GCRP 02/05

21 February 2002

THE NATIONAL GRID COMPANY plc

GRID CODE REVIEW PANEL

GRID CODE PROVISIONS FOR HIGH VOLTAGE DIRECT CURRENT (HVDC) INTERCONNECTORS

1. Introduction

1.1. This paper proposes the inclusion of requirements in the Grid Code of provisions relating to the connection to the NGC Transmission System of HVDC interconnectors. These proposals have been prompted by recent experience on new HVDC interconnectors across the United Kingdom. It outlines the areas considered for inclusion and the resulting changes that would need to be reflected in the Grid Code. They would also be consistent with the proposed amendments to European Union Directive 96/92/EC (commonly known as the Internal Market in Electricity (IME) Directive) and the proposed Regulations.

2. Background

2.1. Currently there are only limited provisions within the Grid Code relevant to HVDC links. The European Commission is proposing changes to the IME Directive arrangements to clarify further the internal market in electricity. The effect of certain of those changes is to encourage the inclusion in Grid Codes of more explicit provisions on interconnectors, in order to aid transparency. Coupled with this drive there are a number of planned HVDC projects in progress requiring interconnection with the England and Wales network. These developments highlighted that there would be benefit in a clear set of basic network connection requirements to be stated in the Grid Code so that future developers and manufacturers have a readily available basis on which to develop tenders and gauge project costs.

3. Main Areas of Proposed Inclusions

3.1 The main areas of the Grid Code that would be affected are the Connection Conditions and Planning Code with consequential definitions being included. Appendix 1 gives a first draft of possible provisions. These change areas are described briefly below.

Connection Conditions

3.2 The approach has been to retain as much as possible of the existing general provisions relating to AC requirements (CC.6.1 - CC.6.2) and to include a separate section, CC.6.5, that details the main requirements for

HVDC links. New inclusions relate to the Import/Export provisions for minimum active power control with change of frequency (both for frequency response and extreme frequency operation). These requirements mirror the form of the current generator provisions (where technically sensible to do so) to simplify drafting. In addition, special features have been highlighted that reflect requirements for elements that should be considered for inclusion at the design stage for HVDC links such as Power Oscillation Damping and Sub-Synchronous Resonance damping controls.

Planning Code Changes

3.3 Additional data requirements have been included, mirroring generator provisions (where appropriate) together with new sections for planning data specifically for DC Converters. Consequential additions to the DRC have also been identified.

Definition Changes

3.4 Inclusions to define DC Converter to cover the apparatus and DC Converter Owner to include the developer have been proposed. To simplify the Planning Code changes HV Generator Connections have been re-named to HV Connections. This allows its dual use for both generators and DC Converters.

BC3 Changes

3.5 Some changes are also suggested to BC3 to incorporate DC Converters. The issue is highlighted in that Code of the interrelationship between the DC Converter Owner and the Externally Interconnected System Operator in terms of the effect of the position of each on the relevant HV DC Interconnector. National Grid is considering that issue further and would welcome some initial views from Panel Members.

4. **The Next Steps**

4.1. The proposed way forward is as follows:-

4.2. It is proposed that the changes identified be developed in conjunction with interested Grid Code Panel members. This could take place by the establishment of a working group (Chaired by National Grid) by March 2002 of interested parties to allow provisions to be submitted for consultation to the August 2002 GCRP. It is suggested that the other interested electricity transmission and distribution companies (Scottish Power, Northern Ireland Electricity and Scottish and Southern Energy) in the UK are copied into the provisions development. This will allow operators in the other UK geographic areas to pursue a consistent approach for regulatory purposes.

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5. **Working Group Nominations**

5.1. In order to ensure correct representation at any working group, the Grid Code Review Panel is asked to nominate representatives to contribute to

this working group. The first working group meeting could be held in March 2002, provided nominations are submitted to the Panel secretary by the 28th February 2002.

6. Recommendation

6.1. The Grid Code Review Panel is invited to agree the proposed way forward.

1. Changes to 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**, but required for the boiler plant's or **Generating Unit's** or **DC Converter'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**, as the case may be.
DC Converter Owner	The owner of a **DC Converter Station.**
DC Converter Station	An installation comprising one or more **DC Converters** connecting a direct current **External Interconnection**: • to the **NGC Transmission System;** or (if the installation has a rating of 50MW or more) to a **User System**.

DC Network	All items of **Plant** and **Apparatus** connected together on the direct current side of a **DC Converter.**
Designed Minimum Operating Level	The output (in whole MW) below which a **Genset** or a **DC Converter** has no **High Frequency Response** capability.
De-Synchronise	a) The act of taking a **Generating Unit** or a **DC Converter** off a **System** to which it has been **Synchronised**, by opening any connecting circuit breaker; or b) The act of ceasing to consume electricity at an importing **BM Unit**; and the term "**De-Synchronising**" shall be construed accordingly.
Export Usable	That portion of **Registered Export Capacity** which remains after the deduction of allowances for **Planned Outages** and breakdown.
Grid Entry Point	A point at which a **Generating Unit** or a **CCGT Module** or a **CCGT Unit** or a **DC Converter**, as the case may be, which is directly connected to the **NGC Transmission System**, connects to the **NGC Transmission System**.
HV ~~Generator~~ Connections	**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**.
Import Usable	That portion of **Registered Import Capacity** which remains after the deduction of allowances for **Planned Outages** and breakdown.
Minimum Export Capacity	The minimum output (in whole MW) 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**) at which a **DC Converter** 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** at the **Grid Entry Point** (or in the case of an **Embedded DC Converter** 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.6.5~~6~~.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**.
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**.
Registered Import Capacity	a) 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**. b) 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**.

Station Transformer

A transformer supplying electrical power to the **Auxiliaries** of:

- a **Power Station**, which is not directly connected to the **Generating Unit** terminals (typical voltage ratios being 132/11kV or 275/11kV), or
- a **DC Converter Station**.

Synchronised

a) The condition where an incoming **Generating Unit**, **DC Converter** or **System** is connected to the busbars of another **System** so that the **Frequencies** and phase relationships of that **Generating Unit**, **DC Converter** or **System**, as the case may be, and the **System** to which it is connected are identical, like terms shall be construed accordingly.

b) The condition where an importing **BM Unit** is consuming electricity.

System Constrained Capacity

That portion of **Registered Capacity** or **Registered Export Capacity** or **Registered Import Capacity** not available due to a **System Constraint**.

User System Entry Point

A point at which a **Generating Unit**, a **CCGT Module**, a **CCGT Unit**, or a **DC Converter**, as the case may be, which is **Embedded** connects to the **User System**.

2. PLANNING CODE EXTRACTS

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**;

(~~b~~c) 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.

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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 Provision

PC.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 l 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.

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APPENDIX A

PLANNING DATA REQUIREMENTS

PC.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.

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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
4A.2.2(b)
4.2.3
4.3.1
4.3.2
4.3.3
4.3.4
4.3.5
4.5(a)(ii) and (b)(ii)
4.6.1
5.2.1.
5.2.2

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
4.5(a)(i), (a)(iii), (b)(i) and (b)(iii)
4A.2.2(a), (c), (d), (e) and (f)
5.3.1
6.2
6.3
7.1.2
7.1.3

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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 1

STANDARD PLANNING DATA

PC.A.2 **USER'S SYSTEM** DATA

PC.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** 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**.

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.

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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.2.5.6~~PC.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.2.5.6~~PC.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 **Embedded DC Converter Stations** 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.2.5.7~~6~~(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 power. 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.2.5.6.3 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.2.5.6~~7~~ 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 to PC.A.4.1.5 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 **D C 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.4.2.3 All forecast **Demand** (**Active Power**) and **Active Energy** specified in PC.A.4.2.1 shall:

(a) 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.4.2.1 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), (c), (d), (e), (f) and (g) are required with respect to each **DC Converter**.

PC.A.4A.2.2 Items (a), (b), (d), (e), (f) and (g) 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** import or export by 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** to facilitate an early assessment, by **NGC**, of the need for more detailed studies;

Rated MW import per pole and
Rated MW export per pole.
DC Converter type.
Number of poles and pole arrangement
Rated DC voltage/pole (kV)
Return path 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** Data

PC.A.4A.4.1 For each **DC Converter** connected to the **DC Network**, 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 π 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** 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** 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** is operating at **Rated MW**, both export and import, 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 import per pole and
Rated MW export per pole.
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)
Positive sequence reactance at minimum, maximum and nominal tap
Positive 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

Diagram of the **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 per **DC Converter** pole

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**, 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, DC voltage and **DC Converter** overlap angle.

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

3. 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

(~~e~~d) **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 provisions 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** where the connection between the **DC Converter** and the **External Interconnection** has a rating 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]

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.6.2.2.2.2, 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**;

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]

CC.6.2.2 Requirements relating to **Generator** or **DC Converter Station/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** 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. Each **DC Converter** must be capable of satisfactory operation across the range of short circuit levels at the point of connection specified in the **Bilateral Agreement**.

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

CC.6.2.2.2.1 Minimum Requirements

Protection of **Generating Units** or **DC Converters** 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**, as the case may be.

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**, as the case may be, 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** 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**, as the case may be, 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 Converters** connected to the **NGC Transmission System** at 400 kV and 275 kV where two **Main Protections** are provided and on **Generating Units** or **DC Converters** 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**, as the case may be, 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** 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** or the **DC Converter Owner**, as the case may be, 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** 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 or **DC Converter Owners**, as the case may be, 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 with the **Generating Unit** or **DC Converter** itself) may be worked upon or altered by the **Generator** or **DC Converter Owner**, as the case may be, 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

Based on CC.6.3

CC.6.5.1 This section sets out the technical and design criteria and performance requirements for **DC Converters** (whether directly connected to the **NGC Transmission System** or **Embedded**) which each **DC Converter Owner** must ensure are complied with in relation to its **DC Converter Stations**.

Plant Performance Requirements

CC.6.5.2 Each **DC Converter** at a **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**) at the **Connection Point** while transferring rated **Active Power** within the voltage range of +5% at 400kV, 275kV, 132kV and lower voltages. While transferring **Active Power** within its operating range and within the voltage range of +5% at 400kV, 275kV, 132kV and lower voltages, each **DC Converter Reactive Power** transfer must remain within the reactive range specified in the **Bilateral Agreement.**

CC.6.5.3 Each **DC Converter** at a **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**) 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**) 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**) 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%.

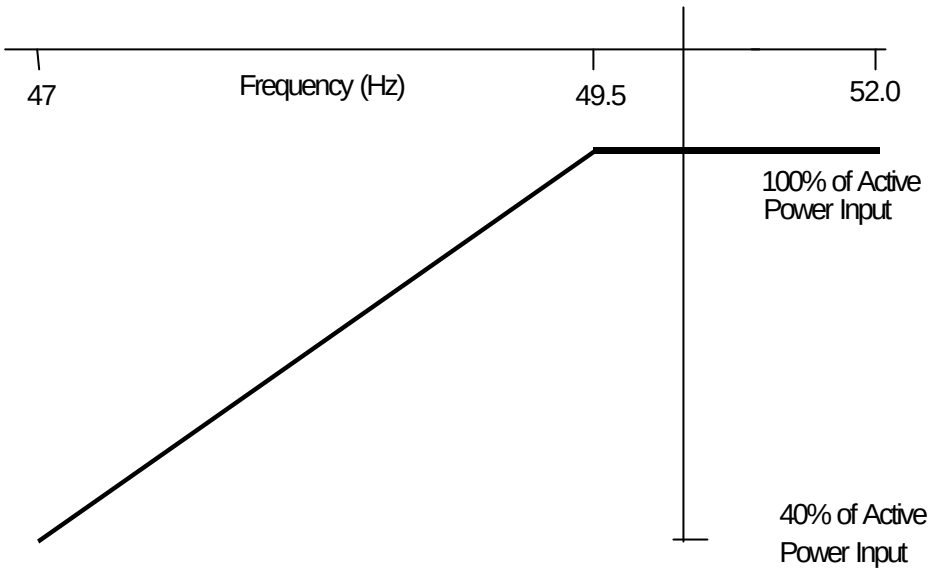


Figure 2

CC.6.5.4 The **Active Power** transfer under steady state conditions of any **DC Converter** 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** 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** at a **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 BC3.1.2, 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** at a **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.6.5.5 (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 Active Power** transfer with stability over the entire operating range of the **DC Converter**; 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, ±0.015Hz);

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

Performance under fault conditions

CC.6.5.8 In addition to meeting the conditions specified in CC.6.2.2.1, each **DC Converter** must be capable of satisfactory operation during and after 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 a transformer of a **DC Converter** at 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** 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** at a **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** within this **Frequency** range, under the **Bilateral Agreement**.

CC.6.5.11 **DC Converter Owners** will be responsible for protecting all their **DC Converters** at **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** [in conjunction with **EISO**] 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** 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** at a **DC Converter Station** is required to be provided with Power Oscillation damping or any other additional control facilities.

CC.6.~~5~~6 COMMUNICATIONS PLANT

CC.6.~~5~~6.1 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. In this CC.6.6, the term **Generator** is to be interpreted to include an **DC Converter Owner,** the term **Generating Unit** or **Genset** is to be interpreted to include a **DC Converter** and the term **Power Station** is to be interpreted to include a **DC Converter Station.**

Control Telephony

CC.6.~~5~~5.2 **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.~~5~~5.3 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.~~5~~5.4 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**. **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.~~5~~5.5 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.~~5~~5.6 (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 disconnector 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.

Instructor Facilities

CC.6.~~5~~5.7 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) 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.** 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,** 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.

CC.6.7~~6~~ **SYSTEM** MONITORING

CC.6.7~~6~~.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** or **DC Converter** circuit 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 Converters at DC Converter Stations

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** at a **DC Converter Station**. 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**.]* Note: this paragraph is due to be added to the Grid Code following Consultation Paper G/01.

For the avoidance of doubt, in this Appendix 3 to the **CC**, for a **DC Converter Station** with more than one **DC Converter**, the phrase **Minimum Export Capacity** applies to each separate **DC Converter**.

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**.

The **Minimum Generation** level may be less than, but must not be more than, 65% of the **Registered Capacity** (or **Registered Export Capacity**, as the case may be). Each **Generating Unit** and/or **CCGT Module** or **DC Converter** 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** is operating below its **Minimum Export Capacity**) because of high **System Frequency**, it should recover adequately to its **Minimum Generation** (or **Minimum Export Capacity**, as the case may be) 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**, as the case may be) 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**, as the case may be) 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** 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**. Although the maximum level of **Minimum Generation** (in the case of **Generating Units** and **CCGT Modules**) and **Minimum Export Capacity** (in the case of **DC Converters**) and **Designed Minimum Operating Level** are limited to 65% and 55% respectively of **Registered Capacity** (or **Registered Export Capacity**), the **Minimum Export Capacity** and **Designed Minimum Operating Level** for **DC Converters** are expected to be much lower than these figures. Typically, the **Designed Minimum Operating Level** for a **DC Converter** could be expected to be about 10% of the **Registered Export Capacity**, with the **Minimum Export Capacity** being at or slightly above this figure.

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**, as the case may be). Each **Generating Unit** ~~and/or,~~ **CCGT Module** or **DC Converter** 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** 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** 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** 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 the case may be) 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** is required to provide 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**, as the case may be) level.

The **Designed Minimum Operating Level** is the output at which a **Generating Unit** ~~and/or,~~ **CCGT Module** or **DC Converter** 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**, as the case may be). This implies that a **Generating Unit** ~~or,~~ **CCGT Module** or **DC Converter** 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** 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 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** 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** 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** 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** 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 Converters.** 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

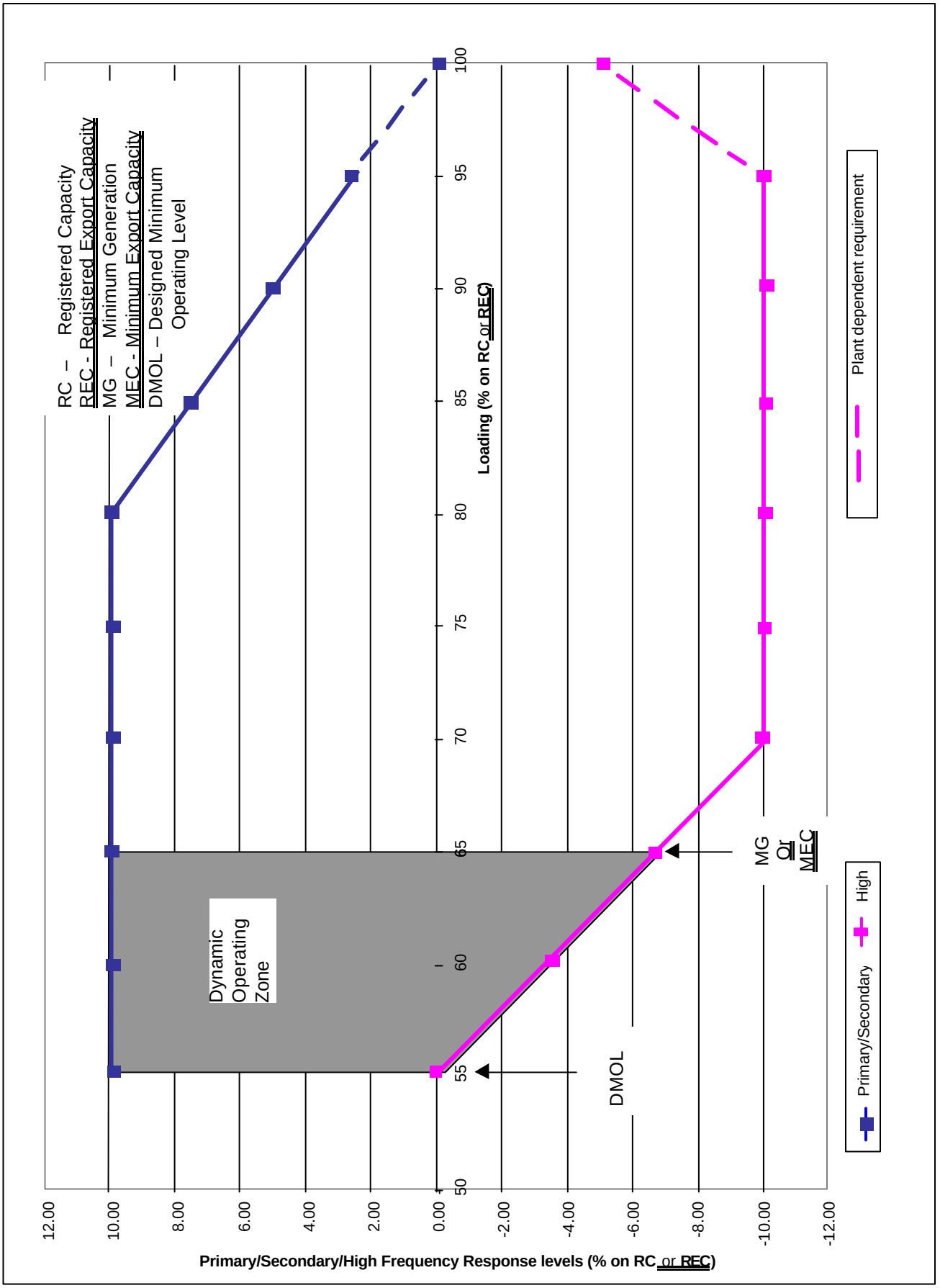


Figure CC.A.3.2 - Interpretation of Primary and Secondary Response Values

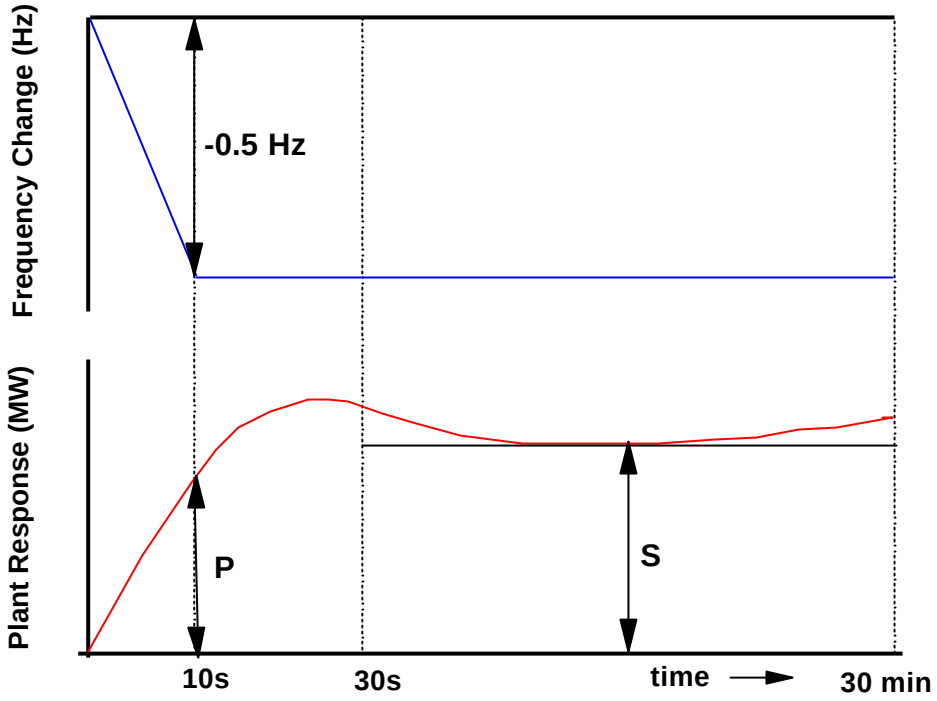
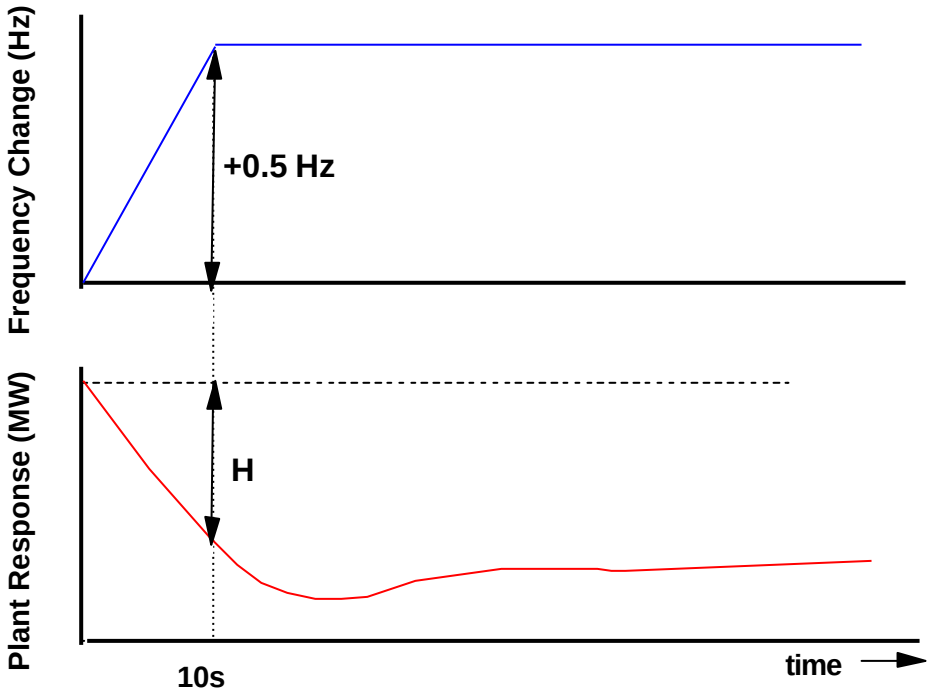


Figure CC.A.3.3 - Interpretation of High Frequency Response Values



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]

4. Extracts from BALANCING CODE NO.3

FREQUENCY CONTROL PROCESS

BC3.1 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 Converters** within a **DC Converter Station** 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 this **BC3**, any reference to a **DC Converter** is to be taken to apply to a **DC Converter** at a **DC Converter Station** which is **Synchronised** and exporting **Active Power** to the **NGC Transmission System** (or **User System** in the case of an **Embedded DC Converter**).

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. In the case of **DC Converters**, any **Ancillary Services Agreement** 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.

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,**

~~(c)~~(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 Converters** within a **DC Converter Station** 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 CONVERTERS**

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** 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 statutory requirements of **Frequency** control. In addition each **Genset** and each **DC Converter** within a **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** within a **DC Converter Station** 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.6.5.3 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** within a **DC Converter Station** 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** 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** within 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 **DC Converter Owner**, as the case may be**.**

(d) Such instruction will continue until countermanded by **NGC** or until:

i. the **Genset** is **De-Synchronised**, or

ii. the **DC Converter** ceases to export **Active Power** to the **NGC Transmission System** (or **User System** in the case of an **Embedded DC Converter**), as the case may be,

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** which assists recovery to **Target Frequency** must not be countermanded by a **Generator** or [**EISO** and/or **DC Converter Owner**], as the case may be, 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**, as the case may be.

BC3.6 RESPONSE TO **LOW FREQUENCY**

BC3.6.1 **Low Frequency Relay** Initiated Response from **Gensets**

(a) **NGC** may utilise **Gensets** or **DC Converters** within a **DC Converter Station** 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** output to the **NGC Transmission System** (or **User System** in the case of an **Embedded DC Converter**)

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**], **Low Frequency Relay** settings to be applied to the **Gensets** or **DC Converters** pursuant to BC3.6.1 (a) in the **Weekly Operational Policy** and instruct the **Low Frequency Relay** initiated response placed in and out of service.

(ii) **Generators** and/or [**EISOs** and/or **DC Converter Owners**] 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

(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 CONVERTERS**

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** in respect of which the [**EISO** and/or **DC Converter Owner**] has been instructed to operate so as to provide **High Frequency Response**, which is exporting **Active Power** to the **NGC Transmission System** (or **User System** in the case of an **Embedded DC Converter**) and which is operating above **Designed Minimum Operating Level**, is required to reduce **Active Power** output to the **NGC Transmission System** (or **User System** in the case of an **Embedded DC Converter**) 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**). –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 [**EISO** and/or **DC Converter Owner**]. If more than one rate is provided for in the **Ancillary Services Agreement NGC** will instruct the rate when the instruction to operate to provide **High Frequency Response** is given.

(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** 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 change to be achieved within one minute of the rise to or above 50.5 Hz. For the avoidance of doubt, the provision of this change in **Active Power** transfer is not an **Ancillary Service**.

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** within a **DC Converter Station** operating in a **Limited Frequency Sensitive Mode** which is exporting **Active Power** to the **NGC Transmission System** (or **User System** in the case of an **Embedded DC Converter**) is also required 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 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** output control devices other than the speed governors 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** 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** within a **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**, as the case may be) then **NGC** should not, upon request, unreasonably withhold issuing a **Bid-Offer Acceptance** to return the **Generating Unit** or **CCGT Module** or **DC Converter** to an output not less than **Minimum Generation** (or **Minimum Export Capacity**, as the case may be).

(b) It is possible that **Synchronised Gensets** (or **DC Converters)** 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** 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 Converters** 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** 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 Converters** 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** 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** 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**.

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** or **DC Converters** 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**.

5. Extracts from DRC

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~~c~~) **Suppliers**;

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

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

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

~~(g)~~(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****. [Note: due to be added following G/01]*

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** Technical Data

Comprising **DC Converter** electrical parameters.

DRC.6.2 The **Schedules** applicable to each class of **User** are as follows:

Generators with **Large Power Stations**	Sched 1, 2, 3, *4,* 9, 14
Generators with **Medium Power Stations** (See note 2)	Sched 1, 9, 14
Generators with **Small Power Stations** directly connected to the **NGC Transmission System**	Sched 1, 6, 14
All **Users** connected directly to **NGC Transmission System**	Sched 5, 6, 9
All **Users** connected directly to the **NGC Transmission System** other than **Generators**	Sched 10,11,13
All **Users** connected directly to **NGC Transmission System** with **Demand**	Sched 7, 9
A **Pumped Storage Generator, Externally Interconnected System Operator** and **Interconnector Users**	Sched12 (as marked)
All **Suppliers**	Sched 12
All **Network Operators**	Sched 12
All **BM Participants**	Sched 8
All **DC Converter Owners**	Sched 15

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**.

DATA REGISTRATION CODE ***[To be added following G/01 - associated with changes to PC]*** *SCHEDULE 4*

GOVERNOR DROOP AND RESPONSE

The Data in this Schedule 4 is to be supplied by ***Generators*** *with respect to all* ***Large Power Station****s, whether directly connected or* ***Embedded.***

DATA DESCRIPTION	***NORMAL VALUE***	***MW***	***DATA CAT***	***DROOP %***			***RESPONSE CAPABILITY***		
				Unit 1	***Unit 2***	***Unit 3***	***Primary***	***Secondary***	***High Frequency***
MLP1	***Designed Minimum Operating Level*** *(for a* ***CCGT Module****, on a Modular basis assuming all units are synchronised)*		***DPD***						
MLP2	***Minimum Generation*** *(for a* ***CCGT Module****, on a Modular basis assuming all units are synchronised)*		***DPD***						
MLP3	*70% of* ***Registered Capacity***		***DPD***						
MLP4	*80% of* ***Registered Capacity***		***DPD***						
MLP5	*95% of* ***Registered Capacity***		***DPD***						
MLP6	***Registered Capacity***		***DPD***						

Notes:

1. *The data provided in this Schedule 4 is not intended to constrain any* ***Ancillary Services Agreement***

2. ***Registered Capacity*** *should be identical to that provided in Schedule 2.*

3. *The Governor Droop should be provided for each* ***Generating Unit****. The Response Capability should be provided for each* ***Genset****.*

4. ***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.*

5. *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 Capacity****. If MLP1 is not provided at the* ***Designed Minimum Operating Level****, the value of the* ***Designed Minimum Operating Level*** *should be separately stated.*

DC CONVERTER TECHNICAL DATA

DC CONVERTER STATION NAME _____ DATE: _____

Data Description	Units	Data Category	**DC Converter Station** Data
DC CONVERTER STATION DEMANDS:			
Demand supplied through **Station Transformers** associated with the **DC Converter Station [PC.A.7.1.2.1]**			
- **Demand** with all **DC Converters** operating at **Rated MW** import.	MW MVAr	**DPD** **DPD**	
- **Demand** with all **DC Converters** operating at **Rated MW** export.	MW MVAr	**DPD** **DPD**	
Additional **Demand** associated with the **DC Converter Station** supplied through the **NGC Transmission System. [PC.A.7.1.2.2]**			
- The maximum **Demand** that could occur.	MW MVAr	**DPD** **DPD**	
- **Demand** at specified time of annual peak half hour of **NGC Demand** at **Annual ACS Conditions.**	MW MVAr	**DPD** **DPD**	
- **Demand** at specified time of annual minimum half-hour of **NGC Demand.**	MW MVAr	**DPD** **DPD**	
DC CONVERTER STATION DATA **[PC.A.4A.3.1]**			
Number of poles, i.e. number of **DC Converters**		**SPD+**	
Pole arrangement (e.g. monopole or bipole)	Text	**SPD+**	

Data Description	Units	Data Category	**DC Converter** Data					
			C1	C2	C3	C4	C5	STN
INDIVIDUAL **DC CONVERTER** DATA								
Point of connection to the **NGC Transmission System** (or the **Total System** if embedded) of the **DC Converter** in terms of geographical and electrical location and system voltage	Text	**SPD**						
If the busbars at the **Connection Point** are normally run in separate sections identify the section to which the **DC Converter** is connected	Section Number	**SPD**						
Rated MW import per pole **[PC.A.4A.3.1]**	MW	**SPD+**						
Rated MW export per pole **[PC.A.4A.3.1]**	MW	**SPD+**						
ACTIVE POWER TRANSFER CAPABILITY								
Registered Export Capacity (on a **DC Converter** basis.)	MW	**SPD**						
Registered Import Capacity [PC.A.4A.2.2 (a)]	MW	**SPD**						
Minimum Export Capacity [PC.A.4A.2.2 (d)]	MW	**SPD**						
Minimum Import Capacity	MW	**SPD**						
Import MW available in excess of **Registered Import Capacity.**	MW	**SPD**						
Time duration for which MW in excess of **Registered Import Capacity** is available **[PC.A.4A.2.2 (e)]**	min	**SPD**						
Export MW available in excess of **Registered Import Capacity.**	MW	**SPD**						
Time duration for which MW in excess of **Registered Export Capacity** is available **[PC.A.4A.2.2 (f)]**	min	**SPD**						
DC CONVERTER TRANSFORMER **[PC.A.7.1.3.1 (b)]**								
Rated MVA	MVA	**DPD**						
Nominal primary voltage	kV	**DPD**						
Nominal secondary (converter-side) voltage(s)	kV	**DPD**						
Positive sequence reactance								
Maximum tap	% on MVA	**DPD**						
Nominal tap	% on MVA	**DPD**						
Minimum tap	% on MVA	**DPD**						
Positive sequence resistance								
Maximum tap	% on MVA	**DPD**						
Nominal tap	% on MVA	**DPD**						
Minimum tap	% on MVA	**DPD**						
Zero phase sequence reactance	% on MVA	**DPD**						
Tap change range	+% / -%	**DPD**						
Tap change step size	%	**DPD**						

Data Description	Units	Data Category	**DC Converter** Data					
			C1	C2	C3	C4	C5	STN
DC NETWORK [PC.A.7.1.3.1 (c)]								
Rated DC voltage per pole	kV	**DPD**						
Rated DC current	A	**DPD**						
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.	Diagram	**DPD**						
DC CONVERTER STATION AC HARMONIC FILTER AND REACTIVE COMPENSATION EQUIPMENT **[PC.A.7.1.3.1 (d)]**								
For all switched reactive compensation equipment								
Type of equipment (e.g. fixed or variable)	Text	**SPD**						
Capacitive rating; or	MVAr	**DPD**						
Inductive rating; or	MVAr	**DPD**						
Operating range	MVAr	**DPD**						
Reactive Power consumption as a function of various MW transfer levels	Table	**DPD**						

Data Description	Units	Data Category	**DC Converter** Data					
			C1	C2	C3	C4	C5	STN
CONTROL SYSTEMS **[PC.A.7.1.3.1 (e)]**								
Static $V_{DC} - I_{DC}$ (DC voltage – DC current) characteristic when operating as								
-Rectifier	Diagram	**DPD**						
-Inverter	Diagram	**DPD**						
Details of rectifier mode control system, in block diagram form showing transfer functions of individual elements.	Diagram	**DPD**						
Details of inverter mode control system, in block diagram form showing transfer functions of individual elements.	Diagram	**DPD**						
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.)	Diagram	**DPD**						
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.)	Diagram	**DPD**						
Details of any frequency and/or load control systems in block diagram form showing transfer functions of individual elements.	Diagram	**DPD**						
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.	Diagram	**DPD**						
LOADING PARAMETERS **[PC.A.7.1.3.1 (f)]**								
MW Export								
Nominal loading rate	MW/s	**DPD**						
Maximum (emergency) loading rate	MW/s	**DPD**						
MW Import								
Nominal loading rate	MW/s	**DPD**						
Maximum (emergency) loading rate	MW/s	**DPD**						
	s	**DPD**						
Maximum recovery time, to 90% of pre-fault loading, following an AC system fault or severe voltage depression.	s	**DPD**						
Maximum recovery time, to 90% of pre-fault loading, following a transient DC Network fault.								

CONTROL SYSTEM RESPONSE [CC Appendix 3]

The Data in this Schedule is to be supplied by **DC Converter Station Owners** with respect to all its **DC Converters** at **DC Converter Stations**, whether directly connected or **Embedded.**

Converter Unit No(s) _____

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

Notes:

1. The data provided is not intended to constrain any **Ancillary Services Agreement**

2. The Response Capability should be provided for each **DC Converter**.

3. **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.

4. 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.

6. Other Consequential Grid Code 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.~~6~~7.1.

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.~~5~~6.8. 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.~~5~~6.8(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.~~5~~6.2.