WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Company Directive

STANDARD TECHNIQUE: TP18A/1

Application of Connection Control Panels for Soft Intertrip and/or Voltage Constraint Schemes

Summary

This document provides guidance on the application of Western Power Distribution's Connection Control Panels (CCPs). These panels may be configured for Soft Intertrip or Voltage Constraint.

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Implementation Date:	**June 2018**
Approved by:	
	Policy Manager
Date:	29th June 2018

IMPLEMENTATION PLAN

Introduction

This document provides guidance on the application of Connection Control Panels. These panels are used by Western Power Distribution to reduce the export and/or import of distributed energy resources, when this is required, to maintain network security and/or to prevent thermal limits, voltage limits or power quality limits from being exceeded.

Main Changes

Text changes due to name change of Western Power supplier.

Renaming of Generator Constraint Panels (GCPs) to Connection Control Panels (CCPs). Note that not all Standard Techniques referring to GCPs have been corrected – until those documents are updated, all references to GCPs should be read as identical to CCPs.

Extensive changes to settings descriptions to explain new functionality of V20 software allowing panels to implement demand constraint.

Revised generic setting sheet in Appendix B.

Impact of Changes

Changes will allow implementation of alternative demand connections as well as alternative generation connections, as outlined in the SD10 series of policy documents.

Implementation

WPD Plant Centres to note changes to Appendix A. These changes are also relevant to ICPs.

Implementation Timescale

This document shall be implemented on issue. No retrospective action is required as a result of its issue.

REVISION HISTORY

DOCUMENT REVISION & REVIEW TABLE		
Date	**Comments**	**Author**
June 2018	Extensive revision as a result of software / firmware change from V18 to V20, allowing panels to be configured for demand constraint and energy storage constraint as well as generation constraint: • New settings explained • General arrangement drawings revised • Generic setting sheet updated • Detailed drawings removed from document, replaced with hyperlink to shared drive	Sven Hoffmann
December 2017	Text revisions due to supplier name change. Revision to clause 5 and the table in Appendix A due to equipment changes.	Stephen Hennell
February 2017	Clause 4.2.1 (l) on page 19 has been corrected	Andy Hood
December 2016	Setting Sheets in Appendix B have been updated	Andy Hood
January 2016	Amended the schematic of the typical 33kV generator constraint connection on page 33	Philip Hooper
May 2015	New Document	Andy Hood

1.0 INTRODUCTION

1.1 This document provides guidance on the application and operation of Connection Control Panels (CCPs). It is based on Western Power Distribution's standard control panels manufactured and supplied by ZIV Automation Ltd. The document will be modified to accommodate other makes of panel as they are developed and approved by the Policy Section and by Surf Telecom.

1.2 Where any difficulty is encountered in the application of the Standard Technique the author of the document shall be consulted who will determine if a variation is appropriate.

2.0 APPLICATION

2.1 Summary

2.1.1 The ZIV control panel may be configured for Soft Intertrip or Voltage Constraint Schemes. Both options are suitable for connections at HV and above and are designed to ensure network limits (e.g. thermal or voltage limits) are not exceeded. While Voltage Constraint Schemes will apply only to generation connections, Soft Intertrip Schemes may be applied to both generation and controllable demand connections.

2.1.2 It should be noted that the Soft Intertrip functionality of the CCP is always available (as long as POF is programmed accordingly) regardless of whether the voltage constraint function is enabled.

2.2 Soft Intertrip Schemes

2.2.1 The Soft Intertrip option is one of three "alternative connection" methods that are currently available. The other two alternative connection methods are "Timed" and "Active Network Management" schemes. Further guidance on alternative connections is included in POL:SD10 and the associated STs in the SD10 series.

2.2.2 When selected to Soft Intertrip mode the CCP relies on POF / ENMAC to determine when the connection needs to be constrained. A sequential control (SQC) scheme is written for POF / ENMAC which monitors analogue information (e.g. current, power, voltage etc.), alarms, and the status of the network (e.g. which switches are open and which are closed). When certain conditions occur, or limits are exceeded, POF / ENMAC sends a signal to the CCP to constrain the connection.

2.2.3 When a constraint signal is received the CCP sends a signal to the customer instructing them to limit their export (in the case of generation) or their import (in the case of controllable demand).

2.3 Voltage Constraint Schemes

2.3.1 Voltage Constraint is not seen an “alternative connection” method but is simply a way of constraining generation under back feed conditions (when the local voltage exceeds limits).

2.3.2 When the CCP is set to Voltage Constraint mode, the scheme measures the local voltage and if this exceeds the voltage limit setting (for a sufficient period of time) the panel sends a signal to constrain the generator.

2.4 Monitoring of the Constraint

2.4.1 Whichever type of scheme is implemented, when the panel signals a constraint it monitors whether the customer successfully implements the first stage of constraint and, if not, initiates a second, more severe, stage of constraint. Typically this second stage trips a customer owned circuit breaker directly disconnecting all, or part of, their load (e.g. generation, energy storage and/or demand).

2.4.2 If the second stage of constraint is not implemented successfully the panel sends an alarm to Control, allowing them to take further action, if required (e.g. tripping the metering circuit breaker).

2.5 When should a Soft Intertrip scheme be installed?

2.5.1 Guidance on the application of Soft Intertrip schemes is included in POL: SD10 and ST:SD10B. Soft Intertrip schemes may be considered where all of the following criteria apply:

- The connection is made at HV or above.
- The aggregate capacity of the connection is 250kW or more.
- The connection needs to be constrained due to thermal limitations, protection limitations, fault level limitations or remote voltage limitations.

2.5.2 Note: the risks associated with exceeding fault level ratings during short term parallels (e.g. when moving open points) are typically controlled by applying appropriate operational restrictions and not by installing Soft Intertrip schemes.

2.6 When should a Voltage Constraint scheme be installed?

2.6.1 A voltage Constraint scheme shall be specified where all of the following criteria are satisfied:

- A generator connection is made at EHV (66KV or 33kV) or HV (11kV or 6.6kV).
- The aggregate capacity of the generation at the connection is 500kW or more.

- Under normal operating conditions the voltage at the connection is not expected to exceed appropriate limits*.

- Under first circuit outage (N-1) conditions, the generation needs to be constrained in order to prevent the voltage at the connection point exceeding appropriate limits* (under certain demand / generation conditions).

2.6.2 Note, if the local voltage is expected to be outside of appropriate limits* when fed normally the network should be reinforced or an alternative connection arrangement provided.

** POL: SD4 provides guidance on appropriate limits for 11kv and 6.6kV network.*

3.0 CONSTRAINT SCHEME DETAILS

3.1 General Description and layout

3.1.1 A constraint scheme consists of a single panel which is connected to the local metering or protection CTs and VT and also requires a 230Vac supply. The panel includes its own 48Vdc battery / charger system that will sustain the panel for 24 hours should the ac supply fail.

3.1.2 All CCPs and their associated switchgear, including the metering circuit breaker must be provided with SCADA facilities. It should be noted that for 11kV Ring Main Unit applications the tee off circuit breaker, in addition to the ring switches, must be automated. In most cases the CCP and switchgear share the same radio system.

This requirement may be waived where retro-fit of SCADA facilities to Primary switchgear is not practical.

3.1.3 The panel is hard wired to the customer's control or protection systems, via a customer interface panel. There are two versions of this panel – a standard version with pull-out links for isolation, and an alternative one incorporating interposing relays for enhanced isolation – to be used where HV and LV earths require segregation. Further guidance is contained in ST:TP21D.

3.1.4 Figures 1 and 2 show how a typical CCP is connected at 33kV and 11kV respectively. Photographs of a CCP are provided in Figures 3 and 4.

3.1.5 The external dimensions of the ZIV Connection Control Panel and CT/VT marshalling cabinet are as follows:

CCP: 800mm (H) x 1000mm (W) x 300mm (D)
CT/VT Cabinet: 300mm (H), 200mm (W) x 60mm (D)

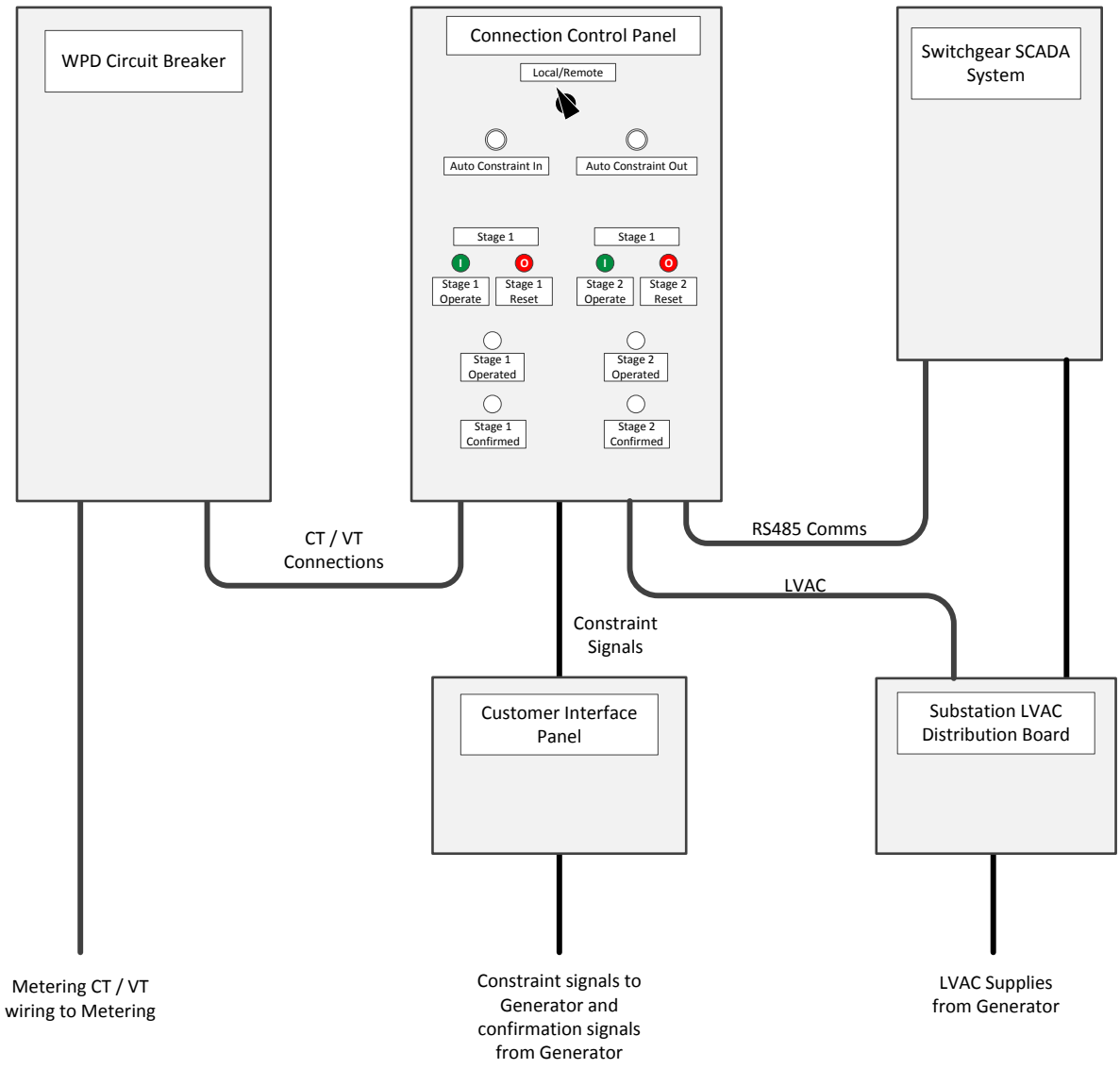


Figure 1 Typical 33kV Connection Arrangement

This arrangement also applies to 11kV arrangements utilising primary type switchgear.

Note: the customer interface panel includes links that may be used to isolate connections to / from the generator's installation.

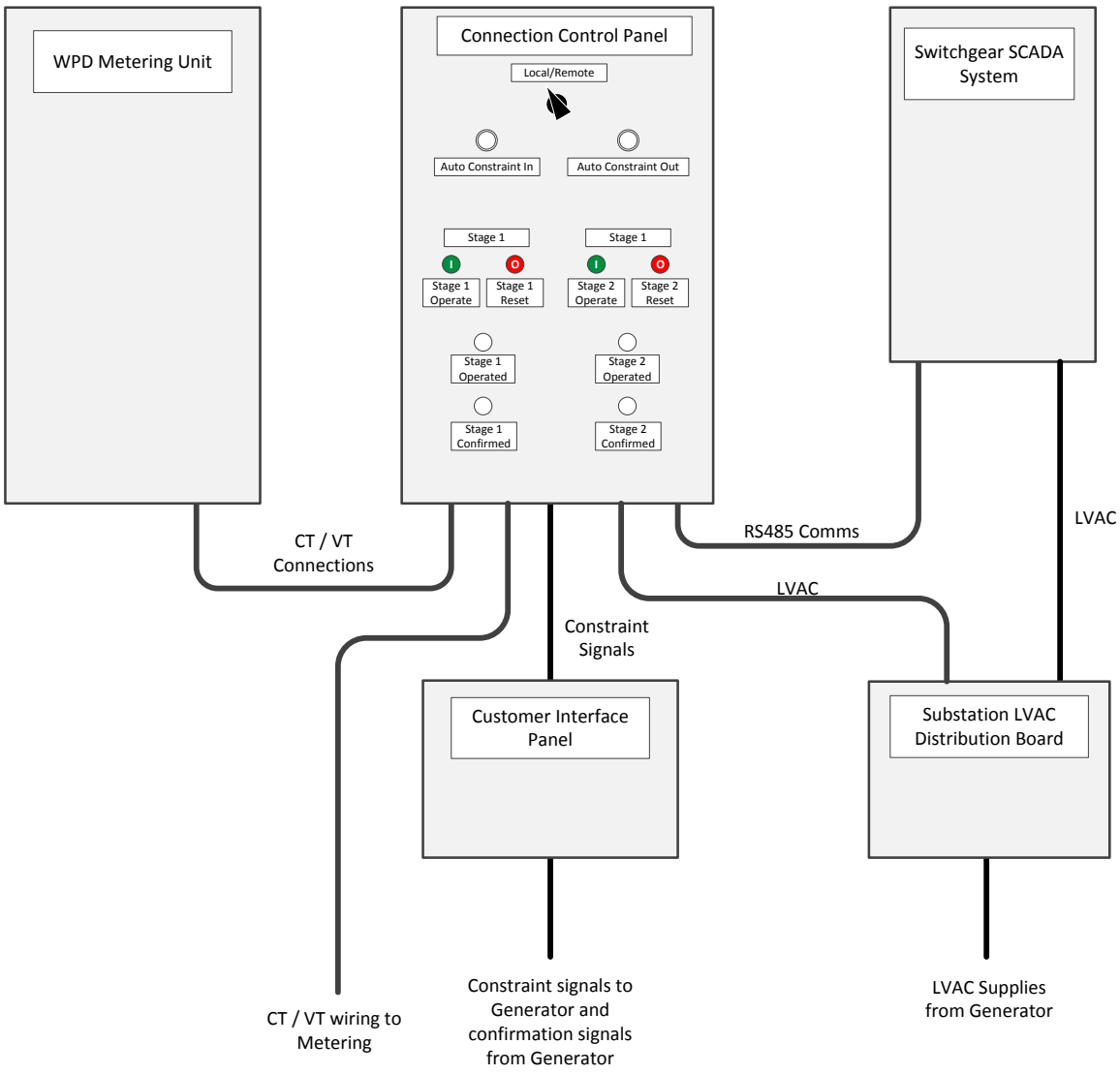


Figure 2 **Typical 11kV Arrangement utilising secondary type switchgear i.e. Ring Main Units**

Note: the customer interface panel includes links that may be used to isolate connections to / from the generator's installation.

Figure 3 CCP (Front Panel)

Figure 4 CCP (Internal Wiring)

3.2 CT and VT Requirements

3.2.1 Connection Control Panels are connected to a VT and a set of CTs so that they can determine the phase voltage (all three phase to phase voltages), current, active power and reactive power.

3.2.2 11kV and 6.6kV connections rated up to 10MVA (i.e. supplied from Ringmaster switchgear or equivalent) may be connected to the metering CTs and a metering VT in the metering unit. This is because Metering Code of Practice 3 (COP 3) which is applicable to loads between 1MVA and 10MVA allows additional burdens to be connected to metering CTs and VT windings.

3.2.3 For larger 11kV and 6.6kV connections (>10MVA) and all connections made at 33kV and above, the current and voltage shall be derived from protection CTs and a protection VT winding. This is because Metering Code of Practice 2 (COP 2) which is applicable to loads between 10MVA and 100MVA prohibits additional burdens from being connected to the main metering CT and VT windings.

3.2.4 Two versions of the Connection Control Panel are available, one for use with 1A CTs and another for use with 5A CTs. It is important that the correct version is ordered.

3.2.5 Normally only two metering CTs are provided (L1 and L3) and so the Connection Control Panel is configured so that it only requires L1 and L3 to calculate power flow. If three CTs are available, L2 must not be connected to the panel.

3.2.6 The burden of the CT inputs and VT inputs of the Connection Control Panel are negligible, however, the secondary wiring and multicore cables may add a significant burden to the CTs.

3.2.7 It is essential that the total burden connected to the CTs is within their rating. Where the panel is connected to metering CTs, the accuracy of the metering will be adversely affected if the CT rating is exceeded.

3.2.8 Table 1 provides information on the burden of the CCP, the secondary wiring / multicores. The 5A CTs provided in standard 11kV metering units have a rated burden of 10VA (as defined in EE SPEC:2 and 1A CTs normally have a rated burden of 7.5VA or higher.

Equipment	Impedance	Burden[1]
ZIV Automation Panel:		
Voltage Inputs	300kΩ	< 0.0411 VA (at 0.37mA)[2]
Current Inputs	<2mΩ (5A board) <5mΩ (1A board)	< 0.0500 VA (at 5A) < 0.0050 VA (at 1A)
Copper Conductor[3][4]:		
2.5 mm^2	7.4 mΩ/m	= 0.1850 VA/m (at 5A) = 0.0074 VA/m (at 1A)
4.0 mm^2	4.6 mΩ/m	= 0.1150 VA/m (at 5A) = 0.0046 VA/m (at 1A)
6.0 mm^2	3.1 mΩ/m	= 0.0775 VA/m (at 5A) = 0.0031 VA/m (at 1A)
10.0 mm^2	1.83 mΩ/m	= 0.0458 VA/m (at 5A) = 0.0018 VA/m (at 1A)
16 mm^2	1.15 mΩ/m	= 0.0288 VA/m (at 5A) = 0.0012 VA/m (at 1A)
25 mm^2	0.73 mΩ/m	= 0.0182 VA/m (at 5A) = 0.0007 VA/m (at 1A)

Table 1 CT and VT Burdens

Note 1 The burden of an item of equipment that has a known impedance is calculated as follows:
Burden (VA) = I^2Z
Where:
I = current (A) flowing into the equipment
Z = the impedance (Ω) of the equipment

Note 2 The high impedance of the voltage inputs (300kΩ) restrict the current flowing into the Voltage Constraint Panel and through the associated VT wring to 0.37mA. This means the burden of the VT secondary wiring and the burden of the voltage inputs is negligible.

Note 3 For CT wiring, the burden is calculated using the rated CT current (i.e. 1A or 5A). The CT current flows in a loop from the CT to the equipment and back to the CT again. The length of the conductor is therefore at least 2x the length of the associated multicore cable.

3.2.9 CT Burden Example

3.2.9.1 CTs with a 5A secondary rating are to be connected to a CCP and are also used to supply the settlement metering. If the meters have a total burden of 1VA and the total length of multicore is 20m, will 2.5mm^2 Copper multicore be acceptable?

- The burden of the metering = 1 VA
- The burden of Voltage Constraint Panel = 0.05 VA

- The burden of 25m of 2.5mm^2 multicore is approximately 20m x 2 x 0.185 = 7.40 VA

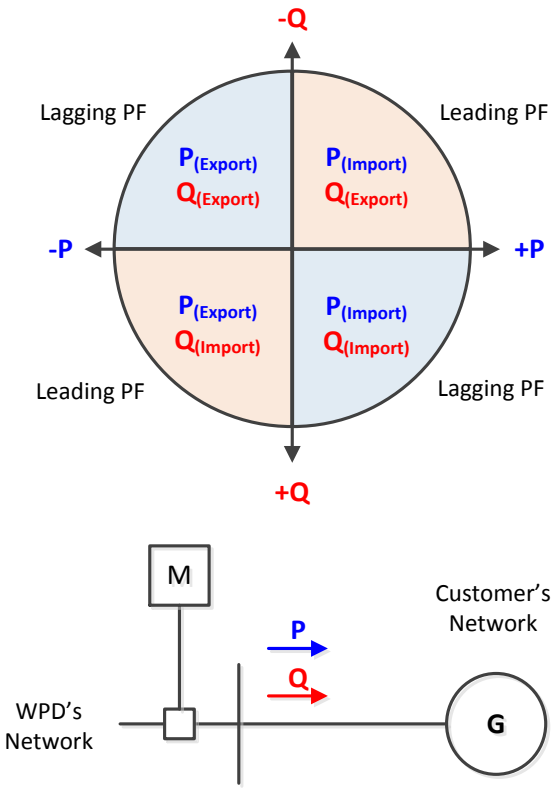
- An additional 2m length of 2.5mm^2 secondary wiring is assumed within the panels themselves giving an additional burden of 2 x 2 x 0.1850 = 0.74 VA.

3.2.9.2 This gives a total burden of 9.19 VA which is just below the 10VA rated burden of the CTs.

3.2.9.3 If the conductors within the multicore cable were doubled up (i.e. each phase consisted of 2 x 2.5mm^2 copper conductors) the burden would be reduced to approximately 5.49 VA.

3.3 Power Flow Conventions

3.3.1 CCPs use the same power flow conventions that are used for Western Power Distribution's transducers. This means that when Active Power is imported (i.e. flows from WPDs network into the Customer's installation the value is deemed to be positive (+ve) and when the Active Power is exported it is deemed to be negative (-ve). The same is true for Reactive Power. This convention is shown in Figure 5.



P = Active Power (kW)
Q = Reactive Power (kVAr)

Figure 5 Power Flow Conventions

3.4 SCADA Requirements

3.4.1 WPD switchgear associated with CCPs, including the metering circuit breaker must be fitted with SCADA tele-control facilities so that Control are able to re-configure the network or disconnect the connection should they fail to constrain. CCPs also require SCADA facilities so that Control can monitor alarms and, if necessary operate, reset, disable or enable the constraint scheme.

3.4.2 The WPD standard CCPs operate using three different communications protocols, Modbus, DNP3.0 and IEC60870-101 which means they can be connected to all of SURF's existing communications systems.

3.4.3 All CCP systems (Soft Intertrip and Voltage Constraint) connected at 33kV and above and all Soft Intertrip schemes connected at 11kV or 6.6kV require a licensed communications system (i.e. scanned telemetry system).

3.4.4 11kV and 6.6kV Voltage Constraint schemes utilise the standard unlicensed communications systems associated 11kv and 6.6kV automation schemes.

3.4.5 Ordering requirements for SCADA / Radio equipment are specified in section 5.2.

3.5 Description of Operation

3.5.1 Automatic Operation

3.5.1.1 All CCPs include two stages of constraint.

3.5.1.2 Panels configured for Soft Intertrip only initiate a Stage 1 Constraint when they receive a Stage 1 Operate signal from POF / ENMAC whereas Panels configured for Voltage Constraint initiate a Stage 1 Constraint when the voltage exceeds the Stage 1 Operate Voltage setting for a period of time that exceeds the Stage 1 Operate Time Delay setting (assuming Automatic Constraint is selected to "in").

3.5.1.3 When Stage 1 Constraint is initiated a normally open contact is closed that instructs the connected customer to reduce their import/export to a predetermined level.

3.5.1.4 If Automatic Constraint is "in" the CCP checks that:

- the customer has closed their Stage 1 Confirmation contact, and;
- Active Power (kW) flowing through the metering circuit breaker is within the agreed limit for Stage 1. In this context imported Active Power has a positive value and exported Active Power has a negative value.

If, for example, it is agreed that the site must export less than 1MW, the scheme checks that the flow of Active Power is mathematically greater than -1MW. A value of -900kW is, for example, greater than -1MW.

3.5.1.5 If the Stage 1 Constraint is successfully implemented by the customer the restriction remains in place until either:

- Stage 1 Constraint is reset via SCADA.
- Stage 1 Constraint is reset locally.
- In the case of a Voltage Constraint scheme only, the measured voltage (on all phases) is below the Reset Voltage setting for a period of time that exceeds the Stage 1 Reset Time Delay setting.

3.5.1.6 If the Stage 1 Constraint is not successfully implemented the scheme will initiate a Stage 2 Constraint condition by closing a second contact. This will either trip the connection or initiate a second stage of power reduction, depending on the approach that is agreed with the customer. The scheme then checks that:

- The customer's Stage 2 Confirmation contact is closed, and;
- Active Power (kW) flowing through the metering circuit breaker is within the agreed limit for Stage 2.

3.5.1.7 The Stage 2 Constraint condition may only be reset via SCADA or locally.

3.5.1.8 If the Stage 2 Constraint is unsuccessful a "failed to constrain" alarm is sent to Control.

3.5.2 Local Operation

3.5.2.1 The Stage 1 Constraint and/or Stage 2 Constraint can be selected manually on site when the Local / Remote switch is in the Local position.

3.5.2.2 If Automatic Constraint is left in its Enabled status when Stage 1 Constraint is operated locally the scheme will escalate to Stage 2 if the customer confirmation and Active Power checks described in 3.1.3 are not successful. Also, in the case of a Voltage Constraint scheme, the scheme may automatically reset if the voltage is below the reset voltage setting.

3.5.2.3 If Automatic Constraint is Disabled the scheme will not escalate to Stage 2 or reset automatically.

3.5.3 Remote Operation

3.5.3.1 The Stage 1 Constraint and/or Stage 2 Constraint can be selected remotely by Control when the Local / Remote switch is in the Remote position.

3.5.3.2 If Automatic Constraint is left in its Enabled status when Stage 1 Constraint is operated locally the scheme is still capable of operating and resetting automatically (as described above).

3.5.3.3 If Automatic Constraint is Disabled the scheme will not reset / operate automatically and it will not check that the customer has successfully implemented their constraint instructions.

4.0 SETTINGS – Soft Intertrip Only

4.1 When determining whether or not a Soft Intertrip scheme is appropriate consideration must be given to the limitations of the SCADA system and ENMAC / POF Sequential Schemes (SQC). Analogue information (e.g. current, voltage and power) measured by relays or transducers and then transmitted over SCADA have certain tolerances and the SCADA system will add significant time delays. Further guidance on the design of SQC schemes may be obtained from Operations Support.

4.2 Soft Intertrip schemes may be configured for connections involving generation only, demand only, or a combination of generation & demand behind a single connection point (e.g. battery storage). It is important that, whatever the specific application, a customer breaker is available to be wired to the Connection Control Panel Stage 2 output.

4.3 The settings applied to Connection Control Panels for Soft Intertrip are relatively straightforward since the conditions that trigger the constraint are implemented within an SQC scheme. Given this, many of the available settings are not applicable and should be left as defaults. A description of the available settings and guidelines on their application are given below:

a) CT Primary Current (A): The primary rating of the CTs. Typical values are 200, 400 or 800A

b) CT Secondary Current (A): The secondary rating of the CTs (i.e. 1A or 5A).

c) VT Primary Voltage (V): The primary voltage rating of the VT (i.e. 6600, 11000, 33000 or 66000).

d) VT Secondary Voltage (V): The secondary voltage rating of the VT (i.e. 110V).

e) Stage 1 Operate Voltage (V): Not applicable (leave on default)

f) Stage 1 Reset Voltage (V): Not applicable (leave on default)

g) Stage 1 Operate Time Delay (s): Not applicable (leave on default)

h) Stage 1 Operate Timer – Reset Delay (s): Not applicable (leave on default)

i) Stage 1 Reset Time Delay (s): Not applicable (leave on default)

j) Stage 1 Confirmation Contact Time Delay (s): This is the time limit within which the connected customer must confirm that the Stage 1 Constraint has been implemented (from initiation of the Stage 1 Constraint). Typically this is set to 1s.

k) Stage 1 Power Limit Time Delay (s): This is the time limit within which the measured Active Power must satisfy the Stage 1 Power Limit (from initiation of the stage 1 constraint).

l) Stage 2 Confirmation Contact Time Delay (s): This is the time limit within which the connected customer must confirm that the Stage 2 Constraint has been implemented (from initiation of the Stage 2 Constraint). This time delay must be greater than the setting on the Stage 2 Output Time Delay relay and is typically set to 25s.

m) Stage 2 Power Limit Time Delay (s): This is the time limit within which the measured Active Power must satisfy the Stage 2 Power Limit (from initiation of the stage 1 constraint). This delay must be greater than the Stage 2 Output Time Delay Relay and is typically set to 30s.

n) Stage 1 Power Setting (kW): depending on the status of the Generator Constraint and Demand Constraint functions, the stage 1 power import/export limit on the connected customer is determined either by the Stage 1 Power Setting alone, or in conjunction with the Stage 1 Power Delta setting (see (4.3.z) below) as follows:

   If the Generator Constraint Function is set to “1” and the Demand Constraint Function is set to “0” the CCP is set for <u>generation constraint</u> and the stage 1 power limit is equal to the Stage 1 Power Setting (irrespective of the Stage 1 Power delta (+/-) setting).

   If the Generator Constraint Function is set to “0” and the Demand Constraint Function is set to “1” the CCP is set for <u>demand constraint</u> and the stage 1 power limit is equal to the Stage 1 Power Setting (irrespective of the Stage 1 Power delta (+/-) setting).

In all cases, a positive value of Active Power indicates imported Active Power, while a negative value indicates exported active power. For a panel in generator constraint mode only, the measured power must be mathematically greater than the Stage 1 setting, in demand constraint mode the measured power must be mathematically lower than the Stage 1 setting.

If the Generator Constraint Function is set to "1" and the Demand Constraint Function is set to "1" the CCP is set for energy storage constraint and two stage 1 power limits (i.e. an upper limit and lower limit are provided).

o) Stage 2 Power Setting (kW): as per the description of the Stage 1 Power Setting (see 4.3.n above), depending on the status of the Generator Constraint and Demand Constraint functions, the stage 2 power import/export limit on the connected customer is determined either by the Stage 2 Power Setting alone, or in conjunction with the Stage 2 Power Delta setting (see (4.3.aa) below).

p) Power Dead Band (kW): This is a range of measured Active Power that is considered, by the CCP, to be zero. The reason for having a dead band is to ensure that errors in the CTs, VTs and programmable logic controller (PLC) do not give rise to false operations when Stage 1 or Stage 2 Power Limits are set at, or close to zero. The required setting depends on the connection voltage (i.e. VT primary voltage) and the rating of the CT primary winding. The minimum settings are given in the following table:

Minimum Power Dead Band Settings (kW)					
CT Primary (A)	**Connection Voltage**				
	132kV	**66kV**	**33kV**	**11kV**	**6.6kV**
50	90	50	30	10	10
100	180	90	50	20	10
200	350	180	90	30	20
400	690	350	180	60	40
600	1030	520	260	90	60
800	1380	690	350	120	70
1000	1720	860	430	150	90
1200	2060	1030	520	180	110

q) Frequent Operation Counter: Not applicable (leave on default)

r) Frequent Operation Alarm Time Delay (s): Not applicable (leave on default)

s) Voltage Block Setting (V): When the voltage drops below this value the Soft Intertrip Scheme is blocked. A setting of 80% of the primary VT winding shall be used.

For example, if an 11kV/110V VT is used the setting shall be 80% of 11kV = 8800V.

t) Soft Intertrip Algorithm: A value of 1 is applied, which implements the soft intertrip logic only (rather than Soft Intertrip logic in conjunction with the Voltage Constraint logic).

u) Agreed Export Capacity: The export capacity of the connected customer as per their connection agreement.

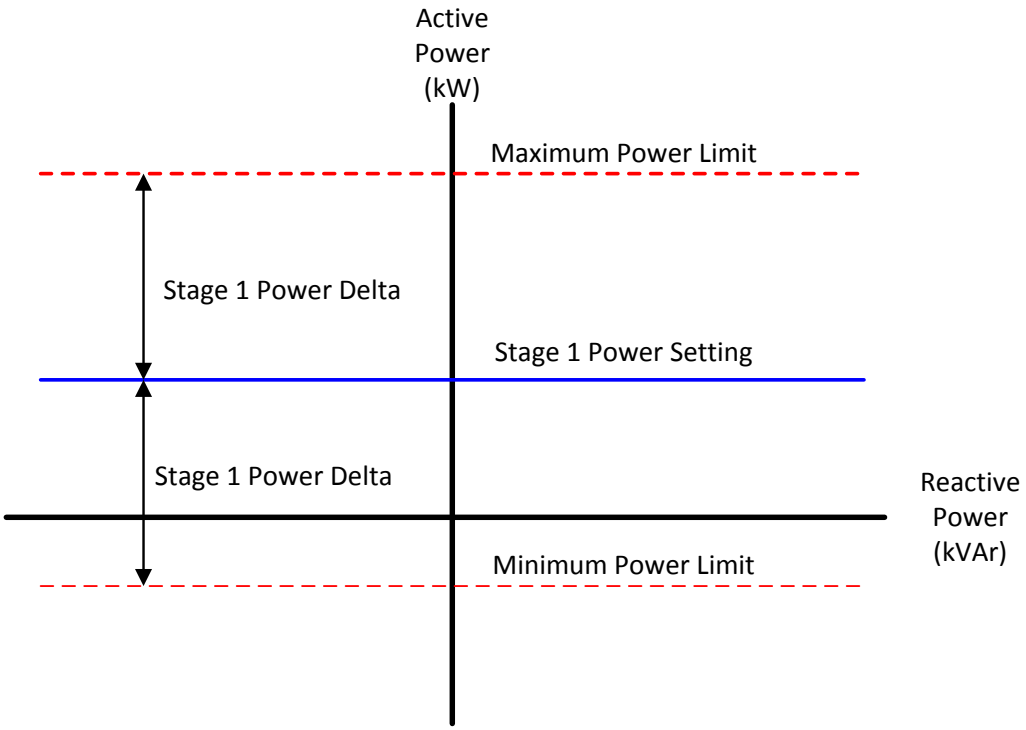
v) Agreed Export Capacity Exceeded Alarm Time Delay: The time period over which export must be above the Agreed Export Capacity before an alarm is sent to Control.

w) Comms Fail Restoration Time: The time period after restoration of communications links between the panel and PowerOn before the panel releases the Stage 1 constraint initiated after comms fail.

x) Agreed Import Capacity: The import capacity of the connected customer as per their connection agreement.

y) Agreed Import Capacity Exceeded Alarm Time Delay: The time period over which import must be above the Agreed Export Capacity before an alarm is sent to Control.

z) Stage 1 Power Delta (+/-): used only when <u>both</u> the demand constraint and generator constraint functions are set to "1". This setting is used in combination with the stage 1 power setting to determine both an upper and lower limit for the permitted power flow at the connection point, as per the diagram below:



aa) Stage 2 Power Delta (+/-): used only when both the demand constraint and generator constraint functions are set to "1". This setting is used in combination with the stage 2 power setting to determine both an upper and lower limit for the permitted power flow at the connection point, as per the diagram above.

The combination of stage 1 / stage 2 power settings and power deltas can be used to impose a "one-sided" constraint where the connected apparatus is capable of both export and import.

If a battery storage site, for example, were to be required to constrain to zero export under stage 1, but be unconstrained for import, then the stage 1 power setting would be half the agreed import capacity, with the stage 1 power delta also being set to half the import capacity.

Alternatively, the stage 2 output from the panel could be wired to trip a customer breaker, disconnecting the apparatus entirely.

bb) Demand Constraint Function: Set to "1" to enable demand constraint.

cc) Generator Constraint Function: Set to "1" to enable generator constraint.

Note that at least one of the demand / generator constraint functions must be enabled. Otherwise the panel will default to generator constraint.

dd) Comms Fail Operate Delay: the time interval over which communications must remain unavailable before the panel initiates a stage 1 constraint.

ee) Stage 2 Output Time Delay (s): This is a discrete time delay relay that closes a normally open contact to implement the stage 2 constraint. In some cases this contact is used to trip one or more generator circuit breakers. Where this is the case and the circuit breakers are located in the same switch room as the Generator Constraint Panel a time delay shall be applied to the relay to give a local operator time to vacate the room before the circuit breaker/s trip. The standard time delay is 20s. Note the Stage 2 Confirmation Time Delay and the Stage 2 Power Limit Time Delay settings must be greater than this setting.

A standard setting sheet is given in Appendix B1.

5.0 SETTINGS - Voltage Constraint Scheme with Soft Intertrip (Generation Only)

5.1 Unlike the Soft Intertrip-only schemes, Voltage Constraint schemes can only be applied to generation connections. Soft Intertrip functionality can, however, still be used.

5.2 Voltage constraint schemes are not, as standard, initiated by ENMAC/POF SQC schemes but instead operate when the voltage exceeds the Stage 1 Operate Voltage setting. The settings applied to Connection Control Panels for Voltage Constraint Schemes are, in general more complex than those for Soft Intertrip schemes. Guidance on the application of these setting is given below:

a) CT Primary Current (A): The primary rating of the CTs. Typical values are 200, 400 or 800A.

b) CT Secondary Current (A): The secondary rating of the CTs (i.e. 1A or 5A)

c) VT Primary Voltage (V): The primary voltage rating of the VT (i.e. 6600, 11000, 33000 or 66000).

d) VT Secondary Voltage (V): The secondary voltage rating of the VT (i.e. 110V)

e) Stage 1 Operate Voltage (V): The phase to phase voltage above which, the scheme picks up and starts the Stage 1 Operate Timer. This value only has to be exceeded by one phase to phase voltage to start the timer. A value that is 1% above the relevant voltage limit is typically applied

For an 11kV or 6.6kV network the maximum voltage limit is derived from Table 1 or Table 2 of POL: SD4, as applicable. For example, if WPD's distribution transformers are set on the +5% tap position the voltage limit is 11.59kV.

In this case a setting of 11590 x 101/100 = 11706V would be applied.

f) Stage 1 Reset Voltage (V): If Stage 1 Constraint is initiated and the measured phase to phase voltage across all phases is below the Stage 1 Reset Voltage setting the Stage 1 Reset Timer starts. Typically a setting of 99% of the Stage 1 Operate Setting is applied For the example in e) above, a setting of 11706 x 99/100 = 11589V would be applied.

g) Stage 1 Operate Time Delay (s): If the measured voltage exceeds the Stage 1 Operate Voltage for more than this duration the Stage 1 Constraint will operate. In most cases this time delay is set above the time delay applied to the tap-change control relays at the substation (primary substation, BSP etc.) that supplies the connection. This allows time for the tap-changers to resolve high voltage issues before the generator is constrained. If the tap-change control relays have a time delay of 90s, for example, a Stage 1 Operate Time Delay of 120s would be appropriate.

In some cases it may be necessary to apply a time delay which is shorter than the tap-change control relay delays, for example, at sites where the voltage is expected to rise substantially under back-feed conditions. Where this is the case the Stage 1 Operate Time Delay could be set as low as 10s.

h) Stage 1 Operate Timer (s) Reset Delay (s): Not currently used. Leave on the default value of 0s.

i) Stage 1 Reset Time Delay (s): Once the Stage 1 Constraint has operated, if the voltage returns below the Stage 1 Reset Voltage for longer than this setting the Stage 1 Constraint will reset. A setting of 10 minutes (600s) is recommended.

j) Stage 1 Confirmation Contact Time Delay (s): This is the time limit within which the Generator must confirm that the Stage 1 Constraint has been implemented (from initiation of the Stage 1 Constraint). Typically this is set to 1s.

k) Stage 1 Power Limit Time Delay (s): This is the time limit within which the measured Active Power must satisfy the Stage 1 Power Limit (from initiation of the stage 1 constraint). A setting of 10s is typical.

l) Stage 2 Confirmation Contact Time Delay (s): This is the time limit within which the Generator must confirm that the Stage 2 Constraint has been implemented (from initiation of the Stage 2 Constraint). This time delay must be greater than the setting on the Stage 2 Output Time Delay Relay and is typically set to 25s.

m) Stage 2 Power Limit Time Delay (s): This is the time limit within which the measured Active Power must satisfy the Stage 2 Power Limit (from initiation of the stage 1 constraint). This delay must be greater than the Stage 2 Output Time Delay Relay and is typically set to 30s.

n) Stage 1 Power Setting (kW): This is the Active Power limit that the Generator must satisfy when a Stage 1 Constraint is initiated. A positive value of Active Power indicates imported Active Power. This means that the measured Active Power must be mathematically greater than the limit in order for this requirement to be satisfied.

   For example, if the export must be reduced to 1MW when Stage 1 Constraint is initiated a value of -1000kW is selected. In this case a measured value of -999kW would satisfy the requirement.

o) Stage 2 Power Setting (kW): This is the Active Power limit that the Generator must satisfy when a Stage 2 Constraint is initiated. This value should be mathematically greater than Stage 1 Power limit.

For example, if the generator is expected to disconnect all generation when a Stage 2 Constraint is initiated a setting of 0kW would be selected. This value is mathematically greater than the -1000kW setting chosen in the Stage 1 Power limit example).

p) Power Dead Band (kW): This is a range of measured Active Power that is considered, by the CCP, to be zero. The reason for having a dead band is to ensure that errors in the CTs, VTs and programmable logic controller (PLC) do not give rise to false operations when Stage 1 or Stage 2 Power Limits are set at, or close to zero. The required setting depends on the connection voltage (i.e. VT primary voltage) and the rating of the CT primary winding. The minimum settings are given in the following table:

Minimum Power Dead Band Settings (kW)					
CT Primary (A)	**Connection Voltage**				
	132kV	**66kV**	**33kV**	**11kV**	**6.6kV**
50	90	50	30	10	10
100	180	90	50	20	10
200	350	180	90	30	20
400	690	350	180	60	40
600	1030	520	260	90	60
800	1380	690	350	120	70
1000	1720	860	430	150	90
1200	2060	1030	520	180	110

q) Frequent Operation Counter: It is possible that under N-1 conditions the voltage constraint scheme will operate and reset several times in short succession (as the generation is constrained then restored again etc. A Frequent Operations Alarm is provided that warns control if the number of operations exceeds the number defined by the Frequent Operations Counter within the Frequent Operation Time Delay. A setting of 3 is recommended.

r) Frequent Operation Alarm Time Delay (s): The time delay associated with the Frequent Operations Alarm as described above. A setting of 40 minutes is typically applied.

s) Voltage Block Setting (V): When the voltage drops below this value the Soft Intertrip Scheme is blocked. A setting of 80% of the primary VT winding shall be used.

For example, if an 11KV/110V VT is used the setting shall be 80% of 11kV = 8800V.

t) Soft Intertrip Algorithm: A value of 0 is applied, which implements the Voltage Constraint logic in conjunction with the Soft Intertrip logic (rather than the Soft Intertrip logic only).

u) Agreed Export Capacity: The export capacity of the connected customer as per their connection agreement

v) Agreed Export Capacity Exceeded Alarm Time Delay: The time period over which export must be above the Agreed Export Capacity before an alarm is sent to Control.

w) Comms Fail Restoration Time: The time period after restoration of communications links between the panel and PowerOn before the panel releases the Stage 1 constraint initiated after comms fail.

x) Agreed Import Capacity: The import capacity of the connected customer as per their connection agreement.

y) Agreed Import Capacity Exceeded Alarm Time Delay: The time period over which import must be above the Agreed Export Capacity before an alarm is sent to Control.

z) Stage 1 Power Delta (+/-): Not applicable.

aa) Stage 2 Power Delta (+/-): Not applicable.

bb) Demand Constraint Function: Voltage constraint schemes applicable to generation only, set to “0” to disable demand constraint.

cc) Generator Constraint Function: Set to “1” to enable generator constraint.

Note that at least one of the demand / generator constraint functions must be enabled. Otherwise the panel will default to generator constraint.

dd) Comms Fail Operate Delay: the time interval over which communications must remain unavailable before the panel initiates a stage 1 constraint.

ee) Stage 2 Output Time Delay (s): This is a discrete time delay relay that closes a normally open contact to implement the stage 2 constraint. In some cases this contact is used to trip one or more generator circuit breakers. If this is the case and the circuit breakers are located in the same switch room as the Generator Constraint Panel a time delay shall is applied to the relay to give a local operator time to vacate the room before the circuit breaker/s trip. The standard time delay is 20s. Note the Stage 2 Confirmation Time Delay and the Stage 2 Power Limit Time Delay settings must be greater than this setting.

A standard setting sheet is given in Appendix B2.

6.0 PLANT ORDERING AND COSTS

6.1 Plant Ordering Process

6.1.1 Plant ordering forms for CCPs are available from the WPD Plant Centre Ordering link on the Corporate Information page. At the time of writing the following options are available:

- Option A: CCP with T1/21 RN2d RMU with 200A tee off, T300, Modbus card, 3 actuators, CT/VT marshalling cabinet, VIP300/VIP400 and MU2d/N25 Metering Unit (100/50/5 metering CTs).

- Option B: CCP with T2/21 RN2d RMU with 200A tee off, T300, Modbus card, 3 actuators, CT/VT marshalling cabinet, VIP300/VIP400 relay and MU2d/N26 Metering Unit (200/100/5 metering CTs).

- Option C: CCP with T2/21 RN6c RMU with 630A tee off, T300, Modbus card, 3 actuators, CT/VT marshalling cabinet, VIP300 relay and MU6/N16 Metering Unit (400/200/5 metering CTs).

- Option D: CCP with T2/21 RN6c RMU with 630A tee off, T300, Modbus card, ACE card, DC to DC converter, 3 actuators, CT/VT marshalling cabinet, Sepam Relay (with NVD) and MU6/N16 Metering Unit (400/200/5 metering CTs).

- Option E: CCP only suitable for use with 1A protection CTs

- Option F: CCP only suitable for use with 5A protection CTs

6.1.2 A marshalling cabinet may, in some cases, be required between the CCP and Generator's equipment/switchgear. Where this is the case, this shall be specified and ordered separately.

6.2 Communications System Ordering Process

6.2.1 SURF Telecom two different ordering processes, one for 11kV Automation (which rely on unlicensed communications) and another for Licensed Communication Systems (for Soft Intertrip Schemes and for all ≥33kV sites):

6.2.1.1 Unlicensed Radio (i.e. for 11kV and 6.6kV Automation)
Unlicensed Radio systems for 11kV and 6.6kV Voltage Constraint Schemes are ordered via the SURF Automation Request Form which may be accessed from the Corporate Information Page or via the following link:

11kV Automation Request Forms

Two forms are available, one for the Midlands and another for the South West and Wales.

For all Midlands Areas, and also for South West and South Wales locations using the new PDR121 radio systems, the following facilities shall be ordered:

- DNP_T200_4 (for the switchgear requirements)
- DNP_LDCON (for the CCP)

For South West and South Wales locations that utilise existing Netman radio systems:

- T200_CGGC (for the switchgear and CCP)

Note, where a SEPAM relay is fitted to the Ringmaster RMU and NVD facilities are required this requirement must be specifically stated in the comments field.

6.2.1.2 Licensed Radio (i.e. Soft Intertrip and all ≥33kV Connections)

For all licensed radio applications the SURF Enquiry Form shall be used. This form is available via "SURF Telecom" and then "SURF Solutions" link on the Corporate Information page. Alternatively the following link may be used:

SURF Enquiry Form

6.3 Costs

6.3.1 CROWN estimating and charging includes Standard Work Elements (SWEs) for CCPs. Two options are included, one for an 11kV or 6.6kV CCP and another for a 33kV or 66kV CCP. In both cases costs are included for connecting and testing the CCPs. These costs include the provision of a CT/VT Marshalling Cabinet (in the case of ordering options A, B, C and D).

6.3.2 An additional marshalling cabinet may, in some cases, need to be installed between the CCP and the Generator's switchgear / equipment (as shown in Figure 1). Any such costs shall be included as an extra.

6.3.3 SWEs have not been set up for the costs associated with the radio system. These costs, which are provided by SURF Telecom, shall be added as an extra.

7.0 COMPETITION IN CONNECTIONS

7.1 The CCPs, customer interface panels, and radio equipment is deemed to be non-contestable whereas the associated switchgear, metering unit and T300 RTU are all contestable. Appendix A includes a list of the contestable plant items for ordering options A to D.

7.2 For ordering option A to D, where an ICP is providing the Schneider RMU, metering unit and RTU, the ICP must deliver their equipment to the WPD's Plant Workshop at Cwmbran or Huthwaite so that the CCP can be connected and all the equipment tested together before being delivered to site. The contestable plant items described in Appendix A includes multicore cables and glands that are used to connect between the various items. Additional cables and glands are provided by WPD.

7.3 In the case of ordering option E and F the Plant Centre will test the CCP separately. It will then be connected to the remaining equipment on site. In this case the multicore cables and glands that connect between the CCP and WPDs switchgear and SCADA equipment will be provided and installed by WPD. The complete system will then be tested and commissioned.

7.4 Multicores required between the customer's equipment and the CCP / marshalling cabinet shall be provided by the customer. WPD or the ICP, as appropriate, shall connect the multicores to the CCP / marshalling cabinet.

8.0 COMMISSIONING REQUIREMENTS

8.1 Testing in the Workshop

8.1.1 CCPs must undergo extensive commissioning in Cwmbran or Huthwaite Plant Workshop prior to being installed on site. Where the panel is associated with a new 11kV ring main unit the CCP, Automation RTU and the plant (switchgear and metering unit) shall be connected and tested together. Further information will be provided in ST:SP10LA (Workshop Testing of Soft Intertrip Schemes) and ST:SP10LB (Workshop testing of Voltage Constraint Schemes).

8.2 On Site Testing

8.2.1 Additional tests and checks are required on site. These tests should include (but are not limited to):

- Visual inspection of the CCP, CT connections VT connections and auxiliary supply connections.
- Application and check of final settings
- On load tests to confirm CT and VT connections and the magnitude of the voltage, current, active power and reactive power measured by the CCP. These test should confirm that the power flow is in the correct direction (imported power is +ve).
- Local and remote operation of the CCP to confirm to its operation and associated indications (local and remote indications and alarms).
- Check that the generation is constrained correctly and the generator provides confirmation signals.

APPENDIX A

LIST OF CONTESTIBLE PLANT ITEMS ASSOCIATED WITH CCP INSTALLATIONS

Description of Item	WPD E5 Reference No.
Plant Ordering Option A	
Schneider T1/21 RN2d RMU with 200A tee off, VIP400 & 3 actuators (including CB actuator)	61750
Schneider Metering Unit MU2d - N25 100/50/5 CTs	61755
Schneider T300	61701
Schneider T300 Mounting Kit	61853
Schneider Modbus Card *	43496
Plant Ordering Option B	
Schneider T1/21 RN2d RMU with 200A tee off, VIP400 & 3 actuators (including CB actuator)	61750
Schneider Metering Unit MU2d - N26 200/100/5 CTs	61756
Schneider T300	61701
Schneider T300 Mounting Kit	61853
Schneider Modbus Card *	43496
Plant Ordering Option C	
Schneider T1/21 RN6c RMU with 630A tee off, VIP300 & 3 actuators (including CB actuator)	42597
Schneider Metering Unit N16 400/200/5 CTs	60769
Schneider T300	61701
Schneider T300 Mounting Kit	61852
Schneider Modbus Card *	43496
Plant Ordering Option D	
Schneider T1/21 RN6c RMU with 630A tee off, SEPAM Relay & 3 actuators (including CB actuator) and DC to DC converter.	60776
Schneider Metering Unit N16 400/200/5 CTs	60769
Schneider T300	61701
Schneider T300 Mounting Kit	61852
Schneider Modbus Card	43496

* For Options A, B and C the Modbus cards are not required for installations in East Midlands and West Midlands Areas

APPENDIX B1

GENERIC SETTING SHEET (Soft Intertrip Only)

Parameter	Setting	Software Parameter	Software Value
CT Primary Current	800A	CT Secondary	800
CT Secondary Current	1A	CT Primary	1
VT Primary	33000V	VT Secondary	300
VT Secondary	110V	VT Primary	1
Stage 1 Operate Voltage	Not used	S1_VT1_ENABLE	Not used
Stage 1 Reset Voltage	Not used	S1_VT2_DISABLE	Not used
Stage 1 Operate Time Delay	Not used	TT1_S1_ENABLE_TIME	Not used
Stage 1 Operate Timer - Reset Delay	Not used	S1_RESET_TIMER_PERIOD	Not used
Stage 1 Reset Time Delay	Not used	TT2_S1_DISABLE_TIME	Not used
Stage 1 Confirmation Contact Time Delay	1s	S1_RESP_TIME	1,000ms
Stage 1 Power Limit Time Delay	10s	TT3_S2_ENABLE_TIME	10,000ms
Stage 2 Confirmation Time Delay*	25s	S2_RESP_TIME	25,000ms
Stage 2 Power Limit Time Delay*	30s	FAILED_TO CONSTRAIN_TIMEOUT	30,000ms
Stage 1 Power Setting	-5000kW	PWR_MIN_ALLOWED	-5000kW
Stage 2 Power Setting	0kW	FTC_PWR_MIN_ALLOWED	0kW
Power Dead Band (+/-)	+/- 500kW	PWR_DISCONNECT _DELTA	500kW
Frequent Operations Alarm Count	3	FOP_ALLOWABLE_COUNT	3
Frequent Operations Alarm Time Delay	2400s	FOP_ALLOWABLE_TIME	2400000mS
Voltage Block Setting	26.40kV	VALID_VOLTAGE_LEVEL	26400V
Soft Intertrip Algorithm 0 = Voltage Constraint 1 = Soft Intertrip	1	ENABLE_SOFT_INTERTRIP	1
Agreed Export Capacity	10000kW	MAX_EXPORT_CAPACITY	-10000kW
Export Capacity Exceeded Alarm Time Delay	30s	EXPORT_ALARM_ENABLE_TIME	30,000mS
Comms. Fail Restoration Time	30s (test) 300s (default)	COMMS_FAIL_RESTORE_TIME	30,000mS
Agreed Import Capacity	10000kW	MAX_IMPORT_CAPACITY	10000kW
Import Capacity Exceeded Alarm Time Delay	30s	IMPORT_ALARM_ENABLE_TIME	30,000mS
Stage 1 Power Delta (+/-)[2]	+/- 0kW	TARGET_POWER_DELTA	0
Stage 2 Power Delta (+/-)[2]	+/- 0kW	FTC_POWER_DELTA	0
Generation Constraint Function[1] 0 = Disabled 1 = Enabled	0	ENABLE_EXPORT_CONSTRAINT	0
Demand Constraint Function[1] 0 = Disabled 1 = Enabled	1	ENABLE_IMPORT_CONSTRAINT	1
Comms. Fail Operate Delay	10s (test) 180s (default)	COMMS_FAIL_DELAY_TIME	10,000mS
Stage 2 Output Time Delay Relay (discrete relay)	10s		

APPENDIX B2

GENERIC SETTING SHEET (Soft Intertrip with Voltage Constraint)

Parameter	Setting	Software Parameter	Software Value
CT Primary Current	800A	CT Secondary	800
CT Secondary Current	1A	CT Primary	1
VT Primary	33000V	VT Secondary	300
VT Secondary	110V	VT Primary	1
Stage 1 Operate Voltage	35.33kV	S1_VT1_ENABLE	35330V
Stage 1 Reset Voltage	34.98kV	S1_VT2_DISABLE	34977V
Stage 1 Operate Time Delay	10s (test) 100s (default)	TT1_S1_ENABLE_TIME	10,000ms
Stage 1 Operate Timer - Reset Delay	0s	S1_RESET_TIMER_PERIOD	0s
Stage 1 Reset Time Delay	10s	TT2_S1_DISABLE_TIME	10,000ms
Stage 1 Confirmation Contact Time Delay	1s	S1_RESP_TIME	1,000ms
Stage 1 Power Limit Time Delay	10s	TT3_S2_ENABLE_TIME	10,000ms
Stage 2 Confirmation Time Delay*	25s	S2_RESP_TIME	25,000ms
Stage 2 Power Limit Time Delay*	30s	FAILED_TO CONSTRAIN_TIMEOUT	30,000ms
Stage 1 Power Setting	-5000kW	PWR_MIN_ALLOWED	-5000kW
Stage 2 Power Setting	0kW	FTC_PWR_MIN_ALLOWED	0kW
Power Dead Band (+/-)	+/- 500kW	PWR_DISCONNECT _DELTA	500kW
Frequent Operations Alarm Count	3	FOP_ALLOWABLE_COUNT	3
Frequent Operations Alarm Time Delay	2400s	FOP_ALLOWABLE_TIME	2400000mS
Voltage Block Setting	26.40kV	VALID_VOLTAGE_LEVEL	26400V
Soft Intertrip Algorithm 0 = Voltage Constraint 1 = Soft Intertrip	0	ENABLE_SOFT_INTERTRIP	0
Agreed Export Capacity	10000kW	MAX_EXPORT_CAPACITY	-10000kW
Export Capacity Exceeded Alarm Time Delay	30s	EXPORT_ALARM_ENABLE_TIME	30,000mS
Comms. Fail Restoration Time	30s (test) 300s (default)	COMMS_FAIL_RESTORE_TIME	30,000mS
Agreed Import Capacity	10000kW	MAX_IMPORT_CAPACITY	10000kW
Import Capacity Exceeded Alarm Time Delay	30s	IMPORT_ALARM_ENABLE_TIME	30,000mS
Stage 1 Power Delta (+/-)[2]	+/- 0kW	TARGET_POWER_DELTA	0
Stage 2 Power Delta (+/-)[2]	+/- 0kW	FTC_POWER_DELTA	0
Generation Constraint Function[1] 0 = Disabled 1 = Enabled	1	ENABLE_EXPORT_CONSTRAINT	1
Demand Constraint Function[1] 0 = Disabled 1 = Enabled	0	ENABLE_IMPORT_CONSTRAINT	0
Comms. Fail Operate Delay	10s (test) 180s (default)	COMMS_FAIL_DELAY_TIME	10,000mS
Stage 2 Output Time Delay Relay (discrete relay)	10s		

APPENDIX C

DRAWINGS

Schematic drawings and wiring diagrams applicable to the ZIV connection control panel can be found here.

APPENDIX D

SUPERSEDED DOCUMENTATION

This document supersedes ST:TP18A dated June 2015 which has now been withdrawn.

APPENDIX E

ANCILLARY DOCUMENTATION

POL:SD4	11kV and 6.6kV Network Design
POL:SD3	33kV and 66kV Network Design
POL:SD10	Managing Processes for Alternative Connections
ST:SD10A	Process for Offering a Timed Connection
ST:SD10B	Process for Offering a Soft Intertrip Connection
ST:SP10LA	Workshop Testing of Generator Constraint Panels Configured for Soft Intertrip
ST:SP10LB	Workshop Testing of Generator Constraint Panels Configured for Voltage Constraint
POL: TP14	Electricity Metering Interface

APPENDIX F

KEY WORDS

Constraint, Curtail, Generator Constraint Panel, Demand Constraint, Energy Storage Constraint, CCP, Voltage Constraint, Soft Intertrip, Active Network Management.