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Code of Practice 342

Issue 3 August 2023

Commissioning of Electrical Equipment to be Connected to the 132kV, 33kV and 11/6.6kV Primary Networks

Amendment Summary

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Contents

1 Introduction

This document specifies generic testing procedures for the commissioning of cables, switchgear, transformers, protection, earthing installations and ancillary equipment that are to be connected to the Grid and Primary systems in Electricity North West Limited.

Application of the procedures in this Code of Practice (CP) will ensure, before the main equipment is energised on to the network, that all equipment will function as intended and that all apparatus connected to Electricity North West Limited's network is adequately protected as required by the Electricity Safety Quality and Continuity Regulations 2002 and the Electricity at Work Regulations 1989.

Detailed site commissioning test schedules for specific items of equipment will be provided in future issues of this CP.

Where a Contractor carries out installation and commissioning tests, the Commissioning Engineer (CE) shall ensure that sufficient tests are satisfactorily witnessed by suitably qualified staff to ensure that the equipment has been installed in accordance with Electricity North West Limited requirements. All tests shall be agreed between the CE and Contractor prior to work commencing on site. All appropriate tests sheets shall be completed and checked by the CE before the equipment is energised. All work and testing must be carried out in accordance with Electricity North West Limited's operational procedures.

2 Scope

This CP outlines the commissioning tests required on switchgear, transformers and cables operating from 132kV down to the outgoing 11/6.6kV circuit breakers at primary substations, and the individual components of the protection equipment plus functional and other tests on protection schemes.

Guidance is provided for generic testing of equipment, but it shall be noted that manufacturers' commissioning recommendations shall be followed at all times.

3 Definitions

Contractor	Engineers or others with whom switchgear, transformer and protection equipment contracts are placed
Commissioning Engineer (CE)	The engineer or other representatives of Electricity North West Limited responsible for site testing and commissioning of the equipment
Switchgear	Circuit breakers, isolators, disconnectors, fault throwers etc forming part of the power distribution network.
Transformers	Power transformers
Cables	Power cables
Multicore Cables	Light current cables

4 Switchgear

4.1 Overvoltage Test of Switchgear

Before commencing the overvoltage power frequency test a 5000V insulation resistance test shall be carried out. After completion of the overvoltage testing a second test shall be carried out to ensure that the resistance measured initially has not changed significantly. The power frequency test shall be carried out in accordance with CP319 (Applied High Voltage Tests).

4.2 Resistance Tests of Main Circuit

Micro-ohm meter tests shall be carried out on all busbars, main connections, and across circuit breaker and disconnector contacts.

4.3 Switchgear Operation and Mechanical Interlock Checks

The following basic operational checks on switchgear shall be carried out:

(a) The mechanical functionality of the switchgear shall be checked.

(b) The operation of all electrical and mechanical interlocks on the switchgear shall be checked to ensure that they operate in a positive manner.

(c) Functionality of switchgear operation counters shall be checked.

4.4 Check of Panels and Connections

Prior to commencing work, it shall be confirmed that any adjacent panels that are in commission are appropriately marked as such in the approved manner, as described in CP660 (Demarcation of Work Zones in Substations).

A physical examination of each panel shall be made to ensure that all wiring, positioning of equipment, fuse ratings and labels are in accordance with the wiring diagram and general arrangement drawings and that all relay ratings are appropriate.

All electrical connections shall be proved for mechanical integrity, e.g. terminal tightness, shrouding etc. The panels, relays and control modules shall be visually inspected to ensure freedom from debris and mechanical damage.

The following shall also be checked:

(a) Wiring identification including ferruling

(b) Polarity of fuses, links and auxiliary components

(c) Component values, e.g. resistor values

(d) Terminations fit for purpose, e.g. current rating, spring loaded where applicable

4.5 Current Transformers

4.5.1 Current Transformer (CT) Insulation Resistance

A 1000V insulation resistance test shall be carried out on all CTs.

4.5.2 CT Secondary Resistance and Magnetisation Characteristics

In order to prove the suitability of CTs for their intended duty the secondary magnetisation curve and the dc resistance of the secondary winding shall be obtained by test. Sufficient readings shall be taken to determine the knee point voltage and saturation where possible, which shall be checked for compliance with the manufacturer's data, when this is available, and recorded to form the basis of the capabilities of the CT. Special measures may have to be taken to ensure that the core is fully demagnetised before commencing the test.

Where schemes use high impedance relays, e.g. high impedance busbar protection and restricted earth fault protection, the results shall be used to calculate the stability limit and fault setting of the scheme. Methods of calculation are given in ENA Technical Specification 48-3 "Instantaneous High-Impedance Differential Protection".

Loop resistance measurements shall be made on all CT circuits associated with circulating current-type protection. These values are required to establish the operating characteristics of the protective scheme and shall be checked against the manufacturer's calculated figures.

4.5.3 CT Primary Injection Tests

The CT circuits of all new equipment shall be tested by the injection of alternating current into the primary of the CTs, giving due regard to existing schemes such as busbar protection (BBZ) not being adversely affected, to prove the following:

(a) The ratio and polarity of the CTs at all ratios and the connections to the relays and other protective equipment are correct.

(b) CT polarities relative to other circuit and neutral CTs in, for example, BBZ and restricted earth fault (REF) schemes, are correct.

(c) Ammeters are correctly scaled.

(d) Numerical relay CT connections, CT ratio selection and instrument display values are correct.

(e) Where practicable, fault setting tests shall establish the values of current necessary to produce operation of the relays. If not practicable these tests shall be carried out by secondary injection.

(f) Prove stability for load and through-fault conditions for unit protection schemes.

Where practicable, primary injection tests shall prove the ratio of CTs over their full rating for feeder circuit breakers and a minimum of 25%, or other agreed percentage, of the CT rating for transformer incomer circuit breakers. This shall ensure that as much of the CT ratio is proven as practicable and that any spill current can be measured and shown to be within acceptable limits.

Where appropriate, transformer turret CTs shall be tested prior to installation.

Where it is impracticable to carry out primary injection testing out of a unit protection scheme on a feeder or transformer, sufficient primary injection testing shall be carried out to ensure that each end of the scheme fulfils the above requirements. Correct pilot cable connections and CT polarity between the respective ends shall then be established by on-load tests. The overall fault setting of the protection shall then be determined by secondary injection.

The details and results of all primary injection tests shall be recorded in a format approved by Electricity North West Limited.

4.6 Voltage Transformers

An insulation resistance test using a 1000V Megger shall be carried out on the secondary winding only of all voltage transformers.

Where practicable, the following tests shall be carried out on all voltage transformers:

(a) Ratio, polarity and phasing of the VTs at all ratios and checking that the connections to the relays and other protective equipment are correct.

(b) LV winding resistance.

(c) HV winding resistance.

(d) Voltmeters - check correctly scaled.

4.7 Secondary Wiring Insulation Resistance Test

A 1000V insulation resistance test using shall be carried out on each circuit in turn, relay or auxiliary contacts being closed as necessary, to ensure that all wiring is included in the test.

When measuring the insulation resistance to earth of an individual circuit, all the other circuits shall be in their normal state, e.g. earth links closed and dc circuit normal. This will ensure that the insulation of this circuit is satisfactory, both to earth and to all other circuits. Where applicable, unearthed dc circuits shall be temporarily earthed. Where a circuit, such as CT or VT wiring, is normally earthed, insulation resistance tests shall be carried out with the earth removed, to ensure that the circuit is earthed at one point only.

Tests shall be carried out as follows:

(a) Insulation resistance of current transformer circuits

(b) Insulation resistance of voltage transformer circuits

(c) Insulation resistance of dc circuits

(d) Insulation resistance between CT and VT circuits

(e) Insulation resistance between dc and VT circuits

(f) Insulation resistance between dc and CT circuits

Where equipment incorporates light current or semiconductor components, e.g. numerical relays, the appropriate terminals may be short-circuited, or other special procedures may be necessary to avoid damage during insulation resistance tests. The manufacturer's recommendations shall be closely followed.

Secondary wiring shall be checked to ensure compliance with the appropriate circuit and wiring diagrams and Electricity North West Limited's standards, i.e. correctly ferruled, terminated and of the appropriate insulation thickness, conductor type and cross-sectional area. Where it is found necessary during pre-commissioning work to carry out site modifications to secondary wiring, site copies of the appropriate schematic and wiring diagrams shall be suitably amended before the circuit is commissioned. One set of red and green marked-up drawings shall be retained on site and an additional copy shall be issued to the design section for the production of "as built" drawings.

4.8 Phasing Out Tests

All construction work shall be phased out, as required in accordance with the Electricity North West Limited Distribution Safety Rules and CP606. Any manufacturers' phasing out devices, such as Pfisterer or neon indicators, shall be proved before use.

5 Protective Relays

5.1 Inspection

Prior to commissioning each relay, a careful visual inspection shall be carried out by personnel trained in the commissioning and maintenance of protection equipment, to ensure, as far as practicable, the electrical and mechanical reliability of the relays.

All electromechanical relays shall be examined, care being taken before opening relay cases to ensure that no foreign matter can fall inside. Note is to be taken, where applicable, of the following points:

(a) Relay movement is free

(b) Magnet gap and induction disc are clean

(c) Gear teeth are clean

(d) Contacts are clean and have adequate wipe

(e) All contacts make simultaneously

(f) Contacts make when time multiplier setting is zero

(g) Resetting times are within limits

(h) Flag mechanism operates in correct sequence with respect to contacts

(i) Flag and relay reset knobs operate with relay cover on

(j) Relay cover glass and gasket provide effective seal

(k) Labelling and phase colours are correct

(l) CT shorting and dc isolating contacts or switches in withdrawable relay cases operate satisfactorily

NOTE: It is not recommended that moving coil type relays be interfered with manually unless a defect is revealed by secondary injection.

5.2 Secondary Injection Testing

5.2.1 Application of Relay Settings

The design section will normally provide relay protection settings. The settings will be in the form of a settings sheet. Where possible, the design section will provide relay configuration files.

Numerical relay settings shall normally be downloaded from a personal computer (PC) using the manufacturer's proprietary software. An electronic and a hard copy of the setting file at the time of the testing and commissioning shall be retained for record purposes. Functionality not being used shall be disabled.

A paper record of the relay protection settings sheets and both a paper copy and an electronic copy of the relay settings file shall be retained on site. The electronic copy shall be in the form of a CD-ROM stored within the panel.

Settings shall be applied in accordance with section S48 of CP606 and S3 and S11 of CP608. Settings shall be stored in accordance with EPD350.

5.2.2 AC Operated Relays

All ac current operated relays shall be tested by the injection of alternating current into the CT secondary circuits. All IDMT relays and others with 'dependent' time delay characteristics shall always be tested by secondary injection, the tests being sufficiently comprehensive to prove correct operation and timing in accordance with IEC 60255 (Electrical Relays). In the case of unit protection schemes the overall fault setting of the protection, if it cannot be obtained by primary injection, shall be obtained during the secondary injection tests.

Where applicable, the operate and reset values for attracted armature relays shall generally be taken at the design setting only.

For circulating current protection employing high impedance voltage operated relays the points of injection for relay voltage setting tests shall be across the relay and stabilising resistance. The fault setting for this type of protection shall be established by secondary injection where it is impracticable to ascertain its value by primary injection. Injection shall be made across the appropriate relay buswires with all associated relays, setting resistors, and CTs connected.

All ac voltage operated relays shall be tested to determine their pick up and drop off voltage settings.

Where automatic test sets are used for generic or specific tests of individual protection relays a hard copy of the tests results shall be kept.

5.2.3 Distance Protection

Reference to the manufacturer's commissioning documentation shall be made when commissioning this type of protection.

The manufacturer's software support package shall be used to apply the relay protection setting and other features.

Where possible an automatic test set shall be used to test distance relays. When used, a complete printout of all tests results shall be retained for record purposes.

The following generic testing shall be carried out.

(a) Apply relay settings.

(b) Check the phase and earth fault reaches of all zones and the characteristic angle.

(c) Check resistance reach if earth fault quadrilateral is in use.

(d) Check distance to fault locator if used.

(e) Carry out all timing tests.

5.2.4 Transformer Differential Protection

Reference to the manufacturer's commissioning documentation shall be made when commissioning this type of protection.

The manufacturer's software support package shall be used to apply the relay protection setting and other features.

The following basic test procedure for Transformer Differential Protection shall be followed:

(a) Measure all lead burdens.

(b) Secondary inject the relay to check the load bias characteristic.

(c) Check the harmonic bias.

(d) Sufficient current shall be injected simultaneously through the HV and LV CTs to check that the ratio, polarities, vector and zero sequence compensation are correct.

(e) After applying the settings, the magnetisation inrush stability shall be checked by energising the transformer. The transformer shall be energised from the HV source at least 3 times.

5.3 Directional Relays

5.3.1 General

Battery voltages on Electricity North West Limited's sites are generally a nominal 48V for telecontrol applications and 110V for protection and control applications. The normal working voltage will be in the order of 54V and 125V respectively.

Newly installed batteries and battery charger equipment shall be visually and physically inspected to ensure freedom from damage and integrity of connections. The continuous load drain on the battery shall be

measured and trickle charging adjusted to cater for this continuous load, a label shall be fitted to the battery cabinet giving the value in mA of the continuous drain and the recommended charge rate.

Battery alarm modules shall be proved to ensure correct operation of high or low voltage alarms, high impedance alarm and battery earth fault alarm.

5.3.2 DC Function Tests

Tests shall be carried out to ensure that:

(a) The polarity of dc incoming supplies to panels, cubicles, etc., is correct.

(b) All dc operated relays, which either perform a tripping function, or control a tripping or measuring function in a protective system shall be tested and proven to operate satisfactorily at the normal battery voltage and at the rated minimum operating voltage, in accordance with ENA Technical Specification 48-4 (DC Relays associated with a Tripping Function in Protection Schemes) or IEC 60255 as applicable. The reduced voltage test shall be carried out as on overall test.

(c) All protective and tripping relays, and, where applicable, all control, alarm and indicating relays correctly operate the appropriate indicators and auxiliary relays.

(d) Positive and negative checks shall be carried out to prove the correct functioning of all dc auxiliary relays, fuses, links, isolating switches, alarms, indication lamps and flag indicators.

(e) All functional links, fuses, auxiliary switches, changeover switches etc. are correctly labelled.

(f) All alarms and annunciations operate correctly at standing voltage, at local and remote control points, as applicable.

(g) All switchgear operates correctly from all control positions and the appropriate control selectors function, that automatic switching and synchronising schemes function correctly and that circuit-breakers trip from all associated trip relays irrespective of selector switch positions.

(h) Where practicable, in the case of busbar protection or other schemes involving a number of circuits, a simultaneous tripping test of all available circuit breakers shall be carried out, to ensure that the tripping battery and wiring is capable of supplying the necessary current.

(i) Check that all points of control including local, remote, telecontrol and all applicable protective devices correctly open the switchgear.

(j) Check that all points of control including local, remote, telecontrol and all applicable protective devices correctly close the switchgear.

(k) The operation of all electrical interlocks on the switchgear shall be checked to ensure that they operate in a positive manner. Checks shall be carried out to ensure that the interlocks cannot be defeated on loss of supply.

5.4 Pilot Cables

Pilot loop impedance and 500V insulation resistance tests shall be carried out on pilot cables used for unit type protection and intertripping (non voice frequency). The measured values shall be recorded.

5.5 Trip Testing

To prove the integrity of all protection schemes trip testing shall be carried out. Prior to energising a circuit, each tripping relay shall be operated to trip the circuit breaker. A full intertrip test shall also be carried out to prove the circuit from the initiating contact to the remote-end receive relay.

Where practicable, trip tests shall be carried out live with the agreement of DSMC. However, if system conditions will not permit this, a test that simulates live conditions shall be carried out. If, when carrying out these tests, it is necessary to disconnect or short circuit switchgear auxiliary switches to simulate operation in either open or closed positions, the switches must be reconnected, or the short circuit removed after the tests. A note shall be made when any disconnections or short circuits are made and reinstated to normal.

5.6 Delayed Auto Reclose (DAR) Testing

To prove the integrity of all protection schemes DAR testing shall be carried out. Where practicable, DAR tests shall be carried out live with the agreement of DSMC. However, if system conditions will not permit this, a test that simulates live conditions shall be carried out. If, when carrying out these tests, it is necessary to disconnect or short circuit switchgear auxiliary switches to simulate operation in either open or closed positions, the switches must be reconnected, or the short circuit removed after the tests. A note shall be made when any disconnections or short-circuits are made and reinstated to normal.

5.7 On-Load Tests

Tests using load current shall be carried out after the main equipment has been commissioned. In view of the hazards inherent in these tests adequate precautions shall be taken.

Where applicable, the following tests shall be carried out:

(a) Operation and stability tests shall be carried out for the on load commissioning of unit type protection.

(b) Tests for restraint shall be carried out to prove the characteristic of protective schemes with directional qualities.

(c) Checks shall be made after the protective gear has been placed in service to ensure that all connections and test links have been replaced and test leads removed and to confirm the integrity of CT circuits.

Special attention shall be paid to open-delta voltage and residual current circuits where zero voltage or current respectively, may not be proof of the completeness of the circuit.

Current readings shall be taken at relay plug bridges or test blocks where these are provided, care being taken to ensure that all circuits are restored to normal, particularly in the case of circuits to earth fault relays.

If it is not possible to detect ‘spill’ current it may be necessary to temporarily create an unbalance to carry out this test ensuring that the circuit is subsequently restored to normal.

If any temporary connections disconnections or shorts are made to facilitate the above testing a note should be made of these and also of their reinstatement to normal.

5.8 Unit Protection of Transformers and Feeders

On-load tests shall always be carried out on unit protection of feeders and transformers. The provision of temporary protection may be necessary to protect the feeder or transformer during the tests if adequate backup protection is not available.

When the correct phasing has been determined, readings shall be taken in all relay coils and pilot wires to ensure that they carry their anticipated currents, having regard to the load conditions at the time. In the case of relay coils and pilot cables which do not normally carry current, temporary alterations, such as the disconnection or reversal of CTs shall be made, via use of the test block, to unbalance the circuits and so prove that these components will in fact carry current and that phasing at each end is compatible. Care shall be taken to ensure that any temporary alterations are restored to normal upon the completion of the tests.

5.9 Protection Schemes Utilising Voltage Transformers

In the case of directional earth fault protection, where voltage for operation of the relay is obtained from the residual winding of a three-phase five-limbed VT or three single VTs, the necessary voltage required for operation during on load tests shall normally be obtained by removing either a VT HV fuse (or link) or a VT HV connection as appropriate.

Where the relay voltage is obtained from a single phase VT connected between a power transformer neutral and earth, it will not be possible to test the neutral displacement protection by an on load test. In order to prove the protection it will be necessary to apply an HV injection test on the VT including the open delta connection.

6 Transformers

In the majority of new installations the manufacturer shall install the transformers and carry out the appropriate manufacturer's installation tests. Reference shall be made to CP312 (Transformer Testing) and ES323 and ES324. The following tests shall be carried out:

6.1 Sweep Frequency Response Analysis

Sweep frequency response analysis tests shall be carried out in accordance with ES323 for 33kV to lower voltage transformers and ES324 for 132kV to lower voltage transformers.

6.2 Physical Inspection

The transformer shall be physically inspected to ensure that there is no damage to the main tank, fins, cable boxes and ancillary equipment. Paintwork shall be checked to ensure that there are no cracks, chips or rust spots. Cable box covers shall be removed and the integrity of gaskets checked. Cable box bushings shall be inspected to ensure that they are not flawed or damaged.

6.3 Insulation Resistance

An insulation resistance test shall be carried out between HV winding and earth, LV winding and earth and between windings. These tests shall be carried out before and after the application of a high voltage pressure test.

6.4 Overvoltage

A high voltage pressure test using an ac source shall be applied between windings and between winding and earth. The test voltage shall be in accordance with CP319 and the manufacturer's recommendations.

6.5 Ratio and Vector Group

The ratio shall be confirmed at all tap positions. The vector group shall be confirmed at the nominal tap position. The transformer manufacturer shall provide the test schedules and method statements for these tests.

6.6 Function

Functional checks shall be carried out on all ancillary equipment once multicore cables have been connected to ensure current functioning of alarms and trips.

6.6.1 Buchholz Protection

Operation of Buchholz surge protection and associated tripping relays shall be tested by the application of compressed air from an approved portable testing vessel to the appropriate test cock, the minimum pressure for operation being recorded. The gas alarm feature shall be tested in a similar manner. Where practicable the alarm shall be checked through to the substation alarm panel. The minimum volume of air necessary to operate the alarm, as indicated on the calibrated scale on the protector, shall be recorded together with the volume required for the alarm to reset.

The stability of transformer Buchholz protection under oil surge conditions shall be proved before commissioning by starting up the oil pumps at least three times. If the oil temperature at the time of this test is less than 15°C, the test shall be repeated after commissioning when the transformer oil temperature is above 15°C.

6.6.2 Winding Temperature Indicators (WTI)

The temperature indicators shall be checked, using a calorimeter, against a mercury in glass thermometer, at intervals of about 10°C at suitable points on the instrument range. The temperature error of the instrument under test at any point on the scale shall not exceed 2°C.

A further test shall also be carried out on the winding temperature indicator to ensure that the winding temperature increment obtained, when the appropriate current given by the transformer manufacturer is injected into the indicator heater circuit, agrees with the figure supplied by the manufacturer.

The winding and oil temperature indicators shall be set to initiate alarm, trip and cooler operation at the temperatures appropriate to the make and rating of the transformer and shall be operated to ensure that they perform their respective functions.

WTI settings shall be in accordance with CP382 (Transformer Ratings).

An on load test of the winding temperature CT shall be carried out following commissioning.

Microprocessor based WTI require a similar testing procedure. Any remote indication transducer output shall be checked.

6.6.3 Motor Protection Relays

Where three phase motors are provided for the tap changer, pumps and fans, the phase unbalance characteristic of the motor protection relays shall be tested by withdrawing, in turn, each fuse of the three phase supply and verifying that the motor protection relays operate and trip out the motor contactors within the prescribed time.

6.6.4 Fans and Pumps

The fans and pumps, where fitted, shall be run for 24 hours.

6.6.5 Pressure Relief Device

The pressure relief device should be confirmed to be in the correct (reset) position with the correct output contact used.

6.7 Tap Change and Automatic Voltage Control (AVC) Panels

Tap change panels shall be subjected to the following checks and tests:

6.7.1 Physical Inspection

All wiring, positioning of equipment, fuse ratings, insulation resistance and labels shall be checked to ensure compliance with the schematic and wiring diagrams and general arrangement drawings. All electrical connections shall be proved for mechanical integrity. Relays shall be visually inspected to ensure freedom from mechanical damage.

6.7.2 Function Tests

The automatic voltage regulating relay shall be tested by secondary current and voltage injection for sensitivity and timing and set in accordance with Electricity North West Limited policy.

Correct operation of the voltage reduction facility, line-drop compensation, relative polarity of applied current and volts and abnormal voltage alarms shall be checked. Any other alarms and indications, which may include tap change incomplete, tap change out of step, VT failure and tap position shall be checked.

When fitted, the line-drop compensation CT shall be subjected to an on-load test. All control facilities such as manual raise/lower and auto/parallel shall be tested and the scheme, as a whole, proved to function correctly in accordance with the relevant schematic diagram.

7 HV Power Cables

High voltage cables shall be subjected to the following tests:

7.1 Physical Inspection

A physical inspection of the cable and terminations shall be carried out wherever possible to ensure freedom from damage and security of connections.

7.2 Insulation Resistance

An insulation resistance test shall be carried out both before and after application of an overvoltage test.

7.3 Overvoltage

Overvoltage tests shall be in accordance with CP319.

8 Earthing Installations

The following tests and inspections shall be carried out on a substation earthing system:

8.1 Physical Inspection

A visual inspection shall be made to ensure that all items of equipment are suitably bonded to the earthing system as indicated on the earthing drawings.

8.2 Measurements

For all new sites and existing sites where substantial modifications have been carried out to the earthing system, the substation earth shall be disconnected from any remote earthing coming into the substation. The earthing system shall be tested using the slope method for complex earthing systems or fall of potential method for simple earthing systems. The integrity of joints in the earthing system shall be tested using a micro-ohm meter. The earth test readings shall be recorded and checked against the design data.

9 Tests After Alterations to Existing Equipment

When an existing installation has been modified, sufficient tests shall be carried out to ensure that the equipment will perform as intended. The scope of testing shall be agreed with the Engineer.

Unless alterations have been made to the CT connections, secondary injection tests from appropriate points shall suffice.

Where CT connections have been modified and it is not possible to carry out primary injection tests, CT excitation curves and sufficient secondary injection and on load tests shall be carried out to ensure the integrity of the installation.

Where protection settings are permanently modified a secondary injection, test shall be carried out where practicable to prove that the correct setting has been applied. It is highly desirable that a secondary injection test should be carried out and it should only be omitted due to over-riding operational constraints.

Where a protection relay is changed a secondary injection test shall be carried out to prove that the correct setting has been applied and, where practicable, a primary injection test shall be carried out in accordance with section 4 of this document.

10 Documentation

The results of all tests, whether carried out by Electricity North West Limited or a Contractor, shall be recorded.

For major new projects the detailed test results shall be held in an appropriately indexed commissioning record Folder on site. The entries shall indicate the panel name, the work carried out, the date, and the engineer responsible. This applies to all major projects, including new connections, replacement and refurbishment work.

Where appropriate, a copy of all wiring and schematic diagrams shall be left on site and arrangements made to obtain revised diagrams as soon as possible.

Requirements for the provision and retention of metering CT&VT certificates are contained in ES501. Requirements for the completion, circulation and retention of commissioning records for metering CTs & VTs are contained in ES510.

Protection settings shall be recorded on relay setting sheets and a copy retained on site.

11 Witnessing

Where equipment is installed and tested by a Contractor it shall be necessary to witness sufficient tests to ensure that the equipment is tested in accordance with Electricity North West Limited's standards.

11.1 Commissioning Engineer's Obligations

Tests that require witnessing shall be agreed with the CE prior to commencement of work on site. The number of tests requiring witnessing shall vary dependent upon the size of project.

The CE shall ensure that the Contractor demonstrates sufficient competency and knowledge and experience of installing and testing power system equipment.

Typically, the CE shall witness all tests including, but not exclusively limited to, panel checks, primary and secondary injection tests, CT magnetisation tests and overall function checks carried out on each generic equipment type. However, the number and types of tests requiring witnessing shall be at the discretion of the CE.

The CE shall co-ordinate overall tests involving more than one Contractor's equipment.

The CE shall witness all overall function tests prior to commissioning to ensure that the equipment has been installed to Electricity North West Limited's requirements.

11.2 Contractor's Obligations

Where Electricity North West Limited cannot provide standard test schedules, the Contractor shall submit test schedules to Electricity North West Limited for approval. All test sheets shall be signed by the Contractor and checked and countersigned by the CE.

The Contractor shall demonstrate that equipment has been installed, has been erected and operates satisfactorily within the appropriate limiting conditions defined in the contract specification.

The Contractor shall demonstrate that equipment cannot operate incorrectly during the removal or operation of secondary circuit isolating devices. Similarly, the Contractor shall demonstrate that equipment cannot operate incorrectly when secondary circuit isolating devices have been removed. This is to prevent spurious operation.

The Contractor shall obtain the agreement of the CE for any tests which he may wish to carry out in addition to those on the test schedules, but the Contractor is not obliged to provide the results of any tests which he may wish to carry out in addition to those on the test schedule as part of the contract.

The Contractor shall be present when any item of equipment is made live for the first time, unless otherwise agreed between the Contractor and the CE.

11.3 General Requirements

The Contractor shall employ sufficiently experienced test personnel and supply all necessary test equipment unless otherwise agreed by the CE. Up to date calibration certificates for all test equipment used by the Contractor shall be provided to the CE. Detailed method statements and risk assessments of the testing shall be provided by the Contractor and agreed with the CE. Details shall be provided on the site commissioning test schedules of the instrument characteristics where these have significance in the test results.

11.3.1 High Voltage Tests

(a) Switchgear

High voltage tests shall be undertaken by the Contractor on site to test the insulation of apparatus, which cannot be completely tested in the works. All tests shall be carried out in accordance with CP319.

(b) Transformers

High voltage tests shall normally be carried out at the Contractor's works. Additional site tests shall be carried out with the agreement of the CE. Reference should be made to CP312 and CP319.

(c) Cables

High voltage tests shall be undertaken on site to test the insulation of cables. All tests shall be carried out in accordance with CP319.

11.3.2 Site Supplies

The Contractor shall provide reasonable notice of the supplies, which are required for the test equipment. The CE shall ensure that supplies within his control are available at the time(s) agreed.

11.3.3 Record of Tests

The Contractor shall provide the CE with a legible set of the test results as completed on site immediately the tests are completed. The test results shall be recorded on the test schedules agreed with the CE. The completed test schedules shall be retained on site.

12 Technical Query Process

In the event of a problem being found with plant, secondary wiring, drawings etc. that require modifications to drawings, investigations by manufacturers etc. a technical query shall be raised for resolution. The technical query pro-forma and process flow chart is attached in Appendix A.

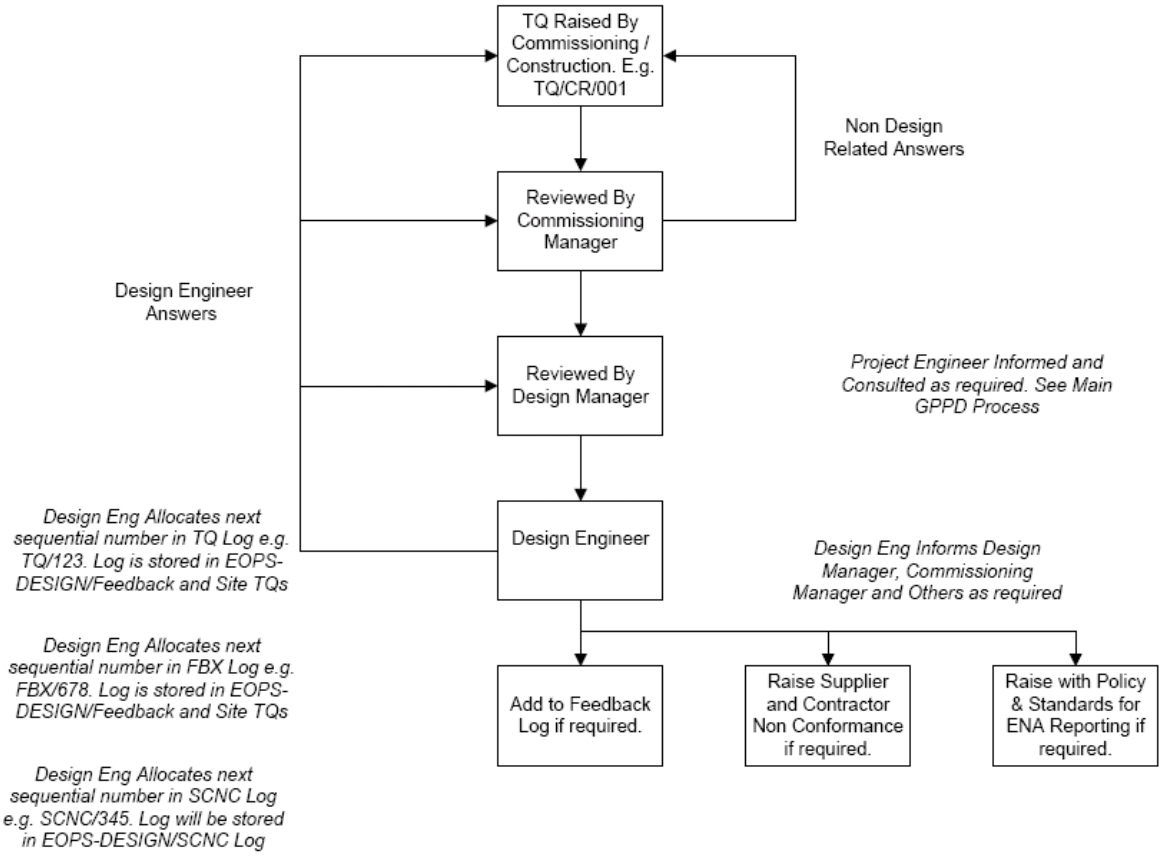
13 Documents Referenced

DOCUMENTS REFERENCED	
Electricity Safety Quality and Continuity Regulations 2002, as amended	
Electricity at Work Regulations 1989	
IEC 60255	Electrical Relays
ENA Technical Specification 48-3	Instantaneous High-Impedance Differential Protection
ENA Technical Specification 48-4	DC Relays associated with a Tripping Function in Protection Schemes
CP312	Transformer Testing
CP319	Applied High Voltage Tests
CP382	Transformer Ratings
CP606	Operations Manual
CP608	System Control Manual
CP660	Demarcation of Work Zones in Substations
ES323	33/11or 6.6kV System Transformers
ES324	132kV/Lower Voltage Transformers and Earthing/Auxiliary Transformers
ES350	Neutral Earthing Resistors for BSP and Primary Substations
ES501	Metering Current &Voltage Transformers
ES510	Procedure for Commissioning Measurement Transformers Connected to Settlement Metering Equipment

14 Keywords

Cable; Commissioning; Grid; Primary; Protection; Switchgear; Transformer.

Appendix A – Technical Query (TQ) Process Flow Chart and TQ Performa



Electricity North West **Grid & Primary Programme Delivery**		**Technical Query**
To: (Design Engineer's Name)	From: (Your Name)	Query reference: TQ (Your Initials)/0001 Date: dd/mm/yyyy
Project:		Project Number:
Equipment:		
Subject:		
Query:		
Site Proposal:		
Project Programme Implication:		

Electricity North West **Grid & Primary Programme Delivery**		**Technical Query**
To: (Design Engineer's Name)	From: (Your Name)	Query reference: TQ (Your Initials)/0001 Date: dd/mm/yyyy
Financial Implications:		
Response:		
Response by:	**Response Date:**	