A REPORT TO THE AUTHORITY

Pursuant to Paragraph 2 of Condition C14 of the Transmission Licence

Grid Code Requirements for OC6.6 (Automatic LFDD)

The purpose of this document is to assist the Authority in its decision of whether to implement the proposed Grid Code Modification

Consultation Paper Ref	D/09
Issue	1.0
Date of Issue	11th December 2009
Prepared by	National Grid

DISTRIBUTION

Name	Organisation
Authority	Ofgem
Grid Code Review Panel Members	Various
National Grid Industry Information Website	

CONTENTS

SUMMARY OF PROPOSALS

0.1 The proposed changes to the Grid Code, as outlined in this report, were developed by a Working Group of the Grid Code Review Panel (GCRP). The intention of the proposals is to provide clarity and consistency for all industry parties in respect of the operation of the Low Frequency Demand Disconnection scheme. The proposals were discussed at the GCRP meeting on 21st May 2009 and the Panel agreed that they should be taken to industry consultation.

0.2 National Grid has consulted Authorised Electricity Operators on this issue. All respondents were supportive of the proposals. Some text changes intended as clarifications were suggested and have been included. One other proposed change, relating to the use of a historic demand background, rather than a forecast background, has not been included as National Grid considers the use of forecast data to be the most consistent and robust approach.

0.3 National Grid recommends to the Authority that these proposals be approved.

A. INTRODUCTION

1. Paragraph 2 of Condition C14 of the Transmission Licence granted to National Grid Electricity Transmission plc ("National Grid") provides that National Grid shall, in consultation with Authorised Electricity Operators liable to be materially affected thereby, periodically review the Grid Code and its implementation. That paragraph also requires National Grid, following such review, to send to the Authority:-

   (a) a report on the outcome of such review;

   (b) any proposed revisions to the Grid Code as National Grid (having regard to the outcome of such review) reasonably thinks fit for the achievement of the objectives set out in sub-paragraph (b) of Condition C14 of the Transmission Licence; and

   (c) any written representations or objections from authorised electricity operators (including any proposals by such operators for revisions to the Grid Code not accepted by National Grid in the course of the review) arising during the consultation process and subsequently sustained.

2. This review examines proposed amendments to the existing Grid Code provisions relating to automatic low frequency demand disconnection schemes (LFDD) that are intended to clarify the requirements and ensure a consistent approach by the Distribution Network Operators (DNO). The proposals were developed through the joint Grid Code/ Distribution Code EC3 OC6.6 Working Group.

3. The proposed changes to the Grid Code were discussed with the Grid Code Review Panel (GCRP) on 21st May 2009. Panel Members agreed that National Grid should issue a Consultation Paper regarding the proposed changes.

4. National Grid, in accordance with its obligations under its Transmission Licence, consulted Authorised Electricity Operators by including Consultation Paper D/09 on the National Grid Industry Information website. This paper contained an explanation of the proposed amendments to the Grid Code and a copy is attached to this Report as Appendix B. National Grid informed interested parties that a copy of the Consultation Paper had been placed on its website to ensure its wide availability.

5. Comments were invited from all such Authorised Electricity Operators by 1st October 2009. National Grid received five responses from Authorised Electricity Operators.

6. The proposed revisions to the Grid Code are explained below.

B. DESCRIPTION OF THE AMENDMENTS PROPOSED IN THE CONSULTATION AND THEIR EFFECTS

7. Background

7.1 On 27th May 2008 an exceptional loss of generation led to the operation of the first stage of the national Low Frequency Demand Disconnection (LFDD) scheme. Though the LFDD scheme operated successfully and limited the frequency fall, there were a few isolated instances of ineffective operation of relays, and many relays did not operate. An investigation by the Energy Emergency Executive Committee (E3C) Task Group led to a recommendation that the Grid Code requirements of OC6.6 be reviewed to see if any improvement to the scheme could be made. The Grid Code Review Panel established the OC6.6 (Automatic LFDD) working group to undertake this review. The group comprised representatives of DNOs, National Grid, the AEP and OFGEM.

7.2 The rationale behind the proposals was developed through discussions in the Working Group. A link to the Working Group Report, which includes the group's Terms of Reference, is given below. The group considered issues, such as relay maintenance regimes, that are not within the scope of the Grid Code in addition to Grid Code requirements. This Report to the Authority only concerns the recommended Grid Code modifications. On 7th December 2009 National Grid wrote to all the DNOs, informing them of the non-code recommendations made by the Working Group and requested their implementation. The recommendations included the issue of a guidance note to internal staff relating to the LFDD scheme and the installation of a highly visible system frequency meter in each DNO control rooms.

https://www.nationalgrid.com/uk/Electricity/Codes/gridcode/workinggroups/E3C_Working_Group/

8. Working Group discussions

8.1 Grid Code clause OC6.6.1 specifies the percentage of demand that should be available for LFDD disconnection and the time on which this figure is based. It specifies a percentage at the time of the DNO's peak demand. This time varies between DNOs and the requirement may not result in the specified percentage demand being available for disconnection at the time of the GB system peak demand, which is the intention of the requirement. It is therefore proposed to modify the requirement to specify the percentage of demand available for low frequency disconnection at the time of GB transmission system peak demand.

8.2 There is a lack of clarity as to whether the requirement should be based on the forecast or historic GB system peak demand. Both interpretations have been made by DNOs in setting up their schemes. Discussions took place on the relative merits of both options. It was agreed that in practice no significant differences were expected. Some members supported using historic demand as a basis as this would not require the application of forecast demand growths, which may not be accurate, at BSP level. Some members preferred to leave the requirement unchanged, allowing DNOs to use historic demands as a basis but taking into account expected significant changes, such as network reconfiguration or the connection of large new loads. Others believe that it is preferable to include a clear requirement that forecast demand should be used to ensure consistency. It is NGET's view that the latter is preferable as the forecast demand growths applied by DNOs to demands for

the next winter will be sufficiently accurate and this option will ensure that any network changes are considered. The proposal is to change the requirements so that they specify that the scheme should be based on forecast demand.

8.3 Table 12a is a proforma drawn up by NGET for the purpose of Grid Code clause OC6.6.2 (d), which requires the annual submission of LFFD data by DNOs. This proforma does not explicitly indicate that the data required relates to a forecast time of GB transmission system peak demand. It is proposed to clarify this and incorporate the table in the Data Registration Code (DRC).

8.4 CC.A.5.1 in Appendix 5 of the Grid Code Connection Conditions specifies the functional requirements of the scheme relays. The stated operating time of 100ms – 150ms refers to the relay, not the demand disconnection time. This operating time is dependent on the rate of change of frequency as that affects the measurement time, and includes any time delay set by the user. As modern relays, for example MICOM P941 and ARGUS AR8, can have a typical operating time of less than 100ms it was agreed that a minimum operating time should not be specified and it is proposed to modify the clause accordingly.

8.5 The total time to disconnect demand includes the operation of the trip relay and circuit breakers. Modern 33kV circuit breakers have a typical operating time of 40-80 ms including arc extinction; older types having typically 80-100ms.

8.6 For the LFDD scheme to perform optimally, the total operating time, ie including breaker operation, should not be more than 200ms. In some cases, even with modern circuit breakers, 200ms may not be achievable (tests would be needed to assess this). The slower scheme operating times associated with existing, slower circuit breakers may require the operation of more scheme stages but they are not expected to prevent successful scheme operation. As low frequency events initiating LF relays are quite rare and sub-optimal operation will not prevent successful scheme operation, the group agreed that accelerated circuit breaker or other asset replacement cannot be justified on the grounds of slower operating time. The group agreed that the Grid Code requirement should reflect the aim to achieve a 200ms operating time whilst recognising that generally it would not be economically justifiable to replace assets to achieve this.

8.7 Table CC.A.5.5.1a specifies for each stage the percentage demand blocks and associated frequency settings. Some DNOs have expressed concern that as there is no tolerance in these settings, it is practically impossible to comply. It is proposed that the % demand blocks shall be qualified with “as far as reasonably practical” for each stage.

9. Proposed Grid Code Changes

9.1 The proposed Grid Code changes are to:

- modify OC6.6.1 to specify that the LFDD scheme should be based on forecast demand at the time of the GB transmission system peak demand.

- remove the minimum operating time requirement from CCA.5.1.1 (b)

- add a new clause CC.A.5.3.2 requiring that the total scheme operating time is less than 200ms where practicable (replacement of plant installed prior to October 2009 has been excluded)

- modify CC.A.5.5.1 in line with the changes to OC6.6.1. In the working group report this proposed change does not include that the basis should be forecast data. This was an error in a previous report.

- to clarify in CC.A.5.5.1 that the percentage figures should be achieved as far as reasonably practicable

- add schedule 12A to the DRC, indicating the format for the submission of LFDD scheme data.

9.2 The proposed amendments are shown in Appendix A.

9.3 The proposed solution will:

- Clarify the arrangements for the Low Frequency Demand Disconnection scheme, ensuring its robustness.

10. Impact on GB Transmission System

10.1 The proposed changes will not have any adverse impact on the GB Transmission System.

11. Impact on Grid Code Users

11.1 The proposals will provide additional clarity to Users and ensure consistency in interpretation of the requirements.

12. Assessment Against Grid Code Objectives

12.1 The proposed changes outlined in D/09 Report to the Authority will better facilitate Grid Code Objectives:

iii) to promote the security and efficiency of the electricity generation, transmission and distribution system in Great Britain

by improving the clarity of the requirements from the Low Frequency Demand Disconnection Scheme.

13. Impact on Industry Documents

Impact on Core Industry Documents

13.1 Grid Code Report to the Authority D/09 has no impact upon Core Industry Documents.

Impact on other Industry Documents

13.2 Grid Code Report to the Authority D/09 has no impact upon other Industry Documents.

14. Environmental Impact Assessment

14.1 Grid Code Report to the Authority D/09 is anticipated to have a zero environmental impact.

C. CONSULTATION RESPONSES

15. National Grid has consulted Authorised Electricity Operators on this issue. Five responses were received. All four respondents who stated an opinion, gave their support for the proposals. All responses, along with National Grid's replies, are included as Appendix C.

16. Respondent D/09-CR-01 (CE Electric UK) was generally supportive of the proposals as they clarify some of the ambiguities relating to the LFDD scheme. An area of discussion raised was whether LFDD schemes should seek to disconnect 60% of historic or forecast transmission system peak demand. The respondent stated that the proposed approach, which uses forecast data requires additional analyses by the DNOs and introduces additional uncertainty and error. Whilst National Grid notes such a proposal, it believes the use of forecast data ensures consistency across all DNOs and ensures robustness of the LFDD scheme and therefore has not revised the proposals in this area.

17. One respondent D/09-CR-02 (ENW) suggested that there should be a specific exclusion for retrospective application of the new requirement for a 200 millisecond operating time for the Low Frequency Demand Disconnection scheme. National Grid responded that although it does not foresee such a requirement becoming an absolute requirement in the future, the clause could be clarified to ensure it fully represents the group view that it is not justifiable to replace existing plant to meet the requirement. Consequently, the final proposals contain an additional sentence within CC.A.5.3.2 excluding the replacement of plant installed prior to October 2009.

18. The same respondent also suggested two clarifications to the Consultation document relating to the use of acronyms and a typographical error. As the Consultation document has fulfilled its purpose and will not be reissued, National Grid will taken such comments on board for subsequent publications but will not be reissuing the original Consultation.

19. Respondent D/09-CR-05 (Magnox) was supportive of the changes. Magnox raised the question of whether an LFDD scheme that is set to disconnect a specific proportion of demand at Winter Peak Demand would have the same characteristics at other times, such as weekends or during the night. National Grid responded that the Working Group's work included an historic assessment at how each DNO's LFDD's schemes would have performed at five specified times and dates in 2008, to cover a range of system conditions. The findings were that variation in performance was small and did not justify modifying the scheme principles in the Grid Code.

D. LEGAL TEXT AND RECOMMENDATIONS

20. Connection Conditions

20.1 It is proposed to amend the existing clause CC Appendix 5 to clarify that:

- remove the minimum operating time requirement from - CCA.5.1.1 (b)
- add a new clause requiring that the total scheme operating time is less than 200ms where practicable, clarifying that replacement of existing assets is not needed - CC.A.5.3.2
- modify CC.A.5.5.1 in line with the changes to OC6.6.1. In the working group report this proposed change does not include that the basis should be forecast data (this was an error in the report).
- to clarify that the percentage figures should be achieved as far as reasonably practicable - CC.A.5.5.1

21. Operating Code 6

22. It is proposed to modify OC6.6.1 to specify that the LFDD scheme should be based on forecast demand at the time of the GB transmission system peak demand.

23. Data Registration Code

24. Add schedule 12A to the DRC, indicating the format for the submission of LFDD scheme data.

25. Recommendation

26. National Grid recommends to the Authority that these proposals be approved such that there is greater clarity and consistency for all industry parties in respect of the operation of the Low Frequency Demand Disconnection scheme.

27. The proposed Grid Code changes are shown in Appendix A with deletions shown struck through and insertions highlighted by text in red with a double underline.

28. As indicated above, having regard to the outcome of the review described in this Report, National Grid proposes the revisions to the Grid Code set out in Appendix A, which revisions we reasonably think fit for the achievement of the objectives referred to in sub-paragraph (b) of paragraph 1 of Condition C14 of the Transmission Licence. In view of this, National Grid would be grateful if the Authority would approve the revisions pursuant to paragraph 3 of Condition C14 of the Transmission Licence.

29. Given the logistic exercise of organising replacement pages to reflect the changes required by your letter of approval, I would be grateful if you would contact me prior to issuing any letter specifying an effective date in order to ensure that the date is consistent with any other Code changes which may then be approved or be close to being approved.

Tom Ireland

APPENDIX A: PROPOSED GRID CODE CHANGES

The proposed legal text is reflective of the current Grid Code baseline as specified in Issue 4 Revision 0

Proposed Changes to ..

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**) at the time of forecast GB transmission system peak demand 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**) at the time of forecast GB transmission system peak demand 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.

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 installed and commissioned after 1st April 2007 and provide an indication, without prejudice to the provisions that may be included in a **Bilateral Agreement**, for those installed and commissioned before 1st April 2007:

(a)	**Frequency** settings:	47-50Hz in steps of 0.05Hz or better, preferably 0.01Hz;
(b)	Operating time:	~~Between 100 and 150ms dependent on measurement period setting~~ Relay operating time shall not be more than 150 ms
(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% of total harmonic distortion

Electromagnetic Compatibility Level.

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%, ie. 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.5.5.1a and is not reduced unacceptably during equipment outage or maintenance conditions.

CC.A.5.3.2 The total operating time of the scheme, including circuit breaker operating time, shall where reasonably practicable, be less than 200 ms.For the avoidance of doubt, the replacement of plant installed prior to October 2009 will not be required in order to achieve lower total scheme operating times.

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**) at the time of forecast GB transmission system peak demand 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.5.5.1a

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

Note – the percentages in table CC.A.5.5.1a 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**.

The percentage demand at each stage shall be allocated as far as reasonably practicable. The cumulative total percentage demand is a minimum.

Schedule 12 in DRC

SCHEDULE 12

DATA DESCRIPTION	UNITS	TIME COVERED	UPDATE TIME	DATA CAT.
*__**Demand Control** or Pump Tripping Offered as Reserve__				
Magnitude of **Demand** or pumping load which is tripped	MW	Year ahead from week 24	Week 24	**DPD**
System Frequency at which tripping is initiated	Hz	"	"	"
Time duration of **System Frequency** below trip setting for tripping to be initiated	S	"	"	"
Time delay from trip initiation to Tripping	S	"	"	"
__Emergency Manual Load Disconnection__				
Method of achieving load disconnection	Text	Year ahead from week 24	Annual in week 24	OC6
Annual ACS Peak Demand (**Active Power**) at **Connection Point** (requested under Schedule 11 - repeated here for reference)	MW	"	"	"
Cumulative percentage of **Connection Point Demand** (**Active Power**) which can be disconnected by the following times from an instruction from **NGET**				
5 mins	%	"	"	"
10 mins	%	"	"	"
15 mins	%	"	"	"
20 mins	%	"	"	"
25 mins	%	"	"	"
30 mins	%	"	"	"
~~Automatic Low **Frequency Disconnection**~~				
~~Magnitude of **Demand** disconnected, and frequency at which **Disconnection** is initiated, for each frequency setting for each **Grid Supply Point**~~	~~MW Hz~~	~~Year ahead from week 24~~	~~Annual in week 24~~	~~OC6~~

Notes

1. **Network Operators** may delay the submission until calendar week 28.

- No information collated under this Schedule will be transferred to the **Relevant Transmission Licensees**

AUTOMATIC LOW FREQUENCY DEMAND DISCONNECTION– SCHEDULE 12A

Time Covered: Year ahead from week 24
DataCategory: OC6
Update Time: Annual in week 24

Grid Supply Point	GSP Demand MW	Low Frequency Demand Disconnection Blocks MW 1 48.8Hz	2 48.75Hz	3 48.7Hz	4 48.6Hz	5 48.5Hz	6 48.4Hz	7 48.2Hz	8 48.0Hz
GSP1 GSP2 GSP3									
Total demand disconnected per block	MW %								
Total demand disconnection	MW (% of aggregate demand of MW)								

Note: All demand refers to that at the time of forecast GB transmission system peak demand.
Network Operators may delay the submission until calendar week 28

No information collated under this schedule will be transferred to the Relevant Transmission Licensees

APPENDIX B: CONSULTATION PAPER D/09

nationalgrid

GRID CODE

CONSULTATION DOCUMENT

OC6.6 (Automatic LFDD)

The purpose of this document is to consult on the above Grid Code Modification Proposal with authorised electricity operators liable to be materially affected by the proposed changes and forms the basis of the subsequent Report to the Authority

Consultation Ref	D/09
Issue	1.0
Date of Issue	3rd September 2009
Responses required by	**1st October 2009**
Prepared by	National Grid

DOCUMENT LOCATION

National Grid website:

http://www.nationalgrid.com/uk/Electricity/Codes/gridcode/consultationpapers/

DISTRIBUTION

Name	Organisation
AEO's	Various
GCRP Members/Alternates	Various
Interested Parties	Various
National Grid Website	

A. INTRODUCTION

1. Paragraph 2 of Condition C14 of the Transmission Licence granted to the National Grid Electricity Transmission plc ("National Grid") provides that National Grid shall, in consultation with Authorised Electricity Operators liable to be materially affected thereby, periodically review the Grid Code and its implementation. That paragraph also requires National Grid, following such review, to send to the Authority:-

   (a) a report on the outcome of such review;

   (b) any proposed revisions to the Grid Code as National Grid (having regard to the outcome of such review) reasonably thinks fit for the achievement of the objectives set out in sub-paragraph (b) of Condition C14 of the Transmission Licence; and

   (c) any written representations or objections from Authorised Electricity Operators (including any proposals by such operators for revisions to the Grid Code not accepted by National Grid in the course of the review) arising during the consultation process and subsequently maintained.

2. This review examines proposed amendments to the existing Grid Code provisions relating to automatic low frequency demand disconnection schemes (LFDD) that are intended to clarify the requirements and ensure a consistent approach by the DNOs. The proposals were developed through the Grid Code OC6.6 (Automatic LFDD) Working.

3. The proposed changes to the Grid Code were discussed with the Grid Code Review Panel (GCRP) on 21st May 2009. Panel Members agreed that National Grid should issue a Consultation Paper regarding the proposed changes.

4. Comments upon the proposed changes within this consultation should be sent to National Grid by **1st October 2009** as detailed in section C. The comments will be reviewed and responded to.

5. Following this consultation, National Grid will prepare a Report to the Authority detailing National Grid's recommended changes to the Grid Code and all comments/responses received from Authorised Electricity Operators through this consultation. Once sent to the Authority this report will be made available on National Grid's website.

6. Where Authorised Electricity Operators' responses have been marked as confidential they will not be published within the version of the Report to the Authority placed on the National Grid website.

7. The revisions to the Grid Code proposed by National Grid and sent to the Authority require approval by that body and will, if approved, come into force on such date (or dates) of which you will be notified by National Grid, in accordance with the Authority's approval.

B. DESCRIPTION OF THE PROPOSED AMENDMENTS AND THEIR EFFECTS

Background

8. On 27th May 2008 an exceptional loss of generation led to the operation of the first stage of the national Low Frequency Demand Disconnection (LFDD) scheme. Though the LFDD scheme operated successfully and limited the frequency fall, there were a few isolated instances of ineffective operation of relays, and many relays did not operate. An investigation by the Energy Emergency Executive Committee (E3C) Task Group led to a recommendation that the Grid Code requirements of OC6.6 be reviewed to see if any improvement to the scheme could be made. The Grid Code Review Panel established the OC6.6 (Automatic LFDD) working group to undertake this review. The group comprised representatives of DNOs, National Grid, the AEP and OFGEM.

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https://www.nationalgrid.com/uk/Electricity/Codes/gridcode/workinggroups/E3C_Working_Group/

10. Working Group Discussions

11. Grid Code clause OC6.6.1 specifies the percentage of demand that should be available for LFDD disconnection and the time on which this figure is based. It specifies a percentage at the time of the DNO's peak demand. This time varies between DNOs and the requirement may not result in the specified percentage demand being available for disconnection at the time of the GB system peak demand, which is the intention of the requirement. It is therefore proposed to modify the requirement to specify the percentage of demand available for low frequency disconnection at the time of GB transmission system peak demand.

12. There is a lack of clarity as to whether the requirement should be based on the forecast or historic GB system peak demand. Both interpretations have been made by DNOs in setting up their schemes. Discussions took place on the relative merits of both options. It was agreed that in practice no significant differences were expected. Some members supported using historic demand as a basis as this would not require the application of forecast demand growths, which may not be accurate, at BSP level. Some members preferred to leave the requirement unchanged, allowing DNOs to use historic demands as a basis but taking into account expected significant changes, such as network reconfiguration or the connection of large new loads. Others believe that it is preferable to include a clear requirement that forecast demand should be used to ensure consistency. It is NGET's view that the latter is preferable as the forecast demand growths applied by DNOs to demands for the next winter will be sufficiently accurate and this option will ensure that any network changes are considered. The proposal is to change the requirements so that they specify that the scheme should be based on forecast demand.

13. Table 12a is a proforma drawn up by NGET for the purpose of Grid Code clause OC6.6.2 (d), which requires the annual submission of LFFD data by DNOs. This

proforma does not explicitly indicate that the data required relates to a forecast time of GB transmission system peak demand. It is proposed to clarify this and incorporate the table in the Data Registration Code (DRC).

14. CC.A.5.1 in Appendix 5 of the Grid Code Connection Conditions specifies the functional requirements of the scheme relays. The stated operating time of 100ms – 150ms refers to the relay, not the demand disconnection time. This operating time is dependent on the rate of change of frequency as that affects the measurement time, and includes any time delay set by the user. As modern relays, for example MICOM P941 and ARGUS AR8, can have a typical operating time of less than 100ms it was agreed that a minimum operating time should not be specified and it is proposed to modify the clause accordingly.

15. The total time to disconnect demand includes the operation of the trip relay and circuit breakers. Modern 33kV circuit breakers have a typical operating time of 40-80 ms including arc extinction; older types having typically 80-100ms.

16. For the LFDD scheme to perform optimally, the total operating time, ie including breaker operation, should not be more than 200ms. In some cases, even with modern circuit breakers, 200ms may not be achievable (tests would be needed to assess this). The slower scheme operating times associated with existing, slower circuit breakers may require the operation of more scheme stages but they are not expected to prevent successful scheme operation. As low frequency events initiating LF relays are quite rare and sub-optimal operation will not prevent successful scheme operation, the group agreed that accelerated circuit breaker or other asset replacement cannot be justified on the grounds of slower operating time. The group agreed that the Grid Code requirement should reflect the aim to achieve a 200ms operating time whilst recognising that generally it would not be economically justifiable to replace assets to achieve this.

17. Table CC.A.5.5.1a specifies for each stage the percentage demand blocks and associated frequency settings. Some DNOs have expressed concern that as there is no tolerance in these settings, it is practically impossible to comply. It is proposed that the % demand blocks shall be qualified with “as far as reasonably practical” for each stage.

18. <u>Proposed Grid Code Changes</u>

19. The proposed Grid Code changes are to:

- modify OC6.6.1 to specify that the LFDD scheme should be based on forecast demand at the time of the GB transmission system peak demand.

- remove the minimum operating time requirement from CCA.5.1.1 (b)

- add a new clause CC.A.5.3.2 requiring that the total scheme operating time is less than 200ms where practicable

- modify CC.A.5.5.1 in line with the changes to OC6.6.1. In the working group report this proposed change does not include that the basis should be forecast data. This is an error in the report.

- to clarify in CC.A.5.5.1 that the percentage figures should be achieved as far as reasonably practicable

- add schedule 12A to the DRC, indicating the format for the submission of LFDD scheme data.

20. The proposed amendments are shown in Appendix A.

21. Impact on GB Transmission System

22. The proposed changes will not have any adverse impact on the GB Transmission System.

23. Impact on Grid Code Users

24. The proposals will provide additional clarity to Users and ensure consistency in interpretation of the requirements.

25. Assessment Against Grid Code Objectives

26. The proposed changes will better facilitate Grid Code Objectives by improving the clarity of the requirements.

27. Impact on Industry Documents

Impact on Core Industry Documents

28. None.

Impact on other Industry Documents

29. None.

C. RESPONSES

30. This section will contain a summary of responses received during the Consultation and will be completed as part of the Report to the Authority.

31. Views are invited upon the proposals outlined in this report, which should be received by 1st October 2009. Views on the following areas would be especially welcomed:

- Impact of the proposals on Grid Code users.
- Any improvements or changes to the proposals that in a respondent's view would better facilitate the objectives of the Grid Code.

34. Your formal responses may be:-

Posted to: Tom Ireland
Electricity Codes
Regulatory Frameworks
National Grid Electricity Transmission plc
National Grid House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

Emailed to: thomas.ireland@uk.ngrid.com

Appendix A: Proposed Grid Code Changes

Proposed Changes in Grid Code

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**) at the time of forecast GB transmission system peak demand 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**) at the time of forecast GB transmission system peak demand 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.

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 installed and commissioned after 1st April 2007 and provide an indication, without prejudice to the provisions that may be included in a **Bilateral Agreement**, for those installed and commissioned before 1st April 2007:

(a)	**Frequency** settings:	47-50Hz in steps of 0.05Hz or better, preferably 0.01Hz;
(b)	Operating time:	~~Between 100 and 150ms dependent on measurement period setting~~ Relay operating time shall not be more than 150 ms
(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% of total harmonic distortion **Electromagnetic Compatibility Level**.

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%, ie. 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.5.5.1a and is not reduced unacceptably during equipment outage or maintenance conditions.

CC.A.5.3.2 The total operating time of the scheme, including circuit breaker operating time, shall where reasonably practicable, be less than 200 ms.

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**) at the time of forecast GB transmission system peak demand 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.5.5.1a

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

Note – the percentages in table CC.A.5.5.1a 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**.

The percentage demand at each stage shall be allocated as far as reasonably practicable. The cumulative total percentage demand is a minimum.

Schedule 12 in DRC

SCHEDULE 12

DATA DESCRIPTION	UNITS	TIME COVERED	UPDATE TIME	DATA CAT.
*__**Demand Control** or Pump Tripping Offered as Reserve__				
Magnitude of **Demand** or pumping load which is tripped	MW	Year ahead from week 24	Week 24	**DPD**
System Frequency at which tripping is initiated	Hz	"	"	"
Time duration of **System Frequency** below trip setting for tripping to be initiated	S	"	"	"
Time delay from trip initiation to Tripping	S	"	"	"
__Emergency Manual Load Disconnection__				
Method of achieving load disconnection	Text	Year ahead from week 24	Annual in week 24	OC6
Annual ACS Peak Demand (**Active Power**) at **Connection Point** (requested under Schedule 11 - repeated here for reference)	MW	"	"	"
Cumulative percentage of **Connection Point Demand** (**Active Power**) which can be disconnected by the following times from an instruction from **NGET**				
5 mins	%	"	"	"
10 mins	%	"	"	"
15 mins	%	"	"	"
20 mins	%	"	"	"
25 mins	%	"	"	"
30 mins	%	"	"	"
~~Automatic Low **Frequency Disconnection**~~				
~~Magnitude of **Demand** disconnected, and frequency at which **Disconnection** is initiated, for each frequency setting for each **Grid Supply Point**~~	~~MW Hz~~	~~Year ahead from week 24~~	~~Annual in week 24~~	~~OC6~~

Notes

1. **Network Operators** may delay the submission until calendar week 28.

- No information collated under this Schedule will be transferred to the **Relevant Transmission Licensees**

AUTOMATIC LOW FREQUENCY DEMAND DISCONNECTION– SCHEDULE 12A

Time Covered: Year ahead from week 24 DataCategory: OC6
Update Time: Annual in week 24

Grid Supply Point	GSP Demand MW	Low Frequency Demand Disconnection Blocks MW									Residual demand MW
		1 48.8Hz	2 48.75Hz	3 48.7Hz	4 48.6Hz	5 48.5Hz	6 48.4Hz	7 48.2Hz	8 48.0Hz	9 47.8Hz	
GSP1 GSP2 GSP3											
Total demand disconnected MW per block %											
Total demand disconnection MW (% of aggregate demand of MW)											

Note: All demand refers to that at the time of forecast GB transmission system peak demand.
Network Operators may delay the submission until calendar week 28

No information collated under this schedule will be transferred to the **Relevant Transmission Licensees**

APPENDIX C: CONSULTATION RESPONSES TO THE PROPOSED CHANGE

The following Appendix contains copies of all representations received from Authorised Electricity Operators through the consultation period.

Original Responses to D/09 Consultation

No.	Company	File Number
1	CE Electric UK	D/09-CR-01
2	Electricity North West	D/09-CR-02
3	Scottish Power Energy Networks	D/09-CR-03
4	Scottish and Southern Energy	D/09-CR-04
5	Magnox	D/09-CR-05

National Grid Replies to Consultation Responses

No.	Company	File Number
1	CE Electric UK	D/09-CRR-01
2	Electricity North West	D/09-CRR-02
3	Scottish Power Energy Networks	D/09-CRR-03
4	Scottish and Southern Energy	D/09-CRR-04
5	Magnox	D/09-CRR-05

Reference	D/09-CR-01
Company	CE Electric UK

CE Electric UK

Your ref

Our ref

Tom Ireland
Electricity Codes
Commercial Frameworks
National Grid Electricity Transmission plc
National Grid House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

Asset Management
98 Aketon Road
Castleford
WF10 5DS
http://www.ce-electricuk.com/
tel: 0191 229 5422
fax: 01977 605594
e-mail: mark.nicholson@ce-electricuk.com

21st September 2009

Dear Tom

Grid Code Consultation D/09– OC6.6 (Automatic LFDD)

I'm writing on behalf of Northern Electric Distribution Limited (NEDL) and Yorkshire Electricity Distribution plc (YEDL), the licensed electricity distributors of CE Electric UK.

In general, CE Electric UK is supportive of the proposals to improve the performance of the Low Frequency Demand Disconnection (LFDD) scheme as described in the consultation document since they clarify some of the ambiguities relating to the scheme in the current Grid Code.

As mentioned in the consultation, one area that was the subject of discussion in the working group relates to whether DNOs should base the scheme on the disconnection of 60% of historic or forecast transmission system peak demand. The objective of the LFDD scheme is to disconnect, as far as reasonably practicable, 60%[1] of customer demand in the event that there is a serious low frequency event on the transmission system. As demand varies continually, to achieve the target LFDD demand blocks, the relay settings would theoretically need to be continuously reviewed in real time. Clearly this is impractical, hence when reviewing the LFDD demand blocks and relay settings there is a need to establish a scheme that stands the greatest chance of disconnecting the required demand in a range of demand scenarios. The two key options are to base the LFDD scheme on either historic or forecast data. If historic demand data is used, suitably adjusted to take into account significant network configuration changes (which are relatively rare), the connection of new material demand and disconnection material demand, there is some degree of certainty that in one particular combination of demand on the network, the 60% disconnection requirement would be achieved. If forecast demand data is used DNOs would need to carry out additional, although relatively limited, analysis to forecast demands at key substations and in some cases individual feeders, which introduces an additional uncertainty and error into the process, and by doing so reduces the robustness of the resulting LFDD scheme.

1 60% in England and Wales, 40% in Scotland

We note that NGET is of the view that the latter approach is preferred i.e. produce a LFDD scheme based on forecast transmission system peak. However, given the absence of any evidence to indicate that one approach is preferable over the other, we are of the view that it should be for the DNO to establish which basis is adopted (i.e. historic or forecast transmission system demands) in order to best meet its Grid Code obligations.

To accommodate this, the explicit requirement for the LFDD scheme to be based on the time of *forecast* GB Transmission System Peak, as in the proposed OC6.6.1, should be removed.

Please contact me if there are any issues arising from this letter that would benefit from further clarification.

Yours sincerely

Mark Nicholson
Head of System Strategy

Reference	D/09-CR-02
Company	Electricity North West

Electricity North West Limited
Dalton House
104 Dalton Avenue
Birchwood Park
Birchwood
Warrington
WA3 6YF

Telephone: 01925 534550

Mr Tom Ireland
Electricity Codes
Regulatory Frameworks
National Grid Electricity Transmission plc
National Grid House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

Direct line 01925 534414
fax if required
bob.wells@enwltd.co.uk

22 September 20098

Dear Tom,

Grid Code Consultation Document – OC6.6 (Automatic LFDD).

Thank you for your consultation document issue 1.0 dated 3ed September 2009 detailing the proposed changes to OC6.6 (Automatic LFDD) within the Grid Code. We have reviewed the document and make the following comments:

1. There are a number of acronyms within the document that are not defined, by providing definitions this will make the document easier to understand.

2. On Page 3, Para 2, add "group" to the end of the paragraph, typographical error.

3. On Page 5 Para 16. We acknowledge that the intention of including the 200ms operating time requirement is for guidance, and it is appropriate to use the wording "*where reasonably practical*" in the revised code clause CC.A.5.3.2, we have concern that this may become an absolute requirement at some time in the future. In order to protect the position of Network Operators we consider it necessary that there is a specific exclusion for retrospective application of this requirement and it shall not be applicable to plant in service at the date of this consultation (October 2009).

\continuation p2

We have no other comments on the document or the suggested changes to the code as detailed in Appendix A of the document. If we can be of any further help in this matter please feel free to contact my Grid and Primary Asset Manager, Bob Wells by e mail (bob.wells@enwltd.co.uk) or by phone on 01925 534414.

Yours sincerely,

Mike Kay

Digitally signed by Mike Kay
DN: cn=Mike Kay, o, ou, email=mkay@iee.org, c=GB
Date: 2009.09.25 14:27:07 +01'00'

Mike Kay
Engineering and Planning Director

Reference	D/09-CR-03
Company	Scottish Power Energy Networks

SP ENERGY NETWORKS

Your ref.

Our Ref

Date
1st October 2009

Contact / Extension
Graeme Vincent
01698 413504

Tom Ireland
Electricity Codes
Regulatory Frameworks
National Grid Electricity Transmission plc
National Grid House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

Dear Tom,

Grid Code Consultation Document D/09 OC6.6 (Automatic LFDD)

I am writing on behalf of SP Distribution Ltd. SP Manweb plc and SP Transmission Ltd in response to the above consultation issued by National Grid Electricity Transmission plc.

We have been actively involved within the GCRP working group and welcome the proposals to clarify the requirements and ensure consistency in approach by Distribution Network Operators and therefore we are supportive of the proposed changes.

Yours sincerely,

Graeme Vincent

Graeme Vincent

Transmission Policy

New Alderston House, Dove Wynd, Strathclyde Business Park, Bellshill ML4 3FF
Telephone 01698 413000, Fax 01698 413053
www.scottishpower.com

Reference	D/09-CR-04
Company	Scottish and Southern Energy

Ireland, Tom

From: Garth.Graham@scottish-southern.co.uk
Sent: 28 September 2009 14:08
To: Ireland, Tom
Subject: Re: Grid Code Consultation D/09 - Automatic LFDD

Dear Sirs,

This response is sent on behalf of SSE Energy Supply Ltd., SSE Generation Ltd., Keady Generation Ltd., Medway Power Ltd., Slough Energy Supplies Ltd., Airtricity Ltd., Airtricity Generation (GB) Ltd. and SSE (Ireland) Ltd.

In relation to the consultation concerning Grid Code D/09 ("Automatic LFDD") contained within your note of 3rd September 2009 we agree with the view of National Grid that this seems a pragmatic approach which would better facilitate the Grid Code Objectives.

Regards

Garth Graham
Scottish and Southern Energy plc

Reference	D/09-CR-05
Company	Magnox

Ireland, Tom

From: david.m.ward@magnoxnorthsites.com
Sent: 18 September 2009 14:26
To: Ireland, Tom
Subject: Grid Code Consultation - D/09

Tom Ireland
Electricity Codes
Regulatory Frameworks
National Grid Electricity Transmission plc National Grid House Warwick Technology Park
Gallows Hill Warwick
CV34 6DA

(By email)

Tom

Grid Code Consultation Paper D/09
OC6.6 (Automatic LFDD)

This email is the formal response of Magnox North Ltd to the above consultation paper. Magnox North Ltd operates the operational Magnox Power Station sites on behalf of the Nuclear Decommissioning Authority.

The proposed change has no material effect on the Magnox power stations, so we have no strong view. The proposed change seems a sensible clarification to remove ambiguity so that distribution companies will behave in a similar way when selecting and setting up demand groups for LFDD.

As I mentioned on the phone, I would be interested to know if National Grid has considered whether basing the percentages on distribution company demand at the time of system peak demand will always result in sensible percentages of demand being disconnected at each stage if a low frequency event occurs at any other time (e.g. at night or a weekend)

My comments are not confidential

Regards

David Ward

Magnox North Ltd
Berkeley Centre
Berkeley
Gloucestershire, GL13 9PB
United Kingdom

Phone: +44 (0)1453 813631
Fax: +44 (0)1453 812845
Mobile: +44 (0)789 906 4052
Email: david.m.ward@magnoxnorthsites.com

Reference	D/09-CRR-01
Company	CE Electric UK

National Grid House
Warwick Technology Park
Gallows Hill, Warwick
CV34 6DA

Mr Mark Nicholson
Head of System Strategy
CE Electric UK
98 Aketon Road,
CASTLEFORD
WF10 5DS

Mark Perry
System Integration Manager

Mark.Perry@uk.ngrid.com
Direct tel +44 (0)1926 655468
Direct fax +44 (0)1926 656521

www.nationalgrid.com

10 December 2009

Dear Mark,

Automatic Low Frequency Demand Disconnection

Thank you for your response on September 21st to our consultation on proposals to modify the Grid Code requirements relating to Low Frequency Demand Disconnection schemes (consultation D/09).

We note your general support for the proposals. We also note your view that the explicit requirement for the LFDD scheme to be based on the time of *forecast* GB Transmission System Peak, as in the proposed OC.6.6.1, should be removed. As we stated in the consultation we continue to believe that the proposed wording is appropriate in ensuring both a consistent approach amongst DNOs and the robustness of the scheme. We also consider that the additional analysis required by DNOs will be small. As you note, it will be necessary to account for any material changes to the network or demand in any method used. We will include your response in our report to OFGEM on the consultation, but will propose the modifications that were consulted on. We intend to submit the report in the next few days.

If you have any queries please contact me at Mark.Perry@uk.ngrid.com

Yours sincerely

Mark Perry

System Integration Manager
Electricity Network Investment
National Grid

Reference	D/09-CRR-02
Company	Electricity North West

nationalgrid

National Grid House
Warwick Technology Park
Gallows Hill, Warwick
CV34 6DA

Mr Mike Kay
Electricity North West Limited
Dalton House,
104 Dalton Ave,
Birchwood Park, Warrington,
WA3 6YF

Mark Perry
System Integration Manager

Mark.Perry@uk.ngrid.com
Direct tel +44 (0)1926 655468
Direct fax +44 (0)1926 656521

www.nationalgrid.com

10 December 2009

Dear Mike,

Automatic Low Frequency Demand Disconnection

Thank you for your response on September 22nd to our consultation on proposals to modify the Grid Code requirements relating to Low Frequency Demand Disconnection schemes (consultation D/09).

Your first two comments relate to the consultation document. In general we do not re-issue a consultation document unless it contains errors that materially affect the proposals being consulted on. We note your comment about the use of acronyms and will endeavour to properly define them in future consultations.

In respect of comment 3, we do not envisage that the requirements of CC.A.5.3.2, which the proposal caveats with "where reasonably practical", will become an absolute requirement in the future. However we do acknowledge that the group agreed it would not be justifiable to replace existing plant in order to reduce the scheme operating time, and that the proposal could be amended to more clearly reflect this. We therefore propose to modify the proposed CC.A.5.3.2 to say:

CC.A.5.3.2 The total operating time of the scheme, including circuit breaker operating time, shall where reasonably practicable, be less than 200 ms. For the avoidance of doubt, the replacement of plant installed prior to October 2009 will not be required in order to achieve lower total scheme operating times.

If you have any queries please contact me at Mark.Perry@uk.ngrid.com

Yours sincerely

Mark Perry

System Integration Manager
Electricity Network Investment
National Grid

Reference	D/09-CRR-03
Company	Scottish Power Energy Networks

nationalgrid

National Grid House
Warwick Technology Park
Gallows Hill, Warwick
CV34 6DA

Mr Graeme Vincent
SP Transmission & Distribution
New Alderston House,
Dove Wynd,
Strathclyde Business Park
BELLSHILL
ML4 3FF

Mark Perry
System Integration Manager

Mark.Perry@uk.ngrid.com
Direct tel +44 (0)1926 655468
Direct fax+44 (0)1926 656521

www.nationalgrid.com

10 December 2009

Dear Graeme,

Automatic Low Frequency Demand Disconnection

Thank you for your response on October 1st to our consultation on proposals to modify the Grid Code requirements relating to Low Frequency Demand Disconnection schemes (consultation D/09).

We note your support for the proposals and will include your response in our report to OFGEM on the consultation. We intend to submit the report in the next few days.

If you have any queries please contact me at Mark.Perry@uk.ngrid.com

Yours sincerely

Mark Perry

System Integration Manager
Electricity Network Investment
National Grid

Reference	D/09-CRR-04
Company	Scottish and Southern Energy

nationalgrid

National Grid House
Warwick Technology Park
Gallows Hill, Warwick
CV34 6DA

Mr Garth Graham (by email)
Garth.Graham@scottish-southern.co.uk

Mark Perry
System Integration Manager

Mark.Perry@uk.ngrid.com
Direct tel +44 (0)1926 655468
Direct fax +44 (0)1926 656521

www.nationalgrid.com

10 December 2009

Dear Garth,

Automatic Low Frequency Demand Disconnection

Thank you for your response on September 28th to our consultation on proposals to modify the Grid Code requirements relating to Low Frequency Demand Disconnection schemes (consultation D/09).

We note your support for the proposals and will include your response in our report to OFGEM on the consultation. We intend to submit the report in the next few days.

If you have any queries please contact me at Mark.Perry@uk.ngrid.com

Yours sincerely

Mark Perry

System Integration Manager
Electricity Network Investment
National Grid

Reference	D/09-CRR-05
Company	Magnox

nationalgrid

National Grid House
Warwick Technology Park
Gallows Hill, Warwick
CV34 6DA

Mr David Ward (by email)
david.m.ward@magnoxnorthsites.com

Mark Perry
System Integration Manager

Mark.Perry@uk.ngrid.com
Direct tel +44 (0)1926 655468
Direct fax +44 (0)1926 656521

www.nationalgrid.com

10 December 2009

Dear David,

Automatic Low Frequency Demand Disconnection

Thank you for your response on September 18th to our consultation on proposals to modify the Grid Code requirements relating to Low Frequency Demand Disconnection schemes (consultation D/09).

We note your support for the proposals and will include your response in our report to OFGEM on the consultation. We intend to submit the report in the next few days.

Your question regarding the amount of demand that would be disconnected at times other than peak was considered by the working group. The DNOs calculated the percentage of their demand that would have been disconnected by each stage of the LFDD scheme at five specified dates and times in 2008. These times and dates were chosen to cover a range of demand conditions. Although there was variation in the percentages the conclusion of the work was that the variation in the performance of all of the schemes in total was small, and not sufficient to justify modifying the principle of the Grid Code requirement that the scheme should be set up on the basis of winter peak demands.

I hope that this reply answers your query.

If you have any further queries please contact me at Mark.Perry@uk.ngrid.com

Yours sincerely

Mark Perry

System Integration Manager
Electricity Network Investment
National Grid