GC0050 Demand Control and OC6 Workgroup Report

What stage is this document at?

01	Workgroup Report
02	Industry Consultation
03	Report to the Authority

This proposal seeks to modify the Grid Code to meet the existing capabilities and requirements of the Distribution Network Operators to implement Demand Control instructions.

This document contains the findings of the Workgroup which formed on 5 December 2012 and concluded on 21 November 2013.

Published on: **08 January 2014**

The Workgroup recommends:
That the technical requirements are taken forward for Industry Consultation as they better facilitate National Grid's development and operation of the Transmission System

High Impact:
Network Operators

Medium Impact:
None identified

Low Impact:
None identified

Contents

About this document

This Workgroup Report outlines the discussions and recommendations of the Demand Control and OC6 Workgroup.

Document Control

Version	Date	Author	Change Reference
0.1	08 January 2014	National Grid	Draft Workgroup Report

Any Questions?

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1 Executive Summary

1.1 The Grid Code paper (pp11/02) on "Demand Control and OC6" (Annex 1) was submitted to the Grid Code Review Panel (GCRP) in February 2011.

1.2 This paper described the existing Distribution Network Operators (DNOs) capability, and put forward the benefits for customers of using Voltage Reduction as a means of providing demand reduction. This paper proposed a revision of the Grid Code obligations relating to Demand Control OC6.

1.3 The GCRP recommended that a Grid Code Workgroup be established to consider the issues further and relevant Terms of Reference (ToR) (Annex 2) were agreed in September 2012.

1.4 The Demand Control Workgroup (DCWG) met on five occasions between December 2012 to November 2013 and debated the issues raised in the ToR.

1.5 The current wording in OC6 allows the DNO to decide how Demand Control is delivered. As a result of this Workgroup it has been identified that nearly all of the DNOs would choose to deliver the first two stages via Voltage Reductions, whilst the third and fourth stages would be delivered through Demand Disconnection.

1.6 Grid Code OC6.5.3 states that the demand control should be implemented as soon as possible but in the event no longer than five minutes from the instruction being given by National Grid. Historically, the assumption has been that a 3% Voltage Reduction would result in a 5% reduction in demand, a 6% Voltage Reduction would result in a 10% reduction in demand.

1.7 It was accepted at the meetings that these timescales and levels of demand reduction currently achievable needed to be investigated, differentiating between Demand Control delivered by Voltage Reduction and Demand Disconnection so that these services can be requested by National Grid.

1.8 To test what actual demand reduction could be expected to be available via Voltage Reduction, National Grid together with the DNOs set up a series of exercises to explore this, as well as the time taken to realise the demand reduction. These tests also tested the inter-control room communications and functionality of DNO control systems.

1.9 These tests showed that a 3% Voltage Reduction was unlikely to deliver the previously expected 5% reduction in demand and that the average demand reduction across all DNOs[1] after 10 minutes was 1.5%.

1.10 The timescales for delivery of Demand Control through Voltage Reduction have been confirmed as initiation within 5 minutes with substantial delivery within 10 minutes, rather than the 5 minutes currently stated within the OC6.

1.11 The scope of the DCWG was limited to a review of Grid Code OC6 Demand Control instructions and implementation. The DCWG was tasked with assessing the existing capabilities of the industry to implement Demand Control instructions and evaluate whether current requirements are still fit for purpose.

1.12 The DCWG determined and assessed:

[1] All DNOs participated in the tests apart SSE in Scotland where the different network topology means Voltage Reduction facilities are not generally available.

- The need for, and requirements of, Demand Control Instructions;
- Existing capabilities of the DNOs to implement Demand Control Instructions;
- Relevant international practice and the approach taken in European Code Development; and
- The costs, benefits and risks of any actions necessary to ensure that DNOs can implement the required Demand Control instructions in the required timescales under future system requirements.

1.13 The Recommendations of the DCWG are;

1.14 The DCWG recommend that the changes to the Grid Code identified in Annex 3 should be progressed to Industry Consultation. The objective of these changes is to improve clarity with regard to explicitly distinguishing between Voltage Reduction and Demand Disconnection services, and the implementation timescales.

1.15 The DCWG recommend that annual Voltage Reduction tests should be carried out with each DNO to confirm the demand reduction achievable via Voltage Reduction. These will be coordinated by National Grid.

1.16 The DCWG recommend that DNO and ENCC procedures and documentation are reviewed, and required changes implemented, to clarify that where a DNO makes Voltage Reduction services available to National Grid, the Demand Control instruction clearly states whether it requires a DNO to implement Voltage Reduction or Demand Disconnection.

1.17 The DCWG recommend that the Week 24 Guidance Document published by National Grid to provide guidance to DNOs is updated to reflect the changes in 6.1. In particular this will require a minor revision to section 4.2 and the proforma Table 12B provided by National Grid, as set out in Annex 4

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2 Purpose & Scope of Workgroup

2.1 At the September 2011 GCRP, Alan Creighton presented pp11/02 which provided additional clarity on the effectiveness of the Voltage Reduction schemes deployed by most DNOs, identified the customer benefits of using Voltage Reduction as a means of delivering Demand Disconnection and suggested a possible change to the drafting of OC6.5. The GCRP agreed that a Workgroup should be established to examine implementation timescales for Demand Control instructions.

2.2 The GCRP agreed that this issue required further investigation and subsequently approved the Terms of Reference.

Terms of Reference

2.3 A copy of the Terms of Reference can be found in (Annex 2) and was presented at the September 2012 GCRP (pp12/44).

Timescales

2.4 It was originally agreed that this Workgroup would report back to the May 2013 GCRP, but by agreement at the May 2013 GCRP this was amended to July 2013. Following these discussions of the Workgroup, that date was

Timeline

Workgroup Meeting Dates

M1 - 05 December 2012
M2 - 01 February 2013
M3 - 03 April 2013
M4 - 30 May 2013
M5 - 21 November 2013

revised to January 2014 to allow enough time to carry out a series of Voltage Reduction testing with each of the DNOs.

Workgroup Members

2.5 The Workgroup was comprised of the following members;

Name	Company
Audrey Ramsay (Chair)	National Grid
Damien McCluskey	National Grid
Jason Bareham/Paul Roebuck	National Grid
Alan Creighton	Northern Powergrid
David Mobsby	Scottish & Southern Energy
Andy Dixon	Scottish Power
Nigel Buckland	Western Power Distribution
Bill D'Albertanson	UK Power Networks
Dan Randles	Electricity North West
Lisa Waters	Water Wye Associates
Graeme Dawson	Npower

3 Why Change?

3.1 The GCRP paper (pp11/02) summarised DNOs positions around Demand Control being implemented within five minutes and investigated the timing of each of the steps that need to be taken to implement Voltage Reduction.

3.2 The historic expectation has been that a 3% Voltage Reduction would deliver a demand reduction of 5%; however studies have since indicated that the demand reduction arising from a 3% Voltage Reduction was variable, and more likely to be in the region of 3%. The current drafting of the Grid Code requires a 5% reduction in demand at the time of the instruction be delivered. DNO's have suggested that they are unlikely to actually deliver a 3% Voltage Reduction within a five minute period, and all DNOs agreed that Demand Control via Voltage Reduction is more likely to be delivered in a period between 5 and 13 minutes.

Background

3.3 The Grid Code obligations relating to Demand Control are documented in OC6.5. OC6.5.3 specifies the functional requirements of the scheme;

3.4 OC6.5.3
(a) Whether a National Electricity Transmission System Warning – High **Risk of Demand Reduction** or **National Electricity Transmission System Warning** - **Demand Control Imminent** has been issued or not:-

(i) provided the instruction relates to not more than 20 per cent of its total **Demand** (measured at the time the **Demand** reduction is required); and

(ii) if less than that, is in four integral multiples of between four and six per cent, each **Network Operator** will abide by the instructions of **NGET** with regard to **Demand** reduction under OC6.5 without delay.

(b) The **Demand** reduction must be achieved within the **Network Operator's System** as far as possible uniformly across all **Grid Supply Points** (unless otherwise specified in the **National Electricity Transmission System Warning - High Risk of Demand Reduction)** either by **Customer** voltage reduction or by **Demand Disconnection**, as soon as possible but in any event no longer than five minutes from the instruction being given by **NGET**.

3.5 The GCRP paper pp11/02 highlighted that most DNOs plan to achieve the Grid Code requirements by a combination of Voltage Reduction and Demand Disconnection. In relation to Voltage Reduction, there are two factors associated with the requirement i.e. demand reduction achieved (which in practice is likely to be less than previously expected) and the implementation time (which in practice is likely to be longer than as currently defined in the Grid Code).

4 Workgroup Discussions

4.1 The Workgroup met five times over the period between 05 December 2012 and 21 November 2013 where the following topics were discussed.

Grid Code Requirements in relation to OC6 and Demand Control

4.2 The Workgroup focused on Section OC6.5 of the Grid Code that allows National Grid to instruct DNOs to reduce demand by up to 20% in four stages, or under certain circumstances up to 40% in 8 stages. Each stage is nominally 5% to be delivered within 5 minutes of instruction. This facility is only used under extreme conditions when all available sources of generation have been exhausted and the only option available to balance the system is to reduce demand.

4.3 Discussions commenced around Demand Control and whether this can be achieved either through Voltage Reduction or the disconnection of customer demand. It has historically been assumed that the first two stages can be achieved through Voltage Reductions with a 3% Voltage Reduction providing a 5% demand reduction, and a 6% Voltage Reduction providing a 10% demand reduction. Further demand reductions would require direct disconnection of customer demand.

4.4 Further discussions focused on the requirements within Grid Code OC6.5.3 which states that Demand Control should be implemented as soon as possible but in the event no longer than five minutes from the instruction being given by National Grid. The five minute requirement was based on being able to stabilise and secure the National Electricity Transmission System in emergency situations.

4.5 Uncertainty was expressed over where the timescale originated, and it was assumed that this timescale was originally worded as ‘promptly’, meaning the time taken to take the call and respond. It is suspected that five minutes comes from the same root as five minute reserve, in that it’s the point where National Grid can reasonably expect to implement manual action following on from primary response (10 seconds) and secondary response (30 seconds to 30 minutes) to ensure that the system frequency is restored back within operational limits (in this case when there is no further reserve that can be called upon).

4.6 The Workgroup reached a view that currently not enough was known about the effectiveness of Voltage Reduction to provide certainty over what it can deliver.

Voltage Reduction

4.7 The DCWG discussed that Voltage Reduction is implemented at DNO primary substations rather than via assets that had previously been owned/operated by CEBG and that in practice the implementation time with modern SCADA systems is probably faster than in the past.

4.8 Alan Creighton summarised the paper that had been presented to the GCRP (pp11/02) to the DCWG explaining DNOs positions around Demand Control being implemented with five minutes, and investigations on the timing of each of the steps that need to be taken to implement Voltage Reduction. The following points were discussed:

- The historic expectation was that a 3% Voltage Reduction would deliver a demand reduction of 5%; however studies had indicated that

the demand reduction for a 3% Voltage Reduction was variable, and more likely to be in the region of 3%.

- The Grid Code is drafted to require 5% reduction in the demand on the system at the time at which the instruction is given and this also introduced a degree of uncertainty around what would actually be delivered.

- The information collated by the DNO's suggested that one DNO might be able to deliver a 3% Voltage Reduction within five minutes, however it was agreed that in general demand reduction is more likely to be delivered in a period between 5 and 15 minutes. The paper illustrated that all DNOs cannot achieve this 5 minute timescale and it was suggested by the DNOs that implementation of a Voltage Reduction instruction within five minutes has never actually been achievable. This piece of work carried out by DNOs provided a view on what can actually be delivered.

4.9 DCWG debated that the key advantage of Voltage Reduction as a means of Demand Control was that it generally has no observable impact on domestic, industrial or commercial customers and in particular does not result in disconnection of customer supplies. It was generally accepted that because of this Demand Control via Voltage Reduction, is a valuable tool that can be used in a system event to reduce the prospects of implementing Demand Control via Demand Disconnection. The key to its value is to understand the demand reduction that it is likely to deliver, the timescales in which that reduction can be delivered and how it should be used in conjunction with other demand management tools available to National Grid.

4.10 DCWG also debated feedback following internal discussions within National Grid concerning Voltage Reduction / Demand Disconnection requirements. The Electricity National Control Centre (ENCC) at National Grid view remains that the 5 minute timescale from instruction by National Grid is still a requirement based on being able to stabilise and secure the National Electricity Transmission System in emergency situations. This is due to the initial time required to analyse incidents and instigate manual actions which would take 5 minutes, leading to a total time of 10 minutes. Timescales greater than 10 minutes from an initial incident were considered to place the system at increased risk.

4.11 Much of the discussion and suggestions at this point had been based on assumptions, as little or no testing has taken place in this area. The Demand Control response has never been formally tested (as black start is) it has only been used when required, which is on relatively rare occasions. It was highlighted that a benchmarking exercise with all DNOs could be beneficially.

Emergency STOR

4.12 In light of the above debate, emergency STOR was discussed. National Grid's current tender volumes equate to around 6GW of which 2.8GW is presently contracted. Within the implementation timescale suggested current availability in the market totals less than 50MW/hr far below the emergency requirement. Worst case scenario to be comparable with OC6 this only equates to 20% of overall demand needed to cover all demand in an emergency situation.

4.13 It was agreed by the DCWG that STOR has potential to be part of the solution and the idea of emergency STOR is worth pursing within other generation forums where National Grid participate, but not the whole answer for the demand control requirements of the Workgroup.

Review of Current Processes

4.14 DCWG discussed an option of explicitly separating the Voltage Reduction and Demand Disconnection elements of the present OC6 obligation such that these services could be called upon separately by National Grid depending on the rate at which a system incident develops; Voltage Reduction could be used in a slower developing incident (as this would take longer to implement and deliver a less certain demand reduction). Demand Disconnection however, could be used in a rapidly developing incident (as it would be implemented quicker and deliver a more certain demand reduction – although customer supplies would be interrupted). On the basis that the two Voltage Reduction stages were (at the time of the discussion) thought likely to deliver say 3% Demand Reduction each, to maintain the existing OC6 functionality of 20% Demand Reduction, this would require three 5% Demand Disconnection stages. In summary:

- VR Stage 1 - 3% Voltage Reduction[2]
- VR Stage 2 - 3% Voltage Reduction
- DD Stage 1 – 4-6% demand reduction via Demand Disconnection
- DD Stage 2 – 4-6% demand reduction via Demand Disconnection
- DD Stage 3 – 4-6% demand reduction via Demand Disconnection

4.15 Following discussion, it was agreed that Voltage Reduction stages should be substantially implemented within ten minutes of instruction from National Grid. Demand Disconnection stages should be completed within five minutes of instruction from National Grid.

Training Procedures

4.16 DCWG discussed the merits of an educational process with a familiarisation of Demand Control implementation procedures to identify where any improvements could be made prior to any national testing. DNOs and National Grid reviewed the existing processes and made some minor procedural updates before the formal exercise took place.

4.17 DNOs and National Grid reviewed current procedures for managing a system event (rather than specifically implementing a demand reduction instruction which is discussed earlier), and the existing information that might be available such that DNOs could be made more aware of an unfolding incident so that they were better prepared to respond to a Demand Control instruction if it was issued. DNOs asked whether National Grid could share the document that is used to DNOs which is used in this situation, suggesting that this document should be very high-level and include process diagrams to clearly define procedures and management approvals. National Grids internal process was presented at the Working Group meeting 2

[2] As a result of the voltage reduction tests, 3% is more likely to be 1.5%

European Codes

4.18 DCWG discussed potential changes required to comply with European Code changes. Currently there are no code requirements covering Demand Reduction criteria with reference in Article 7 Frequency Control Management of the Network Code for Operational Security that “Each TSO shall implement the necessary Remedial Actions, including Demand Side Management or Load Shedding in order to maintain the frequency quality within Operational Security Limits in its Responsibility Area.”

Voltage Reduction Testing

4.19 DCWG discussed that a trial would enable the actual demand reduction delivered by a 3% Voltage Reduction to be established. The tests were carried out during different load windows, morning (10:00am-12:00pm) and afternoon (14:00pm-16:00pm) during periods of relative flat demand. Results from these tests can be found in Annex 5.

5 Impact & Assessment

Impact on the Grid Code

5.1 The Workgroup recommends amendments to the following parts of the Grid Code:

- OC6

5.2 The text required to give effect to the proposal is contained in Annex 3 of this document.

Impact on National Electricity Transmission System (NETS)

5.3 The proposed changes will enhance the economic and efficient operation of the National Electricity Transmission System. The changes will clarify achievable timescales and levels of demand reduction enabling the ENCC to better manage demand control procedures.

Impact on Grid Code Users

5.4 The proposed changes to the Grid Code are for clarification and will not change the DNOs current operational practices hence the impact is negligible on Grid Code Users.

Impact on Greenhouse Gas Emissions

5.5 The Workgroup recommendation will not have any impact on Greenhouse Gas emissions.

Assessment against Grid Code Objectives

5.6 The Workgroup considers that the proposed amendments would better facilitate the Grid Code objective:

(i) to permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity;

This proposal better facilitates this objective by providing the information required to better manage the transmission system for the purposes of operating the transmission system in an emergency situation.

(ii) to facilitate competition in the generation and supply of electricity (and without limiting the foregoing, to facilitate the national electricity transmission system being made available to persons authorised to supply or generate electricity on terms which neither prevent nor restrict competition in the supply or generation of electricity);

The proposal has a neutral impact on this objective

(iii) subject to sub-paragraphs (i) and (ii), to promote the security and efficiency of the electricity generation, transmission and distribution systems in the national electricity transmission system operator area taken as a whole; and

The proposal better facilitates this objective by providing the information required to manage the transmission system.

(iv) to efficiently discharge the obligations imposed upon the licensee by this license and to comply with the Electricity Regulation and any relevant legally binding decisions of the European Commission and/or the Agency.

The proposal has a neutral impact on this objective

Impact on core industry documents

5.7 The proposed modification does not impact on any core industry documents

Impact on other industry documents

5.8 The proposed modification does not impact on any other industry documents

Implementation

5.9 The Workgroup proposes that, should the proposals be taken forward, the proposed changes be implemented by Week 24 2014.

This will allow time for the DNO to establish and implement additional Demand Disconnection stage if required and include the revised information in the 2014 Week 24 submission.

6 Workgroup Recommendations

6.1 The DCWG recommend that the changes to the Grid Code identified in Annex 3 should be progressed to Industry Consultation. The objective of these changes is to improve clarity with regard to explicitly distinguishing between Voltage Reduction and Demand Disconnection services, and the implementation timescales.

6.2 The DCWG recommend that annual Voltage Reduction tests should be carried out with each DNO to confirm the demand reduction achievable via Voltage Reduction. These will be coordinated by National Grid.

6.3 The DCWG recommend that DNO and ENCC procedures and documentation are reviewed, and required changes implemented, to clarify that where a DNO makes Voltage Reduction services available to National Grid, the Demand Control instruction clearly states whether it requires a DNO to implement Voltage Reduction of Demand Disconnection.

6.4 The DCWG recommend that the Week 24 Guidance Document published by National Grid to provide guidance to DNOs is updated to reflect the changes in 6.1. In particular this will require a minor revision to section 4.2 and the proforma Table 12B provided by National Grid, as set out in Annex 4

GCRP pp11/02
February 2011

Demand Control OC6

Industry Technical Code Group

Background

1. The Grid Code obligations relating to Demand Control are documented in OC6.5. OC6.5.3 specifies the functional requirements of the scheme:

   OC6.5.3
   (a) Whether a National Electricity Transmission System Warning – High **Risk of Demand Reduction** or **National Electricity Transmission System Warning - Demand Control Imminent** has been issued or not:-

   (i) provided the instruction relates to not more than 20 per cent of its total **Demand** (measured at the time the **Demand** reduction is required); and

   (ii) if less than that, is in four integral multiples of between four and six per cent, each **Network Operator** will abide by the instructions of **NGET** with regard to **Demand** reduction under OC6.5 without delay.

   (b) The **Demand** reduction must be achieved within the **Network Operator's System** as far as possible uniformly across all **Grid Supply Points** (unless otherwise specified in the **National Electricity Transmission System Warning - High Risk of Demand Reduction)** either by **Customer** voltage reduction or by **Demand Disconnection**, as soon as possible but in any event no longer than five minutes from the instruction being given by **NGET**.

2. Key points to draw out from these requirements are:
   - The demand reduction is a percentage of the demand at the time of the instruction
   - The requirement is to reduce demand; voltage control is a method of achieving demand reduction as is demand disconnection
   - There is some flexibility (4-6%) in the size of each block
   - The demand reduction should be uniformly applied
   - The demand reduction needs to be implemented within 5 minutes
   - There is a need to consider time for the Control Engineer to receive and interpret and respond to the instruction from NGET and initiate the SCADA switching sequence.

3. Most DNOs plan to achieve the Grid Code requirements by a combination of voltage reduction and demand disconnection. There are two key factors associated with this requirement i.e. the demand reduction achieved and the implementation time.

Voltage Reduction – Demand Reduction

4. The historic expectation was that a 3% voltage reduction would achieve a demand reduction of approximately 5% and that a further 3% voltage reduction would deliver a total demand reduction of 10%. Due to this expectation the standard industry approach is typically for voltage reduction to form the first two stages of demand control, thus providing a reduction in the demand on the transmission system whilst continuing to maintain supplies to all customers. This functionality is generally hardwired in to the voltage control schemes installed in approximately 3000 DNO primary substations (e.g. 66/11, 33/11 and 33/6kV substation).

5. Following the Black Start Exercise Phoenix, questions were raised about the effectiveness of voltage reduction given that distribution networks now supply an increasing population of non linear loads i.e. where the demand does not reduce

with the supplied voltage. Two Network Operators conducted limited tests on their live network during the summer and autumn of 2008 to attempt to establish the effectiveness of voltage reduction.

6. Tests were undertaken on three types of primary site; predominately domestic customers, commercial customers and finally large industrial customers.

7. The tests confirmed that voltage reduction will have an impact on the demand but as expected the results differ across the different types of customers. For a 3% voltage reduction instruction the resultant demand reduction ranged from 2.57% to 5.09%. In most cases the demand reduction was sustained for the period of the test, but a slight recovery in demand was observed at times.

Voltage reduction %	Demand reduction %
3.47	2.57
2.63	4.46
4.3	4.34
3.03	3.29
2.02	5
4.35	32.9[1]
2.68	2.67
3.57	3.73
2.64	5.09

8. The results show that the demand reduction associated with a 3% voltage reduction is variable and could be as low as 2.6%; it might be more reasonable to assume from an operational management perspective that a 3% voltage reduction is more likely to result in a 3% demand reduction rather than the 5% that has been historically assumed.

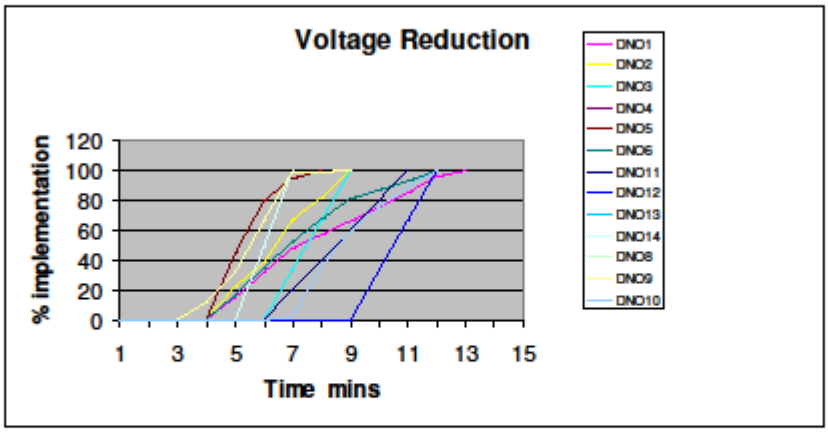
Voltage Reduction – Implementation time

9. As part of the investigation of the 27 May 2008 incident DNOs were asked to provide information to Ofgem relating to the implementation time of the demand reduction scheme. This information provided indicated that the voltage reduction might take longer that the 5 minutes which is specified in Grid Code OC6.5. As a result of this finding DNOs carried out a further assessment of the time taken to implement a voltage reduction stage.

10. This assessment took into account the time taken for the voltage reduction instruction to propagate through their SCADA systems, the time taken for the voltage control scheme to respond and the time taken for the tap changer to progress through a tap change cycle.

11. The following graph summarises the responses from DNOs. The graph illustrates that a single voltage reduction could take up to 13 minutes to implement[2].

[1] Abnormal demand resulted in the high demand reduction
[2] These times include an additional two minute period for receiving an instruction from NGET and initiating the voltage reduction process. It is not clear if all the DNO responses already include for this activity, and it may be that some DNO voltage reduction schemes could be completed two minutes earlier than indicated in this graph.



12. The implementation time is influenced by several factors including:

- The time taken for the Control Engineers to respond to the NGET instruction.
  The time for SCADA systems to convey the instruction from the Control Rooms to the substations. These timescales are largely influence by the architecture of the SCADA and associated communications infrastructure.
  The time for the tap change relay and tap changer to respond to the instruction. This timescale is governed by the basic design of the voltage control scheme in each of substations.

Voltage Reduction – summary

13. The results of investigations carried out by DNOs provide a degree of transparency of the performance of the voltage reduction schemes which have been in place for many years. This additional transparency has identified that there is likely to be a technical non compliance with the Grid Code OC6.5 in terms of the demand reduction delivered by voltage reduction the timescale of delivery.

14. The systems that deliver voltage reduction form an intrinsic part of DNO SCADA and individual substation based systems.

Options

15. There are a range of options for addressing the potential technical compliance with Grid Code OC6.5 which are considered briefly below:

16. Option 1
Reflect the likely performance of the voltage reduction schemes currently employed in terms of the demand reduction likely to be achieved and the implementation time in an amended version of the Grid Code.

17. Option 2
Improve the performance of the voltage reduction schemes currently employed by DNOs by increasing the speed of operation. This could require extensive changes to SCADA systems and changes to substation voltage control schemes. Assuming that there was a need to update the voltage control scheme in 3000 substations this could cost £90m (based at a cost of £30k per substation). Updating the voltage control scheme might deliver an increased implementation time of between 1 – 2 minutes. Changing the substation voltage control scheme would not improve the propagation time through SCADA. More detailed studies would be required to establish if it would be possible to reduce the SCADA propagation times and, if feasible, the associated costs.

Enhancing SCADA and substation equipment would not address the magnitude of the demand reduction achieved.

18. Option 3
There is provision in OC6.5 for DNOs to deliver the prescribed Demand Control using demand disconnection rather than voltage reduction. It would be possible to comply with OC6.5 as currently drafted by using demand disconnection only. Where there is a requirement is for a relatively modest demand reduction on the transmission system, the present voltage reduction scheme can deliver material benefits without disconnecting or having a significant impact on customers.

Recommendation

19. The Grid Code Review Panel is invited to:

- Note the additional transparency on the effectiveness of the voltage reduction schemes used by most DNOs to deliver Demand Control as required by OC6.5.
- Recognise that there are customer benefits from delivering some degree of demand control via voltage reduction rather than relying solely on demand disconnection.
- Consider the acceptability of changing OC6.5 as proposed in Appendix 1 recognising the Demand Control facilities that are generally provided by DNOs.

Appendix 1

Potential changes to the Grid Code to implement Option 1

The Grid Code obligations relating to Demand Control are documented in OC6.5. OC6.5.3 specifies the functional requirements of the scheme:

OC6.5.3
(a) Whether a National Electricity Transmission System Warning – High **Risk of Demand Reduction** or **National Electricity Transmission System Warning - Demand Control Imminent** has been issued or not:-

(i) provided the instruction relates to not more than 20 per cent of its total **Demand** (measured at the time the **Demand** reduction is required); and

(ii) if less than that, is in four integral multiples of demand disconnection each of which is between four and six per cent, each **Network Operator** will abide by the instructions of **NGET** with regard to **Demand** reduction under OC6.5 without delay. or

(iii) if less than that, is in two voltage reduction stages each of which being 3%, followed by two integral multiples of demand disconnection each of which is between four and six per cent, each **Network Operator** will abide by the instructions of **NGET** with regard to **Demand** reduction under OC6.5 without delay.

(b) The **Demand** reduction must be achieved within the **Network Operator's System** as far as possible uniformly across all **Grid Supply Points** (unless otherwise specified in the **National Electricity Transmission System Warning - High Risk of Demand Reduction)** either by **Customer** voltage reduction or by **Demand Disconnection**; as soon as possible but in any event no longer than five minutes from the instruction being given by **NGET**.

(i) **Demand Control** initiated by voltage reduction shall be initiated as soon as possible but in any event no longer than 2 minutes from the instruction being received from **NGET,** and completed within 15 minutes of the instruction being received from **NGET**.

(ii) Demand Control initiated by **Demand Disconnection** shall be implemented as soon as possible but in any event no longer than five minutes from the instruction being given by **NGET**.

Annex 2 - Terms of Reference

pp12/44
September 2012 GCRP

Implementation of Demand Control Instructions
TERMS OF REFERENCE

Governance

1. The Implementation of Demand Control Instructions Workgroup was established by Grid Code Review Panel (GCRP) at the September 2012 GCRP meeting.

2. The Workgroup shall formally report to the GCRP.

Membership

3. The Workgroup shall comprise a suitable and appropriate cross-section of experience and expertise from across the industry, which shall include:

Name	Role	Representing
Audrey Ramsay	Chair	National Grid
Damien McCluskey	Technical Secretary	National Grid
Jason Bareham	National Grid Representative	National Grid
Paul Roebuck	National Grid Representative	National Grid
Bill D'Albertanson	DNO Representative	UK Power Networks
Alan Creighton	DNO Representative	Northern Powergrid
David Mobsby	DNO Representative	Scottish & Southern Energy
Andy Dixon	DNO Representative	Scottish Power
Nigel Buckland	DNO Representative	Western Power Distribution
Dan Randels	DNO Representative	Electricity North West
Lisa Waters	Generator Representative	Waters Wye Associates
Graeme Dawson	DNO Representative	npower
Julian Wayne	Observer - Distribution List	Ofgem

Meeting Administration

4. The frequency of Workgroup meetings shall be defined as necessary by the Workgroup chair to meet the scope and objectives of the work being undertaken at that time.

5. National Grid will provide technical secretary resource to the Workgroup and handle administrative arrangements such as venue, agenda and minutes.

6. The Workgroup will have a dedicated section on the National Grid website to enable information such as minutes, papers and presentations to be available to a wider audience.

Scope

7. The Workgroup will:

   - Review the need for, and requirements of, Demand Control Instructions.
   - Review the existing capabilities of the DNOs to implement Demand Control Instructions.
   - Take account of relevant international practice and the approach taken in European Code development.
   - Evaluate the costs, benefits and risks of any actions necessary to ensure that DNOs can implement the required Demand Control Instructions in the required timescales under future system conditions.

Deliverables

8. The Workgroup will provide updates and a Workgroup Report to the Grid Code Review Panel and Distribution Code Review Panel which will:

   - Detail the findings of the Workgroup;
   - Draft, prioritise and recommend changes to the Grid Code, Distribution Code and associated documents in order to implement the findings of the Workgroup; and
   - Highlight any consequential changes which are or may be required

Timescales

9. It is anticipated that this Group will discuss the issue and determine appropriate timescales. Once these timescales have been determined, the workgroup will confirm with the GCRP that they are suitable.

10. If for any reason the Workgroup is in existence for more than one year, there is a responsibility for the Workgroup to produce a yearly update report, including but not limited to; current progress, reasons for any delays, next steps and likely conclusion dates.

Annex 3 - Proposed Legal Text

This section contains the proposed legal text to give effect to changes identified by the Workgroup. The proposed new text is in red and is based on Grid Code Issue 5 Revision 1.

OC6.5 PROCEDURE FOR THE IMPLEMENTATION OF DEMAND CONTROL ON THE INSTRUCTIONS OF NGET

OC6.5.1 A **National Electricity Transmission System Warning - High Risk of Demand Reduction** will, where possible, be issued by **NGET**, as more particularly set out in OC6.5.4, OC7.4.8 and BC1.5.4 when **NGET** anticipates that it will or may instruct a **Network Operator** to implement **Demand** reduction. It will, as provided in OC6.5.10 and OC7.4.8.2, also be issued to **Non-Embedded Customers**.

OC6.5.2 Where **NGET** expects to instruct **Demand** reduction within the following 30 minutes, **NGET** will where possible, issue a **National Electricity Transmission System Warning – Demand Control Imminent** in accordance with OC7.4.8.2(c) and OC7.4.8.6.

OC6.5.3 (a) Whether a **National Electricity Transmission System Warning - High Risk of Demand Reduction** or **National Electricity Transmission System Warning - Demand Control Imminent** has been issued or not:

(i) provided the instruction relates to not more than 20 per cent of its total **Demand** (measured at the time the **Demand** reduction is required); and

(ii) if less than that, is in

- two voltage reduction stages each of between two and four percent and
- three **Demand Disconnection** stages each of which can reasonably be expected to deliver between four and six percent **Demand** reduction,

Each **Network Operator** will abide by the instructions of **NGET**, which should specify whether a voltage reduction or **Demand Disconnection** stage is required; OR

(iii) if less than that, is in four ~~integral multiples of~~ **Demand Disconnection** stages each of which can reasonably be expected to deliver between four and six per cent **Demand** reduction,

Each **Network Operator** will abide by the instructions of **NGET** with regard to **Demand** reduction under OC6.5 without delay.

(b) The **Demand** reduction must be achieved within the **Network Operator's System** as far as possible uniformly across all **Grid Supply Points** (unless otherwise specified in the **National Electricity Transmission System Warning - High Risk of Demand Reduction**) either by **Customer** voltage reduction or by **Demand Disconnection**; ~~as soon as possible but in any event no longer than five minutes from the instruction being given by NGET~~.

(c) **Demand Contro**l initiated by voltage reduction shall be initiated as soon as possible but in any event no longer than two minutes

from the instruction being received from **NGET**, and completed within 10 minutes of the instruction being received from **NGET.**

(d) **Demand** control initiated by **Demand Disconnection** shall be initiated as soon as possible but in any event no longer than two minutes from the instruction being received from **NGET**, and completed within five minutes of the instruction being received from **NGET.**

(e) Each **Network Operator** must notify **NGET** in writing by calendar week 24 each year, ~~of the integral multiples it will use with effect from the succeeding Financial Year onwards.~~ for the succeeding **Financial Year** onwards, whether **Demand Control** is to be implemented either:

i) by a combination of voltage reduction and **Demand Disconnection**; or

ii) **Demand Disconnection** alone;

together with the magnitude of the voltage reduction stages (where applicable) and for **Demand Disconnection** stages, the demand reduction anticipated.

Thereafter, any changes must be notified in writing to **NGET** at least 10 **Business Days** prior to the change coming into effect.

OC6.7 EMERGENCY MANUAL DISCONNECTION

OC6.7.1 Each **Network Operator** will make arrangements that will enable it, following an instruction from **NGET**, to disconnect **Customers** on its **User System** under emergency conditions irrespective of **Frequency** within 30 minutes. It must be possible to apply the **Demand Disconnections** to individual or specific groups of **Grid Supply Points**, as determined by **NGET**.

OC6.7.2 (a) Each **Network Operator** shall provide **NGET** in writing by week 24 in each calendar year, in respect of the next following year beginning week 24, on a **Grid Supply Point** basis, with the following information (which is set out in a tabular format in the Appendix):
(i) its total peak **Demand** (based on **Annual ACS Conditions**); and
(ii) the percentage value of the total peak **Demand** that can be disconnected ~~(and in the case of that in the first 5 minutes it must include that which can also be reduced by voltage reduction)~~ (and must include that which can also be reduced by voltage reduction, where applicable) within timescales of 5/10/15/20/25/30 minutes.
(b) The information should include, in relation to the first 5 minutes, as a minimum, the 20% of **Demand** that must be reduced on instruction under OC6.5.

OC6.7.3 Each **Network Operator** will abide by the instructions of **NGET** with regard to **Disconnection** under OC6.7 without delay, and the **Disconnection** must be achieved as soon as possible after the instruction being given by **NGET**, and in any case, within the timescale registered in OC6.7.
The instruction may relate to an individual **Grid Supply Point** and/or groups of **Grid Supply Points**.

OC6.7.4 **NGET** will notify a **Network Operator** who has been instructed under OC6.7, of what has happened on the **National Electricity Transmission System** to necessitate the instruction, in accordance with the provisions of **OC7** and, if relevant, **OC10**.

OC6.7.5 Once a **Disconnection** has been applied by a **Network Operator** at the instruction of **NGET**, that **Network Operator** will not reconnect until **NGET** instructs it to do so in accordance with **OC6**.

OC6.7.6 Each **Network Operator** will abide by the instructions of **NGET** with regard to reconnection under OC6.7 without delay, and shall not reconnect until it has received such instruction and reconnection must be achieved as soon as possible and the process of reconnection must begin within 2 minutes of the instruction being given by **NGET**.

OC6.7.7 **NGET** may itself disconnect manually and reconnect **Non-Embedded Customers** as part of a **Demand Control** requirement under emergency conditions.

OC6.7.8 If **NGET** determines that emergency manual **Disconnection** referred to in OC6.7 is inadequate, **NGET** may disconnect **Network Operators** and/or **Non-Embedded Customers** at **Grid Supply Points**, to preserve the security of the **National Electricity Transmission System**.

OC6.7.9 Pursuant to the provisions of OC1.5.6 the **Network Operator** will supply to **NGET** details of the amount of **Demand** reduction or restoration actually achieved.

Annex 4 - Proposed Changes to Week 24 Guidance Note

This section contains the proposed text to give effect to changes identified by the Workgroup. The proposed new text is in red and is based on Guidance Notes for Network Operators Submission of Grid Code Data 2013 - 2014.

4.2 Table 12b – High Risk of Demand Reductions

OC6.5 requires all Network Operators to immediately institute uniform demand reduction if a "GB Transmission System Warning - High Risk of Demand Reduction" is issued. This demand reduction shall be in five tranches between 2% and 6%, e.g. 3% VR, 3% VR, 5% DD, 5% DD and 4% DD.

The requirements of the Network Operator week 24 data submission are specified in **(OC6.5.3 (c))**

HIGH RISK OF DEMAND REDUCTIONS

Network Operator:

GRID CODE: OC 6.5.3(c)

2014/2015

Tranche	Percentage Demand Reduction	Voltage Reduction or Demand Disconnection (please delete as applicable)
1		VR/DD
2		VR/DD
3		VR/DD
4		VR/DD
5		VR/DD

Notes: 1. Demand Control here should be by voltage reduction and/or demand disconnection

2. Tranches should be by integral percentage multiples, and should sum to 20%.

Annex 5 - Operation Juniper Demand Control Exercise

OPERATION JUNIPER - DEMAND CONTROL EXERCISE

BRIEFING NOTES

Changes from last issue:	Final Issue 4 – Following tele-conference 30/09/13
	Draft Issue 3 – Minor changes, Notice to Market
	Draft Issue 2 – Minor changes, Appendices 'G' & 'H'

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PURPOSE AND SCOPE

The Demand Control Workgroup is reviewing the amount of Demand Reduction that would be achieved by Voltage Reduction. Historically, the assumption has been that a 3% Voltage Reduction would result in a 5% Reduction in Demand, a 6% Voltage Reduction a 10% Reduction in Demand.

It is proposed to test what actual reductions are likely through a series of exercises that will explore the reductions achievable, as well as the time taken to realise them. It will also test the inter-control room communications and functionality of DNO Control Systems.

PART 1 - PROCEDURAL

1.1 - INTRODUCTION

Limited operational experience suggests that the Demand Reduction figures assumed might be optimistic. The reduction in effectiveness is thought to be due to increasing electronic control of loads which tend to compensate for variations in the incoming supply voltage.

In order to minimise the effect on the power system, it is proposed to conduct a number of exercises involving a limited number of DNOs at a time.

To minimise the effect on consumers it is proposed to only trial a 3% reduction in voltage.

Demand Reduction must not achieved by the interruption of customer supplies.

Directly Connected Customers (to the National Grid Network) and Embedded Distribution Network Operators will not be involved in the Exercise.

The system will be operated within statutory limits at all times and the overall demand variations and durations will be slight. It is anticipated that messages will be sent to the Market via the BMRS advising them of the Exercise.

1.2 - ROLES AND RESPONSIBILITIES

National Grid Electricity National Control Centre (ENCC)

ENCC will be responsible for organising the Exercises and co-ordinating with the Distribution Network Operators (DNOs).

The Exercises will be timed at periods where Demand is expected to 'flat' for the duration of the tests, so far as it is possible to do, at this time of the year.

Demand Reduction will not be applied where there are active export constraints.

ENCC have access to Operational metering at each GSP that is updated every few seconds. This will be used to monitor the effects of the exercise.

Distribution Network Operators (DNOs)

The DNOs will ensure that their network and systems are configured appropriately and are ready for the Exercise.

The exercises will be dependent on system conditions on the day. There should not be any significant network issues.

If there are sites that need to be excluded from the Exercise for any reason, an indication of the load affected should be noted. This may include some Embedded Distribution Network Operators and those large Customers who have control of their own AVCs. Similarly, if particular sites / areas cannot be instructed on the day, for whatever reason, this should noted.

This trial is to investigate 'real world' reductions and getting a measure of these limitations is a valid part of the exercise.

While the driver for the Exercise is to understand the effect on the National Grid, each DNO is encouraged to log as much information as possible concerning the Reduction in Demand within their respective networks. These results will be compared to the readings seen on the National Grid. Any additional information, e.g predominant type of Demand (rural / urban / industrial etc.), effect on embedded generation etc. within each GSP would also be useful. A suggested template to record demands is included in Appendix 'G'. It is understood that each DNO will have differing restrictions on the amount of information available, time / effort required to provide it. Any / all information gratefully received.

There is not an entirely 'flat' Demand period at this time of year. To help judge the rate of Demand changes due to the Exercise, a log of the number / percentage of the sites where Demand Control has been completed, would be useful. This will also give a measure of where we stand with current control systems and methodologies. Appendices 'H' and 'I' have been included to help with this. Again, different control systems will have differing

abilities to provide this information, so a 'best guess' will do. It will help us judge delays from issuing instructions, to the effect being seen.

PART 2 - TEST SCENARIOS

2.1 - ASSUMPTIONS

All communications be they Fax / email / telephone will be prefixed by the words 'Operation Juniper' to ensure clarity.

The Exercises will be arranged so as to keep the expected reduction below the normal Demand loss catered for during the day (560MW).

The Exercises will be reliant on there being no system or weather issues that might be exacerbated by the Exercise.

The Exercises are dependent on Control telephony systems being fully available. It is accepted that communications to sites may not be 100% available on a day to day basis. As indicated above, this is a valid part of the trial.

Each System Operator remains responsible for the control and operation of their respective systems. Consequently, the exercises can be curtailed at any point, by any party, should system conditions change on an Operator's System.

Tests will be carried out once for each DNO area, with multiple DNOs instructed in each of the test periods.

The provisional test programme is shown below, in Appendix 'A'

2.2 - DAY -1

Confirmation of the Exercise will be sent out on the day before the Exercise. This is in lieu of the 'High Risk of Demand Notice' that might have been sent in the event of a foreseen generation shortage. (See Appendix 'B')

This confirmation will be sent by Fax to the normal Control Fax machine and followed up by a telephone call to ensure receipt / understanding.

The Fax will be sent out around lunchtime. This will be after confirmation from our Day-Ahead Planners that there are no issues resulting from the submission of the generators Initial PN data for the following day.

2.3 - DAY 0

Before, during and after the tests, National Grid will be monitoring the change in demand across the DNO's area. Metering is updated every few seconds for each SGT at each BSP and will allow for detailed post exercise analysis.

T – 30min (Approx.)

Confirmation that the tests are proceeding will be given by FAX and follow up telephone call approximately 30 minutes before the Exercise commences. This will be

analogous to a 'High Risk of Demand Reduction Imminent' warning and will give time for participants to prepare for the test / check systems. (See Appendix 'C')

ENCC Transmission Desks to liaise with the Operational Energy Manager so that changes in demand can be anticipated.

T-10

For Northern Power Grid an additional warning will be given at T-10 to enable them to force a 'rescan' of their SCADA system to allow better monitoring.

T0

ENCC will call the DNO Control Room and issue a 'Demand Control Instruction' for 'Reduce Demand Stage One'. Reference will be made to 'Operation Juniper' and that the instruction is to be implemented by 3% Voltage reduction only. **No Customer supplies are to be interrupted.**

T0 to T+10min

The DNO will implement the 'Demand Control Instruction' by using those mechanisms currently used in these situations. New strategies should not be trialled at this time.

T+10min to T+50min

Voltage reduction will be maintained to allow effectiveness to be monitored over a period of time.

Transmission Desk to liaise with the Operational Energy Manager so that changes in demand can be anticipated when the instruction is cancelled.

T+50min

ENCC will call the DNO Control Room and cancel the Demand Control Instruction and confirm that Voltage Reduction measures should be reversed, so restoring Demand levels.

T+50min to T+60min

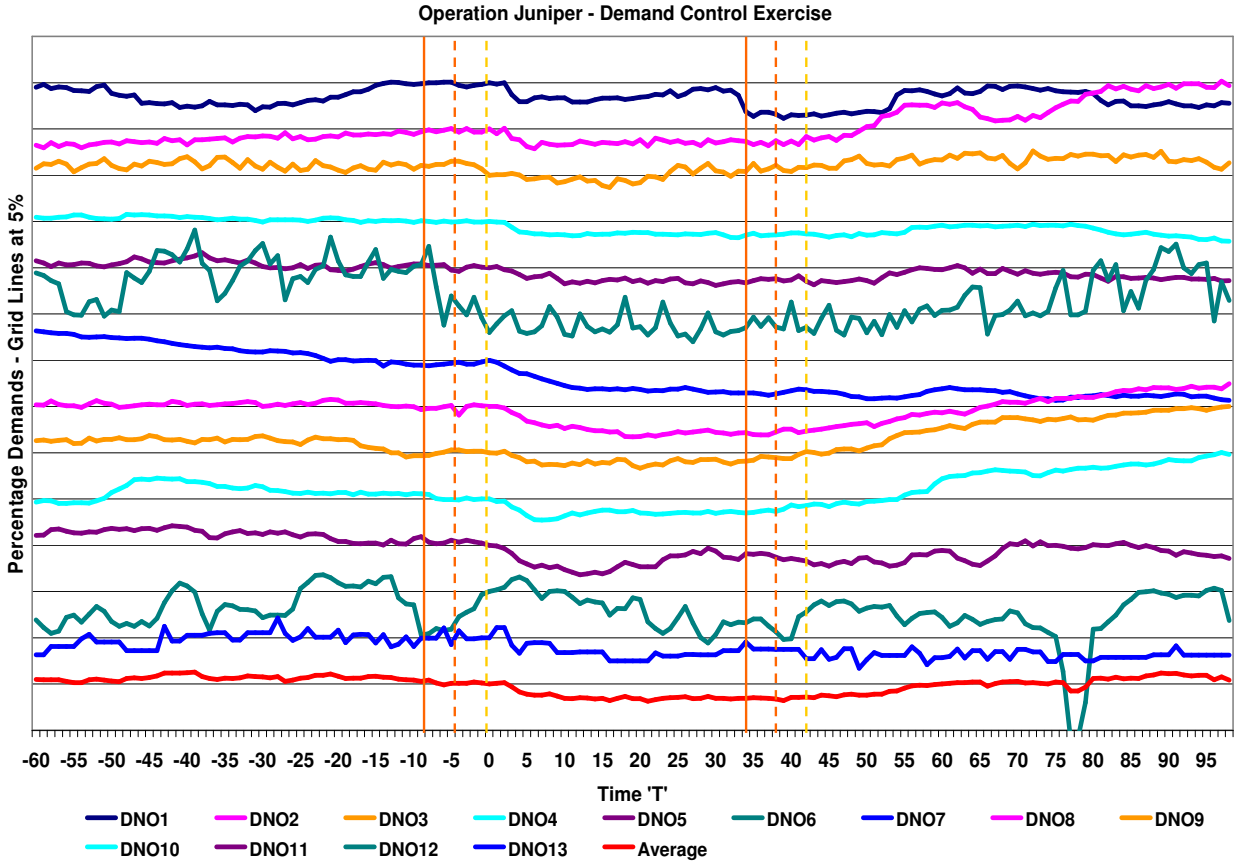
The DNO will restore voltage controls to normal

2.4 END OF EXERCISE

All issues arising during the exercise will be 'Control to Control'. Following the Exercise, all feedback, results, observations etc. should be fed back via the usual Workgroup channel. (i.e. via Damien McCluskey).

Initial feedback should follow as soon as possible after the Exercise, in case there are learning points for following Exercises. It is understood it may take some time for the full data to be made available. Initial 'out-turn' demand profiles will be disseminated as soon as possible following each test.

Annex 6 – Results from Operation Juniper Demand Control Exercise



The chart above illustrates the demand reduction achieved by the thirteen DNOs who participated in the Voltage reduction tests.
The magnitude of the reductions is detailed in the table below.

	T=0	T=5	T=10	T=50	T=55	T=60
DNO1	0.0%	2.0%	1.6%	0.0%	2.3%	1.7%
DNO2	0.0%	1.9%	1.7%	0.0%	2.3%	2.5%
DNO3	0.0%	0.4%	0.7%	0.0%	0.6%	0.4%
DNO4	0.0%	1.2%	1.4%	0.0%	0.3%	1.1%
DNO5	0.0%	1.2%	1.7%	0.0%	0.9%	1.2%
DNO6	0.0%	0.1%	0.2%	0.0%	2.3%	2.4%
DNO7	0.0%	1.4%	2.7%	0.0%	0.2%	1.1%
DNO8	0.0%	1.6%	2.4%	0.0%	0.6%	1.0%
DNO9	0.0%	1.0%	1.4%	0.0%	1.6%	2.1%
DNO10	0.0%	1.8%	1.8%	0.0%	0.7%	2.4%
DNO11	0.0%	2.0%	2.6%	0.0%	-0.6%	0.8%
DNO12	0.0%	-1.2%	0.0%	0.0%	-1.9%	-1.0%
DNO13	0.0%	0.6%	1.6%	0.0%	0.5%	0.2%
Average	**0.0%**	**1.1%**	**1.5%**	**0.0%**	**0.8%**	**1.2%**