 Not tripped
LOR 86 Not trip
89/41PPAF-JS-1102 Closed
57L1/41PPAF-JT-1102 Open
57L2/41PPAF-JT-1002 Open
MAINTENANCE OPERATION
57L1/41PPAF-JT-1102 Closed
57L2/41PPAF-JT-1002 Closed
AND
AND
(*)
69LR-66kV in Local
CMD PACIS
69LR-66kV in Remote
CMD CODAC
AND
AND
OR
OR
69 - 52 Local
69 - 52 Remote
BCU Local
CMD from Front Panel
69 - 52 Remote
BCU Remote
AND
AND
AND
OR
SF6 Low Pressure alarm
Spring position signal discharged
Protective motor switch
CB Heating Failure
52 Open
TCS-1 Not operated
TCS-2 Not operated
OR
AND
Interlock [DO03]
Closing CMD Remote Position [DO11]
Feeder Name
Equipment Ref.
CB Tag
MB Tag
Feeder 1
/CM-BR-1001
52/41PPAF-JA-1001
52/41PPAF-BJ-1001
89/41PPAF-JU-1101
89/41PPAF-BJ-1101
57L1/41PPAF-JU-1101
57L1/41PPAF-BJ-1131
57L2/41PPAF-JT-1001
57L2/41PPAF-BJ-1021
Feeder 2
/CM-BR-1002
52/41PPAF-JA-1002
52/41PPAF-BJ-1002
89/41PPAF-JU-1102
89/41PPAF-BJ-1102
57L1/41PPAF-JU-1102
57L1/41PPAF-BJ-1132
57L2/41PPAF-JT-1002
57L2/41PPAF-BJ-1022
NOTE:
* Per reply to RFI#296, this part of the logic to be set in PACIS and CODAC side
69LR-66kV: Local/Remote Key-selector Switch according to RFI#296
VER
K
DATE
2021/03/23
CUSTOMER FOR
STATION REFERENCE
ITER PULSE HV Substation
© Schneider Electric Shanghai Power Automation Co.Ltd
Interlocks
66kV Incoming and Feeder Control & Protection Cubicle-1
DRG No
PDB28-14-HL01/1
ENG'R Ying Guo
SHEET 9B
CHECKED Xiaobo Yang
TOTAL 68
APPROVED Chenhui Bao
Schneider Electric

Technical Specifications



Feeder Name	Equipment Ref.	CB Tag	MB Tag
Feeder 1	/CM-BR-1001	52/41PPAF-JA-1001	52/41PPAF-BJ-1001
		89/41PPAF-JU-1101	89/41PPAF-BJ-1101
		57L1/41PPAF-JU-1101	57L1/41PPAF-BJ-1131
		57L2/41PPAF-JT-1001	57L2/41PPAF-BJ-1021
Feeder 2	/CM-BR-1002	52/41PPAF-JA-1002	52/41PPAF-BJ-1002
		89/41PPAF-JU-1102	89/41PPAF-BJ-1102
		57L1/41PPAF-JU-1102	57L1/41PPAF-BJ-1132
		57L2/41PPAF-JT-1002	57L2/41PPAF-BJ-1022

NOTE:

* Per reply to RFI#296, this part of the logic to be set in PACIS and CODAC side 69LR-66kV: Local/Remote Key-selector Switch according to RFI#296

VER	DATE
K	2021/03/23

CUSTOMER FOR	
STATION REFERENCE	ITER PULSE HV Substation

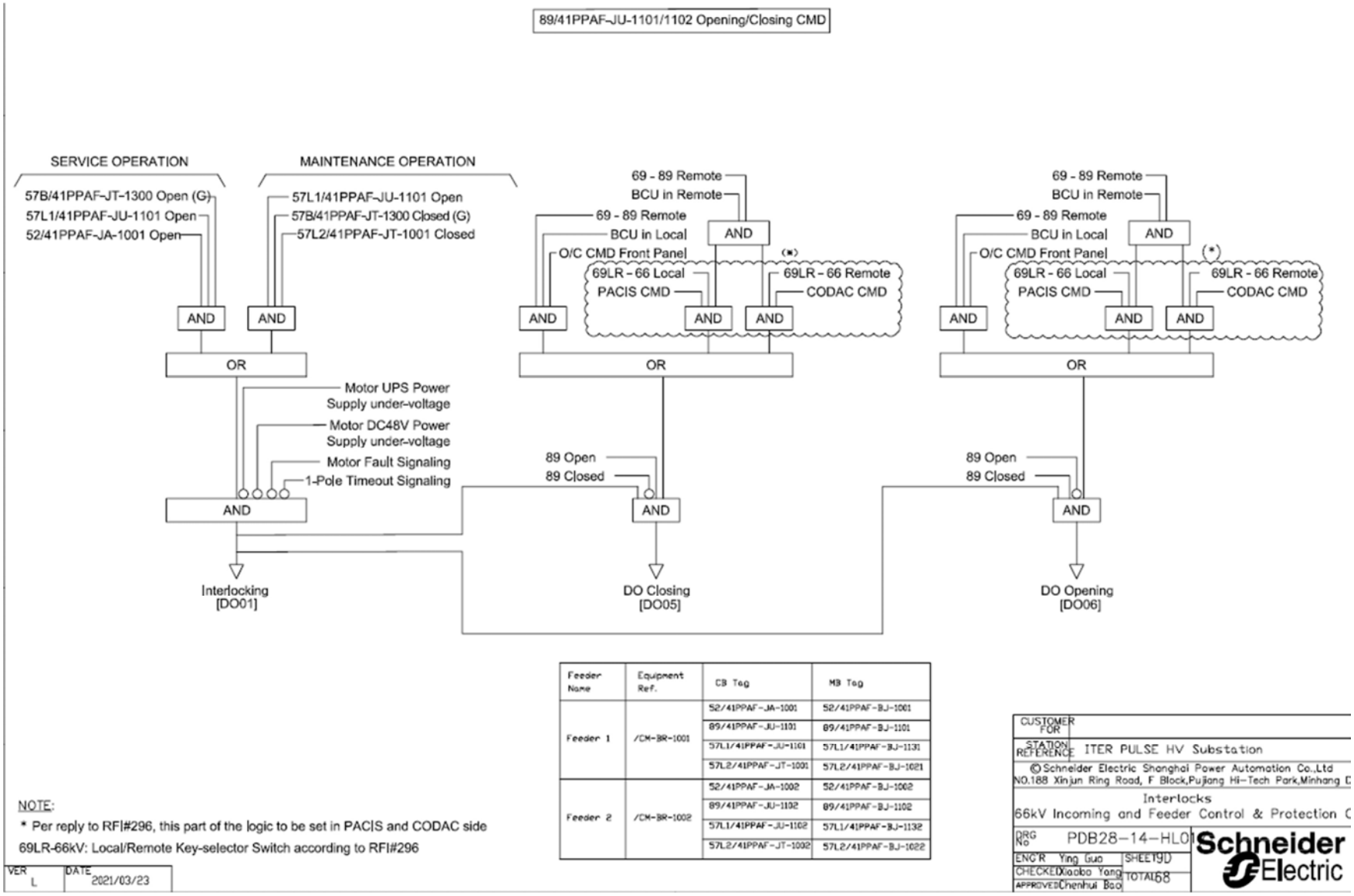
NO.188 Xinjun Ring Road, F Block,Pujiang Hi-Tech Park,Minhang District ,Shanghai

Interlocks

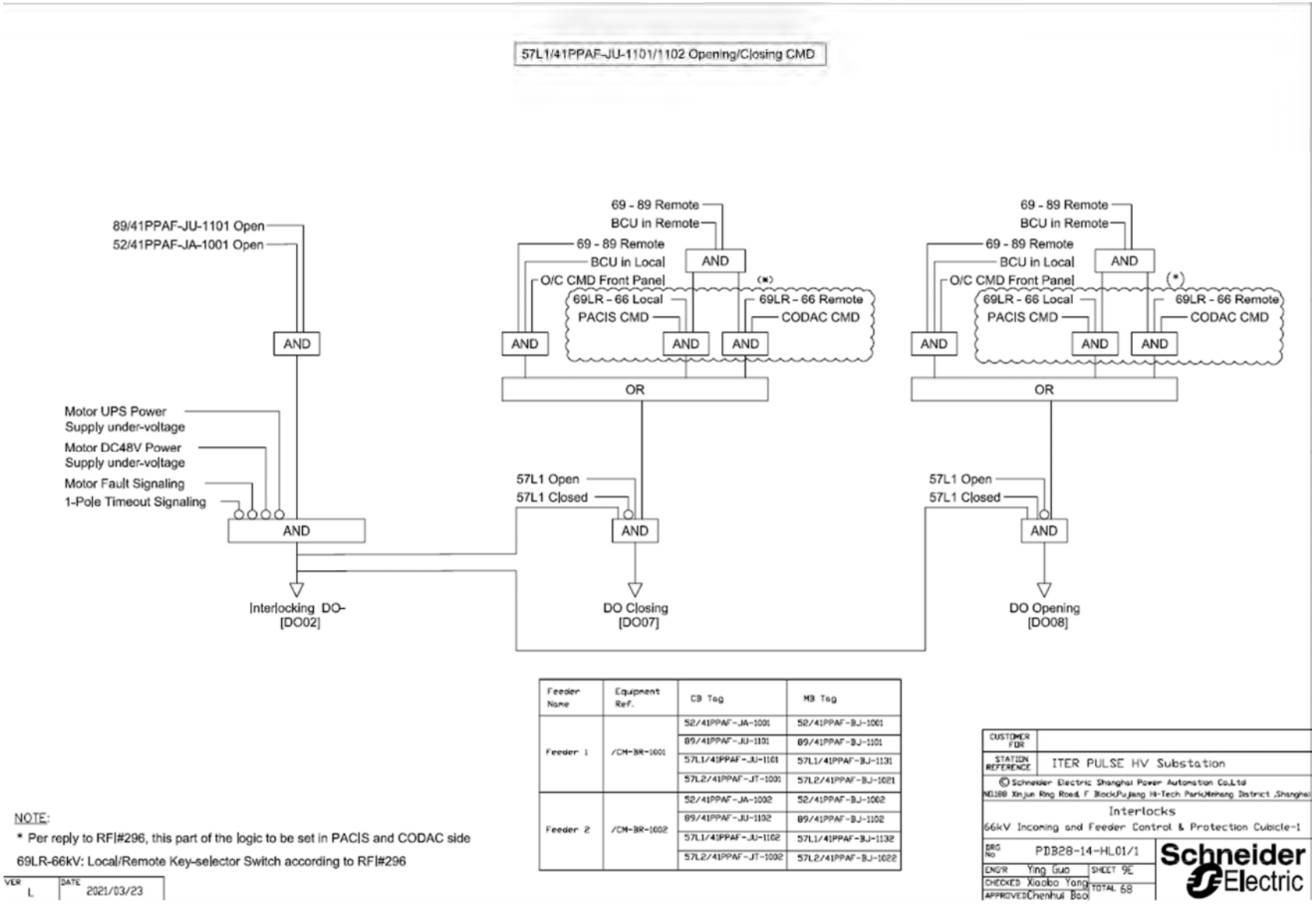
66kV Incoming and Feeder Control & Protection Cubicle-1

DRG No	PDB28-14-HL01/1		
ENG'R	Ying Guo	SHEET	9C
CHECKED	Xiaobo Yang	TOTAL	68
APPROVED	Chenhui Bao		

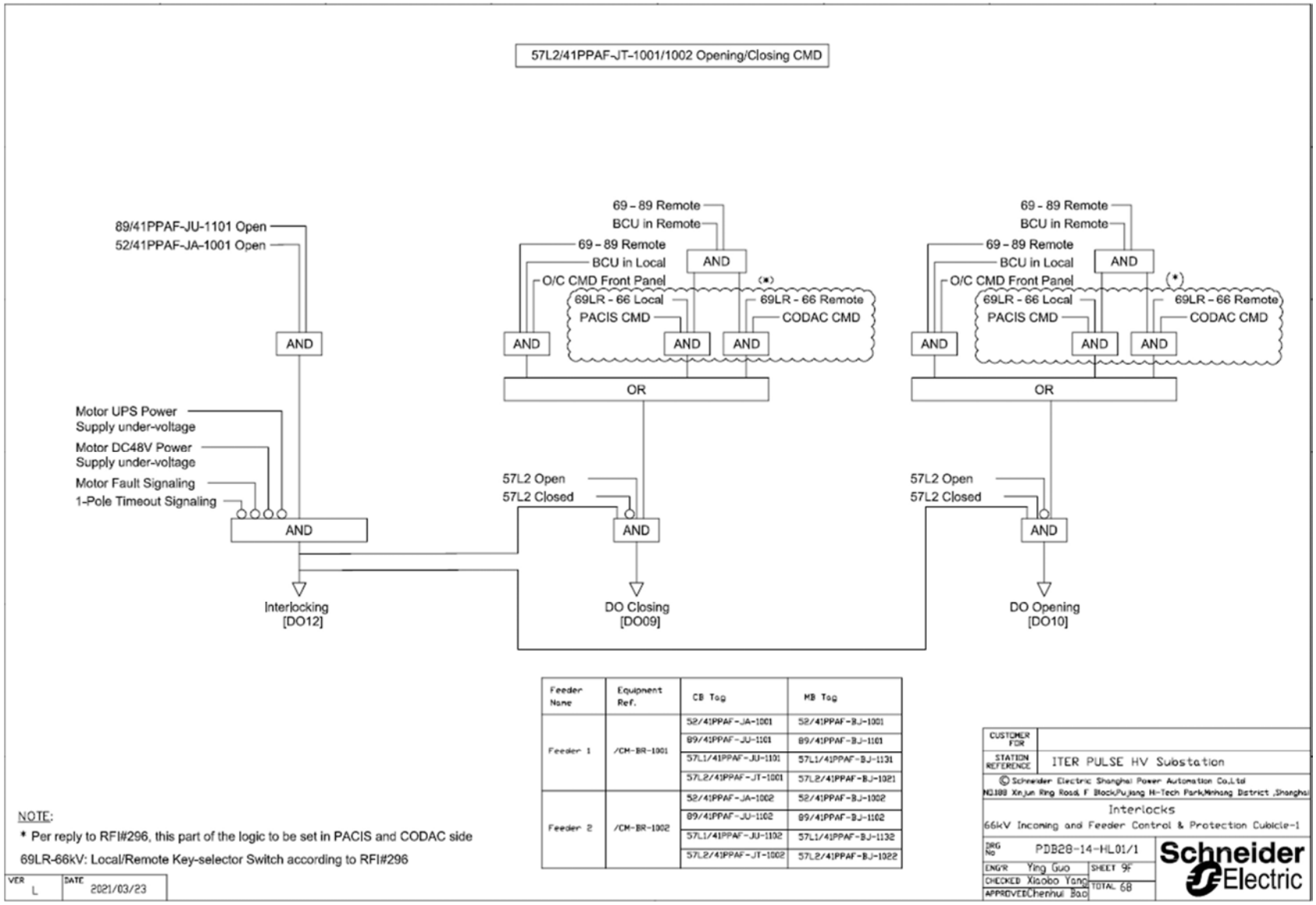
Schneider Electric



Feeder Name	Equipment Ref.	CB Tag	MB Tag
Feeder 1	/CM-BR-1001	52/41PPAF-JA-1001	52/41PPAF-BJ-1001
		89/41PPAF-JU-1101	89/41PPAF-BJ-1101
		57L1/41PPAF-JU-1101	57L1/41PPAF-BJ-1131
		57L2/41PPAF-JT-1001	57L2/41PPAF-BJ-1021
Feeder 2	/CM-BR-1002	52/41PPAF-JA-1002	52/41PPAF-BJ-1002
		89/41PPAF-JU-1102	89/41PPAF-BJ-1102
		57L1/41PPAF-JU-1102	57L1/41PPAF-BJ-1132
		57L2/41PPAF-JT-1002	57L2/41PPAF-BJ-1022

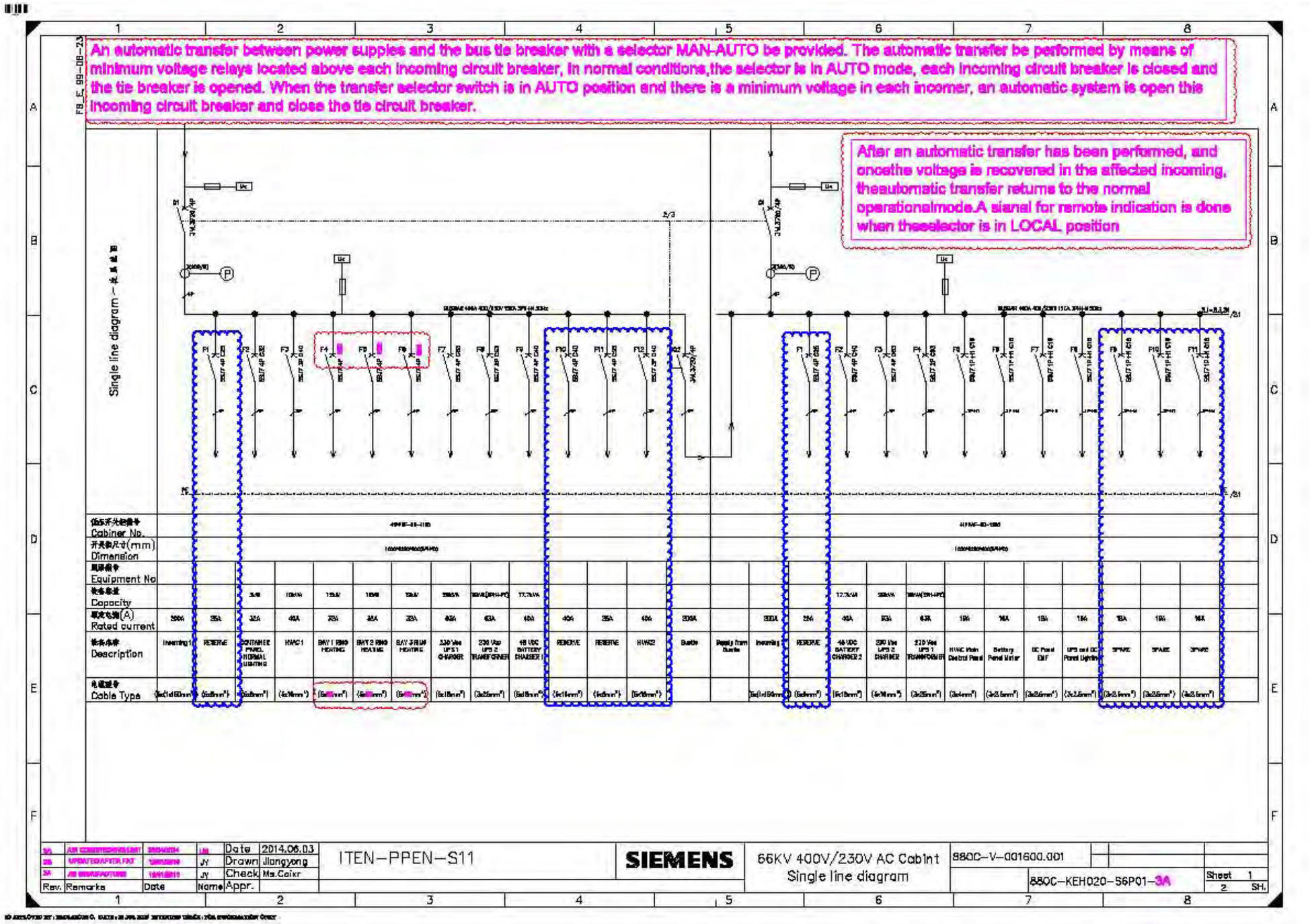

57L1/41PPAF-JU-1101/1102 Opening/Closing CMD
89/41PPAF-JU-1101 Open
52/41PPAF-JA-1001 Open
AND
Motor UPS Power Supply under-voltage
Motor DC48V Power Supply under-voltage
Motor Fault Signaling
1-Pole Timeout Signaling
AND
Interlocking DO- [DO02]
69 - 89 Remote
BCU in Remote
69 - 89 Remote
BCU in Local
O/C CMD Front Panel
AND
(*)
69LR - 66 Local
PACIS CMD
69LR - 66 Remote
CODAC CMD
AND
AND
AND
OR
57L1 Open
57L1 Closed
AND
DO Closing [DO07]
69 - 89 Remote
BCU in Remote
69 - 89 Remote
BCU in Local
O/C CMD Front Panel
AND
(*)
69LR - 66 Local
PACIS CMD
69LR - 66 Remote
CODAC CMD
AND
AND
AND
OR
57L1 Open
57L1 Closed
AND
DO Opening [DO08]
NOTE:
* Per reply to RFI#296, this part of the logic to be set in PACIS and CODAC side
69LR-66kV: Local/Remote Key-selector Switch according to RFI#296
VER L
DATE 2021/03/23
Feeder Name
Equipment Ref.
CB Tag
MB Tag
Feeder 1
/CM-BR-1001
52/41PPAF-JA-1001
52/41PPAF-BJ-1001
89/41PPAF-JU-1101
89/41PPAF-BJ-1101
57L1/41PPAF-JU-1101
57L1/41PPAF-BJ-1131
57L2/41PPAF-JT-1001
57L2/41PPAF-BJ-1021
Feeder 2
/CM-BR-1002
52/41PPAF-JA-1002
52/41PPAF-BJ-1002
89/41PPAF-JU-1102
89/41PPAF-BJ-1102
57L1/41PPAF-JU-1102
57L1/41PPAF-BJ-1132
57L2/41PPAF-JT-1002
57L2/41PPAF-BJ-1022
CUSTOMER FOR
STATION REFERENCE
ITER PULSE HV Substation
© Schneider Electric Shanghai Power Automation Co.,Ltd
NO.188 Xinjun Ring Road F Block,Fujiang Hi-Tech Park,Minhang District ,Shanghai
Interlocks
66kV Incoming and Feeder Control & Protection Cubicle-1
DRG No PDB28-14-HL01/1
ENG'R Ying Guo
SHEET 9E
CHECKED Xiaobo Yang
TOTAL 58
APPROVED Chenhui Bao
Schneider Electric

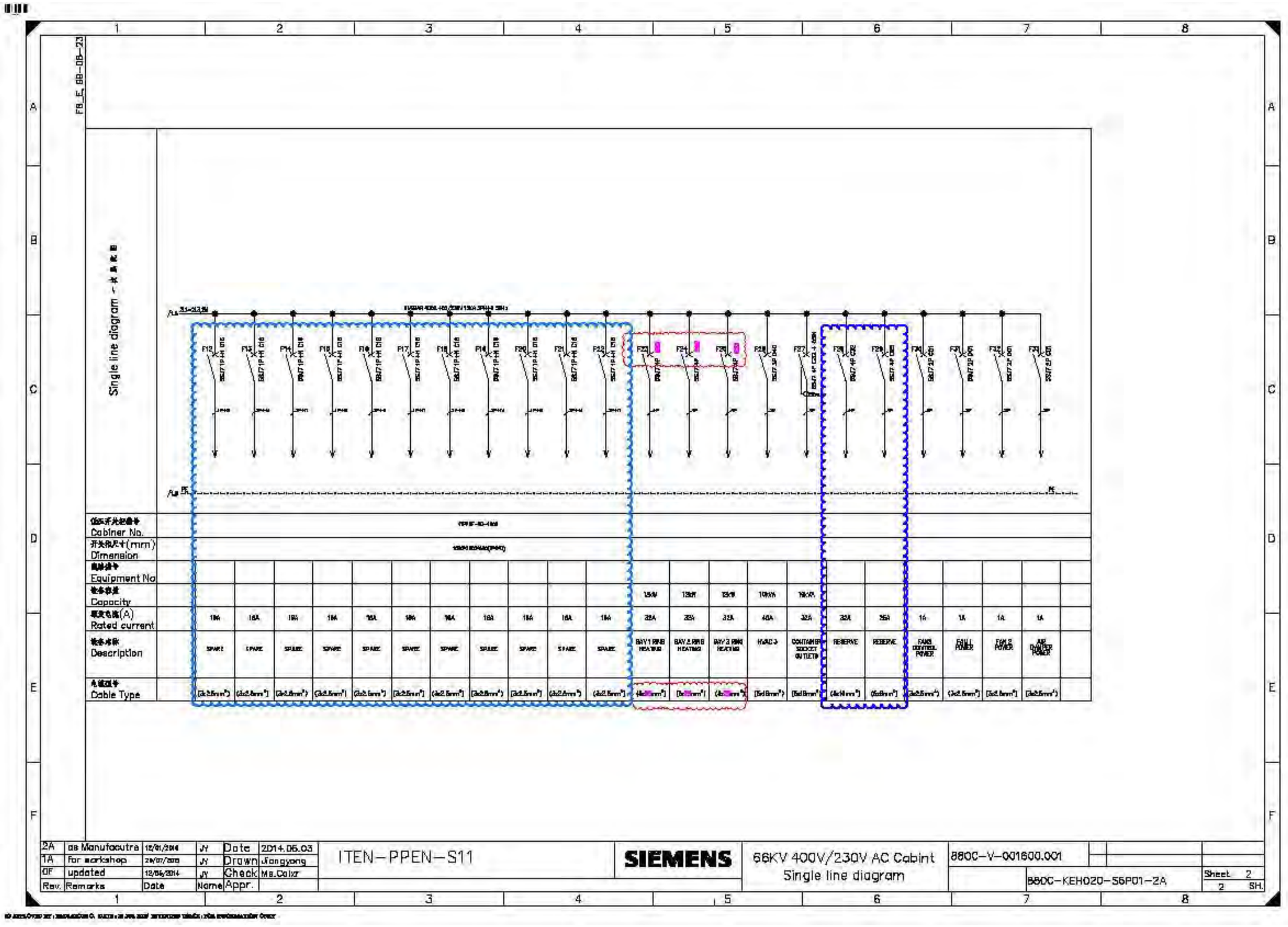
Technical Specifications



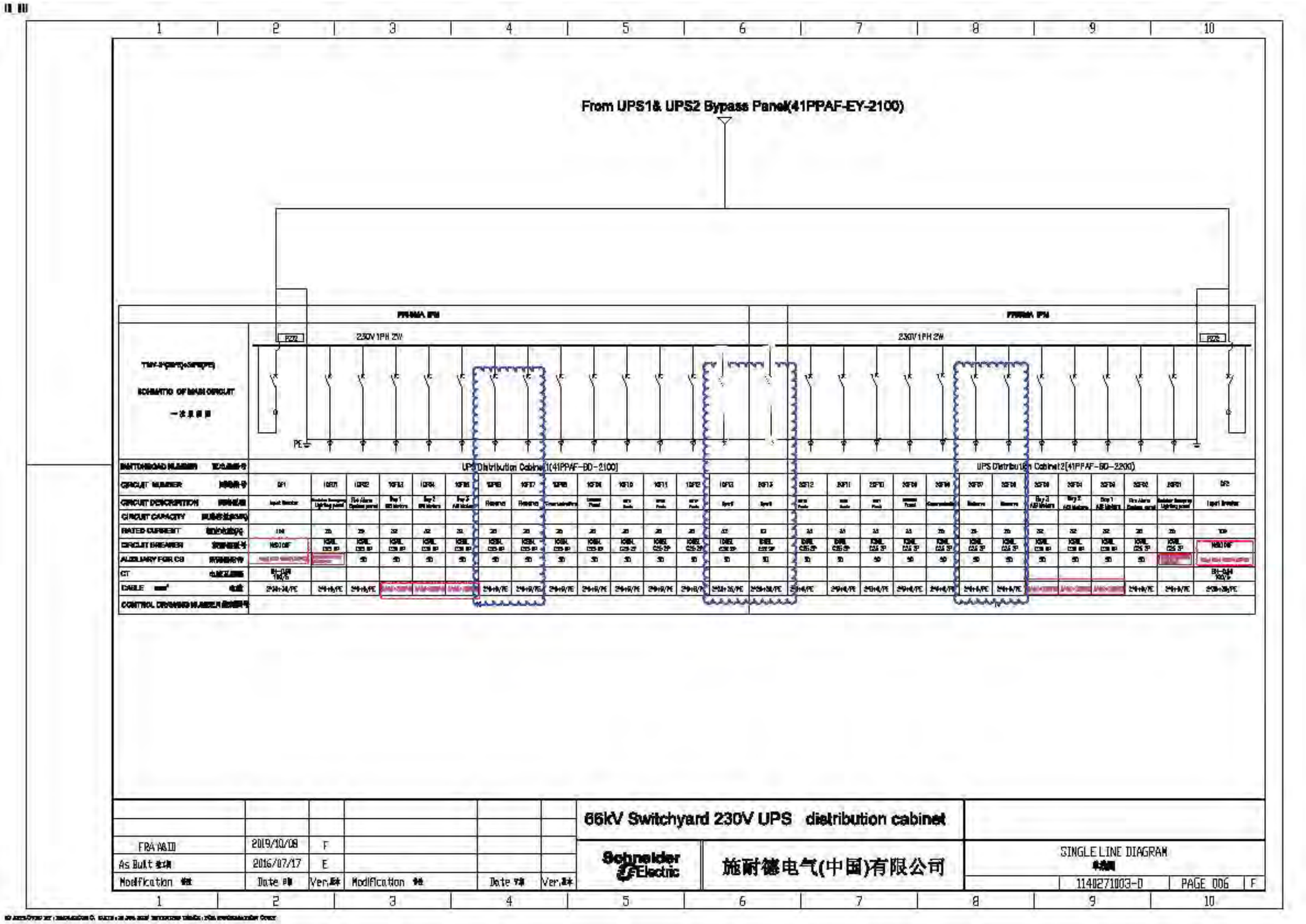
16.5 Substation Auxiliary Services One Line Diagram

16.5.1 Single Line Diagram AC 400V/230V

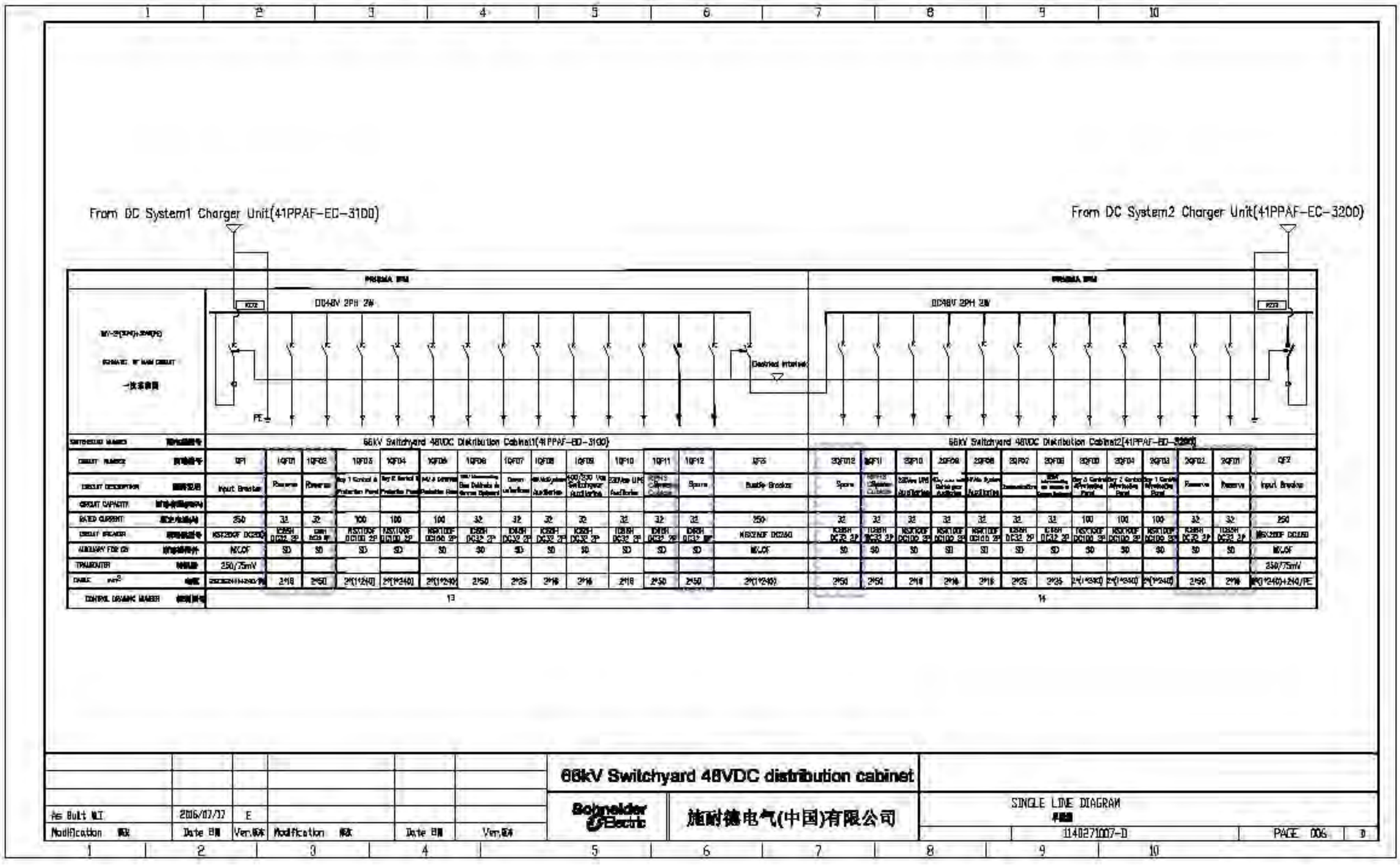



Single line diagram
Cabiner No.
Dimension
Equipment No
Capacity
Rated current
Description
Cable Type
SPARE
BAY 1 RMB HEATING
BAY 2 RMB HEATING
BAY 3 RMB HEATING
HVAC 3
CONTAINER SOCKET OUTLETS
RESERVE
RESERVE
FANS CONTROL POWER
FAN 1 POWER
FAN 2 POWER
AIR CONDITIONER POWER
ITEN-PPEN-S11
SIEMENS
66KV 400V/230V AC Cabint
Single line diagram
880C-V-001600.001
880C-KEH020-S6P01-2A
Sheet 2
2 SH.

16.5.2 Single Line Diagram-UPS AC 230V



16.5.3 Single Line Diagram-DC 48V



16.6 PPEN 66 kV System LV Cable Definition

Low voltage cables had been estimated with the reference of the adjacent 66kV feeder module of each busbar which had been constructed at PPEN 66kV stage 1. **The Contractor shall calculate with CANECO and update the BOM as per the manufacturing documentation.**

Interfacing I&C cable with MCPC stage 2 are estimated with reference to PBS41 design of MCPC stage 1. The interface signals must be confirmed after MCPC stage 2 FDR, and **cable sizes might be impacted. The procurement of control cables has to be hold on until MCPC Stage 2 FDR.**

Category		ITER Cable Code	Number * Section	Cable Description[9]	Estimated length (m)
Substation LV cables (**ON HOLD**)					
LV Power	CAP	MU3G10LN	3x6	0.6/1 kV UNSHIELDED, LSZH	2,600
LV Power	CAP	MU3G06LN	3x16	0.6/1 kV UNSHIELDED, LSZH	644
LV Power	CAP	MU5G06LN	5x16	0.6/1 kV UNSHIELDED, LSZH	1,264
LV Power	CAP	MU5G04LN	5x25	0.6/1 kV UNSHIELDED, LSZH	490
LV Power	CAP	MU3G02LN	3x35	0.6/1 kV UNSHIELDED, LSZH	358
LV Power	CAP	SU0130LN	1x95	0.6/1 kV UNSHIELDED, LSZH	180
Control	CAS	MS0406LN	4x16	450/750 V SHIELDED, LSZH	1,242
Control	CAS	MS0504LN	5x25	450/750 V SHIELDED, LSZH	1,246
Control	CAS	MS0304LN	3x25	450/750 V SHIELDED, LSZH	1,254
Control	CAS	MS0412LN	4x4	450/750 V SHIELDED, LSZH	4,856
Control	CAS	MS1212LN	12x4	450/750 V SHIELDED, LSZH	5,216
Control	CAM	MS0410LN[10]	4x6	450/750 V SHIELDED, LSZH	5,442
Control	CAM	MS0610LN[9]	6x6	450/750 V SHIELDED, LSZH	256
Interface I&C control cable with MCPC Stage 2 (**ON HOLD**)					
Control	CAS	MS0514LN	5x2.5	450/750 V SHIELDED, LSZH	710
Control	CAS	MS0714LN	7x2.5	450/750 V SHIELDED, LSZH	4100
Control	CAS	MS1414LN	14x2.5	450/750 V SHIELDED, LSZH	800
Control	CAS	MS0412LN	4x4	450/750 V SHIELDED, LSZH	4000

[9] Refer to Section 8.4 for the technical requirement on substation cables.

[10] The CAM cable is sized with assumption of 5A for current transformer secondary current. In case the Contractor choose the current transformer with 1A of secondary current, the cable size could be optimized.

16.7 Acceptance Criteria for Tests

16.7.1 66kV Circuit Breaker

No.	Test	Test Description	Applicable Standard	Test Values	Test Tolerance	Acceptance Criteria
1	**Dielectric Tests**					
1.1	Type Test	Short−duration power−frequency withstand voltage (1 min)	IEC 62271−100 and IEC 62271−1, subclause 6.2.6.1	Phase−to−earth/Phase−to−phase voltage: 140 kV. Voltage across isolating distance:160kV	Test voltage: ± 1 %. Frequency: 45 to 65 Hz. Wave shape: ± 5 %	No disruptive discharges (1)
1.2	Type Test	Lightning impulse voltage test (1.2/50 µs)	IEC 62271−100 and IEC 62271−1, subclause 6.2.6.2	Phase−to−earth/Phase−to−phase voltage: 325 kV. Voltage across isolating distance: 375 kV	Test voltage: ± 3 %. Front time: ± 30 %. Time to half−value: ± 20 %	No more than two disruptive discharges for each series of 15 impulses. No disruptive discharges on non−self−restoring insulation
2	Type Test	Resistance of the main circuit	IEC 62271−100 and IEC 62271−1, subclause 6.4	DC voltage drop with IDC applied. (50 A ≤ IDC ≤ rated current)	−	Measured resistance after temperature−rise test shall not be increased by more than 20% related to resistance before temperature rise test
3	Type Test	Temperature−rise	IEC 62271−100 and IEC 62271−1, subclause 6.5	Rated current. Rated frequency	Rated current: + 2 %, −0%. Rated frequency: +2 %, −5%	Temperature rise of parts shall not exceed the values specified in table 3 of IEC 62271−1
4	Type Test	Short time withstand current and peak withstand current	IEC 62271−100 and IEC 62271−1, subclause 6.6	Rated frequency, rated peak withstand current, rated short time withstand current, rated short−circuit duration, rated value I^2t	As specified in subclause 6.6 of table B.1 of IEC 62271−1 (Annex B)	No mechanical damage or separation of the contacts. Compliance with subclause 6.102.9 of IEC 62271−1. Correct operation of overcurrent release.
5	Type Test	Verification of the degree of protection	IEC 60529	−	−	As specified in clauses 11, 12, 13 and 15 of IEC 60529
6	Type Test	Tightness tests	IEC 62271−100 and IEC 62271−1, subclause 6.8	SF6 leakage at different temperatures (see table 13 of IEC 62271−1)	−	Leakages in accordance with table 13 of IEC 62271−1, with a tolerance of +10 %.
7	**Electromagnetic Compatibility Tests**					
7.1	Type Test	Emission tests from auxiliary and control circuits	IEC 62271−1, subclause 6.9.1.2	As defined in IEC 62271−1, subclause 6.9.1.2	As defined in IEC 62271−1, subclause 6.9.1.2	As defined in IEC 62271−1. Subclause 6.9.1.2

Technical Specifications

No.	Test	Test Description	Applicable Standard	Test Values	Test Tolerance	Acceptance Criteria
7.2	Type Test	Immunity tests on auxiliary and control circuits	IEC 62271−1, subclauses 6.9.2 and 6.9.3	As defined in IEC 62271−1, subclauses 6.9.2 and 6.9.3	As defined in IEC 62271−1, subclauses 6.9.2 and 6.9.3	As defined in IEC 62271−1. Subclauses 6.9.2 and 6.9.3
8	Type Test	Mechanical operation tests at ambient temperature	IEC 62271−100, subclauses 6.101.2.1, 6.101.2.2 and 6.101.2.3	As defined in IEC 62271−100, subclauses 6.101.2.1, 6.101.2.2 and 6.101.2.3	As defined in IEC 62271−100, subclauses 6.101.2.1, 6.101.2.2 and 6.101.2.3	As defined in IEC 62271−100, subclause 6.101.2.5
9	Type Test	Short−circuit current making and breaking tests	IEC 62271−100, subclauses 6.102 to 6.106	As defined in IEC 62271−100, subclauses 6.102 to 6.106	As specified in subclauses 6.102 to 6.106 of table B.1 of IEC 62271−100 (Annex B)	As defined in IEC 62271−100, subclauses 6.102 to 6.106
10	Type Test	Out of phase making and breaking tests	IEC 62271−100, subclause 6.110	As defined in IEC 62271−100, subclause 6.110	As specified in subclause 6.110 of table B.1 of IEC 62271−100 (Annex B)	As defined in IEC 62271−100, subclause 6.110
11	Type Test	Short−line fault tests	IEC 62271−100, subclause 6.109	As defined in IEC 62271−100, subclause 6.109	As specified in subclause 6.109 of table B.1 of IEC 62271−100 (Annex B)	As defined in IEC 62271−100, subclause 6.109
12	Type Test	Single phase and double earth fault	IEC 62271−100, subclause 6.108	As defined in IEC 62271−100, subclause 6.108	As specified in subclause 6.108 of table B.1 of IEC 62271−100 (Annex B)	As defined in IEC 62271−100, subclause 6.108
13	Routine Test	Dielectric tests on the main circuit. Short−duration Power−frequency withstand voltage (1 min)	IEC 62271−100 and IEC 62271−1, subclause 7.1	Phase−to−earth/Phase−to−phase voltage/ Across isolating distance: 140 kV	Test voltage: ± 1 %. Frequency: 45 to 65 Hz. Wave shape: ± 5 %	No disruptive discharges
14	Routine Test	Dielectric test on auxiliary and control circuits. Short−duration power−frequency	IEC 62271−1, subclause 7.2.4	1 kV	–	No disruptive discharges

No.	Test	Test Description	Applicable Standard	Test Values	Test Tolerance	Acceptance Criteria
		withstand voltage (1 s)				
15	Routine Test	Resistance of the main circuit	IEC 62271−1, subclause 7.3	DC voltage drop with IDC applied. (50 A ≤ IDC ≤ rated current)	−	Measured resistance after temperature−rise test shall not be increased by more than 20% related to resistance before temperature−rise test
16	Routine Test	Tightness test	IEC 62271−1, subclause 7.4	SF6 leakage at different temperatures (see table 13 of IEC 62271−1)	−	Leakages in accordance with table 13 of IEC 62271−1, with a tolerance of +10 %.
17	Routine Test	Design and visual checks	IEC 62271−100, subclause 7.5	−	−	As defined in IEC 62271−100, subclause 7.5
18	Routine Test	Mechanical operating tests	IEC 62271−100, subclause 7.101	As defined in IEC 62271−100, subclause 7.101	As defined in IEC 62271−100, subclause 7.101	As defined in IEC 62271−100, subclause 7.101

16.7.2 66kV Disconnector Switch and Earthing Switch

No.	Test	Test Description	Applicable Standard	Test Values	Test Tolerance	Acceptance Criteria
1	**Dielectric Tests**					
1.1	Type Test	Short−duration power−frequency withstand voltage (1 min)	IEC 62271−102 and IEC 62271−1, subclause 6.2.6.1	Phase−to−earth/Phase−to−phase voltage: 140 kV. Voltage across isolating distance: 160 kV	Test voltage: ± 1 %. Frequency: 45 to 65 Hz. Wave shape: ± 5 %	As defined in IEC 62271−102, subclause 6.2.4

Technical Specifications

No.	Test	Test Description	Applicable Standard	Test Values	Test Tolerance	Acceptance Criteria
1.2	Type Test	Lightning impulse voltage test (1.2/50 µs)	IEC 62271−102 and IEC 62271−1, subclause 6.2.6.2	Phase−to−earth/Phase−to−phase voltage: 325 kV. Voltage across isolating distance: 375 kV	Test voltage: ± 3 %. Front time: ± 30 %. Time to half−value: ± 20 %	As defined in IEC 62271−102, subclause 6.2.4
2	Type Test	Resistance of the main circuit	IEC 62271−102 and IEC 62271−1, subclause 6.4	DC voltage drop with I_{DC} applied. (50 A ≤ I_{DC} ≤ rated current)	−	Measured resistance after temperature−rise test shall not be increased by more than 20% related to resistance before temperature−rise test
3	Type Test	Temperature−rise	IEC 62271−102 and IEC 62271−1, subclause 6.5	Rated current. Rated frequency	Rated current: + 2 %, −0 %. Rated frequency: + 2 %, −5 %.	Temperature rise of parts shall not exceed the values specified in table 3 of IEC 62271−1
4	Type Test	Short time withstand current and peak withstand current	IEC 62271−102 and IEC 62271−1, subclause 6.6	Rated frequency, rated peak withstand current, rated short time withstand current, rated short−circuit duration, rated value I^2t	As defined in IEC 62271−102, subclause 6.6	As defined in IEC 62271−102, subclause 6.6,3
5	Electromagnetic Compatibility Tests					
5.1	Type Test	Emission tests from auxiliary and control circuits	IEC 62271−1, subclause 6.9.1.2	As defined in IEC 62271−1, subclause 6.9.1.2	As defined in IEC 62271−1, subclause 6.9.1.2	As defined in IEC 62271−1. Subclause 6.9.1.2
5.2	Type Test	Immunity tests on auxiliary and control circuits	IEC 62271−1, subclauses 6.9.2 and 6.9.3	As defined in IEC 62271−1, subclauses 6.9.2 and 6.9.3	As defined in IEC 62271−1, subclauses 6.9.2 and 6.9.3	As defined in IEC 62271−1. Subclauses 6.9.2 and 6.9.3

Technical Specifications

No.	Test	Test Description	Applicable Standard	Test Values	Test Tolerance	Acceptance Criteria
6	Type Test	Short−circuit making performance of earthing switches	IEC 62271−102, subclause 6.101 and IEC 62271−103, subclause 6.101	As defined in IEC 62271−1, subclause 6.101 and IEC 62271−103, subclause 6.101	As defined in IEC 62271−1, subclause 6.101 and IEC 62271−103, subclause 6.101	As defined in IEC 62271−1, subclause 6.101
7	Type Test	Mechanical endurance tests	IEC 62271−102, subclause 6.102	As defined in IEC 62271−102, subclause6.102	As defined in IEC 62271−102, subclause 6.102	As defined in IEC 62271−102, subclause 6.102
8	Routine Test	Dielectric tests on the main circuit. Short−duration power−frequency withstand voltage (1 min)	IEC 62271−102 and IEC 62271−1, subclause 7.1	Phase−to−earth/Phase−to−phase voltage/ Across isolating distance: 140 kV	Test voltage: ± 1 %. Frequency: 45 to 65 Hz. Wave shape: ± 5 %	No disruptive discharges
9	Routine Test	Dielectric test on auxiliary and control circuits. Short−duration power−frequency withstand voltage (1 s)	IEC 62271−1, subclause 7.2.4	1 kV	–	No disruptive discharges
10	Routine Test	Resistance of the main circuit of disconnectors	IEC 62271−1, subclause 7.3	DC voltage drop with IDC applied. (50 A ≤ IDC ≤ rated current)	–	Measured resistance after temperature−rise test shall not be increased by more than 20 % related to resistance before temperature−rise test
11	Routine Test	Design and visual checks	IEC 62271−102, subclause 7.5	–	–	As defined in IEC 62271−100, subclause 7.5
12	Routine Test	Mechanical operating tests	IEC 62271−102, subclause 7.101	As defined in IEC 62271−100, subclause 7.101	As defined in IEC 62271−100, subclause 7.101	As defined in IEC 62271−100, subclause 7.101

16.7.3 66kV Current Transformer

No.	Test	Test Description	Applicable Standard	Test Values	Test Tolerance
1	Type Test	Short−time current test	IEC 61869-2, subclause 7.2.201	Ith = 31.5 kA. Idyn = 80 kA	As defined in IEC 61869-2, subclause 7.2.201
2	Type Test	Temperature rise tests	IEC 61869-2, subclause 7.2.2	Rated current	In accordance with table 5 of IEC 61869-1
3	**Dielectric Tests**				
3.1	Type Test	Lightning impulse voltage test on primary winding	IEC 61869-2, subclause 7.2.3	325 kV peak	No disruptive discharges. No insulation failure
3.3	Type Test	Power frequency voltage test in wet conditions	IEC 61869-2, subclause 7.2.4	140 kV peak	No disruptive discharges
4	Type Test	Accuracy test	IEC 61869-2, subclause 7.2.6 as applicable.	As defined in IEC 61869-2, subclause 7.2.6 as applicable.	As defined in IEC 61869-2, subclause 7.2.6, as applicable.
5	Routine Test	Power frequency withstand tests on primary windings	IEC 61869-2, subclause 7.3.1	140 kV	No disruptive discharges
6	Routine Test	Partial discharge measurement	IEC 61869-1, subclause 7.3.2	As defined in IEC 61869-1, subclause 7.3.2	As defined in IEC 61869-1, subclause 7.3.2
7	Routine Test	Power−frequency withstand test between sections of primary and secondary windings and on secondary windings	IEC 61869-1, subclause 7.3.3	As defined in IEC 61869-1, subclause 5.3.4	As defined in IEC 61869-, subclause 5.3.4
8	Routine Test	Inter−turn overvoltage test	IEC 61869-2, subclause 7.3.204	As defined in IEC 61869-2, subclause 5.3.201	As defined in IEC 61869-2, subclause 5.3.201
10	Routine Test	Accuracy test	IEC 61869-2, subclause 7.3.5	As defined in IEC 61869-2, table 201 of subclause 5.6.201 and Table 205 of subclause 5.6.202.2. as applicable	As defined in IEC 61869-2, table 201 of subclause 5.6.201 and Table 205 of subclause 5.6.202.2. as applicable

Technical Specifications

16.7.4 66kV Cable and Accessories

No.	Test	Test Description	Applicable Standard	Test Values	Test Tolerance
1	Type Test	Bending test	IEC 60840, subclause 12.3.3	As defined in IEC 60840, subclause 12.3.3	No mechanical damage
2	Type Test	Partial discharge test[11]	IEC 60840, subclause 12.3.4, and IEC 60885-3	63 kV for 10 s, and then slowly reduced to 54 kV[12]	5 pC
3	Type Test	Tan δ measurement	IEC 60840, subclause 12.3.5	36 kV at least[11]	Measured values shall not exceed the value given in table 3 of IEC 60840
4	Type Test	Heating cycle test	IEC 60840, subclause 12.3.6	72 kV at least[11]	No breakdown
5	Type Test	Partial discharge test at ambient temperature and at high temperature[13]	IEC 60840, subclause 12.3.4, and IEC 60885-3	63 kV for 10 s, and then slowly reduced to 54 kV[11]	5 pC
6	Type Test	Lightning impulse voltage test followed by power frequency voltage test	IEC 60840, subclause 12.3.7, and IEC 60230	Lightning impulse voltage test: 10 positive and 10 negative voltage impulses of 325 kV. Power frequency voltage test: 90 kV[11]	No breakdown of the insulation or flashover shall occur
7	Type Test	Examination	IEC 60840, subclause 12.3.8	-	No signs of deterioration
8	Type Test	Resistivity of semi-conducting screens	IEC 60840, subclause 12.3.9 and Annex D	As defined in IEC 60840, Annex D	Conductor screen resistivity shall not exceed 1,000 Ω·m. Insulation screen resistivity shall not exceed 500 Ω·m.
9	Routine Test	Electrical test on oversheath of the cable cover	IEC 60229, subclause 3.1	d.c. voltage of 8 kV/mm of overseath (25 kV maximum)	No breakdown
10	Routine Test	Partial discharge test	IEC 60840, subclause 9.2 and IEC 60885-3	63 kV for 10 s, and then slowly reduced to 54 kV	10 pC for cables. 5 pC for cable main insulation of accessories
11	Routine	Voltage test	IEC 60840, subclause 9.3	90 kV	No breakdown of the insulation

[11] To be applied after bending test

[12] If necessary, test voltage values shall be adjusted as stated in IEC 60840, subclause 12.3.1

[13] The tests shall be carried out after the heating cycle voltage test or, alternatively, after the lightning impulse voltage test

Technical Specifications

No.	Test	Test Description	Applicable Standard	Test Values	Test Tolerance
	Test				
12	Sample Test	Conductor examination	IEC 60840, subclause 10.4, and IEC 60228	-	As defined in IEC 60228
13	Sample Test	Measurement of the thickness of the insulation and the oversheath	IEC 60840, subclause 10.6, and clause 8 of IEC 60287-1-1	-	As defined in IEC 60840, subclause 10.7
14	Sample Test	Measurement of the electrical resistance of the conductor and the metallic screen	IEC 60840, subclause 10.5	d.c. resistance measurement al 20 ºC	d.c. resistance shall not exceed the declared value
15	Sample Test	Measurement of the thickness of the metallic sheath	IEC 60840, subclause 10.7	-	As defined in IEC 60840, subclause 10.7
16	Sample Test	Measurement of the diameter of the conductor and of the exterior diameter of the cable	IEC 60840, subclause 10.8, and subclause 8.3 of IEC 60811-1-1	-	As defined in IEC 60811-1-1, subclause 8.3
17	Sample Test	Hot set test for XLPE insulation	IEC 60840, subclause 10.9, and IEC 60811-2-1	As defined in IEC 60811-2-1, clauses 8 and 9	As defined in IEC 60811-2-1, clauses 8 and 9
18	Sample Test	Measurement of the capacitance	IEC 60840, subclause 10.10	-	The measured value shall not exceed the declared value by more than 8 %
19	Sample Test	Water penetration test	IEC 60840, subclause 10.9 and Annex F	As defined in IEC 60840, subclause 10.9 and Annex F	No water shall emerge from the ends of the test piece
20	Sample Test	Tests on components of cables with a longitudinally applied metal foil (if applicable)	IEC 60840, subclause 12.4.9 and Annex G	As defined in IEC 60840 Annex G	As defined in IEC 60840 Annex G
21	Non-electrical type tests on cable components and on completed cables				
21.1	Type Test	Check of cable construction	IEC 60840, subclause 12.4.1	-	Compliance with requirements of IEC 60840, subclauses 10.4, 10.6, 10.7
21.2	Type Test	Mechanical properties of insulation before and after ageing	IEC 60840, subclause 12.4.2	As defined in IEC 60840, subclause 12.4.2	Compliance with table 6 of IEC 60840
21.3	Type Test	Mechanical properties of overseaths before & after ageing	IEC 60840, subclause 12.4.3	As defined in IEC 60840, subclause 12.4.3	Compliance with table 7 of IEC 60840

Technical Specifications

No.	Test	Test Description	Applicable Standard	Test Values	Test Tolerance
21.4	Type Test	Ageing tests on pieces of complete cable	IEC 60840, subclause 12.4.4	As defined in IEC 60840, subclause 12.4.4	The variations between the median values of tensile strength and elongation at break after ageing shall comply with IEC 60840, table 6 for insulations and table 7 for overseaths
21.5	Type Test	Pressure test at high temperature on overseaths (if applicable)	IEC 60840, subclause 12.4.6	As defined in IEC 60840, subclause 12.4.6	As defined in IEC 60811-3-1, subclause 8.2
21.6	Type Test	Hot set test for XLPE insulation	IEC 60840, subclause 10.9, and IEC 60811-2-1	As defined in IEC 60811-2-1, clauses 8 and 9	As defined in IEC 60811-2-1, clauses 8 and 9
21.7	Type Test	Shrinkage test for XLPE insulation	IEC 60840, subclause 12.4.13, and IEC 60811-1-3, clause 10	As defined in IEC 60840, subclause 12.4.13, and IEC 60811-1-3, clause 10	Compliance with table 8 of IEC 60840
21.8	Type Test	Shrinkage test for PE overseaths	IEC 60840, subclause 12.4.14, and IEC 60811-1-3, clause 11	As defined in IEC 60840, subclause 12.4.13, and IEC 60811-1-3, clause 11	The shrinkage shall not exceed 3 %
21.9	Type Test	Water penetration test	IEC 60840, subclause 10.9 and Annex F	As defined in IEC 60840, subclause 10.9 and Annex F	No water shall emerge from the ends of the test piece
21.10	Type Test	Tests on components of cables with a longitudinally applied metal foil (if applicable)	IEC 60840, subclause 12.4.9 and Annex G	As defined in IEC 60840 Annex G	As defined in IEC 60840 Annex G

16.7.5 22kV Cable and Accessories

No.	Test	Test Description	Applicable Standard	Test Values	Test Tolerance
1	Type Test	Bending test	IEC 60502-2, subclause 18.1.3	As defined in IEC 60502-2, subclause 18.1.3	No mechanical damage
2	Type Test	Partial discharge test[14]	IEC 60502-2, subclause 18.1.4, and IEC 60885-3	24 kV for 10 s, and then slowly reduced to 20,8 kV	5 pC
3	Type Test	Tan δ measurement	IEC 60502-2, subclause 18.1.5	2 kV at least	Measured values shall not exceed the value given in table 15 of IEC 60502-2
4	Type Test	Heating cycle test	IEC 60502-2, subclause 18.1.6	As defined in IEC 60502-2, subclause 18.1.6	No mechanical damage
5	Type Test	Partial discharge test[15]	IEC 60502-2, subclause 18.1.4, and IEC 60885-3	24 kV for 10 s, and then slowly reduced to 20,8 kV	5 pC
6	Type Test	Lightning impulse voltage test followed by power frequency voltage test	IEC 60502-2, subclause 18.1.7, and IEC 60230	Lightning impulse voltage test: 10 positive and 10 negative voltage impulses of 125 kV. Power frequency voltage test: 42 kV	No breakdown of the insulation
7	Type Test	Voltage test for 4 h	IEC 60502-2 subclause 18.1.8	48kV	No breakdown of the insulation
8	Type Test	Resistivity of semi-conducting screens	IEC 60502-2 subclause 18.1.9	As defined in IEC 60502-2, Annex D	Conductor screen resistivity shall not exceed 1,000 Ω·m. Insulation screen resistivity shall not exceed 500 Ω·m.
9	Routine Test	Measurement of the electrical resistance of conductors	IEC 60502-2, subclause 16.2	As defined in IEC 60228	As defined in IEC 60228
10	Routine Test	Partial discharge test	IEC 60502-2, subclause 16.3, and IEC 60885-3	24 kV for 10 s, and then slowly reduced to 20,8 kV	10 pC
11	Routine Test	Voltage test	IEC 60502-2, subclause 16.4	42 kV (5 min)	No breakdown of the insulation
12	Sample Test	Conductor examination	IEC 60502-2, subclause 17.4, and IEC 60228	-	As defined in IEC 60228
13	Sample Test	Measurement of the thickness of the insulation and the oversheath	IEC 60502-2 subclause 17.5, and clause 8 of IEC 60287-1-1	-	As defined in IEC 60502-2 subclause 17.5
14	Sample Test	Measurement of external diameter	IEC 60502-2 subclause 17.8, and clause 8 of IEC 60811-1-1	-	As defined in IEC 60811-1-1, clause 8
15	Sample Test	Voltage test for 4 h	IEC 60502-2, subclause 17.9 clause 9	48kV	No breakdown of the insulation
16	Sample Test	Hot set test for XLPE insulation and elastomeric sheaths	IEC 60502-2, subclause 17.10, and IEC 60811-2-1, clause 9	As defined in IEC 60811-2-1, clause 9	Compliance with table 19 of IEC 60502-2

[14] To be applied after bending test

[15] The tests shall be carried out after the heating cycle test

Technical Specifications

No.	Test	Test Description	Applicable Standard	Test Values	Test Tolerance
17	Non-electrical type tests on cable components and on completed cables				
17.1	Type Test	Measurement of thickness of insulation	IEC 60502-2, subclause 19.1, and IEC 60811-1-1, subclause 8.1	-	As defined in IEC 60502-2, subclause 17.5.2
17.2	Type Test	Measurement of thickness of non-metallic sheaths	IEC 60502-2, subclause 19.2, and IEC 60811-1-1, subclause 8.2	-	As defined in IEC 60502-2, subclause 17.5.3
17.3	Type Test	Mechanical properties of insulation before and after ageing	IEC 60502-2 subclause 19.3	As defined in IEC 60502-2, subclause 19.3	Compliance with table 17 of IEC 60502-2
17.4	Type Test	Tests for determining the mechanical properties of nonmetallic sheaths before and after ageing	IEC 60502-2 subclause 19.4	As defined in IEC 60502-2, subclause 19.4	Compliance with table 20 of IEC 60502-2
17.5	Type Test	Additional ageing test on pieces of completed cables	IEC 60502-2 subclause 19.5	As defined in IEC 60502-2, subclause 19.5	The variations between the median values of tensile strength and elongation at break after ageing shall comply with IEC 60502-2, table 17 for insulations and table 20 for overseaths
17.6	Type Test	Pressure test at high temperature on insulations and non-metallic sheaths (if applicable)	IEC 60502-2, subclause 19.7, and IEC 60811-3-1, clause 8	As defined in IEC 60502-2, subclause 19.7, and IEC 60811-3-1, clause 8	As defined in IEC 60811-3-1, clause 8
17.7	Type Test	Hot set test for XLPE insulations and elastomeric sheaths	IEC 60502-2 subclause 17.10, and IEC 60811-2-1	As defined in IEC 60811-2-1, clause 9	Compliance with IEC 60811-2-1, table 19
17.8	Type Test	Oil immersion test for elastomeric sheaths	IEC 60502-2 subclause 19.12, and IEC 60811-2-1	As defined in IEC 60811-2-1, clause 10	Compliance with IEC 60811-2-1, table 23
17.9	Type Test	Water absorption test on insulation	IEC 60502-2 subclause 19.13, and IEC 60811-1-3	As defined in IEC 60811-1-3, subclauses 9.1 or 9.2, as applicable	Compliance with IEC 60811-1-3, tables 18 or 19, as applicable
17.10	Type Test	Shrinkage test for XLPE insulation	IEC 60502-2 subclause 19.16, and IEC 60811-1-3, clause 10	As defined in IEC 60811-1-3, clause 10	Compliance with table 19 of IEC 60502-2
17.11	Type Test	Shrinkage test for PE oversheaths	IEC 60502-2, subclause 19.20, and IEC 60811-1-3 clause 11	As defined in IEC 60811-1-3, clause 11	Compliance with table 22 of IEC 60502-2
17.12	Type Test	Water penetration test	IEC 60502-2, subclause 19.22	As defined in IEC 60502-2, subclause 19.22, and Annex F	No water shall emerge from the ends of the test piece

16.8 List of Documentation Deliverables

Please use the appropriate sheet (CDR/PDR/FDR/MRR) for preparation of Input Data Package for your Design Review and delete other sheets

1 General Information about the Review

This section is to general information of the Design Review (title, design developer, …)

2 System Documents for Design Review

This section lists the main system documents produced for the system - and also to provide different attributes of these documents as explained below:

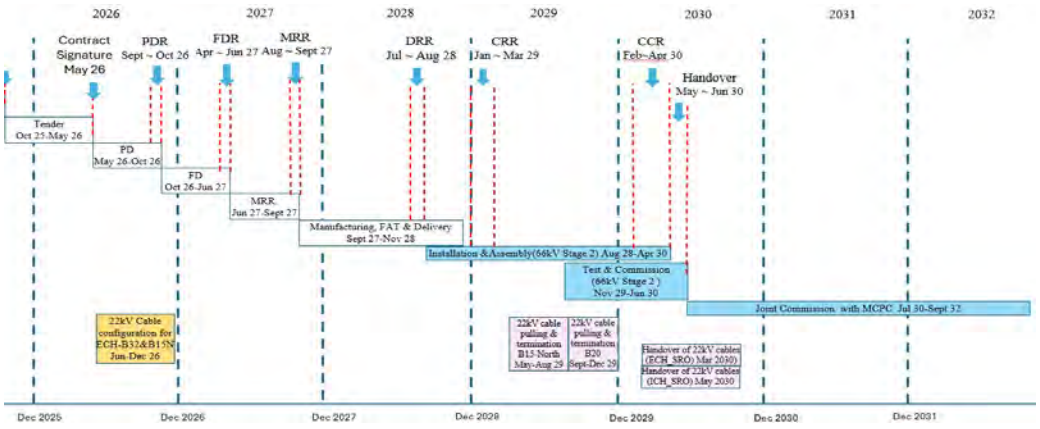
Responsible	Columns	Description/Actions
Pre filled	SDP Aspect	Design aspects defined for different sets of documents as grouped in SDP Appendix 2 are mentioned ITER System Design Process (SDP) Working Instruction (4CK4MT)
	ICP Doc type	Refers to the right type of document that is to be selected in ICP
	Expected Document	Identifies the required document defined in ITER System Design Process (SDP) Working Instruction (4CK4MT)
	Document Maturity	Defined here the particular maturity that is required for a GDT at a certain Design Review gate (CDR/PDR/FDR/MRR)
Columns to be filled in by PBS team	ICP UID (IDM, SMDD,…) (hyperlink)	To provide here the ICP UID of the document (with hyperlink) if it already exists in IDM,SMDD,…
	Title	To provide here the actual title of the document
	Description	To provide here a short description of the document e.g. the abstract in IDM
	ICP Version	To provide here the applicable version of the document planned (should be frozen when the data input package is released)
	Status	To provide here the actual status of the document from available options in the drop down menu. **1. Status at the time of the Design Review Preparation (i.e. before Design Review Meeting)** Available - Ready for the design review: For documents that are already approved by the Design Organisation and ready to be submitted to the Design Review Panel Available - To be revised before design review: For documents that were produced earlier (ex: previous design gates) but requires update for this Design review scope Available - Under review: For documents currently under review in IDM To be Created: For documents that are planned to be created for the Design Review but are still in production/yet to be created. Not Applicable: For topics that are not considered to be applicable for your System/Scope of the particular Design Review **2 Status at the time of the Design Review Closure (i.e. after Design Review Meeting)** Available - Accepted for the design phase: For documents that are in line with the requirements of the phase and that take into account comments from required chits. Available - Revision required: For documents that need to be updated in next phase, to incorporate chits, reviewers comments,…. Not Applicable: For topics that are not considered to be applicable for your System/Scope of the particular Design Review
	Justification if not provided for DR	If a SDP-WI requested document is not planned to be submitted for some reason then this can be detailed here providing the justification
	Comments if any	To add any comments if required to give some additional information for any document
	PBS Scope Node of the document	To define here the scopes (PBS node) covered by the identified document. As much as possible, PBS Level 3 to be selected
	Operation Stage [SRO, DT-1, DT-2]	To provide here the operation stages of the document for which the document is applicable (SRO,DT-1,DT-2)
to be filled in by CMS team	CMS Comments	CMS will provide here the comments after their review when it is submitted to them

3 Control gates and Schedule

Schedule Milestones	Deliverables**	Acceptance criteria	Expected Time (T0*+x month)
KOM	Documentation package submission	Documents accepted by IO CRO	T0+1
PDR	Completion of Preliminary Design documentation package	Preliminary Design Review Deliverables accepted by IO CRO	T0+5
FDR	Completion of Final Design documentation package	Final Design Review Deliverables accepted by IO CRO	T0+13
MRR	Completion of Manufacturing Design documentation package	Manufacturing Design Review Deliverables accepted by IO CRO	T0+16
Manufacturing and FAT	Completion of the manufacturing of components Completion of the Factory Acceptance Test	MIP reports signed by IO FAT reports accepted by IO CRO	T0+26
DRR	Completion of Delivery Readiness Review	Delivery Readiness Review Deliverables accepted by IO CRO	T0+27
CRR	Completion of the Construction Readiness Review	Final Design Review Deliverables accepted by IO CRO	T0+32
Assembly &Installation	Completion of the assembly and installation of all elements in the Contractor's scope	Relevant MIPs signed by IO	T0+45
CCR	Completion of the Construction Completion Readiness	Construction Completion Readiness Deliverables accepted by IO CRO	T0+47
SAT	Completion of the Stage 2 components Site Acceptance Test (incl. integration with I&C system of PPEN 66kV stage 1)	All SAT reports accepted by IO CRO	T0+53
Handover to IO	Completion Review with the as-built deliverables	MCD accepted by IO CRO and Final Acceptance Certificates issued to the Contractor.	T0+54

* T0 = Contract Signature date.

** the detailed list of deliverables is available in Appendix 16.8 of this document.



KOM_Documentation package

No.	Title	Description	ICP/IDM Version	Status
1	Contract management plan	including procument plan		
2	Quality Assurance Plan			
3	Detailed Work Schedule (DWS)			
4	Other Documents for Project Management			

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Title	Scope node*_Node name_Review gate_Input Data Package
Design Review Gate	Preliminary Design Review (PDR)
Design Review Date	
IO TRO	
Design Developer	

Note on the approval/acceptance status of documents

Documents have to be approved by the design entity in charge of producing them before the review meeting

Documents have to be accepted/approved by IO for the closure of the design phase.

System Documents for Design Review

If you need to add extra document, just add new rows in the table below and select the Aspect/ Expected document

Please note that the below list is based on SDP WI requested documents for PDR, appropriate list needs to be used according to the intended Design Review

For selection and definition of the expected document, please refer to https://confluence.iter.org/display/BC/Technical+Document+Types

Aspect *Select the main Aspect to guide you to the Document selection.*	**Expected Document**	**ICP Doc Type**	**PDR Maturity** *(Please don't change values)*	**ICP UID (IDM, SMDD,...)** *(hyperlink)*	**Title**	**Description**	**ICP Version**	**Status**	**Justification if not provided for DR**	**Comments if any**	**PBS Scope Node of the document** *PBS Level 3*	**Operation Stage [SRO,DT-1,DT-2]**	**CMS Comments**
[Design Requirements]	System Requirements Document-SRD (or Sub-SRD)	--select--	Please select a Document Type										
[Design Requirements]	Interface Control Document-ICD	Interface Control Document-ICD	Complete										
[Design Requirements]	Interface Sheet-IS	Interface Sheet-IS	Consolidated										
[Design Requirements]	Configuration Management Model-CMM	Please provide CMAF Ref	Consolidated										
[Design Requirements]	System Load Specification	Load Specification	Consolidated										
[Design Definition]	System Design Description-DDD	System Design Description-DDD	Consolidated										
[Design Definition]	System Layout Drawing	System layout drawing	Consolidated										
[Design Definition]	Building Drawing	Site & Building Drawing	Consolidated										
[Design Definition]	Process Flow Diagram-PFD	Process Flow Diagram-PFD	Complete										
[Design Definition]	Piping and Instrumentation Diagram-PID	Piping and Instrumentation Diagram-PID	Preliminary										
[Design Definition]	Single Line Diagram or One Line Diagram	Single Line Diagram	Complete										
[Design Definition]	Cabling Diagram-CBD	Cabling Diagram-CBD	Preliminary										
[Design Definition]	Instrumentation and Control Document	Instrumentation and Control Document	Preliminary										
[Design Definition]	Instrumentation and Control - Physical and Functional Architecture	Instrumentation and Control Document - Physical and Functional Architecture	Preliminary										
[Design Definition]	Equipment or Component List	Component list	Consolidated										
[Design Definition]	Bill of Material - BOM	Bill of Material - BOM	Preliminary										
[Design Definition]	System Detailed Performance Definition-SDPD	Technical Requirements Specification	If Useful										
[Design Definition]	Component Technical Specification	Technical Requirements Specification	Preliminary										
[Design Definition]	Assembly Drawing	--select--	Please select a Document Type										
[Design Justification]	Design Justification Plan-DJP	Verification and Validation Plan	Complete										
[Design Justification]	Design Compliance Matrix - DCM	Compliance Matrix - DCM or VCM or ICM	Consolidated										
[Design Justification]	Functional Analysis Report-FAR	Functional Analysis	Complete										
[Design Justification]	Structural Integrity Report	Structural Integrity Report	Consolidated										
[Design Justification]	Engineering Analysis (2)	Engineering Analysis	Preliminary										
[Design Justification]	Hazard Identification and Risk Analysis (HIRA)	Engineering Analysis	Consolidated										
[Design Justification]	RAMI Analysis	Engineering Analysis	Consolidated										
[Design Justification]	Hazard and Operability Study (HAZOP)	Engineering Analysis	Consolidated										
[Design Justification]	Human and Organisational Factor Analysis (HOF)	Engineering Analysis	Consolidated										
[Design Justification]	Remote Handling Compatibility Report (Plant Definition Form, Task Definition Form, Remote Handling Compatibility Assessment Report)	Engineering Analysis	Consolidated										
[Design Justification]	Qualification Plan	Qualification Plan	Preliminary										
[Design Justification]	Requirement Validation Matrix	Compliance Matrix - DCM or VCM or ICM	Preliminary										
[Design Justification]	ROX and Research and Development Report	ROX and Research and Development Report	If Useful										
[Commissioning]	System Commissioning Plan	Commissioning Plan	Preliminary										
[Assembly and Installation]	Assembly or Installation Plan	Installation Execution Document	Preliminary										
[Operation and Maintenance]	Concept of Operations	Concept of Operation	Preliminary										
[Operation and Maintenance]	System Maintenance and In-Service Inspection Plan	System Maintenance and In-Service Inspection Plan	Preliminary										
[Decommissioning]	Decommissioning Plan	Decommissioning Document	Preliminary										
[Other]	Design Plan	Design Plan	If Useful										
Non Technical Documents													
[Other]	Issue or Risk or Opportunity Analysis Report	Please Provide PROR DataBase Link	At any stage										
[Other]	Change Request or Record, Deviation Request, Non-Conformance Report - NCR	--select--	Please select a Document Type										
[Other]	Quality Plan	--select--	Please select a Document Type										

(1) Document type for Computational Fluid Dynamics-CFD Analysis Report, Contamination Analysis Report, Electromagnetic-EM Analysis Report, Nuclear Analysis Report, Seismic Analysis Report, Structural and Thermal Analysis Report, Functional Analysis Report-FAR
(2) Document type for any Engineering Analysis such as OD or 1D Thermohydraulic Analysis Report, ALARA Analysis Report, Analysis Model, Checklist for Analyses or Calculations, Constructability Analysis Report, EEE NRC Analysis Report, Fire Protection Analysis Report, Investment Protection Analysis Report, Logistics Analysis Report, Maintainability Analysis Report, Manufacturability Analysis Report, Nuclear Safety Analysis Report, Operation Analysis Report, Scoping Calculation Report, Simulation Analysis Report, Task Analysis Report.

Title	Scope node*_Node name_Review gate_Input Data Package
Design Review Gate	Final Design Review (FDR)
Design Review Date	
IO TRO	
Design Developer	

Example :
PBS 32.Storage and Delivery system PDR_Input Data Package

Note on the approval/acceptance status of documents

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System Documents for Design Review

If you need to add extra document, just add new rows in the table below and add correct document

Please note that the below list is based on SDP WI requested documents for FDR, appropriate list needs to be used according to the intended Design Review

For selection and definition of the expected document, please refer to https://confluence.iter.org/display/BC/Technical+Document+Types

Aspect *Select the main Aspect to guide you to the Document selection.*	Expected Document	ICP Doc Type	FDR Maturity *(Please don't change values)*	ICP UID (IDM, SMDD,...) *(hyperlink)*	Title	Description	ICP Version	Status	Justification if not provided for DR	Comments if any	PBS Scope Node of the document *PBS Level 3*	Operation Stage [SRO,DT-1,DT-2]	CMS Comments
[Design Requirements]	System Requirements Document-SRD (or Sub-SRD)	--select--	Please select a Document Type										
[Design Requirements]	Interface Control Document-ICD	Interface Control Document-ICD	Complete										
[Design Requirements]	Interface Sheet-IS	Interface Sheet-IS	Complete										
[Design Requirements]	Configuration Management Model-CMM	Please provide CMAF Ref	Complete										
[Design Requirements]	System Load Specification	Load Specification	Complete										
[Design Definition]	System Design Description-DDD	System Design Description-DDD	Complete										
[Design Definition]	System Layout Drawing	System layout drawing	Complete										
[Design Definition]	Building Drawing	Site & Building Drawing	Complete										
[Design Definition]	Process Flow Diagram-PFD	Process Flow Diagram-PFD	Complete										
[Design Definition]	Piping and Instrumentation Diagram-PID	Piping and Instrumentation Diagram-PID	Complete										
[Design Definition]	Single Line Diagram or One Line Diagram	Single Line Diagram	Complete										
[Design Definition]	Cabling Diagram-CBD	Cabling Diagram-CBD	Complete										
[Design Definition]	Detailed Wiring Diagram-WD	Detailed Wiring Diagram-WD	Preliminary										
[Design Definition]	Plant System Instrumentation and Control Specification	Technical Requirements Specification	Consolidated										
[Design Definition]	Instrumentation and Control - List of Signals	Instrumentation and Control Document	Consolidated										
[Design Definition]	List of Data at Central Instrumentation and Control Interface	Instrumentation and Control Document	Consolidated										
[Design Definition]	Cubicle Hardware Configuration Diagram	Instrumentation and Control Document	Consolidated										
[Design Definition]	Description of Plant System State Machines	Instrumentation and Control Document	Consolidated										
[Design Definition]	Instrumentation and Control - Physical and Functional Architecture	Instrumentation and Control Document - Physical and Functional Architecture	Complete										
[Design Definition]	Equipment or Component List	Component list	Complete										
[Design Definition]	Bill of Material - BOM	Bill of Material - BOM	Consolidated										
[Design Definition]	System Detailed Performance Definition-SDPD	Technical Requirements Specification	If Useful										
[Design Definition]	Component Technical Specification	Technical Requirements Specification	Complete										
[Design Definition]	Assembly Drawing	--select--	Please select a Document Type										
[Design Definition]	Cubicle Internal Definition	Cubicle Internal Definition	Complete										
[Design Justification]	Qualification Plan	Verification and Validation Plan	Complete										
[Design Justification]	Design Compliance Matrix - DCM	Compliance Matrix - DCM or VCM or ICM	Complete										
[Design Justification]	Interface Compliance Matrix	Compliance Matrix - DCM or VCM or ICM	Complete										
[Design Justification]	Functional Analysis Report-FAR	Functional Analysis	Complete										
[Design Justification]	Structural Integrity Report	Structural Integrity Report	Complete										
[Design Justification]	Calculation report (1)	Calculations	Complete										
[Design Justification]	Engineering Analysis (2)	Engineering Analysis	Complete										
[Design Justification]	Hazard Identification and Risk Analysis (HIRA)	Engineering Analysis	Complete										
[Design Justification]	RAMI Analysis	Engineering Analysis	Complete										
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[Design Justification]	Remote Handling Compatibility Report (Remote Handling Compatibility Assessment Report, Mock up report)	Engineering Analysis	Complete										
[Design Justification]	Qualification Plan	Qualification Plan	Preliminary										
[Design Justification]	Acceptance Plan (FAT, SAT)	FAT & SAT Plan and Procedure	Preliminary										
[Design Justification]	Requirement Validation Matrix	Compliance Matrix - DCM or VCM or ICM	Complete										
[Design Justification]	ROX and Research and Development Report	ROX and Research and Development Report	If Useful										
[Commissioning]	System Commissioning Plan	Commissioning Plan	Complete										
[Commissioning]	Commissioning Test Procedure	Commissioning Test Procedure	Preliminary										
[Manufacturing]	Part Drawing	Part Drawing	Preliminary										
[Assembly and Installation]	Installation Drawing	Installation Drawing	Complete										
[Assembly and Installation]	Assembly or Installation Plan	Installation Execution Document	Complete										
[Operation and Maintenance]	Concept of Operations	Concept of Operation	Complete										
[Operation and Maintenance]	Operation and Maintenance Manual	Equipment Operation and maintenance Manual	If Useful										
[Operation and Maintenance]	System Maintenance and In-Service Inspection Plan	System Maintenance and In-Service Inspection Plan	Complete										
[Decommissioning]	Decommissioning Plan	Decommissioning Document	Complete										
[Decommissioning]	Radwaste Checklist	Decommissioning Document	Complete										
[Other]	Design Plan	Design Plan	If Useful										
Non Technical Documents													
[Other]	Issue or Risk or Opportunity Analysis Report	Please Provide PROR DataBase Link	At any stage										
[Other]	Change Request or Record, Deviation Request, Non-Conformance Report - NCR	--select--	Please select a Document Type										
[Other]	Quality Plan	--select--	Please select a Document Type										

(1) Document type for Computational Fluid Dynamics-CFD Analysis Report, Contamination Analysis Report, Electromagnetic-EM Analysis Report, Nuclear Analysis Report, Seismic Analysis Report, Structural and Thermal Analysis Report, Functional Analysis Report-FAR
(2) Document type for any Engineering Analysis such as 0D or 1D Thermohydraulic Analysis Report, ALARA Analysis Report, Analysis Model, Checklist for Analyses or Calculations, Constructability Analysis Report, EEE NRC Analysis Report, Fire Protection Analysis Report, Investment Protection Analysis Report, Logistics Analysis Report, Maintainability Analysis Report, Manufacturability Analysis Report, Nuclear Safety Analysis Report, Operation Analysis Report, Scoping Calculation Report, Simulation Analysis Report, Task Analysis Report.

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Title	Scope node*_Node name_Review gate_Input Data Package
Review Gate	Manufacturing Readiness Review (MRR)
Review Date	
IO TRO	

Example :
PBS 32.Storage and Delivery system PDR_Input Data Package

Note on the approval/acceptance status of documents

Documents have to be approved by the design entity in charge of producing them before the review meeting

Documents have to be accepted/approved by IO for the closure of the review phase.

System Documents for Manufacturing Review

If you need to add extra document, just add new rows in the table below and add a document

Please note that the below list is based on SDP WI and MRR WI requested documents for MRR, appropriate list needs to be used according to the intended Review

For selection and definition of the expected document, please refer to https://confluence.iter.org/display/BC/Technical+Document+Types

Aspect *Select the main Aspect to guide you to the Document selection.*	**Expected Document**	**ICP Doc Type**	**MRR Maturity** *(Please don't change values)*	**ICP UID (IDM, SMDD,...)** *(hyperlink)*	**Title**	**Description**	**ICP Version**	**Status**	**Justification if not provided for DR**	**Comments if any**	**PBS Scope Node of the document** *PBS Level 3*	**Operation Stage [SRO,DT-1,DT-2]**	**CMS Comments**
[Design Requirements]	Configuration Management Model-CMM	Please provide CMAF Ref	If Useful										
[Design Definition]	Building Drawing	Site & Building Drawing	Complete										
[Design Definition]	Cabling Diagram-CBD	Cabling Diagram-CBD	Complete										
[Design Definition]	Detailed Wiring Diagram-WD	Detailed Wiring Diagram-WD	Complete										
[Design Definition]	Instrumentation and Control Document	Instrumentation and Control Document	Complete										
[Design Definition]	Instrumentation and Control - Physical and Functional Architecture	Instrumentation and Control Document - Physical and Functional Architecture	Complete										
[Design Definition]	Equipment or Component List	Component list	Complete										
[Design Definition]	Bill of Material - BOM	Bill of Material - BOM	Complete										
[Design Definition]	Component Technical Specification	Technical Requirements Specification	Complete										
[Design Definition]	Assembly Drawing	--select--	Please select a Document Type										
[Design Definition]	Cubicle Internal Definition	Cubicle Internal Definition	Complete										
[Design Justification]	Compliance Matrix - DCM or VCM	Compliance Matrix - DCM or VCM or ICM	Complete										
[Design Justification]	Calculation report (1)	Calculations	If Useful										
[Design Justification]	Engineering Analysis (2)	Engineering Analysis	If Useful										
[Design Justification]	Qualification Plan	Qualification Plan	Complete										
[Design Justification]	Qualification Summary Report for PIC Components	Qualification Synthesis Report for PIC Component	Complete										
[Design Justification]	Acceptance Plan (FAT, SAT)	FAT & SAT Plan and Procedure	Complete										
[Design Justification]	Factory Acceptance Test Procedure	FAT & SAT Plan and Procedure	Complete										
[Design Justification]	ROX and Research and Development Report	ROX and Research and Development Report	If Useful										
[Manufacturing]	Manufacturing Flow or Assembly Sequence	Manufacturing execution document	Complete										
[Manufacturing]	Manufacturing Inspection Plan-MIP	Manufacturing Inspection Plan-MIP	Complete										
[Manufacturing]	Manufacturing Instruction or Procedure	Manufacturing execution document	Complete										
[Manufacturing]	Non-destructive Examination Procedure	Manufacturing execution document	Complete										
[Manufacturing]	List of Manufacturing Tools and Equipment	Manufacturing execution document	Complete										
[Manufacturing]	Manufacturing Process Qualification Report	Manufacturing execution document	Complete										
[Manufacturing]	Training or Qualification Record	Manufacturing execution document	Complete										
[Manufacturing]	Data Sheet	Manufacturing execution document	Complete										
[Manufacturing]	Manufacturing Drawing	Manufacturing Drawing	Complete										
[Manufacturing]	Part Drawing	Part Drawing	Complete										
[Operation and Maintenance]	Operation and Maintenance Manual	Equipment Operation and maintenance Manual	Preliminary										
Non Technical Documents													
[Other]	Issue or Risk or Opportunity Analysis Report	Please Provide PROR DataBase Link	Complete										
[Other]	Change Request or Record, Deviation Request, Non-Conformance Report - NCR	--select--	Please select a Document Type										
[Other]	Quality Plan	--select--	Please select a Document Type										

(1) Document type for Computational Fluid Dynamics-CFD Analysis Report, Contamination Analysis Report, Electromagnetic-EM Analysis Report, Nuclear Analysis Report, Seismic Analysis Report, Structural and Thermal Analysis Report, Functional Analysis Report-FAR
(2) Document type for any Engineering Analysis such as 0D or 1D Thermohydraulic Analysis Report, ALARA Analysis Report, Analysis Model, Checklist for Analyses or Calculations, Constructability Analysis Report, EEE NRC Analysis Report, Fire Protection Analysis Report, Investment Protection Analysis Report, Logistics Analysis Report, Maintainability Analysis Report, Manufacturability Analysis Report, Nuclear Safety Analysis Report, Operation Analysis Report, Scoping Calculation Report, Simulation Analysis Report, Task Analysis Report.

For selection and definition of the expected document, please refer to

https://confluence.iter.org/display/BC/Technical+Document+Types

Working Instruction for the Delivery Readiness Review (DRR) (X3NEGB v3.0)

Technical Design Family (TDF)	Generic Document Title (GTD)
Acceptance Instruction or Procedure	Factory Acceptance Test Procedure
Acceptance Plan	Factory Acceptance Test Plan-FATP
Building Drawing	Finishing Works - Cladding or Roofing or Door or Window Drawing (if applicable)
Inspection and Test Record or Report	Inspection Report for Construction
Inspection and Test Record or Report	Inspection Report for Manufacturing
Other Manufacturing Input	Factory Qualification Tests Plan
Other Manufacturing Output	Calibration Record - from Manufacture
Other Manufacturing Output	Manufacturing Data Record-MDR
Verification Report	Compliance Matrix - DCM or VCM
Verification Report	Component Qualification Report
Verification Report	EPMN or PMA Report
Verification Report	Functional Allocation Matrix
Verification Report	Interface Compliance Matrix
Verification Report	Qualification Report-QR
Verification Report	Qualification Summary Report for PIC Component
Verification Report	Requirement Applicability Matrix
Verification Report	Requirement Definition Matrix
Verification Report	Requirement Propagation Matrix-RPM
Verification Report	Requirement Traceability Matrix
Acceptance Record or Report	Factory Acceptance Test Report-FATR
Change Request or Record	Change Notice-CN (if applicable)
Change Request or Record	Construction Field Change Request-FCR (if applicable)
Change Request or Record	Corrective Action Request-CAR (if applicable)
Change Request or Record	Deviation Request-DR (if applicable)
Change Request or Record	Non-Conformance Report-NCR (if applicable)
Change Request or Record	Project Change Request-PCR (if applicable)
Change Request or Record	Request for Information-RFI (if applicable)
Deliverable List	Software Delivery Note-SDN
Installation Execution Document	Inspection and Test Plan-ITP - for Assembly and Installation
Installation Execution Document	Methods Statement - Installation
Installation Execution Document	Welding Map - for Assembly or Installation
Installation Execution Document	Welding Procedure Qualification Record - Assembly or Installation
Instrumentation and Control Document	SIL compliance report and SIL safety manuals
Maintenance or Inspection Record	In-Service Inspection Record
Maintenance or Inspection Record	Preservation Record
Operations Plan	Operator Training Plan
Other Manufacturing Output	Manufacturing Dossier-MD
Other Manufacturing Output	Material Certificate
Other Manufacturing Output	Mechanical Acceptance Package
Other Manufacturing Output	Metrology Survey
Other Manufacturing Output	Software Release Note-SRN
Other Manufacturing Output	Welding Record - from Manufacture
Procurement Record	Certificate of Conformity
Procurement Record	Release Note
Shipping or Logistics Instruction or Procedure	Equipment Storage and Preservation Requirements
Shipping or Logistics Instruction or Procedure	HS Requirements or Procedures or Guidelines
Shipping or Logistics Plan	Transportation Quality Plan or Shipping Plan of Load-SPL
Shipping or Logistics Record	Contractors Release Note
Shipping or Logistics Record	Delivery Report
Shipping or Logistics Record	Packing List
Software or Programming Code	Analysis Software
Software or Programming Code	Instrumentation and Control Software Source Code
Software or Programming Code	Mini CODAC Configuration
Software or Programming Code	Product Software
Software or Programming Code	Software Configuration
Contract Management	Subcontractor Approval Form (SAF)
Deliverable List	Material Safety Data Sheet
Deliverable List	Export Control Document
Installation Execution Document	Site installation procedures
Installation Drawing	Site installation drawings
Deliverable List	Issue or Risk or Opportunity Analysis Report (if applicable)
Deliverable List	Proof test precedure
Deliverable List	Contractor Release Note (CRN)
Deliverable List	Delivery Report
Deliverable List	Packing List (PL)
Deliverable List	Equipment Storage & Preservation Requirements Form
Instrumentation and Control Document	PCDH Compliance Matrix

Name of the output	Is there a need for template? If yes, UID	Where this output stored?	If IDM, which document type?	How do you name this file? (naming convention)	Accountable team for the availability of the output	Retention period
Software documentation Check list	ITER_D_SUDNWD	ITER_D_VK4M6G	Memorandum /note	Check list	requester	over the project lifecycle
Safety code validation and verification report with cover sheet	ITER_D_STGKQP (report) ITER_D_STMCPF (cover sheet)	ITER_D_VK4M6G	Memorandum /note	V&V report	requester	over the project lifecycle

For selection and definition of the expected document, please refer to **https://confluence.iter.org/display/BC/Technical+Document+Types**

WI for Commissioning Certificate Readiness (CCR) (X8LS3F v4.1)

Stream	Expected document	ICP Doc Type	Maturity	Applicability
Engineering	Diagram for Cabling Diagram (CBD)	Cabling Diagram-CBD	Complete ("IO As-built")	
Engineering	Drawing for circulation drawings, evacuation drawings	Circulation/Evacuation drawing	Complete ("IO As-built")	Limited to building/area
Engineering	Document for any type of Component List, Valve List, Tooling List, Support Structure List, Pipeline List, PIC List, Interface and Component List, Instrumentation List, Equipment List, Cable Tray and Conduit List, Cable Termination Input List, Cable List, Cable Collection List, etc	Equipment or Component list	Complete ("IO As-built")	
Engineering	Diagram for Piping and Instrumentation Diagram (P&ID)	Piping and Instrumentation Diagram-PID	Complete ("IO As-built")	
Engineering	Diagram for Single Line Diagram (SLD) or One Line Diagram (OLD)	Single Line Diagram or One Line Diagram	Complete ("IO As-built")	
Engineering	Diagram for Instrumentation and Control Architecture Diagram	Instrumentation and Control Architecture Diagram	Complete ("IO As-built")	
Engineering	Magnetic Zoning, Fire Sectorization, Hazardous Area Classification Drawing (ATEX…), Ventilation Zoning, Load Capacity Drawing, Radiological Zoning	Zoning Drawing	Complete ("As-constructed")	Limited to building/area
Engineering	Diagram for Control Logic Diagram	Control Logic Diagram	Complete ("As-constructed")	
Engineering	Instrument Loop Diagram of the full signal path from the sensors/actuators to the I/O boards of the controllers including powering and conditioning, with identification of test points for fault analysis or calibration and identification of the terminal blocks	Instrument Loop Diagram	Complete ("As-constructed")	
Engineering	Drawing type for general arrangement drawings or layout drawings representing several systems in a building, level, room, etc	Multi-System General arrangement drawing	Complete ("As-constructed")	Limited to building/area
Engineering	Drawing for Concrete Outline Drawing	Site & building drawing	Complete	Limited to building/area
Engineering	Document for Qualification Synthesis Report, Qualification Summary Report	Qualification Synthesis Report for PIC component	Preliminary	Limited to PIC scope
Engineering	Document for Verification and Validation Report, Qualification Report for non-PIC Component (e.g. Electromagnetic qualification)	Verification and Validation Report	Preliminary	
Engineering	Configuration Management Model-CMM (CMAF)	CMAF	If Useful	Limited to building/area
Construction	Mechanical Completion Dossier (MCD) for IO in cash and/or equivalent for in-kind deliverables	Assembly and Installation Report	Complete	
Construction	Mechanical Completion Certificate (MCC) for in cash and/or equivalent for in-kind deliverables (e.g. CRN for Contractor Release Note)	Assembly and Installation Report	Complete	
Construction	Takeover certificate	Assembly and Installation Report	Complete	
Construction	Regulatory inspection report and/or certificate (electrical inspection, declaration of conformity & commissioning declaration for PE/NPE, CE markings certificates…)	Assembly and Installation Report	Complete	
Construction	Compliance Matrix (DCM or VCM)	Compliance Matrix - DCM or VCM or ICM	Complete	Limited to PIC scope
Construction	Pulling card (as-constructed or as-built version)	Assembly and Installation Report	Complete ("As-constructed")	
Construction	Assembly Configuration Drawing (ACD) show the final configuration of component as it will be at end of CWP	Assembly Configuration Drawing	Complete ("As-constructed")	
Construction	Drawing for Assembly Drawing	Assembly Drawing	Complete ("As-constructed")	
Construction	Drawing for Component Drawing	Component Drawing	Complete ("As-constructed")	
Construction	Drawing for Concrete Formwork Drawing	Site & building drawing	Complete ("As-constructed")	Limited to building/area
Construction	Drawing for Cubicle Drawing	Cubicle internal definition	Complete ("As-constructed")	
Construction	Diagram for Detailed Wiring Diagram (WD)	Detailed Wiring Diagram-WD	Complete ("As-constructed")	
Construction	Installation drawings illustrate how components and parts are installed, including all relevant information	Installation Drawing	Complete ("As-constructed")	
Construction	Drawing for Isometric Drawing	Isometric Drawing	Complete ("As-constructed")	
Construction	Concrete Works, Structural Steelwork and Metalworks, Architectural and Finishing Works, Site Infrastructure Works	Site & building drawing	Complete ("As-constructed")	Limited to building/area
Construction	Drawing for Support Drawing	Support Drawing	Complete ("As-constructed")	
Construction	Document for Factory Acceptance Test Report (FAT), Equivalent to Manufacturing Dossier (MD) and/or End of Manufacturing Report (EoMR)	Manufacturing Report	If Useful	
Construction	Instrument Hook Up drawing/diagram in as-constructed or as-built version (it is a detailed drawing showing typical installation of an instrument in a correct manner so that the instrument operates properly and prevent issues which could potentially affect the measurement such as liquid trap in gas impulse)	Hook-up Drawing	If Useful	
Commissioning	Site Acceptance Test Plan	FAT & SAT Plan and Procedure	Complete	Limited to direct DA contribution (as in-kind) if SAT was included as part of the PA.
Commissioning	Site Acceptance Test Report	Assembly and Installation Report	Complete	Limited to direct DA contribution (as in-kind) if SAT was included as part of the PA.
Commissioning	Final Acceptance Certificate after the Acceptance Tests	Assembly and Installation Report	Complete	Limited to direct DA contribution (as in-kind) if SAT was included as part of the PA.
Commissioning	System Commissioning Plan	Commissioning Plan	Complete	
Commissioning	TOP scope definition	Commissioning Plan	Complete	
Commissioning	Requirements Validation Matrix (RVM)	Compliance Matrix - DCM or VCM or ICM or RVM	Complete	
Commissioning	Software Test Plan-STP	FAT & SAT Plan and Procedure	Preliminary	
Commissioning	Software Test Procedure	FAT & SAT Plan and Procedure	Preliminary	
Commissioning	Commissioning Test Procedure	Commissioning Test Procedure	Preliminary	
Commissioning	Temporary Modification List	Commissioning Plan	If Useful	
Maintenance	Maintenance Manual (it can be part of the Equipment Operation and maintenance Manual)	Equipment Operation and maintenance Manual	Complete	
Maintenance	Software User Manual-SUM (including passwords)	Equipment Operation and maintenance Manual	Complete	
Maintenance	IO in cash: Preservation records stage #3 for IO or for in-kind: preservation record up to takeover to IO (stage #2 evidences shall be part of the MCD)	Equipment Preservation Record	Complete	
Maintenance	Equipment or System Preservation Plan	Equipment Preservation Requirements	Complete	
Maintenance	In-Service Inspection Record	Maintenance or In-Service Inspection Record	Complete	
Maintenance	Instrumentation and Control Software Source Code	Software or Programming Code	Complete	
Maintenance	Spare Parts List	System Maintenance and In-Service Inspection Plan	Complete	
Maintenance	System Maintenance and Inspection Plan	System Maintenance and In-Service Inspection Plan	Complete	
Maintenance	In-Service Inspection Procedure	Maintenance or In-Service Inspection Procedure	Preliminary	
Maintenance	Maintenance or Inspection Instruction or Procedure	Maintenance or In-Service Inspection Procedure	Preliminary	
Operation	Concept of Operations	Concept of Operations	Complete	
Operation	Operation Manual (it can be part of the Equipment Operation and maintenance Manual)	Equipment Operation and maintenance Manual	Preliminary	
Operation	System Operations Manual	Operation Procedure	Preliminary	
Operation	System Test Manual	Operation Procedure	Preliminary	
Operation	Operation diagram	Operation Procedure	If Useful	
Non-technical documents (to be linked as "other documents" as part of the HOP CCR)				
Commissioning	Fire Extinguisher Plan	System layout drawing	If Useful	
Commissioning	Emergency Intervention Plans (EIP)	[TBD]	If Useful	
Commissioning	List of temporary OHS measures	[TBD]	If Useful	
Commissioning	OHS Act of Acceptance and readiness	[TBD]	If Useful	
[All]	List of Non-Conformance Report-NCR	List	Complete	
[All]	List of Deviation Request-DR	List	Complete	
[All]	List of Project Change Request-PCR	List	Complete	
Engineering	List of Chits (not closed yet)	List	Complete	
[All]	List of Request for Information-RFI	List	Complete	
[All]	List of Construction Field Change Request-FCR	List	Complete	
[All]	Punch items list (and/or snag list)	List	Complete	

For selection and definition of the expected document, please refer to

https://confluence.iter.org/display/BC/Technical+Document+Types

Working Instruction for Operations Readiness Review (ORR) (55E54L v1.1)

Technical Design Family (TDF)	Generic Document Title (GTD)
Acceptance Record or Report	Site Acceptance Test Report
Assembly and Installation Record or Report	Mechanical Completion Certificate
Assembly and Installation Record or Report	Mechanical Completion Dossier
Commissioning Record or Report	Calibration and Test Record
Commissioning Record or Report	Commissioning Test Record
Commissioning Record or Report	Control Set Point List
Commissioning Record or Report	Integrated Commissioning Report
Commissioning Record or Report	Software Test Report
Commissioning Record or Report	System Commissioning Report
Maintenance or Inspection Instruction or Procedure	Maintenance Procedure
Maintenance or Inspection Plan	Spare Parts List
Maintenance or Inspection Plan	System Maintenance and Inspection Plan
Maintenance or Inspection Plan	System Maintenance Plan
Operation and Maintenance Manual	Equipment Operation and Maintenance Manual
Operation and Maintenance Manual	Software User Manual-SUM
Operation Instruction or Procedure	Operating Order
Operation Instruction or Procedure	Operating Procedure
Operation Instruction or Procedure	Operations Memo and System Opeations Manual
Operation Instruction or Procedure	Operator Actions
Operation Instruction or Procedure	System Operations Manual
ROX and Research and Development Report	Lessons Learned Report-LLR
ROX and Research and Development Report	Research and Development Data
Shipping or Logistics Record	Goods Receive Report-GRR
Shipping or Logistics Record	Receiving Inspection Report-RIR
Shipping or Logistics Record	Shipping Damage Claim Form
Shipping or Logistics Record	Shipping Record
Technical Baseline for Operations	Commissioning Plan
Technical Baseline for Operations	Integrated Commissioning Plan
Technical Baseline for Operations	ConOps
Technical Baseline for Operations	M&IP[1]
Technical Baseline for Operations	P&ID
Technical Baseline for Operations	PFD
Technical Baseline for Operations	SLD
Technical Baseline for Operations	Cabling Diagram
Technical Baseline for Operations	Site Routing
Technical Baseline for Operations	General Arrangement Drawing
Technical Baseline for Operations	Equipment List & Attributes
Technical Baseline for Operations	Operating Manual
Technical Baseline for Operations	Normal Operating Procedures
Technical Baseline for Operations	Abnormal Operating Procedures
Technical Baseline for Operations	Alarm Sheet
Technical Baseline for Operations	Emergency Operating Procedures
Technical Baseline for Operations	Test Manual
Technical Baseline for Operations	Post Maintenance Procedures
Technical Baseline for Operations	Post Modification Procedures
Technical Baseline for Operations	Functional Test Procedure
Technical Baseline for Operations	Maintenance and Inspection Manual
Technical Baseline for Operations	Maintenance Procedures
Technical Baseline for Operations	Inspection Procedures

ITER_D_258LKL v3.1

Name of the output	Is there a need for template? If yes, UID	Where this output stored?	If IDM, which document type?	How do you name this file? (naming convention)	Accountable team for the availability of the output	Retention period
Software documentation Check list	ITER_D_SUDNWD	ITER_D_VK4M6G	Memorandum /note	Check list	requester	over the project lifecycle
Safety code validation and verification report with cover sheet	ITER_D_STGKQP (report) ITER_D_STMCPF (cover sheet)	ITER_D_VK4M6G	Memorandum /note	V&V report	requester	over the project lifecycle