

# GRID CODE REVIEW PANEL

21 November 2002

## HV DC INTERCONNECTORS WORKING GROUP REPORT TO THE GRID CODE REVIEW PANEL

### Contents

1. Summary .....	2
2 Introduction.....	2
3 Issues Discussed.....	2
4 Recommendations.....	3
Appendix 1 - Terms of Reference .....	4
Appendix 2 - Working Group Membership .....	5
Appendix 3 – Outstanding Issues .....	6
Appendix 4 - Proposed Grid Code Modifications.....	7
A) Extracts from Glossary and Definitions .....	7
B) Extracts from The Planning Code .....	11
C) Extracts from Connection Conditions.....	28
D) Extracts from Balancing Code No 3 .....	48
E) Extracts from Data Registration Code.....	56
F) Consequential Changes .....	64

## 1. Summary

- 1.1 This report has been prepared by a working group of the Grid Code Review Panel to report on the review and suggestions for Grid Code amendments to deal with the inclusion of provisions for new HV DC Interconnectors.

## 2 Introduction

- 2.1 At a meeting of the Grid Code Review Panel on 21<sup>st</sup> February 2002, NGC tabled paper GCRP 02/05 containing initial proposals for Grid Code additions and it was agreed that a working group should be established to review these proposals, with the Terms of Reference as shown in [Appendix 1](#). The membership of the Working Group is shown in [Appendix 2](#).

## 3 Issues Discussed

- 3.1 The Working Group met on 4 occasions between June and September 2002. The proposals contained in paper GCRP 02/05 formed the basis of the Working Group discussions. Members expressed a number of views – in some instances believing that it would be inappropriate to include such detailed provisions in the Grid Code. Major issues discussed included:-
- ∂ Recognition that the proposed revisions would only apply to new DC Converters as they mainly related to facilities being built in at the design stage.
  - ∂ Concern over the provisions for DC Converters being modelled on those for Generating Units when the technology and utilisation is completely different.
  - ∂ The desirability to express obligations on the basis of a “DC Converter Station in each of its viable operating configurations” rather than on the basis of an individual DC Converter;
  - ∂ The need for a distinction between the requirement for **capability** for certain services (e.g. frequency response) to be built in at the planning stage, but for the **usage** of the capability to be subject to a separate agreement between the DC Converter owner and the operators of the two systems on either side of the interconnector, outside of the Grid Code.
  - ∂ Potential confusions arising from the use of terms “import” and “export” and the direction of power flow.
  - ∂ A number of “current operational issues” were raised by the representative from SEEBoard Power Networks. It was agreed that these would be discussed outside of the Working Group.
- 3.2 The discussions in the Working Group did not lead to the resolution of all outstanding issues. As there was a desire to complete the work of this group as soon as possible in the expectation of its output being passed to the “Generic Provisions Working Group”, it was agreed that a list of outstanding issues would be compiled for inclusion in the Working Group Report. This can be found in [Appendix 3](#).

- 3.3 Arising from the Working Group discussions, a number of changes were made to the original proposals attached to GCRP 02/05 and these are included in this report as [Appendix 4](#).

## **4 Recommendations**

- 4.1 Members of the Grid Code Review Group are invited to discuss the work of the HV DC Interconnectors Working Group with a view to agreeing that this report and the minutes of working group meetings should be passed to the Generic Provisions Working Group for inclusion with the work being undertaken by that Group.

## **Appendix 1 - Terms of Reference**

### **Workplan**

Review background to the need for additional provisions in the Grid Code

Consider National Grid initial proposals of paper GCRP 02/05

- ∂ Connection Conditions
- ∂ Defined terms
- ∂ Planning Code
- ∂ BC3
- ∂ Other Consequential changes

Produce Working Group Report

### **Timescales**

A target is set of a report from the working group to be provided to the meeting of the Grid Code Review Panel in November 2002

## Appendix 2 - Working Group Membership

Geoff Charter	National Grid (Chair)
Nigel Brooks	National Grid (Operations & Trading)
Steve Mortimer	National Grid (Network Strategy)
Alan Roe/Keith Jackson	National Grid (Interconnectors)
William Hung	National Grid
Piers Anthony	Powergen
Francois Boulet	RTE
Stuart Stone	SEEBoard Power Networks
Steve Drummond	SMD Consulting
Allan Macleod	Scottish Power
Peter Sherwood	Scottish Power
Hamish Dallachy	Scottish Power

### **Appendix 3 – Outstanding Issues**

1. PC.A.7 needs to refer to new types of plant other than just Power Stations.
2. Provision of frequency response capability in the CC and utilisation in BC3 need to be specified for operation of link in either direction.
3. There is a need to highlight low level of DC Converter Station DMOL compared with generating units.
4. Export & Import directions need to be resolved, as the “natural” meaning of “Export” on an Interconnector implies a power flow away from the NGC system, whereas “Export” from a power station implies a power flow into the NGC system.
5. CUSC Amendment Proposal 43 is currently being discussed with a view to clarifying some of the terms in use which relate to access to the Transmission System. This is likely to lead to some required changes to some Grid Code terms which may interact with some of the terms proposed in this paper.
6. Consequential changes to be checked and developed.

## Appendix 4 - Proposed Grid Code Modifications

### A) Extracts from Glossary and Definitions

**Auxiliaries** Any item of **Plant** and/or **Apparatus** not directly a part of the boiler plant or **Generating Unit** or **DC Converter Station**, but required for the boiler plant's or **Generating Unit's** or **DC Converter Station's** functional operation.

**Control Centre** A location used for the purpose of control and operation of the **NGC Transmission System** or a **User System** other than a **Generator's** or **DC Converter Owner's** **System** or an **External System**.

**Control Point** The point from which:-

- a) A **Non-Embedded Customer's Plant** and **Apparatus** is controlled; or
- b) A **BM Unit**, in England or Wales at a **Large Power Station** or at a **Medium Power Station** or with a **Demand Capacity** with a magnitude of 50MW or more, is physically controlled by a **BM Participant**; or
- c) In the case of any other **BM Unit**, data submission is co-ordinated for a **BM Participant** and instructions are received from **NGC**,

as the case may be. For a **Generator** this will normally be at a **Power Station**. In the case of a **BM Unit** of an **Interconnector User**, the **Control Point** will be the **Control Centre** of the relevant **Externally Interconnected System Operator**. In the case of a **DC Converter Station**, the **Control Point** will be at a location agreed with **NGC**.

**DC Converter** Any **Apparatus** with a **Completion Date** after *[the Implementation Date]* used to convert alternating current electricity to direct current electricity, or vice-versa for the purpose of connection to the **NGC Transmission System** or a **User System**. A **DC Converter** is a standalone operative configuration at a single site comprising one or more converter bridges, together with one or more converter transformers, converter control equipment, essential protective and switching devices and auxiliaries, if any, use for conversion. In a bipolar arrangement, a **DC Converter** represents the bipolar configuration.

**DC Converter Owner** The owner of a **DC Converter Station**.

<b><u>DC Converter Station</u></b>	<p><u>An installation comprising one or more DC Converters connecting a direct current interconnector:</u></p> <p><u>∂ to the NGC Transmission System; or</u></p> <p><u>∂ (if the installation has a rating of 50MW or more) to a User System,</u></p> <p><u>comprising part of an External Interconnection.</u></p>
<b><u>DC Network</u></b>	<u>All items of Plant and Apparatus connected together on the direct current side of a DC Converter.</u>
<b><u>Designed Minimum Operating Level</u></b>	The output (in whole MW) below which a <b>Genset or a DC Converter Station</b> (in any of its viable operating configurations) has no <b>High Frequency Response</b> capability.
<b><u>De-Synchronise</u></b>	<p>a) The act of taking a <b>Generating Unit or a DC Converter Station</b> off a <b>System</b> to which it has been <b>Synchronised</b>, by opening any connecting circuit breaker; or</p> <p>b) The act of ceasing to consume electricity at an importing <b>BM Unit</b>;</p> <p>and the term "De-Synchronising" shall be construed accordingly.</p>
<b><u>Export Usable</u></b>	<u>That portion of Registered Export Capacity which remains after the deduction of allowances for Planned Outages and breakdown.</u>
<b><u>Grid Entry Point</u></b>	A point at which a <b>Generating Unit</b> or a <b>CCGT Module</b> or a <b>CCGT Unit or a DC Converter</b> , as the case may be, which is directly connected to the <b>NGC Transmission System</b> , connects to the <b>NGC Transmission System</b> .
<b><u>HV Generator Connections</u></b>	Apparatus connected at the same voltage as that of the NGC Transmission System, including Users' circuits, the higher voltage windings of Users' transformers and associated connection Apparatus.
<b><u>Import Usable</u></b>	<u>That portion of Registered Import Capacity which remains after the deduction of allowances for Planned Outages and breakdown.</u>
<b><u>Limited Frequency Sensitive Mode</u></b>	A mode whereby the operation of the <b>Genset (or DC Converter Station exporting Active Power to the Total System)</b> is <b>Frequency</b> insensitive except when the <b>System Frequency</b> exceeds 50.4Hz, from which point <b>Limited High Frequency Response</b> must be provided.
<b><u>Limited High Frequency Response</u></b>	A response of a <b>Genset (or DC Converter Station exporting Active Power to the Total System)</b> to an increase in <b>System Frequency</b> above 50.4Hz leading to a reduction in <b>Active Power</b> in accordance with the provisions of BC3.7.2.

**Minimum Export Capacity**

The minimum output (in whole MW) from a DC Converter Station (in any of its viable operating configurations) at the Grid Entry Point (or in the case of an Embedded DC Converter Station at the User System Entry Point) at which a DC Converter Station can operate in a stable manner, as registered with NGC under the PC (and amended pursuant to the PC). For the avoidance of doubt, the output may go below this level as a result of operation in accordance with BC3.7, unless the Minimum Export Capacity equals the Designed Minimum Operating Level.

**Minimum Import Capacity**

The minimum input (in whole MW) into a DC Converter Station (in any of its viable operating configurations) at the Grid Entry Point (or in the case of an Embedded DC Converter Station at the User System Entry Point) at which a DC Converter Station can operate in a stable manner, as registered with NGC under the PC (and amended pursuant to the PC).

**Operational Intertripping**

The automatic tripping of circuit-breakers to prevent abnormal system conditions occurring, such as over voltage, overload, **System** instability, etc. after the tripping of other circuit-breakers following power **System** fault(s) which includes **System** to **Generating Unit**, **System** to **CCGT Module**, **System to DC Converter** and **System** to **Demand** intertripping schemes.

**Planned Maintenance Outage**

An outage of the **NGC** electronic data communication facilities as provided for in CC.6.56.8 and **NGC's** associated computer facilities of which normally at least 5 days notice is given, but in any event of which at least twelve hours notice has been given by **NGC** to the **User** and which is anticipated to last no longer than 2 hours. The length of such an outage may in exceptional circumstances be extended where at least 24 hours notice has been given by **NGC** to the **User**. It is anticipated that normally any planned outage would only last around one hour.

**Rated MW**

The "rating-plate" MW output of a **Generating Unit**, being that output up to which the **Generating Unit** was designed to operate (Calculated as specified in **British Standard BS EN 60034 - 1: 1995**) or the nominal rating for the MW import capacity and export capacity of a DC Converter Station at the Grid Entry Point (or in the case of an Embedded DC Converter Station at the User System Entry Point).

**Registered Export Capacity**

a) In the case of a DC Converter Station, the maximum amount of Active Power transferable from a DC Converter Station at the Grid Entry Point (or in the case of an Embedded DC Converter Station at the User System Entry Point), as declared by the DC Converter Owner, expressed in whole MW.

b) In the case of a DC Converter, the normal full load amount of Active Power transferable from a DC Converter at the Grid Entry Point (or in the case of an Embedded DC Converter Station at the User System Entry Point), as declared by the DC Converter Owner, expressed in whole MW.

<u>Registered Import Capacity</u>	<p>a) <u>In the case of a DC Converter Station, the maximum amount of Active Power transferable into a DC Converter Station at the Grid Entry Point (or in the case of an Embedded DC Converter Station at the User System Entry Point), as declared by the DC Converter Owner, expressed in whole MW.</u></p> <p>b) <u>In the case of a DC Converter, the normal full load amount of Active Power transferable into a DC Converter at the Grid Entry Point (or in the case of an Embedded DC Converter Station at the User System Entry Point), as declared by the DC Converter Owner, expressed in whole MW.</u></p>
<u>Station Transformer</u>	<p>A transformer supplying electrical power to the <b>Auxiliaries</b> of:</p> <p><u>∂</u> –a <b>Power Station</b>, which is not directly connected to the <b>Generating Unit</b> terminals (typical voltage ratios being 132/11kV or 275/11kV), <u>or</u></p> <p><u>∂</u> a <b>DC Converter Station</b>.</p>
<u>Synchronised</u>	<p>a) The condition where an incoming <b>Generating Unit, DC Converter</b> or <b>System</b> is connected to the busbars of another <b>System</b> so that the <b>Frequencies</b> and phase relationships of that <b>Generating Unit, DC Converter</b> or <b>System</b>, as the case may be, and the <b>System</b> to which it is connected are identical, like terms shall be construed accordingly.</p> <p>b) The condition where an importing <b>BM Unit</b> is consuming electricity.</p>
<u>System Constrained Capacity</u>	<p>That portion of <b>Registered Capacity</b> <u>or Registered Export Capacity or Registered Import Capacity</u> not available due to a <b>System Constraint</b>.</p>
<u>User System Entry Point</u>	<p>A point at which a <b>Generating Unit</b>, a <b>CCGT Module</b>, a <b>CCGT Unit</b>, <u>or a DC Converter</u>, as the case may be, which is <b>Embedded</b> connects to the <b>User System</b>.</p>

## B) Extracts from The Planning Code

PC.3 SCOPE

PC.3.1 The **PC** applies to **NGC** and to **Users**, which in the **PC** means:

- (a) **Generators;**
- (b) **Network Operators;**~~and~~
- (c) **Non-Embedded Customers;** and
- (d) **DC Converter Owners.**

The above categories of **User** will become bound by the **PC** prior to them generating, supplying or consuming, as the case may be, and references to the various categories (or to the general category) of **User** should, therefore, be taken as referring to them in that prospective role as well as to **Users** actually connected.

PC.3.2 In the case of **Embedded Power Stations** and Embedded DC Converters, unless provided otherwise, the following provisions apply with regard to the provision of data under this **PC**:

- (a) each **Generator** shall provide the data direct to **NGC** in respect of **Embedded Large Power Stations** and **Embedded Medium Power Stations**;
- (b) each **DC Converter Owner** shall provide the data direct to **NGC** in respect of **Embedded DC Converter Stations**;
- (bc) although data is not normally required specifically on **Embedded Small Power Stations** (or on installations of direct current converters which do not form a DC Converter Station) under this **PC**, each **Network Operator** in whose **System** they are **Embedded** should provide the data (contained in the Appendix) to **NGC** in respect of **Embedded Small Power Stations** or installations of direct current converters which do not form a DC Converter Station if:
  - (i) it falls to be supplied pursuant to the application for a **CUSC Contract** or in the **Statement of Readiness** to be supplied in connection with a **Bilateral Agreement** and/or **Construction Agreement**, by the **Network Operator**; or
  - (ii) it is specifically requested by **NGC** in the circumstances provided for under this **PC**.

PC.3.3 Certain data does not normally need to be provided in respect of certain **Embedded Power Stations** or Embedded DC Converter Stations, as provided in PC.A.1.12.

PC.4 PLANNING PROCEDURES

PC.4.1 Pursuant to Supplementary Standard Condition C7G of the **Transmission Licence**, the means by which **Users** and proposed **Users** of the **NGC Transmission System** are able to assess opportunities for connecting to, and using, the **NGC Transmission System** comprise two distinct parts, namely:

- (a) a statement, prepared by **NGC** under the **Transmission Licence**, showing for each of the seven succeeding **NGC Financial Years**, the opportunities available for connecting to and using the **NGC Transmission System** and indicating those parts of the **NGC Transmission System** most suited to new connections and transport of further quantities of electricity (the "**Seven Year Statement**"); and
- (b) an offer, in accordance with the **Transmission Licence**, by **NGC** to enter into a **CUSC Contract** for connection to (or, in the case of **Embedded Large Power Stations** ~~and~~, **Embedded Medium Power Stations** and Embedded DC Converter Stations, use of) the **NGC Transmission System**. A **Bilateral Agreement** is to be entered into for every **Connection Site** (and for certain **Embedded Power Stations** and for Embedded DC Converter Stations, as explained above) within the first two of the following categories and the existing **Bilateral Agreement** may be required to be varied in the case of the third category:
  - (i) existing **Connection Sites** (and for certain **Embedded Power Stations**, as detailed above) as at the **Transfer Date**;
  - (ii) new **Connection Sites** (and for certain **Embedded Power Stations**, and for Embedded DC Converter Stations as detailed above) with effect from the **Transfer Date**;
  - (iii) a **Modification** at a **Connection Site** (or in relation to the connection of certain **Embedded Power Stations** and for Embedded DC Converter Stations, as detailed above) (whether such **Connection Site** or connection exist on the **Transfer Date** or are new thereafter) with effect from the **Transfer Date**.

In this **PC**, unless the context otherwise requires, "connection" means any of these 3 categories.

.....

PC.4.2.4 Clearly, an existing **User** proposing a new **Connection Site** (or **Embedded Power Station** or Embedded DC Converter Station in the circumstances outlined in PC.4.1) will need to supply data both in an application for a **Bilateral Agreement** and under the **PC** in relation to that proposed new **Connection Site** (or **Embedded Power Station** or Embedded DC Converter Station in the circumstances outlined in PC.4.1) and that will be treated as **Preliminary Project Planning Data** or **Committed Project Planning Data** (as the case may be), but the data it supplies under the **PC** relating to its existing **Connection Sites** will be treated as **Connected Planning Data**.

NGC Data

PC.4.2.5 In addition, there is **Network Data** supplied by **NGC** in relation to short circuit current contributions.

PC.4.3 Data ProvisionPC.4.3.1 Seven Year Statement

To enable the **Seven Year Statement** to be prepared, each **User** is required to submit to **NGC** (subject to the provisions relating to **Embedded Power Stations** and Embedded DC Converter Stations in PC.3.2) both the **Standard Planning Data** and the **Detailed Planning Data** as listed in parts 1 and 2 of the Appendix. This data should be submitted in calendar week 24 of each year (although **Network Operators** may delay the submission until calendar week 28) and should cover each of the seven succeeding **NGC Financial Years** (and in certain instances, the current year). Where, from the date of one submission to another, there is no change in the data (or in some of the data) to be submitted, instead of re-submitting the data, a **User** may submit a written statement that there has been no change from the data (or in some of the data) submitted the previous time.

.....

APPENDIX APLANNING DATA REQUIREMENTSPC.A.1. INTRODUCTION

PC.A.1.1 The Appendix specifies data requirements to be submitted to **NGC** by **Users**, and in certain circumstances to **Users** by **NGC**.

Submissions by Users

- PC.A.1.2 (a) Planning data submissions by **Users** shall be:
- (i) with respect to each of the seven succeeding **NGC Financial Years** (other than in the case of **Registered Data** which will reflect the current position and data relating to **Demand** forecasts which relates also to the current year);
  - (ii) provided by **Users** in connection with a **CUSC Contract** (PC.4.1, PC.4.4 and PC.4.5 refer); and
  - (iii) provided by **Users** on a routine annual basis in calendar week 24 of each year to maintain an up-to-date data bank (although **Network Operators** may delay the submission until calendar week 28). Where from the date of one annual submission to another there is no change in the data (or in some of the data) to be submitted, instead of re-submitting the data, a **User** may submit a written statement that there has been no change from the data (or some of the data) submitted the previous time.
- (b) Where there is any change (or anticipated change) in **Committed Project Planning Data** or a significant change in **Connected Planning Data** in the category of **Forecast Data** or any change (or anticipated change) in **Connected Planning Data** in the categories of **Registered Data** or **Estimated Registered Data** supplied to **NGC** under the **PC**, notwithstanding that the change may subsequently be notified to **NGC** under the **PC** as part of the routine annual update of data (or that the change may be a **Modification** under the **CUSC**), the **User** shall, subject to PC.A.3.2.3, notify **NGC** in writing without delay.
- (c) The notification of the change will be in the form required under this **PC** in relation to the supply of that data and will also contain the following information:
- (i) the time and date at which the change became, or is expected to become, effective;
  - (ii) if the change is only temporary, an estimate of the time and date at which the data will revert to the previous registered form.
- (d) The routine annual update of data, referred to in (a)(iii) above, need not be submitted in respect of **Small Power Stations** or installations of direct current converters which do not form a DC Converter Station

(except as provided in PC.3.2.(b)), or unless specifically requested by **NGC**, or unless otherwise specifically provided.

.....

PC.A.1.6 The following paragraphs in this Appendix relate to **Forecast Data**:

- 3.2.2(b), (h), (i) and (j)(part)
- 4.2.1
- 4.3.1
- 4.3.2
- 4.3.3
- 4.3.4
- 4.3.5
- 4.5(a)(ii) and (b)(ii)
- 4.7.1
- 4A.2.2(b)
- 5.2.1.
- 5.2.2
- 7.1.2.1
- 7.1.2.2

PC.A.1.7 The following paragraphs in this Appendix relate to **Registered Data** and **Estimated Registered Data**:

- 2.2.1
- 2.2.4
- 2.2.5
- 2.2.6
- 2.3.1
- 2.4.1
- 2.4.2
- 3.2.2(a), (c), (d), (e), (f), (g), (j) (part) and (k)
- 3.4.1
- 3.4.2
- 4.2.3
- 4.5(a)(i), (a)(iii), (b)(i) and (b)(iii)
- 4.6
- 4A.2.2(a), (c), (d), (e) and (f)
- 4A.4.1
- 5.3.2
- 5.4
- 6.2
- 6.3
- 7.1.3.1

.....

PC.A.1.12 Certain data does not need to be supplied in relation to **Embedded Power Stations** or **Embedded DC Converter Stations** where these are connected at a voltage level below the voltage level directly connected to the **NGC Transmission System** except in connection with a **CUSC Contract**, or unless specifically requested by **NGC**.

PART 1STANDARD PLANNING DATAPC.A.2 USER'S SYSTEM DATAPC.A.2.1 Introduction

PC.A.2.1.1 Each **User**, whether connected directly via an existing **Connection Point** to the **NGC Transmission System**, or seeking such a direct connection, shall provide **NGC** with data on its **User System** which relates to the **Connection Site** and/or which may have a system effect on the performance of the **NGC Transmission System**. Such data, current and forecast, is specified in PC.A.2.2 to PC.A.2.5. In addition each **Generator with Embedded Large Power Stations** or **Embedded Medium Power Stations** connected to the **Subtransmission System**, shall provide **NGC** with fault infeed data as specified in PC.A.2.5.5, and each **DC Converter Owner with Embedded DC Converter Stations** connected to the **Subtransmission System** shall provide **NGC** with fault infeed data as specified in PC.A.2.5.6.

PC.A.2.1.2 Each **User** must reflect the system effect at the **Connection Site(s)** of any third party **Embedded** within its **User System** whether existing or proposed.

PC.A.2.1.3 Although not itemised here, each **User** with an existing or proposed **Embedded Small Power Station** or **Medium Power Station** or **DC Converter Station with a Registered Export Capacity of less than 100MW** or a **Registered Import Capacity of less than 100MW** or an installation of direct current converters which does not form a **DC Converter Station** in its **User System** may, at **NGC's** reasonable discretion, be required to provide additional details relating to the **User's System** between the **Connection Site** and the existing or proposed **Embedded Small Power Station** or **Medium Power Station** or **DC Converter Station** or installation of direct current converters which does not form a **DC Converter Station**.

PC.A.2.1.4 At **NGC's** reasonable request, additional data on the **User's System** will need to be supplied. Some of the possible reasons for such a request, and the data required, are given in PC.A.6.2, PC.A.6.4, PC.A.6.5 and PC.A.6.6.

PC.A.2.2 User's System Layout

PC.A.2.2.1 Each **User** shall provide a **Single Line Diagram**, depicting both its existing and proposed arrangement(s) of load current carrying **Apparatus** relating to both existing and proposed **Connection Points**.

PC.A.2.2.2 The **Single Line Diagram** (two examples are shown in Appendix B) must include all parts of the **User System** operating at **Supergrid Voltage**, and those parts of its **Subtransmission System** at any **NGC Site**. In addition, the **Single Line Diagram** must include all parts of the **User's Subtransmission System** operating at a voltage greater than 50kV which, under either intact network or **Planned Outage** conditions:-

- (a) normally interconnects separate **Connection Points**, or busbars at a **Connection Point** which are normally run in separate sections; or
- (b) connects **Embedded Large Power Stations**, or **Embedded Medium Power Stations**, or **Embedded DC Converter Stations** connected to the **User's Subtransmission System**, to a **Connection Point**.

At the **User's** discretion, the **Single Line Diagram** can also contain additional details of the **User's Subtransmission System** not already included above, and also details of the transformers connecting the **User's Subtransmission System** to a lower voltage. With **NGC's** agreement, the **Single Line Diagram** can also contain information about the **User's System** at a voltage below the voltage of the **Subtransmission System**.

The **Single Line Diagram** must include the points at which **Demand** data (provided under PC.A.4.3.4) and fault infeed data (provided under PC.A.2.5) are supplied.

.....

PC.A.2.4.2 **DC Converter Station Owners** are also required to provide information about the reactive compensation and harmonic filtering equipment required to ensure that their **Plant and Apparatus** complies with the criteria set out in CC.6.1.5.

PC.A.2.5 **Short Circuit Contribution to NGC Transmission System**

PC.A.2.5.1 **General**

- (a) To allow **NGC** to calculate fault currents, each **User** is required to provide data, calculated in accordance with **Good Industry Practice**, as set out in the following paragraphs of PC.A.2.5.
- (b) The data should be provided for the **User's System** with all **Generating Units and DC Converters Synchronised** to that **User's System**. The **User** must ensure that the pre-fault network conditions reflect a credible **System** operating arrangement.
- (c) The list of data items required, in whole or part, under the following provisions, is set out in PC.A.2.5.6PC.A.2.5.7. Each of the relevant following provisions identifies which data items in the list are required for the situation with which that provision deals.

The fault currents in sub-paragraphs (a) and (b) of the data list in PC.A.2.5.6PC.A.2.5.7 should be based on an a.c. load flow that takes into account any pre-fault current flow across the **Point of Connection** being considered.

Measurements made under appropriate **System** conditions may be used by the **User** to obtain the relevant data.

- (d) **NGC** may at any time, in writing, specifically request for data to be provided for an alternative **System** condition, for example minimum plant, and the **User** will, insofar as such request is reasonable, provide the information as soon as reasonably practicable following the request.

PC.A.2.5.2 **Network Operators and Non-Embedded Customers** are required to submit data in accordance with PC.A.2.5.4. **Generators** are required to submit data in accordance with PC.A.2.5.5. **DC Converter Owners are required to submit data in accordance with PC.A.2.5.6.**

PC.A.2.5.3 Where prospective short-circuit currents on equipment owned, operated or managed by **NGC** are close to the equipment rating, and in **NGC's** reasonable opinion more accurate calculations of the prospective short circuit currents are required, then **NGC** will request additional data as outlined in PC.A.6.6 below.

PC.A.2.5.4 Data from **Network Operators** and **Non-Embedded Customers**

Data is required to be provided at each node on the **Single Line Diagram** provided under PC.A.2.2.1 at which motor loads and/or **Embedded Small Power Stations** and/or **Embedded Medium Power Stations** and/or installations of direct current converters which do not form a DC Converter Station are connected, assuming a fault at that location, as follows:-

The data items listed under the following parts of ~~PC.A.2.5.6~~PC.A.2.5.7:-

(a) (i), (ii), (iii), (iv), (v) and (vi);

and the data items shall be provided in accordance with the detailed provisions of ~~PC.A.2.5.6~~PC.A.2.5.7(c) - (f).

PC.A.2.5.5 Data from **Generators**

PC.A.2.5.5.1 For each **Generating Unit** with one or more associated **Unit Transformers**, the **Generator** is required to provide values for the contribution of the **Power Station Auxiliaries** (including **Auxiliary Gas Turbines** or **Auxiliary Diesel Engines**) to the fault current flowing through the **Unit Transformer(s)**.

The data items listed under the following parts of PC.A.2.5.~~7~~6(a) should be provided:-

(i), (ii) and (v);

(iii) if the associated **Generating Unit** step-up transformer can supply zero phase sequence current from the **Generating Unit** side to the **NGC Transmission System**;

(iv) if the value is not 1.0 p.u;

and the data items shall be provided in accordance with the detailed provisions of PC.A.2.5.~~7~~6(c) - (f), and with the following parts of this PC.A.2.5.5.

PC.A.2.5.5.2 Auxiliary motor short circuit current contribution and any **Auxiliary Gas Turbine Unit** contribution through the **Unit Transformers** must be represented as a combined short circuit current contribution at the **Generating Unit's** terminals, assuming a fault at that location.

PC.A.2.5.5.3 If the **Power Station** has separate **Station Transformers**, data should be provided for the fault current contribution from each transformer at its high voltage terminals, assuming a fault at that location, as follows:-

The data items listed under the following parts of PC.A.2.5.~~7~~6

(a) (i), (ii), (iii), (iv), (v) and (vi);

and the data items shall be provided in accordance with the detailed provisions of PC.A.2.5.76(b) - (f).

PC.A.2.5.5.4 Data for the fault infeeds through both **Unit Transformers** and **Station Transformers** shall be provided for the normal running arrangement when the maximum number of **Gensets** are **Synchronised** to the **System**. Where there is an alternative running arrangement which can give a higher fault infeed through the **Station Transformers**, then a separate data submission representing this condition shall be made.

PC.A.2.5.5.5 Unless the normal operating arrangement within the **Power Station** is to have the **Station** and **Unit Boards** interconnected within the **Power Station**, no account should be taken of the interconnection between the **Station Board** and the **Unit Board**.

#### PC.A.2.5.6 Data from DC Converter Stations

PC.A.2.5.6.1 If the DC Converter Station has Station Transformers, data should be provided for the fault current contribution from each transformer at its high voltage terminals, assuming a fault at that location, as follows:-

The data items listed under the following parts of PC.A.2.5.7

(a) (i), (ii), (iii), (iv), (v) and (vi):

and the data items shall be provided in accordance with the detailed provisions of PC.A.2.5.7(b) - (f).

PC.A.2.5.6.2 Data for the fault infeeds through the Station Transformers shall be provided for the normal running arrangement when the DC Converter Station is transferring Rated MW in either direction. Where there is an alternative running arrangement or transfer which can give a higher fault infeed through the Station Transformers, then a separate data submission representing this condition shall be made.

PC.A.2.5.6.3 Auxiliary motor short circuit current contribution and any auxiliary DC Converter Station contribution through the Station Transformers must be represented as a combined short circuit current contribution through the Station Transformers.

#### PC.A.2.5.67 Data Items

- (a) The following is the list of data utilised in this part of the **PC**. It also contains rules on the data which generally apply:-
- (i) Root mean square of the symmetrical three-phase short circuit current infeed at the instant of fault, ( $I_1''$ );
  - (ii) Root mean square of the symmetrical three-phase short circuit current after the subtransient fault current contribution has substantially decayed, ( $I_1'$ );
  - (iii) the zero sequence source resistance and reactance values of the **User's System** as seen from the node on the **Single Line Diagram** provided under PC.A.2.2.1 (or **Station Transformer** high voltage terminals or **Generating Unit** terminals or DC Converter terminals, as

appropriate) consistent with the infeed described in PC.A.2.5.1.(b);

- (iv) root mean square of the pre-fault voltage at which the maximum fault currents were calculated;
- (v) the positive sequence X/R ratio at the instant of fault;
- (vi) the negative sequence resistance and reactance values of the **User's System** seen from the node on the **Single Line Diagram** provided under PC.A.2.2.1 (or **Station Transformer** high voltage terminals, or **Generating Unit** terminals or DC Converter terminals if appropriate) if substantially different from the values of positive sequence resistance and reactance which would be derived from the data provided above.

.....

#### PC.A.4 **DEMAND AND ACTIVE ENERGY DATA**

##### PC.A.4.1 Introduction

PC.A.4.1.1 Each **User** directly connected to the **NGC Transmission System** with **Demand** shall provide **NGC** with the **Demand** data, historic, current and forecast, as specified in PC.A.4.2, PC.A.4.3 and PC.A.4.5. Paragraphs PC.A.4.1.2 and PC.4.1.3 apply equally to **Active Energy** requirements as to **Demand** unless the context otherwise requires.

PC.A.4.1.2 Data will need to be supplied by:

- (a) each **Network Operator**, in relation to **Demand** and **Active Energy** requirements on its **User System**;
- (b) each **Non-Embedded Customer** (including **Pumped Storage Generators** with respect to Pumping **Demand**) in relation to its **Demand** and **Active Energy** requirements
- (c) each **DC Converter Owner**, in relation to its **Demand** and **Active Energy** requirements.

**Demand** of **Power Stations** directly connected to the **NGC Transmission System** is to be supplied by the **Generator** under PC.A.5.2.

.....

PC.A.4.2.4 All forecast **Demand (Active Power)** and **Active Energy** specified in PC.A.4.2.1 and PC.A.4.2.3 shall:

- (a) in the case of PC.A.4.2.1(a), (b) and (c), be such that the profiles comprise average **Active Power** levels in 'MW' for each time marked half hour throughout the day;
- (b) in the case of PC.A.4.2.1(a), (b) and (c), be that remaining after any deductions reasonably considered appropriate by the **User** to take account of the output profile of all **Embedded Small Power Stations** and **Embedded Medium Power Stations** and **Customer**

**Generating Plant** and imports across **Embedded External Interconnections and installations of direct current converters which do not form a DC Converter Station**;

- (c) in the case of PC.A.4.2.1(a) and (b), be based on **Annual ACS Conditions** and in the case of PC.A.4.2.1(c) and the details of the annual **Active Energy** required under PC.A.4.2.3 be based on **Average Conditions**.

PC.A.4.3 **Connection Point Demand (Active and Reactive Power)**

.....  
PC.A.4.3.2

All forecast **Demand** specified in PC.A.4.3.1 shall:

- (a) be that remaining after any deductions reasonably considered appropriate by the **User** to take account of the output of all **Embedded Small Power Stations** and **Embedded Medium Power Stations** and **Customer Generating Plant** and imports across **Embedded External Interconnections and installations of direct current converters which do not form a DC Converter Station** and such deductions should be separately stated;
- (b) include any **User's System** series reactive losses but exclude any reactive compensation equipment specified in PC.A.2.4 and exclude any network susceptance specified in PC.A.2.3;
- (c) in the case of PC.A.4.3.1(a) and (b) be based on **Annual ACS Conditions** and in the case of PC.A.4.3.1(c) be based on **Average Conditions**.

.....  
**PC.A.4A DC CONVERTER DATA**

**PC.A.4A.1 Introduction**

**PC.A.4A.1.1 Each DC Converter Owner with an existing, or proposed, DC Converter Station shall provide NGC with data relating to that DC Converter Station, both current and forecast, as specified in PC.A.4A.2 to PC.A.4A.4.**

**PC.A.4A.1.2 Each Network Operator shall provide NGC with the data specified in PC.A.4A.2.2(c).**

**PC.A.4A.1.3 Where a DC Converter Station is connected to the NGC Transmission System via a busbar arrangement which is or is expected to be operated in separate sections, the section of busbar to which each DC Converter is connected is to be identified in the submission.**

**PC.A.4A.1.4 (a) PC.A.4.2.3(b) and PC.A.4.3.2(a) explain that the forecast Demand submitted by each Network Operator must be net of the output of all installations of direct current converters which do not form a DC Converter Station Embedded in that Network Operator's System. The Network Operator must inform NGC of the number of such installations of direct current converters which do not form a DC Converter Station together with their summated capacity.**

- (b) On receipt of this data, the **Network Operator** may be further required, at **NGC's** reasonable discretion, to provide details of installations of direct current converters which do not form a **DC Converter Station**, both current and forecast, as specified in PC.A.4A.2 to PC.A.4A.4, as though the installation forms a **DC Converter Station**. Such requirement would arise where **NGC** reasonably considers that the collective effect of a number of such installations of direct current converters which do not form a **DC Converter Station** may have a significant system effect on the **NGC Transmission System**.

PC.A.4A.2 **Active Power Transfer Capability**

PC.A.4A.2.1 Data items PC.A.4A.2.2 (a), (b), (d), (e) and (f) are required with respect to each **DC Converter Station** in each of its viable operating configurations.

PC.A.4A.2.2 Items (a), (b), (d), (e) and (f) are to be supplied by each **DC Converter Owner** in accordance with PC.A.4A.1. Item (c) is to be supplied by each **Network Operator** in all cases:-

- (a) **Registered Export Capacity (MW) and Registered Import Capacity (MW);**
- (b) **Export Usable (MW) and Import Usable** on a monthly basis;
- (c) **System Constrained Capacity (MW)** i.e. any constraint placed on the capacity of the **Embedded DC Converter Station** due to the **Network Operator's System** in which it is embedded. Where **DC Converters** are connected to a **Network Operator's User System** via a busbar arrangement which is or is expected to be operated in separate sections, details of busbar running arrangements and connected circuits at the substation to which the **Embedded DC Converter** is connected sufficient for **NGC** to determine where the **MW** transfer from each **DC Converter** would appear onto the **NGC Transmission System**;
- (d) **Minimum Import Capacity (MW) and Minimum Export Capacity (MW);**
- (e) import **MW** obtainable from **DC Converter Stations** in excess of **Registered Import Capacity** and the time duration for which this excess is available;
- (f) export **MW** obtainable from **DC Converter Stations** in excess of **Registered Export Capacity** and the time duration for which this excess is available.

PC.A.4A.3. **Rated Parameters Data**

PC.A.4A.3.1 The following information is required for each **DC Converter Station** to facilitate an early assessment, by **NGC**, of the need for more detailed studies;

**Rated MW** per pole for transfer in each direction.  
**DC Converter** type.  
Number of poles and pole arrangement  
Rated DC voltage/pole (kV)

Return path arrangement  
Remote AC connection arrangement

This information should only be given in the data supplied with the application for a **CUSC Contract** (if appropriate for any variation), as the case may be.

PC.A.4A.4            **General DC Converter Station Data**

PC.A.4A.4.1        For each **DC Converter Station**, the point of connection to the **NGC Transmission System** or the **Total System**, if other than to the **NGC Transmission System**, in terms of geographical and electrical location and system voltage is also required.

PART 2

**DETAILED PLANNING DATA**

.....

PC.A.6.4            Harmonic Studies

PC.A.6.4.1        It is ~~occasionally~~ necessary for **NGC** to evaluate the production/magnification of harmonic distortion on **NGC** and **User's Systems**, especially when **NGC** is connecting equipment such as capacitor banks. At **NGC's** reasonable request, each **User** is required to submit data with respect to the **Connection Site**, current and forecast, and where not already supplied under PC.A.2.2.4 and PC.A.2.2.5, as follows:-

.....

PC.A.6.4.3        **DC Converter Owners** shall provide such additional further information as required by **NGC** in order that compliance with CC.6.1.5 can be demonstrated.

.....

PC.A.6.6.2        For all circuits of the **User's Subtransmission System**:-

Positive phase sequence resistance;  
Positive phase sequence reactance;  
Positive phase sequence susceptance;  
Zero phase sequence resistance (both self and mutuals);  
Zero phase sequence reactance (both self and mutuals);  
Zero phase sequence susceptance (both self and mutuals);

and for all transformers connecting the **User's Subtransmission System** to a lower voltage:-

Rated MVA;  
Voltage Ratio;  
Positive phase sequence resistance (at max, min and nominal tap);  
Positive Phase sequence reactance (at max, min and nominal tap);  
Zero phase sequence reactance (at nominal tap);  
Tap changer range;  
Earthing method: direct, resistance or reactance;

Impedance if not directly earthed;

and at the lower voltage points of those connecting transformers:-

The maximum **Demand** (in MW and Mvar) that could occur;

Short-circuit infeed data in accordance with ~~PC.A.2.5.6~~PC.A.2.5.7 unless the **User's** lower voltage network runs in parallel with the **User's Subtransmission System**, when to prevent double counting in each node infeed data, a ~~o~~ equivalent comprising the data items of ~~PC.A.2.5.6~~PC.A.2.5.7 for each node together with the positive phase sequence interconnection impedance between the nodes shall be submitted.

PC.A.7 **ADDITIONAL DATA FOR NEW TYPES OF POWER STATIONS, DC CONVERTER STATIONS AND CONFIGURATIONS**

Notwithstanding the **Standard Planning Data** and **Detailed Planning Data** set out in this Appendix, as new types of configurations and operating arrangements of **Power Stations and DC Converter Stations** emerge in future, **NGC** may reasonably require additional data to represent correctly the performance of such **Plant** and **Apparatus** on the **System**, where the present data submissions would prove insufficient for the purpose of producing meaningful **System** studies for the relevant parties.

PC.A.7.1 DC CONVERTER DATA

PC.A.7.1.1 Introduction

PC.A.7.1.1.1 Each DC Converter Owner, with existing or proposed DC Converters shall provide NGC with data relating to that Plant and Apparatus, both current and forecast, as specified in PC.A.7.1.2 and PC.A.7.1.3.

PC.A.7.1.1.2 (a) PC.A.4.2.3(b) and PC.A.4.3.2(a) explain that the forecast Demand submitted by each Network Operator must be net of the output of all installations of direct current converters which do not form a DC Converter Station Embedded in that Network Operator's System. In such cases (PC.A.4A.4 also refers) the Network Operator must inform NGC of the number of such installations of direct current converters which do not form a DC Converter Station together with their summated capacity.

(b) On receipt of this data, the Network Operator may be further required, at NGC's reasonable discretion, to provide details of installations of direct current converters which do not form a DC Converter Station, both current and forecast, as specified in PC.A.7.1.2 to PC.A.7.1.3, as though the installation forms a DC Converter Station. Such requirement would arise where NGC reasonably considers that the collective effect of a number of such installations of direct current converters which do not form a DC Converter Station may have a significant system effect on the NGC Transmission System.

PC.A.7.1.2 Demand

PC.A.7.1.2.1 For each DC Converter Station which has associated Station Transformers, the value of the Demand supplied through this Station Transformer when the

DC Converter Station is operating at Rated MW in either direction is to be provided.

PC.A.7.1.2.2 Where the DC Converter Station has associated Demand additional to the Demand of PC.A.7.1.2.1 which is supplied from either the NGC Transmission System or the DC Converter Station Owner's User System the DC Converter Owner shall supply forecasts for each DC Converter of:

- a) the maximum Demand that, in the User's opinion, could reasonably be imposed on the NGC Transmission System or the DC Converter Station Owner's User System as appropriate;
- b) the Demand at the time of the peak NGC Demand;
- c) the Demand at the time of minimum NGC Demand.

PC.A.7.1.2.3 No later than calendar week 17 each year NGC shall notify each DC Converter Owner in writing of the following, for the current NGC Financial Year and for each of the following seven NGC Financial Years, which will be regarded as the relevant specified days and times under PC.A.7.1.2.2:

- a) the date and time of the annual peak of the NGC Demand at Annual ACS Conditions;
- b) the date and time of the annual minimum of the NGC Demand at Average Conditions.

PC.A.7.1.2.4 At its discretion, NGC may also request further details of the Demand as specified in PC.A.4.6

PC.A.7.1.3 DC Converter, DC Network and Associated Control System Data

PC.A.7.1.3.1 The following DC Converter Station and DC Network data should be supplied:

Note: Details are required for each DC Converter connected to the DC Network, unless each is identical or where the data has already been submitted for an identical DC Converter at another Connection Point.

(a) DC Converter Parameters

Rated MW per pole for transfer in each direction.  
DC Converter type.  
Number of poles and pole arrangement  
Rated DC voltage/pole (kV)  
Return path arrangement

(b) DC Converter Transformer Parameters

Rated MVA  
Nominal primary voltage (kV)  
Nominal secondary (converter-side) voltage(s) (kV)  
Winding arrangement  
Positive phase sequence reactance at minimum, maximum and nominal tap  
Positive phase sequence resistance at minimum, maximum and nominal tap  
Zero phase sequence reactance

Tap-changer range  
Tap-changer step size

(c) DC Network Parameters

Rated DC Voltage per pole  
Rated DC Current per pole

Diagram of the complete DC Network.

Details of the complete DC Network, including resistance, inductance and capacitance of all DC cables and/or DC lines.

Details of any line reactors (including line reactor resistance), line capacitors and/or DC-side filters that form part of the DC Network.

(d) AC Filter and Reactive Compensation Equipment Parameters

Note: The data provided pursuant to this paragraph must not include any contribution from reactive compensation plant owned by NGC.

Total number of AC filter banks

Diagram of filter arrangement and connections

Reactive Power generation, per AC filter bank, at rated voltage

Reactive Power consumption of the DC Converter Station, as a function of MW transfer, with all filters and reactive compensation plant, belonging to the DC Converter Station Owner working correctly.

(e) DC Converter Control System Models

Note: The following data is required by NGC to represent DC Converters and associated DC Networks in dynamic power system simulations, in which the AC power system is typically represented by a positive sequence equivalent. DC Converters are represented by simplified equations and are not modelled to switching device level.

Static  $V_{DC}$ - $I_{DC}$  (DC voltage - DC current) characteristics, for both the rectifier and inverter modes.

Transfer function block diagram representation of the control systems of each DC Converter and of the DC Converter Station, for both the rectifier and inverter modes. Any system oscillation damping control systems must be included. A suitable model would feature the DC Converter firing angle as output variable; input variables would typically include DC current and DC voltage.

Transfer function block diagram representation of the DC Converter transformer tap changer control systems, including time delays

Transfer function block diagram representation of AC filter and reactive compensation equipment control systems, including any time delays.

Transfer function block diagram representation of any frequency and/or load control systems.

(f) Plant Flexibility Performance

Nominal and maximum (emergency) loading rate with the **DC Converter** in rectifier mode.

Nominal and maximum (emergency) loading rate with the **DC Converter** in inverter mode.

Maximum recovery time, to 90% of pre-fault loading, following an AC system fault or severe voltage depression.

Maximum recovery time, to 90% of pre-fault loading, following a transient **DC Network** fault.

## C) Extracts from Connection Conditions

### CC.1 INTRODUCTION

CC.1.1 The **Connection Conditions** ("CC") specify both the minimum technical, design and operational criteria which must be complied with by any **User** connected to or seeking connection with the **NGC Transmission System** or **Generators** (other than in respect of **Small Power Stations**) or DC Converter Owners connected to or seeking connection to a **User's System** which is located in England and/or Wales, and the minimum technical, design and operational criteria with which **NGC** will comply in relation to the part of the **NGC Transmission System** at the **Connection Site** with **Users**.

### CC.2 OBJECTIVE

CC.2.1 The objective of the **CC** is to ensure that by specifying minimum technical, design and operational criteria the basic rules for connection to the **NGC Transmission System** and (for certain **Users**) to a **User's System** are similar for all **Users** of an equivalent category and will enable **NGC** to comply with its statutory and **Transmission Licence** obligations.

### CC.3 SCOPE

CC.3.1 The **CC** applies to **NGC** and to **Users**, which in the **CC** means:

- (a) **Generators** (other than those which only have **Embedded Small Power Stations**)
- (b) **Network Operators**;
- (c) **Non-Embedded Customers**;
- (d) DC Converter Owners; and
- (~~ee~~) **BM Participants** and **Externally Interconnected System Operators** in respect of ~~CC.6.5~~CC.6.6 only.

The above categories of **User** will become bound by the **CC** prior to them generating, distributing, supplying or consuming, as the case may be, and references to the various categories should, therefore, be taken as referring to them in that prospective role as well as to **Users** actually connected.

### CC.4 PROCEDURE

CC.4.1 The **CUSC** contains provisions relating to the procedure for connection to the **NGC Transmission System** or, in the case of **Embedded Power Stations** or Embedded DC Converter Stations, becoming operational and includes sprovisions relating to certain conditions to be complied with by **Users** prior to **NGC** notifying the **User** that it has the right to become operational.

### CC.5 CONNECTION

CC.5.1 The provisions relating to connecting to the **NGC Transmission System** (or to a **User's System** in the case of a connection of an **Embedded Large Power Station** or **Embedded Medium Power Station** or Embedded DC Converter

**Station**) are contained in the **CUSC** and/or **CUSC Contract** (or in the relevant application form or offer for a **CUSC Contract**), and include provisions relating to both the submission of information and reports relating to compliance with the relevant **Connection Conditions** for that **User**, **Safety Rules**, commissioning programmes, **Operation Diagrams** and approval to connect. References in this **CC** to the "**Bilateral Agreement**" and/or "**Construction Agreement**" shall be deemed to include references to the application form or offer therefor.

CC.5.2

Prior to the **Completion Date** under the **Bilateral Agreement** and/or **Construction Agreement**, the following is submitted pursuant to the terms of the **Bilateral Agreement** and/or **Construction Agreement**:

- (a) updated **Planning Code** data (both **Standard Planning Data** and **Detailed Planning Data**), with any estimated values assumed for planning purposes confirmed or, where practical, replaced by validated actual values and by updated estimates for the future and by updated forecasts for **Forecast Data** items such as **Demand**, pursuant to the requirements of the **Planning Code**;
- (b) details of the **Protection** arrangements and settings referred to in CC.6;
- (c) copies of all **Safety Rules** and **Local Safety Instructions** applicable at **Users' Sites** which will be used at the **NGC/User** interface (which, for the purpose of **OC8**, must be to **NGC's** satisfaction regarding the procedures for **Isolation** and **Earthing**);
- (d) information to enable **NGC** to prepare **Site Responsibility Schedules** on the basis of the provisions set out in Appendix 1;
- (e) an **Operation Diagram** for all **HV Apparatus** on the **User** side of the **Connection Point** as described in CC.7;
- (f) the proposed name of the **User Site** (which shall not be the same as, or confusingly similar to, the name of any **NGC Site** or of any other **User Site**);
- (g) written confirmation that **Safety Coordinators** acting on behalf of the **User** are authorised and competent pursuant to the requirements of **OC8**;
- (h) **RISSP** prefixes pursuant to the requirements of **OC8**. **NGC** is required to circulate prefixes utilising a proforma in accordance with **OC8**;
- (i) a list of the telephone numbers for **Joint System Incidents** at which senior management representatives nominated for the purpose can be contacted and confirmation that they are fully authorised to make binding decisions on behalf of the **User**, pursuant to **OC9**;
- (j) a list of managers who have been duly authorised to sign **Site Responsibility Schedules** on behalf of the **User**;
- (k) information to enable **NGC** to prepare **Site Common Drawings** as described in CC.7; and
- (l) a list of the telephone numbers for the **Users** facsimile machines referred to in ~~CC.6.5~~CC.6.6.9.

CC.5.3 As explained in the **Bilateral Agreement** and/or **Construction Agreement**, of the list:

(a) items CC.5.2(c), (e), (g), (h) and (k) need not be supplied in respect of **Embedded Power Stations** or Embedded DC Converter Stations,

(b) item CC.5.2(i) need not be supplied in respect of **Embedded Small Power Stations** ~~and~~ or Embedded Medium Power Stations or Embedded DC Converter Stations with a Registered Export Capacity of less than 100MW or a Registered Import Capacity of less than 100MW, and

(c) items CC.5.2(d) and (j) are only needed in the case where the **Embedded Power Station** or the Embedded DC Converter Station is within a **Connection Site** with another **User**.

CC.5.4 In addition, at the time the information is given under CC.5.2(g), **NGC** will provide written confirmation to the **User** that the **Safety Co-ordinators** acting on behalf of **NGC** are authorised and competent pursuant to the requirements of **OC8**.

CC.6 TECHNICAL, DESIGN AND OPERATIONAL CRITERIA

CC.6.1 NGC TRANSMISSION SYSTEM PERFORMANCE CHARACTERISTICS

[No changes proposed to CC.6.1, hence not shown]

CC.6.2 PLANT AND APPARATUS RELATING TO USER/NGC CONNECTION SITE

The following requirements apply to **Plant** and **Apparatus** relating to the **User/NGC Connection Point**, which (except as otherwise provided in the relevant paragraph) each **User** must ensure are complied with in relation to its **Plant** and **Apparatus** and which in the case of CC.6.2.2.2, CC.6.2.3.1.1 and CC.6.2.1.1(b) only, **NGC** must ensure are complied with in relation to its **Plant** and **Apparatus**, as provided in those paragraphs.

CC.6.2.1 General Requirements

CC.6.2.1.1 (a) The design of connections between the **NGC Transmission System** and:-

(i) any **Generating Unit** (other than a **CCGT Unit**) or **CCGT Module**, or

(ii) any **Network Operator's User System**, or

(iii) **Non-Embedded Customers** equipment or

(iv) any DC Converter Station (in all viable operating configurations);

will be consistent with the **Licence Standards**.

(b) The **NGC Transmission System** at nominal **System** voltages of 132kV and above is designed to be earthed with an **Earth Fault Factor** of below 1.4. Under fault conditions the rated **Frequency** component of voltage could fall transiently to zero on one or more phases or rise to 140% phase-to-earth voltage. The voltage rise would last only for the time that

the fault conditions exist. The fault conditions referred to here are those existing when the type of fault is single or two phase-to-earth.

- (c) For connections to the **NGC Transmission System** at nominal **System** voltages of below 132kV the earthing requirements and voltage rise conditions will be advised by **NGC** as soon as practicable prior to connection.

#### CC.6.2.1.2

[No change proposed to CC.6.2.1.2, hence not shown]

#### CC.6.2.2 Requirements relating to **Generator or DC Converter Owner**/NGC Connection Points

CC.6.2.2.1 Each connection between a **Generating Unit** (other than a **CCGT Unit**) or a **CCGT Module or a DC Converter Station** and the **NGC Transmission System** must be controlled by a circuit breaker capable of interrupting the maximum short circuit current at the point of connection. The **Seven Year Statement** gives values of short circuit current and the rating of **NGC** circuit breakers at existing and committed **Connection Points** for future years.

#### CC.6.2.2.2 Generating Unit and Power Station and DC Converter Station Protection Arrangements

##### CC.6.2.2.2.1 Minimum Requirements

**Protection of Generating Units or DC Converter Stations** and their connections to the **NGC Transmission System** must meet the minimum requirements given below. These are necessary to reduce to a practical minimum the impact on the **NGC Transmission System** of faults on circuits owned by **Generators or DC Converter Owners**.

##### CC.6.2.2.2.2 Fault Clearance Times

- (a) The fault clearance times for faults on the **Generator's or DC Converter Owner's** equipment directly connected to the **NGC Transmission System** and for faults on the **NGC Transmission System** directly connected to the **Generator's or DC Converter Owner's** equipment, from fault inception to the circuit breaker arc extinction, shall be set out in accordance with the **Bilateral Agreement**. The times specified in accordance with the **Bilateral Agreement** shall not be faster than:

- (i) 80mS at 400kV
- (ii) 100mS at 275kV
- (iii) 120mS at 132kV and below

but this shall not prevent a **User** or **NGC** having faster fault clearance times.

Slower fault clearance times may be specified in accordance with the **Bilateral Agreement** for faults on the **NGC Transmission System**. Slower fault clearance times for faults on the **Generator's or DC Converter Owner's** equipment may be agreed in accordance with the terms of the **Bilateral Agreement** but only if **System** requirements, in **NGC's** view, permit. The probability that the fault clearance times stated in accordance with the **Bilateral Agreement** will be exceeded by any given fault, must be less than 2%.

- (b) For the event that the above fault clearance times are not met as a result of failure to operate on the **Main Protection System(s)** provided, the **Generators or the DC Converter Owners, as the case may be,** shall provide **Back-Up Protection**. NGC will also provide **Back-Up Protection** and these **Back-Up Protections** will be co-ordinated so as to provide **Discrimination**.

On a **Generating Unit or a DC Converter Station** connected to the **NGC Transmission System** where only one **Main Protection** is provided to clear faults on the **~~HV Generator Connections~~HV Connections** within the required fault clearance time, the **Back-Up Protection** provided by the **Generators or DC Converter Owners** shall operate to give a fault clearance time of no slower than 300 ms at the minimum infeed for normal operation for faults on the **~~HV Generator Connections~~HV Connections**. On **Generating Units or DC Converter Stations** connected to the **NGC Transmission System** at 400 kV and 275 kV where two **Main Protections** are provided and on **Generating Units or DC Converter Stations** connected to the **NGC Transmission System** at 132 kV and below, the **Back-Up Protection** shall operate to give a fault clearance time of no slower than 800 ms at the minimum infeed for normal operation for faults on the **~~HV Generator Connections~~HV Connections**.

**Generators' and DC Converter Owners' Back-Up Protection** will also be required to withstand, without tripping, the loading incurred during the clearance of a fault on the **NGC Transmission System** by breaker fail **Protection** at 400kV or 275kV or of a fault cleared by **Back-Up Protection** where the **Generator or DC Converter Owner** is connected at 132kV and below. This will permit **Discrimination** between **Generator or DC Converter Owner Back-Up Protection** and **Back-Up Protection** provided on the **NGC Transmission System** and other **Users' Systems**.

- (c) When the **Generating Unit or DC Converter Station** is connected to the **NGC Transmission System** at 400kV or 275kV and a circuit breaker is provided by the **Generator, or DC Converter Owner or NGC**, as the case may be, to interrupt fault current interchange with the **NGC Transmission System, or Generator's System, or DC Converter Owner's System**, as the case may be, circuit breaker fail **Protection** shall be provided by the **Generator, or DC Converter Owner, or NGC**, as the case may be, on this circuit breaker. In the event, following operation of a **Protection** system, of a failure to interrupt fault current by these circuit-breakers within the **Fault Current Interruption Time**, the circuit breaker fail **Protection** is required to initiate tripping of all the necessary electrically adjacent circuit-breakers so as to interrupt the fault current within the next 200 ms.
- (d) The target performance for the **System Fault Dependability Index** shall be not less than 99%. This is a measure of the ability of **Protection** to initiate successful tripping of circuit breakers which are associated with the faulty item of **Apparatus**.

CC.6.2.2.3 Equipment to be provided

CC.6.2.2.3.1 Protection of Interconnecting Connections

The requirements for the provision of **Protection** equipment for interconnecting connections will be specified in the **Bilateral Agreement**. In this **CC** the term "interconnecting connections" means the primary conductors from the current transformer accommodation on the circuit side of the circuit breaker to the **Connection Point**.

CC.6.2.2.3.2 Circuit-breaker fail Protection

The **Generator** and/or DC Converter Owner will install circuit breaker fail **Protection** equipment in accordance with the requirements of the **Bilateral Agreement**. The **Generator** or the DC Converter Owner, as the case may be, will also provide a back-trip signal in the event of loss of air from its pressurised head circuit breakers, during the **Generating Unit** (other than a **CCGT Unit**) or **CCGT Module** or DC Converter Station run-up sequence, where these circuit breakers are installed.

CC.6.2.2.3.3 Loss of Excitation

The **Generator** must provide **Protection** to detect loss of excitation on a **Generating Unit** and initiate a **Generating Unit** trip.

CC.6.2.2.3.4 Pole-Slipping Protection

Where, in **NGC's** reasonable opinion, **System** requirements dictate, **NGC** will specify in the **Bilateral Agreement** a requirement for **Generators** to fit pole-slipping **Protection** on their **Generating Units**.

CC.6.2.2.3.5 Signals for Tariff Metering

**Generators** and DC Converter Owners will install current and voltage transformers supplying all tariff meters at a voltage to be specified in, and in accordance with, the **Bilateral Agreement**.

CC.6.2.2.4 Work on Protection Equipment

No busbar **Protection**, mesh corner **Protection**, circuit-breaker fail **Protection** relays, AC or DC wiring (other than power supplies or DC tripping associated only with the **Generating Unit** or DC Converter Station#self) may be worked upon or altered by the **Generator** or DC Converter Owner personnel in the absence of a representative of **NGC**.

CC.6.2.2.5 Relay Settings

**Protection** and relay settings will be co-ordinated (both on connection and subsequently) across the **Connection Point** in accordance with the **Bilateral Agreement** to ensure effective disconnection of faulty **Apparatus**.

CC.6.2.3 Requirements relating to Network Operator/NGC and Non-Embedded Customers/NGC Connection Points

.....

[Not shown as having no relevance and no changes necessary]

.....

CC.6.3      GENERAL GENERATING UNIT REQUIREMENTS

.....

CC.6.4      GENERAL NETWORK OPERATOR AND NON-EMBEDDED CUSTOMER REQUIREMENTS

.....

CC.6.5      GENERAL DC CONVERTER REQUIREMENTS

CC.6.5.1      This section sets out the technical and design criteria and performance requirements for DC Converter Stations (whether directly connected to the NGC Transmission System or Embedded) which each DC Converter Owner must ensure are complied with. References to DC Converter Station within this CC.6.5 apply to a DC Converter Station in each of its viable operating configurations.

Plant Performance Requirements

CC.6.5.2      Each DC Converter Station must be capable of supplying its own Reactive Power requirements without any transfer of Reactive Power from the NGC Transmission System (or User System in the case of an Embedded DC Converter Station) at the Connection Point while transferring rated Active Power within the voltage range of  $\pm 5\%$  at 400kV, 275kV, 132kV and lower voltages. While transferring Active Power within its operating range and within the voltage range of  $\pm 5\%$  at 400kV, 275kV, 132kV and lower voltages, each DC Converter Station Reactive Power transfer must remain within the reactive range specified in the Bilateral Agreement.

CC.6.5.3      Each DC Converter Station must be capable of operating in a stable manner across the range of short circuit levels at the point of connection specified in the Bilateral Agreement. Within this short circuit level range, each DC Converter Station must be capable of:

- (a)      continuously maintaining constant Active Power output (i.e., when operating in a mode analogous to a Generating Unit) to the NGC Transmission System (or User System in the case of an Embedded DC Converter Station) for System Frequency changes within the range 50.5 to 47.0 Hz; and
- (b)      continuously maintaining constant Active Power input (i.e., when operating in a mode analogous to Demand) from the NGC Transmission System (or User System in the case of an Embedded DC Converter Station) for System Frequency changes within the range 49.5 to 52.0 Hz as shown in Figure 2.
- (c)      maintaining its Active Power input (i.e., when operating in a mode analogous to Demand) from the NGC Transmission System (or User System in the case of an Embedded DC Converter Station) at a level not greater than the figure determined by the linear relationship shown in Figure 2 for System Frequency changes within the range 49.5 to 47 Hz, such that if the System Frequency drops to 47 Hz the Active Power input decreases by more than 60%.

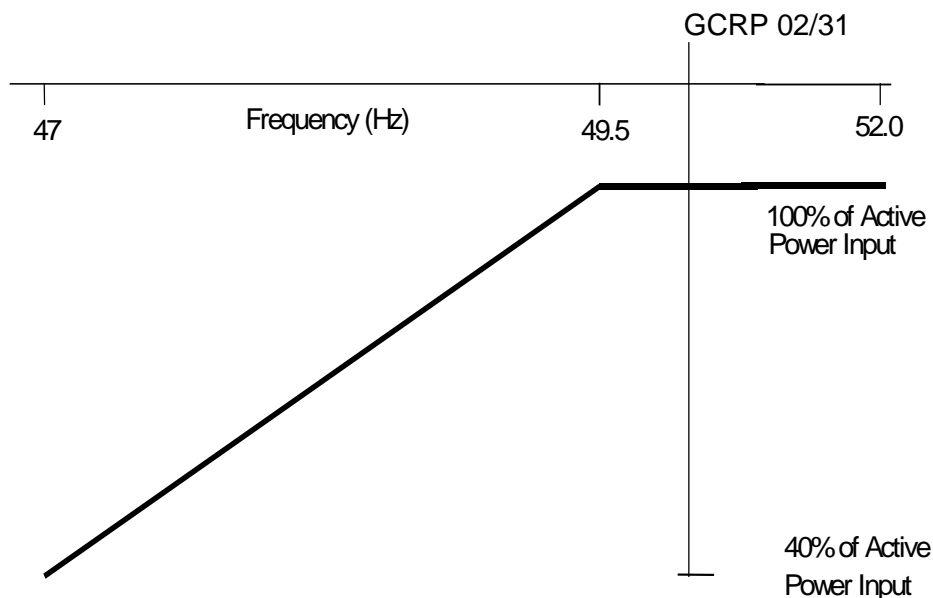


Figure 2

CC.6.5.4 The **Active Power** transfer under steady state conditions of any **DC Converter Station** directly connected to the **NGC Transmission System** should not be affected by voltage changes in the operating range specified in paragraph **CC.6.1.4**. In addition, a **DC Converter Station** must be capable of withstanding any short-term voltage variations outside of this range as may be specified in the **Bilateral Agreement**.

Control Arrangements

CC.6.5.5 Each **DC Converter Station** must be capable of contributing to **Frequency** control by continuous modulation of **Active Power** supplied to the **NGC Transmission System** or the **User System** in which it is **Embedded**. As stated in **BC3.1.3**, any **Ancillary Services Agreement** for the provision of **Frequency** response service (other than by operation in **Limited Frequency Sensitive Mode** or in accordance with **BC3.7.1(c)**), will be agreed between **NGC**, the **DC Converter Owner** and the relevant **Externally Interconnected System Operator** as provided for in the **Bilateral Agreement** or any other relevant agreements.

CC.6.5.6 (a) Each **DC Converter Station** must be fitted with a control device to provide **Frequency** response under normal operational conditions in accordance with **Balancing Code 3 (BC3)**. The control device must be designed and operated to the appropriate:

(i) European Specification; or

(ii) in the absence of a relevant European Specification, such other standard which is in common use within the European Community;

as at the time when the installation of which it forms part was designed or (in the case of modification or alteration to the frequency controller) when the modification or alteration was designed.

The European Specification or other standard utilised in accordance with sub-paragraph CC.6.5.6 (a) (ii) will be notified to NGC as:

- (i) part of the application for a **Bilateral Agreement**; or
- (ii) part of the application for a varied **Bilateral Agreement**; or
- (iii) soon as possible prior to any modification or alteration to the frequency controller; and
- (b) The control device in co-ordination with other control devices must control the **DC Converter Station Active Power** transfer with stability over the entire operating range of the **DC Converter Station**; and
- (c) The control device must meet the following minimum requirements:
  - (i) the control device must be capable of being set so that it operates with an overall frequency droop of between 3% and 5%;
  - (ii) the frequency controller deadband should be no greater than 0.03Hz (for the avoidance of doubt,  $\pm 0.015\text{Hz}$ );

For the avoidance of doubt, the minimum requirements in (i) and (ii) for the provision of **System Ancillary Services** do not restrict the negotiation of **Commercial Ancillary Services** between **NGC** and the **User** using other parameters; and
- (d) A facility to modify, so as to fulfil the requirements of the **Balancing Codes**, the **Target Frequency** setting either continuously or in a maximum of 0.05 Hz steps over at least the range 50 ° 0.1 Hz should be provided in the unit load controller or equivalent device.
- (e) Each **DC Converter Station** (in any of its viable operating configurations) must be capable of meeting the minimum frequency response requirement profile subject to and in accordance with the provisions of Appendix 3.

CC.6.5.7 All **DC Converter Station** control systems, including those specified in the **Bilateral Agreement**, must operate satisfactorily without instability over the entire operating range of the **DC Converter Station**.

Performance under fault conditions

CC.6.5.8 In addition to meeting the conditions specified in CC.6.2.2.1, each **DC Converter Station** must be capable of operating in a stable manner during and after credible faults on the a.c **System** or the **DC Network**. The transient performance requirements will be specified in the **Bilateral Agreement**.

Neutral **Earthing**

CC.6.5.9 At nominal **System** voltages of 132kV and above the windings on the **NGC Transmission System** side of any transformer of a **DC Converter Station** must be star connected with the star point suitable for connection to earth. The earthing arrangement and the winding arrangement on the **DC Converter Station** side of such transformer shall be such as to ensure that the **Earth Fault Factor** requirement of paragraph CC.6.2.1.1 (b) will be met on the **NGC Transmission System** at nominal **System** voltages of 132kV and above.

Frequency Sensitive Relays

CC.6.5.10 As stated in CC.6.1.3, the **System Frequency** could rise to 52Hz or fall to 47Hz. Each **DC Converter Station** must continue to operate within this **Frequency** range for at least the periods of time given in CC.6.1.3 unless **NGC** has agreed to any **Frequency**-level relays and/or rate-of-change-of-**Frequency** relays which will trip such **DC Converter Station** within this **Frequency** range, under the **Bilateral Agreement**.

CC.6.5.11 **DC Converter Owners** will be responsible for protecting all their **DC Converter Stations** against damage should **Frequency** excursions outside the range 52Hz to 47Hz ever occur. Should such excursions occur, it is up to the **DC Converter Owner** to decide whether to disconnect his **Apparatus** for reasons of safety of **Apparatus, Plant** and/or personnel.

Sub-Synchronous Resonance Damping

CC.6.5.12 **DC Converter Owners** must ensure that any of their **DC Converter Stations** will not cause a Sub-Synchronous Resonance problem on the **System**. Where specified in the **Bilateral Agreement**, each **DC Converter Station** is required to be provided with Sub-Synchronous Resonance damping control facilities.

Additional Control Facilities

CC.6.5.13 Where specified in the **Bilateral Agreement**, each **DC Converter Station** is required to be provided with Power Oscillation damping or any other identified additional control facilities.

CC.6.65 COMMUNICATIONS PLANT

CC.6.65.1 In order to ensure control of the **NGC Transmission System**, telecommunications between **Users** and **NGC** must, if required by **NGC**, be established in accordance with the requirements set down below.

Control Telephony

CC.6.65.2 **Control Telephony** is the method by which a **User's Responsible Engineer/Operator** and **NGC Control Engineers** speak to one another for the purposes of control of the **Total System** in both normal and emergency operating conditions. **Control Telephony** provides secure point to point telephony for routine **Control Calls**, priority **Control Calls** and emergency **Control Calls**.

CC.6.65.3 Supervisory tones indicate to the calling and receiving parties dial, engaged, ringing, secondary engaged (signifying that priority may be exercised) and priority disconnect tones.

CC.6.65.4 Where **NGC** requires **Control Telephony**, **Users** are required to use the **Control Telephony** with **NGC** in respect of all **Connection Points** with the **NGC Transmission System** and in respect of all **Embedded Large Power Stations and Embedded DC Converter Stations**. **NGC** will install **Control Telephony** at the **User's** location where the **User's** telephony equipment is not capable of providing the required facilities or is otherwise incompatible with the **NGC Control Telephony**. Details of and relating to the **Control Telephony** required are contained in the **Bilateral Agreement**.

CC.6.65.5 Detailed information on **Control Telephony** facilities and suitable equipment required for individual **User** applications will be provided by **NGC** upon request.

#### Operational Metering

CC.6.65.6 (a) **NGC** shall provide system control and data acquisition (SCADA) outstation interface equipment. The **User** shall provide such voltage, current, **Frequency**, **Active Power** and **Reactive Power** measurement outputs and plant status indications and alarms to the **NGC** SCADA outstation interface equipment as required by **NGC** in accordance with the terms of the **Bilateral Agreement**.

(b) For the avoidance of doubt, for **Active Power** and **Reactive Power** measurements, circuit breaker and disconnecter status indications from **CCGT Modules** at **Large Power Stations**, the outputs and status indications must each be provided to **NGC** on an individual **CCGT Unit** basis. In addition, where identified in the **Bilateral Agreement**, **Active Power** and **Reactive Power** measurements from unit and/or station transformers must be provided.

(c) For the avoidance of doubt, for **Active Power** and **Reactive Power** measurements, circuit breaker and disconnecter status indications from **DC Converters** at **DC Converter Stations**, the outputs and status indications must each be provided to **NGC** on an individual **DC Converter** basis. In addition, where identified in the **Bilateral Agreement**, **Active Power** and **Reactive Power** measurements from converter and/or station transformers must be provided.

#### Instructor Facilities

CC.6.65.7 The **User** shall accommodate **Instructor Facilities** provided by **NGC** for the receipt of operational messages relating to **System** conditions.

#### Electronic Data Communication Facilities

CC.6.65.8 (a) All **BM Participants** must ensure that appropriate electronic data communication facilities are in place to permit the submission of data, as required by the **Grid Code**, to **NGC**.

(b) In addition, any **User** that wishes to participate in the **Balancing Mechanism** must ensure that appropriate automatic logging devices are installed at the **Control Points** of its **BM Units** to submit data to and to receive instructions from **NGC**, as required by the **Grid Code**. For the avoidance of doubt, in the case of an **Interconnector User** the **Control Point** will be at the **Control Centre** of the appropriate **Externally Interconnected System Operator**.

(c) **NGC** also undertakes to give all current **Users** the opportunity to comment if **NGC** proposes to change any of the specifications at any time as a result of changes to the electronic facilities which will have an effect on **Users'** systems or which, in the reasonable opinion of **NGC**, may have an effect on **Users'** systems. Following the assessment of any such comments, **NGC** will provide reasonable notice of the implementation date to all current **Users** for the specification changes then proposed.

(d) Detailed specifications of these required electronic facilities will be provided by **NGC** on request.

Facsimile Machines

- CC.6.65.9 Each **User** and **NGC** shall provide a facsimile machine or machines:-
- (a) in the case of **Generators**, at the **Control Point** of each **Power Station** and at its **Trading Point**;
  - (b) in the case of **NGC** and **Network Operators**, at the **Control Centre(s)**; and
  - (c) in the case of **Non-Embedded Customers** and **DC Converter Owners**, at the **Control Point**.

Each **User** shall notify, prior to connection to the **System** of the **User's Plant and Apparatus**, **NGC** of its or their telephone number or numbers, and will notify **NGC** of any changes. Prior to connection to the **System** of the **User's Plant and Apparatus** **NGC** shall notify each **User** of the telephone number or numbers of its facsimile machine or machines and will notify any changes.

CC.6.65.10 Busbar Voltage

**NGC** shall, subject as provided below, provide each **Generator** at each **Grid Entry Point** where one of its **Large Power Stations** is connected with appropriate voltage signals to enable the **Generator** to obtain the necessary information to synchronise its **Gensets** to the **NGC Transmission System**. **NGC shall provide each DC Converter Owner at each Grid Entry Point where one of its DC Converter Stations is connected with appropriate voltage signals to enable the DC Converter Owner to obtain the necessary information to permit its DC Converter Station to be Synchronised to the NGC Transmission System.** The term "**voltage signal**" shall mean in this context, a point of connection on (or wire or wires from) a relevant part of **NGC's Plant and/or Apparatus** at the **Grid Entry Point**, to which the **Generator** or **DC Converter Owner**, with **NGC's** agreement (not to be unreasonably withheld) in relation to the **Plant** and/or **Apparatus** to be attached, will be able to attach its **Plant** and/or **Apparatus** (normally a wire or wires) in order to obtain measurement outputs in relation to the busbar.

Bilingual Communication Facilities

CC.6.6.11 A Bilingual Message Facility is the method by which the **User's Responsible Engineer/Operator**, the **Externally Interconnected System Operator** and **NGC Control Engineers** communicate clear and unambiguous information in two languages for the purposes of control of the **Total System** in both normal and emergency operating conditions.

CC.6.6.12 A Bilingual Message Facility, where required in accordance with the terms of the **Bilateral Agreement**, will provide up to two hundred pre-defined messages with up to five hundred and sixty characters each. A maximum of one minute is allowed for the transmission to, and display of, the selected message at any destination. The standard messages must be capable of being displayed at any combination of locations and can originate from any of these locations. Messages displayed in the UK will be displayed in the English language.

CC.6.6.13 Detailed information on a Bilingual Message Facility and suitable equipment required for individual **User** applications will be provided by **NGC** upon request.

CC.6.76 **SYSTEM MONITORING**

CC.6.76.1 Monitoring equipment is provided on the **NGC Transmission System** to enable **NGC** to monitor its power system dynamic performance conditions. Where this monitoring equipment requires voltage and current signals on the **Generating Unit** circuit or DC Converter Station equipment from the **User**, **NGC** will inform the **User** and they will be provided by the **User** with both the timing of the installation of the equipment for receiving such signals and its exact position being agreed (the **User's** agreement not to be unreasonably withheld) and the costs being dealt with, pursuant to the terms of the **Bilateral Agreement**.

CC.7 **SITE RELATED CONDITIONS**

[Not shown as it all refers to User, and therefore requires no change]

CC.8 **ANCILLARY SERVICES**

CC.8.1 **System Ancillary Services**

The **CC** contain requirements for the capability for certain **Ancillary Services**, which are needed for **System** reasons ("**System Ancillary Services**"). There follows a list of these **System Ancillary Services**, together with the paragraph number of the **CC** (or other part of the **Grid Code**) in which the minimum capability is required or referred to. The list is divided into two categories: Part 1 lists the **System Ancillary Services** which **Generators** are obliged to provide and DC Converter Owners are obliged to have the capability to supply, and Part 2 lists the **System Ancillary Services** which **Generators** will provide only if agreement to provide them is reached with **NGC**:

Part 1

- (a) **Reactive Power** supplied otherwise than by means of synchronous or static compensators - CC.6.3.2 (in the case of Generators)
- (b) **Frequency Control** by means of **Frequency** sensitive generation - CC.6.3.7 (in the case of Generators), CC.6.5.5 and CC.6.5.6 (in the case of DC Converter Owners) and BC3.5.1

Part 2

- (c) **Frequency Control** by means of **Fast Start** - CC.6.3.14
- (d) **Black Start Capability** - CC.6.3.5

CC.8.2 **Commercial Ancillary Services**

Other **Ancillary Services** are also utilised by **NGC** in operating the **Total System** if these have been agreed to be provided by a **User** (or other person) under an **Ancillary Services Agreement** or under a **Bilateral Agreement**, with payment being dealt with under an **Ancillary Services Agreement** or in the case of **Externally Interconnected System Operators** or **Interconnector Users**, under any other agreement (and in the case of **Externally Interconnected System Operators** and **Interconnector Users** includes ancillary services equivalent to or similar to **System Ancillary Services**) ("**Commercial Ancillary Services**"). The capability for these **Commercial**

**Ancillary Services** is set out in the relevant **Ancillary Services Agreement** or **Bilateral Agreement** (as the case may be).

**CONNECTION CONDITIONS**

**APPENDIX 1**

**FORMAT, PRINCIPLES AND BASIC PROCEDURE TO BE USED IN THE  
PREPARATION OF SITE RESPONSIBILITY SCHEDULES**

[Not shown as this Appendix generally refers to User and requires no change]

**CONNECTION CONDITIONS**

**APPENDIX 2**

[Not shown as this Appendix is general and requires no change]

**CONNECTION CONDITIONS****APPENDIX 3****MINIMUM FREQUENCY RESPONSE REQUIREMENT PROFILE AND OPERATING RANGE for new Generating Units and/or CCGT Modules with a Completion Date after 1 January 2001 and for DC Converter Stations (which have a Completion Date after [the Implementation Date])****CC.A.3.1 SCOPE**

The frequency response capability is defined in terms of **Primary Response**, **Secondary Response** and **High Frequency Response**. This appendix defines the minimum frequency response requirement profile for each **Generating Unit** and/or **CCGT Module** which has a **Completion Date** after 1 January 2001 and for each DC Converter Station (operating in any one of its viable operating configurations) which has a Completion date after [the Implementation Date]. For the avoidance of doubt, this appendix does not apply to **Generating Units** and/or **CCGT Modules** which have a **Completion Date** before 1 January 2001 or to **Small Power Stations** or for other installations of direct current converters which do not form a DC Converter Station. The functional definition provides appropriate performance criteria relating to the provision of frequency control by means of frequency sensitive generation in addition to the other requirements identified in CC.6.3.7.

In this Appendix 3 to the **CC**, for a **CCGT Module** with more than one **Generating Unit**, the phrase **Minimum Generation** applies to the entire **CCGT Module** operating with all **Generating Units Synchronised** to the **System**.

The minimum frequency response requirement profile is shown diagrammatically in Figure CC.A.3.1. The capability profile specifies the minimum required levels of **Primary Response**, **Secondary Response** and **High Frequency Response** throughout the normal plant operating range. The definitions of these frequency response capabilities are illustrated diagrammatically in Figures CC.A.3.2 & CC.A.3.3.

**CC.A.3.2 PLANT OPERATING RANGE**

The upper limit of the operating range is the **Registered Capacity** of the **Generating Unit** or **CCGT Module** or the Registered Export Capacity of the DC Converter Station.

The **Minimum Generation** level (or Minimum Export Capacity) may be less than, but must not be more than, 65% of the **Registered Capacity** (or Registered Export Capacity). Each **Generating Unit** and/or **CCGT Module** or DC Converter Station must be capable of operating satisfactorily down to the **Designed Minimum Operating Level** as dictated by **System** operating conditions, although it will not be instructed to below its **Minimum Generation** (or Minimum Export Capacity) level. If a **Generating Unit** or **CCGT Module** is operating below **Minimum Generation** (or a DC Converter Station is operating below its Minimum Export Capacity) because of high **System Frequency**, it should recover adequately to its **Minimum Generation** (or Minimum Export Capacity) level as the **System Frequency** returns to **Target Frequency** so that it can provide **Primary** and **Secondary Response** from **Minimum Generation** (or Minimum Export Capacity) if the **System Frequency** continues to fall. For the avoidance of doubt, under normal operating conditions steady state operation below **Minimum Generation** (or Minimum Export Capacity) is not expected. The **Designed Minimum Operating Level** must not be more than 55% of **Registered Capacity**.

In the event of a **Generating Unit** ~~or~~ **CCGT Module** or DC Converter Station load rejecting down to no less than its **Designed Minimum Operating Level** it should not trip as a result of automatic action as detailed in BC3.7. If the load rejection is to a level less than the **Designed Minimum Operating Level** then it is accepted that the condition might be so severe as to cause it to be disconnected from the **System**.

### CC.A.3.3 MINIMUM FREQUENCY RESPONSE REQUIREMENT PROFILE

Figure CC.A.3.1 shows the minimum frequency response requirement profile diagrammatically for a 0.5 Hz change in **Frequency**. The percentage response capabilities and loading levels are defined on the basis of the **Registered Capacity** of the **Generating Unit** or **CCGT Module** (or Registered Export Capacity of the DC Converter Station). Each **Generating Unit** ~~and/or~~ **CCGT Module** or DC Converter Station must be capable of operating in a manner to provide frequency response at least to the solid boundaries shown in the figure. If the frequency response capability falls within the solid boundaries, the **Generating Unit** ~~or~~ **CCGT Module** or DC Converter Station is providing response below the minimum requirement which is not acceptable. Nothing in this appendix is intended to prevent a **Generating Unit** ~~or~~ **CCGT Module** or DC Converter Station from being designed to deliver a frequency response in excess of the identified minimum requirement.

The frequency response delivered for **Frequency** deviations of less than 0.5 Hz should be no less than a figure which is directly proportional to the minimum frequency response requirement for a **Frequency** deviation of 0.5 Hz. For example, if the **Frequency** deviation is 0.2 Hz, the corresponding minimum frequency response requirement is 40% of the level shown in Figure CC.A.3.1. The frequency response delivered for **Frequency** deviations of more than 0.5 Hz should be no less than the response delivered for a **Frequency** deviation of 0.5 Hz.

Each **Generating Unit** ~~and/or~~ **CCGT Module** or DC Converter Station must be capable of providing some response, in keeping with its specific operational characteristics, when operating between 95% to 100% of **Registered Capacity** (or Registered Export Capacity) as illustrated by the dotted lines in Figure CC.A.3.1.

At the **Minimum Generation** level, each **Generating Unit** and/or **CCGT Module** is required to provide high and low frequency response depending on the **System Frequency** conditions. At the Minimum Export Capacity level, each DC Converter Station is required to be capable of providing high and low frequency response depending on the System Frequency conditions. Where the **Frequency** is high, the **Active Power** output is therefore expected to fall below the **Minimum Generation** (or Minimum Export Capacity) level.

The **Designed Minimum Operating Level** is the output at which a **Generating Unit** ~~and/or~~ **CCGT Module** or DC Converter Station has no **High Frequency Response** capability. It may be less than, but must not be more than, 55% of the **Registered Capacity** (or Registered Export Capacity). This implies that a **Generating Unit** ~~or~~ **CCGT Module** or DC Converter Station is not obliged to reduce its output to below this level unless the **Frequency** is at or above 50.5 Hz (cf BC3.7).

### CC.A.3.4 TESTING OF FREQUENCY RESPONSE CAPABILITY

The response capabilities shown diagrammatically in Figure CC.A.3.1 are measured by taking the responses as obtained from some of the dynamic response tests specified by **NGC** and carried out by **Generators** or DC Converter Stations for compliance purposes and to validate the content of **Ancillary Services Agreements** using an injection of a frequency change to the plant control system (~~ie e.g.~~ governor

and load controller). The injected signal is a linear ramp from zero to 0.5 Hz frequency change over a ten second period, and is sustained at 0.5 Hz frequency change thereafter, as illustrated diagrammatically in figures CC.A.3.2 and CC.A.3.3.

The **Primary Response** capability (P) of a **Generating Unit~~-or-a~~, CCGT Module or DC Converter Station** is the minimum increase in **Active Power** output between 10 and 30 seconds after the start of the ramp injection as illustrated diagrammatically in Figure CC.A.3.2.

The **Secondary Response** capability (S) of a **Generating Unit~~-or-a~~, CCGT Module or DC Converter Station** is the minimum increase in **Active Power** output between 30 seconds and 30 minutes after the start of the ramp injection as illustrated diagrammatically in Figure CC.A.3.2.

The **High Frequency Response** capability (H) of a **Generating Unit~~-or-a~~, CCGT Module or DC Converter Station** is the decrease in **Active Power** output provided 10 seconds after the start of the ramp injection and sustained thereafter as illustrated diagrammatically in Figure CC.A.3.3.

#### CC.A.3.5 REPEATABILITY OF RESPONSE

When a **Generating Unit~~-or-~~, CCGT Module or DC Converter Station** has responded to a significant **Frequency** disturbance, its response capability must be fully restored as soon as technically possible. Full response capability should be restored no later than 20 minutes after the initial change of **System Frequency** arising from the **Frequency** disturbance.

#### CC.A.3.6 APPLICABILITY OF TERMS

In Figure CC.A.3.1, the terms **Registered Capacity (RC)** and **Minimum Generation (MG)** apply to **Generating Units** and/or **CCGT Modules**. The terms **Registered Export Capacity (REC)** and **Minimum Export Capacity (MEC)** apply to **DC Converter Stations**. The term **Designed Minimum Operating Level (DMOL)** applies to all.

Figure CC.A.3.1 - Minimum Frequency Response Requirement Profile  
 for a 0.5 Hz frequency change from Target Frequency  
 GCRP 02/31

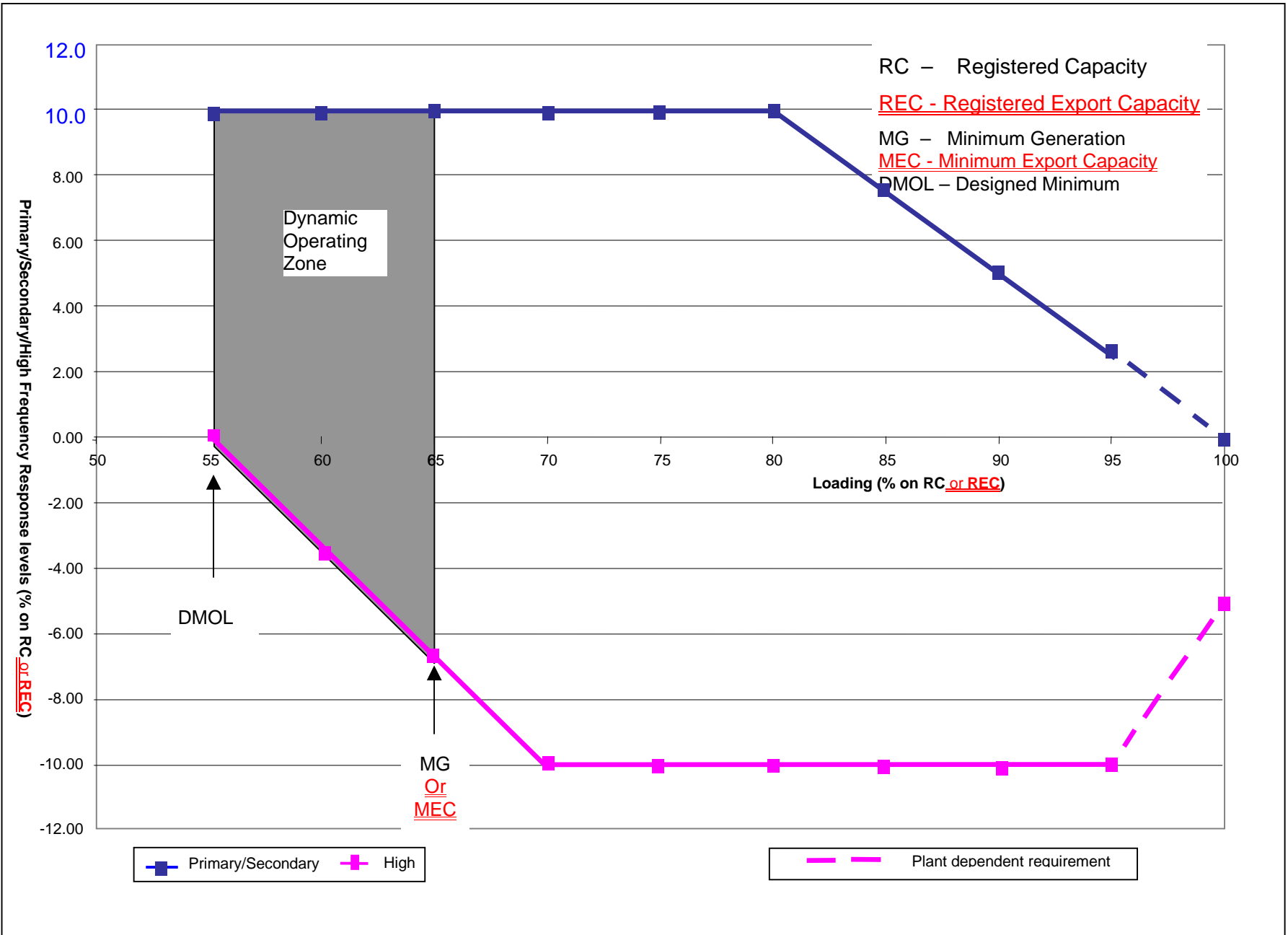


Figure CC.A.3.2 - Interpretation of Primary and Secondary Response Values

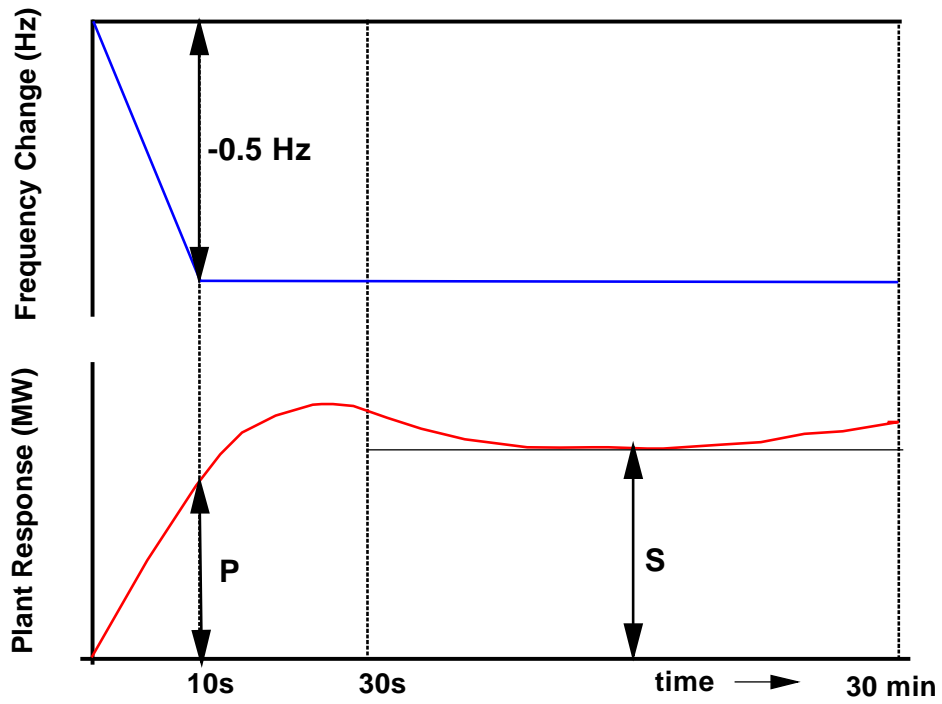
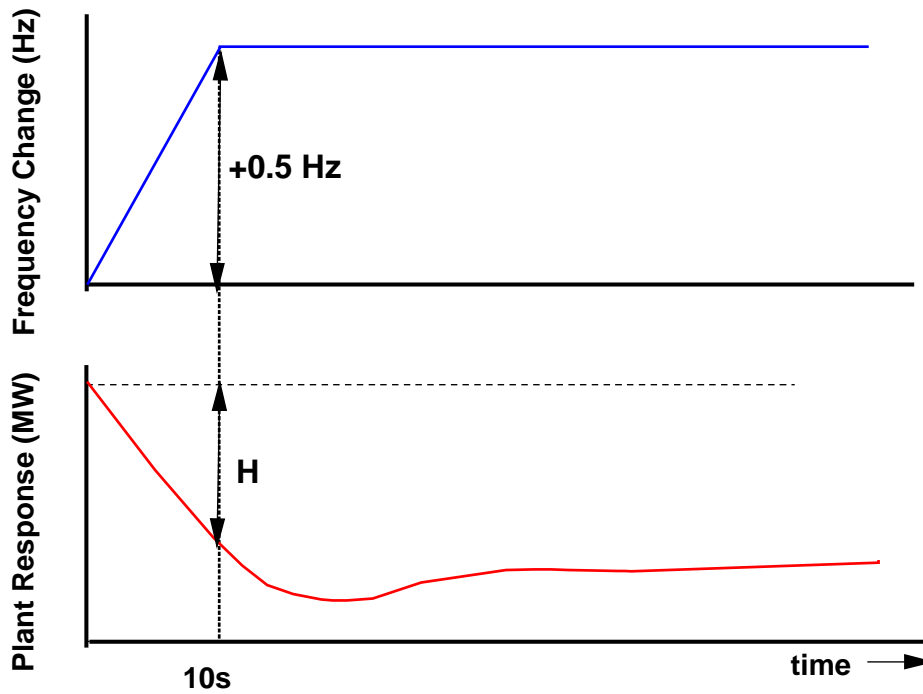


Figure CC.A.3.3 - Interpretation of High Frequency Response Values



APPENDIX 4

**[Not Used]**

APPENDIX 5

TECHNICAL REQUIREMENTS  
**LOW FREQUENCY RELAYS FOR THE AUTOMATIC**  
**DISCONNECTION OF SUPPLIES AT LOW FREQUENCY**

**[Not shown as not relevant]**

## D) Extracts from Balancing Code No 3

FREQUENCY CONTROL PROCESSBC3.1 INTRODUCTION

BC3.1.1 **BC3** sets out the procedure for **NGC** to use in relation to **Users** to undertake **System Frequency** control. **System Frequency** will be controlled by response from **Gensets** and **DC Converter Stations** operating in **Limited Frequency Sensitive Mode** or **Frequency Sensitive Mode**, by the issuing of instructions to **Gensets** and **EISOs** and/or **DC Converter Owners** and by control of **Demand**. The requirements for **Frequency** control are determined by the consequences and effectiveness of the **Balancing Mechanism**, and accordingly, **BC3** is complementary to **BC1** and **BC2**. In the case of **DC Converter Stations**, the provisions of **BC2.9.6** are also relevant.

BC3.1.2 Inter-relationship with Ancillary Services

The provision of response (other than by operation in **Limited Frequency Sensitive Mode** or in accordance with BC3.7.1(c)) in order to contribute towards **Frequency** control, as described in **BC3**, by **Generators** or **EISOs** and/or **DC Converter Owners** will be an **Ancillary Service**. **Ancillary Services** are divided into three categories, **System Ancillary Services** Parts 1 and 2 and **Commercial Ancillary Services**. **System Ancillary Services**, Parts 1 and 2, are those **Ancillary Services** listed in CC.8.1; those in Part 1 of CC.8.1 are those for which the **Connection Conditions** require the capability as a condition of connection and those in Part 2 are those which may be agreed to be provided by **Users** and which can only be utilised by **NGC** if so agreed. **Commercial Ancillary Services** like those **System Ancillary Services** set out in Part 2 of CC.8.1, may be agreed to be provided by **Users** and which can only be utilised by **NGC** if so agreed.

BC3.1.3 Provision of Frequency control by DC Converter Stations

The delivery of **Frequency** control services, if any, from an **External System** via a **DC Converter Station** will be provided for in the **Bilateral Agreement** or any other relevant agreements with the **DC Converter Owner**.

BC3.2 OBJECTIVE

The procedure for **NGC** to direct **System Frequency** control is intended to enable (as far as possible) **NGC** to meet the statutory requirements of **System Frequency** control.

BC3.3 SCOPE

**BC3** applies to **NGC** and to **Users**, which in this BC3 means:-

- (a) **Generators** with regard to their **Large Power Stations**,
- (b) **DC Converter Owners**,
- (b)(c) **Network Operators**,
- (e)(d) other providers of **Ancillary Services**, and

(d)(e) **Externally Interconnected System Operators.**BC3.4 **MANAGING SYSTEM FREQUENCY**BC3.4.1 **Statutory Requirements**

When **NGC** determines it is necessary (by having monitored the **System Frequency**), it will, as part of the procedure set out in **BC2**, issue instructions (including instructions for **Commercial Ancillary Services**) in order to seek to regulate **System Frequency** to meet the statutory requirements of **Frequency** control. **Gensets** and/or DC Converter Stations operating in **Frequency Sensitive Mode** will be instructed by **NGC** to operate taking due account of the **Target Frequency** notified by **NGC**.

BC3.4.2 **Target Frequency**

**NGC** will give 15 minutes notice of variation in **Target Frequency**.

BC3.4.3 **Electric Time**

**NGC** will endeavour (in so far as it is able) to control electric clock time to within plus or minus 10 seconds by specifying changes to **Target Frequency**, by accepting bids and offers in the **Balancing Mechanism**. Errors greater than plus or minus 10 seconds may be temporarily accepted at **NGC's** reasonable discretion.

BC3.5 **RESPONSE FROM GENSETS AND DC CONVERTER STATIONS**BC3.5.1 **Capability**

Each **Genset** must at all times have the capability to operate automatically so as to provide response to changes in **Frequency** in accordance with the requirements of CC.6.3.7 in order to contribute to containing and correcting the **System Frequency** within the statutory requirements of **Frequency** control. Each DC Converter Station must at all times have the capability to operate automatically so as to provide response to changes in Frequency in accordance with the requirements of CC.6.5.5 and CC.6.5.6 in order to contribute to containing and correcting the System Frequency within the scope of Frequency control agreed as described in BC3.1.3. In addition each **Genset** and each DC Converter Station must at all times have the capability to operate in a **Limited Frequency Sensitive Mode** by operating so as to provide **Limited High Frequency Response**.

BC3.5.2 **Limited Frequency Sensitive Mode**

Each **Synchronised Genset** producing **Active Power** must operate at all times in a **Limited Frequency Sensitive Mode** (unless instructed in accordance with BC3.5.4 below to operate in **Frequency Sensitive Mode**). Operation in **Limited Frequency Sensitive Mode** must achieve the capability requirement described in CC.6.3.3 for **System Frequencies** up to 50.4Hz and shall be deemed not to be in contravention of CC.6.3.7. Each Synchronised DC Converter Station transferring Active Power to the Total System must have the capability to operate at all times in a Limited Frequency Sensitive Mode (unless instructed in accordance with BC3.5.4 below to operate in Frequency Sensitive Mode). Operation in Limited Frequency Sensitive Mode must achieve the capability requirement described in CC.6.5.3 for System Frequencies up to 50.4Hz and shall be deemed not to be in contravention of CC.6.5.5 and CC.6.5.6.

BC3.5.3 **Existing Gas Cooled Reactor Plant**  
 NGC will permit **Existing Gas Cooled Reactor Plant** other than **Frequency Sensitive AGR Units** to operate in **Limited Frequency Sensitive Mode** at all times.

BC3.5.4 **Frequency Sensitive Mode**

- (a) **NGC** may issue an instruction to a **Genset or a DC Converter Station (if so agreed as described in BC3.1.3)** to operate so as to provide **Primary Response** and/or **Secondary Response** and/or **High Frequency Response** (in the combinations agreed in the relevant **Ancillary Services Agreement**). When so instructed, the **Genset or DC Converter Station** must operate in accordance with the instruction and will no longer be operating in **Limited Frequency Sensitive Mode**, but by being so instructed will be operating in **Frequency Sensitive Mode**.
- (b) **Frequency Sensitive Mode** is the generic description for a **Genset or a DC Converter Station** operating in accordance with an instruction to operate so as to provide **Primary Response** and/or **Secondary Response** and/or **High Frequency Response** (in the combinations agreed in the relevant **Ancillary Services Agreement**).
- (c) The magnitude of the response in each of those categories instructed will be in accordance with the relevant **Ancillary Services Agreement** with the **Generator or the Bilateral Agreement or any other relevant agreements with the DC Converter Owner.**
- (d) Such instruction will continue until countermanded by **NGC** or until:
- i. the Genset is De-Synchronised, or
- ii. the DC Converter Station ceases to transfer Active Power to the Total System, subject to the conditions of any relevant agreement relating to the operation of the DC Converter Station.
- whichever is the first to occur.
- (e) **NGC** will not so instruct **Generators** in respect of **Existing Gas Cooled Reactor Plant** other than **Frequency Sensitive AGR Units**.

BC3.5.5 **System Frequency Induced Change**  
 A **System Frequency** induced change in the **Active Power** output of a **Genset or a DC Converter Station** which assists recovery to **Target Frequency** must not be countermanded by a **Generator or DC Converter Owner** except where it is done purely on safety grounds (relating to either personnel or plant) or, where necessary, to ensure the integrity of the **Power Station or DC Converter Station.**

BC3.6 **RESPONSE TO LOW FREQUENCY**

BC3.6.1 **Low Frequency Relay Initiated Response from Gensets or DC Converter Stations**

- (a) **NGC** may utilise **Gensets or DC Converter Stations** with the capability of **Low Frequency Relay** initiated response as:
- (i) synchronisation and generation from standstill;

- (ii) generation from zero generated output;
- (iii) increase in generated output;
- (iv) increase in DC Converter Station output to the Total System (if so agreed as described in BC3.1.3);
- (v) decrease in DC Converter Station input from the Total System (if so agreed as described in BC3.1.3)

in establishing its requirements for **Operating Reserve**.

- (b) (i) **NGC** will specify within the range agreed with **Generators and/or EISOs and/or DC Converter Owners (if so agreed as described in BC3.1.3)**, **Low Frequency Relay** settings to be applied to the **Gensets or DC Converter Stations** pursuant to BC3.6.1 (a) and instruct the **Low Frequency Relay** initiated response placed in and out of service.
- (ii) **Generators and/or EISOs and/or DC Converter Owners (if so agreed as described in BC3.1.3)** will comply with **NGC** instructions for **Low Frequency Relay** settings and **Low Frequency Relay** initiated response to be placed in or out of service. **Generators or EISOs and/or DC Converter Owners** may not alter such **Low Frequency Relay** settings or take **Low Frequency Relay** initiated response out of service without **NGC's** agreement (such agreement not to be unreasonably withheld or delayed), except for safety reasons.

#### BC3.6.2

**Low Frequency Relay Initiated Response from Demand and other Demand modification arrangements (which may include a DC Converter Station when transferring Active Power from the Total System)**

- (a) **NGC** may, pursuant to an **Ancillary Services Agreement**, utilise **Demand** with the capability of **Low Frequency Relay** initiated **Demand** reduction in establishing its requirements for **Frequency Control**.
- (b) (i) **NGC** will specify within the range agreed the **Low Frequency Relay** settings to be applied pursuant to BC3.6.2 (a), the amount of **Demand** reduction to be available and will instruct the **Low Frequency Relay** initiated response to be placed in or out of service.
- (ii) **Users** will comply with **NGC** instructions for **Low Frequency Relay** settings and **Low Frequency Relay** initiated **Demand** reduction to be placed in or out of service. **Users** may not alter such **Low Frequency Relay** settings or take **Low Frequency Relay** initiated response out of service without **NGC's** agreement, except for safety reasons.
- (iii) In the case of any such **Demand** which is **Embedded**, **NGC** will notify the relevant **Network Operator** of the location of the **Demand**, the amount of **Demand** reduction to be available, and the **Low Frequency Relay** settings.

- (c) **NGC** may also utilise other **Demand** modification arrangements pursuant to an agreement for **Ancillary Services**, in order to contribute towards **Operating Reserve**.

BC3.7 **RESPONSE TO HIGH FREQUENCY REQUIRED FROM SYNCHRONISED GENSETS AND DC CONVERTER STATIONS**

BC3.7.1 **Plant in Frequency Sensitive Mode instructed to provide High Frequency Response**

- (a) Each **Synchronised Genset** in respect of which the **Generator** has been instructed to operate so as to provide **High Frequency Response**, which is producing **Active Power** and which is operating above **Designed Minimum Operating Level**, is required to reduce **Active Power** output in response to an increase in **System Frequency** above the **Target Frequency** (or such other level of **Frequency** as may have been agreed in an **Ancillary Services Agreement**). Each DC Converter Station in respect of which the EISO and/or DC Converter Owner has been instructed to operate so as to provide Frequency control services (if so agreed as described in BC3.1.3), which is transferring Active Power to the Total System and which is operating above Designed Minimum Operating Level, is required to reduce Active Power output to the Total System in response to an increase in System Frequency above the Target Frequency (or such other level of Frequency as may have been agreed in the Bilateral Agreement or any other relevant agreements). The **Target Frequency** is normally 50.00 Hz except where modified as specified under BC3.4.2.
- (b) (i) The rate of change of **Active Power** output with respect to **Frequency** up to 50.5 Hz shall be in accordance with the provisions of the relevant **Ancillary Services Agreement** with each **Generator** or the Bilateral Agreement or any other relevant agreements with the DC Converter Owner. If more than one rate is provided for in the **Ancillary Services Agreement, Bilateral Agreement or other relevant agreement,** **NGC** will instruct the rate when the instruction to operate to provide **High Frequency Response** is given. In the case of DC Converter Stations, the provisions of BC3.7.7 are also applicable.
- (ii) The reduction in **Active Power** output by the amount provided for in the relevant **Ancillary Services Agreement** must be fully achieved within 10 seconds of the time of the **Frequency** increase and must be sustained at no lesser reduction thereafter.
- (iii) It is accepted that the reduction in **Active Power** output may not be to below the **Designed Minimum Operating Level**.

- (c) In addition to the **High Frequency Response** provided, the **Genset** must continue to reduce **Active Power** output in response to an increase in **System Frequency** to 50.5 Hz or above at a minimum rate of 2 per cent of output per 0.1 Hz deviation of **System Frequency** above that level, such reduction to be achieved within five minutes of the rise to or above 50.5 Hz. For the avoidance of doubt, the provision of this reduction in **Active Power** output is not an **Ancillary Service**. In addition to the **High Frequency Response** provided, the **DC Converter Station** must have the capability to continue to reduce **Active Power** output in response to an increase in **System Frequency** to 50.5 Hz or above at a minimum rate of 2 per cent of output per 0.1 Hz deviation of **System Frequency** above that level, such change to be achievable within one minute of the rise to or above 50.5 Hz.

## BC3.7.2

Plant in **Limited Frequency Sensitive Mode**

- (a) Each **Synchronised Genset** operating in a **Limited Frequency Sensitive Mode** which is producing **Active Power** is also required to reduce **Active Power** output in response to **System Frequency** when this rises above 50.4 Hz. Each **DC Converter Station** operating in a **Limited Frequency Sensitive Mode** which is transferring **Active Power** to **Total System** is also required to have the capability to reduce **Active Power** output in response to **System Frequency** when this rises above 50.4 Hz. For the avoidance of doubt, the provision of this reduction in **Active Power** output is not an **Ancillary Service**. Such provision is known as "**Limited High Frequency Response**".
- (b) (i) The rate of change of **Active Power** output must be at a minimum rate of 2 per cent of output per 0.1 Hz deviation of **System Frequency** above 50.4 Hz.
- (ii) The reduction in **Active Power** output must be continuously and linearly proportional, as far as is practicable, to the excess of **Frequency** above 50.4 Hz and must be provided increasingly with time over the period specified in (iii) below.
- (iii) As much as possible of the proportional reduction in **Active Power** output must result from speed governor or frequency control action and must be achieved within 10 seconds of the time of the **Frequency** increase above 50.4 Hz.
- (iv) The residue of the proportional reduction in **Active Power** output which results from automatic action of the **Genset** or **DC Converter Station** output control devices other than the speed governors or frequency controls must be achieved within 3 minutes from the time of the **Frequency** increase above 50.4 Hz.
- (v) Any further residue of the proportional reduction which results from non-automatic action initiated by the **Generator** or **DC Converter Owner** shall be initiated within 2 minutes, and achieved within 5 minutes, of the time of the **Frequency** increase above 50.4 Hz.
- (c) Each **Genset** or **DC Converter Station** which is providing **Limited High Frequency Response** in accordance with this BC3.7.2 must continue to provide it until the **Frequency** has returned to or below 50.4 Hz or until otherwise instructed by **NGC**.

BC3.7.3

Plant operation to below **Minimum Generation (or Minimum Export Capacity in the case of a DC Converter Station)**

- (a) As stated in CC.A.3.2, steady state operation below **Minimum Generation (or Minimum Export Capacity)** is not expected but if **System** operating conditions cause operation below **Minimum Generation (or Minimum Export Capacity)** which give rise to operational difficulties for the **Genset (or DC Converter Station)** then **NGC** should not, upon request, unreasonably withhold issuing a **Bid-Offer Acceptance** to return the **Generating Unit** or **CCGT Module** to an output not less than **Minimum Generation** or to return a **DC Converter Station** to not less than **Minimum Export Capacity**. In the case of a DC Converter Station not participating in the Balancing Mechanism, then NGC will, upon request, attempt to return the DC Converter Station to an output not less than Minimum Export Capacity or to zero transfer or to reverse the transfer of Active Power.
- (b) It is possible that **Synchronised Gensets (or DC Converter Stations)** which have responded as required under BC3.7.1 or BC3.7.2 to an excess of **System Frequency**, as therein described, will (if the output reduction is large or if the **Genset or DC Converter Station** output has reduced to below the **Designed Minimum Operating Level**) trip after a time.
- (c) All reasonable efforts should in the event be made by the **Generator or EISO and/or DC Converter Owner** to avoid such tripping, provided that the **System Frequency** is below 52Hz.
- (d) If the **System Frequency** is at or above 52Hz, the requirement to make all reasonable efforts to avoid tripping does not apply and the **Generator** is required to take action to protect the **Generating Units** as specified in CC.6.3.13, and the DC Converter Owner is required to take action to protect the DC Converter Stations as specified in CC.6.5.11.
- (e) In the event of the **System Frequency** becoming stable above 50.5Hz, after all **Genset or DC Converter Station** action as specified in BC3.7.1 and BC3.7.2 has taken place, **NGC** will issue appropriate **Bid-Offer Acceptances** and/or **Ancillary Service** instructions, which may include **Emergency Instructions** under **BC2** to trip **Gensets or DC Converter Stations (or to reverse the transfer of Active Power)** so that the **Frequency** returns to below 50.5Hz and ultimately to **Target Frequency**.
- (f) If the **System Frequency** has become stable above 52 Hz, after all **Genset or DC Converter Station** action as specified in BC3.7.1 and BC3.7.2 has taken place, **NGC** will issue **Emergency Instructions** under **BC2** to trip appropriate **Gensets or DC Converter Stations (or to reverse the transfer of Active Power)** to bring the **System Frequency** to below 52Hz and follow this with appropriate **Bid-Offer Acceptances** or **Ancillary Service** instructions or further **Emergency Instructions** under **BC2** to return the **System Frequency** to below 50.5 Hz and ultimately to **Target Frequency**.

BC3.7.4

The **Generator or DC Converter Owner** will not be in breach of any of the provisions of BC2 by following the provisions of BC3.7.1, BC3.7.2 or BC3.7.3.

BC3.7.5

Information update to **NGC**

In order that **NGC** can deal with the emergency conditions effectively, it needs as much up to date information as possible and accordingly **NGC** must be informed of the action taken in accordance with BC3.7.1(c) and BC3.7.2 as soon as

possible and in any event within 7 minutes of the rise in **System Frequency**, directly by telephone from the **Control Point** for the **Power Station** or **DC Converter Station**.

BC3.7.6 **Existing Gas Cooled Reactor Plant**

For the avoidance of doubt, **Generating Units** within **Existing Gas Cooled Reactor Plant** are required to comply with the applicable provisions of this BC3.7 (which, for the avoidance of doubt, other than for **Frequency Sensitive AGR Units**, do not include BC3.7.1).

BC3.7.7 **Externally Interconnected System Operators**

**NGC** will use reasonable endeavours to ensure that, if **System Frequency** rises above 50.4Hz, and an **Externally Interconnected System Operator** (in its role as operator of the **External System**) is transferring power into the **NGC Transmission System** from its **External System**, the amount of power transferred in to the **NGC Transmission System** from the **System** of that **Externally Interconnected System Operator** is reduced at a rate equivalent to (or greater than) that which applies for **Synchronised Gensets** operating in **Limited Frequency Sensitive Mode** which are producing **Active Power**. This will be done either by utilising existing arrangements which are designed to achieve this, or by issuing **Emergency Instructions** under **BC2**.

< End of BC3 >

## E) Extracts from Data Registration Code

### DRC.3 SCOPE

DRC.3.1 The **DRC** applies to **NGC** and to **Users**, which in this **DRC** means:-

(a) **Generators;**

(b) **Network Operators;**

~~(c)~~ **DC Converter Owners**

~~(d)~~ **Suppliers;**

~~(e)~~ **Non-Embedded Customers** (including, for the avoidance of doubt, a **Pumped Storage Generator** in that capacity);

~~(f)~~ **Externally Interconnected System Operators;**

~~(g)~~ **Interconnector Users;** and

~~(h)~~ **BM Participants.**

.....

### DRC.6 DATA TO BE REGISTERED

DRC.6.1 Schedules 1 to 14 attached cover the following data areas.

DRC.6.1.1 SCHEDULE 1 - **GENERATING UNIT (OR CCGT Module) TECHNICAL DATA.**

Comprising **Generating Unit** (and **CCGT Module**) fixed electrical parameters.

DRC.6.1.2 SCHEDULE 2 - **GENERATION PLANNING PARAMETERS**

Comprising the **Genset** parameters required for **Operational Planning** studies.

DRC.6.1.3 SCHEDULE 3 - **LARGE POWER STATION OUTAGE PROGRAMMES, OUTPUT USABLE AND INFLEXIBILITY INFORMATION.**

Comprising generation outage planning, **Output Usable** and inflexibility information at timescales down to the daily **BM Unit Data** submission.

DRC.6.1.4 SCHEDULE 4 - **LARGE POWER STATION** Droop and Response data.

Comprising data on Governor droop settings, and **Primary, Secondary** and **High Frequency Response** data for **Large Power Stations**.

DRC.6.1.5 SCHEDULE 5 - **USER'S SYSTEM DATA.**

Comprising electrical parameters relating to **Plant** and **Apparatus** connected to the **NGC Transmission System**.

- DRC.6.1.6      SCHEDULE 6 - **USERS** OUTAGE INFORMATION.  
Comprising the information required by **NGC** for outages on the **Users System**, including outages at **Power Stations** other than outages of **Gensets**
- DRC.6.1.7      SCHEDULE 7 - LOAD CHARACTERISTICS.  
Comprising the estimated parameters of load groups in respect of, for example, harmonic content and response to frequency.
- DRC.6.1.8      SCHEDULE 8 - **BM UNIT** DATA.
- DRC.6.1.9      SCHEDULE 9 - DATA SUPPLIED BY **NGC** TO **USERS**.
- DRC.6.1.10     SCHEDULE 10 - **USER'S DEMAND** PROFILES AND **ACTIVE ENERGY** DATA  
Comprising information relating to the **User's** total **Demand** and **Active Energy** taken from the **NGC Transmission System**
- DRC.6.1.11     SCHEDULE 11 - **CONNECTION POINT** DATA  
Comprising information relating to **Demand**, demand transfer capability and a summary of the **Small Power Station, Medium Power Station** and **Customer** generation connected to the **Connection Point**
- DRC.6.1.12     SCHEDULE 12 - **DEMAND CONTROL** DATA  
Comprising information related to **Demand Control**
- DRC.6.1.13     SCHEDULE 13 - **FAULT INFEED** DATA  
Comprising information relating to the Short Circuit contribution to the **NGC Transmission System** from **Users** other than **Generators**.
- DRC.6.1.14     SCHEDULE 14 - **FAULT INFEED** DATA  
Comprising information relating to the Short Circuit contribution to the **NGC Transmission System** from **Generators**.
- DRC.6.1.15     SCHEDULE 15 - **DC Converter Station Technical Data**  
Comprising **DC Converter Station** electrical parameters and control system information.
- DRC.6.2        The **Schedules** applicable to each class of **User** are as follows:
- |  |                         |
|--|-------------------------|
| <b>Generators with Large Power Stations</b>  | Sched 1, 2, 3, 4, 9, 14 |
| <b>Generators with Medium Power Stations</b> (See note 2)  | Sched 1, 9, 14          |
| <b>Generators with Small Power Stations</b> directly connected to the <b>NGC Transmission System</b> | Sched 1, 6, 14          |
| All <b>Users</b> connected directly to <b>NGC Transmission System</b>                                | Sched 5, 6, 9           |
| All <b>Users</b> connected directly to   |                         |

the <b>NGC Transmission System</b> other than <b>Generators</b>	Sched 10,11,13
All <b>Users</b> connected directly to <b>NGC Transmission System</b> with <b>Demand</b>	Sched 7, 9
A <b>Pumped Storage Generator, Externally Interconnected System Operator</b> and <b>Interconnector Users</b>	Sched12 (as marked)
All <b>Suppliers</b>	Sched 12
All <b>Network Operators</b>	Sched 12
All <b>BM Participants</b>	Sched 8
<u>All <b>DC Converter Owners</b></u>	<u>Sched 15</u>

## Notes:

1. **Network Operators** must provide data relating to **Small Power Stations** and/or **Customer Generating Plant Embedded** in their **Systems** when such data is requested by **NGC** pursuant to PC.A.3.1.4 or PC.A.5.1.4.
2. The data in schedules 1 and 14 need not be supplied in relation to **Medium Power Stations** connected at a voltage level below the voltage level of the **Subtransmission System** except in connection with a **CUSC Contract** or unless specifically requested by **NGC**.

**DC CONVERTER STATION TECHNICAL DATA**

DC CONVERTER STATION NAME \_\_\_\_\_

DATE: \_\_\_\_\_

<u>Data Description</u>	<u>Units</u>	<u>Data Category</u>	<u>DC Converter Station Data</u>
<b><u>DC CONVERTER STATION DEMANDS:</u></b>			
<b><u>Demand supplied through Station Transformers associated with the DC Converter Station [PC.A.7.1.2.1]</u></b>			
<u>- Demand with all DC Converters operating at Rated MW import.</u>	<u>MW</u> <u>Mvar</u>	<u>DPD</u> <u>DPD</u>	
<u>- Demand with all DC Converters operating at Rated MW export.</u>	<u>MW</u> <u>Mvar</u>	<u>DPD</u> <u>DPD</u>	
<b><u>Additional Demand associated with the DC Converter Station supplied through the NGC Transmission System. [PC.A.7.1.2.2]</u></b>			
<u>- The maximum Demand that could occur.</u>	<u>MW</u> <u>Mvar</u>	<u>DPD</u> <u>DPD</u>	
<u>- Demand at specified time of annual peak half hour of NGC Demand at Annual ACS Conditions.</u>	<u>MW</u> <u>Mvar</u>	<u>DPD</u> <u>DPD</u>	
<u>- Demand at specified time of annual minimum half-hour of NGC Demand.</u>	<u>MW</u> <u>Mvar</u>	<u>DPD</u> <u>DPD</u>	
<b><u>DC CONVERTER STATION DATA [PC.A.4A.3.1]</u></b>			
<u>Number of poles, i.e. number of DC Converters</u>	<u>Text</u>	<u>SPD+</u>	
<u>Pole arrangement (e.g. monopole or bipole)</u>	<u>Text</u>	<u>SPD+</u>	
<u>Details of each viable operating configuration</u>		<u>SPD+</u>	
<u>Configuration 1</u>	<u>Diagram</u>		
<u>Configuration 2</u>	<u>Diagram</u>		
<u>Configuration 3</u>	<u>Diagram</u>		
<u>Configuration 4</u>	<u>Diagram</u>		
<u>Configuration 5</u>	<u>Diagram</u>		
<u>Configuration 6</u>	<u>Diagram</u>		
<u>Remote ac connection arrangement</u>	<u>Diagram</u>	<u>SPD</u>	

Data Description	Units	Data Category	Operating Configuration					
			1	2	3	4	5	6
<b><u>DC CONVERTER STATION DATA</u></b>								
<u>Point of connection to the <b>NGC Transmission System</b> (or the <b>Total System</b> if embedded) of the <b>DC Converter Station</b> configuration in terms of geographical and electrical location and system voltage</u>	Text	SPD						
<u>If the busbars at the <b>Connection Point</b> are normally run in separate sections identify the section to which the <b>DC Converter Station</b> configuration is connected</u>	Section Number	SPD						
<u>Rated MW import per pole [PC.A.4A.3.1]</u>	MW	SPD+						
<u>Rated MW export per pole [PC.A.4A.3.1]</u>	MW	SPD+						
<b><u>ACTIVE POWER TRANSFER CAPABILITY</u></b>								
<u>Registered Export Capacity</u>	MW	SPD						
<u>Registered Import Capacity [PC.A.4A.2.2 (a)]</u>	MW	SPD						
<u>Minimum Export Capacity [PC.A.4A.2.2 (d)]</u>	MW	SPD						
<u>Minimum Import Capacity</u>	MW	SPD						
<u>Import MW available in excess of Registered Import Capacity</u>	MW	SPD						
<u>Time duration for which MW in excess of Registered Import Capacity is available [PC.A.4A.2.2 (e)]</u>	min	SPD						
<u>Export MW available in excess of Registered Import Capacity</u>	MW	SPD						
<u>Time duration for which MW in excess of Registered Export Capacity is available [PC.A.4A.2.2 (f)]</u>	min	SPD						
<b><u>DC CONVERTER TRANSFORMER [PC.A.7.1.3.1 (b)]</u></b>								
<u>Rated MVA</u>	MVA	DPD						
<u>Winding arrangement</u>								
<u>Nominal primary voltage</u>	kV	DPD						
<u>Nominal secondary (converter-side) voltage(s)</u>	kV	DPD						
<u>Positive sequence reactance</u>								
<u>Maximum tap</u>	% on MVA	DPD						
<u>Nominal tap</u>	% on MVA	DPD						
<u>Minimum tap</u>	% on MVA	DPD						
<u>Positive sequence resistance</u>								
<u>Maximum tap</u>	% on MVA	DPD						
<u>Nominal tap</u>	% on MVA	DPD						
<u>Minimum tap</u>	% on MVA	DPD						
<u>Zero phase sequence reactance</u>	% on MVA	DPD						
<u>Tap change range</u>	+%/-%	DPD						
<u>Tap change step size</u>	%	DPD						

<u>Data Description</u>	<u>Units</u>	<u>Data Category</u>	<u>Operating configuration</u>					
			<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
<p><b><u>DC NETWORK [PC.A.7.1.3.1 (c)]</u></b></p> <p><u>Rated DC voltage per pole</u> <u>Rated DC current</u></p> <p><u>Details of the DC Network described in diagram form including resistance, inductance and capacitance of all DC cables and/or DC lines. Details of any line reactors (including line reactor resistance), line capacitors, DC filters, earthing electrodes and other conductors that form part of the DC Network should be shown.</u></p>	<p><u>kV</u> <u>A</u></p> <p><u>Diagram</u></p>	<p><u>DPD</u> <u>DPD</u> <u>DPD</u></p>						
<p><b><u>DC CONVERTER STATION AC HARMONIC FILTER AND REACTIVE COMPENSATION EQUIPMENT [PC.A.7.1.3.1 (d)]</u></b></p> <p><u>For all switched reactive compensation equipment</u></p> <p><u>Diagram of filter connections</u> <u>Type of equipment (e.g. fixed or variable)</u> <u>Capacitive rating; or</u> <u>Inductive rating; or</u> <u>Operating range</u></p> <p><u>Reactive Power consumption as a function of various MW transfer levels</u></p>	<p><u>Text</u> <u>Mvar</u> <u>Mvar</u> <u>Mvar</u></p> <p><u>Table</u></p>	<p><u>SPD</u> <u>DPD</u> <u>DPD</u> <u>DPD</u> <u>DPD</u></p>						

Data Description	Units	Data Category	Operating configuration					
			1	2	3	4	5	6
<b>CONTROL SYSTEMS [PC.A.7.1.3.1 (e)]</b>								
<u>Static <math>V_{DC} - I_{DC}</math> (DC voltage – DC current) characteristic when operating as</u>								
<u>-Rectifier</u>	<u>Diagram</u>	<u>DPD</u>						
<u>-Inverter</u>	<u>Diagram</u>	<u>DPD</u>						
<u>Details of rectifier mode control system, in block diagram form showing transfer functions of individual elements.</u>	<u>Diagram</u>	<u>DPD</u>						
<u>Details of inverter mode control system, in block diagram form showing transfer functions of individual elements.</u>	<u>Diagram</u>	<u>DPD</u>						
<u>Details of converter transformer tap changer control system in block diagram form showing transfer functions of individual elements. (Only required for DC converters connected to the NGC system.)</u>	<u>Diagram</u>	<u>DPD</u>						
<u>Details of AC filter and reactive compensation equipment control systems in block diagram form showing transfer functions of individual elements. (Only required for DC converters connected to the NGC system.)</u>	<u>Diagram</u>	<u>DPD</u>						
<u>Details of any frequency and/or load control systems in block diagram form showing transfer functions of individual elements.</u>	<u>Diagram</u>	<u>DPD</u>						
<u>Details of any large or small signal modulating controls, such as power oscillation damping controls or sub-synchronous oscillation damping controls, that have not been submitted as part of the above control system data.</u>	<u>Diagram</u>	<u>DPD</u>						
<b>LOADING PARAMETERS [PC.A.7.1.3.1 (f)]</b>								
<u>MW Export</u>								
<u>Nominal loading rate</u>	<u>MW/s</u>	<u>DPD</u>						
<u>Maximum (emergency) loading rate</u>	<u>MW/s</u>	<u>DPD</u>						
<u>MW Import</u>								
<u>Nominal loading rate</u>	<u>MW/s</u>	<u>DPD</u>						
<u>Maximum (emergency) loading rate</u>	<u>MW/s</u>	<u>DPD</u>						
<u>Maximum recovery time, to 90% of pre-fault loading, following an AC system fault or severe voltage depression.</u>	<u>s</u>	<u>DPD</u>						
<u>Maximum recovery time, to 90% of pre-fault loading, following a transient DC Network fault.</u>	<u>s</u>	<u>DPD</u>						

CONTROL SYSTEM RESPONSE [CC Appendix 3]

The Data in this Schedule is to be supplied by DC Converter Station Owners with respect to all viable operating configurations at each DC Converter Station, whether directly connected or Embedded.

Operating Configuration No(s) \_\_\_\_\_

<u>DATA DESCRIPTION</u>	<u>NORMAL VALUE</u>	<u>MW</u>	<u>DATA CAT</u>	<u>DROOP %</u>	<u>RESPONSE CAPABILITY</u>		
					<u>Primary</u>	<u>Secondary</u>	<u>High Frequency</u>
<u>MLP1</u>	<u>Designed Minimum Operating Level</u>		<u>DPD</u>				
<u>MLP2</u>	<u>Minimum Export Capacity</u>		<u>DPD</u>				
<u>MLP3</u>	<u>70% of Registered Export Capacity</u>		<u>DPD</u>				
<u>MLP4</u>	<u>80% of Registered Export Capacity</u>		<u>DPD</u>				
<u>MLP5</u>	<u>95% of Registered Export Capacity</u>		<u>DPD</u>				
<u>MLP6</u>	<u>Registered Export Capacity</u>		<u>DPD</u>				

Notes:

- The data provided is not intended to constrain any Ancillary Services Agreement
- The Response Capability should be provided for each viable operating configuration of the DC Converter Station.
- Primary, Secondary and High Frequency Response are defined in CC.A.3.2, and are based on a frequency ramp of 0.5Hz over 10 seconds. Primary Response is the minimum value of response between 10s and 30s after the frequency ramp starts, Secondary Response between 30s and 30 minutes, and High Frequency Response is the minimum value after 10s on an indefinite basis.
- For plants which have not yet Synchronised, the data values of MLP1 to MLP6 should be as described above. For plants which have already Synchronised, the values of MLP1 to MLP6 can take any value between Designed Minimum Operating Level and Registered Export Capacity. If MLP1 is not provided at the Designed Minimum Operating Level, the value of the Designed Minimum Operating Level should be separately stated.

## F) Consequential Changes

### EXTRACTS FROM PREFACE (Not forming part of the Grid Code)

1. The operating procedures and principles governing **NGC's** relationship with all **Users** of the **NGC Transmission System**, be they **Generators**, **DC Converter Owners**, **Suppliers** or **Non-Embedded Customers** are set out in the **Grid Code**. The **Grid Code** specifies day-to-day procedures for both planning and operational purposes and covers both normal and exceptional circumstances.

.....

3. The **Grid Code** is divided into the following sections:-
  - (a) a **Planning Code** which provides generally for the supply of certain information by **Users** in order for **NGC** to undertake the planning and development of the **NGC Transmission System**;
  - (b) **Connection Conditions**, which specify the minimum technical, design and operational criteria which must be complied with by **NGC** at **Connection Sites** and by **Users** connected to or seeking connection with the **NGC Transmission System** or by **Generators** (other than in respect of **Small Power Stations**) or **DC Converter Owners** connected to or seeking connection to a **User's System**;

### OC2 - OUTAGE PLANNING

[We believe this requires amendment to cover DC Converters as the existing reference to "taking into account External Interconnections" is not adequate]

### EXTRACT FROM OC5 - TESTING AND MONITORING

[We believe this requires amendment to cover DC Converters]

- OC5.5.2.1 The performance of the **BM Unit** will be recorded at **NGC Control Centres** with monitoring at site when necessary, from voltage and current signals provided by the **User** for each **BM Unit** under CC.6.67.1.

### OC7 - OPERATIONAL LIAISON

[Changes will be needed to reflect liaison on DC Converters]

### OC8 - SAFETY CO-ORDINATION

[Changes will be needed to reflect liaison on DC Converters]

### OC10 - EVENT INFORMATION SUPPLY

[Changes will be needed to reflect liaison on DC Converters]

### OC11 - NUMBERING AND NOMENCLATURE

[Changes will be needed to reflect liaison on DC Converters]

**EXTRACT FROM BC1**

## BC1.4.1      Communication with Users

- (a)      Submission of **BM Unit Data** by **Users** to **NGC** specified in BC1.4.2 to BC1.4.4 (with the exception of BC1.4.2(f)) is to be by use of electronic data communications facilities, as provided for in CC.6.56.8. However, data specified in BC1.4.2(c) and BC1.4.2(e) only, may be revised by telephone following its initial submission by electronic data communication facilities.

.....

## BC1.4.2

.....

- (d)      **Bid-Offer Data**  
 Each **BM Participant** may, in respect of each of its **BM Units**, submit to **NGC** for any **Settlement Period** of the next following **Operational Day** the data listed in **BC1** Appendix 1 under the heading of "**Bid-Offer Data**" to amend the data already held by **NGC** in relation to **Bid-Offer Data**, which would otherwise apply to those **Settlement Periods**. **Bid-Offer Data** may not be submitted unless an automatic logging device has been installed at the **Control Point** for the **BM Unit** in accordance with CC.6.56.8(b).

**EXTRACT FROM GC**

- GC.5.3      Unless otherwise specified in the **Grid Code**, all instructions given by **NGC** and communications (other than relating to the submission of data and notices) between **NGC** and **Users** will be given by means of the **Control Telephony** referred to in CC.6.56.2.

End of report