

PROTECTION AND CONTROL RELAY SETTINGS

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TABLE OF CONTENTS

PURPOSE AND SCOPE.....	2
PART 1 - PROCEDURAL	2
1 OBJECTIVES.....	2
2 RELAY SETTING SHEET PHILOSOPHY	3
3 RESPONSIBILITIES	4
4 PROCEDURE FOR DETERMINING AND CONFIRMING CORRECT CT RATIO	7
5 PROCEDURE FOR NUMERIC RELAYS	8
6 DOCUMENTATION	18
7 SETTINGS RECORD DATABASE (MARS)	19
8 MARS CPM LIVELINK SYSTEM	19
9 ELECTRONIC COMPARISON SOFTWARE.....	19
10 ADMINISTRATION	19
11 PROCEDURE FOR SETTING CHANGES TO EXISTING NUMERIC RELAYS.....	20
12 PROCEDURE FOR IMPLEMENTING SETTING CHANGES TO NON-NUMERIC RELAYS AND NON-INTEGRATED NUMERIC RELAYS.....	22
13 RECORDING OF SETTINGS FOR AUXILIARY EQUIPMENT	23
14 RECORDING OF SETTINGS FOR HVDC & COMPENSATION EQUIPMENT.....	24
15 MANAGEMENT OF SETTINGS FOLLOWING IN SERVICE RELAY FAILURE.....	24
16 SETTINGS AUDIT	25
17 FORMS AND RECORDS.....	27
PART 2 - DEFINITIONS AND DOCUMENT HISTORY	27
18 DEFINITIONS	27
19 AMENDMENT RECORD	29
20 IMPLEMENTATION	30
PART 3 – GUIDANCE NOTES AND APPENDICES.....	31
21 REFERENCES.....	31
APPENDIX A - RELAY SETTINGS RESPONSIBILITIES OVERVIEW	33
APPENDIX B1 - RELAY SETTINGS PROCESS OVERVIEW.....	34
APPENDIX B2 - PROCESS FOR DETERMINING AND CONFIRMING CORRECT CT RATIO	35
APPENDIX B3 - PROCESS DIAGRAM WHEN NUMERIC RELAY SUBJECT TO FACTORY ACCEPTANCE TESTS.....	36
APPENDIX B5 - PROCESS DIAGRAM FOR PROGRESSING DISCREPANCIES / ERRORS FOUND ON SITE	38
APPENDIX B6 - DETAILED DOCUMENTATION AND ADMINISTRATION REQUIREMENTS	39
APPENDIX B7 - RELAY OPERATE CURRENT VERIFICATION OVERVIEW	39
APPENDIX B7 - RELAY OPERATE CURRENT VERIFICATION OVERVIEW	40
APPENDIX C - SETTINGS POLICY DOCUMENTATION AND DATA SOURCES	41
APPENDIX D1 - EXAMPLE SETTING SHEET	42
APPENDIX D2 - EXAMPLE OF DETAILS TO BE ENTERED INTO RELAY SETTINGS TEXT AREA OF SETTINGS SHEET	45
APPENDIX E - COMPLETING THE RELAY SETTINGS SHEET.....	47
APPENDIX F - RELAY SETTINGS MONITOR LOG	49
APPENDIX G - RELAY SETTING SHEET ADMINISTRATION.....	50
APPENDIX H - MULTI-FUNCTION RELAY TESTS FOR UNWANTED FUNCTIONALITY	51
APPENDIX I - PROCESS DIAGRAM FOR SETTING CHANGE TO AN EXISTING NUMERIC RELAY.....	52
APPENDIX J - PROCESS DIAGRAM FOR SETTING CHANGE TO NON-NUMERIC RELAYS AND NON-INTEGRATED NUMERIC RELAYS.....	52
APPENDIX J - PROCESS DIAGRAM FOR SETTING CHANGE TO NON-NUMERIC RELAYS AND NON-INTEGRATED NUMERIC RELAYS.....	53
APPENDIX K – CAPITAL DELIVERY - RELAY SETTINGS ROLES AND RESPONSIBILITIES.....	54
APPENDIX L - RELAY SETTINGS	55

APPENDIX L - RELAY SETTINGS	55
QUALITY - AUDIT SCHEDULE	55
APPENDIX M - CUSTOMER CORRESPONDENCE PRO FORMA.....	57

PURPOSE AND SCOPE

The health of the Transmission System is critically dependent upon correct relay settings. It is therefore essential that this process is adhered to both rigorously and diligently.

The purpose of this procedure is to define the management process for the preparation, application, verification, dissemination, recording and auditing of protection and control relay settings. This procedure defines both the Client side (i.e. National Grid) tasks, responsibilities and levels of surveillance, and the Contractor side tasks and responsibilities.

The procedure applies to all protection and control relays owned by National Grid, or for which National Grid has entered into an arrangement to carry out and hold the settings. The procedure is formatted on the basis that relay settings calculations will be carried out by UKBP/TP141 authorised Contractor engineers either as part of a capital scheme, or as part of ongoing support through a Post Delivery Support Agreement (PDSA).

It is recognised that for investments of medium and low complexity the full application of this Transmission Procedure (TP) may not provide the most cost efficient means of delivering that investment and hence TP governance options as per UKBP/TP500 Appendix A - Attachment A3 can be applied to this procedure.

TP governance options defined in UKBP/TP500 Appendix A - Attachment A3 include those that are already detailed in this Transmission Procedure and those that are additional and not detailed in this Transmission Procedure.

Amendments to this procedure shall be reflected in UKBP/TP500 Appendix A – Attachment A3 (if required) and may result in re-issue of UKBP/TP500 within the same period.

The scope of this procedure covers all protection and control equipment which require a setting, including associated equipment such as current transformers and facility selection functions. It covers the settings process associated with

- the capital programme
- maintenance & operations
- following equipment failure
- third party interfaces as required by the Grid Code
- setting changes requested by Market Operation

PART 1 - PROCEDURAL

1 OBJECTIVES

The objective of this procedure is to define procedural requirements that ensure that relay settings, and their associated relay inputs and outputs, are correct and free from error. This shall be accomplished by ensuring that each relay is subject to the following requirements.

- a) The relay type and application is correctly defined and specified.
- b) The relay settings are correctly calculated.
- c) The relay settings are correctly linked to the relay inputs and outputs.

- d) The calculated relay settings are correctly applied.
- e) The relay settings in use are verified by Factory Acceptance Tests and on-site secondary injection tests and calculations.
- f) The relay settings associated with unrequired functionality are verified as being disabled by both Factory Acceptance Tests and a settings loading verification test.
- g) Confirmation that the applied settings correctly allow the loadings defined on the circuit rating schedule by subjecting the relay to a settings loading verification test.
- h) Ensuring that the settings process is enacted by National Grid and Contractor engineers who are UKBP/TP141 authorised for this purpose.
- i) The provision of an audit trail by adherence to the documented quality management process, as defined in this procedure.

In addition there will be a defined ongoing audit programme to provide reassurance that relay settings across the transmission system are correctly documented, recorded and free from error.

2 RELAY SETTING SHEET PHILOSOPHY

2.1 Historical

Historically a relay settings sheet was prepared by a Settings Engineer for the following reasons.

- a) As an instruction to the Commissioning Engineer for setting the relay.
- b) As a source of information and record held both at site and the construction office to aid operational decisions.
- c) As an audit trail for purposes of good governance.

2.2 Multi-Functional Relays

- a) The advent of programmable multi-functional Numeric Relays circa 1999 witnessed a dramatic increase in the number of pages of settings required for a relay. Typically from a historic number of only one or two pages up to over one hundred for Numeric Relays. Managing such a large number of setting sheets resulted in time and resourcing difficulties.
- b) In 2004, in an endeavour to minimise the scale of the setting sheet problem, procedural requirements were modified such that the setting sheets would only record power system quantities, with the fixed settings (see Appendix E Section 6) being verified by the Commissioning Officer at time of Factory Acceptance Testing (FAT). The Commissioning Engineers, on site, were then only required to set / confirm the relay against the power system settings on the setting sheet. This was only partially successful since the setting sheets were still very large in number and the process was highly dependent upon a significant 'people' input both at site and at time of FAT (ie. laboriously confirming that the project specific settings file had been correctly modified from the T/R file).

2.3 Setting Sheet Format and Philosophy – September 2008 Onwards

- a) The incorporation of MARS into CPM Livelink coupled with the ability to carry out electronic comparison of files enables a much less resource intensive process to be developed with a corresponding reduction in the size of setting sheets. In doing so the objective of the setting sheet has moved from specifying all settings to be applied to

the relay to that of verifying settings which have already been applied and proved at time of FAT.

- b) The content and purpose of the setting sheet is now as follows.
- (i) A statement of the key power system operational quantities of the relay (eg. operate amps, volts, impedances, timers) – to be verified by secondary injection on site.
 - (ii) A statement of power system quantities considered to be useful for operational purposes (eg. primary operate current of an overcurrent relay).
 - (iii) Other information believed to be beneficial (eg. for testing purposes).
 - (iv) As source information, record and audit trail for purposes of good governance.
- NB: Integral to (i) above the relay setting sheet will also state the 'setting file reference' of the file loaded into the relay.
- c) Relay setting templates for particular relays will be defined at time of Type Registration. All setting sheets must accord with these templates.

3 RESPONSIBILITIES

3.1 Head of Assurance & Business Planning

The Head of Assurance & Business Planning has overall accountability for ensuring that relay settings and their associated input / output configuration are correct and free from error. To oversee and deliver this task the Head of Assurance & Business Planning will appoint a Settings Manager (Assurance).

3.2 Settings Manager (Assurance)

The Settings Manager (Assurance) is the manager nominated by the Head of Assurance & Business Planning with overall responsibility for both the content and satisfactory enactment of this procedure. Specific responsibilities comprise the following.

- a) The technical standard, governance requirements and ongoing development of this procedure.
- b) The determination of all settings which fall within the scope of this procedure. This includes accountability for settings work undertaken by a Contractor. Integral to this responsibility is that consideration is given to the impact of changes to the power system on existing settings – thus a power system wide approach to relay settings is undertaken.
- c) Stewardship and the ongoing development of the Multi-Access Relay Settings (MARS) database.
- d) Ensuring that the relay settings requirements across the interface with a customer accord with the Grid Code.
- e) The management and ongoing development of a Settings Engineer (Assurance) and Settings Engineer (Verification) authorisation process and database in accordance with UKBP/TP141. See Appendix K for listing of duty holders.
- f) Monitoring the health of the settings process by carrying out an annual audit for incorporation into a Health of Engineering Report for submission to the EPAG. Responsibility will extend to the progression of report recommendations.

- g) Authority to sanction deviations from this procedure if required by business critical situations. Such deviations must be supported by a full audit trail.

3.3 Engineering Assurance Manager (Substations)

On behalf of the Settings Manager (Assurance) the Engineering Assurance Manager (Substations) will discharge the following day to day responsibilities.

- a) Management responsibility for all tasks undertaken by Settings Engineers (Assurance) as defined in this procedure.
- b) Management of the MARS database.
- c) Training and development of all Settings Engineers (Assurance).
- d) Management of the relay settings authorisation process.
- e) Implementation of the annual settings audit, preparation of the report and progression of the recommendations.
- f) Deputy Settings Manager (Assurance) with full responsibility for discharging all duties when the Settings Manager (Assurance) is unavailable.

3.4 Settings Engineer (Assurance)

- a) A UKBP/TP141 authorised, experienced and technically proficient engineer who has been nominated by the Settings Manager (Assurance) to carry out the requirements of this procedure. Those authorised are listed in Appendix K.

Engineers within other organisations may also discharge the role of Settings Engineer (Assurance) when authorised for this purpose. Whilst undertaking this role they are not permitted to undertake the role of Settings Engineer (Verification) on the same project.

- b) Once authorised a Settings Engineer (Assurance) may undertake any relay setting, i.e. personally calculate/determine the setting or carry out a surveillance check of a Supplier's setting. Where a Settings Engineer (Assurance) is unsure about the correctness of a setting (eg. due to reasons of experience or setting complexity) it shall be agreed, and the calculation countersigned, by a second Settings Engineer (Assurance).
- c) A Settings Engineer (Assurance) will always retain accountability (i.e. ultimate responsibility) for all settings provided by a Contractor including their accuracy, completeness and timeliness. This does not in any way remove a Contractor's responsibility for the correctness of the settings provided. For capital projects the Settings Engineer (Assurance) will be the Settings Engineer defined in the DID, and for other settings requirements it will be, in the first instance, the Settings Technical Engineer or other Settings Engineer (Assurance) if the former is unavailable.
- d) In discharging this accountability professional judgement will be exercised to determine whether a full or rudimentary surveillance check is carried out on a Contractor's settings. This will be determined by both the uniqueness and complexity of a setting and Supplier performance history.
- e) The Settings Engineer (Assurance) must highlight all settings changes on the settings sheet prior to dispatch to site – see Appendix D2.

3.5 Settings Technical Engineer (Assurance)

A UKBP/TP141 authorised Settings Engineer (Assurance) nominated by the Engineering Assurance Manager (Substations) with responsibility for technical advice on, and the support

arrangements, technical well being and development of, the MARS database system. The Settings Technical Engineer will undertake the settings audit – see Appendix K. The Settings Technical Engineer shall also give final approval to the setting sheet templates at time of Type Registration and their alignment with the SCT procedure.

3.6 Settings Manager (Verification)

A manager of suitable technical ability nominated by a Contractor to provide a quality management and co-ordination role in ensuring that all calculations and settings undertaken for National Grid are correct and presented to an acceptable standard. The Settings Manager (Verification) must be able to demonstrate a sound understanding of the Contractor responsibilities in this procedure by successful completion of the UKBP/TP141 settings process authorisation paper.

3.7 Settings Engineer (Verification)

A UKBP/TP141 authorised, experienced and technically proficient engineer who has been nominated by the Settings Manager (Verification) to carry out the requirements of this procedure for defined projects.

3.8 ETAM Head of Network Engineering

The Head of Network Engineering is responsible for:

- a) Providing protection and control settings policy. NB: Individual equipment setting policy/guidance requirements are to be provided by a Contractor as part of the Type Registration process.
- b) Defining generic power system performance requirements which must be taken into account when preparing settings policy.
- c) Providing the Substation Engineering Manager or representative with circuit specific relay settings requirement for static voltage compensator (SVCs).

3.9 Transmission Network Service

The Network Strategy Manager is responsible for:

- a) Maintaining and providing the impedances database, containing parameters for transmission circuits and the annual statement of system maximum and minimum fault level studies.

3.10 ETAM Heads of Operations - North & South

The Heads of Operations - North & South are responsible for providing authorised Commissioning Engineers, either Basic or Advanced, to undertake the following.

- a) Confirming the settings on the relay match those on the setting sheet by carrying out/accepting a Stage 1 commissioning secondary injection of the relay.
- b) Confirming that the settings on the relay do not restrict circuit loading by carrying out a settings loading verification test – see UKBP/TP106 and CH20.
- c) Signing the setting sheet and returning to the Settings Manager (Assurance).
- d) The appointment of Substation Delivery Engineers who have an ongoing responsibility for ensuring that substation setting sheet files under their stewardship are maintained to a high standard fully populated with current setting sheets.

- e) Requesting the consent of the Electricity Operations Control Engineer prior to modifying existing settings, and confirming the subsequent implementation to Electricity Operations Control Engineer.

3.11 Market Operation

- a) The Control Support & Review Manager is responsible for:
 - (i) Notifying the Substation Engineering Manager of changes in the way the Transmission System is operated, which require changes to relay settings.
 - (ii) Notifying the Substation Engineering Manager of control settings required for AVC, ARS, Synchronising Systems etc and for direct/indirect tripping requirements.
 - (iii) Providing the interface for settings requests from outside National Grid.

3.12 MARS Administrators

The person(s) with responsibility for administrating the day to day settings process within National Grid Capital Delivery (see Appendix G and Appendix K).

3.13 P & C Design Engineer (Assurance)

Responsibilities defined in UKBP/TP188.

3.14 Contractor Design Approval Engineer (P & C)

Responsibilities defined in UKBP/TP188.

4 PROCEDURE FOR DETERMINING AND CONFIRMING CORRECT CT RATIO

The procedure for determining the CT ratio is more exacting and separate to that for other settings – and is therefore defined separately in this section of the document.

Appendix B1 shows the relay settings high level process overview. Included within the term 'relay settings' is the CT ratio. Appendix B2 defines the detailed process diagram for determining and confirming the correct CT ratio. The instance of CT ratios for both new CTs and retained CTs are considered.

4.1 Supplier Factory QA Process – for CTs

- a) The Settings Engineer (Verification) should determine from the DID whether an existing CT is being retained. Where this is the case the existing setting sheet shall be obtained to determine the existing CT ratio [see Step 1 of Appendix B2].
- b) The Settings Engineer (Verification) shall determine the CT ratio required for both new and retained CTs as part of the settings calculations. With reference to a retained CT, the need for either a change of CT ratio or the retention of the existing CT ratio must be clearly stated in the calculations document. A typical example of this requirement is

The existing CT feeding the First Main Protection is required to undergo a ratio change from 1000/1 to 2000/1

or

The existing CT feeding the First Main Protection is required to retain the existing ratio of 1000/1

[See Step 2 of Appendix B2]

4.2 Design Assurance QA Process – for CTs

- a) The Settings Engineer (Assurance), on receipt of the calculation from the Settings Engineer (Verification), will check the accuracy of the CT ratio and shall confirm agreement (together with agreement on the other settings) [see Step 3 of Appendix B2].
- b) On receipt of the setting sheet in the Pending area of MARS the Settings Engineer (Assurance) shall print a copy of the setting sheet and shall confirm with the calculations that the correct CT ratio is stated and that any ratio change is noted.
- c) The Contractor Design Approval Engineer (P & C) shall ensure that the circuit diagram is drawn to show the CT ratio in use [see Step 6 of Appendix B2].
- d) The Contractor Design Approval Engineer (P & C) will ensure that the commissioning programme stipulates commissioning tests to prove both new CTs and CTs retained in service requiring a change of CT ratio [see Step 7 of Appendix B2].

4.3 On-Site QA Requirements – for CTs

- a) Following examination of the setting sheet the Commissioning Engineer (Supplier) shall check that appropriate CT tests are included in the commissioning programme [see Step 8 of Appendix B2].
- b) Following examination of the setting sheet the Commissioning Officer shall check that appropriate CT tests are in the commissioning programme [see Step 4 of Appendix B2].
- c) The Commissioning Engineer (Supplier) shall visually confirm that the CT ratio on site accords with the setting sheet [see Step 9 of Appendix B2].
- d) The Commissioning Engineer (National Grid) shall visually confirm that the CT ratio on site accords with the setting sheet and, following Stage 1 commissioning tests, shall indicate this by ticking the setting sheet [see Step 5 of Appendix B2].
- e) The Commissioning Engineer (Supplier) shall verify the CT ratio by Stage 1 commissioning tests in accordance with the commissioning programme and circuit diagram [see Step 10 of Appendix B2].
- f) Both the Commissioning Engineer (Supplier) and Commissioning Engineer (National Grid) shall confirm the CT ratio as part of the SCT procedure on Stage 2 commissioning load tests [see Step 11 of Appendix B2].
- g) Both the Commissioning Engineer (Supplier) and Commissioning Engineer (National Grid) shall confirm the same CT ratio at both circuit ends of a unit protection whilst undertaking protection Stage 2 commissioning on-load stability tests [see Step 12 of Appendix B2].

5 PROCEDURE FOR NUMERIC RELAYS

This procedure is formatted on the basis that the Settings Engineer (Verification) will both calculate the settings and prepare the settings sheet. However, this does not preclude this task being undertaken by the Settings Engineer (Assurance) should the need arise. The procedure should be read in conjunction with the process diagrams in Appendices A, B1, B2, B3, B4, B5 and B6. The abbreviation T/R is short for Type Registration.

NB: Commissioning Handbook CH21 defines the formal documentation arrangements which confirm that the setting applied to the relay on site is correctly derived from the T/R solution.

5.1 Settings Policies and Data

- a) Protection and control setting calculations must only be carried out in accordance with relay setting policies and system data defined in Appendix C.
- b) All project specific relay data shall be defined in the Design Intent Document (DID) – see TP188.
- c) The Settings Engineer (Verification) shall acquire equipment/wiring test data from site where this is required to determine settings (e.g. high impedance circulating current wiring burdens). Data associated with existing installations shall be requested from the Settings Engineer (Assurance).

5.2 Process Overview

Appendix B1 provides a process overview of the settings lifecycle and the required checks and balances to ensure that the correct settings are on the relay.

5.3 Process for Relay Subject to a Factory Acceptance Test

Appendix B3 provides the process diagram for a relay that will be subject to a Factory Acceptance Test, i.e. the majority situation. The following is required.

5.3.1 Factory Alignment of Calculations, Setting Sheets and Relay Files

- a) The DID, as specified in UKBP/TP188, shall define the project specific relay requirements. [Step 1 of Appendix B1]
- b) The Contractor Design Approval Engineer (P & C) shall ensure the preparation of a project specific circuit diagram based upon the DID and T/R standard application diagram. This shall be agreed by the P & C Design Engineer (Assurance). [Step 2 of Appendix B1]
- c) The Settings Engineer (Verification), based upon the requirements of the DID and T/R settings guidance document, shall prepare and sign the project specific power system calculations. These must be checked and signed by a second Settings Engineer (Verification). These shall be loaded into MARS and formally agreed by the Settings Engineer (Assurance). [Step 1 of Appendix B3] It is to be noted that all project specific power system calculations shall be provided – not just those to be entered on the setting sheet. A set of calculations shall be prepared for each numerical relay (i.e. one set of calculations for each end of a circuit). The calculations sheet for each numerical relay shall include all functions used within that device. It should also state any functions which are not in use.
- d) Where no formal Settings Policy exists for a relay or function the setting calculations must be agreed by two Setting Engineers (Assurance), one of whom must be a National Grid employed engineer. The policy omission must be notified to Asset Policy and recorded.
- e) The Contractor Design Approval Engineer (P & C) shall ensure the modification of the T/R setting File X with the project specific power system calculations, to create File Y. [Steps 2 and 3 of Appendix B3]
- f) The Contractor Design Approval Engineer (P & C) shall ensure the electronic comparison of File X and File Y to produce a 'Difference List'. [Step 4 of Appendix B3] The Contractor Design Approval Engineer (P & C) shall then ensure the visual comparison of the Difference List with the project specific power system calculations to confirm that they are identical. This shall be formally agreed by the Commissioning Officer who shall sign the CH21 documentation.

- g) The Settings Engineer (Verification) shall ensure the preparation of a TXT file (based upon a MARS proforma agreed at the time of Type Registration) which shall record key settings based upon the project specific power system calculations [Step 6 of Appendix B3] and shall forward a copy to the Settings Engineer (Assurance). See section 2.3 and Appendix D1 and D2 for criterion of settings to be entered on to the setting sheet. The Settings Engineer (Assurance) shall print a copy of the TXT file, ensure it agrees with the calculations, and formally notify the Settings Engineer (Verification) that the FAT may commence [Step 7 of Appendix B3]. NB: Agreement to (e) and (f) may take place at the same time.

5.3.2 Factory Acceptance Test

- a) The Contractor Design Approval Engineer (P & C) shall ensure that File Y is loaded into the relay [Step 8 of Appendix B3].
- b) The Contractor Design Approval Engineer (P & C) shall ensure that the FAT is carried out to confirm the following.
 - (iv) That the settings determined by the secondary injection accord with the settings on the TXT file.
 - (v) That the relay inputs and outputs accord with the project specific circuit diagram.

The above will be agreed by the Commissioning Officer, the Contractor Design Approval Engineer (P & C) or Settings Engineer (Verification) as appropriate and the Settings Engineer (Assurance) by signing the CH21 documentation [Step 9 of Appendix B3]. The Contractor must forward the signed CH21 documentation to site for the Commissioning Engineer (National Grid) & (Supplier) to sign. The CH21 documentation is then filed in the Commissioning File.

5.3.3 MARS Pending Area

This and the following sections should also be read in conjunction with Appendix B6.

- a) The Settings Engineer (Verification) shall ensure the forwarding of both the TXT file and an electronic copy of File Y to the MARS pending area to create the setting sheet, at which point File Y will be stored as part of the setting sheet.
- b) The Settings Engineer (Assurance) will authorise the setting sheet via the Livelink workflow in the PENDING area of MARS.
- c) The Settings Engineer (Assurance) shall then
 - (i) check the settings against the calculations [see Step 10 of Appendix B3].
 - (ii) forward the setting sheet to site (via Livelink)
 - (iii) Notify the Settings Administrator that the setting sheet has been forwarded to site.
- d) The Settings Administrator shall, having received the notification the setting sheet has been forwarded to site, print the setting sheet, annotate it as 'PENDING', place it in the Construction relay setting sheet master file – and attach it to any existing setting sheet

5.3.4 Site

- a) The Stage 1 Commissioning Tests must not commence until the setting sheets have been forwarded to site.
- b) The Commissioning Engineer (National Grid) shall access the setting sheet including File Y received at site and the Commissioning Engineer (Supplier) shall carry out an electronic comparison of File Y in the relay and File Y stored with the setting sheet to confirm that they are identical [Step 11 of Appendix B3]. This shall be confirmed by the Commissioning Engineer (National Grid) and recorded in the CH21 documentation
- c) The Commissioning Engineer (National Grid) shall print two copies of the setting sheet on green paper.
- d) The Commissioning Engineer (Supplier) will carry out secondary injections, in accordance with the requirements of SCT sheets, to confirm that the settings on the relay are identical to the settings on the setting sheet. Each setting on both copies of the setting sheet shall be ticked (✓) by the Commissioning Engineer (National Grid) to indicate that it has been confirmed [Step 12 of Appendix B3]. Settings to be ticked (✓) shall include CT ratio, relay function, type, serial no, rating and range.
- e) If when carrying out the injections/tests an error/anomaly arises between the settings on the relay and the settings on the setting sheet, the Commissioning Engineer (National Grid) must refer the matter to the Settings Engineer (Assurance) – see section 5.5 and Appendix B5.
- f) With reference to overcurrent and earth fault relays, confirmation that the applied setting accords with the required level of primary operate current (POC), will be through a calculation that verifies that the POC stated on the Setting Sheet (MARS) is equal to the injected current to cause operation (at the setting in use) multiplied by the CT ratio, i.e. a back calculation. See Appendix B7.
- g) On completion of all tests on the relay, the Commissioning Engineer (Supplier) shall again carry out an electronic comparison of File Y on the relay and File Y stored in the setting sheet file to confirm that they are identical and all settings on the relay are normal [Step 13 of Appendix B3]. This shall be confirmed by both the Commissioning Engineer (National Grid) and Commissioning Engineer (Supplier) signing the setting sheet – see Appendix D1.
- h) **The Commissioning Engineer (National Grid), on completion of Stage 1 commissioning, shall**
 - (i) **place a copy of the (✓) setting sheet in the Site Setting Sheet File**
 - (ii) **return the (✓) setting sheet to the Settings Administrator by post [see Steps 11 to 13 of Appendix B6]. It is acceptable to return the setting sheet by fax or a scanned copy by email.**
- i) The Commissioning Engineer (Supplier) shall also confirm that the settings on the relay do not restrict circuit loading by carrying out a settings loading verification test. This shall be confirmed by the Commissioning Engineer (National Grid). This shall be the final Stage 1 commissioning test and shall be carried out in accordance with a Commissioning Handbook Procedure 20.
- j) **The Commissioning Engineer (National Grid), on completion of Stage 2 commissioning, shall notify the Settings Engineer (Assurance) via Livelink that the settings process at site is complete [see Step 14 of Appendix B6].**

- k) On completion of this process future reference to settings on site may be via electronic access direct to the MARS system. However, the site paper copy must be retained and maintained to a high professional standard to act as a backup reference source should MARS access not be available.

5.3.5 MARS Operational Area

- a) The Settings Administrator shall stamp the returned setting sheet with the date of receipt and shall record the date of receipt in the Monitor Log – see Appendix F.
- b) The Settings Administrator shall then file the returned ticked (✓) green setting sheet in the Relay Setting Sheet Master File, replacing the 'Pending' copy (which should be destroyed).
- c) Any existing setting sheets must be filed in the Superseded Settings File.
- d) The Settings Engineer (Assurance), on receiving notification from the Commissioning Engineer (National Grid) via Livelink that the settings process at site is complete (see section 5.3.4), shall then confirm with the Settings Administrator that a green paper copy of the setting sheet has been received from site and filed in the Relay Setting Sheet Master File. If there are any mark ups on the setting sheet the Settings Engineer (Assurance) must review them and if necessary, transfer them into Livelink. If the site copy has not been received and filed, the Settings Administrator shall chase and progress.
- e) The Settings Engineer (Assurance), following confirmation that the site setting sheet has been received and filed, shall transfer the setting sheet residing in the PENDING area of MARS to the OPERATIONAL area [see Step 14 in Appendix B3] [see Step 11 to 17 of Appendix B6].
- f) On completion of a project the Settings Engineer (Assurance) shall produce a list of any obsolete or superseded relays and email this to the Settings Administrator. The Settings Administrator shall then delete these relays from MARS or alternatively the Settings Engineer (Assurance) can delete these relays from MARS but must also advise the Settings Administrator of the Setting Sheets which have been deleted. The Settings Administrator shall remove the paper Setting Sheets from the active files and transfer them to the Superseded Settings File.

5.4 Process for Relay Undergoing Type Registration

Appendix B4 provides the process diagram for a relay subject to Type Registration. This is the minority situation since a relay type is only subject to T/R (and associated FAT) once – thereafter subsequent relays of this type are subject to project specific FAT. The T/R originates documentation which later applies to project specific FAT. The following is required.

- a) A Contractor Design Approval Engineer (P & C) will ensure that a T/R settings guidance document containing both power system settings (i.e. project specific) and fixed settings is prepared. This will be formally agreed by the Commissioning Officer who shall refer the document to a Settings Engineer (Assurance) if the Commissioning Officer is not an authorised Settings Engineer (Assurance) [Step 2 of Appendix B4].
- b) A Contractor Design Approval Engineer (P & C) will prepare a T/R standard application diagram. This shall be formally agreed by the Commissioning Officer [Step 3 of Appendix B4].
- c) The Settings Engineer (Verification) will prepare the project specific power system calculations based upon the requirements of the DID and T/R settings guidance document. These shall be formally agreed by the Settings Engineer (Assurance). [Step 4 of Appendix B4]

- d) The Contractor Design Approval Engineer (P & C) will ensure the preparation of the project specific circuit diagram based upon the T/R standard application diagram. This shall be formally agreed by the P & C Design Engineer (Assurance) [Step 2 of Appendix B1].
- e) The Contractor Design Approval Engineer (P & C) will ensure the preparation of the T/R relay settings file X. This shall be based upon
 - (i) T/R settings guidance document – for fixed settings
 - (ii) project specific power system calculations – for power system settings
 - (iii) project specific circuit diagram – for input/output connectionThe Commissioning Officer will agree the File X contents [Step 6 of Appendix B4].
- f) The Settings Engineer (Verification) shall prepare a setting sheet (based upon a MARS proforma) which shall record relevant settings based upon the project specific power system calculations [Step 7 of Appendix B4]. See section Appendix D2 for criterion of settings to be entered on to the setting sheet. The Settings Engineer (Assurance) shall formally agree the settings sheet [Step 8 of Appendix B4].
- g) The Contractor Design Approval Engineer (P & C) will ensure that File X is loaded on to the relay [Step 9 of Appendix B4].
- h) The remainder of the process is identical to that of a project specific FAT, commencing at section 5.3.2 and as shown in Appendix B3.

5.5 Process for Site Changes

Appendix B5 defines the change management process for settings discrepancies / errors found on site. The process recognises that the discrepancy / error may or may not be recorded on the setting sheet.

The following is required.

- a) The Commissioning Engineer (Supplier) and Commissioning Engineer (National Grid) shall conclude that there is a settings error / anomaly. The setting in question may be, or may not be, recorded on the setting sheet since the setting sheet only records key project specific power system settings.

The Commissioning Engineer (National Grid) shall notify the discrepancy / error to the Settings Engineer (Assurance) who in turn shall resolve the discrepancy / error with the Settings Engineer (Verification). [See Step 1 of Appendix B5]

- b) If the discrepancy / error is associated with a fixed setting (say output / input configuration) as defined in Appendix E Section 6 – then the implications for Type Registration must be discussed with Network Engineering – Asset Policy.

If the discrepancy / error is associated with a project specific power system setting as defined in Appendix E section 6 then the Settings Engineer (Verification) shall correct the calculation document [see Step 2 of Appendix B5] and this shall be agreed by the Settings Engineer (Assurance).

If the discrepancy / error is also recorded on the setting sheet – then the Settings Engineer (Verification) shall correct the settings sheet [see Step 2 of Appendix B5] and this shall be agreed by the Settings Engineer (Assurance).

- c) The Contractor Design Approval Engineer (P & C) shall then modify (or arrange to have modified) File Y with the changes, to become File Z. [See Step 3 of Appendix B5]

- d) The Contractor Design Approval Engineer (P & C) shall then carry out (or arrange to have carried out) an electronic comparison between File Y and File Z to produce a difference list. [See Step 4 of Appendix B5]
- e) If the discrepancy / error is associated with a setting on the setting sheet – then the Settings Engineer (Verification) will confirm that the difference accords with the new setting on the setting sheet. This shall be confirmed by the Settings Engineer (Assurance). [See Step 5 of Appendix B5]
- f) If the discrepancy / error is associated with a setting which is not on the setting sheet – then the Settings Engineer (Verification) will confirm that the difference accords with the modified calculation file. This shall be confirmed by the Settings Engineer (Assurance). [See Step 6 of Appendix B5]
- g) Depending upon whether a re-FAT is required (see CH21 for criterion for a re-FAT) the process connects to Step 9 or Step 10 of Appendix B3 respectively.

5.6 Emergency Procedure

- a) The emergency procedure should only be utilised when the timescales for settings preparation and application is immediate. In such instances recourse should be made directly to the Settings Engineer (Assurance) defined in Appendix K.
- b) If it becomes necessary for the Settings Engineer (Assurance) to convey relay settings verbally (e.g. due to remoteness from, or unavailability of, MARS), the Commissioning Engineer (National Grid) shall produce a legible manuscript copy whilst the settings are being given and shall repeat the contents of the manuscript copy to the sender. If possible the settings should be conveyed to site by email. Both the sender and recipient shall keep a written record of their respective names, the relays involved and the specified settings until the formal settings sheet is issued, which should be as soon as possible after the emergency settings have been applied.
- c) An existing setting must NOT be changed in any way on a circuit which is in service without the agreement of a Settings Engineer (Assurance), unless covered by standing procedures. In addition, no settings must be changed without the agreement of an ENCC Control Engineer.

5.7 Temporary Settings for Commissioning Purposes

- a) The setting sheet for a relay which is permanently installed for commissioning purposes (but when not in use must have the tripping disabled), eg. HSOC, should define the permanent setting as the highest setting available on the relay (ie. least possibility of operation on either load or fault conditions).
- b) Temporary settings shall follow the same process as section 5.3., i.e. a setting sheet must be issued for each temporary setting and if appropriate an electronic relay configuration file should be prepared, tested and forwarded to site. A CH21 form will be required for numerical relays.
- c) The temporary setting termed 'TEMP' shall be created in MARS and forwarded to the Commissioning Engineer (National Grid) who must reference both the application of the temporary settings and reinstatement of the permanent settings in the Commissioning Switching Programme. The setting sheet must include a reference to the Commissioning Switching Programme to which it applies at the top of the settings area within the settings sheet. This should state:

'This Setting is for use with CSP####. After completion of the CSP the temporary relay must be removed/the relay setting returned to the in service setting*'. (* delete as appropriate).

- d) On return of the temporary settings sheet to the Settings Administrator the following shall be undertaken.
 - (i) The temporary setting sheet, both in MARS and in the master file, shall be removed and destroyed.
 - (ii) The returned temporary setting sheet shall be placed in the superseded setting file.
 - (iii) The temporary setting shall be removed from MARS.
- e) Where a temporary setting is achieved through selection of a 'settings group' then unless this is executed through the movement of a mechanical switch external to the relay – it must be undertaken by a UKBP/TP141 authorised Commissioning Engineer (National Grid) either Basic or Advanced.

NB: Where the temporary setting is to be applied to a programmable numeric relay it must be confirmed that on completion the circuit specific master setting file, held by the Contractor, holds the permanent relay setting (i.e. not the temporary setting). This shall be achieved by the Setting Engineer (Assurance), on receiving the returned temporary setting sheet, obtaining written confirmation from the Settings Engineer (Verification).

5.8 Temporary Settings for Emergency Return to Service (ERTS) Purposes

An ERTS setting sheet is a setting sheet for a temporary relay which is available on site to be installed and commissioned in the event a circuit is required to be returned to service during outage conditions at the request of Market Operation (refer to UKBP/TP105 for further details). An ERTS setting must be managed as follows:

- a) Temporary settings for ERTS purposes shall follow the same process as section 5.3.
- b) The setting must be of class 'ERTS'.
- c) If the relay is required to be commissioned in the event of an ERTS the setting sheet should be confirmed and returned to the settings administrator following the process in section 5.3.
- d) When the relay is removed from service the Commissioning Engineer (National Grid) shall copy the setting sheet on site, mark it 'Relay Removed from Service' and return it to the Settings Administrator.
- e) If the relay is not required during the outage the Commissioning Engineer (National Grid) shall mark the setting sheet 'Relay Not Used' and return it to the Settings Administrator. The workflow in Livelink should also be rejected.
- f) On return of the ERTS settings sheet to the Settings Administrator the following shall be undertaken.
 - (i) The ERTS setting sheet, both in MARS and in the master file, shall be removed and destroyed.
 - (ii) The returned ERTS setting sheet shall be placed in the superseded setting file.
 - (iii) The Settings Administrator should inform the Settings Engineer (National Grid) that the ERTS setting sheet has been returned and the Settings Engineer (National Grid) shall remove the setting from MARS.

5.9 Project Settings – Timescales

- a) The circuit specific Power System Calculations/Setting Document shall be prepared by the Settings Engineer (Verification), and agreed as correct by the Settings Engineer (Assurance) no later than 20 weeks in advance of the circuit energisation date (see Step 3 of Appendix B1).

Project timescales may require that the settings must be calculated and agreed in advance of the above timescales to facilitate FAT and build programmes. In this case the Settings Engineer (Verification) must agree the required timescales with the Settings Engineer (Assurance) and submit the calculations to meet these requirements.

Confirmation of correctness shall be through the Settings Engineer (Assurance) notifying the Settings Engineer (Verification) accordingly. This timescale is to facilitate Thermal Ratings timescales (UKBP/TP175).

The Settings Engineer (Assurance) should confirm the correctness of the Settings Calculations no more than 4 weeks after receiving them from the Settings Engineer (Verification).

NB: To facilitate the 20 week timescale the Settings Engineer (Assurance) should reasonably be expected to be in receipt of the calculation / setting document 2-3 weeks in advance of the 20 weeks deadline.

- b) Prior to the start of Stage 1 commissioning and no later than 4 weeks in advance of the circuit energisation date (unless otherwise requested by the Commissioning Panel to meet construction timescales), the Commissioning Engineer (National Grid) must be in receipt of the settings sheets. Upon completion of Stage 1 commissioning, the Commissioning Engineer (National Grid) must return the ticked (✓) and signed settings sheets to the Settings Administrator.

5.10 Relay Default Settings

Where a relay is manufactured with default settings, and these settings are not to be used in a specific application, then they must be disabled.

5.11 Tests for Unwanted Functionality

To confirm that with multi-function Numeric Relays there is no unwanted functionality unintentionally set to operate in parallel with the required functionality, additional testing (over and above the traditional secondary to confirm the operate setting) will be undertaken. Appendix H summarises the testing to be undertaken – which should be incorporated into SCT procedures.

5.12 Replacement of Equipment which has Failed in Service – Settings Timescales

Where new or revised settings result from the need to replace equipment that has failed in service, the resulting Commissioning Panel shall discuss and agree the timescales for settings, with the Settings Technical Engineer, at the earliest time practicable.

Where a Commissioning Panel is not deemed appropriate (i.e. replacement of a failed relay) the timescales must be discussed and agreed between the Settings Engineer (Assurance) and the Commissioning Engineer (National Grid).

5.13 Setting Changes During Maintenance

- a) Setting changes may be required to facilitate maintenance tests. This may be undertaken, in accordance with a maintenance procedure, by an engineer who has been scheduled for this purpose.

- b) All maintenance procedures must conclude with the requirement to confirm that the setting left on the relay accords with the setting sheet.
- c) All temporary changes for maintenance purposes to multi-functional relays must be carried out/ supervised by a Commissioning Engineer (National Grid).

5.14 Settings Not Associated With National Grid Projects

- a) All requests for settings changes to commissioned equipment required by either National Grid or Customers must be formally made to the Engineering Assurance Manager (Substations). All work, which is capable of being planned, must be requested at least 6 weeks in advance of the setting having to be applied.
- b) To enable correct determination of the setting, the person requesting the settings must provide the following information.
 - (i) A statement detailing why the settings are required.
 - (ii) Identification and details of the relays to which the settings are to be applied. Where new relays are to be installed, the following must be provided.
 - Relay function
 - Relay type
 - Relay rating
 - Relay range
 - CT ratio to be used
 - Settings details
 - (iii) An operation diagram.
 - (iv) Where the relay is not protecting the National Grid system, the positive and zero sequence impedances of all related items of equipment and the maximum and minimum fault levels at in feeding busbars are required.
 - (v) The date the settings are to become operational.
 - (vi) The name of the individual to whom the settings should be forwarded.
 - (vii) The requirements of section 5 of the document shall be followed but the settings shall only be applied after first gaining the consent of the ENCC Control Engineer and providing confirmation to the latter on completion.

5.15 Customer Settings and Grading across a Customer Interface

Settings requirements relating to a Customer and Customer interface shall be in accordance with the Grid Code and Design Handbook N°12. All settings related correspondence with the Customer shall be via the Settings Engineer (Assurance). All correspondence, including copies of setting sheets sent to and received by the Customer, shall be filed in the appropriate Capital Delivery Relay Settings Calculation File.

When a Customer is to be notified of a setting change across a customer interface, correspondence to the Customer should follow the format in Appendix M.

5.16 Multi-functional Relay Quality Management System

The quality management system for multi-functional relays is defined in commissioning Handbook N°21. This must be rigorously applied and adhered to by both National Grid and Contractor personnel who have responsibilities under this procedure. This system manages and formalises the whole lifecycle of Type Registration, FAT and Stage 1 commissioning.

6 DOCUMENTATION

6.1 General

The following documentation shall be used.

- a) Protection Settings Sheet comprising one or more pages with a standard format as Appendix D. The Settings Sheet shall specify the settings to be confirmed, and provide a permanent record of the settings.
- b) For non-integrated numerical relays, a software configuration file containing all relay parameters shall be produced and managed by the Settings Technical Engineer.
- c) Both Capital Delivery files and Electricity Transmission Asset Management site files shall contain an index, identifying all circuits defined on the settings sheets for that substation. The index shall be prepared and updated by the Settings Administrator for the Capital Delivery files and the Commissioning Engineer (National Grid) for the site files.

6.2 Capital Delivery Files

Four categories of files are required as follows:

- a) Relay Settings Sheet Master Files

These shall contain the master copies, collated on an individual substation basis. In the first instance they shall contain a copy of the settings sheet sent to the Commissioning Engineer (National Grid). On return, the signed copy shall replace the unsigned copy in this file. Each relay settings sheet master file shall contain an index identifying each circuit (i.e. each circuit for which there is a setting sheet, e.g. DAR may be defined as a circuit).

- b) Superseded Settings Sheets File

When superseded, setting sheets shall be endorsed 'superseded' and retained for a minimum period of seven years.

- c) Relay Settings Calculations Files

These shall contain a formal record of the relay settings calculations (and associated correspondence) collated on a per substation, circuit and date basis. These are to be retained as part of an electronic, or paper, based filing system by the Technical Assurance Manager and by any third party so contracted to carry out such work. Supplementary calibration/test result for determining the required settings shall be kept in the appropriate settings calculation file.

- d) Non-integrated Numerical Relay Configuration Files

These files relate to non-integrated numerical relays and, where not covered under PDSA, shall be kept in a controlled system under the management of the Settings Technical Engineer. They shall have a unique file name, e.g. **Directory / MARS / Station Identity / NASAP Code / Protection Relay Identity**. The file shall be labelled consistently and appropriately.

NB: These files may include setting upload programmes.