1. SCOPE

This document defines the technical and functional requirements of the LV Automation and protection deployed in LV Engine project. This document covers the controllable circuit breakers at secondary substations and controllable switches deployed at link boxes and link pillars used on low voltage underground cable networks. It should be noted that the requirements specified in this document can be used for any LV Automation implementation excluding sections specific to LV Engine.

This technical specification document has been prepared as part of the LV Engine project and utilises previous learnings generated from LV automation schemes trial by other DNOs.

2. Disclaimer

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3. ISSUE RECORD

This is a Future Networks project document prepared to facilitate transition to Business as Usual application following successful demonstration of LV Engine smart transformer sites. Updates will be required post trial.

Issue Date	Issue No.	Author	Amendment details
October 2019	0	LV Engine	First release
May 2020	0.1	LV Engine	Incorporating wider business inputs

4. ISSUE AUTHORITY

Author	Owner	Issue Authority

5. REVIEW

This is a PROJECT document and shall be reviewed prior to Business as Usual application.

6. DISTRIBUTION

This is a PROJECT document and is not part of a Manual maintained by Document Control and does not have a maintained distribution list.

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8. DEFINITIONS

Abbreviation	Definition
AC	Alternating Current
CB	Circuit Breaker
DAB	Dual Active Bridge
DC	Direct Current
DER	Distributed Energy Resources
DNO	Distribution Network Operator
DoS	Denial of Service
DT	Definite Time
EFI	Earth Fault Indication
EMC	Electromagnetic Compatibility
EMS	Energy Management System
ESQCR	Electricity Safety, Quality and Continuity Regulations
ETR	Engineering Technical Report
EV	Electric Vehicle
FE	Functional Earthing
FPI	Fault Passage Indicator
GIS	Geographic Information System
GSP	Grid Supply Point
HFT	High Frequency Transformer
HV	High Voltage (1,000V-22,000V)
IEC	International Electrotechnical Commission
LCT	Low Carbon Technology
LDAPs	Lightweight Directory Access Protocol secure
LS	Logical Switching [Scheme]
LV	Low Voltage
LVAC	Low Voltage Alternating Current (<1.0kV)
C-LVCB	Low Voltage Circuit Breaker – Controllable Single-phase circuit breaker
LVDC	Low Voltage Direct Current (<1,500V)
C-LVS	Low Voltage Switch – Controllable – Single phase switch
MCB	Miniature Circuit Breaker
MCCB	Moulded Case Circuit Breaker
MITM	Man-in-the-Middle
NOP	Normal Open Point
PCC	Point of Common Coupling
PE	Protective Earthing
PEN	Combined PE conductor and an N conductor
PENDA	Public Electricity Network Distribution Assembly
PFC	Prospective Fault Current
PU	Per Unit
RCD	Residual Current Devices
RBAC	Role-based access control
EMS	Smart Control System
SDIF	Smart Data Integration Fabric
SE	Structural Earthing
SPD	SP Distribution
SPM	SP Manweb
SST	Solid State Transformer
ST	Smart Transformer
TC	Telecontrol
TN	'T': Direct connection of a point with earth (Latin: Terra) 'N': Earth connection is supplied by the electricity supply Network

Abbreviation	Definition
TN-C	TN with a Combined PE conductor and an N conductor
TN-C-S	A Combined PEN conductor occurs between the substation and the entry point into the customer installations, and earth and neutral are Separated in the service head.
TN-S	PE and N are Separate conductors and connected only at source
UMV	Utility Map Viewer

LV Pillar / Take Off Chamber	The assembly which facilitates both the incoming and outgoing LV circuits by a combination of isolators, fuses ways or LV circuit breakers.
Pad Mounted Transformer	Compact ground-mounted cable-connected double-wound transformer complete with high voltage and low voltage cable boxes and with a maximum size of 100 kVA single-phase, 200 kVA split-phase and 200 kVA three-phase.
Direct Coupling	A mechanical means of electrical connection whereby the HV switchgear and LV fuse gear is directly mounted on the transformer. The rated power of the transformer shall be available for this arrangement.
Substation	As defined in the Electricity Safety, Quality and Continuity Regulations 2002
Standard Indoor Substation	A Ground Mounted Transformer with individual HV Switchgear and LV Fuse Board all enclosed within a brick building.
Pad Mounted Substation	Ground Mounted Transformer with Integral 11/6.6kV 'Off Load' Isolation and 11/6.6kV and LV fuses, enclosed in one cabinet. The design is NOT enclosed by a fence, GRP or other housing.
Unit Substation	A Ground Mounted Transformer with attached 11/6.6kV Switchgear and LV Fuse Board all enclosed within a GRP housing, building or perimeter fence.
X Type	X-Type is the designation given to the fully interconnected 11kV and LV system in the SP Manweb licence area.
Y Type	Y-Type is the designation given to the interconnected 11kV system in the SP Manweb licence area with the caveat of interconnection 'less' so at LV.
LV Pillar / Take Off Chamber	The assembly which facilitates both the incoming and outgoing LV circuits by a combination of isolators, fuses ways or LV circuit breakers.

9. REFERENCE AND RELATED DOCUMENTS

This specification refers to the following and other listed documents. It is important that the users ensure that they are applying the most recent editions together with any amendments

9.1 International Electrotechnical Commission Publications (IEC)

IEC 60269-1	Low Voltage Fuses, General Requirements
IEC 60947	Low Voltage Switchgear and Controlgear
IEC 60947-2	Low Voltage Switchgear and Controlgear. Part 2 – Circuit Breakers
IEC 61000	Electromagnetic Compatibility (EMC)
IEC61850	Communication networks and systems for power utility automation.
IEC 62351-1	Power systems management and associated information exchange - Data and communications security - Part 1: Communication network and system security - Introduction to security issues
IEC 62351-3	Power systems management and associated information exchange - Data and communications security - Part 3: Communication network and system security - Profiles including TCP/IP
IEC 62351-5	Power systems management and associated information exchange - Data and communications security - Part 5: Security for IEC 60870-5 and derivatives
IEC 62351-7	Power systems management and associated information exchange - Data and communications security - Part 7: Network and system management (NSM) data object models

IEC 62351-8	Power systems management and associated information exchange - Data and communications security - Part 8: Role-based access control
IEC 62351-9	Power systems management and associated information exchange - Data and communications security - Part 9: Cyber security key management for power system equipment
IEC 62351-90-1	RBAC Guidelines

9.2 European Standards (BS EN)

BS EN ISO 9001	Quality Systems
BS EN ISO 14001	Environmental
BS EN 60073	Basic and safety principles for man-machine interface, marking and identification. Coding principles for indicators and actuators
BS EN 60269-1	Low Voltage Fuses, General Requirements
BS EN 60947-1	Low Voltage Switchgear and Controlgear, General Rules
BS EN 60947-2	Low Voltage Switchgear and Controlgear, Circuit Breakers
BS EN 60947-6-2	Low-Voltage Switchgear and Controlgear, Multiple Function Equipment - Control and Protective Switching Devices (or equipment)
BS EN 61439-1	Low Voltage Switchgear and Controlgear Assemblies, General Rules
BS EN 61439-5	Low-voltage Switchgear and Controlgear Assemblies - Assemblies for Power Distribution in Public Networks

9.3 Energy Networks Association (ENA) Technical Specifications and British Standards

ENA TS 37-01	400V AC Switchgear, Controlgear and Fuse assemblies.
ENA TS 37-02	Public Electricity Network Distribution Assemblies
ENA TS 48-5	Environmental Test Requirements for Protection and Control Equipment and Systems
ENA TS 48-6-6	ENA Protection Assessment – Functional Test Requirements – Overcurrent and Earth Fault Protection.
BS EN ISO 9001	Quality Systems
BS EN ISO 14001	Environmental
BS EN 60269-1	Low Voltage Fuses, General Requirements
BS EN 60947-2	Low Voltage Switchgear and Controlgear, Circuit Breakers
BS EN 60947-6-2	Low-Voltage Switchgear and Controlgear, Multiple Function Equipment - Control and Protective Switching Devices (or equipment)
BS EN 61439-1	Low Voltage Switchgear and Controlgear Assemblies, General Rules
BS EN 61439-5	Low-voltage Switchgear and Controlgear Assemblies - Assemblies for Power Distribution in Public Networks
BS HD 60269-2 (BS88-2:2013)	Low-voltage fuses. Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application). Examples of standardized systems of fuses A to K.
HSE	The Electricity at Work Regulations 1989
HSE	The Health & Safety at Work Act 1974
HSE	The Control of Substances Hazardous to Health Regulations 2002
HSE PUWER 1998	Provision and use of work equipment Regulations

10. INTRODUCTION

The LV Engine innovation project intends to trial Smart Transformers (ST) within secondary substations as the central point of an active and intelligent 11kV and LV distribution network. This represents a significant change to how the LV network has traditionally operated. This document proposes to use intelligent LV switching devices that can be remotely controlled, sense feeder flows and offer dynamic reconfiguration of the LV network providing a centralised LV network management and automation platform.

The ST's trialled during the project will bring together sophisticated power electronic hardware with intelligent network monitoring and control to maximise the performance and efficiency of the distribution network. The ST will offer a number of valuable functionalities to the LV and 11kV networks to facilitate the uptake of Low Carbon Technologies (LCTs) and Distributed Generation (DG) whilst minimising cost to GB electricity consumers. It is expected that these additional functionalities, including phase voltage regulation and power flow control, will release additional capacity from within existing network infrastructure and defer the requirement for wider network reinforcement caused by increased thermal loading of network assets and network voltages out with statutory limits.

The core functionality provided by the LV Engine project and the Smart Transformer will include the following as a minimum:

- LV phase voltage regulation
- Power flow control for sharing thermal capacity across multiple substations;
- The automated reconfiguration of LV networks through Normally Open Points (NOPs);
- Access to a LV DC customer supply for EV charging and LED street lighting;
- LV power factor correction;
- 11kV reactive power compensation;
- Bi-directional power flow control and;
- HV load balancing.

The technical performance of the ST will be trialled within five different trial schemes within both of SP Energy Network's distribution licensed areas, each of these aiming to demonstrate the performance of the LV Engine functionalities under different network configurations. Prior to these important network trials the project will both design and manufacture an ST which is fit-for-purpose for use within a distribution network and can interface effectively with both the HV and LV networks. This includes considering the impact on traditional LV network and customer protection devices and network earthing of both AC and DC customer supplies.

LV Engine provides an opportunity to demonstrate the performance and benefits of STs in different network conditions. SPEN aims to ensure the final LV Engine solution, and in particular the ST design, can be deployed for BaU adoption. If successful, as reflected in the LV Engine Full Submission Proposal to Ofgem, the LV Engine solution can potentially be deployed in over 1,700 ground mounted substations by 2035 within SPEN to facilitate the growing integration of Low Carbon Technologies.

11. GENERAL REQUIREMENTS

11.1 Service Conditions

Equipment purchased in accordance with this Specification is intended for installation within LV distribution network and shall comply with BS EN 60947-1 series and relevant associated parts of the BS EN 60947 series and ENA TS 37-1, the characteristics of which are summarised in the table below:

Item	Value	
Ambient air temperature	-25 °C to +55 °C	Class "-25 outdoor"
Maximum ambient air temperature	+40 °C	Shall not exceed this limit for more than a

		period of 24hr
Altitude	1000m	Not exceeding
Humidity	50%	Shall not exceed this limit for a maximum temperature of +40°C
Wind Speed	34m/s	Higher wind speed may be encountered on a site per site basis

Tenderers shall ensure that the equipment will have a degree of protection not less than IP XXB at the operating surfaces. Refer to Basic Safety Publication (see 8.12 of IEC 61140) which sets a minimum level of protection against electric shock of IP XXB for the equipment.

The EMC environment is defined as 'Environment A' defined as a power network supplied from a transformer dedicated to the supply.

Tenderers shall confirm that all items offered shall comply with these conditions and shall state in their tender the installation design ambient temperatures of the items tendered.

11.2 LV Network Earthing

There are four types on earthing on the LV network that the equipment will interface with. These are summarised below:

- TN-C-S connections are associated with networks comprising combined neutral earth cables where the neutral and earth functions are combined in a single conductor. (often referred as PME – Protective Multiple Earthing).
- A TNS supply has a separate neutral and earth conductor between the service point and the neutral earth connection at the source of the main distributor cable.
- In a TT supply the customer's earth terminal is electrically separate from the SPEN network.
- Although PME is the preferred option protective neutral bonding (PNB) may provide an alternative solution in circumstances where it is not practical to install the LV earth at the transformer.

The above earthing arrangements are encountered on the network however the preferred method of earthing is PME

11.3 Network Specific Parameters

11.3.1 Voltage

The nominal voltage of the LV Distribution Network is 230V (phase to neutral) and 400V (phase to phase). Acceptable voltage limits are defined with ESQCR and to be within -6% to 10% of the nominal value. It should be noted that the deviation (-6% to 10%) from nominal voltage in normal condition specified by ESQCR is the average voltage variations recorded in a 10 minute interval where any voltage sample can deviate -15% to 10% of nominal voltage

During periods of abnormal running conditions, system voltages may exceed statutory limits.

11.3.2 Frequency

The nominal frequency is 50Hz and the statutory limits are between 49.5Hz to 50.5Hz. The system frequency range is between 47.0Hz to 52.0Hz for 100% of the time. This range is considered as the normal frequency variations within the network. It should be noted that the system frequency is 49.5 to 50.5 for 95% of the time.

11.3.3 Fault Level

The design fault level for the LV network is 25MVA for 3s.

The final site selection shall define network location for device installation.

12. REMOTE CONTROL LV CIRCUIT BREAKERS

12.1 General Requirements

The information provided in this document is specific to the design, installation and operation of the retrofit Controllable LV Circuit Breakers (C-LVCB) as applied to the LV trial networks. The C-LVCB consists of three single phase circuit breakers

The C-LVCB shall be used as an alternative to traditional LV fuses and be fitted within existing LV outgoing distributor units broadly in accordance with Section 3.1.201 (TFX – Fuseboxes) and related requirements of ENA TS 37-02. These will provide both the protection required for the LV network and the controllability required by SPEN Energy Management System (EMS).

The C-LVCB shall protect outgoing and incoming feeders connected to the secondary side of Distribution Transformers at a nominal voltage of 0.4kV. The C-LVCB devices shall use a dedicated communications and control hub that can communicate securely to EMS.

C-LVCB units shall only be considered for installation where the following conditions have been met:.

- Power system studies, including load flow and fault analysis, shall be performed for the chosen section of network.
- Network layout and distribution of customers has been understood.
- The associated LV network shall be comprised of underground cable only.
- Maximum fault current shall not exceed short circuit breaking capacity of equipment.
- Peak fault current shall not exceed instantaneous fault withstand rating or thermal capability of C-LVCB units and substation equipment.
- Circuits being used for implementation shall not cross HV protection zone boundaries.

12.1.1 Normal Operation

The C-LVCB units shall remain passive during normal network operation and shall only operate in the event of a network fault or an instruction from EMS.

The C-LVCB shall be fully automatic in normal operation. The C-LVCB shall be capable of local and remote operation, capable of self-resetting following a transient event without manual intervention. It shall be able to open / close locally with a configurable delay when pushing the local closed button.

The C-LVCB shall be self-monitoring during both normal operation and fault conditions.

The C-LVCB (or its associated communications and control hub) shall communicate with the EMS through a approved protocol by SPEN, enabling real time information to be reviewed by the operator.

12.1.2 EMS Instructed Operations

Following an instruction to open or close from the EMS, the C-LVCB shall confirm status both locally and remotely.

Following an instruction to open or close from the EMS the C-LVCB shall remain automatic in normal operation. The C-LVCB shall remain capable of local and remote operation and when closed capable of self-resetting following a transient event without manual intervention.

12.1.3 Fault Conditions

Should a fault occur on a circuit protected by an C-LVCB, the C-LVCB shall operate to isolate and clear the fault, overriding any instruction from EMS.

The operator shall have a clear indication that a fault has occurred both locally and remotely.

The C-LVCB may have two means of protection, primary (up to the defined threshold) and backup which shall operate above the threshold to protect the network.

After operation of any backup protection, the operator shall have a clear indication that a fault has occurred operating the device's back up protection both locally and remotely. Manual intervention shall then be prompted to progress normal post fault restoration procedures, including asset health.

Where the fault event is transient, the C-LVCB shall have the capability to identify this fault condition and, after initially operating to clear the fault, attempt to safely reclose based on reclosing procedure agreed with SPEN. If a safe reclose can be achieved the C-LVCB shall remain closed and network supplies shall be restored.

The C-LVCB shall have a configurable reclosing cycle. This shall enable the C-LVCB to attempt reclosing at least once within 1 minute of fault inception with no more than 4 'trips' to lock-out. The dead time between C-LVCB reclosing attempts and the total number of reclose attempts shall be user configurable. The Tenderer shall identify any conditions or limits of programmable settings.

Where the fault is permanent the C-LVCB shall identify the nature of this fault event and, after initially operating to clear the fault, remain open and in a safe position. The C-LVCB shall not reclose when a fault remains on the connected circuit.
Internal faults logged via internal self-monitoring shall be raised to the operator by a form of warning and or alarm both locally and remotely. Where the fault compromises device operation and thus protection of the network the C-LVCB shall fail safe.

The primary element of C-LVCB shall, for all occurrences, fail safe (OPEN).

12.2 Technical Requirements

The C-LVCB is required to comply with the standards as defined in BS EN 60947 series and ENA TS 37-2 and those specified in table below

Rated Operational Voltage (Ue)	400Vac
Rated Impulse withstand Voltage (Uimp)	8kV
Conventional Free Air Thermal Current (Ith)	400A rms
Conventional Enclosed Thermal Current (Ithe)	400A rms
Rated Operational Current (Ie)	400A rms
Rated Frequency	50Hz
Making Capacity	27kA rms
Breaking Capacity	37kA rms, 400V

12.2.1 Protection Requirements

Conventional LV feeder protection (outgoing fuse ways) at identified secondary substations shall be replaced with C-LVCB units meeting the requirements of this specification. Where deemed suitable, existing LV feeder protection (typically 400A fuses) shall be replaced with C-LVCB units.

C-LVCB devices shall differentiate between transient and permanent faults on the LV network. The C-LVCB shall be programmable with Inverse Definite Minimum Time (IDMT), low set and high set definite time elements (normal inverse, very inverse and extremely inverse characteristic to IEC 60255-151) and characteristics compatible with the requirements of BS88 (or equivalent for legacy and BS HD 60269-2 for new installations) fuses.

The C-LVCB shall have capability to be programmed with multiple protection characteristics. These characteristics shall be stored in a protection register that can be accessed either remotely or locally at the device. It shall also have the capability to make any modifications made to the originally

programmed protection settings either remotely or locally without compromising the existing protection scheme and shall be logged for operator awareness.

The C-LVCB shall be capable of remote resetting following operation to clear a fault event, except where backup protective device has operated.

Where the number of pre-set reclosing attempts are exceeded the C-LVCB will lockout to a safe position (OPEN).

Where the fault event is permanent the C-LVCB shall not attempt to reclose. The C-LVCB shall remain in a safe state (OPEN) until a reset operation is initiated after which the C-LVCB will only reclose when safe to do so.

The C-LVCB shall have a programmable lockout function for cumulative making/breaking operations. This function shall result in the C-LVCB failing safe after the pre-set value is exceeded. A means of warning for both the operator locally and remotely, that the C-LVCB is within a defined range of this limit shall be provided.

Testing functionality should be available to the operator for local testing of programmable settings upon upload to the C-LVCB.

12.2.2 Secondary Protection

C-LVCB devices shall be fitted with a secondary means of protection such that in the event of a fault, exceeding capability of the primary device, the C-LVCB primary component will not operate and the fault be cleared by this secondary protection.

Secondary protection shall be a fuse and shall comply with definitions in BS88 (or equivalent) and requirements of BS EN 60269.

Fuse Type	Type J Fuselink, 415V
Max Fuse Rating	400A

12.2.3 Control Circuits

Control circuits associated with C-LVCB units shall comply with the requirements of BS EN 60947. Where electronic control circuits are used the following characteristics must be provided by the manufacturer:

- type of current;
- power consumption;
- rated frequency (or d.c.);
- rated control circuit voltage, Uc (nature: a.c./d.c.);
- rated control supply voltage, Us (nature: a.c./d.c.);
- nature of external control circuit devices (contacts, sensors, optocouplers, electronic active components, etc.).

12.2.4 Reverse Power Flow

The C-LVCB shall be configurable of operating for reverse power flow. Specifically, LV circuits which exceed the individual LV circuit rating or contribute to an overall breach of the rating of the transformer for a specified time caused by the occurrence of reverse power flow.

An alarm shall be generated both locally and remotely to alert the operator to the occurrence of reverse power flow.

12.3 Design and Consideration

12.3.1 General Requirements

This section covers the design and construction of the C-LVCB to be used in SPEN LV network.

All equipment shall be constructed in accordance with BS EN 60947-1 series and relevant associated parts of the BS EN 60947 series.

The equipment with its enclosure, if any, whether integral or not, shall be designed and constructed to withstand the stresses occurring during installation and normal use and, in addition, shall provide a specified degree of resistance to abnormal heat and fire and are defined in Section 7 of BS EN 60947-1.

The C-LVCB shall have maximum dimensions of 120mm (W) x 200mm (H) x 300mm (D). The Tenderer shall provide the exact dimensions of their proposed product.

C-LVCB shall be capable of retro-fitting into existing BS88 JSU 92mm fuse holders at secondary substations.

The minimum number of operations at a fault level of 6kA shall be 40. The Tenderer shall also confirm the maximum number of device life time operations at different fault level.

No significant civil works are anticipated for installation of the C-LVCB. Tenderer shall specify any civil work requirement in the tender response.

The weight of C-LVCB device shall be such that an individual operator can lift, remove or replace the device without the need for assistance and comply with Manual Handling Operations Regulations 1992.

Current-carrying parts shall have the necessary mechanical strength and current-carrying capacity for their intended use, as defined in BS EN 60947-1. Compliance shall be verified by inspection and by conducting the test sequences according to the relevant standards.

Equipment shall be constructed in accordance with 7.2.3.3 and 7.2.3.4 of BS EN 60947-1 for Creepage and Clearance distances.

12.3.2 Communication

If the C-LVCB devices provided by a Tenderer requires a Communication and/or Control Unit the following should be noted:

- The C-LVCB Controller and communication equipment shall be housed in control cabinets and be suitable for rack or wall mounting in the substation and shall be supplied with all aerials, leads, masts and other related equipment. The type and layout of these cabinets shall be suitable for deployment at secondary substations of all standard construction formats;
- Where required, a battery and charger unit shall be included in this tender and shall comply with BS6290 – Part 4 and BS EN 608696-22;
- Auxiliary supplies are available at 230V 50Hz. Tender shall specify the Auxiliary supply requirements in the tender response;

- The batteries for the central communication unit shall be positioned away from heat sources that may affect the battery lifetime. A low voltage cut-off shall be provided to protect the battery from a damaging degree of discharge. A high voltage cut off shall be provided to prevent battery overcharging;
- Suitable climatic controls shall be provided to regulate the ambient temperature within the enclosures such that the temperature does not exceed that which would otherwise guarantee full life of the battery. No moving parts such as fans are anticipated in this instance;
- It should be supplied from a permanently connected fused spur, through auxiliary connection to the C-LVCB or directly from LV busbars in accordance with the requirements of BS 7671;
- The RTU should be in an area with adequate mobile phone coverage, as data connectivity to the LV Control Centre is via GPRS or 3G; if the signal is weak the aerial must be capable of positioning in a location to improve reception or alternatively a high gain antenna should be available.

The C-LVCB Controller shall marshal the data from all the C-LVCBs located in the substation. The C-LVCB Controller shall be fitted with an Ethernet port (RJ45) for connection to the substation's SPEN approved 4G router. The C-LVCB Controller shall be required to communicate the real time data signals from the C-LVCBs over DNP3, Modbus, IEC 60870-5-101 or IEC 61850. At minimum it shall be possible to close and trip the C-LVCBs and receive digital and analogue instantaneous measurements from the C-LVCBs from external applications over these interfaces If the C-LVCB Controller uses DNP3, it will act as a DNP3 slave. The 4G router has a gateway facility to allow protocol conversion between DNP3 and IEC 60870-5-101, and will act as the DNP3 master. IEC 60870-5-101 is the protocol current used to communicate data between the router and SPEN's NMS.

The C-LVCB Controller shall also be required to communicate with the vendor supplied Application Suite located in a SPEN data centre. The Application Suite shall provide the following functionality:

- Facilitate the rollout of firmware updates to the Gateway and C-LVCBs;
- Via a web portal. allow the remote interrogation of the Gateway and C-LVCBs. The vendor is required to provide a description of what functions can be accessed over the web portal;
- Allow diagnostics to be carried out on the Gateway and C-LVCBs
- Provide recorded events (transient and fault events) in the format specified by SPEN

12.3.3 Alarms and Monitoring

Alarm and monitoring capability shall be inherently designed within the C-LVCB. All alarms and monitoring notifications shall be capable of being replicated at the SPEN EMS.

Local alarms and warnings shall be clearly visible to the Operator on the device when installed at the secondary substation.

In addition to the control interface, following equipment failure or a fault event to which the C-LVCB reacts, appropriate notifications in form of email or SMS shall be sent to responsible parties e.g. (LV operational staff) from the devices. These notifications shall be limited to those which represent an operational impact.

A list of alarms, warnings and monitoring notifications is detailed below to present minimum requirements. Tenderers shall submit additional capabilities available to SPEN for review and agreement.

Status	L1	L2	L3	System
OPEN	X	X	X	
CLOSE	X	X	X	
Primary Protection Operated				X
Secondary Protection Operated				X
Comms Fail				X

Status	L1	L2	L3	System
Manual Operation				X
Setting Modification				X

12.3.4 I/O Schedule

The below table details a list of input and output functionalities that the device shall provide.

I.D	Alarm/Warning/Notification/measurement	Description	C = Critical D = Desired O = Optional
Loss of Power	Alarm	Device has lost power supply	C
Power Restored	Notification	Power supply to device has been restored	C
Device Error Fail	Alarm	An internal device error has occurred and the device has failed safe	C
Device Error	Warning	An internal device error has occurred but has not caused the device to fail	D
Temperature Warning	Warning	The device temperature is exceeding normal range	D
Device Upgrade	Notification	The device is currently performing an upgrade	C
Device Upgrade Fail	Warning	The upgrade being performed has failed	C
Communication Failure	Alarm	Communications have failed between devices and/or SPEN EMS system	C
C-LVCB Closed	Notification	The C-LVCB device is in the Closed position	C
C-LVCB Open	Notification	The C-LVCB device is in the Open position	C
C-LVCB Operated	Alarm	The C-LVCB device has operated	C
C-LVCB Reclosed	Notification	The C-LVCB device has reclosed within pre-set conditions	C
C-LVCB Close Manual	Notification	The C-LVCB device was closed manually by the operator	O
C-LVCB Close Fail	Alarm	The C-LVCB device has failed to close	C
C-LVCB Lock Out	Alarm	The C-LVCB has attempted reclose	C

I.D	Alarm/Warning/Notification/measurement	Description	C = Critical D = Desired O = Optional
		and is now locked out	
C-LVCB Secondary Operated	Alarm	The C-LVCB secondary protective device has operated	C
C-LVCB Reverse Power Prot Op'd	Alarm	The C-LVCB device has operated due to reverse power flow	C
C-LVCB Ops Low	Warning	The C-LVCB has only a limited number of operations remaining	D
Breaker life remaining	Notification	The C-LVCB has only a limited number of fault break remaining	C
Average RMS current	Measurement	over given window (>= 1.0 sec), available for every 10.0ms	C
Average current angle	Measurement	over given window (>= 1.0 sec), available for every 10.0ms	C
Average RMS bus-neural voltage	Measurement	over given window (>= 1.0 sec), available for every 10ms	C
Average active power	Measurement	over given window (>= 1.0 sec), available for every 1.0s	C
Average Reactive power	Measurement	over given window (>= 1.0 sec), available for every 1.0s	C

12.3.5 Device Labelling and Identification

All information and markings shall be clearly legible and shall comply with by BS EN 60947-1 Section 5.1 and 5.2 by the tenderer and where relevant marked on the device. Additional information to be marked on devices shall be in alignment with the relevant sub-part of the above standard.

Every device shall be fitted with a clearly marked and affixed nameplate or label. A unique default asset ID shall be assigned to the device but this shall be configurable.

Indication of the open and closed positions shall be clearly visible.

A clear reference shall be made on the device which states the standards to which the device is compliant with, e.g. BS EN 60947-2.

13. REMOTE CONTROL LV SWITCHES

13.1 General Requirements

The information provided in this document is specific to the design, installation and operation of the retrofit Controllable LV Switches (C-LVS).

The C-LVS is a single-phase unit and shall be used to facilitate the closing of Network Open Points (NOPs) within the LV Distribution Network. They shall serve as an alternative to the use of solid links or conventional LV fuses in link boxes or mini-pillars for such purpose.

C-LVS units shall only be considered for installation where the following conditions have been met:

- Power system studies, including load flow and fault analysis, shall be performed for the chosen sections of network, investigating open and closed NOPs.
- Network layout and distribution of customers has been understood.
- The associated LV network shall be comprised of underground cable only.
- Peak fault current shall not exceed instantaneous fault withstand rating or thermal capability of remote-control circuit breakers and substation equipment.
- Circuits being used for implementation shall not cross HV protection zone, primary substation, group or busbar boundaries.
- Circuits where C-LVS are to be fitted shall be chosen such that the distance between partnering substations is not too long ensuring voltage drop and losses stay within statutory limits.

C-LVS shall be able to fit securely within existing LV infrastructure preferably without the need for additional civil works to take place.

The C-LVS shall be capable of restoring the LV network in the event of a fault taking place while the network is interconnected.

The C-LVS shall work in conjunction with C-LVCB units to isolate the fault location. The C-LVS shall, for all occurrences, fail safe (OPEN).

Due to the automated nature of the devices, which could alter the running arrangement of the network in real-time, there is a requirement for analogue and digital status information to be relayed to the SPEN Control.

The C-LVS units shall have means of communication that enables data to be securely transferred to EMS. A communications hub may be implemented to control C-LVS – this hub shall be integral to all associated LV infrastructure and should allow for remote control.

13.1.1 Normal Operation

During normal operation, the C-LVS shall be closed to interconnect LV network. Where a C-LVS device is normally open this will be at the discretion of SPEN.

The C-LVS shall be self-monitoring during normal operation.

The C-LVS device shall communicate with the SPEN Control, enabling real time information to be sent and received by the responsible engineer.

13.1.2 EMS Instructed Operations

Following an instruction to open or close from the EMS, the C-LVS shall confirm status both locally and remotely.

Following an instruction to open or close from the EMS the C-LVCB shall remain automatic in normal operation. The C-LVCB shall remain capable of local and remote operation and when closed capable of self-resetting without manual intervention.

13.1.3 Fault Condition

Should a fault occur on the LV Distribution System, the C-LVS shall operate as follows:

- Where a network fault, of any kind, occurs and the C-LVS is Open – no action
- Where a network fault, of any kind, occurs and the C-LVS is Closed – the C-LVS shall only operate to Open once the fault has been cleared by substation protection (C-LVCB). After the fault has been cleared, and remote substation protection reinstated, the C-LVS shall automatically close following local checks of the network performed by inbuilt logic and shall not rely on communication between C-LVS and C-LVCB.
- The C-LVS device shall open automatically when a loss of volts condition is noted on either side of the device. The device shall automatically close when voltage is restored to both sides of the C-LVS device and continuity of the network has been verified locally.
- Any faults that are determined by the internal self-monitoring function shall be raised to the operator by a form of warning and or alarm both locally and remotely. Where the fault compromises device operation and thus protection of the network the C-LVS shall fail safe.
- The C-LVS shall, for all other occurrences, fail safe (OPEN).
- The C-LVS device shall not operate automatically for load sharing capability.

13.2 Technical Requirements

C-LVS units are required to comply with the standards as defined by BS EN 60947 series and ENA TS 37-2 and and those specified in table below

Rated Operational Voltage (Ue)	400Vac
Rated Impulse withstand Voltage (Uimp)	8kV
Conventional Free Air Thermal Current (Ith)	400A rms
Conventional Enclosed Thermal Current (Ithe)	400A rms
Rated Operational Current (Ie)	400A rms
Rated Frequency	50Hz
Making Capacity	600A
Breaking Capacity	600A

13.2.1 Rated Short Time Withstand Current

As per BS EN 60947-3, the value of the rated short-time withstand current shall be not less than 12x the maximum rated operational current and, unless otherwise stated by the Tenderer, the duration of the current shall be 1 or 3 seconds.

13.2.2 Control Circuits

Control circuits associated with the C-LVS shall comply with the requirements of BS EN 60947. Where electronic control circuits are used the following characteristics must be provided by the manufacturer:

- type of current;
- power consumption;
- rated frequency (or d.c.);
- rated control circuit voltage, Uc (nature: a.c./d.c.);
- rated control supply voltage, Us (nature: a.c./d.c.);
- nature of external control circuit devices (contacts, sensors, optocouplers, electronic active components, etc.).

13.3 Design and Consideration

13.3.1 General Requirements

This section covers the design and construction of the C-LVS for use on SPEN LV distribution system.

All equipment shall be constructed in accordance with BS EN 60947-1 series and relevant associated parts of the BS EN 60947 series.

The C-LVS shall have maximum dimensions of 70mm (W) x 130mm (L) x 225mm (D)

The C-LVS shall be contained within an underground link box or a mini-pillar cabinet and shall be fully shrouded against inadvertent contact when the main access to the chamber is open. C-LVS should be capable of fitting existing J-Type 82mm link holder within a mini-pillar cabinets or underground link boxes.

The Tendered shall prepare a strategy for installing C-LVS devices within LV infrastructure comprising both mini-pillar cabinets and underground link boxes.

The C-LVS shall be contained within a link box and fully shrouded against inadvertent contact when the main access to the chamber is open. The C-LVS should be capable of retro-fitting into existing link holder within a link box.

The weight of C-LVS device shall be such that an individual operator can lift, remove or replace the device without the need for assistance and comply with Manual Handling Operations Regulations 1992.

Equipment shall be constructed in accordance with 7.2.3.3 and 7.2.3.4 of BS EN 60947-1 for Creepage and Clearance distances

13.3.2 Communication

The C-LVS shall be capable of communication using ancillary equipment.

- C-LVS EMS if applicable.
- Aerial shall be unobtrusive.

13.3.3 Alarms and Monitoring

Alarm and monitoring capability shall be inherently designed within the C-LVS. All alarms and monitoring notifications shall be capable of being replicated remotely.

Local alarms and warnings shall be clearly visible to the Operator on the device when installed at the normal open point.

Status	**L1**	**L2**	**L3**	**System**
OPEN	X	X	X	
CLOSE	X	X	X	
Comms Fail				X
Manual Operation				X

13.3.4 I/O Schedule

The below table details a list of input and output functionalities that the device shall provide.

I.D	Alarm/Warning/Notification	Description	C = Critical D = Desired O = Optional

I.D	Alarm/Warning/Notification	Description	C = Critical D = Desired O = Optional
Loss of Power	Alarm	Device has lost power supply	C
Power Restored	Notification	Power supply to device has been restored	C
Device Error Fail	Alarm	An internal device error has occurred and the device has failed safe	C
Device Error	Warning	An internal device error has occurred but has not caused the device to fail	D
Temperature Warning	Warning	The device temperature is exceeding normal range	D
Device Upgrade	Notification	The device is currently performing an upgrade	C
Device Upgrade Fail	Warning	The upgrade being performed has failed	C
Communication Failure	Alarm	Communications have failed between devices and/or SPEN EMS system	C
C-LVS Closed	Notification	The C-LVS device is in a Closed position	C
C-LVS Open	Alarm	The C-LVS device is in an Open position	C
C-LVS Operated	Alarm	The C-LVS device has operated to interconnect the radial network	C
C-LVS Reclosed	Notification	The C-LVS device has reclosed after fault restoration	C
C-LVS Close Manual add remote and manual operation	Notification	The C-LVS device was closed manually by the operator	O
C-LVS Close Fail	Alarm	The C-LVS has failed to close	C

13.3.5 Device Labelling and Identification

All information and markings shall be clearly legible and shall comply with by BS EN 60947-3 Section 5.1 and 5.2 by the tenderer and where relevant marked on the device. Additional information to be marked on devices shall be in alignment with the relevant sub-part of the above standard.

Every device shall be fitted with a clearly marked and affixed nameplate or label.

Indication of the open and closed positions shall be clearly visible.

A clear reference shall be made on the device which states the standards to which the device is compliant with, e.g. BS EN 60947-3.

14. CONTROL & COMMUNICATION SYSTEMS

14.1 Real-time performance monitoring and SCADA

The performance of each LV Engine trial scheme will be monitored in real time using a dedicated Dashboard. Whilst this can be achieved by creating a dashboard within the PowerOn Fusion application this will not be implemented within the course of the project as currently LV network monitoring and control is not part of the day to day practices carried out by control engineers.

Therefore, it is envisaged that the integration of the LV network into PowerOn Fusion may not be the most effective way of monitoring the real-time performance of the LV Engine trials. As such a separate LV Engine Dashboard will be created as specified within the LV Engine Smart Transformer Technical Specification.

14.2 Communication between devices

The data architecture requires a number of layers:

- Data Capture: Raw capture of data, either in structured or unstructured formats, from devices such as sensors, fault recorders, power quality monitors, battery monitors etc.
- Comms Link: The communications layer used to transmit data and event information.
- Event / Data Collection: Data is collected from various sources at this layer. Field Online, which is aimed at collection of data from Industrial IoT devices such as sensors or fault recorders, will support protocols including:
- TCP: Transport layer protocol, called the Transmission Control protocol, which allows clients to connect to the remote broker using a TCP socket.
- MQTT (Message Queue Telemetry Transport): an ISO standard (ISO/IEC PRF 20922) application layer, asynchronous, publish-subscribe-based messaging protocol. It works on top of the TCP/IP protocol. It is designed for connections with remote locations where a small code footprint is required or the network bandwidth is limited. The publish-subscribe messaging pattern requires a message broker. It is good for low power, bandwidth constrained devices to help achieve longer battery life. MQTT offers message-delivery guarantees including at least once, exactly once and at most once.
- AMQP (Advanced Message Queueing Protocol): AMQP is a binary, application layer, asynchronous protocol, designed to efficiently support a wide variety of messaging applications and communication patterns. It provides flow controlled, message-oriented communication with message-delivery guarantees, and authentication and/or encryption based on SASL and/or TLS. It assumes an underlying reliable transport layer protocol such as Transmission Control Protocol (TCP). AMQP is more feature rich than MQTT, however requires more bandwidth and power as a consequence. Given the higher power requirements, it is often used for messaging between business applications although may be suitable for IoT devices that are not power or bandwidth constrained.
- HTTP(S) (Hypertext Transfer Protocol) – unlike AMQP and MQTT, HTTP is a synchronous protocol. Typical use cases using HTTP include invocation of web services (e.g. SOAP/REST) between business applications or for accessing web sites (client-server

communications), but it is a more heavyweight protocol. Unlike AMQP and MQTT, it is not best suited for use cases which require one-to-many communication of events, message-delivery guarantees or low power and bandwidth consumption.

- SFTP (Secure File Transfer Protocol) – as the name suggests, this protocol is commonly used for transferring files. It is often used for delivery of high message payloads, usually by batch (i.e. where real-time delivery of messages or low latency is not a requirement). Different files types and formats of data can be transferred such as text files, spreadsheets etc.
- Streaming Analytics: This layer can offer near real-time analytics of the inbound data as it arrives, including detection of anomalies or trend analysis (based on time window).
- Data Storage: Depending on the variety of data, different types of storage are available ranging from time series to unstructured/semi-structured data in Hadoop File System (HDFS) / NoSQL data stores, as well as structured data storage (SQL) solutions such as SQL Server or Oracle databases.
- Integration/Orchestration: As the data arrives, having passed through the analytics layer, complex events may be detected or alarms received which require some action to be taken. For example, if any issues / alarms have been detected which require to be sent to the Control Room, the integration / orchestration layer (Enterprise Service Bus) can interact with the Network Management System (NMS). An API gateway also exists at this layer where APIs need to be exposed to other systems (e.g. mobile phone apps, BI tools etc.).
- Batch Analytics: Similar to the “Streaming Analytics” layer, except done by batch (not real time) or manually by ad hoc processes.
- Data Preparation: At this layer of the data architecture, data can be transformed for specific business purposes, such as visualisation through tools like PowerBI.
- End Users / Systems: End users / systems who require access to the data. The data may be accessed in its raw form or a structured, normalised format depending on the end user’s requirements.

14.3 Existing system Interfaces

Logical Architecture

The logical architecture shows a simplified view of the layers required in order to achieve SGAM (Smart Grid Architecture Model) compliance and security via ‘defence-in-depth’.
The following layers are shown:

- Field Devices: externally located (out in the field). This is the “data capture” layer shown in appendix 1.
- Comms: externally located and will be used to provide a communications layer between the LV Engine Local Controller and Regional Controller.
- Integration (DMZ): located internally, but at the edge of the network. This is also referred to as the Operational Data Network (ODN). Integration is expected to take place between the Regional Smart Controller and Field Online, using the protocols described in appendix 1. This is the “data collection” layer shown in appendix 1.
- Integration (Internal): If any issues / alarms have been detected which require action to be taken, such as sending events to the Control Room, the integration / orchestration layer (Enterprise Service Bus) can interact with the appropriate internal systems (e.g. NMS).
- Applications (Internal): deep within the internal network are the IT systems which end users work with on a daily basis. This includes systems such as EnergyIP (Smart Meter data), Customer Relationship Management (CRM), Network Management System (NMS) etc.
- Cloud Services: cloud services, hosted in Azure, will act as an extension of the internal data centre and its capabilities. For example, use cases which would be suited for cloud services include analytics, AI/ML and large-scale storage of data

14.4 IT/OT Security

14.4.1 Requirements

An appropriate security architecture model shall be presented to SPEN with the Tender submission. Critical points of communication and security measures shall be highlighted by the Tenderer.

Access to parameters, data and control interfaces shall be limited by role-based access control (RBAC). The rights to connect to, communicate with and manage devices shall be limited to named personnel or groups of authenticated users. The actions permitted and roles will be agreed at design stage with the successful Tenderer**.**

User Identity shall be authenticated using secure Single Sign On Lightweight Directory Access Protocol (LDAPs). LV remote control Devices shall be able to carry out authentication using digital certificates, and authorisation of actions (e.g. connect, send events etc.). This shall be enforced using associated Role Based Access Controls which are configured for the device. Revocation of access for the device, for example during the decommissioning process (e.g. End of Life or due to maintenance), shall also be possible.

Further validation of certificates shall occur prior to any control action which could affect network operation. Any control actions taken by a device or user shall also be recorded within an event log (audit trail). The audit trail (log) shall be available for authenticated users to view, and search and shall act as a syslog client to standardise wider IED interfaces.

The data communicated shall be secured and encrypted. HTTP services shall use TLS v1.2 or higher (forced use and optional). File transfer / remote file systems for data access shall require SSH File Transfer Protocol (SFTP). Alternatively, or in addition to this, VPN connection will be accepted.

Inclusion and checking of signatures shall ensure the integrity of the message sent before processing (e.g. set point information).

The solution shall be resilient against common ‘cyber’ attacks such as Denial of Service (DoS), Spoofing and Man-in-the-Middle (MITM).

The solution shall be hardened against potential security vulnerabilities which are subsequently found in any bespoke or dependent software, library, module, operating system etc.

All the components in the overall scheme shall be physically secured to prevent any unauthorised access.

14.4.2 Software and Firmware Maintenance

The Tenderer is required to provide software patches and firmware updates as necessary. It shall be possible to install such patches remotely and from a local interface. It shall be possible to quickly deploy these updates and configuration changes to a single device or at scale. The code signature of any update shall be verified by the remote device prior to any update.

The solution shall maintain availability of service during updates to software, firmware or configuration; and during other routine maintenance activities.

The solution shall have the ability to rollback software and firmware changes; and operational configuration parameters should a change result in unexpected behaviour.

Any changes to the software or firmware shall be considered an auditable control action; and the status of any software push shall be confirmed by message to a remote user and recorded within event logs.

14.4.3 Device Management

The overall system shall be compatible with DNP3 and 101 serial connection. Authentication for serial local access shall be through a per-device code rather than through LDAPS.

Repeated failed login attempts to local access shall lock out local connections for a specified duration or permanently as required by SPEN. The number of attempts and duration of lock out shall be configurable parameters.

The solution shall allow the user to:

- Change the service status of the C-LVCB and C-LVS through predefined routine.
- Manually set individual operational parameters
- Upload configuration files;
- Allow the user to replace software and firmware components

15. NETWORK INTEGRATION

All equipment detailed within this specification shall be compatible for use on SPEN Distribution Network. The implementation of the equipment shall enable LV Engine schemes without compromising the overall integrity of the network or increasing health and safety risks.

Through implementation of the equipment defined within this specification, LV Engine schemes shall be used to improve utilisation of SPEN LV distribution networks.

These schemes shall manage network voltage and power flows to offer a deferral of conventional network reinforcement.

All LV Engine schemes shall be implemented within existing infrastructure where possible mitigating civil work within existing substations.

15.1 LV Plant & Equipment

Low voltage outgoing feeder panels are equipped with a fuseway equivalent for each feeder in accordance with the requirements of ENA TS 37-02.

The normal fuse links are historically provided in accordance with BS 88-2 which can provide LV isolation and LV cable protection. The C-LVCB shall be contained within a cabinet or applied to open LV busbars within secondary substations and will be fully shrouded against inadvertent contact when the main access to the chamber is open.

Normally open points within the existing LV circuits, identified during the site selection, shall be fitted with C-LVS devices as defined within the specification. These C-LVS devices shall serve to interconnect LV circuits.

16. TEST REQUIREMENTS

16.1 General

Low voltage switchgear and control gear offered shall be type tested in accordance with ENATS 37-02, Section 10 and Routinely Tested in accordance with ENATS 37-02, Section 11.

Tests shall be made to prove compliance with the requirements laid down in BS EN 60947-2 or BS EN 60947-6-2.

Tests to be undertaken shall align with BS EN 60947-1 and be as follows:

- Type Tests made on representative samples of each equipment.
- Routine Tests made on each individual pieces of equipment manufactured to the quoted standard.
- Sampling Tests made if called for in the relevant product standard.

The above tests may consist of test sequences, according to the requirements of the relevant product standard. Where such test sequences are specified in a product standard, tests, the result of which are not influenced by preceding tests and have no significance for the subsequent tests of a given test sequence may be omitted from that test sequence, and made on separate new samples, by agreement with the manufacturer. Product standards shall specify such tests, where applicable.

Where deemed appropriate and subject to specification within the relevant product standard, Special Tests may be performed. In this case agreement shall be sought between the Tenderer and SPEN. Special tests shall be carried out at an independent test facility chosen by SPEN, following contract award.

16.2 Type Testing

Type tests shall be used to verify compliance of the design for given equipment as per the requirement of BS EN 60947-1 Section 8.3.

They shall comprise, as appropriate, verification of the following:

- constructional requirements;
- temperature-rise;
- dielectric properties
- making and breaking capacities;
- short-circuit making and breaking capacities;
- operating limits;
- tripping limits and characteristics;
- operational performance;
- degree of protection of enclosed equipment;
- tests for EMC.

These will be supplemented by relevant type tests from BS EN 60947-2 or BS EN 60947-6-2, whichever is deemed applicable.

This list, including the supplementary tests conditioned, shall not be considered definitive. An agreed list of type tests shall be determined between the Tenderer and SPEN.

The type tests to which the equipment shall be submitted, the results to be obtained, and, if relevant, the test sequences and the number of samples, shall be specified in the relevant product standard.

16.3 Routine Testing

Routine tests shall be conducted as per the requirement of BS EN 60947-1 and shall be made on each individual piece of equipment.
Routine tests shall as a minimum comprise

- Functional Tests;
- Operation and Operating Limits
- Dielectric Tests.

Details for all routine tests and the conditions under which they shall be made, for a given piece of equipment, shall be subject to the conditions outlined by BS EN 60947-2 or BS EN 60947-6-2, dependent upon the applicability of these standards.

16.4 Test Witnessing

For FATs, the supplier shall provide at least two weeks' notice to SPEN Networks prior to any testing taking place. It is acceptable for the initial induction meeting and factory acceptance tests to occur on the same visit.

At all stages of the testing process, SPEN Networks shall be able to undertake inspection and observation of the processes taking place. This includes assessment during the manufacturing process to verify quality of the woks performed.

17. QUALITY POLICY

17.1 Defects

SPEN has a policy of zero defects with its customers and therefore expects support from its suppliers aimed at year on year quality improvement. Analysis of defective items on receipt and I use will be used to assist in subsequent tender analysis.

17.2 Quality Assurance

Suppliers shall operate a fully documented quality assurance system, and shall indicate with their tenders the QA Approvals granted to the supplier. The tenderer shall submit the following documents with the tender:

- Manufacturer's overall quality policy statement.
- Tenderer's overall quality policy statement.
- Copies of any formal quality approvals.
- Quality plans identifying the control stages during manufacture and test.
- Statement on handling and disposal of waste accruing from product manufacture.

17.3 Health, Safety and Environmental Issues

All aspects in relation to the items tendered shall comply with current relevant legislative requirements as applicable throughout the life of the contract. The tenderer shall provide details of any hazards associated with handling, installing, inspecting, maintain, repairing and decommissioning the items tendered and associated by-products (including packaging) that may constitute a risk to the safety and health of the purchasing companies, employees (including subcontractors), livestock and public.

18. LOGISTICAL REQUIREMENTS

18.1 Technical Support and Consultation

It may be necessary for SPEN to obtain support and expert advice with respect to the items tendered. To facilitate this, the tenderer shall provide the name, telephone number and email address of the key contacts for technical and user support. Where details are not provided at the time of the tender, such technical user support shall be regarded as unavailable. The following summarises the expected vendor provisions:

- Visits to the trial sites in Wrexham, to identify any site preparation required and support SPEN staff for the final design and site preparation prior to installation of the Gateway and C-LVCBs;
- Two training sessions to SPEN staff on the installation, operation and maintenance of the C-LVCBs and Gateway at location specified by SPEN;
- Resources and technical supports to work closely with SPEN IT and OT staff for full integration of the LV automation solution that includes establishing communication with SPEN's Real Time System via the SPEN 4G router and establishing remote access for troubleshooting and firmware updates. All communications shall comply with security requirements specified by SPEN;
- Software/firmware updates and modifications to C-LVCB Gateway and Application Suite where required in line with LV Engine and system integration requirements;
- Training and support to SPEN's IT staff for the installation and maintenance of the vendor's Application Suite;
- Provide support for any pre-commissioning equipment tests that may be required;
- On-site support to SPEN staff during the commissioning of the LV automation scheme;
- Post-commissioning support for 2 years

18.2 Packaging & Labelling

The Tenderer shall ensure that each item is suitably packaged and protected to maintain the product and packaging as "fit for service" prior to installation taking account of the potential for an outdoor storage environment. All packaging shall be sufficiently durable giving regard to the function, reasonable use and contents of the packaging.

Where items are provided in bagged/boxed form, the material from which the bags are manufactured shall be capable of sustaining the package weight and resisting puncture by the materials within.

Tenderers shall submit, at the time of tendering, the details of the proposed packaging (i.e. materials composition and structure) to be used for each item. Where the Tenderer is unable to provide packaging suitable for outdoor storage then this shall be stated at the time of tender.
Clearly legible, easily identifiable, durable and unambiguous labelling shall be applied to each individual package of like products.

As a minimum requirement, the following shall be included:

- Manufacturer's trademark or name
- Supplier's trademark or name
- Description of items
- Quantity of items
- Date of packaging and/or batch number
- SPEN's order number
- SPEN's SAP number
- Weight

Tenderer shall submit at the time of tendering a sample of the proposed labelling for each package type.
Details of the required package sizes/unit volumes are detailed within the Schedule to this specification.

18.3 Storage

To enable SPEN to store the items in accordance with the manufacturer's recommendations, the Tenderer shall provide details of the recommended storage environment with respect to each item tendered.

Details shall be provided in respect to the minimum and maximum exposure levels, frequency of exposure and duration of exposure of the packaged item with respect to:

- Ambient temperature
- Humidity
- Impact
- Water
- Solar radiation

18.4 Delivery

The availability of the products is crucial to SPEN assessment of the tender. The Tenderer shall provide details of the lead times applicable to each item tendered from receipt of initial order and, if different, subsequent orders. Tenderers wishing to offer alternative means to reduce lead times shall provide details at the time of tender.

19. OPERATION AND MAINTENANCE MANUALS

The tenderer shall provide an operations and maintenance manual for the remote-control LV circuit breakers and link switches, for their estimated lifetime, detailing but not limited to:

- Frequency of maintenance
- Tools Required
- Check and maintenance procedure
- Guidance of when to replace components and/or asset