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Electricity Specification 320

Issue 9 September 2022

Preparation and Assembly of Substation Plant (11/6.6kV and LV)

Amendment Summary

ISSUE NO. DATE	DESCRIPTION
Issue 6 **May 2021**	This document has been placed into the new format and a new depot test table has been added to Appendix C for the RN2D RMU from Schneider Electric with a P116 relay fitted. MAMs references updated. Standards updated as marked. New EFI test sheet added to Appendix C as C4 and referenced to be completed in section 6.13. Prepared by: Matthew Kayes Approved by: Policy Approval Panel and signed on its behalf by Steve Cox, Engineering and Technical Director
Issue 7 **September 2021**	New depot test tables have been added to Appendix C for the RN6D RMU (new C4) and CE2 / CE6 from Schneider Electric with a P116 relay fitted. C2 title updated and C4 for EFI testing renumbered to C5 and hyperlinks updated as marked. A note has been added to Appendix C regarding the MICOM P116 relay SET files and where to locate them. Prepared by: Matthew Kayes Approved by: Policy Approval Panel and signed on its behalf by Steve Cox, Engineering and Technical Director
Issue 8 **January 2022**	Appendix C – Sections C3, C4, C6 and C7 MICOM P116 relay cortec code corrected. Prepared by: Matthew Kayes Approved by: Policy Approval Panel and signed on its behalf by Steve Cox, DSO Director
Issue 9 **September 2022**	Appendix C – New Section 5 added for the Lucy Sabre 7SR45 relay, all subsequent sections in Appendix C numbers increased by 1 as a result. Prepared by: Matthew Kayes Approved by: Policy Approval Panel and signed on its behalf by Steve Cox, DSO Director

Contents

1 Introduction

This Electricity Specification (ES) covers the standards of plant preparation and assembly required by Electricity North West Limited (Electricity North West). Plant preparation and assembly are the customisation processes necessary to prepare individual plant items or prepare assemblies of plant items for delivery to site, ready for installation, in accordance with the customer requirements as summarised on a Plant Assembly Form (see form in Appendix A).

The most common preparation and assembly tasks are listed in this specification, together with the standards required for each task.

2 Scope

This specification covers the preparation and assembly of distribution substation plant (6.6/11kV and LV) as listed in Section 5.

Preparation and assembly comprise the work involved in receipt of as-built plant items from the equipment supplier through to preparation for delivery to site. (Logistical requirements such as appropriate timing of the work, storage of the completed unit(s) in appropriate conditions are not included in this specification but are the responsibility of the contractor.)

The work shall be completed to the standards given in this specification.

The contractor shall be responsible for delivery and off-loading of the assembled substation plant to stores or direct to site.

This specification does not include any methodology for planning, management or carrying out the work. Where the contractor is also carrying out the site works, it is the responsibility of the contractor to provide Electricity North West with details of how the work will be planned, co-ordinated, managed, undertaken and recorded, etc.

3 Definitions

Approval	Sanction by the Electricity North West Plant Policy Manager that specified criteria have been satisfied
Contractor	The person or person's firm or company, including personal representatives, successors and permitted assigns, who's Tender has been accepted by Electricity North West.
Specification	The Specifications and schedules (if any) agreed by the parties for the purpose of the Contract.
Sub-Contractor	Any person (other than the Contractor) named in the Contract for any part of the Works or any person to whom any part of the Contract has been sub-let with the consent in writing of the Electricity North West Plant Policy Manager, and the legal representatives, successors and assigns of such person.
Supplier	Any person or person's firm or company who supplies goods to Electricity North West or to its Contractor.
Tender	An offer in writing to execute work or supply goods at a fixed price.
Tenderer	The person or person's firm or company, including personal representatives, successors and permitted assigns, invited by Electricity North West to submit a Tender.
Words	Words importing persons shall include firms and corporations; words importing the singular only, also include the plural, and vice versa where the context requires.
Work	All materials, labour and actions required to be provided or performed by the Contractor under the Contract. The work will normally be detailed on a 'Plant Assembly Form'.
Writing	Any manuscript, typewritten or printed statement under seal or hand as the case may be.

4 General Requirements for Approvals and Testing

4.1 Product not to be Changed

No change in the product, packaging or labelling shall be made after Approval has been granted without prior notice to the Electricity North West Plant Policy Manager, and receipt of a written agreement to the proposed change from the Electricity North West Plant Policy Manager.

4.2 Electricity North West Technical Approval

The Tenderer shall submit, with this Tender, proposals for testing which will demonstrate, to the satisfaction of the Electricity North West Plant Policy Manager, compliance with this Specification. Such tests shall be carried out without expense to Electricity North West.

Alternatively, technical reports and other data may be submitted that the Tenderer considers will demonstrate, to the satisfaction of the Electricity North West Plant Policy Manager, compliance with this Specification. Acceptance of this evidence shall be at the discretion of the Electricity North West Plant Policy Manager but will not be unreasonably withheld.

Approval shall be 'factory specific' and is not transferable to another factory without the written Approval of the Electricity North West Plant Policy Manager.

The Supplier and product shall comply with all the relevant requirements of Electricity North West Policy CP311.

4.3 Quality Assurance

The Tenderer shall confirm whether or not Approval is held in accordance with a quality assurance scheme accredited under ISO 9000. If not, the Tenderer shall submit a statement of the quality assurance procedures employed to control the quality of the product, including the performance of Suppliers and Sub-Contractors.

The right is reserved for the repeat of such tests, from time to time, that the Electricity North West Plant Policy Manager may deem to be reasonably necessary to demonstrate continued compliance with the Specification.

The Tenderer shall submit, with the Tender, a list of tests and inspections which are carried out on the product prior to despatch which shall demonstrate, to the satisfaction of the Electricity North West Plant Policy Manager, fitness for installation and service.

The Tenderer shall provide free of charge to Electricity North West such samples as may, in the opinion of the Electricity North West Plant Policy Manager, be reasonably required for inspection and/or retention as quality control samples. The Electricity North West Plant Policy Manager will confirm the requirement for samples at the time of Tendering.

The right is reserved for inspections to be made of Tenderer's facilities, from time to time, as deemed reasonably necessary by the Electricity North West Plant Policy Manager to ensure compliance with this Specification and any Contract of which it forms a part.

The Tenderer shall submit, with the Tender, such details of product packaging disposal, as will enable Electricity North West to comply with the requirements of BS EN ISO 14001:2015 - Environmental Management Systems.

4.4 Formulation

The Tenderer shall submit, with the Tender, such details of the formulation and use of the product and associated substances as will enable Electricity North West to comply with the obligations of the Health and Safety at Work Act 1974 and the Control of Substances Hazardous to Health Regulations 2002, in the use, storage and disposal of the product. The Tenderer may stipulate, prior to submission of such information, that it is to remain confidential, and the Electricity North West Plant Policy Manager will, if requested, confirm agreement to this prior to receipt of the information.

4.5 Identification Markings

The Tenderer shall submit, with the Tender, details of markings which it is proposed to apply to the product or packaging to identify manufacturing batches or items. The forms and content of such markings shall be subject to the Approval of the Electricity North West Plant Policy Manager and shall in all cases include the Electricity North West approved description and commodity code number.

The Tenderer shall submit, with the Tender, such details of marking gross weight on components, assemblies and packages, as will enable Electricity North West to comply with the Health and Safety Manual Handling Operation Regulations 1992, for components, assemblies and packages supplied with a gross weight over 1kg. The forms and content of such markings shall be subject to the Approval of the Electricity North West Plant Policy Manager.

4.6 Minimum Life Expectancy

The minimum life expectancy of all products covered by this Specification is 40 years.

4.7 Product Conformity

Preference will be given to those Suppliers who can provide suitable product conformity certification to a recognised or specified standard, or an equivalent certification.

5 Plant Types and Requirements

This specification covers the preparation, assembling and testing of combinations of oil or SF_6 filled 11kV/6.6kV Switchgear, Transformers, LV Cabinets and Metering Units for installation in Distribution substations

The Plant Assembly Form in Appendix A shall be completed for each job. The form shall define the customer requirements for that job, e.g.:

(a) Plant items and order of assembly.

(b) Proposed substation name.

(c) Fitting of earth fault indicator, metering requirements, etc.

(d) Cable sizes, fuse sizes and labels.

(e) Protection Settings or TLF sizes and CT Ratio Settings for protection and metering.

The plant preparation and assembly standards given in Section 6 shall be met.

A Quality Control Checklist (see form in Appendix B) shall be completed for each job.

6 Plant Preparation and Assembly Standards

6.1 General

This section details general standards that shall be met when doing any preparation or assembly procedure.

NOTE: It shall be borne in mind by the contractor that Electricity North West will, from time-to-time, need to gain access to interiors of units for maintenance purposes.

All work shall be done to a standard such that the as-built life of a unit is not unduly reduced as a result of the preparation and assembly procedures included in this specification. (For example, seals shall be made securely, without distortion, to ensure water cannot penetrate, thus avoiding oil contamination, short-circuits, corrosion, etc.) Care shall be taken to avoid damaging paintwork during preparation or assembly work. The standards listed here shall be maintained for all preparation or assembly work (even in cases where some dismantling may be necessary during final installation of the unit - e.g. for jointers to access cable boxes, busbars etc.) The apparatus shall be protected from moisture, humidity and temperature extremes at all stages of delivery, storage, preparation and assembly commensurate with the design and materials of the apparatus and its components.

A written method statement shall be provided by the Tenderer for each type of plant preparation and assembly work undertaken.

6.2 Securing Fixings, Making Waterproof Seals and Electrical Connections

All fixings shall be tightened to the appropriate torque setting. All neoprene or rubber gaskets, such as those around test apertures, shall be secured (using appropriate adhesive) and greased as per suppliers' recommendations prior to being fitted. Cork Gaskets shall not be reused. Sealant shall be applied to mating surfaces where necessary to avoid the ingress of water.

No distortion of completed unit or assembly (or individual parts) due to preparation or assembly work is acceptable. Electrical connection points shall be cleaned prior to being made, then secured appropriately to ensure good electrical contact.

6.3 Quality Control Documentation

A Quality Control Checklist (see form in Appendix B) shall be generated prior to the start of a job and shall be completed and signed off at the end of that job. This document lists checks and tests that shall be done on each item by plant type. The contractor shall provide an electronic copy of the Quality Control Checklist to the Electricity North West Plant Policy Manager for subsequent attachment to the Master Asset Register (ELLIPSE) record.

6.4 Personnel Doing the Work

Any plant preparation or assembly procedure shall only be done by qualified fitting staff who are trained and authorised to work in the appropriate environment, and who are trained and authorised to use all the equipment necessary to do the job. Contractors shall maintain written records of training of personnel

involved in this work. Any party and/or personnel commissioning CTs and VTs used for settlement metering purposes shall be suitably competent and authorised, as specified in ES501.

6.5 Initial Job Preparation

Prior to commencement of work, the customer requirement (Plant Assembly Form) shall be read and understood.

6.6 Initial Inspection

All plant shall be checked as follows:

(a) All permanent labels, etc (e.g. unit identification plate) shall be secure and legible.

(b) Plant identification details shall be noted and recorded.

(c) Only units containing oil: these shall be checked for signs of oil leaks (particularly around gaskets and seals), ensuring, as far as is reasonably practicable, that the gaskets and seals are correctly seated and in good condition.

(d) Only units containing SF_6: the reading on the pressure indicator shall be checked.

(e) Check the correct operation of all switching devices and interlocks.

(f) The integrity of the external connectors shall be checked.

(g) The exterior of the unit shall be checked for any obvious defects, e.g. dents, bent pins, etc.

(h) If any obvious damage or out-of-tolerance items are discovered, the unit shall be labelled appropriately and returned to the supplier for repair or replacement. The details shall be recorded and passed on to Electricity North West for statistical analysis.

All defects found shall be reported to the Electricity North West Plant Policy Manager using the defects form within Code of Practice (CP) 305.

6.7 Inspection of Oil Tanks (Interior)

The following items shall be inspected:

(a) The condition of the oil shall be visually checked - the oil shall be clear and free from obvious contamination.

(b) The interior of the tank shall be visually checked for any obvious signs of damage or foreign objects.

(c) The integrity of the internal components shall be checked, as far as is reasonably practicable.

(d) If any obvious damage or out-of-tolerance items are discovered, the unit shall be returned to the manufacturer.

6.8 Requirements for Insulating Oil

Tenderers shall demonstrate that they have two completely separate oil systems: one for draining dirty oil and one for supplying clean oil. There shall be no common items. Each system shall have separate, and clearly labelled, hoses and pumps.

Only approved oil shall be used in the clean oil system, i.e.:

(a) Oil supplied by the Electricity North West Central Oil Reprocessing Depot (CORD).

Or

(b) Unused insulating oil which has been supplied by an approved processor. This unused insulating oil shall be in accordance with BS EN 60296 – Fluids for electrotechnical applications. Mineral oils for electrical equipment.

Clean oil (in the storage tanks of the clean oil system) shall be tested monthly as follows:

TEST	ACCEPTABLE TEST RESULT
1. Moisture content	Less than 15 parts per million.
2. Dielectric strength	Breakdown shall not occur at less than 60 kV.
3. Acidity	As BS EN 60296.
4. PCB content	It shall be certified free from Polychlorinated Biphenyls (PCB).

The results of the above test shall be sent to the Electricity North West Plant Policy Manager.

If it is found that the contractor's oil system does not meet the standard given in this clause, the contractor shall be liable for the full cost of replacing the oil in all units supplied from the date of the last acceptable oil test. This cost includes all operational work as a result of the oil changes (e.g.: warning off customers or switching), site works and oil testing.

6.9 Oil Flushing, Replacement and Replenishment

All switchgear oil tanks received from the manufacturer shall be flushed and cleaned three times with clean oil, before being refilled with clean oil. Any switchgear oil tanks that are received full from the manufacturer shall be drained to the dirty oil store before flushing and filling as above. Clean oil is defined in clause 6.8. All other oil shall be considered dirty.

After filling, a green label shall be fixed to all oil filled plant with the wording 'FILLED WITH OIL' and containing the date, and the signatures of the person who has filled the unit and of the second person who has checked the filled level.

6.10 Cabling and Wiring, and Fixings

All additional cabling, wiring and fixings introduced into a unit or assembly as part of the preparation assembly procedure (e.g.: for making continuous earths) shall meet the appropriate standard for the intended purpose. Only the minimum length of cabling or wiring required for a specific purpose shall be used. Guides and cable ties shall be used to neatly secure wiring or cabling to appropriate parts of a structure, thus avoiding loose lengths of cable or wire.

6.11 LV Cabinets – LV Connections

Continuity tests shall be carried out between the transformer LV connectors and the top of each phase on the busbar side using a micro-ohmmeter. Record the values on the Quality Control Checklist.

If the fuse cabinet contains 'Ganged' LV fuseways, continuity tests shall be carried out between the lower phase stalks of each of the ganged ways and the common cable connection plate in the bottom of the cabinet. Record the values in the Quality Control Checklist.

If any reading is greater than the following values*, the security of associated fixing shall be investigated, and the fixing tightened as necessary and retested:

(a) 5-way cabinet: readings generally shall be less than 70 microhms (phases) or 100 microhms (neutral earth).

(b) 3-way cabinet: readings generally shall be less than 150 microhms (phases) or 250 microhms (neutral earth).

NOTE: that the resistance measured also depends upon the copper content between the measurement points and the above figures are for general guidance.

6.12 LV and HV Fuse Ratings and Installation

LV fuses to Electricity North West current specification and with ratings as specified in the Plant Assembly Form shall be fitted in the fuse carriers. The fuse ratings fitted shall be entered on the Quality Control Checklist against the appropriate way number.

HV fuses to Electricity North West current specification and with ratings as specified in the Plant Assembly Form shall be fitted in HV switchgear. A label shall be fixed to the switch stating the fuse Rating, Manufacturer and Type fitted. The fuse rating fitted shall be entered on the Quality Control Checklist.

6.13 Protection and Testing and Settings

If the switchgear is fitted with CT operated protection, Primary injection tests shall be carried out to verify the CT ratio, correct connection and correct operation of all parts of the protection scheme. Where protection settings have been supplied, secondary injection tests at setting shall also be carried out.

A full record of all measurements shall be appended to the Quality Control Checklist. The protection test result sheets in Appendix C shall be completed.

Should protection settings and CT ratios be supplied on the Plant Assembly Form then these settings shall be applied and such application noted on the Quality Control Checklist

All Earth Fault Indicators (EFI) fitted shall be tested by a primary injection method, Appendix C4 Test Sheet Completed and the results noted on the Quality Control Checklist. The EFI shorting links will be fitted after Testing has been completed.

6.14 Metering CT & VT Testing

If the switchgear is fitted with an HV metering unit or LV CTs for metering purposes these shall be tested and commissioned in accordance ES510 and the results recorded using the appropriate test sheet in Appendix A of CP510. These tests meet the requirements for Electricity North West compliance with the Balancing & Settlement Code (BSC). Primary injection tests shall be completed to confirm CT & VT (where appropriate) ratio, polarity, correct phase relationship and correct connection. It is acceptable to test concurrently the protection CTs, and the metering CTs and VTs during primary injection testing, as appropriate.

A full record of all measurements shall be appended to the Quality Control Checklist. The appropriate test sheet in Appendix A of CP510 shall be completed, as appropriate, and a copy shall be emailed to Data Management at P283commissioning@enwl.co.uk.

Should the metering CT ratios be supplied on the Plant Assembly Form then these settings shall be applied and noted on the Quality Control Checklist.

The metering CTs & VTs shall be tested by the manufacturer in accordance with ES501. Copies of the metering CT & VT test certificates shall be provided by the manufacturer with the metering unit. Copies of these certificates shall be scanned and emailed to Data Management at P283commissioning@enwl.co.uk. Paper copies of the CT & VT test certificates provided by the manufacturer shall be removed from the equipment and kept with the original Quality Control Checklist and test result sheets. Any instances of missing or incomplete CT/VT test certificates shall be recorded in the 'Field notes' section on the test sheet.

6.15 Final Inspection and Clean Prior to Dispatch

All units and assemblies shall be inspected and cleaned prior to dispatch as follows:

(a) Oil-filled units shall be checked for any signs of oil leaks, particularly where an original seal was broken or disturbed as a result of the fitting procedure (e.g. at HV unit or transformer HV flange).

(b) Units containing SF_6: the reading on the pressure indicator shall be within the acceptable limits for the unit.

(c) The unit(s) shall be wiped down.

(d) To avoid future corrosion, scratched paintwork shall be cleaned and touched up using supplier-approved paint and method of application.

(e) All means of access and operating switches etc shall be locked off using the appropriate customer-supplied padlocks. The tap change switch shall be set to Tap 3 and locked.

(f) Quality documentation shall be completed.

(g) Customer documentation shall be completed and included with the unit or assembly as necessary.

(h) HV and LV circuit labels shall be inscribed as specified on the Plant Assembly Form and supplied in a securely attached bag with the plant.

(i) The operating handle shall be present and secured by padlock.

7 Documents Referenced

DOCUMENTS REFERENCED	
Health and Safety at Work Act 1974	
Control of Substances Hazardous to Health Regulations 2002	
Balancing and Settlement Code, Code of Practice Four	Code of Practice for the Calibration, Testing and Commissioning Requirements of Metering Equipment for Settlement Purposes
BS EN ISO 14001:2015	Environmental Management Systems.
ISO 9000	Quality Management & Quality Assurance Standards.
BS EN 60296	Fluids for electrotechnical applications. Mineral oils for electrical equipment
CP311	Equipment Approval Policy and Processes
CP305	Reporting and Investigation of Network Equipment Defects – Procedures
ES501	Metering CTs & VTs
CP510	Commissioning of Measurement Transformers connected to Tariff Metering Equipment
ES510	Procedure for Commissioning Measurement Transformers Connected to Settlement Metering Equipment

8 Keywords

Fitter, Plant, Substation, Switchgear, Transformer.

Appendix A – Plant Assembly Form

Site Date: _____ Logistics ID _____

Project Title: Plant to be used:

_____ HV Switchgear _____

_____ Transformer _____

_____ LV Equipment _____

_____ Details of any special assembly requirements:

Project No: _____

Proposed S/S name: _____ S/S No: _____

CABLE SIZES/FUSE SIZES/LABELS

	CIRCUIT	CABLE SIZE	FUSE SIZE	LABEL
HV	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
LV	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			

LABELS FOR EXISTING SUBSTATIONS

Note: Modern SW/GR label sizes are known, please indicate sizes of older units

S/S NAME	MAKE/TYPE OF SW/GR	EXISTING LABEL	PROPOSED LABEL

Signed: _____ Tel: _____

Print: _____ Date: _____

Appendix B – Quality Control Checklist

Contractor Details

Company name		Preparation/Assembly location	
Contractor reference			

Plant Details

Transformer

Manufacturer's name		Type	
Serial number		Rating	
Cable connected or unit?			

HV Switchgear

Manufacturer's name		Type	
Serial number		Metering Unit Serial No	

LV Fuse cabinet

Manufacturer's name		Type	
Serial number			

Destination Details

Substation name		Substation number (if known)	

(Continued)

Quality Checks

Receipt

Job details recorded?		Initial inspection complete?	

Transformer

Drain valve operates?		HV connections complete?	
Oil level correct?		Lid fixings secure?	
LV connections complete?		Tap changer operates, and is locked off?	
Earth connections complete?			

HV Switchgear

Interlock check OK?		Oil tank examined?	
Oil tank cleaned?		Oil level correct?	
Oil seals fitted correctly?		Covers secured?	
HV trip test complete?		Fuse(s) fitted?	
HV connections complete?		Earth connections complete?	
EFI/CT fitted and Tested?		Metering Unit fitted?	
Destination Labels fitted?		X56 locks fitted?	

LV Fuse Cabinet

Cable cleats drilled?		LV fuses prepared?	
Ways/test sockets complete?		Stand-off pins positioned?	
LV connections complete?		A4/2 additional lock supplied?	
Termination fixings supplied?		MDI set?	

Metering CT & VT Testing

Commissioning complete?		CP510 forms completed?	
CP510 forms emailed to Data Management?			

Ensure micro-ohmmeter readings are within range given in procedure (for cabinet type) and record readings in μΩ (below):

Way number:							
R							
Y							
B							
N							

Cabinet with ganged ways

Ganged R to cable conn.							
Ganged Y to cable conn.							
Ganged B to cable conn.							

Destination labels fitted?		A4/2 locks fitted?	

Final Assembly

HV connections made?		LV connections made?	
Final earth connections made?		Destination labels fitted?	
S/S nameplates supplied?		Locked off?	
Danger of Death labels fitted?		Free from oil leaks?	
SF_6 pressure OK?		Assembly secure and stable?	
Cleaned?		Scratches touched up?	
'Filled with oil' label fitted		'Tested' label, Transformer Test Cert and Protection Test Results attached	

Additional Comment?

Name Signature Date

Appendix C – Protection Test Result Sheets

NOTE: The appropriate MICOM P116 SET Files for Depot Testing are available from the Electricity North West Library under the files named P116 Test 200, P116 Test 400 and P116 Test 800.

The SET files named Default 200 & 400 are the files to be uploaded to the relay for despatch to site, these set files have minimum settings applied. The correct site settings shall be applied during the commissioning process as per ES320.

The appropriate Set Files for the Lucy Sabre VRN2a Argus 7SR45 relay are available on the Electricity North West Library under the files named 7SR45 Test 100 and 200.

The SET files for the Argus 7SR45 relay in Lucy Sabre VRN2a for site commissioning is named 7SR45 Prot ENW. The correct site settings shall be applied during the commissioning process as per ES320.

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C1 – TLF Protection Pre-Assembly Commissioning Sheet

Manufacturer / Type _____/_____

Serial Number: _____

CT Ratio: _____ CT Serial Numbers: R: _____

Y: _____

AC Wiring Insulation Resistance: _____Ω B: _____

DC Resistance Tests

CT		RESISTANCE MEASURED (Ω)	RESISTANCE OF MEASURING CIRCUIT (Ω)	TRUE RESISTANCE (Ω)
100/5 Ratio	R (L1)			
	Y (L2)			
	B (L3)			
50/5 Ratio	R (L1)			
	Y (L2)			
	B (L3)			

CT Magnetisation Characteristics

Secondary Current			50 mA	100mA	200mA	300mA	400mA	500mA	600mA	750mA	1A	1.5A	2A
Sec Volts	100/5 Ratio	R (L1)											
		Y (L2)											
		B (L3)											
	50/5 Ratio	R (L1)											
		Y (L2)											
		B (L3)											

NOTE: For Schneider RN2c CT Magnetisation Characteristic testing the maximum range used is 600mA.

CT Ratio & Polarity

		R-Y (L1-L2)			R-B (L1-L3)	
Ratio	Primary Current (A)	Secondary Current R (L1) CT (A)	Secondary Current Y (L2) CT (A)	Spill Current (mA)	Secondary Current B (L3) CT (A)	Spill Current (mA)
100/5	100					
50/5	50					

Primary Injection Overcurrent Test CT Ratio _____ (use service setting, if known)

PRIMARY CONNECTIONS	VOLT DROP AT 8A (V)		CURRENT TO TRIP (A)	EARTH FAULT SPILL AT 100A (MA)
	R (L1)	B (L3)		
R-Y (L1-L2)				
R-B (L1-L3)				
Y-B (L2-L3)				

Primary Injection Earth Fault Test CT Ratio _____ (use service setting, if known)

PRIMARY CONNECTIONS	VOLT DROP AT 16A (V)	CURRENT TO TRIP (A)
R-R (L1-L1)		
Y-Y(L2-L2)		
B-B(L3-L3)		

Voltage Presence Indication System (VPIS) Tests (if fitted)

NOTE: Sheet assumes RMU, if extensible switch make entries for (a) – (c) only

(a) 250V ac applied to L1 and Earth on Right Hand Switch Bushings

	LHS VPIS TEST POINTS			RHS VPIS TEST POINTS		
VPIS Points	**L1-Earth**	**L2-Earth**	**L3-Earth**	**L1-Earth**	**L2-Earth**	**L3-Earth**
Voltage (V)						

(b) 250V ac applied to L2 and Earth on Right Hand Switch Bushings

	LHS VPIS TEST POINTS			RHS VPIS TEST POINTS		
VPIS Points	**L1-Earth**	**L2-Earth**	**L3-Earth**	**L1-Earth**	**L2-Earth**	**L3-Earth**
Voltage (V)						

(c) 250V ac applied to L3 and Earth on Right Hand Switch Bushings

	LHS VPIS TEST POINTS			RHS VPIS TEST POINTS		
VPIS Points	**L1-Earth**	**L2-Earth**	**L3-Earth**	**L1-Earth**	**L2-Earth**	**L3-Earth**
Voltage (V)						

(d) 250V ac applied to L1 and Earth on Left Hand Switch Bushings

	LHS VPIS TEST POINTS			RHS VPIS TEST POINTS		
VPIS Points	**L1-Earth**	**L2-Earth**	**L3-Earth**	**L1-Earth**	**L2-Earth**	**L3-Earth**
Voltage (V)						

(e) 250V ac applied to L2 and Earth on Left Hand Switch Bushings

	LHS VPIS TEST POINTS			RHS VPIS TEST POINTS		
VPIS Points	**L1-Earth**	**L2-Earth**	**L3-Earth**	**L1-Earth**	**L2-Earth**	**L3-Earth**
Voltage (V)						

(f) 250V ac applied to L3 and Earth on Left Hand Switch Bushings

	LHS VPIS TEST POINTS			RHS VPIS TEST POINTS		
VPIS Points	**L1-Earth**	**L2-Earth**	**L3-Earth**	**L1-Earth**	**L2-Earth**	**L3-Earth**
Voltage (V)						

Tested by (signature): _____

Print Name: _____

Company: _____

Date: _____

C2 – Relay Protection Pre-Assembly Commissioning Sheet (excluding RN2D / RN6D with Micom P116 & VRN2a with 7SR45)

Manufacturer / Type _____/_____

Serial Number: _____

CT Ratio: _____ CT Serial Numbers: R: _____

Y: _____

AC Wiring Insulation Resistance: _____Ω B: _____

DC Resistance Tests

CT	RESISTANCE MEASURED (Ω)	RESISTANCE OF MEASURING CIRCUIT (Ω)	TRUE RESISTANCE (Ω)
R (L1)			
Y (L2)			
B (L3)			

CT Polarity Check (Flick Test)

CT	POLARITY CHECKED
R (L1)	
Y (L2)	
B (L3)	

Primary Injection Tests

PRIMARY CURRENT (A)	R-Y (L1-L2)			R-B (L1-L3)	
	Secondary Current R (L1) CT (A)	Secondary Current Y (L2) CT (A)	Spill Current (mA)	Secondary Current B (L3) CT (A)	Spill Current (mA)

Ammeter Check

Primary Current (A): _____ Ammeter Reading (A): _____

CT Magnetisation Characteristics

SECONDARY CURRENT		1MA	4MA	8MA	10MA	15MA	30MA	100MA
Sec Volts	R (L1)							
	Y (L2)							
	B (L3)							

CT Star Point Earth Link Resistance:_____Ω

Overcurrent Minimum Operation

PRIMARY CURRENT SETTING (A)	SECONDARY CURRENT AT MINIMUM OPERATION (A)		
	R-Y (L1-L2)	R-B (L1-L3)	Y-B (L2-L3)

Overcurrent Timing Test

CURRENT MULTIPLE	TIME MULTIPLIER	INJECTED CURRENT (A)	OPERATING TIME (S)		
			R-Y (L1-L2)	R-B (L1-L3)	Y-B (L2-L3)
2X					
4X					
High Set					

Earth Fault Minimum Operation

PRIMARY CURRENT SETTING (A)	SECONDARY CURRENT AT MINIMUM OPERATION (A)		
	R-E (L1-E)	Y-E (L2-E)	B-E (L3-E)

Earth Fault Timing Test

CURRENT MULTIPLE	TIME MULTIPLIER	INJECTED CURRENT (A)	OPERATING TIME (S)
2X			
4X			
High Set			

Relay Left Set At:

ELEMENT	NORMAL SETTING			HIGH SET SETTINGS	
	Current	Curve	Time Multiplier	Current Multiple	Time Multiplier
Overcurrent					
Earth Fault					

Tested by (signature): _____

Print Name: _____

Company: _____

Date: _____

C3 – Relay Protection Pre-Assembly Commissioning Sheet – RN2D

Site		**Circuit**		
Unit Type	Schneider RN2D-M-N4/21	**Relay Type**	Micom P116A1N2N14121111N	
Unit Serial No.		**Relay Serial No.**		
CT Ratio	200/1	**Prot CT Serial No.**	**L1.**	
			L2.	
			L3.	

Insulation Tests @1kV

CT IR Test @ 1kV:_____Ω

DC Resistance Tests

	MEASURED VALUE Ω	MEASURING CIRCUIT Ω	TRUE VALUE Ω
CT Earth Link			
L1 CT C11-C70			
L2 CT C31-C70			
L3 CT C51-C70			

Magnetisation Characteristics

	1mA	2mA	5mA	10mA	25mA	50mA	100mA
L1 CT C11-C70							
L2 CT C31-C70							
L3 CT C51-C70							

Ratio Check

PHASE	PRIMARY CURRENT	SECONDARY CURRENT				RELAY CURRENT DISPLAY			
		C12	C32	C52	C71	IA	IB	IC	IN
L1-L2	50								
L1-L3	50								
L1-E	50								

Relay Minimum Operation

ELEMENT	MIN OP CURRENT
IA Start	
IB Start	
IC Start	
IN_1 Start	

Relay Timing Tests

ELEMENT	INJECTION POINT	SECONDARY CURRENT	EXPECTED TIME (S)	ACTUAL TIME (S)
L1-L2	C11-C31	0.50	10.03	
L2-L3	C31-C51	0.50	10.03	
L3-L1	C51-C11	0.50	10.03	
L1-E	C11-C70	0.20	10.03	

VPIS Tests

APPLIED VOLTAGE	RING SWITCH 1 VPIS (V)			RING SWITCH 2 VPIS (V)		
300V	**L1**	**L2**	**L3**	**L1**	**L2**	**L3**
Ring Switch 1 L1						
Ring Switch 1 L2						
Ring Switch 1 L3						
Ring Switch 2 L1						
Ring Switch 2 L2						
Ring Switch 2 L3						

NOTE: Left set a minimum setting. Service settings to be applied on site and confirmed by secondary injection tests.

Tested by (signature): _____

Print Name: _____

Company: _____

Date: _____

C4 - Relay Protection Pre-Assembly Commissioning Sheet – RN6D

Site			**Circuit**		
Unit Type	Schneider RN6D-M-N4/21		**Relay Type**	Micom P116A1N2N14121111N	
Unit Serial No.			**Relay Serial No.**		
CT Ratio	800/400/1		**Prot CT Serial No.**	**L1.**	
				L2.	
				L3.	

Insulation Resistance Tests @1kV

CT IR Test @ 1kV		**Ω**

DC Resistance Tests

RATIO		MEASURED VALUE Ω	MEASURING CIRCUIT Ω	TRUE VALUE Ω
	CT Earth Link			
400/1	L1 CT C11-C210			
	L2 CT C31-C230			
	L3 CT C51-C250			
800/1	L1 CT C11-C110			
	L2 CT C31-C130			
	L3 CT C51-C150			

Magnetisation Characteristics

RATIO		1MA	2MA	5MA	10MA	25MA	50MA	100MA
400/1	L1 CT C11-C210							
	L2 CT C31-C230							
	L3 CT C51-C250							
800/1	L1 CT C11-C110							
	L2 CT C31-C130							
	L3 CT C51-C150							

Ratio Check

	PHASE	PRIMARY	SECONDARY CURRENT MA				RELAY CURRENT DISPLAY			
		Current	C12	C32	C52	C71	IA	IB	IC	IN
800/1	L1-L2	200								
	L1-L3	200								
	L1-E	200								
400/1	L1-L2	100								
	L1-L3	100								
	L1-E	100								

Relay Minimum Operation

ELEMENT	MIN OP
	Current
IA Start	
IB Start	
IC Start	
IN_1 Start	

7. VPIS Tests

APPLIED VOLTAGE	RING SWITCH 1 VPIS (V)			RING SWITCH 2 VPIS (V)		
300V	L1	L2	L3	L1	L2	L3
Ring Switch 1 L1						
Ring Switch 1 L2						
Ring Switch 1 L3						
Ring Switch 2 L1						
Ring Switch 2 L2						
Ring Switch 2 L3						

NOTE: Left set a minimum setting. Service settings to be applied on site and confirmed by secondary injection tests.

Tested by (signature): _____

Print Name: _____

Company: _____

Date: _____

C5 – Relay Protection Pre-Assembly Commissioning Sheet – VRN2a with 7SR45 Relay

Site		**Circuit**	
Unit Type	Lucy Sabre VRN2a	**Relay Type**	Siemens 7SR4504-1HB20-1AA0/HH
Unit Serial No.		**Relay Serial No.**	
CT Ratio	200/100/1		

1 Insulation Tests @1kV

CT IR Test @ 1kV:_____Ω

2 DC Resistance Tests

Ratio		MEASURED VALUE Ω	MEASURING CIRCUIT Ω	TRUE VALUE Ω
	CT Earth Link			
100/1	L1 CT C11-C210			
	L2 CT C31-C230			
	L3 CT C51-C250			
200/1	L1 CT C11-C110			
	L2 CT C31-C130			
	L3 CT C51-C150			

3 Magnetisation Characteristics

RATIO		1mA	2mA	5mA	10mA	25mA	50mA	100mA
100/1	L1 CT C11-C70							
	L2 CT C31-C70							
	L3 CT C51-C70							
200/1	L1 CT C11-C70							
	L2 CT C31-C70							
	L3 CT C51-C70							

4 Ratio Check

RATIO	PHASE	PRIMARY CURRENT	SECONDARY CURRENT				RELAY CURRENT DISPLAY			
			C110 (1)	C130 (2)	C150 (3)	C72 (4)	Ia	Ib	Ic	Ig/In
200/1	L1-L2	50								
	L1-L3	50								
	L1-E	50								
			C210 (5)	C230 (6)	C250 (7)	C72 (4)	Ia	Ib	Ic	Ig/In
100/1	L1-L2	25								
	L1-L3	25								
	L1-E	25								

5 Relay Minimum Operation

ELEMENT	MIN OP CURRENT
IL1 Pickup	
IL2 Pickup	
IL3 Pickup	
IE Pickup	

6 Relay Timing Tests

ELEMENT	INJECTION POINT	SECONDARY CURRENT	EXPECTED TIME (S)	ACTUAL TIME (S)
L1-L2	C11-C31	1.00	10.03	
L2-L3	C31-C51	1.00	10.03	
L3-L1	C51-C11	1.00	10.03	
L1-E	C11-C70	0.50	10.03	

7 VPIS Tests

APPLIED VOLTAGE	RING SWITCH 1 VPIS (V)			RING SWITCH 2 VPIS (V)		
300V	L1	L2	L3	L1	L2	L3
Ring Switch 1 L1						
Ring Switch 1 L2						
Ring Switch 1 L3						
Ring Switch 2 L1						
Ring Switch 2 L2						

Ring Switch 2 L3						

NOTE: Left set a minimum setting. Service settings to be applied on site and confirmed by secondary injection tests.

Tested by (signature): _____

Print Name: _____

Company: _____

Date: _____

C6 - Earth Fault Indicator(s) (EFI) Pre-Assembly Commissioning Sheet

Manufacturer / Type _____/_____

Serial Number: _____

September 2022

CT Ratio: Normally 500/1

CT Serial Numbers:

Ring Switch 1	CT Serial Number
L1	
L2	
L3	

Ring Switch 2	CT Serial Number
L1	
L2	
L3	

AC Wiring Insulation Resistance: _____Ω

CT IR Test @ 1kV:_____Ω

DC Resistance Tests

CT		MEASURED VALUE Ω	MEASURING CIRCUIT Ω	TRUE VALUE Ω
Ring Switch 1	L1			
	L2			
	L3			
Ring Switch 2	L1			
	L2			
	L3			

Magnetisation Characteristics

Secondary Current		1mA	2mA	5mA	10mA	25mA	50mA	100mA	200mA
Ring Switch 1	L1								
	L2								
	L3								
Ring Switch 2	L1								
	L2								
	L3								

CT Ratio and Polarity Check

RATIO	PRIMARY CURRENT (A)	L1 – L2			L1 – L3	
		Secondary Current R CT (A)	Secondary Current Y CT (A)	Spill Current (mA)	Secondary Current B CT (A)	Spill Current (mA)
500/1	125					
500/1	125					

NOTE: EFI Shorting Links Shall be Replaced After Testing

Shorting Links Replaced: _____

Tested by (signature): _____

Print Name: _____

Company: _____

Date: _____

C7 - Relay Protection Pre-Assembly Commissioning Sheet – CE2

Site			**Circuit**		
Unit Type	**Schneider CE2-N121/21**		**Relay Type**	**Micom P116A1N2N14121111N**	
Unit Serial No.			**Relay Serial No.**		
CT Ratio	**200/1**		**Prot CT Serial No.**	**L1.**	
				L2.	
				L3.	

September 2022

Insulation Resistance Tests @1kV

CT IR Test @ 1kV		**Ω**

DC Resistance Tests

	MEASURED VALUE Ω	MEASURING CIRCUIT Ω	TRUE VALUE Ω
CT Earth Link			
L1 CT C11-C70			
L2 CT C31-C70			
L3 CT C51-C70			

Magnetisation Characteristics

	1mA	2mA	5mA	10mA	25mA	50mA	100mA
L1 CT C11-C70							
L2 CT C31-C70							
L3 CT C51-C70							

Ratio Check

PHASE	PRIMARY	SECONDARY CURRENT MA				RELAY CURRENT DISPLAY			
	Current	C12	C32	C52	C71	IA	IB	IC	IN
L1-L2	50								
L1-L3	50								
L1-E	50								

Relay Minimum Operation

ELEMENT	MIN OP
	Current
IA Start	
IB Start	
IC Start	
IN_1 Start	

Relay Timing Tests

ELEMENT	INJECTION	SECONDARY	EXPECTED	ACTUAL
	Point	Current	Time (s)	Time (s)
L1-L2	C11-C31	0.50	10.03	
L2-L3	C31-C51	0.50	10.03	
L3-L1	C51-C11	0.50	10.03	
L1-E	C11-C70	0.20	10.03	

VPIS Tests

APPLIED VOLTAGE	VPIS (V)		
300V	**L1**	**L2**	**L3**
L1			
L2			
L3			

NOTE: Left set a minimum setting. Service settings to be applied on site and confirmed by secondary injection tests.

Tested by (signature): _____

Print Name: _____

Company: _____

Date: _____

C8 - Relay Protection Pre-Assembly Commissioning Sheet – CE6

Site			**Circuit**		
Unit Type	**Schneider CE6-N213/21**		**Relay Type**	**Micom P116A1N2N14121111N**	
Unit Serial No.			**Relay Serial No.**		
CT Ratio	**800/400/1**		**Prot CT Serial No.**	**L1.**	
				L2.	
				L3.	

September 2022

Insulation Resistance Tests @1kV

CT IR Test @ 1kV		**Ω**

DC Resistance Tests

RATIO		MEASURED VALUE Ω	MEASURING CIRCUIT Ω	TRUE VALUE Ω
	CT Earth Link			
400/1	**L1 CT C11-C210**			
	L2 CT C31-C230			
	L3 CT C51-C250			
800/1	**L1 CT C11-C110**			
	L2 CT C31-C130			
	L3 CT C51-C150			

Magnetisation Characteristics

RATIO		1mA	2mA	5mA	10mA	25mA	50mA	100mA
400/1	L1 CT C11-C210							
	L2 CT C31-C230							
	L3 CT C51-C250							
800/1	L1 CT C11-C110							
	L2 CT C31-C130							
	L3 CT C51-C150							

Ratio Check

	PHASE	PRIMARY	SECONDARY CURRENT MA				RELAY CURRENT DISPLAY			
		Current	C12	C32	C52	C71	IA	IB	IC	IN
800/1	L1-L2	200								
	L1-L3	200								
	L1-E	200								
400/1	L1-L2	100								
	L1-L3	100								
	L1-E	100								

Relay Minimum Operation

ELEMENT	MIN OP
	Current
IA Start	
IB Start	
IC Start	
IN_1 Start	

Relay Timing Tests

ELEMENT	INJECTION	SECONDARY	EXPECTED	ACTUAL
	Point	Current	Time (s)	Time (s)
L1-L2	C11-C31	0.50	10.03	
L2-L3	C31-C51	0.50	10.03	
L3-L1	C51-C11	0.50	10.03	
L1-E	C11-C70	0.20	10.03	

VPIS Tests

APPLIED VOLTAGE	VPIS (V)		
300V	L1	L2	L3
L1			
L2			
L3			

NOTE: Left set a minimum setting. Service settings to be applied on site and confirmed by secondary injection tests.

Tested by (signature): _____

Print Name: _____

Company: _____

Date: _____