Grid Code Working Group Review of OC6.6

Report on the Review of the Automatic Low Frequency Demand Disconnection Scheme in OC6.6 of the Grid Code

EXECUTIVE SUMMARY

On 27th May 2008, 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, 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.

Low voltage networks (DNO controlled, e.g 132kV, 33kV) configured for parallel running between different Grid Supply Points (or Bulk Supply Points) can have an effect on the efficient operation of LFDD schemes. Demand that should be tripped by LFDD relays could be inadvertently transferred to another supply point. Auto switching schemes for the maintenance of customer supplies under fault conditions could produce similar effects. A review by DNOs however concluded that the risk and impact of interconnected running arrangements, Delayed Auto Reclose and auto close schemes on the efficient operation of the LFDD relays is very low. Some improvements have nevertheless been identified for guidance of DNO staff in their involvement with LFDD schemes.

A majority of the relays set at stage 1 (48.80 Hz) did not operate because the frequency fell to 48.795 Hz, which is within the design tolerance of compliant Grid Code relays. Post event tests by some DNOs confirmed that their relays would have tripped if the frequency had fallen slightly lower.

Although OC6.6 of the Grid Code specifies LFDD provision for a minimum of 60% of DNO demand in England and Wales (40% in Scotland) at the time of GB transmission system peak demand, returns of demands for five times in 2008 showed that this percentage was also maintained across a range of system demand levels, adding confidence to the adequate performance of the LFDD scheme.

Current Grid Code OC6.6 provisions for LFDD are found to be adequate. Some minor modifications are proposed to OC6.6 for clarity in respect of GB transmission system peak demand and overall demand disconnection time. Other changes are also recommended with the intention of addressing several minor issues identified during working group discussions.

Maintenance schedules of LF relays vary significantly from annually to every 12 years. However no correlation was found between these maintenance schedules and the non-operation of the relays.

CONTENTS

1 BACKGROUND

1.1 On 27th May 2008, the exceptional loss of generation resulted in the system frequency dropping to below 48.8 Hz, which is the setting for the first stage of the nine stage national LFDD scheme. The first stage is set to trip approximately 5% of each DNO's (in England and Wales) demand. Approximately 546MW of demand was disconnected, sufficient to arrest the frequency fall and turn it around to recovery. Data submitted by the DNOs following this incident showed that some 2260MW of demand would have been disconnected if all relays in stage 1 had operated, constituting 6.3% of demand in England and Wales. It was clear that some relays did not operate. The E3C Task Group report recommended that the Grid Code Review Panel (GCRP) should review OC6.6 to determine if any improvements could be made. The GCRP set up a working group comprising industry representatives to investigate.

2 WORKING GROUP TERMS OF REFERENCE

2.1 To identify if any improvements are required to OC6.6 (and the scheme in general) such that the scheme's effectiveness is not compromised by:

i) LV interconnected operation and/or LV running arrangement.
ii) DAR or automatic switching schemes.
iii) Relay reliability and settings.
iv) Uninstructed manual demand restoration and control room awareness.

2.2 The working group will also:

v) Provide an update on the programmes of replacing obsolete relays.
vi) Provide an update on the testing regime of relays.
vii) Make recommendations.
viii) Draft any necessary text modifications to implement the recommendations.
ix) Provide regular updates to the GCRP.

3 MEMBERSHIP

Members of the Working Group are:

Mark Perry (Chair)	National Grid
Lilian Macleod/Kabir Ali (Secretary)	National Grid
Darren Chan	National Grid
Raj Nagarajan	National Grid
Bridget Morgan	Ofgem
Graham Brewster	EON UK
Nigel Buckland	Western Power Distribution
Ian Burgess	EDF Energy
Alan Creighton	CE Electric UK
Diyar Kadar	Scottish Power
Bob Wells	Electricity North West
Guy Nicholson	Senergy Econnect
Russell Swift	Scottish and Southern Electricity
Barbara Vest	AEP

4 PERFORMANCE OF LFDD RELAYS ON 27th MAY

4.1 System frequency fell below 48.8 Hz for 1.2 seconds, initiating the operation of the relays and restricting the fall to 48.795 Hz. The relays that operated tripped some 546MW of demand, constituting about 1.5% of the total DNO demand in England and Wales at that time. DNO returns showed that the number of relays with stage 1 setting of 48.8 Hz was 91 but only 26 relays actually operated and disconnected demand. It was found that of the relays that didn't trip demand, most did not operate because the frequency was within the design tolerance of the relays of ± 0.01 Hz as set out in the Grid Code (the remainder of the relays operated but were not effective). Tests by at least one DNO showed that had the frequency fallen to below 48.79 Hz, more relays would have operated successfully.

4.2 Examples of instances when the LF relays operated but were not effective include:

- No demand was disconnected because of 33kV interconnected back feed.
- Trip links had been removed, thus not disconnecting demand.
- Three grid transformers were connected in parallel onto a solid 33kV busbar. The relay on one transformer operated but the other relays didn't, so no demand was disconnected (the relay that operated was of a different type from the others)

In these cases, better operational audit and awareness of the network configuration's impact on LFDD operation would likely have enabled successful operation of the local LFDD scheme.

4.3 In a further example two 33kV sites were interconnected through 33kV circuits. One site tripped but the demand was still connected because the other site didn't trip as the frequency was within the relay tolerance. The interconnecting circuits became overloaded and tripped on overcurrent protection, disconnecting demand from one site but DAR restored the circuit connections; this sequence was repeated several times. The relays on these two sites were of a different type. It is possible that if the relays were the same type at the two sites, the operation would have been successful at both sites (or perhaps not operated at all)

4.4 On the whole, the LFDD scheme operated successfully, the few relays that didn't operate effectively did not have a detrimental effect on the performance of the scheme. If the frequency had fallen lower than 48.79 Hz, it is expected that all the stage 1 relays (that did not operate because the frequency was within the relay operational tolerance) would have operated and disconnected more demand, speeding up the frequency recovery.

5 DEMAND ALLOCATED FOR DISCONNECTION

5.1 OC6.6 stipulates that each DNO in England and Wales shall make available at least 60% of its peak demand (discussed further in paragraph 5.2) for LFDD (40% in Scotland). Post the 27th May 2008 incident, submissions by the DNOs showed that on average 6.3% of their demand at the time of the incident was expected to have tripped for stage 1 relay operation. The Grid Code requirement of available demand for LFDD is based on the time of GB transmission system peak demand under ACS conditions. In order to investigate if the percentages of LFDD demand vary significantly throughout the year,

five times/dates were chosen in 2008, including a calendar year peak at 17:30 on 3rd January 2008 (time of GB transmission system peak refers to financial year; this was 17:30 on 17th December 2007). DNOs were requested to submit their actual data if these were available; in one case these data were estimates as actual data was not easily obtainable. The five times/dates were chosen to give a sensible spread of demand across different times of the day and months of the year. Table 1 in Appendix 1 shows a summary of the results. This table shows the percentages of demand available for LFDD disconnection in 2008 and does not imply compliance or otherwise with OC6.6. On the whole the percentages do not vary significantly from the target percentages; the national average for England and Wales shows that at 05:30 hrs on 5th August, the percentage is 57% compared to the 60% at 1730 hrs on 3rd January. The majority of the DNOs (in England and Wales) had demand at about 60% or more, with a couple at around 50%. The table gives confidence that the LFDD scheme would disconnect approximately the percentage of demand as designed, regardless of when it is called to operate

5.2 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 refers incorrectly to total DNO peak demand; it should be total DNO demand at time of GB transmission system peak demand. There has been a lack of clarity as to whether the requirement relates to the forecast or historic GB system peak demand, partly due to an inclear accompanying letter sent out by NGET with the request for Week 24 data submission. Week 24 data is used by NGET for system and operational planning, and LFDD data (Table 12a) submitted under Week 24 is required to ensure that there will be adequate provision in the unlikely event of the LFDD scheme being called to operate. Thus the time of GB transmission system peak demand provided by NGET refers to time of forecast peak demand, not historic. However, during working group discussions, it became apparent that some DNOs (YEDL, NEDL) based their submissions on the time of the previous year's GB transmission system outturn peak demand. Discussions took place on the relative merits of both options; it was agreed that in practice no significant differences were expected. EDF also stated their preference to use historic demand but it wasn't clear which basis was used for their Table 12a submission. It is proposed to clarify that the basis should be forecast demand (note that CE Electric UK is of the opinion historic demand is more accurate and would prefer the submission to be on this basis). It is proposed to modify OC.6.6.1 as follows:

(i) 60 per cent of its 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 Area

(ii) 40 per cent of its 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 Area

5..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).

5.4 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.

6 NETWORK CONFIGURATION

6.1 DNO networks are sometimes configured to provide lower voltage (e.g 66kV, 33kV, or 11kV) interconnection between two or more groups supplied from separate Grid Supply Points (GSPs). Operation of LFDD relays in one group should trip demand and not transfer the demand to the other interconnected group(s), making the local LFDD scheme ineffective. Where it is not possible to ensure that no such interconnection maintains demand following relay operation the DNO should not include this demand in its Week 24 Table 12a submission to NGET.

6.2 One way of preventing unintended demand transfer is by having the LF relays initiate intertripping of the interconnecting circuits. Where this is not practical, LF relays associated with demand in interconnected groups should have the same relay settings so that the groups' demands are disconnected at the same time. However there was a reported instance whereby relays in one group did not operate (as the frequency was within the relays' operating tolerance) but relays at another group did. This situation could possibly have been excerbated due to the different types of relays installed. This resulted in one group's demand being transferred to the other group, overloading the interconnecting circuits. Overcurrent protection tripped out these circuits and after a delay the DAR returned the circuits to service. Overcurrent protection again tripped them out, with DAR switching them back in. This cycle was repeated until the DAR was switched out.

6.3 The above incident meant that the particular local LFDD scheme wasn't effective. Even if the DAR wasn't present or was switched out prior to the event, relying on overcurrent protection to switch out circuits would add a delay (unless it's instantaneous) which could undermine the local scheme's performance. Having relays of the same type and settings (confirmed by the relay being tested at the operating setting) for interconnected groups may decrease the risk of the LFDD relays being ineffective.

6.4 Auto switching schemes may affect the effective operation of LF relays. Where 33kV substations are operated radially, an auto close scheme may be used to switch in an interconnecting circuit(s) to restore supply to the substation that has lost its infeed. Newer auto close designs incorporate a software feature which inhibits the auto close if frequency is below a prescribed setting (for example 49 Hz). In older schemes a frequency relay can be used to perform similar function. In some DNOs the frequency inhibit function is not featured where it is not normally possible for an auto close scheme to restore demand via a different substation, as it is felt that the risk of abnormal configuration coinciding with an auto close and LF tripping is very low

6.5 Some DNOs have installed 'network automation points' on their 11kV radially operated systems where intelligent fault isolation and supply restoration through 11kV interconnection circuits can be automatically effected in order to improve security of supply to consumers. These schemes, in some designs, have a low frequency inhibit function similar to the auto close schemes.

6.6 In the May 27th incident where only the first stage of the LFDD scheme operated, the adverse impact of low voltage (e.g 33kV, 11kV) interconnection, DAR and auto switching schemes on the efficient operation of LFDD relays was very small, practically negligible. Reviews by DNOs indicate that low voltage network configuration and interaction of DAR and auto switching schemes could have a very limited effect on the optimal performance of the LFDD scheme. Nevertheless, some improvements have been identified, and it is proposed that DNOs should draw upon the following guidelines for the use of those responsible for the implementation, management and operation of LFDD schemes. Bearing in mind that the risk of LFDD is very low, the following guidelines should be followed as far as reasonably practicable, with economic assessment as necessary.

i) Where substations equipped with LF relays are normally operated in parallel, such substations should have the same LFDD settings. LF relays should preferably be of the same types, including where applicable firmware versions. Intertripping should be considered where practicable.

ii) Where DAR or auto switching schemes are installed, low frequency inhibit should be a functional feature of such schemes if the operation of DAR or auto close could limit the effectiveness of LF relay operation.

iii) Prior to allocation of substations to LFDD groups, the impact of any auto switching schemes and manual restoration on LFDD operation should be considered.

iv) When implementing changes to the transmission or distribution system, it is important to consider the impact of permanent demand transfers and the creation of new parallel circuits between different LFDD groups that could compromise the effective operation of the LFDD scheme.

7 TECHNICAL REQUIREMENTS OF LFDD SCHEME

7.1 CC.A.5.1 in Appendix 5 of the Grid Code Connection Conditions specifies the functional requirements of the relays. The stated operating time of 100ms – 150ms refers to the relay, not the demand disconnection time. As modern relays, for example MICOM P941 and ARGUS AR8, can have a typical operating time of less than 100ms a minimum operating time should not be specified. 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.

7.2 It is proposed to change the wording of CC.A.5.1 to read:

b) Operating time: Relay operating time shall not be more than 150ms

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

7.4 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, it is difficult to justify accelerated circuit breaker or other asset replacement 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.

7.5 CC.A.5.3 contains details of the overall scheme requirements. It is proposed to add:

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.

8 CONTROL ROOM ACTION

8.1 There was an initial reported case(s) of manual demand restoration following the immediate tripping of demand, arising perhaps due to the lack of situational awareness. This report wasn't confirmed from the returns of the DNO questionnaire issued by NGET. This 'manual' demand restoration could possibly be the case of DAR restoration as described earlier in Section 4 of this report.

8.2 The Grid Code states that manual restoration of demand following LFDD operation should only be carried out under instruction from NGET control room. DNO control engineers are trained in accordance with prescribed programmes which entail interface with NGET, operation of LFDD schemes, black start procedures, and Grid Code obligations. Almost all control rooms have frequency meters, although it was reported that at least one DNO did not have a frequency meter and where meters are present, some are in obscure positions and not clearly visible. Additionally, operation of circuit breakers by LFDD relays would be indicated in the SCADA systems. It is thought unlikely that control engineers would be unaware of any operation of LFDD relays and unwittingly restore demand manually. Nevertheless an easily visible frequency meter can only enhance the situational awareness of engineers.

9 MAINTENANCE POLICY

9.1 The maintenance routine varies greatly with DNOs. Some carry out Operational Check and Inspection every 3 years, with a more detailed Check and Maintenance every 6 years. Some DNOs maintain their relays every 12 years. NGET also owns a limited number of LFDD relays which disconnect DNO demands; NGET relays are maintained every 6 years. There is no evidence to suggest there is any correlation between the maintenance frequency and the number of LF relays that did not operate.

9.2 Each maintenance activity would entail at least the following:

- visual inspection of components
- injection of variable frequency to establish pick up and drop off frequencies
- record the operating time of the relay

Appendix 2 lists the maintenance schedule of each DNO and NGET.

10 UPDATE ON RELAY REPLACEMENT PROGRAMME

10.1 NGET reviewed the LFDD scheme in 2000/01 and recommended the replacement of slower, obsolete relays. Relays have been replaced as necessary in accordance with individual DNO's asset replacement programme. In 2002 Ofgem allowed expenditure for these relays to be treated retrospectively in their next price review. Below is an update on each DNO and NGET.

NEDL - 2 sites, although these are not required to be in service to meet the Grid Code requirements. They will be replaced when other protection replacement work is carried out on site.

YEDL - 11 sites, although these are not required to be in service to meet the Grid Code requirements. They will be replaced when other protection replacement work is carried out on site.

NGET - 1 site (in YEDL), to be replaced in 2009/10
2 additional sites (in NEDL), awaiting scheme confirmation and dates.
2 sites at WPD to be replaced in 2009/10.

EDF - all relays have been replaced.

SPT all relays in both SPM and SPD should be replaced by the end of summer 2009.

CN - all relays thought to have been replaced but 3 are subsequently found to have been missed.

S&S - all relays to be replaced by the end of 2009/10

WPD - all relays have been replaced.

ENW - all relays have been replaced.

11 NON – EMBEDDED CUSTOMERS

11.1 The Grid Code requirements for non-embedded customers is presently under review within NGET and will be subject to GCRP consultation.

11.2 NGET has informed the GCRP that it proposes to clarify the GC requirements to ensure consistency, i.e 60% of non-embedded customers to be part of the LFDD scheme.

12 CONCLUSIONS

12.1 The existing national LFDD scheme performed successfully in the May 27th low frequency incident. The present Grid Code obligations are satisfactory to meet the functional requirements of the scheme though some minor Grid Code modifications are necessary for clarity.

12.2 Low voltage network configuration, with its DAR and/or auto switch schemes to enhance security of supplies to customers, would only have a very limited adverse impact on the overall performance of LFDD relays. Issuing of guidelines within DNOs could help to further minimise the adverse impact.

12.3 The percentage of demand allocated for LFDD in 2008 for a range of five selected times and dates, was approximately consistent at around 60%. This gives confidence in the performance of the LFDD scheme regardless of when the scheme is called upon to operate.

13 RECOMMENDATIONS

13.1 The following are recommendations to further enhance the performance of the LFDD scheme. It should be noted that there is no consensus within the Working Group in relation to 'forecast time of GB transmission system peak demand'. CE-Electric's view is that historic outturn demand should be used.

i OC6.6.1 to be modified to provide clarity that the LFDD requirement is based on time of forecast GB Transmission System peak demand.

ii Amendment to CC.A.5.1 on relay operating time to remove the 100 ms minimum.

iii Addition in CC.A.5.3 of a requirement for the total operating time for demand disconnection.

iv Table CC.A.5.5.1A to be modified to qualify the percentage demand associated with each stage

v Table 12a is to be incorporated within the DRC as Schedule 12a

vi DNOs should issue guidance to staff relating to the impact of low voltage interconnected configuration, DAR, and auto close schemes on the successful operation of LVDD relays, along the lines as stated in Section 6.6, before week 24 of 2010.

vii To increase the situational awareness of engineers, a highly visible frequency meter should be present in the DNO control. If an obscured meter is fitted it should be relocated to a prominent position

13.2 Appendix 3 shows the proposed Grid Code changes to implement the above recommendations.

APPENDIX 1

Survey of LFDD demand as a percentage of DNO demand in 2008

			Percentage Demand Allocation for 2008				
			03/01/08 1730	**13/03/08 1430**	**08/05/08 0630**	**05/08/08 0530**	**23/10/08 2030**
	GB demand GW		57.6	47.2	36.3	26.9	41.1
	Frequency	% required	% actual	% actual	% actual	% actual	% actual
DNO 1	48.50	10	12.9	12.27	11.86	12.28	12.52
	48.40	10	13.32	13.08	13.12	13.64	13.83
	48.20	10	12.72	12.21	12.55	12.25	13.85
	48.00	10	13.31	13.82	13.35	13.46	14.6
total		40	52.25	51.38	50.88	51.63	54.8
DNO 2	48.80	5	6.19	5.94	6.24	5.95	6.38
	48.75	5	4.66	3.8	3.68	3.23	4.82
	48.70	10	10.91	9.89	10.01	8.79	11.05
	48.60	7.5	12.01	12.68	14.32	13.31	12.38
	48.50	7.5	7.56	6.66	6.53	5.77	7.68
	48.40	7.5	9.53	8.71	9.23	7.81	8.57
	48.20	7.5	6.84	7.52	9.02	15.61	8.85
	48.00	5	4.87	4.75	4.59	4.25	5.18
	47.80	5	6.81	6.21	5.67	4.82	6.44
total		60	69.38	66.16	69.29	69.54	71.35
DNO 3	48.80	5	5.24	5.31	4.91	4.61	5.09
	48.75	5	5.56	5.27	4.83	4.8	5.39
	48.70	10	10.25	9.94	9.4	9.3	9.78
	48.60	7.5	7.01	6.74	6.65	6.4	6.73
	48.50	7.5	7.44	7.5	7.49	6.99	7.38
	48.40	7.5	7.54	7.25	6.51	6.45	7.32
	48.20	7.5	8.01	7.49	6.88	6.5	7.66
	48.00	5	5.16	4.61	4.93	5.49	5.31
	47.80	5	5.34	5.16	4.97	4.69	4.9
total		60	61.55	59.27	56.57	55.23	59.56
DNO 4	48.80	5	6.28	5.24	4.57	3.98	4.63
	48.75	5	5.79	5.26	5.71	5.75	5.77
	48.70	10	5.13	5.38	5.85	5.75	5.44
	48.60	7.5	5.56	4.85	4.27	4.28	5.29
	48.50	7.5	5.77	5.82	5.08	5.09	5.85
	48.40	7.5	6.04	5.29	4.67	4.28	6.35
	48.20	7.5	4.92	4.28	3.73	3.69	4.53
	48.00	5	4.37	4.25	3.8	3.65	4.43
	47.80	5	6.83	6.18	5.48	5.38	7.19
total		60	50.69	46.55	43.16	41.85	49.48

Percentage Demand Allocation for 2008

			03/01/08 1730	13/03/08 1430	08/05/08 0630	05/08/08 0530	23/10/08 2030
	GB demand GW		57.6	47.2	36.3	26.9	41.1
	Frequency	% required	% actual	% actual	% actual	% actual	% actual
DNO 5	48.80	5	4.84	5.04	5.95	5.37	5.53
	48.75	5	4.85	5.14	4.08	4.53	5.03
	48.70	10	8.55	8.41	8.75	9.3	8.94
	48.60	7.5	8.35	7.75	5.21	6.95	8.94
	48.50	7.5	7.77	7.69	6.61	8.28	7.52
	48.40	7.5	8.12	7.73	8.67	8.2	8.08
	48.20	7.5	5.88	4.77	4.39	4.77	4.58
	48.00	5	7.54	7.94	9.33	8.2	7.11
	47.80	5	2.41	2.28	1.24	2.38	2.68
total		60	58.31	56.75	54.23	57.98	58.41
DNO 6	48.80	5	4.82	4.94	5.41	5.59	4.59
	48.75	5	5.55	5.12	5.12	4.82	5.64
	48.70	10	8.86	8.86	8.67	8.54	10
	48.60	7.5	5.29	5.79	6.69	5.27	5.67
	48.50	7.5	11.04	11.39	10.83	10.73	10.59
	48.40	7.5	4.97	4.75	4.54	4.69	4.68
	48.20	7.5	11.18	10.76	10.59	9.57	9.9
	48.00	5	2.32	2.38	2.33	3.15	2.21
	47.80	5	4.91	4.78	6.17	5.33	5.34
total		60	58.94	58.77	60.35	57.69	58.62
DNO 7	48.80	5	5.46	4.64	6.03	5.33	6.66
	48.75	5	4.96	5.3	4.94	5.98	4.82
	48.70	10	10.23	8.88	11.07	10.77	12.36
	48.60	7.5	8.52	8.38	7.3	9.21	7.51
	48.50	7.5	6.79	6.47	6.48	7.89	8.43
	48.40	7.5	8.04	9.31	7.8	8.06	6.19
	48.20	7.5	7.49	7.5	7.76	7.64	11.06
	48.00	5	5.78	5.98	5.93	5.33	6.39
	47.80	5	3.7	3.56	4.14	3.57	3.65
total		60	60.97	60.02	61.45	63.78	67.07
DNO 8	48.80	5	5.08	4.31	4.56	4.28	6.64
	48.75	5	3.98	4.33	4.54	4.25	4.89
	48.70	10	10.35	10.22	8.38	9.43	13.08
	48.60	7.5	8.5	8.28	7.16	8.46	7
	48.50	7.5	7.16	6.81	6.97	7.41	8.63
	48.40	7.5	8.69	7.19	6.99	7.01	7.53
	48.20	7.5	8.62	9.69	9.69	9.13	9.96
	48.00	5	4.26	4.5	4.57	4.21	3.1
	47.80	5	5.78	4.84	5.06	4.72	6.35
total		60	62.42	60.17	57.92	58.9	67.18

Percentage Demand Allocation for 2008

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	48.75	5	5.3	6.18	5.73	5.91	5.42
	48.70	10	12.29	12.32	11.23	11.32	11.08
	48.60	7.5	6.37	5.78	5.64	5.56	6.15
	48.50	7.5	7.98	6.53	7.32	7.25	7.48
	48.40	7.5	6.77	6.36	7.37	6.41	5.79
	48.20	7.5	7.62	6.63	8.22	8.8	8.45
	48.00	5	5.03	5.14	4.58	4.01	4.86
	47.80	5	6.75	7.38	6.08	7	6.35
total		60	65.09	63.35	63.21	62.97	62.37
DNO 10	48.80	5	8.53	7.41	8.55	8.5	8.6
	48.75	5	4.26	5.14	4.39	6.68	5.18
	48.70	10	10.15	11.37	10.23	9.32	10.98
	48.60	7.5	6.54	6.55	6.73	3.8	6.53
	48.50	7.5	5.78	5	3.73	5.45	6.32
	48.40	7.5	6.21	6.59	6.43	5.94	6.47
	48.20	7.5	9.07	8.23	8.26	8.66	8.98
	48.00	5	5.71	6.05	5.77	5.53	6.84
	47.80	5	4.37	5.5	4.39	4.7	5.13
total		60	60.62	61.84	58.48	58.58	65.03
DNO 11	48.80	5	4.24	3.86	3.34	3.2	3.46
	48.75	5	4.58	4.83	4.71	4.18	5.17
	48.70	10	8.77	9.03	8.82	6.67	10.68
	48.60	7.5	7.61	8.24	7.96	7.11	5.45
	48.50	7.5	8.29	7.95	6.42	5.96	7.95
	48.40	7.5	7.52	7.44	6.42	6.13	7.67
	48.20	7.5	6.46	5.85	4.37	4.98	6.25
	48.00	5	4.96	5.74	5.48	6.04	5.51
	47.80	5	3.86	4.15	3.68	3.47	4.03
total		60	56.29	57.09	51.2	47.74	56.17
DNO 12	48.80	5	4.08	3.99	3.98	4.29	4.04
	48.75	5	6.73	7.22	6.88	6.26	6.57
	48.70	10	14.35	14.84	14.06	13.37	12.91
	48.60	7.5	7.45	7.26	6.75	7.07	7.74
	48.50	7.5	9.63	9.84	10.47	9.93	10.15
	48.40	7.5	8.88	9.26	9.06	8.14	8.58
	48.20	7.5	6.83	6.84	6.89	7.22	6.69
	48.00	5	4.6	4.36	3.91	3.72	4.33
	47.80	5	0.56	0.53	0.42	0.53	0.58
total		60	63.11	64.14	62.42	60.53	61.59

Percentage Demand Allocation for 2008

			03/01/08 1730	13/03/08 1430	08/05/08 0630	05/08/08 0530	23/10/08 2030
	GB demand GW		57.6	47.2	36.3	26.9	41.1
	Frequency	% required	% actual	% actual	% actual	% actual	% actual
DNO 13	48.80	5	4.15	4.23	3.98	3.95	4.19
	48.75	5	3.33	3.32	3.38	3.33	3.19
	48.70	10	9.42	9.49	8.47	8.36	8.94
	48.60	7.5	6.34	6.14	6.28	6.13	6.26
	48.50	7.5	6.72	6.16	6.88	6.66	6.71
	48.40	7.5	6.98	6.77	6.59	6.44	6.64
	48.20	7.5	6.18	6.18	6.09	6.25	6.84
	48.00	5	4.5	4.64	4.26	5.23	4.67
	47.80	5	3.63	4.34	4.13	4.13	4.21
total		60	51.25	51.27	50.06	50.48	51.65
National average	48.80	5	5.77	5.37	5.66	5.35	5.84
	48.75	5	4.95	5.04	4.77	5.01	5.21
	48.70	10	9.55	9.43	9.24	8.92	10.34
	48.60	7.5	7.58	7.50	7.19	7.04	7.17
	48.50	7.5	7.56	7.18	6.75	7.08	7.78
	48.40	7.5	7.34	7.06	6.86	6.50	6.87
	48.20	7.5	7.61	7.27	7.29	7.94	8.02
	48.00	5	5.00	5.13	5.13	4.99	5.09
	47.80	5	5.08	5.00	4.69	4.61	5.21
total		60	59.89	58.78	57.36	57.11	60.71

APPENDIX 2

Relay Maintenance

Each maintenance schedule would entail at least the following:

- visual inspection of components
- injection of variable frequency to establish pick up and drop off frequencies
- record the operating time of the relay

Maintenance Schedules

CE Electric UK - operational check and inspection every 3 years
YEDL, NEDL - every 6 years: as above, plus additional checks

EDF Energy
SPN, LPN, EPN - every 12 years

ENW - every 12 years

CN West, East - every year

SPT: SPM, SPD - every 12 years

S&S – SE, SHETL- every 4 years

WPD: South Wales - every 2 years
South West - as above

NGET - every 6 years

APPENDIX 3

Proposed Changes in Grid Code

a) Amendment to OC6.6.1:

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.

b) Amendment to CC.A.5.1.1

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 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.

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 Data Category: 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	9 47.8Hz	Residual demand MW
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**