

Grid Code Review Panel

Proposed Grid Code changes to include Low Frequency Demand Disconnection Relay settings

Introduction

1. This paper proposes amendments to the Grid Code Connection Conditions and Operating Codes to include the specification of the settings of low frequency demand disconnection relays. The change is proposed following requests by users to improve the visibility of settings required by National Grid, which currently are included in bilateral agreements.

Background

2. The electricity system in Great Britain is protected against system collapse due to a severe fall in system frequency by the national automatic low frequency demand disconnection scheme specified under Grid Code OC6.6. This was originally conceived by the CEGB and the Scottish companies in the late 1960s and further developed in the 1970s and 1980s. In the event of a large fall in system frequency caused by very severe generation deficits beyond those normally considered in planning and operational security standards, the relays are specified to operate to disconnect customer demand in stages. In total, up to 60% of system demand in England and Wales and 40% in Scotland can be disconnected by the Low Frequency Relays.
3. The Grid Code requirements on National Grid and Distribution Network Operators relating to the settings and operation of the automatic low frequency demand disconnection scheme are included in CC.6.4.3 and OC6.6. A specification of the technical requirements of the relays is included in CC.A.5. The frequency settings applied to the relays, and the percentage of total demand that should be disconnected at a particular frequency, are currently specified in Bilateral Agreements.
4. The relay settings and demand disconnection values are applied consistently to all Distribution Network Operators connected to a particular Transmission Licensee's Transmission System.
5. OC6.6 specifies that the demand disconnection will be spread across the total demand of a Distribution Network Operator. It requires that NGET and the Distribution Network Operator discuss the demand distribution annually and that the settings are reviewed annually. Experience indicates that less frequent reviews of the total levels of demand to be disconnected at a particular frequency are more appropriate as system conditions do not change sufficiently quickly to require annual changes. Annual discussions on the distribution of the demand to be disconnected are still useful, even though changes are likely to be infrequent.
6. For these reasons, and to aid visibility to users, it is appropriate to include the frequency settings and demand disconnection percentage values in the Grid Code rather than the Bilateral Agreement of each Network Operator. Any consequential changes to other codes and agreements, for example TOCAs, will need to be made through the appropriate forum.

Proposal

7. National Grid proposes to include the required frequency settings for Low Frequency Demand Disconnection relays together with the percentage demand reduction required at each specified level in the Grid Code, removing the requirement to specify them in Bilateral Agreements. It is also proposed to remove the requirement to review the settings annually, allowing reviews to be undertaken when it is appropriate.
8. The proposed changes will improve visibility by publicising the settings to be applied to Low Frequency Relays. They will also remove the requirement to undertake reviews of the settings more often than is necessary and will make any changes to the settings the subject of a Grid Code modification.
9. Draft legal text that would give effect to the proposals is attached to this paper. As these proposals interact with the changes contained within Grid Code consultation A/06 that were approved by the Authority for implementation on 1st January 2007 two sets of legal text are provided. The first will apply if these proposals are approved by the Authority for implementation on or before 31st December 2006, the second if the proposals were approved by the Authority for implementation on or after 1st January 2007.

Recommendation

10. Members of the GCRP are invited to consider and discuss the proposed changes to Connection Conditions and Operating Code. Having considered all comments at the meeting, National Grid intends to carry out a short industry consultation on the changes.

Attachment 1 - Proposed Grid Code Text

Note – this is based on Issue 3, Revision 17 of the Grid Code. Attachment 2 shows the proposed changes to Appendix 5 based on the Grid Code changes that have been approved for implementation from January 1st 2007 (Grid Code A/06).

Frequency Sensitive Relays

CC.6.4.3 As explained under **OC6**, each **Network Operator**, will make arrangements that will facilitate automatic low **Frequency Disconnection of Demand** (based on **Annual ACS Conditions**). CC.A.5.4 of Appendix 5 includes specifications of the total percentage **Demand** that shall be disconnected at specific frequencies. The manner in which **Demand** subject to low **Frequency** disconnection will be split into discrete MW blocks is specified in OC6.6. Technical requirements relating to **Low Frequency Relays** are also listed in Appendix 5.

APPENDIX 5

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

CC.A.5.1 LOW FREQUENCY RELAYS

CC.A.5.1.1 The **Low Frequency Relays** to be used shall have a setting range of 47.0 to 50Hz and be suitable for operation from a nominal AC input of 63.5, 110 or 240V. The following general parameters specify the requirements of approved **Low Frequency Relays** for automatic installations:

- | | | |
|-----|-------------------------------------|--|
| (a) | Frequency settings: | 47-50Hz in steps of 0.05Hz or better, preferably 0.01Hz; |
| (b) | Measurement period settings: | Within a minimum selectable settings range of 4 to 6 cycles; |
| (c) | Operating time: | Between 100 and 150ms dependent on measurement period setting; |
| (d) | Voltage lock-out: | Selectable within a range of 55 to 90% of nominal voltage; |
| (e) | Facility stages: | One or two stages of Frequency operation; |
| (f) | Output contacts: | Two output contacts per stage to be capable of repetitively making and breaking for 1000 operations. |

CC.A.5.2 LOW FREQUENCY RELAY VOLTAGE SUPPLIES

CC.A.5.2.1 It is essential that the voltage supply to the **Low Frequency Relays** shall be derived from the primary **System** at the supply point concerned so that the **Frequency** of the **Low Frequency Relays** input voltage is the same as that of the primary **System**. This requires either:

- (a) the use of a secure supply obtained from voltage transformers directly associated with the grid transformer(s) concerned, the supply being obtained where necessary via a suitable automatic voltage selection scheme; or
- (b) the use of the substation 240V phase-to-neutral selected auxiliary supply, provided that this supply is always derived at the supply point concerned and is never derived from a standby supply **Generating Unit** or from another part of the **User System**.

CC.A.5.3 SCHEME REQUIREMENTS

CC.A.5.3.1 The tripping facility should be engineered in accordance with the following reliability considerations:

(a) Dependability

Failure to trip at any one particular **Demand** shedding point would not harm the overall operation of the scheme. However, many failures would have the effect of reducing the amount of **Demand** under low **Frequency** control. An overall reasonable minimum requirement for the dependability of the **Demand** shedding scheme is 96%, i.e. the average probability of failure of each **Demand** shedding point should be less than 4%. Thus the **Demand** under low **Frequency** control will not be reduced by more than 4% due to relay failure.

(b) Outages

Low **Frequency Demand** shedding schemes will be engineered such that the amount of **Demand** under control is as specified in table CC.A.5.4.1a and is not reduced unacceptably during equipment outage or maintenance conditions.

CC.A.5.4 SCHEME SETTINGS

CC.A.5.4.1 Table CC.A.5.4.1a shows, for each **Transmission Area**, the percentage of peak **Demand** (based on **Annual ACS Conditions**) that each **Network Operator** whose **System** is connected to the **GB Transmission System** within such **Transmission Area** shall disconnect by **Low Frequency Relays** at a range of frequencies. Where a **Network Operator's System** is connected to the **GB Transmission System** in more than one **Transmission Area**, the settings for the **Transmission Area** in which the majority of the **Demand** is connected shall apply.

Table CC.A.5.4.1a

Frequency Hz	%Demand disconnection for each Network Operator in
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	Transmission Area		
	NGET	SPT	SHETL
48.8	5		
48.75	5		
48.7	10		
48.6	7.5		
48.5	7.5	10	10
48.4	7.5	10	10
48.3			10
48.2	7.5	10	
48.0	5	10	10
47.8	5		
Total % Demand	60	40	40

Note – the percentages in table CC.A.5.4.1a are cumulative such that, for example, should the frequency fall to 48.6 Hz in the **NGET Transmission Area**, 27.5% of the total **Demand** connected to the **GB Transmission System** in the **NGET Transmission Area** shall be disconnected by the action of **Low Frequency Relays**

OC6.6 **AUTOMATIC LOW FREQUENCY DEMAND DISCONNECTION**

OC6.6.1 Each **Network Operator** will make arrangements that will enable automatic low **Frequency Disconnection** of at least:

- (i) 60 per cent of its total peak **Demand** (based on **Annual ACS Conditions**) where such **Network Operator's System** is connected to the **GB Transmission System** in **NGET's Transmission Area**
- (ii) 40 per cent of its total peak **Demand** (based on **Annual ACS Conditions**) where such **Network Operator's System** is connected to the **GB Transmission System** in either **SPT's** or **SHETL's Transmission Area**

in order to seek to limit the consequences of a major loss of generation or an **Event** on the **Total System** which leaves part of the **Total System** with a generation deficit. Where a **Network Operator's System** is connected to the **GB Transmission System** in more than one **Transmission Area**, the figure above for the **Transmission Area** in which the majority of the **Network Operator's Demand** is connected shall apply.

- OC6.6.2
- (a) The **Demand** of each **Network Operator** which is subject to automatic low **Frequency Disconnection** will be split into discrete MW blocks.
 - (b) The number, size (%**Demand**) and the associated low **Frequency** settings of these blocks, will be as specified in Table CC.A.5.4.1.a. NGET will keep the settings under review.
 - (c) The distribution of the blocks will be such as to give a reasonably uniform **Disconnection** within the **Network Operator's System**, as the case may be, across all **Grid Supply Points**.
 - (d) Each **Network Operator** will notify **NGET** in writing by calendar week 24 each year of the details of the automatic low **Frequency Disconnection** on its **User System**. The information provided should identify, for each **Grid Supply Point** at the date and time of the annual peak of the **GB Transmission System Demand** at **Annual ACS Conditions** (as notified pursuant to OC1.4.2), the frequency settings at which **Demand Disconnection** will be initiated and amount of **Demand** disconnected at each such setting.

Attachment 2 – Proposed Grid Code Text for Appendix 5 based on version to be implemented on January 1st 2007

Frequency Sensitive Relays

CC.6.4.3 As explained under **OC6**, each **Network Operator**, will make arrangements that will facilitate automatic low **Frequency Disconnection of Demand** (based on **Annual ACS Conditions**). CC.A.5.5 of Appendix 5 includes specifications of the total percentage **Demand** that shall be disconnected at specific frequencies. The manner in which **Demand** subject to low **Frequency** disconnection will be split into discrete MW blocks is specified in OC6.6. Technical requirements relating to **Low Frequency Relays** are also listed in Appendix 5.

APPENDIX 5

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

CC.A.5.1 **LOW FREQUENCY RELAYS**

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- (a) **Frequency** settings: 47-50Hz in steps of 0.01Hz;
- (b) **Operating time**: Between 100 and 150ms dependent on measurement period setting;
- (c) **Voltage lock-out**: Selectable within a range of 55 to 90% of nominal voltage;
- (d) **Facility stages**: One or two stages of **Frequency** operation;
- (e) **Output contacts**: Two output contacts per stage to be capable of repetitively making and breaking for 1000 operations.
- (f) **Accuracy**: 0.01 Hz maximum error under reference environmental and system voltage conditions.
0.05 Hz maximum error at 8% total harmonic distortion **Electromagnetic Compatibility Level**.

CC.A.5.2 **LOW FREQUENCY RELAY VOLTAGE SUPPLIES**

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It is essential that the voltage supply to the **Low Frequency Relays** shall be derived from the primary **System** at the supply point concerned so that the **Frequency** of the **Low Frequency Relays** input voltage is the same as that of the primary **System**. This requires either:

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Low **Frequency Demand** shedding schemes will be engineered such that the amount of **Demand** under control is as specified in table CC.A.5.5.1a and is not reduced unacceptably during equipment outage or maintenance conditions.

CC.A.5.4

LOW FREQUENCY RELAY TESTING

CC.A.5.4.1

Low Frequency Relays installed and commissioned after 1st January 2007 shall be type tested in accordance with and comply with the functional test requirements for **Frequency Protection** contained in Energy Networks Association Technical Specification 48-6-5 Issue 1 dated 2005 "ENA Protection Assessment Functional Test Requirements – Voltage and Frequency Protection".

For the avoidance of doubt, **Low Frequency Relays** installed and commissioned before 1st January 2007 shall comply with the version of CC.A.5.1.1 applicable at the time such **Low Frequency Relays** were commissioned.

CC.A.5.5 SCHEME SETTINGS

CC.A.5.5.1 Table CC.A.5.5.1a shows, for each **Transmission Area**, the percentage of peak **Demand** (based on **Annual ACS Conditions**) that each **Network Operator** whose **System** is connected to the **GB Transmission System** within such **Transmission Area** shall disconnect by **Low Frequency Relays** at a range of frequencies. Where a **Network Operator's System** is connected to the **GB Transmission System** in more than one **Transmission Area**, the settings for the **Transmission Area** in which the majority of the **Demand** is connected shall apply.

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