# Customer Load Active System Services SQSS and Code Review

29 June 2015

Customer Load Active System Services

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VERSION HISTORY

| Version | Date | Author | Status | Comments |
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| 1.0 | 12th Jan 2015 | K Jackson | Draft | |
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# EXECUTIVE SUMMARY

**Executive Summary**

This report satisfies the CLASS Successful Delivery Reward Criteria (SDRC) to

*"Publish on CLASS website NETS SQSS Change Proposal Report by June 2015."*

The report presents a review of the National Electricity System Security and Quality of Supply Standard, SQSS, undertaken to assess whether there is a need to propose changes as a result of the findings from the CLASS project. It also explores other relevant Standards and Codes, which may be influenced by the outcomes and knowledge gained from CLASS and identifies where CLASS learning can be employed in their application. This includes the Grid Code, in particular section OC6, and Engineering Recommendation P2/6 "Security of Supply".

This review has been informed by a partners' workshop held with National Grid and the University of Manchester in January 2015, and by an industry workshop held in April 2015.

The conclusions of this review are:-

- No changes to the SQSS are required as a result of CLASS learning.
- The improved understanding of the relationship between demand and voltage, arising from the CLASS trials, will better inform the assessments that National Grid use when checking that voltage step changes are within the limits quoted in the SQSS. In particular, the CLASS outputs will inform National Grid's in-house guidance documents on modelling load response.
- CLASS has applied a comprehensive process, with hundreds of tests across multiple time periods and demand groups, and the trial results have revealed robust conclusions about the relationship between demand and voltage. This new understanding of the relationship between demand and voltage, determined from the analysis of the CLASS trial data, will be valuable in improving the quality of modelling and forecasting.
- Electricity Safety, Quality and Continuity Regulations, ESQCR, will not need to change to enable the application of CLASS findings.
- CLASS findings may be valuable as part of a more fundamental system review in the longer term, for example considering definition of peak demand or acceptable operational voltage ranges. A thought for the future is that relaxation of the voltage limits in ESQCR Regulation 27 would enable a more widespread application of the CLASS voltage reduction technique to provide demand response.
- The CLASS review identified Operating Code OC6 relating to demand control as the part of the Grid Code most relevant to the CLASS techniques and project findings. OC6 was revised in 2014 to provide clarification in response to new learning arising from the system testing carried out under the auspices of the GC0050 Demand Control and OC6 Workgroup. The recent changes to OC6 are supported by the findings from the CLASS trials; CLASS findings will provide National Grid with improved understanding of the demand reduction that will be achieved by voltage changes instructed under OC6 in the event of emergency system operating conditions.
- With regard to ER P2/6 it is concluded that there could be some uncertainty with regards to applying predicted CLASS benefits in security of supply assessments because P2/6 does not explicitly allow for reductions in demand as a response to operational actions. However, it is expected that the current ENA review of ER P2/6 should capture the need for consideration of a range of operational actions. It is recommended that the need for the future Security of Supply standard to accommodate CLASS techniques to ensure that

their total benefit is realised, is communicated to the consortium undertaking the ER P2/6 review during their consultation process.

- The improved understanding of the relationship between demand and voltage arising from the CLASS trials will be valuable in improving the accuracy of investment planning modelling and operational planning modelling, and in determining the effectiveness of applying voltage reduction instructions during power system operational emergencies. An accurate understanding of the demand voltage relationship is also important when modelling networks that are constrained by voltage stability.

- The CLASS trials have also examined in detail the capability for reactive power absorption by tap-stagger in the distribution network. These findings, which are potentially valuable for transmission system voltage control, are reported separately and are not discussed here as they have no bearing on industry Codes and Standards.

# 1 PURPOSE OF DOCUMENT / BACKGROUND / OBJECTIVES

## 1.1 Purpose of document

This report satisfies the CLASS SDRC to

*“Publish on CLASS website NETS SQSS Change Proposal Report by June 2015.”*

This arose from the CLASS bid document which stated: “The CLASS Project will recommend changes to the National Electricity System Security and Quality of Supply Standard in the area of demand response”.

As CLASS Partners, PB Power (Parsons Brinckerhoff Ltd) and Chiltern Power Ltd have supported Electricity North West with the suite of activities for achieving this SDRC.

At an initial meeting of the parties involved, it was agreed that there should be a review to identify the sections of the System Security and Quality of Supply Standard, SQSS, that CLASS has the potential to influence. It was further agreed that the review should go beyond the SQSS, and should also explore other relevant Standards and Codes, which may potentially be influenced by the outcomes and knowledge gained from CLASS. This included the Grid Code, in particular section OC6, and Engineering Recommendation P2/6 “Security of Supply”.

This review report identifies and outlines the sections/areas/themes in the SQSS and the other standards that are potentially influenced by CLASS.

The review of standards and codes was carried out in two stages. Stage 1 eliminated those codes and standards where the demand versus voltage relationship does not feature or CLASS is not expected to have an influence. The reviewed documents are summarised in section 2 of this report where those identified in stage 1 as requiring no further consideration are also highlighted. Stage 2 of the work reviewed the remaining standards and codes in greater detail. These are covered in this report from section 3 onwards, specifically;

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|---|---|
| Section 3 | The Security and Quality of Supply Standard (SQSS) |
| Section 4 | Electricity Safety, Quality and Continuity Regulations, ESQCR |
| Section 5 | The Grid Code including OC6 |
| Section 6 | The Distribution Code, including DOC6 and ER P2/6 |

This review has been informed by a partners’ workshop held with National Grid and the University of Manchester in January 2015, and by an industry workshop held in April 2015.

## 1.2 Background

The CLASS project has investigated the demand response to decreases and increases in network voltage. National Grid's Planning Standard, NETS SQSS was originally drafted using data collected by the nationalised industry in the early 1980’s. It was anticipated that the data collected in the CLASS Trials would allow relevant sections of the planning standard and associated guidance documentation to be re-validated and brought up to date.

## 1.3 CLASS Trial Outcomes

The CLASS project included four Trials.

**Trial 1** investigated the voltage / demand relationship for normal increments and decrements of system voltage at Primary substations across an annual period. The outcome from this Trial is a new voltage / demand relationship matrix, developed by The University of

Manchester. This relationship enables system demand responses to be estimated. The knowledge gained is primarily useful to network operators (DNOs, IDNOs and TOs) and the transmission system operator, NETSO. Network operators can apply the knowledge for informing investment decisions and for changing the operation of their networks, and NETSO can apply the knowledge for enhancing the forecast of the provision of the Grid Code, OC6 emergency demand reduction obligations.

**Trial 2** investigated the viability of the proposed CLASS technique for demand response to achieve peak reduction at Primary substations. The test regime investigated the use of a demand response, initiated by a voltage reduction, to manage the peak demand at a Primary substation. The outcome of this Trial is the confirmation that a demand response provided at the peak demand of a Primary substation (normally in winter) can defer network reinforcement.

**Trial 3** investigated the application of demand response for frequency response providing support to the NETSO through two approaches. The first test regime investigated the use of a low frequency relay to switch out one transformer of a standard Primary substation and quantify the demand response. The second test regime investigated the use of demand response as a means of providing fast frequency response to the NETSO through the lowering of Primary substation taps.

**Trial 4** investigated the viability of the tap staggering technique for the provision of reactive power services (ie regulation for high voltages) to NETSO and DNOs. The test regime initiated the offsetting of the tap positions across a pair of Primary transformers and monitored the change in power factor (ie the reactive power absorbed) at each Primary substation. The outcome of this Trial is the confirmation that a reactive power absorption service can be provided and to quantify the impact on the distribution network in terms of losses and network loading, and the aggregate impact of this on the transmission network for voltage stabilisation.

During the Trials, power and voltage data was collected at the Primary substations, distribution substations and at LV substations using four-quadrant metering. The data collected from these devices has enabled identification of the impact of the voltage regulation techniques on power quality, energy losses, voltage levels and network capacity performance at different times of day and across seasons. The monitoring results indicated that the trials of the CLASS voltage regulation techniques did not compromise compliance with licence or statutory obligations.

The University of Manchester has been responsible for the analysis of the CLASS trial results and the development of the updated demand voltage relationships. Interim capability reports which present initial findings were issued by the University of Manchester in November 2014 and January 2015.

The CLASS trials also implemented a communication and control interface link between the control rooms of Electricity North West and National Grid and developed informative dashboard displays for operators.

# 2 THE STANDARDS AND CODES REVIEWED

There are a number of statutory documents governing the electricity industry, as follows:

i. The Electricity Act 1989
ii. The Electricity (Standards of Performance) Regulations 2010
iii. Electricity (Connections Standards of Performance) Regulations 2010
iv. Electricity Safety, Quality and Continuity Regulations, ESQCR

These statutory documents are the responsibility of the UK government. The regulator, Ofgem, is responsible for issuing generation, transmission, distribution and supply licences in Great Britain.

Distribution and transmission licensees are required to comply with the standard conditions included in the Electricity Distribution and Transmission Licences respectively.

There is an obligation for compliance with core industry documents that provide technical and commercial requirements, including, but not limited to:

**Transmission Licence Conditions**

- The Balancing and Settlement Code
- The Connection and Use of System Code
- The Grid Code*
- The System Operator Transmission Owner Code
- National Electricity Transmission System Security and Quality of Supply Standard*

**Distribution Licence Conditions**

- The Distribution Code*
- The Revenue Protection Code
- The Master Registration Agreement
- Connection RIG (standard condition 15A)
- The Distribution Connection and Use of System Agreement (standard condition 22)
- Engineering Recommendation P2/6 (standard condition 24)*
- Regulatory Instructions and Guidance (standard condition 46)

## 2.1 Documents not requiring further consideration

Commercial documents were found not to require further consideration and are not discussed in this report. Some technical documents were also judged to not need further consideration in respect to the influences of CLASS findings. These documents are explained in the following subsections.

### 2.1.1 The Electricity Act 1989[1]

The Electricity Act provides a framework for the function of the transmission, distribution and supply of Electricity within Great Britain. No technical aspects of

[1] Statutory Instrument, The Electricity Act, Chapter 29, 27th July 1989. http://www.legislation.gov.uk/ukpga/1989/29/contents

The Electricity Act 1989 are considered to limit the provision of demand response through a decrease or increase in network voltage, i.e. CLASS techniques.

### 2.1.2 The Electricity (standards of performance) Regulations 2010[2]

The statutory Electricity (Standards of Performance) Regulations 2010 defines the compensation for failure to restore supplies following a qualifying interruption, subject to certain exemptions. There are no changes required as a consequence of CLASS findings.

### 2.1.3 The Electricity (Connections standards of performance) Regulations 2010[3]

The statutory Electricity (Connections Standards of Performance) Regulations 2010 defines the standards to be met by electricity distributors when providing connection budget estimates and quotations, along with the levels of compensation when the standards are not met. There are no changes required as a consequence of CLASS findings.

[2] Statutory Instrument, The Electricity (Standards of Performance) Regulations 2010 No 698, 8th March 2010. http://www.legislation.gov.uk/uksi/2010/698/introduction/made
[3] Statutory Instrument, The Electricity (Standards of Performance) Regulations 2010 No 698, 8th March 2010. http://www.legislation.gov.uk/uksi/2010/698/introduction/made

# 3 THE SECURITY AND QUALITY OF SUPPLY STANDARD (SQSS)

## 3.1 Overview of the SQSS

The National Electricity Transmission System Security and Quality of Supply Standard, NETS SQSS[4] defines the design and operation of GB transmission systems. NETS SQSS is not applicable to distribution systems.

National Grid has its own internal guidance documentation on how to apply the high level requirements given in the SQSS. This guidance includes the voltage dependent load models used currently, based on system tests from the 1970s.

## 3.2 Areas of the SQSS relevant to CLASS

Section 3 of the SQSS defines the planning criteria for the connection of demand groups to the onshore transmission system. Section 3 is the transmission planning criteria so CLASS is not relevant to this particular section of the SQSS, other than having the potential to affect the forecast maximum demand for a GSP.

Table 5.1 of the SQSS relates to the loss of supply capacity following a secured fault on the transmission system. The system has to be resilient without operator intervention following a fault, however operational measures can be put in place pre-fault to facilitate speedy restoration of system security. Under these fault conditions 'there shall not be ….unacceptable voltage conditions in NGET's transmission system'. These are then defined further in section 6.

Section 6 of the SQSS defines voltage limits in planning and operating the onshore transmission system. These limits are relevant to CLASS in that the requirements for National Grid to maintain the transmission voltage within these limits determine the need for National Grid to purchase reactive power services.

Sections 6.4 and 6.5 of the SQSS define voltage step change limits, when assessing these the voltage dependency of the load should be taken into account.

One of the major requirements of the SQSS is the avoidance of cascade failure, so National Grid will have to be given assurance that the schemes used on the distribution system could not propagate and cause issues on the transmission system.

## 3.3 How CLASS may be able to influence those sections/assumptions

CLASS trials 2 and 4 are relevant to Section 6 of the SQSS, in determining what reactive power services DNOs may be able to offer to National Grid in the future.

Section 6.4 of the SQSS quotes 'The voltage step change limits must be applied with load response taken into account', therefore the voltage demand relationship arising from the CLASS trials will better inform the assessments which National Grid use when checking that voltage step changes are within the limits quoted in the SQSS.

National Grid currently use voltage dependent load models based on system tests from the 1980s. The CLASS trials will be very useful to National Grid as input into updating their load models to reflect the voltage response characteristics of present system loads.

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[4] National Electricity Transmission System Security and Quality of Supply Standard, Version 2.2, 5th March 2012.

Internationally there has been significant progress in understanding how to model load response, this is summarised well in CIGRE technical brochure 566, published in February 2014, on the ‘Modelling and Aggregation of Loads in Flexible Power Networks’. This was issued by CIGRE Working Group C4.605, for which Professor Jovica Milanovic from the University of Manchester was the convenor. The CLASS trials will provide some of the data required for developing aggregated load models.

At the partners’ meeting, National Grid agreed that the CLASS results are more likely to inform and influence their in-house support documentation, rather than requiring changes to SQSS itself. The CLASS outputs will inform their in-house guidance documents on modelling load response. They would also need to update some of their other internal documents if CLASS was to be rolled out more widely, for example, those used by their control room.

### 3.4 Conclusions

It is concluded that no specific changes are required to SQSS as a result of CLASS findings.

The findings of the CLASS trials will better inform the assessments which National Grid use when checking that voltage step changes are within the limits stated in the SQSS. In particular, the CLASS findings will inform National Grid’s in-house guidance documents on modelling load response.

# 4 ELECTRICITY SAFETY, QUALITY AND CONTINUITY REGULATIONS, ESQCR[5]

## 4.1 Overview

The ESQCR specify requirements for the installation and use of electrical networks and equipment owned or operated by generators, distributors and suppliers. Minimum standards for the installation of equipment, protection and earthing are defined along with requirements for associated records and reporting. Basic levels of quality of supply are defined in terms of supply failure limitations and electrical supply parameters with associated tolerances.

## 4.2 Areas relevant to CLASS

Regulation 27 defines statutory voltage and frequency limits, and is the underlying framework against which National Grid procures frequency and reactive power responses. These limits were enshrined in the Regulations to ensure a secure operating envelope for generation, networks, and consumer demands in Britain. They are the product of analysis of the power system configuration and equipment characteristics at the time they were drafted and it is possible that in the future they will be revised as the inherent characteristics of the system change (for example more use of power electronic controllers, greater deployment of distributed generation, and home energy management systems).

## 4.3 How CLASS may be able to influence those sections/assumptions

In view of the comments above, there is no need to change ESQCR as a consequence of CLASS but the CLASS findings may be valuable as part of a fundamental system review in the longer term. It was noted in the industry workshop that a relaxation of the statutory voltage limits would enable a more widespread use of CLASS techniques to provide demand response.

## 4.4 Conclusions

There is no need to change the Electricity Safety, Quality and Continuity Regulations in response to CLASS findings or to enable the application of CLASS techniques, but the CLASS findings may be valuable as part of a more fundamental system review in the longer term, for example considering definition of peak demand or acceptable operational voltage ranges.

Future relaxation of the voltage limits in Regulation 27 would enable a more widespread use of the CLASS voltage reduction technique to provide demand response.

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[5] Statutory Instrument, The Electricity (Standards of Performance) Regulations 2010 No 698, 8th March 2010. http://www.legislation.gov.uk/uksi/2010/698/introduction/made

# 5 THE GRID CODE

## 5.1 Overview

The Grid Code states the operating procedures and principles governing NG's relationship with all Users of the GB Transmission System and comprises:

- Planning Code
- Connection Conditions
- Operating Code
- Balancing Code, including statement of balancing principles
- Data registration code (data exchange code)
- General Conditions, including grid code review panel

## 5.2 Areas relevant to CLASS

The Grid Code obligations relating to Demand Control are documented in the Operating Code, Section OC6.4, Section OC6.5 and Section OC6.7.2. OC6 was amended and reissued on 1 July 2014[6], to incorporate a number of changes proposed by the GC0050 Demand Control and OC6 Workgroup[7], established by the Grid Code Review Panel. These changes went through an industry consultation process and were approved by Ofgem on 5 June 2014.

Section OC6.4 details the NGET notification process which DNOs must follow when planning to reduce customer voltage or disconnect demand, when the demand change on any grid supply point could be equal to or greater than 12 MW (the Demand Control Notification Level). This requires notification in writing.

Up until 1 July 2014, OC6 allowed National Grid to instruct DNOs to reduce demand by up to 20% in four stages, with each stage achieving between 4% and 6% demand reduction. This was normally only used under extreme conditions when all available sources of reserve generation had been exhausted and the only option available to balance the system was to reduce demand. Demand reduction could be achieved by either voltage reduction or the direct disconnection of loads and had to be, as far as possible, achieved uniformly across all Grid Supply Points within the DNO's system. The reduction had to be achieved in no longer than five minutes from the time of instruction by National Grid.

It had historically been a reasonable assumption that the first two stages of demand reduction could be achieved through voltage reductions, with a 3% voltage reduction providing a 5% demand reduction, and a 6% voltage reduction (maximum allowable under the NETS SQSS) providing a 10% demand reduction. It had also been assumed that the demand reduction could be achieved within five minutes of the instruction from National Grid.

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[6] http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Grid-code/The-Grid-code/

[7] http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Grid-code/Modifications/GC0050/

The Workgroup examined these assumptions and concluded, with the help of system tests (Operation Juniper), that in reality a 3% voltage reduction could only be expected to deliver on average a 1.5% demand reduction, and that voltage reduction would not be able to reduce demand within the five minute window required by National Grid. It should be noted that Operation Juniper was a relatively limited set of tests, carried out in autumn 2013 with thirteen DNOs during periods of relatively flat demand, and during two load windows (10am to 12pm and 2pm to 4pm). The results showed wide variability, with a range of demand reduction between 0% and 2.7% achieved through a voltage reduction of 3%.

The resultant modification to OC6, clause 6.5.3, on 1 July 2014 now provides two options to deliver the required demand reduction, namely:-

i. By a combination of voltage reduction in two stages, and demand reduction through direct disconnection of loads, in three stages (clause 6.5.3 (a) (ii))

or

ii. In four stages of direct disconnection of loads (clause 6.5.3 (a) (iii))

Each voltage reduction stage should be between 2 and 4 percent, each of which can be expected to deliver around 1.5% demand reduction (clause 6.5.3 (a) (ii)).

Each DNO is required to notify NGET in writing by calendar week 24, of the option it will adopt for the following year.

There is still a requirement for the reduction to be as far as possible uniform across all Grid Supply Points (clause 6.5.3 (b)).

OC6 now also specifies separately the required implementation time for demand reduction using voltage reduction and the required (faster) implementation time for demand reduction through the direct disconnection of loads.

From clause 6.5.3 (c) the exact requirement for demand control by voltage reduction is as follows:

*'**Demand Control** 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.'*

OC6.5.9 requires the DNO to notify National Grid in writing that it has complied with the demand control instruction, within five minutes of doing so.

### 5.3 How CLASS may be able to influence those sections/assumptions

It should be noted that the requirement under OC6.4 for DNOs to notify National Grid in writing when planning to reduce customer voltage or disconnect demand, when the demand change on any grid supply point could be equal to or greater than 12 MW (Demand Control Notification Level) could potentially restrict the use of CLASS techniques. This could be an issue to be addressed if CLASS techniques are applied to multiple supply points simultaneously. However, it is not expected to be a significant issue since it is anticipated that the probability of such a change in demand will be low in practice.

The results from Trials 1 and 2 also improve on the results from the system testing work (Operation Juniper) which was done under the auspices of the GC0050 Demand Control and OC6 Workgroup, and give a more comprehensive indication of what range of demand response could be expected for a voltage reduction of between 2 and 4%. The CLASS trial results for seasonal/diurnal variation and any variation with the mix of load types lead to more robust conclusions about the relationship between demand and voltage. This is valuable to investment planning modelling, operational planning modelling, and emergency management. It will improve the understanding of the validity of current expectations in regard to expected demand reduction achievable.

It should be noted that the recent changes in OC6 provide clarity on how the demand change can be achieved; direct disconnection of loads and voltage reduction are given as options to meet the OC6 requirements rather than the general inference and presumed behaviour associated with the previous version of OC6. This clarity gives DNOs more freedom and assurance to use voltage reduction through transformer tap operation to deliver the required response. For the transmission system operators the changes mean that the DNO actions are better defined and can be better assessed to give adequate demand management.

The recent work completed by the GC0050 Demand Control and OC6 Workgroup, and the resultant changes in OC6 are a significant development for CLASS. Indeed it is considered that the changes start to address some of the concerns contemplated when developing the scope of the CLASS project. The system testing carried out under the auspices of the GC0050 Demand Control and OC6 Workgroup was relatively limited, but has raised awareness of the changing nature of system demand. CLASS has applied a more comprehensive process, with hundreds of tests across multiple time periods and demand groups, and provides more robust conclusions about the relationship between voltage and demand, as well as better information on achievable implementation times.

Although CLASS findings could potentially lead to further modifications to OC6, clause 6.5.3, to improve the effectiveness of OC6, there are unlikely to be any changes necessary. This was discussed with National Grid and at the industry workshop. It was agreed that OC6 should not be changed, however, the CLASS results would give National Grid more certainty and confidence that the OC6 requirements could be achieved by voltage reduction. There was also discussion regarding how CLASS could and should be used. National Grid would like to have CLASS as a service that they can use to avoid the system conditions which could trigger OC6. The DNOs may, however, want to use CLASS techniques to help achieve the OC6 requirements or to resolve a local thermal overload issue. It was discussed at the review workshop that there is a potential conflict if when a CLASS voltage reduction is enacted, the load contracted to provide the load response service is not on the system because it is already participating in resolving a local thermal overload issue.

These issues point towards a need for future work around the commercial and market issues that could impede the full application of CLASS techniques to provide demand control.

The CLASS project has trialled enhanced use of an ICCP (Inter control centre protocol) link and it is proposed that it could be utilised to achieve timely demand control requirements under OC6. An additional function of the link would be to provide immediate visibility of the system response and possibly automate a message to National Grid. It is considered that the provision of information via the ICCP link satisfies the need for the confirmation in writing as specified in OC6.5.9 therefore there would be no explicit need for written confirmation, although this should be checked further with National Grid.

The requirement under OC6.5.9 for the DNO to notify National Grid in writing that it has complied with the demand control instruction, within five minutes of doing so should be reviewed to clarify the use of an ICCP link.

### 5.4 Conclusions

The system testing carried out under the auspices of the GC0050 Demand Control and OC6 Workgroup was relatively limited, but has raised awareness of the changing nature of system demand response. CLASS has applied a more comprehensive process, with hundreds of tests across multiple time periods and demand groups, and the resulting seasonal/ diurnal variation and any variation with the mix of load types, has led to more robust conclusions about the relationship between demand and voltage. This will give National Grid more certainty and confidence that the OC6 requirements could be achieved by voltage reduction. The results will also give the DNOs a better understanding of how to achieve the OC6 requirements for demand reduction using voltage reduction.

The conclusions from CLASS on the relationship between demand and voltage are valuable to investment planning modelling, operational planning modelling, and emergency management.

The requirement under OC6.5.9 for the DNO to notify National Grid in writing that it has complied with the demand control instruction, within five minutes of doing so may need reviewing, if in future an ICCP link is used to achieve the demand control requirements under OC6.

# 6 DISTRIBUTION CODE [8]

## 6.1 Overview

The Distribution Code covers all material technical aspects relating to connections to, and the operation and use of the **DNO's Distribution System:**

- Planning and Connection Code
- Operating Code
- Data registration code (data exchange code)
- Annex containing the Distribution Code requirements (via Electricity Supply Industry standards in respect of power quality, security of supply, embedded generation, plant and equipment ratings and earthing)
- Appendix stating categories of Users and applicability

All DNOs currently operate with the same version of the Code, and the Code is maintained by the Distribution Code Review Panel. All modifications to the Code have to be approved by Ofgem, including the consultation and change process that has been adopted in each case.

## 6.2 Areas relevant to CLASS

The Distribution Code includes DOC6 which defines control of demand in the distribution system and is the distribution equivalent of the Grid Code OC6.

Distribution Code section DPC 4.2.3.3 relates to voltage step changes within the 'Voltage Disturbances and Harmonic Distortion' section. Limits for acceptable voltage step changes are defined along with the descriptions for the types of circumstances that they are relevant

The Distribution Code includes a number of Engineering Recommendations, as Annex 1 Standards, defined as *"An electricity industry national standard that implements Distribution Code requirements and which is listed in Annex 1 of the Distribution Code, and forms part of the Distribution Code".* In particular, utilising CLASS techniques could affect application of Engineering Recommendation P2/6 "Security of Supply" (ER P2/6)[9].

As well as being a standard included in Annex 1 of The Distribution Code, ER P2/6, is a DNO licence condition (Standard Licence Condition 24).

Security of supply requirements are defined in terms of the time to restore supplies to all/most customers affected by any circuit outage; larger groups of load (Group Demand) must be resupplied in shorter times. Engineering Technical Reports ETR130[10] and ETR131[11] provide additional information that supports ER P2/6. A system's ability to satisfy the requirements of ER P2/6 is judged by comparing the Group Demand with the capability of the network. Group Demand

[8] The Distribution Code and the Guide to the Distribution Code of Licensed Distribution Network Operators of Great Britain Issue 25– 1 November 2014. http://www.dcode.org.uk/assets/files/dcode-pdfs/DCode%20v25.pdf

[9] Energy Networks Association, Engineering Recommendation P2/6 - Security of Supply, July 2006.
[10] Energy Networks Association, Application Guide for Assessing the Capacity of Networks Containing Distributed Generation, July 2006.
[11] Energy Networks Association, Analysis Package for Assessing Generation Security Capability – Users' Guide, July 2006.

is defined as the sum of the Measured and Latent demands, where Latent demand is the increase in demand that would be observed if all distributed generation (DG) in the group were not producing any output. The capability of the network is calculated as the sum of the capability of the network equipment following an outage of the most critical circuit, and includes allowances for the transfer capacity to adjacent circuits, for any appropriately contracted DG and Demand Side Response.

There is an on-going review of ER P2/6 commissioned by the Distribution Code Review Panel, through the Energy Network Association. The review is considering future options for ER P2/6 and has commenced consultations with the industry.

This report on the consideration of the impact of CLASS techniques is limited to the present version of ER P2/6 but will be informative for the review project.

### 6.3 How CLASS may be able to influence those sections/assumptions

The earlier comments about the CLASS knowledge improving investment planning and operational planning modelling for transmission should apply equally to distribution. Refinement of the modelling of distribution system performance can be expected to become more important in the future as asset utilisation increases and new demands such as EV charging add to network stress.

Distribution Code Section DOC6.4.3 states “The DNO will arrange to have available within the DNO’s Distribution System, four stages of Demand Control in integral multiples of between four and six per cent. These stages may include the use of Voltage Reduction and/or other forms of Demand Control determined by the DNO”. DOC6 has clearly not been changed in the same way that Grid Code OC6 has been to provide clarity on how the demand change can be achieved. Consequently, if DOC6 is subsequently changed to match the approach of OC6, then the learning from the CLASS findings will give a more comprehensive indication of what voltage reduction is necessary to provide the required demand reduction of between four and six percent.

Distribution Code section DPC4.2.3.3 with regard to voltage step changes clearly recognises the dependence of load characteristics in its statement “The magnitude of a voltage step change depends on the method of voltage control, types of load connected and the presence of local generation”. No guidance is given within the Distribution Code on how to assess voltage step change, but this is where the enhanced understanding of the relationship between voltage and demand arising from the CLASS trials will inform load models.

Application of CLASS techniques during periods of peak demand could reduce demand levels and hence influence ER P2/6 assessments and contribute to system security and potentially defer network investment. However, ER P2/6 and its associated guidance document do not explicitly mention making allowances for the effect of operational actions such as the CLASS techniques on Group Demand. Consequently, it could be questioned if ER P2/6 allows system planners to include the effects of operational actions with confidence in their assessments of ER P2/6 compliance.

Group Demand depends on Measured Demand, which could inherently reflect reductions in demand brought about by the historic applications of CLASS techniques. This approach is supported by present practice; Measured Demands used for determining Group Demand are not modified to reflect operational parameters such as voltage, i.e. there is no adjustment made to monitored power levels that may have been measured when the system voltages were above or below nominal.

However, measurements of the effect of the CLASS techniques would not be available when looking to their future application, for example as an operational technique to maintain ER P2/6 compliance subsequent to an increase in demand due to a new connection. In this case, ER P2/6's lack of clear guidance on the effects of operational actions could limit the realisation of the benefits of the CLASS techniques.

## 6.4 Conclusions

With regard to Distribution Code sections on Demand Control and Voltage Step changes, it is concluded that the CLASS project outputs will increase DNO understanding and consequently improve their ability to comply with the requirements and undertake more accurate assessments.

The DOC6 approach does not align with OC6 and therefore CLASS can provide clarity on how the DNO can achieve the required demand reduction of between four and six percent by voltage reduction.

With regard to ER P2/6 it is concluded that there could be some uncertainty with regards to applying predicted CLASS benefits in security of supply assessments. However, it is expected that the current ENA review of ER P2/6 will capture the need for consideration of a range of operational actions. It is recommended that the need for the future Security of Supply standard to accommodate CLASS techniques to ensure that their total benefit is realised, is communicated to the consortium undertaking the ER P2/6 review at during their consultation process.