electricity north west

Bringing energy to your door

CLASS Trial design and associated test schedule

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1 INTRODUCTION

1.1 What is CLASS?

In 2012 Electricity North West was granted £9 million from the Low Carbon Network Fund for the CLASS project.

CLASS (Customer Load Active System Services) will trial an innovative approach which aims to increase the capacity of the electricity network. It has the potential to provide a low-cost solution which uses voltage control to manage electricity consumption at peak times and provide the Transmission System Operator (TSO) with an alternative source for a number of ancillary services, while still providing customers with the same standard of service.

The ability to manage peak demand and offer alternative sources for ancillary services could provide a useful tool to help meet the increasing demand for electricity and brings a number of other advantages:

- Facilitates the connections of low carbon technologies onto the electricity network such as heat pumps, electric vehicles and wind and solar power generation
- Avoids or defers the cost and disruption of expanding our network of overhead lines, underground cables and substations
- Reduces costs for all electricity customers
- Can be rolled out on a national level

1.2 The CLASS Trials

The objective of the CLASS Trials is to demonstrate that the CLASS solution can be applied to reduce peak network demands and provide at GB level, a new mechanism for frequency management and voltage control to support the TSO. The Trials will also enable a developed understanding of the relationship between voltage and connected substation demand whilst confirming that any active voltage management techniques to deliver the CLASS solution will not affect customers.

Extensive tests are planned for the period of April 2014 to end of March 2015 to robustly evaluate the application of the CLASS principles and deliver results and learning that is transferrable to all UK DNOs.

The CLASS solution will be trialled on 60 Primary substations across the ENWL network capturing approximately 350 000 customers.

1.3 Trial Design and Test Schedule

The purpose of this document is to present the agreed design methodology and subsequent test schedule for each CLASS Trial. This will allow all relevant parties to understand what, where and when the CLASS techniques will be applied.

The point of reference for the CLASS Trial design methodology is the CLASS Full Submission document. However, where required this has been developed through consultation with our internal and external stakeholders in order to reach an agreed approach and resultant test schedule.

This document should be considered as a ‘living document’, as it will be updated with any lessons learnt from the earlier trials.

1.4 Overview of the CLASS Trials

An outline of the CLASS Trials is presented below.

Table 1 - List of CLASS Trials

Reference	Description	Objective	Technique	Trial Period	Customer Survey Requirement
T1	*Load modelling*	*Establish voltage-demand relationship*	*Raise and lower tap positions*	*Across entire annual cycle*	*No*
T2	*Peak demand reduction*	*Demand response for peak reduction*	*Lower tap position*	*Peak demand*	*Yes*
T3a	*Stage 1 frequency response*	*Response to reduce demand when system frequency falls*	*Switch out transformer*	*Anytime*	*Yes*
T3b	*Stage 2 frequency response*		*Lower tap position*	*Anytime*	*Yes*
T4	*Reactive power absorption*	*Reduce high volts on transmission network*	*Stagger tap position*	*Minimum demand*	*No*

2 TRIAL 1 – LOAD MODELLING

2.1 Why we need to carry out this Trial

At the centre of the CLASS project is the basic principle that the demand of certain loads can change with voltage. Therefore, employing active management of transformer tap changers can increase or decrease network demand during certain periods and bring benefits to both the distribution network and whole GB system. The actual demand response to dynamic voltage control is dependent upon the composition of the connected load. In order to confidently predict the response of the demand, accurate load models need to be developed for different load compositions. Typically, most network operators for the purposes of network planning and operation have assumed predefined static load models, most commonly being a combination of constant power and constant impedance. However to fully quantify the potential benefits of the CLASS solution the behaviour of loads has to be described through more rigorous load models.

In order to understand the actual load response to the actions of dynamic voltage control, real time data capture will be carried out to record such events. This data will then be used by the University of Manchester to develop suitable load models and estimate model parameters.

2.2 Trial Objective

The objective of this Trial is to develop a voltage-demand matrix that will mathematically quantify the relationship for every half hour across the annual cycle, for different types of connected load.

2.3 Site Selection

A methodology has been developed by the University of Manchester to aid with the selection of the Primary substations to be included within the CLASS Trials. The transferability and potential application of this approach to other distribution networks was considered in the development of the methodology. The methodology was developed to ensure the selection of representative samples covered different load classes and loading levels within each of the 15 major Grid Supply Point regions in the Electricity North West operating area. This will ensure that a broad spectrum of demand types and customers are to be included within the Trials, to provide and facilitate a robust investigation of the voltage-demand relationship.

Each Primary substation in the Trial has been categorised according to its customer composition, based on peak load sharing per Common Distribution Charging Methodology profile class[1]. Three generic load classes have subsequently been derived:

1. Largely Industrial and Commercial – primaries where the demand at time of peak demand is supplying industrial and commercial load types (ie Profile Classes 3 to 8)

2. Largely Domestic – primaries where the demand at time of peak demand is largely supplying domestic loads (ie Profile Classes 1 and 2)

3. Mixed – primaries where there is roughly equal share of domestic and non domestic loads at times of peak demand

Further to the categorisation above, factors such as geography, socio-economic activity and in the case of the large industrial and commercial customers the types of processes and

[1] Common Distribution Charging Methodology profile classes are set out in the Distribution Connection and Use of System Agreement (DCUSA) document

equipment connected have been considered when selecting the fifteen sites where measurements will be undertaken for the load modelling studies. Consideration of these factors may demonstrate potential variance in demand response across the three categories and provide a more granular approach to classifying the voltage-demand relationship for a particular load type.

Table 2 - List of Primaries for Load Modelling Trial by category

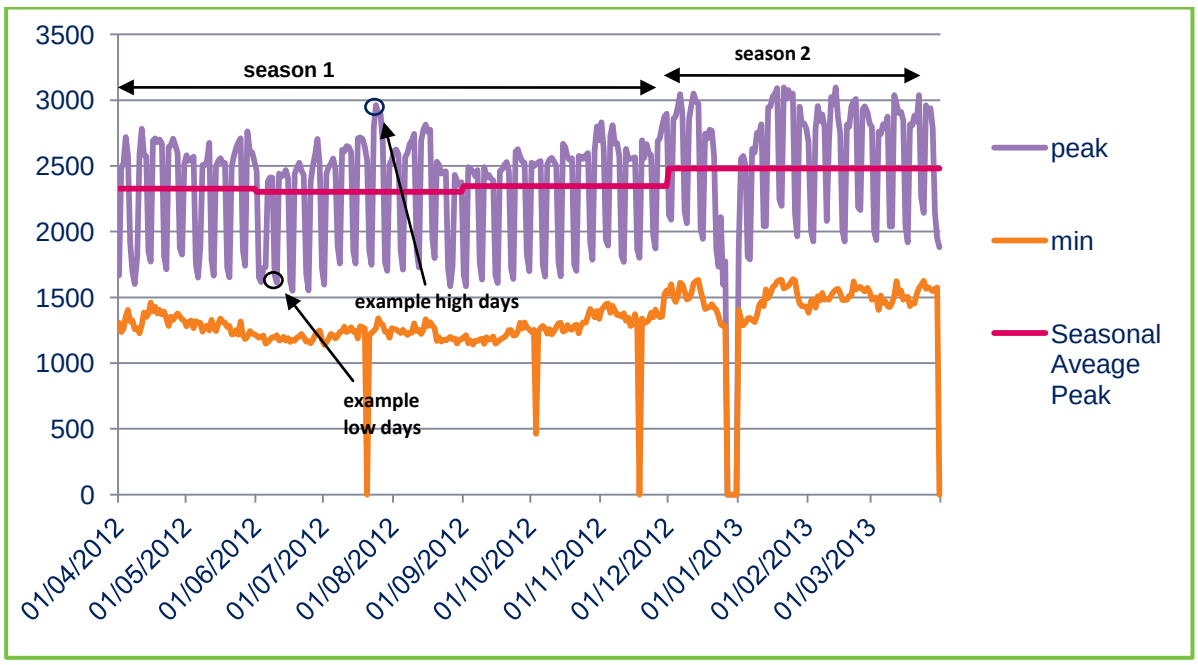
Large Industrial and Commercial	Largely Domestic	Mixed
Trafford Park North	Fallowfield	Buckshaw
Dickinson Street	Romiley	Victoria Park
Kitt Green	Wilmslow	Hyndburn Road
Avenham	Egremont	Blackfriars
Central Manchester	Ashton (Golborne)	Bridgewater

2.4 Approach to determining the test schedule

In order to understand the load response to dynamic voltage control across the annual cycle for the Primary substations included within Trial 1, a representative number of tests will be conducted across the annual period to fully quantify the response for every half hour. When examining daily and annual load profiles for each Primary they typically show a level of similarity in terms of profile shape and demand value, for example over a season or a 24 hour period.

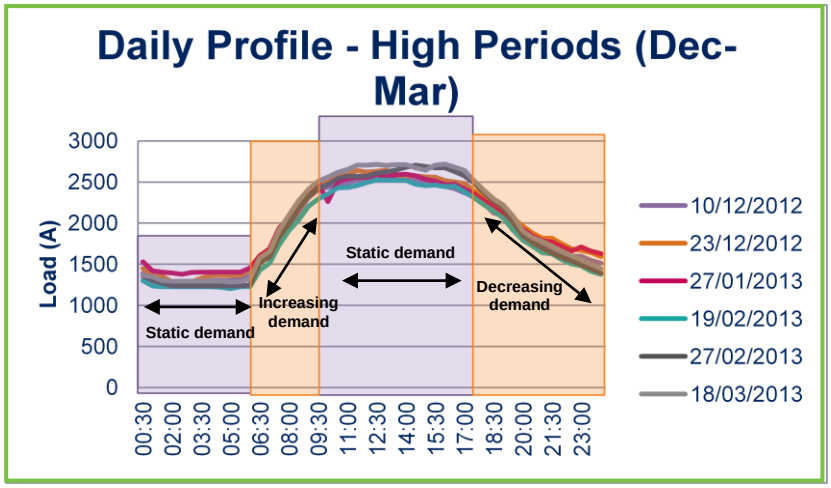
For example, figure 1 is the 2012/13 daily maximum and minimum demand values for Dickinson Street Primary. By examining the average maximum value, the annual load profile can be split up into two discrete seasons, April to November and December to March.

Figure 1: 2012/13 daily maximum and minimum demand values for Dickinson Street Primary



The annual profile also highlights for this particular Primary a cycle of high and low days throughout the year. Figure 2 shows the daily load profile for an example number of high days in season 2. The similarity in terms of profile shape and demand values permits the assumption that all high days across season 2, depending upon the time of day, will exhibit the same demand response for a change in voltage. This therefore allows the number of tests that need to be carried out to quantify the voltage-demand relationship to be streamlined to a number of representative periods.

Figure 2: Daily load profile for an example number of high days in season 2



The daily profile can be further separated into periods of changing and static demand. These periods occur at similar times for a high day in season 2 and therefore the assumption can be made that by testing in each of these four discrete periods the demand response for a high day in season 2 can be quantified.

A test schedule for each Primary in Trial 1 has been developed by following this same level of analysis and inspection to determine representative periods for testing across the annual cycle. An example is provided below for the Dickinson Street primary.

Table 3: Example test Schedule for Dickinson Street Primary

Number and length of seasons	***Daily Variations within a season***	***Time Variations within a day***	***Number of tests***	
			Voltage reduction	***Voltage boost***
Season 1 (1st April – 30th November)	*High Day (Tuesday – Saturday)*	*01:00 – 06:00*	*3*	*3*
		06:00 – 09:00	*3*	*3*
		09:00 -17:00	*3*	*3*
		17:00 – 01:00	*3*	*3*
	Low Day (Sunday – Monday)	*02:00 – 07:00*	*3*	*3*
		07:00 – 11:00	*3*	*3*
		11:00 – 17:00	*3*	*3*
		17:00 – 02:00	*3*	*3*
Season 2 (1st December – 31st March)	*High Day (Monday – Thursday)*	*00:00 – 06:00*	*3*	*3*
		06:00 – 09:30	*3*	*3*
		09:30 – 17:30	*3*	*3*

		17:30 – 24:00	*3*	*3*
	Low Day (Saturday – Sunday)	*01:00 – 07:00*	*3*	*3*
		07:00 – 10:00	*3*	*3*
		10:00 – 18:00	*3*	*3*
		18:00 – 01: 00	*3*	*3*

In order to have sufficient data points to build up an accurate load model and output the voltage-demand relationship matrix for this Primary, it is proposed that each test will be repeated three times.

2.5 The importance of testing voltage increase and reduction

As the volume of renewable generation increases there is an increasing probability that at certain times generation on the network may exceed demand or available network capacity leading to a constraint on the network. This constraint may result in curtailed generation output or further investment in network infrastructure. For the future, a technique where the constraint can be managed through voltage controlled demand management will provide a cost effective solution. Using the CLASS solution to increase network voltage and correspondingly the network demand, could result in balancing of demand and generation at times of possible constraint. Therefore, within this Trial it is aimed to understand demand response for both increase and decrease of network voltages so that the CLASS Solution can be deployed across a range of emerging network conditions. During the trial in each designated test period a test to reduce network voltage will be followed by a test to increase the voltage.

2.6 How we will conduct a test

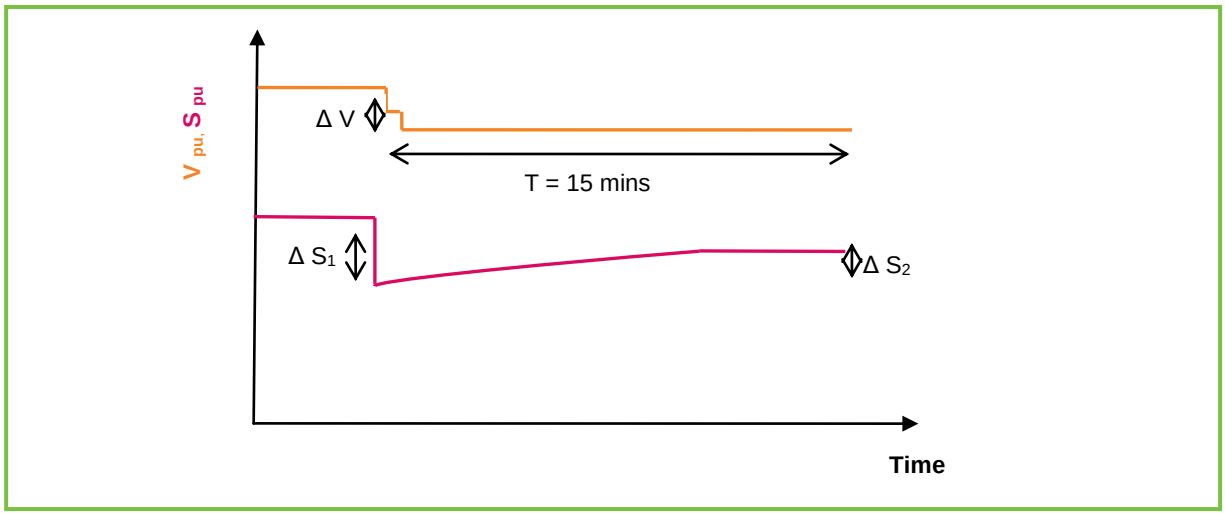
Typically, tap changer operation at a Primary substation may occur between 2 and 20 times a day with each operation changing the secondary voltage by approximately 1.5%. This normal operation could provide sufficient data for the purposes of Trial 1. However, to ensure that every required test period is covered and the full dynamics of the voltage regulation is captured, tests will be initiated in specific periods as outlined in the test schedule for each Primary.

The data collected in each test by changing the voltage by 1.5% will be sufficient to confidently build load models that will be accurate for voltage changes of up to 6%.

During this test period, both parallel Primary transformers will each be tapped by one tap position, which will change the voltage depending on tap changer type and position by approximately 1.5%. The new tap position will then be held for 15 minutes to capture any recovery phase of the demand.

In order to capture any discernible effects caused by any initial dynamic response of the load following a change in voltage, high resolution monitoring will be deployed. However, with regard to the future deployment of dynamic voltage control, the period of interest will be the minimum response that can be sustained over the 15 minute period.

Figure 3: Response of load to change in voltage



2.7 Summary of Trial 1

The key attributes of Trial 1 are summarised in the table below.

Table 4: Summary of Trial 1 - Load Modelling

Objective	*Where*	*When*	*Technique*	*Parameters of test*
Data capture to determine voltage-demand relationship	*15 Primary Substations across 3 load categories*	*Across annual cycle – see test schedule per Primary*	*Raising and lowering by one tap position followed by 15 minutes of no voltage regulation*	*~1.5% voltage reduction for 15 minutes*

3 TRIAL 2 – PEAK DEMAND REDUCTION

3.1 Why we are carrying out this Trial

The ability to actively reduce peak network demand in a manner undetectable by customers has the potential to significantly reduce the need for network investment. Peak demand management using the CLASS solution has the potential to provide a low cost, quickly deployable solution that retains optionality for network operators where there is a degree of uncertainty in the long term; for example, with regard to demand on a network or realisation of new smart grid technologies, uptake of DG and energy efficiency measures.

For a network operator, demand reduction through dynamic voltage control on a local distribution network at times of peak has the potential to defer investment on both Primary transformers and upstream assets. For this purpose, the peak demand at a Primary substation is of interest, as is the relevant maximum apparent power demand reduction that can be sustained, so that system flows remain within network thermal capacity without causing demand disconnection due to under-voltages.

3.2 Trial Objective

This Trial seeks to demonstrate that at peak load when voltage reductions of up to 6% are applied across a range of Primary substations, the demand at that substation is reduced and customers do not observe any adverse effects on their electricity supply. In addition to this the technology required to deliver this on a business as usual basis will be tested.

3.3 Trial Parameters

In a supporting document to the CLASS submission[2] it was evaluated for the ENWL area that in the next five years with an annual demand increase of 1% the reinforcement of 4.2% of our Primary transformer population could be deferred by a 3% load reduction and 5.6% reinforcement deferment by a 6% load reduction when applied at peak demands.

The actual active and reactive power reduction following a voltage reduction will be dependent upon the type of load connected. Recent practical evidence has shown that the downstream active power reduction when applying a voltage reduction is generally linear. Therefore, to deliver the benefits of the CLASS solution articulated in the study work by the University of Manchester, tests will be conducted on an incremental voltage basis up to a maximum of a 6% reduction.

Across the ENWL network, for current Primary substations exceeding capacity the duration of the excursion outside of rating typically lasts for 2 coincidental half hour periods. Therefore, all tests will be enabled for 60 minutes.

3.4 Site Selection

As set out in the CLASS full submission, this method will be tested on a subset of the CLASS trial area on 14 Primaries. These sites have currently been assigned ENWL Load Index 5 [3] status or approaching this level and cover all three load categories.

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[2] Feasibility study notes on system benefits from flexible transformer tap changer operation, P. Mancarella, University of Manchester, June 2012.

[3] ENWL Load index 5 equates to demand (as a percentage of firm capacity) of greater than 103% for more than 9 half hours in a year.

CLASS is also interested in understanding the feasibility of demand reduction for peak management on rural networks. Many 11kV feeders are designed with voltage regulation being the main consideration, and that a further voltage reduction at peak times may lead to under voltage issues. A number of rural networks have been included within the site selection to assess this.

3.5 Approach to Testing

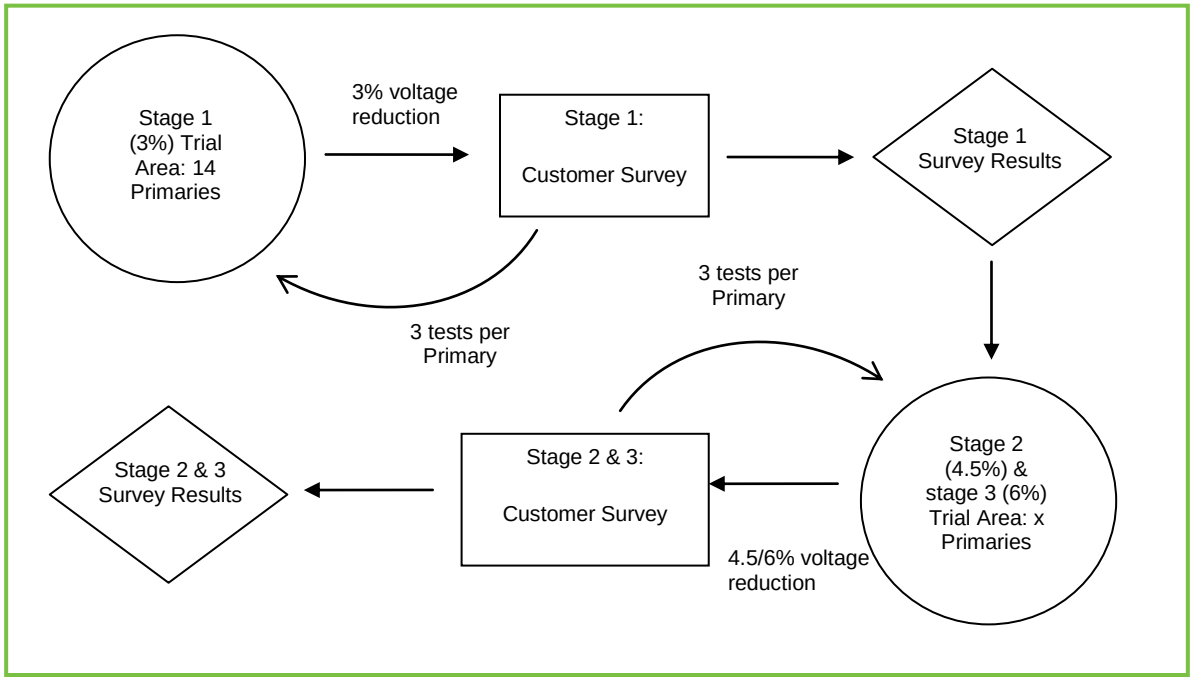
In order to determine if a specific level of voltage reduction at peak demand causes perceptible effects on a customer's electricity supply, a tiered approach to testing is planned.

A first round of tests will be conducted where a 3% voltage reduction is applied. A series of customer post-event surveys will then be conducted and assessed in conjunction with LV monitored data to determine any adverse effects. The results from this round of surveys will then determine whether two further rounds of tests with a 4.5% and 6% voltage reduction respectively, will be applied to all Primaries within this trial. Customer surveys will then be conducted to evaluate the effects of each level of testing before moving on to the next level of voltage reduction.

All of these tests will be scheduled based on historic loading data of when previous excursions above capacity occurred, so to test at a representative time for when this service would be required.

The voltage reduction will be instigated from the CLASS dashboard and prior to any test the starting voltage will be adjusted to nominal.

Figure 4: Trial 2 implementation process



3.6 Evaluating the onsite technology

A key output from this trial is to understand and test the capability of the Siemens Autonomous Substation Controller (ASC). The device can be pre-set with a maximum demand value for the site and if it detects load approaching this level it automatically initiates the tap changer to start reducing the HV voltage.

This would be the preferred method of implementing the peak demand reduction service in a future 'business as usual' scenario, and therefore testing its capability provides valuable learning for any wider roll out.

A series of tests at five Primaries will be conducted using this method of peak demand reduction following the tests outlined above.

3.7 Summary of Trial 2

The key attributes of Trial 2 are summarised in the table below.

Table 5: Summary of Trial 2 - Peak Demand Reduction Summary of Trial 2 Peak Demand Reduction

Objective	Where	When	Technique	Parameters of test
Application of voltage reductions up to 6% at peak times has no adverse effect on customers. *The future technology used to apply the voltage reduction will also be verified.*	*14 Primary Substations*	*Peak loadings – see test schedule*	*Lowering tap positions*	*Up to 6% voltage reduction for up to 60 minutes*

4 TRIAL 3 – FREQUENCY RESPONSE BY DEMAND MANAGEMENT

4.1 Why we are carrying out this Trial

System frequency is a continuously changing variable that is determined and controlled by the real time balance between system demand and total generation. National Grid Electricity Transmission (NGET) has a statutory obligation under Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002 to maintain system frequency within 1 percent above or below declared system frequency (50.0Hz), except in abnormal or exceptional circumstances. NGET must therefore ensure that sufficient generation and/or demand is held in automatic readiness to manage all credible circumstances that might result in frequency variations.

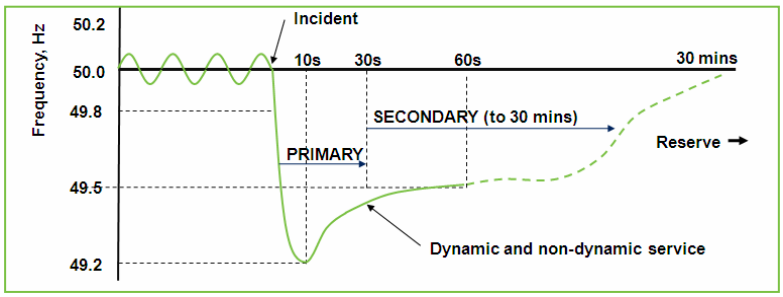
The anticipated change towards a low inertia intermittent generation mix in the future is likely to increase the requirement to access system reserves to maintain system stability. Conventional spinning reserve used for frequency and system balancing attracts a high financial and carbon cost. The implementation of the CLASS Solution therefore has the potential to be a cost effective, fast acting and flexible alternative. In particular, the CLASS Solution has the potential to provide a new mechanism for system management for the TSO and significantly reduce the cost of the ancillary services market, and ultimately, the costs to consumers.

4.2 Implementing the CLASS Solution for Frequency Response

There are two types of Frequency Response, dynamic and static response. Dynamic Frequency Response is a continuously provided service used to manage the normal real time changes on the system. While static Frequency Response is usually a discrete service triggered at a defined frequency deviation.

Following an incident where system frequency has exceeded operating limits (49.8 – 50.2 Hz) a combination of Frequency Response and Reserve services are called upon to correct system frequency. The speeds at which these services are implemented determine whether they are used within the Primary timescale (2 - 30 seconds) or Secondary timescale (30 seconds – 30 minutes).

Figure 5: Example frequency deviation and response



The CLASS Solution aims to utilise the capability and arrangement of our existing assets to provide Static Frequency Response, the details of which are listed below.

Table 6: Summary of CLASS Solution for provision of Frequency Response

CLASS Solution	Asset Capability		Number of Primary Substations included in Trial
	Response time (seconds)	*Max. duration (minutes)*	
Stage 1: Primary Transformer The disconnection of one of a paired arrangement of Primary transformers will result in the voltage supplying the substation load to instantaneously reduce triggering a demand reduction.[4] Disconnection of a primary transformer is achieved by automatic on site detection of a low frequency signal.	*< 2*	*30*	*10*
Stage 2: Tap changer Operation Change of secondary (HV) volts at a Primary substation by raising or lowering tap positions and consequently changing level of demand.	*~30*	*30*	*60*

Stage 1 is capable of providing a Static Low Frequency Response which acts within the Primary and Secondary timescale.

Stage 2 is capable of providing a Static Frequency Response which acts over the Secondary timescales (30 seconds – 30 minutes).

NGET currently procure these Frequency Response requirements through a number of commercial services which are open to demand side and distributed energy sources. The table below describes these current commercial services, and which stage of the CLASS Solution could be aligned to the service giving consideration to the service parameters.

Table 7: Summary of CLASS Solution alignment with current commercial services

Commercial Service	CLASS Solution
Frequency Control by Demand Management (FCDM) Provides frequency response through interruption of demand customers, when the system frequency transgresses the low frequency relay setting on site. The demand customers who partake will provide the service within 2 seconds of instruction and deliver it for up a minimum of 30 minutes. FCDM is required to manage large deviations in frequency, for example caused by the loss of a significantly large generator.	*Stage 1*
Firm Frequency Response (FFR) is designed to compliment other forms of frequency response and delivers firm availability. Providers must have the capability to operate in a frequency sensitive mode for dynamic response or change their active power level via automatic relay for a non-dynamic response. The service requires a high speed response of 30 seconds for a minimum duration of 10 minutes.	*Stage 1 and Stage 2*

[4] It is assumed that the connected demand is at unity or lagging power factor and the demand reduction is greater than the expected increase in losses.

Fast Reserve (FR) provides rapid and reliable delivery of active power through an increased output from generation or a reduction in consumption from demand sources, following receipt of an electronic despatch instruction from the TSO. Delivery must be within two minutes of instruction and sustain output for 15 minutes.	*Stage 2*

4.3 Trial Objective

To test that the installed CLASS technology and existing network assets can deliver Primary and Secondary timescale Static Frequency Response, and ascertain whether customers observe any adverse effects. The parameters of each test (ie trigger, response time and duration) are based upon the delivery benchmarks of current commercial services procured by NGET.

Table 8: Summary of Trial objectives

Use of ENWL Assets	***Test Objective***	
Stage 1: Trip of Primary transformer	*Trigger – automatic on site detection of LF signal (49.7Hz)[5]* *Response time – maximum of 2 seconds between receiving LF signal and tripping of a Primary Transformer circuit breaker* *Duration - 30 minutes*	
Stage 2: Tap Changer Operation	*Type 1:* *Trigger – automatic on site detection of frequency signal at 49.8Hz[5].* *Response time – <30 seconds* *Duration - >10 minutes*	*Type 2:* *Trigger – response to despatch instruction from NGET* *Response time – <2 minutes* *Duration - 15 minutes*

The scale of the response will be noted during each test but is not a specific objective of the Trial. Compliance with NGET response size will be evaluated post trial.

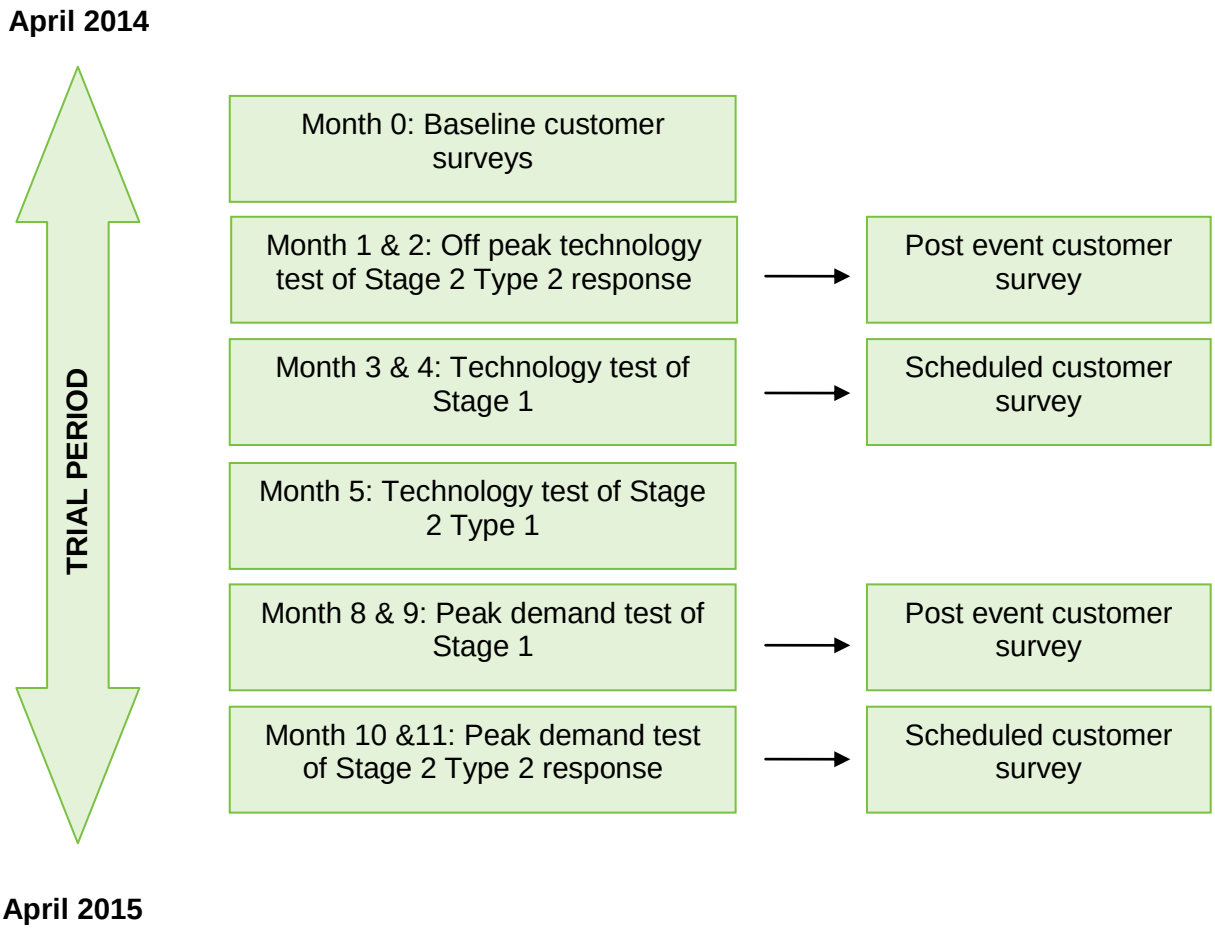
4.4 Testing Approach

The frequency response and reserve services outlined could be required and activated at any point throughout the year. However, it is projected that customers would be most likely to observe any adverse effects to the Trial at times of highest demand on the network, for example the tripping of a Primary transformer in a period of peak demand, would cause a larger instantaneous change in voltage than at a lighter loaded period (off peak period).

With a dual objective in this Trial of proving the technical capability and assessing customers' perceptions, a progressive method to testing is to be applied. The Trial period will be split into two seasons (peak and off-peak), the first of which will allow the technology to be robustly tested. With confidence in the technology, implementation in the second season aims to assess customer observation of the tests by repeating all of the tests in the winter peak demand period.

[5] The frequency thresholds to be used in the Trial are based on historic NGET frequency excursion data. The value of 49.7Hz for Stage 1 equates to approximately 1 excursion beyond this threshold per month. The frequency excursion beyond the Stage 2 values of 49.8Hz typically occurs 3 times per month.

Figure 6: Scheduling of Trial 3



It is deemed sufficient that only a technology test for Stage 2 Type 1 will take place in the off peak season, any collective effects from the co-ordinated tapping at multiple primaries will be captured in the peak season Stage 2 Type 2 test and subsequent survey.

4.5 Involvement of NGET in testing

In order to replicate the Fast Response service, the Stage 2 Type 2 tests will be initiated by a despatch signal from NGET in order to test the communication and control technology required to automatically request these services. The scheduling and resource of each of these tests has been agreed between both parties.

4.6 Summary of Trial 3

The key attributes of Trial 3 are summarised in the table below.

Table 9: Summary of Trial 3 – Frequency Response

Frequency Response *Objective*	***Where***	***When***	***Technique***	***Parameters of test***
Detection and sustained response to a low frequency event or electronic despatch signal.	*Stage 1 -10 Primary Substations Stage 2 – 60 Primary substations*	*Across annual cycle - see test schedule*	*Stage 1 – Trip Primary transformer Stage 2 – lowering tap positions*	*See requirements for each type of test*

5 TRIAL 4 – REACTIVE POWER ABSORPTION

5.1 Why we are carrying out this Trial

A new challenge that is faced by all network operators is managing the unacceptably high voltages that can occur on networks during periods when high Distributed Generation (DG) output coincides with low local demand. This problem of high voltages will progressively worsen as system power factor is further eroded by non-linear loads and by high volumes of non-synchronous DG. The CLASS Solution has the potential to deliver a low cost and quickly deployable alternative to traditional expensive asset solutions for mitigating excessive voltages. If proven to be applicable, the CLASS Solution would have the benefit of being both less expensive and less carbon-intensive.

5.2 Implementing the CLASS Solution for Reactive Power Absorption Capability

If a pair of Primary transformers are operated at different tap positions (ie with staggered taps), a circulating current is introduced around the pair. The circulating current decreases the network power factor and effectively absorbs reactive power from the upstream network. The consequential increase in reactive demand reduces network voltages higher up in the network, but leaves customers voltages unaffected. The method can deliver reactive power absorption capabilities quickly in real time so as to meet the needs of both a DNO and TSO.

5.3 Trial Objective

To test the installed CLASS technology and the existing network assets have the capability to deliver three levels of reactive power absorption at the required times. A successful test will quantify the change in power factor on the 33kV network to demonstrate reactive power absorption.

The data collected during this Trial will be used by the University of Manchester to determine the impact on the distribution network, in terms of losses and network loading, as well as the aggregate effect on the transmission network for voltage control.

5.4 Trial Approach

Simulations indicate that for a typical 4 tap stagger (2 tap up and 2 tap down) that an average reactive power consumption of 0.24MVAr/substation can be seen from the transmission network. Therefore, it is recognised that a co-ordinated aggregated response across a number of substations will be needed to deliver the necessary reactive power requirements. For both DNO and TSO purposes, the service will need to be enabled over a large number of substations. Therefore, the the response areas for testing are as follows; per Grid Supply Point (GSP), per region (north, central and south) and the whole ENWL Trial area.

The service would typically be required during times of lowest load; overnight, weekends and public holidays during the summer months have historically been times of lowest load. The GSP level tests will therefore be conducted between 22:00 - 07:00 throughout the week and sustained for a minimum of 1 hour duration. NGET define the peak high voltage period as 02:00 – 06:00 and the regional and whole area tests will be scheduled and sustained for the duration of this time period.

The level of reactive power absorption is proportional to the number of positions the taps are staggered. Theoretically most tap changers could achieve a maximum of 12 staggered tap positions but the operating voltage may not be at nominal, therefore a realistic figure of four or six staggered taps is considered appropriate. Additionally, across the general population of Primary transformers the reverse power capability may be limited and become a constraint to a higher order of tap stagger.

Again a progressive approach to testing is to be employed by starting with GSP level tests at the minimum tap stagger level of 2 before sequentially increasing the level of tap stagger and the response area. This approach is summarised in the table below.

Response Area	*Level of tap stagger*	*Initiated by*
No. 1-15 GSPs	*2, 4 & 6*	*ENWL*
3 Regions	*2, 4 & 6*	*ENWL and replicated by NGET*
ENWL area	*2, 4 & 6*	*NGET*

5.5 Involvement of NGET

The provision of reactive power absorption across a region or whole network area may be a powerful method of mitigating overly high voltages on the transmission network. In order to test the communication and control technology required for the TSO to automatically request these services, a test will be initiated by NGET for each of the regional response areas and whole ENWL area for various levels of reactive power absorption. The scheduling and resource of each of these tests has been agreed between both parties.

5.6 Parallel Provision of Reactive Power and Demand Response Services

The concurrent provision of reactive power and demand response may in the future be required; for example in instances where there are high volts on the transmission network and an abundance of generation on the distribution network. Therefore it is important to test the limits of the tap changer operation and therefore determine the subsequent availability of the two services in parallel.

This will be achieved by replicating all the GSP level tests during the NGET peak high voltage period of 02:00 - 06:00 with 1.5% and 3% increase in nominal voltage and recording whether this can firstly be achieved and subsequently sustained for the four hour period.

5.7 Summary of Trial 4

The key attributes of Trial 4 are summarised in the table below.

Table 10: Summary of Trial 4 – Reactive power absorption

Objective	*Where*	*When*	*Technique*	*Parameters of test*
To test the installed technology can deliver reactive power absorption capability across a number of Primary substations within a defined response area at a selected level of tap stagger.	*GSP, regional and ENWL area*	*Low demand periods – see schedule*	*Staggering of tap positions*	*Tap stagger 2, 4 or 6.* *GSP: 22:00-07:00. 1 hour duration.* *Region/ ENWL area: 02:00-06:00. 4 hour duration.*

6 CONCLUDING COMMENTS

The Trial Design methodology and associated test schedule presented in this document will be re-evaluated after every quarter period of the Trial to ensure the data collected is appropriate for assessment of the capability of the CLASS Solution. This document should therefore be considered as a 'living document', as it will be updated with any lessons learnt as the series of trials progress.

Throughout the Trial findings will be collated in more detail and communicated to all interested stakeholders via a range of knowledge dissemination routes including conferences, close-down reports and additional white papers. Further information on the CLASS Project can be found on our website at www.enwl.co.uk/CLASS.

7 APPENDIX A - TEST SCHEDULE

7.1 Summary

Undertaking	Season 1					Season 2			Season 3			Season 4		
	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15
Baseline Customer Survey	Baseline Customer Survey													
Trial 1		Trial 1												
Trial 2						ASC Testing 5 LI5 Primaries			Peak Demand Tests 14 LI5 Primaries 3, 4, 5 and 6% sequential Reductions per site					
Trial 3		Stage 2 Type 2 ENWL: Group 1-15 NGT: Region, Area		Stage 1 Enabled 10 Primaries		Stage 2 Type 1 Enabled 60 Primaries			Stage 1 Enabled 10 Primaries		Stage 2 Type 2 ENWL: Group 1-15 NGT: Region, Area			
Trial 4		Level 2 ENWL: Groups 1-15 NGT: Region, Area	Level 4 ENWL: Groups 1-15 NGT: Region, Area	Level 6 ENWL: Groups 1-15 NGT: Region, Area										

KEY	
Customer surveys required	Involves both
Technology Testing	

7.2 Season 1

Weeks beginning

GSP Group	Trial Primaries	07/04/2014 – 28/04/2014	05/05/2014 Trial 1	05/05/2014 Trial 2	05/05/2014 Trial 3	05/05/2014 Trial 4.a	05/05/2014 Trial 4.b
Group 4 Harker / Hutton	EGREMONT	Baseline customer surveys	Mon-Sun 01:00-05:00 05:00-08:30			Level 2 (ENWL)	Level 2 1.5%, 3% (ENWL)
	KIRKBY STEPHEN						
	ANNIE PIT						
	CHATSWORTH ST						
Group 5 Heysham	BURROW BECK	Baseline customer surveys				Level 2 (ENWL)	Level 2 1.5%, 3% (ENWL)
	WESTGATE						
Group 9 Penwortham East / Rochdale SGT 1	BAMBER BRIDGE	Baseline customer surveys					
	AVENHAM		Mon-Fri 05:30-09:30				
	GRIFFIN						
	DOUGLAS ST						
Group 10 Penwortham West / Stanah	BUCKSHAW	Baseline customer surveys	Mon-Fri 01:00-07:00 07:00-09:00				
	TARLETON						
	CLEVELEYS						
	BLACKPOOL						
	CECIL ST						
Group 11 Rochdale / Padiham	HYNDBURN RD	Baseline customer surveys	Mon-Fri 00:00-06:00 06:00-10:00				
	KINGSWAY						
	LITTLEBOROUGH						
	HEADY HILL						
Group 6 Kearsley	TRINITY	Baseline customer surveys					
	HARWOOD						
	CHAMBERHALL						
	BLACKFRIARS		Mon-Sun 02:00-09:00				
	LOSTOCK						
Group 7 Kearsley Local	CAMPBELL ST	Baseline customer surveys					
	CARR ST						
Group 1 Bold (Manweb)	ASHTON-Golborne	Baseline customer surveys	Mon-Sun 00:00-06:00 06:00-09:00		Stage 2 Type 2 Central dispatch x3 (ENWL)	Level 2 (ENWL)	Level 2 1.5%, 3% (ENWL)
	GOLBORNE						
Group 14 Washway Farm	SKELMERSDALE	Baseline customer surveys					
	KITT GREEN		Mon-Fri 00:00-06:30 06:30-08:00				
	UPHOLLAND						
Group 8 Macclesfield	BOLLINGTON	Baseline customer surveys					
	S.W. MACCLESFIELD						
Group 2 Bredbury	FALLOWFIELD	Baseline customer surveys	Mon-Sun 06:00-11:00		Stage 2 Type 2 Central dispatch x3 (ENWL)	Level 2 (ENWL)	Level 2 1.5%, 3% (ENWL)
	LONGSIGHT						
	MOSS SIDE (Longsight)						
	WINIFRED RD						
	VICTORIA PARK		Mon-Fri 00:00-06:00 06:00-14:00				
	LEVENSHULME						
	ROMILEY		Mon-Sun 00:00-06:00 06:00-08:00				
Group 3 Carrington	GREEN LANE-Altrincham	Baseline customer surveys				Level 2 (ENWL)	Level 2 1.5%, 3% (ENWL)
	CHASSEN RD						
	TRAFFORD PARK NORTH		Mon-Sun 00:00-06:00 06:00-12:00				
	IRLAM						
	BAGULEY						
Group 12 South Manchester	BRIDGEWATER	Baseline customer surveys	Mon-Fri 00:00-06:00 06:00-11:00				
	DICKINSON ST		Tue-Sat 01:00-06:00				
	WILMSLOW		Mon-Sun 00:00-07:00				
	DIDSBURY						
	WITHINGTON						
Group 13 Stalybridge	DENTON EAST	Baseline customer surveys					
	DROYLSDEN EAST						
	OPENSHAW						
	HYDE						
	GOWHOLE						
	STUART ST						
	CENTRAL MANCHESTER		Mon-Fri 21:00-07:00				
Group 15 Whitegate	MIDDLETON JUNCTION	Baseline customer surveys					
	BELGRAVE						
	WILLOWBANK						

KEY		
Trial 1	Load Modelling	1 tap increase followed by decrease in next half hour, time of day
Trial 2	Peak Voltage Reduction	Size of voltage reduction, number of tests, time window
Trial 3	Frequency Response	Stage, automatic enable or dispatched centrally (ENWL or NGT)
Trial 4.a	Reactive Power Absorption	Level of tap stagger
Trial 4.b	Reactive Power Absorption and Demand Boost	Level of tap stagger with voltage increase applied

7.3 Season 2

GSP Group	Trial Primaries	Weeks beginning: 01/09/2014				08/09/2014				15/09/2014				22/09/2014				29/09/2014				06/10/2014				13/10/2014				20/10/2014				27/10/2014				03/11/2014				10/11/2014				17/11/2014				24/11/2014			
		Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4
Group 4 Harker / Hutton	EGREMONT	Mon-Sun 01:00-05:00 05:00-08:30				Mon-Sun 08:30-15:30 15:30-17:00				Mon-Sun 17:00-18:30 18:30-01:00								Mon-Sun 01:00-05:00 05:00-08:30				Mon-Sun 08:30-15:30 15:30-17:00				Mon-Sun 17:00-18:30 18:30-01:00												Mon-Sun 01:00-05:00 05:00-08:30												Mon-Sun 08:30-15:30 15:30-17:00				Mon-Sun 17:00-18:30 18:30-01:00							
	KIRKBY STEPHEN																																																					
	ANNIE PIT																																																					
	CHATSWORTH ST																																																					
Group 5 Heysham	BURROW BECK																																																					
	WEST GATE																																																					
Group 9 Penwortham East / Rochdale SGT 1	BAMBER BRIDGE		Auto reduction enabled				Auto reduction enabled				Auto reduction enabled				Auto reduction enabled				Auto reduction enabled																																								
	AVENHAM	Mon-Fri 05:30-09:30 09:30-16:30				Mon-Fri 16:30-21:00 21:00-05:30				Sat-Sun 09:00-10:30 10:30-16:00				Sat-Sun 16:00-17:00 17:00-09:00								Mon-Fri 05:30-09:30 09:30-16:30								Mon-Fri 16:30-21:00 21:00-05:30				Sat-Sun 09:00-10:30 10:30-16:00				Sat-Sun 16:00-17:00 17:00-09:00																			
	GRIFFIN																																																					
	DOUGLAS ST																																																					
Group 10 Penwortham West / Stanah	BUCKSHAW	Sat-Sun 03:00 09:00				Sat-Sun 15:00 21:00												Mon-Fri 01:00-07:00 07:00-09:00				Mon-Fri 09:00-19:00 19:00-01:00				Sat-Sun 03:00 09:00				Sat-Sun 15:00 21:00				Mon-Fri 01:00-07:00 07:00-09:00				Mon-Fri 09:00-19:00 19:00-01:00				Sat-Sun 03:00 09:00				Sat-Sun 15:00 21:00				Mon-Fri 01:00-07:00 07:00-09:00			
	TARLETON																																																				
	CLEVELEYS																																																				
	BLACKPOOL																																																				
	CECIL ST																																																				
Group 11 Rochdale / Padiham	HYNDBURN RD	Mon-Fri 00:00-06:00 06:00-10:00				Mon-Fri 10:00-16:00 16:00-00:00				Sat-Sun 00:00-08:00 08:00-11:00				Sat-Sun 11:00-19:00 19:00-00:00								Mon-Fri 00:00-06:00 06:00-10:00								Mon-Fri 10:00-16:00 16:00-00:00				Sat-Sun 00:00-08:00 08:00-11:00				Sat-Sun 11:00-19:00 19:00-00:00																			
	KINGSWAY																																																				
	LITTLEBOROUGH																																																				
	HEADY HILL																																																				
Group 6 Kearsley	TRINITY																																																				
	HARWOOD																																																				
	CHAMBERHALL																																																				
	BLACKFRIARS	Mon-Sun 02:00-09:00				Mon-Sun 09:00-02:00																Mon-Sun 02:00-09:00				Mon-Sun 09:00-02:00								Mon-Sun 02:00-09:00				Mon-Sun 09:00-02:00																			
	LOSTOCK																																																			
Group 7 Kearsley Local	CAMPBELL ST																																																			
	CARR ST																																																			
Group 1 Bold (Manweb)	ASHTON-Golborne	Mon-Sun 00:00-06:00 06:00-09:00				Mon-Sun 09:00-15:00 15:00-18:00				Mon-Sun 18:00-19:00 19:00-00:00								Mon-Sun 00:00-06:00 06:00-09:00				Mon-Sun 09:00-15:00 15:00-18:00				Mon-Sun 18:00-19:00 19:00-00:00												Mon-Sun 00:00-06:00 06:00-09:00				Mon-Sun 09:00-15:00 15:00-18:00				Mon-Sun 18:00-19:00 19:00-00:00							
	GOLBORNE		Auto reduction enabled				Auto reduction enabled				Auto reduction enabled				Auto reduction enabled				Auto reduction enabled																																						
Group 14 Washway Farm	SKELMERSDALE																																																				
	KITT GREEN	Mon-Fri 08:00-19:00 19:00-00:00		Stage 2 Type 1 Auto-enable		Sat-Sun 00:00-06:30 06:30-08:00		Stage 2 Type 1 Auto-enable		Sat-Sun 08:00-19:00 19:00-00:00		Stage 2 Type 1 Auto-enable		Mon-Fri 00:00-06:30 06:30-08:00		Stage 2 Type 1 Auto-enable		Mon-Fri 08:00-19:00 19:00-00:00		Stage 2 Type 1 Auto-enable		Sat-Sun 00:00-06:30 06:30-08:00				Sat-Sun 08:00-19:00 19:00-00:00				Mon-Fri 00:00-06:30 06:30-08:00				Mon-Fri 08:00-19:00 19:00-00:00				Sat-Sun 00:00-06:30 06:30-08:00				Sat-Sun 08:00-19:00 19:00-00:00				Mon-Fri 00:00-06:30 06:30-08:00				Mon-Fri 08:00-19:00 19:00-00:00			
	UPHOLLAND																																																			
Group 8 Macclesfield	BOLLINGTON																																																			
	S.W. MACCLESFIELD																																																			
Group 2 Bredbury	FALLOWFIELD	Mon-Sun 06:00-11:00				Mon-Sun 11:00-23:00				Mon-Sun 23:00-06:00				Mon-Sun 06:00-11:00				Mon-Sun 11:00-23:00				Mon-Sun 23:00-06:00				Mon-Sun 06:00-11:00				Mon-Sun 11:00-23:00				Mon-Sun 23:00-06:00																			
	LONGSIGHT																																																			
	MOSS SIDE (Longsight)																																																			
	WINIFRED RD																																																			
	VICTORIA PARK	Mon-Fri 00:00-06:00 06:00-14:00				Mon-Fri 14:00-17:00 17:00-00:00				Sat-Sun 05:00 17:00								Mon-Fri 00:00-06:00 06:00-14:00				Mon-Fri 14:00-17:00 17:00-00:00				Sat-Sun 05:00 17:00								Mon-Fri 00:00-06:00 06:00-14:00				Mon-Fri 14:00-17:00 17:00-00:00				Sat-Sun 05:00 17:00											
	LEVENSHULME		Auto reduction enabled				Auto reduction enabled				Auto reduction enabled				Auto reduction enabled				Auto reduction enabled																																						
	ROMILEY	Mon-Sun 00:00-06:00 06:00-08:00				Mon-Sun 08:00-16:30 16:30-18:00				Mon-Sun 18:00-19:30 19:30-00:00								Mon-Sun 00:00-06:00 06:00-08:00				Mon-Sun 08:00-16:30 16:30-18:00				Mon-Sun 18:00-19:30 19:30-00:00								Mon-Sun 00:00-06:00 06:00-08:00				Mon-Sun 08:00-16:30 16:30-18:00				Mon-Sun 18:00-19:30 19:30-00:00											
Group 3 Carrington	GREEN LANE-Altrincham																																																			
	CHASSEN RD		Auto reduction enabled				Auto reduction enabled				Auto reduction enabled				Auto reduction enabled				Auto reduction enabled																																						
	TRAFFORD PARK NORTH	Mon-Sun 00:00-06:00 06:00-12:00				Mon-Sun 12:00-18:00 18:00-00:00																Mon-Sun 00:00-06:00 06:00-12:00				Mon-Sun 12:00-18:00 18:00-00:00								Mon-Sun 00:00-06:00 06:00-12:00				Mon-Sun 12:00-18:00 18:00-00:00																			
	IRLAM																																																			
	BAGULEY																																																			
Group 12 South Manchester	BRIDGEWATER																																																			
	DICKINSON ST	Sun-Mon 02:00-07:00	Auto reduction enabled			Sun-Mon 07:00-11:00	Auto reduction enabled			Sun-Mon 11:00-17:00	Auto reduction enabled			Sun-Mon 17:00-02:00	Auto reduction enabled				Auto reduction enabled			Sun-Mon 01:00-06:00				Sun-Mon 06:00-09:00				Sun-Mon 09:00-17:00				Sun-Mon 17:00-01:00																			
	WILMSLOW																					Mon-Sun 01:00-06:00 06:00-09:00				Mon-Sun 09:00-14:00 14:00-17:00				Mon-Sun 17:00-01:00				Mon-Sun 01:00-06:00 06:00-09:00				Mon-Sun 09:00-14:00 14:00-17:00				Mon-Sun 17:00-01:00				Mon-Sun 01:00-06:00 06:00-09:00				Mon-Sun 09:00-14:00 14:00-17:00			
	DIDSBURY																																																			
	WITHINGTON																																																			
Group 13 Stalybridge	DENTON EAST																																																			
	DROYLSDEN EAST																																																			
	OPENSHAW																																																			
	HYDE																																																			
	GOWHOLE																																																			
	STUART ST																																																			
	CENTRAL MANCHESTER	Mon-Fri 21:00-07:00				Mon-Fri 07:00-10:00				Mon-Fri 10:00-18:00				Mon-Fri 18:00-21:00				Sat-Sun 00:00-00:00				Mon-Fri 21:00-07:00				Mon-Fri 07:00-10:00				Mon-Fri 10:00-18:00				Mon-Fri 18:00-21:00				Sat-Sun 00:00-00:00				Mon-Fri 21:00-07:00				Mon-Fri 07:00-10:00				Mon-Fri 10:00-18:00			
Group 15 Whitegate	MIDDLETON JUNCTION																																																		
	BELGRAVE																																																		
	WILLOWBANK																																																		

KEY		
Trial 1	Peak Modelling	1 tap increase followed by decrease in next half hour, time of day
Trial 2	Peak Voltage Reduction	Size of voltage reduction, number of tests, time window
Trial 3	Frequency Response	Stage, automatic enable or dispatched centrally (ENWL or NGT)
Trial 4	Reactive Power Absorption	Level of tap stagger

7.4 Season 3

Weeks beginning

GSP Group	Trial Primaries	01/12/2014				08/12/2014				15/12/2014				22/12/2014			
		Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4
Group 4 Harker / Hutton	EGREMONT	Mon-Sun 01:00-05:00 05:00-08:30	3% x3 17:00-19:00			Mon-Sun 08:30-15:30 15:30-17:00				Mon-Sun 17:00-18:30 18:30-01:00					4.5% x3 17:00-19:00		
	KIRKBY STEPHEN																
	ANNIE PIT						3% x3 11:00-13:00										
	CHATSWORTH ST																
Group 5 Heysham	BURROW BECK														3% x3 17:00-18:00		
	WESTGATE																
Group 9 Penwortham East / Rochdale SGT 1	BAMBER BRIDGE						3% x3 17:00-18:00										
	AVENHAM	Mon-Fri 05:30-09:30 09:30-16:30				Mon-Fri 16:30-21:00 21:00-05:30				Sat-Sun 09:00-10:30 10:30-16:00				Sat-Sun 16:00-17:00 17:00-09:00			
	GRIFFIN																
	DOUGLAS ST																
Group 10 Penwortham West / Stanah	BUCKSHAW	Mon-Fri 09:00-19:00 19:00-01:00				Sat-Sun 03:00 09:00				Sat-Sun 15:00 21:00				Mon-Fri 01:00-07:00 07:00-09:00			
	TARLETON																
	CLEVELEYS																
	BLACKPOOL																
	CECIL ST																
Group 11 Rochdale / Padiham	HYNDBURN RD	Mon-Fri 00:00-06:00 06:00-10:00		Stage 1 Auto-enable		Mon-Fri 10:00-16:00 16:00-00:00		Stage 1 Auto-enable		Sat-Sun 00:00-08:00 08:00-11:00		Stage 1 Auto-enable		Sat-Sun 11:00-19:00 19:00-00:00		Stage 1 Auto-enable	
	KINGSWAY																
	LITTLEBOROUGH																
	HEADY HILL																
Group 6 Kearsley	TRINITY																
	HARWOOD																
	CHAMBERHALL																
	BLACKFRIARS	Mon-Sun 02:00-09:00		Stage 1 Auto-enable		Mon-Sun 09:00-02:00		Stage 1 Auto-enable				Stage 1 Auto-enable				Stage 1 Auto-enable	
	LOSTOCK																
Group 7 Kearsley Local	CAMPBELL ST																
	CARR ST																
Group 1 Bold (Manweb)	ASHTON-Golborne	Mon-Sun 00:00-06:00 06:00-09:00				Mon-Sun 09:00-15:00 15:00-18:00				Mon-Sun 18:00-19:00 19:00-00:00							
	GOLBORNE			Stage 1 Auto-enable			3% x3 17:00-18:00	Stage 1 Auto-enable				Stage 1 Auto-enable				Stage 1 Auto-enable	
Group 14 Washway Farm	SKELMERSDALE																
	KITT GREEN	Sat-Sun 00:00-06:30 06:30-08:00				Sat-Sun 08:00-19:00 19:00-00:00				Mon-Fri 00:00-06:30 06:30-08:00				Mon-Fri 08:00-19:00 19:00-00:00			
	UPHOLLAND																
Group 8 Macclesfield	BOLLINGTON																
	S.W. MACCLESFIELD										3% x3 17:00-19:00						
Group 2 Bredbury	FALLOWFIELD	Mon-Sun 06:00-11:00		Stage 1 Auto-enable		Mon-Sun 11:00-23:00		Stage 1 Auto-enable		Mon-Sun 23:00-06:00		Stage 1 Auto-enable		Mon-Sun 06:00-11:00		Stage 1 Auto-enable	
	LONGSIGHT		3% x3 16:30-20:00	Stage 1 Auto-enable				Stage 1 Auto-enable			4.5% x3 16:30-20:00	Stage 1 Auto-enable				Stage 1 Auto-enable	
	MOSS SIDE (Longsight)																
	WINIFRED RD																
	VICTORIA PARK	Mon-Fri 00:00-06:00 06:00-14:00				Mon-Fri 14:00-17:00 17:00-00:00				Sat-Sun 05:00 17:00							
	LEVENSHULME						3% x3 16:30-20:00								4.5% x3 16:30-20:00		
	ROMILEY	Mon-Sun 00:00-06:00 06:00-08:00		Stage 1 Auto-enable		Mon-Sun 08:00-16:30 16:30-18:00		Stage 1 Auto-enable		Mon-Sun 18:00-19:30 19:30-00:00		Stage 1 Auto-enable				Stage 1 Auto-enable	
Group 3 Carrington	GREEN LANE-Altrincham										3% x3 16:30-18:00						
	CHASSEN RD		3% x3 17:30-19:00														
	TRAFFORD PARK NORTH	Mon-Sun 00:00-06:00 06:00-12:00				Mon-Sun 12:00-18:00 18:00-00:00											
	IRLAM			Stage 1 Auto-enable			3% x3 16:30-18:00	Stage 1 Auto-enable				Stage 1 Auto-enable				Stage 1 Auto-enable	
	BAGULEY			Stage 1 Auto-enable				Stage 1 Auto-enable			3% x3 17:00-18:30	Stage 1 Auto-enable				Stage 1 Auto-enable	
Group 12 South Manchester	BRIDGEWATER																
	DICKINSON ST	Mon-Thu 00:00-06:00				Mon-Thu 06:00-09:30				Mon-Thu 09:30-17:30				Mon-Thu 17:30-00:00	3% x3 11:00-18:00		
	WILMSLOW	Mon-Sun 17:00-01:00				Mon-Sun 01:00-06:00 06:00-09:00				Mon-Sun 09:00-14:00 14:00-17:00				Mon-Sun 17:00-01:00			
	DIDSBURY																
	WITHINGTON																
Group 13 Stalybridge	DENTON EAST																
	DROYLSDEN EAST																
	OPENSHAW																
	HYDE																
	GOWHOLE																
	STUART ST																
	CENTRAL MANCHESTER	Mon-Fri 18:00-21:00		Stage 1 Auto-enable		Sat-Sun 00:00-00:00		Stage 1 Auto-enable		Mon-Fri 21:00-07:00		Stage 1 Auto-enable		Mon-Fri 07:00-10:00		Stage 1 Auto-enable	
Group 15 Whitegate	MIDDLETON JUNCTION			Stage 1 Auto-enable				Stage 1 Auto-enable				Stage 1 Auto-enable				Stage 1 Auto-enable	
	BELGRAVE																
	WILLOWBANK																

GSP Group	Trial Primaries	29/12/2014				05/01/2015				12/01/2015				19/01/2015			
		Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4
Group 4 Harker / Hutton	EGREMONT					Mon-Sun 01:00-05:00 05:00-08:30				Mon-Sub 08:30-15:30 15:30-17:00				Mon-Sun 17:00-18:30 18:30-01:00	6% x3 17:00-19:00		
	KIRKBY STEPHEN																
	ANNIE PIT						4.5% x3 11:00-13:00										
	CHATSWORTH ST																
Group 5 Heysham	BURROW BECK														4.5% x3 17:00-18:00		
	WESTGATE																
Group 9 Penwortham East / Rochdale SGT 1	BAMBER BRIDGE														4.5% x3 11:00-15:00		
	AVENHAM									Mon-Fri 05:30-09:30 09:30-16:30				Mon-Fri 16:30-21:00 21:00-05:30			
	GRIFFIN																
	DOUGLAS ST																
Group 10 Penwortham West / Stanah	BUCKSHAW	Mon-Fri 09:00-19:00 19:00-01:00				Sat-Sun 03:00 09:00				Sat-Su 15:00 21:00				Mon-Fri 01:00-07:00 07:00-09:00			
	TARLETON																
	CLEVELEYS																
	BLACKPOOL																
	CECIL ST																
Group 11 Rochdale / Padiham	HYNDBURN RD			Stage 1 Auto-enable				Stage 1 Auto-enable				Stage 1 Auto-enable				Stage 1 Auto-enable	
	KINGSWAY																
	LITTLEBOROUGH																
	HEADY HILL																
Group 6 Kearsley	TRINITY																
	HARWOOD																
	CHAMBERHALL																
	BLACKFRIARS			Stage 1 Auto-enable		Mon-Sun 02:00-09:00		Stage 1 Auto-enable		Mon-Sun 09:00-02:00		Stage 1 Auto-enable				Stage 1 Auto-enable	
	LOSTOCK																
Group 7 Kearsley Local	CAMPBELL ST																
	CARR ST																
Group 1 Bold (Manweb)	ASHTON-Golborne					Mon-Sun 00:00-06:00 06:00-09:00				Mon-Su 09:00-15:00 15:00-18:00				Mon-Sun 18:00-19:00 19:00-00:00			
	GOLBORNE			Stage 1 Auto-enable				Stage 1 Auto-enable			3% x3 17:00-18:00	Stage 1 Auto-enable				Stage 1 Auto-enable	
Group 14 Washway Farm	SKELMERSDALE																
	KITT GREEN	Sat-Sun 00:00-06:30 06:30-08:00				Sat-Sun 08:00-19:00 19:00-00:00				Mon-Fri 00:00-06:30 06:30-08:00				Mon-Fri 08:00-19:00 19:00-00:00			
	UPHOLLAND																
Group 8 Macclesfield	BOLLINGTON																
	S.W. MACCLESFIELD						4.5% x3 17:00-19:00								6% x3 17:00-19:00		
Group 2 Bredbury	FALLOWFIELD	Mon-Sun 11:00-23:00		Stage 1 Auto-enable		Mon-Sun 23:00-06:00		Stage 1 Auto-enable		Mon-Su 06:00-11:00		Stage 1 Auto-enable		Mon-Sun 11:00-23:00		Stage 1 Auto-enable	
	LONGSIGHT		6% x3 16:30-20:00	Stage 1 Auto-enable				Stage 1 Auto-enable				Stage 1 Auto-enable				Stage 1 Auto-enable	
	MOSS SIDE (Longsight)																
	WINIFRED RD																
	VICTORIA PARK					Mon-Fri 00:00-06:00 06:00-14:00				Mon-Fr 14:00-17:00 17:00-00:00				Sat-Sun 05:00 17:00			
	LEVENSHULME						6% x3 16:30-20:00										
	ROMILEY		3% x3 17:30-18:30	Stage 1 Auto-enable		Mon-Sun 00:00-06:00 06:00-08:00		Stage 1 Auto-enable		Mon-Su 08:00-16:30 16:30-18:00	4.5% x3 17:30-18:30	Stage 1 Auto-enable		Mon-Sun 18:00-19:30 19:30-00:00		Stage 1 Auto-enable	
Group 3 Carrington	GREEN LANE-Altrincham										4.5% x3 16:30-18:00						
	CHASSEN RD						4.5% x3 17:30-19:00										
	TRAFFORD PARK NORTH					Mon-Sun 00:00-06:00 06:00-12:00				Mon-Sun 12:00-18:00 18:00-00:00							
	IRLAM			Stage 1 Auto-enable				Stage 1 Auto-enable			4.5% x3 16:30-18:00	Stage 1 Auto-enable				Stage 1 Auto-enable	
	BAGULEY			Stage 1 Auto-enable				Stage 1 Auto-enable				Stage 1 Auto-enable			4.5% x3 17:00-18:30	Stage 1 Auto-enable	
Group 12 South Manchester	BRIDGEWATER																
	DICKINSON ST	Sat-Sun 01:00-07:00				Sat-Sun 07:00-10:00				Sat-Sun 10:00-18:00	4.5% x3 11:00-18:00			Sat-Sun 18:00-01:00			
	WILMSLOW					Mon-Sun 01:00-06:00 06:00-09:00				Mon-Su 09:00-14:00 14:00-17:00				Mon-Sun 17:00-01:00			
	DIDSBURY																
	WITHINGTON																
Group 13 Stalybridge	DENTON EAST																
	DROYLSDEN EAST																
	OPENSHAW																
	HYDE																
	GOWHOLE																
	STUART ST																
	CENTRAL MANCHESTER	Mon-Fri 10:00-18:00		Stage 1 Auto-enable		Mon-Fri 18:00-21:00		Stage 1 Auto-enable		Sat-Sun 00:00-00:00		Stage 1 Auto-enable		Mon-Fri 21:00-07:00		Stage 1 Auto-enable	
Group 15 Whitegate	MIDDLETON JUNCTION			Stage 1 Auto-enable				Stage 1 Auto-enable				Stage 1 Auto-enable				Stage 1 Auto-enable	
	BELGRAVE																
	WILLOWBANK																

GSP Group	Trial Primaries	26/01/2015				02/02/2015				09/02/2015				16/02/2015				23/02/2015			
		Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4
Group 4 Harker / Hutton	EGREMONT					Mon-Sun 01:00-05:00 05:00-08:30				Mon-Sun 08:30-15:30 15:30-17:00				Mon-Sun 17:00-18:30 18:30-01:00							
	KIRKBY STEPHEN											Stage 2 Type 2 Central dispatch x3 (ENWL)									
	ANNIE PIT		6% x3 11:00-13:00																		
	CHATSWORTH ST																				
Group 5 Heysham	BURROW BECK											6% x3 17:00-18:00				Stage 2 Type 2 Central dispatch x3 (ENWL)					
	WESTGATE																				
Group 9 Penwortham East / Rochdale SGT 1	BAMBER BRIDGE														6% x3 11:00-15:00						
	AVENHAM	Sat-Sun 09:00-10:30 10:30-16:00				Sat-Sun 16:00-17:00 17:00-09:00															
	GRIFFIN																				
	DOUGLAS ST																				
Group 10 Penwortham West / Stanah	BUCKSHAW	Mon-Fr 09:00-19:00 19:00-01:00				Sat-Sun 03:00 09:00				Sat-Sun 15:00 21:00				Mon-Fri 01:00-07:00 07:00-09:00				Mon-Fri 09:00-19:00 19:00-01:00			
	TARLETON																				
	CLEVELEYS																				
	BLACKPOOL																				
	CECIL ST																				
Group 11 Rochdale / Padiham	HYNDBURN RD			Stage 1 Auto-enable		Mon-Fri 00:00-06:00 06:00-10:00				Mon-Fri 10:00-16:00 16:00-00:00				Sat-Sun 00:00-08:00 08:00-11:00				Sat-Sun 11:00-19:00 19:00-00:00			
	KINGSWAY																				
	LITTLEBOROUGH																				
	HEADY HILL																				
Group 6 Kearsley	TRINITY																				
	HARWOOD																				
	CHAMBERHALL															Stage 2 Type 2 Central dispatch x3 (ENWL)					
	BLACKFRIARS			Stage 1 Auto-enable		Mon-Sun 02:00-09:00				Mon-Sun 09:00-02:00											
	LOSTOCK																				
Group 7 Kearsley Local	CAMPBELL ST																			Stage 2 Type 2 Central dispatch x3 (ENWL)	
	CARR ST																				
Group 1 Bold (Manweb)	ASHTON-Golborne					Mon-Sun 00:00-06:00 06:00-09:00		Stage 2 Type 2 Central dispatch x3 (ENWL)		Mon-Sun 09:00-15:00 15:00-18:00				Mon-Sun 18:00-19:00 19:00-00:00							
	GOLBORNE			Stage 1 Auto-enable							3% x3 17:00-18:00										
Group 14 Washway Farm	SKELMERSDALE																				
	KITT GREEN	Sat-Sun 00:00-06:30 06:30-08:00				Sat-Sun 08:00-19:00 19:00-00:00				Mon-Fri 00:00-06:30 06:30-08:00				Mon-Fri 08:00-19:00 19:00-00:00				Sat-Sun 00:00-06:30 06:30-08:00			
	UPHOLLAND																				
Group 8 Macclesfield	BOLLINGTON																			Stage 2 Type 2 Central dispatch x3 (ENWL)	
	S.W. MACCLESFIELD																				
Group 2 Bredbury	FALLOWFIELD	Mon-Sun 23:00-06:00		Stage 1 Auto-enable																	
	LONGSIGHT			Stage 1 Auto-enable																	
	MOSS SIDE (Longsight)																				
	WINIFRED RD							Stage 2 Type 2 Central dispatch x3 (ENWL)													
	VICTORIA PARK					Mon-Fri 00:00-06:00 06:00-14:00				Mon-Fri 14:00-17:00 17:00-00:00				Sat-Sun 05:00 17:00							
	LEVENSHULME																				
	ROMILEY		6% x3 17:30-18:30	Stage 1 Auto-enable		Mon-Sun 00:00-06:00 06:00-08:00				Mon-Sun 08:00-16:30 16:30-18:00				Mon-Sun 18:00-19:30 19:30-00:00							
Group 3 Carrington	GREEN LANE-Altrincham		6% x3 16:30-18:00																		
	CHASSEN RD						6% x3 17:30-19:00														
	TRAFFORD PARK NORTH					Mon-Sun 00:00-06:00 06:00-12:00				Mon-Sun 12:00-18:00 18:00-00:00		Stage 2 Type 2 Central dispatch x3 (ENWL)									
	IRLAM			Stage 1 Auto-enable							6% x3 16:30-18:00										
	BAGULEY			Stage 1 Auto-enable											6% x3 17:00-18:30						
Group 12 South Manchester	BRIDGEWATER																				
	DICKINSON ST	Mon-Thu 00:00-06:00	6% x3 11:00-18:00			Mon-Thu 06:00-09:30				Mon-Thu 09:30-17:30				Mon-Thu 17:30-00:00				Sat-Sun 01:00-07:00			
	WILMSLOW					Mon-Sun 01:00-06:00 06:00-09:00				Mon-Sun 09:00-14:00 14:00-17:00				Mon-Sun 17:00-01:00							
	DIDSBURY																				
	WITHINGTON																				
Group 13 Stalybridge	DENTON EAST																				
	DROYLSDEN EAST																				
	OPENSHAW																				
	HYDE																				
	GOWHOLE																				
	STUART ST																				
	CENTRAL MANCHESTER	Mon-Fri 07:00-10:00		Stage 1 Auto-enable		Mon-Fri 10:00-18:00				Mon-Fri 18:00-21:00				Sat-Sun 00:00-00:00				Mon-Fri 21:00-07:00			
Group 15 Whitegate	MIDDLETON JUNCTION			Stage 1 Auto-enable																	
	BELGRAVE																				
	WILLOWBANK																				

KEY		
Trial 1	Load Modelling	1 tap increase followed by decrease in next half hour, time of day
Trial 2	Peak Voltage Reduction	Size of voltage reduction, number of tests, time window
Trial 3	Frequency Response	Stage, automatic enable or dispatched centrally (ENWL or NGT)
Trial 4	Reactive Power Absorption	Level of tap stagger

7.5 Season 4

GSP Group	Trial Primaries	Weeks beginning: 02/03/2015				09/03/2015				16/03/2015				23/03/2015				30/03/2015				06/04/2015				13/04/2015				20/04/2015				27/04/2015				04/05/2015				11/05/2015				18/05/2015				25/05/2015			
		Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4	Trial 1	Trial 2	Trial 3	Trial 4
Group 4 Harker / Hutton	EGREMONT	Mon-Sun 01:00-05:00 05:00-08:30				Mon-Sun 08:30-15:30 15:30-17:00				Mon-Sun 17:00-18:30 18:30-01:00				Mon-Sun 01:00-05:00 05:00-08:30				Mon-Sun 08:30-15:30 15:30-17:00				Mon-Sun 17:00-18:30 18:30-01:00				Mon-Sun 01:00-05:00 05:00-08:30				Mon-Sun 08:30-15:30 15:30-17:00				Mon-Sun 17:00-18:30 18:30-01:00																			
	KIRKBY STEPHEN																																																		
	ANNIE PIT															Stage 2 Type 2 Central dispatch (ENWL/NGT)																																					
	CHATSWORTH ST																																																		
Group 5 Heysham	BURROW BECK																																																		
	WESTGATE																																																		
Group 9 Penwortham East / Rochdale SGT 1	BAMBER BRIDGE																																																		
	AVENHAM	Mon-Fri 05:30-09:30 09:30-16:30		Stage 2 Type 2 Central dispatch x3 (ENWL)		Mon-Fri 16:30-21:00 21:00-05:30				Sat-Sun 09:00-10:30 10:30-16:00				Sat-Sun 16:00-17:00 17:00-09:00								Mon-Fri 05:30-09:30 09:30-16:30				Mon-Fri 16:30-21:00 21:00-05:30				Sat-Sun 09:00-10:30 10:30-16:00				Sat-Sun 16:00-17:00 17:00-09:00																			
	GRIFFIN																																																		
	DOUGLAS ST																																																		
Group 10 Penwortham West / Stanah	BUCKSHAW	Mon-Fri 01:00-07:00 07:00-09:00		Stage 2 Type 2 Central dispatch x3 (ENWL)		Mon-Fri 09:00-19:00 19:00-01:00				Sat-Sun 09:00 09:00				Sat-Sun 15:00 21:00				Mon-Fri 01:00-07:00 07:00-09:00				Mon-Fri 09:00-19:00 19:00-01:00				Sat-Sun 03:00 09:00				Sat-Sun 15:00 21:00																			
	TARLETON																																																		
	CLEVELEYS																																																		
	BLACKPOOL																																																		
	CECIL ST																																																		
Group 11 Rochdale / Padiham	HYNDBURN RD	Mon-Fri 00:00-06:00 06:00-10:00				Mon-Fri 10:00-16:00 16:00-00:00		Stage 2 Type 2 Central dispatch x3 (ENWL)		Sat-Sun 00:00-08:00 08:00-11:00				Sat-Sun 11:00-19:00 19:00-00:00																																									
	KINGSWAY																																																		
	LITTLEBOROUGH															Stage 2 Type 2 Central dispatch (ENWL/NGT)																																					
	HEADY HILL																																																		
Group 6 Kearsley	TRINITY																																																		
	HARWOOD																																																		
	CHAMBERHALL																																																		
	BLACKFRIARS	Mon-Sun 02:00-09:00				Mon-Sun 09:00-02:00																Mon-Sun 02:00-09:00				Mon-Sun 09:00-02:00																											
	LOSTOCK																																																		
Group 7 Kearsley Local	CAMPBELL ST																																																		
	CARR ST																																																		
Group 1 Bold (Manweb)	ASHTON-Golborne	Mon-Sun 00:00-06:00 06:00-09:00				Mon-Sun 09:00-15:00 15:00-18:00				Mon-Sun 18:00-19:00 19:00-00:00				Mon-Sun 00:00-06:00 06:00-09:00				Mon-Sun 09:00-15:00 15:00-18:00				Mon-Sun 18:00-19:00 19:00-00:00				Mon-Sun 00:00-06:00 06:00-09:00				Mon-Sun 09:00-15:00 15:00-18:00				Mon-Sun 18:00-19:00 19:00-00:00																			
	GOLBORNE																																																		
Group 14 Washway Farm	SKELMERSDALE											Stage 2 Type 2 Central dispatch x3 (ENWL)																																														
	KITT GREEN	Sat-Sun 08:00-13:00 19:00-00:00				Mon-Fri 00:00-06:30 06:30-08:00				Mon-Fri 08:00-19:00 19:00-00:00				Sat-Sun 00:00-06:30 06:30-08:00				Sat-Sun 08:00-19:00 19:00-00:00				Mon-Fri 05:00-06:30 06:30-08:00				Mon-Fri 08:00-19:00 19:00-00:00				Sat-Sun 00:00-06:30 06:30-08:00				Sat-Sun 08:00-19:00 19:00-00:00																			
	UPHOLLAND																																																		
Group 8 Macclesfield	BOLLINGTON																			Stage 2 Type 2 Central dispatch (ENWL/NGT)																																					
	S.W. MACCLESFIELD																																																		
Group 2 Bredbury	FALLOWFIELD																	Mon-Sun 06:00-11:00								Mon-Sun 11:00-23:00				Mon-Sun 23:00-06:00				Mon-Sun 06:00-11:00				Mon-Sun 11:00-23:00				Mon-Sun 23:00-06:00											
	LONGSIGHT																																																		
	MOSS SIDE (Longsight)																																																		
	WINIFRED RD																																																		
	VICTORIA PARK	Mon-Fri 00:00-06:00 06:00-14:00				Mon-Fri 14:00-17:00 17:00-00:00				Sat-Sun 05:00 17:00												Mon-Fri 05:00-06:00 06:00-14:00				Mon-Fri 14:00-17:00 17:00-00:00				Sat-Sun 05:00 17:00																			
	LEVENSHULME																																																	
	ROMILEY																	Mon-Sun 00:00-08:00 08:00-08:00				Mon-Sun 08:00-16:30 16:30-18:00				Mon-Sun 18:00-19:30 19:30-00:00				Mon-Sun 00:00-06:00 06:00-08:00				Mon-Sun 08:00-16:30 16:30-18:00				Mon-Sun 18:00-19:30 19:30-00:00											
Group 3 Carrington	GREEN LANE-Altrincham																																																	
	CHASSEN RD																																																	
	TRAFFORD PARK NORTH	Mon-Sun 00:00-06:00 06:00-12:00				Mon-Sun 12:00-18:00 18:00-00:00																Mon-Sun 00:00-06:00 06:00-12:00				Mon-Sun 12:00-18:00 18:00-00:00																							
	IRLAM																																																	
	BAGULEY																			Stage 2 Type 2 Central dispatch (ENWL/NGT)																																					
Group 12 South Manchester	BRIDGEWATER							Stage 2 Type 2 Central dispatch x3 (ENWL)																																														
	DICKINSON ST	Sat-Sun 07:00-10:00				Sat-Sun 10:00-18:00				Sat-Sun 18:00-01:00				Mon-Thu 00:00-06:00				Mon-Thu 06:00-09:30				Mon-Thu 09:30-17:30				Mon-Thu 17:30-00:00				Sat-Sun 01:00-07:00				Sat-Sun 07:00-10:00				Sat-Sun 10:00-18:00				Sat-Sun 18:00-01:00											
	WILMSLOW	Mon-Sun 01:00-06:00 06:00-09:00				Mon-Sun 09:00-14:00 14:00-17:00				Mon-Sun 17:00-01:00				Mon-Sun 01:00-06:00 06:00-09:00				Mon-Sun 09:00-14:00 14:00-17:00				Mon-Sun 17:00-01:00				Mon-Sun 01:00-06:00 06:00-09:00				Mon-Sun 09:00-14:00 14:00-17:00				Mon-Sun 17:00-01:00																			
	DIDSBURY																																																	
	WITHINGTON																																																	
Group 13 Stalybridge	DENTON EAST											Stage 2 Type 2 Central dispatch x3 (ENWL)																																													
	DROYLSDEN EAST																																																	
	OPENSHAW																																																	
	HYDE																																																	
	GOWHOLE																																																	
	STUART ST																																																	
	CENTRAL MANCHESTER	Mon-Fri 07:00-10:00				Mon-Fri 10:00-18:00				Mon-Fri 18:00-21:00				Sat-Sun 00:00-00:00				Mon-Fri 21:00-07:00				Mon-Fri 07:00-10:00				Mon-Fri 10:00-18:00				Mon-Fri 18:00-21:00				Sat-Sun 00:00-00:00																			
Group 15 Whitegate	MIDDLETON JUNCTION											Stage 2 Type 2 Central dispatch x3 (ENWL)																																													
	BELGRAVE																																																	
	WILLOWBANK																																																	

KEY		
Trial 1	Load Modelling	1 tap increase followed by decrease in next half hour, time of day
Trial 2	Peak Voltage Reduction	Size of voltage reduction, number of tests, time window
Trial 3	Frequency Response	Stage, automatic enable or dispatched centrally (ENWL or NGT)
Trial 4	Transient Power Absorption	Level of tap Stage2