

Technical Specification

T0003

Critical pump sites – control panels

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1 Purpose

The purpose of this Specification is to provide designers and tenderers / contractors with the minimum technical standards and physical requirements that pump control equipment (*at critical pump sites*) shall be designed and constructed to meet.

2 Scope

This Specification applies to critical pump sites. These are pump sites where structural or serviceability failure would result in restrictions to the operational transport networks (*e.g. by track, station, highway or underpass closure*) within 4 hours; this is termed the *Pump Failure Impact Time* (PFIT). Refer to London Underground (LU) Category 1 Standard *S1056 Civil Engineering – Pump Drainage Systems* for the detailed methodology concerning determination of pump site criticality. The LU Asset Management System (AMS) is called ELLIPSE; all *critical pump sites* are labelled as such in ELLIPSE.

3 Requirements

3.1 Preamble

- 3.1.1 This specification is as far as possible, a performance based standard. However, given that the Transport for London (TfL) environment is rather unique in certain respects, some prescription remains in the document. In particular, the specification mandates compatibility with a particular manufacturer's *Supervisory Control and Data Acquisition* (SCADA) system (namely the *Xylem Flygt Aquaview System – aka the 'Aquaview System'*). It is not possible to avoid this prescription, since the system in question is already installed and operating across many TfL pump sites, and for safety reasons all pump sites that require such monitoring must be connected to the same central control in the same way.
- 3.1.2 This document contains references to the 'Client', 'Engineer' and 'Contractor'. It should be noted that in the context of this specification those terms shall be taken to have logical meaning in the broad senses of the words and shall be viewed as independent of the specific Conditions of Contract. Thus the term 'Client' shall be taken to mean Employer, Authority, Purchaser, etc.; similarly 'Contractor' shall mean 'Contractor' in the traditional contractual sense if appropriate, or shall mean the relevant entity within other forms of contract such as *Alliancing* and *Joint Ventures*, etc.; and the term 'Engineer' shall also be construed in a generic sense to mean Contract Administrator, Project Manager, etc., as appropriate to the contract.
- 3.1.3 It is not possible to define a single system of control which would be suitable for all installations because of the wide range of pump applications found within the TfL transport network and its associated infrastructure (*i.e. depots, access roads, etc.*). This specification therefore identifies the general requirements and variable features, which must be adhered to. Any changes to those requirements must be authorised by the *Technical Authority* for the relevant TfL transport mode.
- 3.1.4 In preparing a Particular Specification (*site-specific specification*) the designer must be aware of the specific circumstances relating to the environment, power

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supplies and access for the project/site under consideration and any potential difficulties which may occur.

- 3.1.5 This Specification makes reference to the '*Technical Authority*' for the relevant TfL transport mode. In the case of LU, this is the *Profession Head (Pumps & Drainage)*. Other transport modes, such as Surface Transport (ST) for example, shall self-identify their equivalent Technical Authority to ensure appropriate Assurance is received.

3.2 General

3.2.1 Terms and Abbreviations

- 3.2.1.1 Unless specifically defined otherwise in Clauses 6.2 and 6.3, the definitions of terms used in this specification and associated documents are those in *BS ISO 6707 Building and civil engineering works – Vocabulary, Part 1: General Terms*.

3.2.2 British, European and International Standards

- 3.2.2.1 British, European and International standards shall be deemed to be those current 28 days prior to the date for return of tenders, or those current at the date of receipt of this specification document, whichever may be applicable.

3.2.3 Health, Safety, Environment and Quality

- 3.2.3.1 TfL related construction, installation, testing and commissioning work shall comply with the TfL requirements for '*Managing HS&E with contractors and suppliers*' provided on the Intranet here: <http://intranet.tfl/working-at-tfl/2553.aspx>.
- 3.2.3.2 TfL ST, *London Highway Alliance Contracts* (LoHAC) requirements and guidance shall be complied with during all ST related construction, installation, testing and commissioning work.
- 3.2.3.3 *Factory Acceptance Tests* (FAT) shall be carried out in accordance with Clause 3.11.
- 3.2.3.4 New work and maintenance work shall comply with BS EN 752 Clause 7, Health and Safety Principles.

3.2.4 Existing and As-built Survey Drawings

- 3.2.4.1 Where required by the contract, as-built drawings for LU related work, shall be provided in electronic format and comply with LU Category 1 Standard *S1037 Computer Aided Design Data* and the particular requirements of *Attachment 1*.
- 3.2.4.2 Where required by the contract, as-built drawings for ST related work, shall be provided in electronic format and comply with the requirements of the LoHAC contract and the particular requirements of *Attachment 1*.

3.2.5 Impact on Outside Party Assets

- 3.2.5.1 Where required by the contract, the impact on *Outside Party* assets for LU related work, shall be determined in accordance with LU Category 1 Standard *S1023 Infrastructure Protection*.

- 3.2.5.2 Where required by the contract, the impact on Outside Party assets for ST related work shall be determined in accordance with the LoHAC contract.

3.2.6 Contractor Designs

- 3.2.6.1 Control Panels are typically Contractor designed items. *Attachment 1* shall detail the contract specific requirements for them.
- 3.2.6.2 The Contractor shall provide a fully signed-off *Design Check Certificate* for the category of check undertaken and appropriate for the asset designed, in accordance with LU Category 1 Standard S1538 Assurance, or in accordance with LoHAC design assurance requirements, as applicable.

3.2.7 Setting Out

- 3.2.7.1 In setting out the Works it shall be the Contractor's responsibility to satisfy himself that any dimensions, sizes and levels given are correct, and should he wish to query any of these he shall give written notice to the Engineer before putting work in hand. During installation the Contractor shall be responsible for the setting out of the Works, and for the correctness of the positions, levels and dimensions of the Works.
- 3.2.7.2 If at any time during the progress of the Works any error shall appear or arise in the positions, levels or dimensions of the Works, the Contractor shall at his own expense, remove and amend the work to the satisfaction of the Engineer, and shall become liable for any costs associated with any delay caused to the Contract due to such error.

3.2.8 Damage to Structures

- 3.2.8.1 The contractor shall exercise due care and attention in carrying out the works and will be held fully responsible for any damage caused to the structure or building finishes by his employees. The Contractor shall obtain permission from the Engineer before any holes are cut in floors, walls, steelwork, etc.

3.2.9 Protection of Plant and Equipment

- 3.2.9.1 All new and existing plant and equipment shall be protected during the execution of the work by the Contractor.

3.2.10 Safety of Moving Machinery

- 3.2.10.1 All machinery with moving or rotating parts shall be guarded for safe working by the Contractor in accordance with BSI Published Document *PD 5304 Guidance on safe use of machinery*.

3.2.11 Manufacturers Test Certificates

- 3.2.11.1 Certificates of specified tests carried out at manufacturer's works for any items of plant or equipment shall be forwarded to the Engineer for his approval, prior to shipment of the plant or equipment to site.

3.2.12 Codes of Practice

- 3.2.12.1 The Contractor shall ensure that all work is installed in accordance with the standards of good practice and workmanship contained within the relevant

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standards (*British, European and International*), British Standards Codes of Practice or British Standards Published Documents. Where any requirement of the above documents conflicts with an explicit requirement of this specification then this specification shall prevail.

3.2.13 Contract Drawings and Schedules

- 3.2.13.1 A complete list of all contract drawings and schedules (*site-specific and standard details*) shall be included in *Attachment 1*.

3.2.14 Programmable Logic Control and Man Machine Interface

- 3.2.14.1 *Programmable Logic Control* (PLC) and '*Man Machine Interface*' is always required. This requirement must be identified in the Particular Specification (*refer to Attachment 1*).
- 3.2.14.2 PLC's must be SCADA units capable of communicating with the *Aquaview System* and of using standard TfL/LU software.

3.2.15 Incorporation of Controls for Non-critical equipment in Critical Pump Sites Control Panels

- 3.2.15.1 In some cases it may be considered necessary to incorporate controls for non-critical equipment in a critical site control panel. These may be for auxiliary sump pumps or ventilation fans, etc. Where required, the control panel may be extended to include such controls based on the Non-critical Pump Site – Control Panel Specification. This could take the form of a single compartment with additional starter and controls or extra multiple sections. In such cases the incoming mains power supply and distribution load shall be upgraded accordingly.

3.2.16 TfL Standards

- 3.2.16.1 All references to TfL Standards shall be deemed to refer to the current version of those Standards.

3.3 Manufacturing

- 3.3.1 Cabinets shall be manufactured from minimum 2mm thick sheet stainless steel Grade A304 and shall be of folded and welded construction. The cabinets shall be of a robust nature with no undue flexing. The panels may have to be made in sections to facilitate access, with wall and / or floor mounting. A gold or silver passivated steel back plate shall be used. Internally, doors shall have studs fitted allowing cable support systems to be rigidly fitted.

3.4 Design Philosophy Overview

- 3.4.1 The primary purpose of the pumps operated by control equipment is to control water entering the transport networks, structures and premises. In this situation, reliability of design and components is of prime importance.
- 3.4.2 The minimum number of protective devices consistent with safe working practice shall be used. Any protection (*such as motor temperature cut-outs*) shall reset automatically wherever possible, so as to allow the system to return to normal operation on clearance of the fault.

- 3.4.3 The design philosophy for the power, control and monitoring equipment for critical sites, is that the pumping plant should be '*fail-safe*'. This is defined as ensuring that pumping shall be unaffected by all but the most critical faults. Those faults which would otherwise stop the plant shall instead bring up alarms.
- 3.4.4 In order to achieve the requirements in sub-Clause 3.4.3, the panel shall have the following features:
- a) Separate isolation of sections, which permits pump or control system maintenance whilst other pumps are running.
 - b) Internal *Aquaview System* control and monitoring systems.
 - c) Alarms which are reliable but do not stop pumps.
 - d) Automatic analogue level control system (via *Aquaview System*) with independent self-checking digital level control and high level alarm back-up.
 - e) An interface with the local pump station alarm panel system.
 - f) An interface with an *Aquaview System* telemetry outstation.
- 3.4.5 The objective of the designs shall be to provide control systems that remove water from the TfL transport networks, structures and premises in all reasonable circumstances. The control system shall provide reliable alarms and telemetry outputs to rapidly inform station and maintenance staff of any faults and enable rapid, accurate and safe diagnosis and repair of any faults within the control system, while continuing pumping wherever possible.
- 3.4.6 The philosophy for power control and monitoring control panels, their installation, connection and testing, is to provide robust, reliable and low maintenance facilities employing standard design principles wherever possible. Consideration must be given to simplicity of layout and operation using readily available standard products from the LU Products Register (see *sub-Clause 3.4.7*) or equivalent ST approved list.
- 3.4.7 The *LU Products Register* can be found via the following URL: www.lu-apr.co.uk . Contractors, Engineers, suppliers, manufacturers and Client-side organisations can all submit products for acceptance on to this register. Evidence (*of various kinds*) is required in support of an application. Such evidence relates to a product's proposed field of use and limits of applicability; for example, a product proposed for use in the LU tunnel environment, will need to be supported by evidence which demonstrates compliance with LU's relevant fire safety standard. The checking and verification of evidence is undertaken by the *Technical Authority* for the relevant TfL transport mode.

3.5 Design Philosophy Implementation

- 3.5.1 It is not possible to define a single system of control which would be suitable for all installations because of the wide range of pump applications found within TfL transport networks, structures and premises.
- 3.5.2 The basic features must be similar for all panels. However, consideration must be given to the specific requirements for the applications outlined in the *Particular Specification*; the main areas of variability are as follows:
- a) Number of sumps / tanks associated with each panel and their title / designation.

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- b) Number of pumps associated with each sump / tank and their associated number / designation and operating basis:
 - I) Two Pump – Duty / Assist (submersible pumps)
 - II) Three Pump – Duty / Assist / Assist (submersible pumps)
- c) Motor sizes and types of starting required for each pump:
 - I) Direct on Line starter
 - II) Star / Delta starter
 - III) Soft Start
 - IV) Invertors
- d) Method of control:
 - I) *Primary* automatic level control and monitoring shall be via pressure transducer (*Engineer authorisation is required for model and type*).
 - II) *Secondary (backup)* automatic level control and monitoring shall be via conductivity electrodes (*rods*). Alternatively, *floats* may be used as a backup method of automatic level control and monitoring, but only via a relay system, and only if explicitly identified as required or permitted within the *Particular Specification*.
 - III) Other control methods may be considered, but will require the explicit agreement of the *Technical Authority* for the relevant TfL transport mode.
- e) The designer shall comply with his obligations under the *Construction (Design & Management) Regulations 2015*. The designer shall outline safety considerations in a conceptual design and installation statement in the *Particular Specification* and develop these for the design and installation stages.

3.5.3 In order to achieve the above objectives, the following requirements shall be complied with:

- a) *Critical pump sites* shall use TfL preferred components and circuit diagrams unless there are specific requirements to the contrary stated in the Particular Specification. Preference engineering by consultants / contractors or the panel manufacturer is NOT permitted.
- b) Components shall be standardised. Different manufacturers for contactors, overloads, Miniature Circuit Breakers (MCB), etc., are acceptable provided the components comply with the following:
 - I) They shall be readily available in the United Kingdom (UK).
 - II) They shall be interchangeable (*e.g. Top Hat rail mounted*).
 - III) They shall be wired with sufficient spare cable to permit replacement by units with different terminal locations.
 - IV) All control relays, level relays and timers shall be of the plug-in type.
- c) Control of pumps shall be by *Xylem Flygt Aquaview System* unit with hardwired backup. The software requirements shall be stated in the Particular Specification. For detailed information relating to the *Xylem Flygt Aquaview System*, refer to the *LU Profession Head (Pumps and Drainage)*.
- d) Pump failure shall be monitored by the *Aquaview System* unit with hardwired backup.

- ### 3.6 Control Philosophy – Submersible Pumps

- a) On rising sump water level, the *Aquaview System* shall start the first duty pump at a preset level. If the level continues to rise the *Aquaview System* shall start the second and subsequent assist pumps at their respective pre-set levels. The *Aquaview System* shall not start pumps simultaneously under any circumstances, *timed staggered starting* shall be provided if the level requires more than one pump to start when the *Aquaview System* is initiated.
- b) The *Aquaview System* shall automatically rotate the duty sequence through available pumps.
- c) If the level falls then the *Aquaview System* shall stop the pumps at their respective pre-set levels.
- d) If the level continues to rise above the last duty pump start level, then the 'Start' electrodes for each pump, which shall be set at different levels for each pump, shall be reached. When the 'Start' electrode for a pump is reached, the electrode relay changes state and the pump shall start. It shall continue to run until the level falls to its 'Stop' level electrode. Each pump shall have a specific electrode rod.
- e) When a pump is started by the backup system the digital high level alarm ('float / rod') shall be initiated.

- 3.6.4 A test button shall be provided for each pump to simulate the water level reaching the backup 'Start' point.

3.7 Monitoring Philosophy – Submersible Pumps

- 3.7.1 The monitoring philosophy shall be determined by what software version is required in the Particular Specification. In addition, selected alarms and signals shall be provided to the *Station Supervisors Alarm Panel* and to the *Aquaview System* telemetry central server and these will also be identified and approved by the *Technical Authority* for the relevant TfL transport mode.

3.8 Power Supplies

- 3.8.1 It should be noted that the Normal (LU) power supply is subject to large fluctuations and spikes. Where sensitive electrical equipment is used precautions should be taken to prevent damage occurring. The voltage has been known to drop to 200v AC.
- 3.8.2 Under normal circumstances LU *Critical Pump Site* Control Panels are fed from a dual power supply source. These are derived from the 'Normal' (*known as the 'LU Supply' for railways*) and the local public electricity supply (*known as the 'Emergency Supply' for railways*). TfL ST critical control panels are fed from a single power supply provided by the local electricity supplier, incorporating a generator plug socket for use of a backup power supply should the main power supply fail. The requirements for a particular project will be identified in the Particular Specification. However, where two live power supplies are present, automatic changeover contactors, monitoring equipment and distribution MCB's normally form part of the priority pump site control panel requirements. Other TfL transport modes may have different requirements from those described above.
- 3.8.3 Unless specified otherwise in the Particular Specification, the basic requirements for dual supplies is that in the event of any phase failure, under voltage or total failure of the Normal supply, a relay will automatically switch to the Emergency (*stand-by*) supply. The control circuit shall be designed to tolerate the interruption caused by the supply changeover. The supply shall automatically revert to the Normal supply when it is restored.

3.9 Local Alarms

- 3.9.1 The purpose of the Local Alarm is to alert local staff to adverse pumping station events, such that they may then escalate the event via agreed procedures if the primary escalation methods (*SCADA – Xylem Flygt Aquaview System*) have failed.
- 3.9.2 *Pump Station Alarm Box*
- 3.9.2.1 The local pump station alarm box is the only approved method for local alarm on LU. Other TfL transport modes may have different requirements from those described above.
- 3.9.2.2 An alternative alarm system may be specified in parallel with the local pump station alarm box. In such cases, the alternative alarm system shall be specified in the Particular Specification but is not to be considered a direct replacement.

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Suitable alternative alarm systems can include those provided via a *Building Management System* (BMS) or *Station Management System* (SMS).

- 3.9.2.3 Under normal circumstances, alarm signals are required to be directly transmitted to an alarm box installed in a local office. These shall comprise two volt-free signals identified as follows:
- a) '*Pump System Failure*' – incorporating contacts from mains failure relays and starter cut-outs wired in parallel to terminals.
 - b) '*Common High Level*' – comprising signals from each *High Level* alarm relay provided in the control panel and wired in parallel to terminals.
- 3.9.2.4 Other alarm signals may be identified as required by the Engineer and detailed in the Particular Specification, any additional alarm signals must be agreed by the Technical Authority for the relevant TfL transport mode.
- 3.9.3 *Building or Station Management System*
- 3.9.3.1 The connectivity requirements shall match the *Pump Station Alarm Box* requirements set out in *Clause 3.9.2*.
- 3.9.3.2 All alarms must be outgoing only and shall comprise two volt-free signals identified as follows:
- a) '*Pump System Failure*' – incorporating contacts from mains failure relays and starter cut-outs wired in parallel to terminals.
 - b) '*Common High Level*' – comprising signals from each *High Level* alarm relay provided in the control panel and wired in parallel to terminals.
- 3.9.3.3 No extra equipment shall be added to the control panel to give signals that are not already generated by the control panel.
- 3.9.3.4 No alarm system shall be allowed to compromise the reliability of the pumping system or interact with the pumping system operation. For BMS/SMS purposes it is deemed that the '*pumping system*' shall finish on the output terminals of the control panel.
- 3.9.3.5 The operational requirements for the use of a BMS/SMS in parallel with pumping system alarms are:
- a) The BMS/SMS cabling and all attached equipment from the output terminal of the control panel shall not be considered part of the '*pumping system*' and shall be subject to its own approvals for use.
 - b) The BMS/SMS shall not be considered an integral part of the pump maintenance, call or refurbishment procedures, and shall not be the responsibility of the '*pumping system*' maintainer.

3.10 Test Condition

- 3.10.1 Pressing the following test buttons shall cause the following to happen:

'Sump High Level Test Button'

- a) Initiate a pumping cycle as though the liquid had reached the pump 'Start' level.

- b) Cause the pump to continue pumping until the normal 'Stop' level is reached.
- c) The system shall then revert to 'Automatic' control.

3.11 Works Tests and Site Commissioning

- 3.11.1 The control panels shall be subject to a full FAT at the control panel manufacturer's works, (*witnessed by TfL's appointed commissioning engineer- if so identified in the Particular Specification*), in accordance with this Clause.
- 3.11.2 The panel manufacturer shall include for all their costs associated with the conducting of the FAT and allow sufficient time in the Contract programme.
- 3.11.3 The control panel manufacturer should demonstrate inspection and test requirements in accordance with their *Quality Assurance* system and to the satisfaction of TfL. A FAT proforma is provided as *Attachment 2* for this purpose.
- 3.11.4 A dedicated phone line shall be provided by the control panel manufacturer in order to complete the FAT, allowing both outgoing and incoming functions to be conducted during the test.
- 3.11.5 A personal computer (PC) with internet access shall be made available in the test area to allow TfL software to be installed, in order to provide TfL Engineers with remote access to the TfL Local Area Network (LAN) via a Virtual Private Network (VPN) for testing purposes.
- 3.11.6 Materials Inspection
 - 3.11.6.1 Certificates of conformity must be provided to ensure that the materials used are of the correct type, quantity, size, rating, etc. when checked against the Parts List and Drawings.
 - 3.11.6.2 If any materials are found to be incorrect or damaged, etc., they must be reported to the Engineer and a *Non-conformance Report* shall be raised (*if required*).
- 3.11.7 Control Panel Assembly Inspection
 - 3.11.7.1 Verify adequacy of spacing requirement.
 - 3.11.7.2 Verify component layout is in accordance with the Contract drawings.
 - 3.11.7.3 Any deviation must be reported to the Engineer and a *Non-conformance Report* raised (if required).
 - 3.11.7.4 Check security of fixings.
 - 3.11.7.5 If the check is satisfactory sign the inspection record.
- 3.11.8 Control Panel Wiring Inspection
 - 3.11.8.1 Check all wiring is in accordance with the Contract drawing.
 - 3.11.8.2 Check security and adequacy of terminations.

- 3.11.8.3 Check colour coding of wiring is in accordance with the Contract drawings / parts list.
- 3.11.8.4 Any deviation must be reported to the Engineer and a *Non-conformance Report* raised (*if required*).
- 3.11.8.5 If the inspection is satisfactory sign the inspection record.
- 3.11.9 Final Verification
- 3.11.9.1 This requirement consists of inspection and test activities following build / assembly, for the purpose of confirming that the product is satisfactory for release into service.
- 3.11.9.2 A competency record should be available to clearly identify those personnel authorised to carry out final verification.
- 3.11.9.3 The test engineer will sign and date the record to confirm that final verification has been completed.
- 3.11.9.4 For each item, the test engineer should initial the record.
- 3.11.9.5 Where a defect is recorded, the test engineer shall ensure that rectification has been carried out to enable re-testing. The test engineer will report defects to the Engineer and raise a Non-conformance Report (*if required*).
- 3.11.9.6 The identification numbers of test equipment shall also be recorded.
- 3.11.9.7 Final verification includes inspection items, mechanical function checks, and electrical function tests requiring power to be applied.
- 3.11.10 General Condition
- 3.11.10.1 Carry out a general visual inspection of the control panel enclosure and component assembly overall, including neatness and tidiness and confirm that all is to a satisfactory standard.
- 3.11.10.2 Check that the items are correct for the project, e.g. Panel Serial No., manufacturer, number of pumps, number of sumps in accordance with the system specification. Record details on the relevant commissioning sheet.
- 3.11.11 Certificates
- 3.11.11.1 Review certificates to confirm that the control panel and any enclosures are compliant with *Ingress / International Protection Marking* level 55 (IP55). This confirms they are resistant to dust and water ingress to the specified degree.
- 3.11.11.2 Review the Electromagnetic Compatibility (EMC) Certification to confirm compliance with the EMC requirements of LU Category 1 Standard S1222, BS EN 50121 and BS EN 61000.
- 3.11.11.3 Check the crimp tool certification to ensure that the tools used met the agreed requirements when the work was carried out.
- 3.11.12 Communications Method

3.11.12.1 Check the communications method being used for the FAT.

3.11.12.2 Check the communications method to be used at the site installation, to ensure that the correct communication is reinstated.

3.11.13 SCADA Setup

3.11.13.1 Verify operation of remote communication with the SCADA system, checking that the correct software version and Remote Terminal Unit (RTU) are used in conjunction with the set points specified.

3.11.14 Sign-off all testing completed and control panel ready for shipment

3.11.14.1 When the testing has been completed, the TfL inspector and the manufacturer's representative shall sign to accept the pump system and to approve the control panel for shipping.

3.11.15 Visual Inspection

3.11.15.1 Visually inspect the following for damage, sharp edges or incorrect installation. Where possible check the functionality, e.g. door locks, push-buttons, etc.

- Steel work sharp edges, etc.
- General layout
- Door catches / locks
- Security of assemblies
- RTU controller mount
- Electrical terminal protection
- Size of panel
- Access plate position
- Short isolator handle
- Doors fitting
- Glazed door fitting
- Cabinet labels
- Battery mounting
- Layout of terminals & numbering
- Engineer On/Off site
- Earthing
- Motor starter mounting
- Push-buttons
- Hours-run meters
- Current meters
- Indication lamps
- Socket outlet

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- Overloads
- Phase failure relay
- Backup system (P4)
- Timers
- Thermal test
- Break-in / intruder switches
- Siox Cards
- Pull test on sample of crimps
- MCB type & rating

3.11.16 Functional Testing of Items including SCADA Data

3.11.16.1 Functionally test the following items to certify the correct SCADA indications are correctly displayed.

- Socket outlet
- Timers
- Phase failure relay
- Socket outlet
- MCB type & rating
- Engineer On/Off site
- RTU power supply
- Break-in / intruder
- Intruder buzzer
- Voltages scale up & down (mA)
- Power consumption up & down

3.11.17 Voltages

3.11.17.1 Check the following voltages and record the result on the commissioning sheets. Record voltages from analogue readings.

3.11.17.1.1 Voltages Normal

- L1 Digital
- L2 Digital
- L3 Digital

3.11.17.1.2 Voltages Emergency

- L1 Digital
- L2 Digital
- L3 Digital

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