CLASS Monitoring Location Selection

CLASS Project

Produced by: Electricity North West
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CONTENTS

VERSION HISTORY

Version	Date	Author	Status (draft, etc)	Comments
1	*30 August 2013*	*Electricity North West*	*Final*	

GLOSSARY OF TERMS

Abbreviation	Term
AVC	*Automatic Voltage Control*
CLASS	*Customer Load Active System Services*
CVA	*Central Volume Allocation*
GPRS	*General Packet Radio Service*
GSP	*Grid Supply Point*
HV	*High Voltage*
LCN	*Low Carbon Networks*
LV	*Low Voltage*
Ofgem	*Office of the Gas and Electricity Markets*
PC	*Profile Class*
PLS	*Peak Load Share*
SDRC	*Successful Delivery Reward Criteria*
TSO	*Transmission System Operator*

All other definitions shown starting with a Capital letter are as per LCN Fund Governance Document v6.

1 EXECUTIVE SUMMARY

The Ofgem Project Direction issued on 21st December 2012, outlines a number of Successful Delivery Reward Criteria (SDRCs) against which the success of the Customer Load Active System Services (CLASS) project will be assessed. For each criterion, the Project Direction defines the evidence that is required to demonstrate successful delivery. There are seven discrete SDRC evidence required for the Technology Build Workstream of the CLASS project (as per the list below).

This report is one of two[1] documents to deliver evidence 2 on the list.

1. Publish the design of the regulation scheme for substation Voltage Controllers by February 2014
2. ***Publish the site selection report including the methodology by August 2013***
3. Network monitoring equipment installed and commissioned by March 2014
4. Publish the commissioning reports by April 2014
5. Technology go-live by April 2014
6. ICCP installed and commissioned by March 2014
7. Publish the ICCP commissioning reports by April 2014

In order to conduct analyses, share learning and assess the CLASS hypotheses, a range of data will have to be collected throughout the various CLASS trials. Amongst other things, voltage, power and power quality data will be collected to quantify the effects of the CLASS techniques.

This report describes and applies a robust methodology for identifying the locations where monitoring equipment for the CLASS trials will be installed. It should be noted however, that this report does not address the specification of monitoring equipment.

The key points from the report are as follows:

- Monitoring will be undertaken at all Grid Supply Points, ie, where Electricity North West's network interfaces with the National Grid transmission network, to observe the aggregate effect of CLASS techniques and any effects on the national electricity network.
- All Primaries included in the CLASS trials will have monitoring equipment installed to facilitate evaluation of the relationship between voltage change and demand response. This will be done by modifying existing transducer systems.
- 10 HV and 45 LV monitors will be located in areas where customers are most likely to observe a change in their electricity supply.

[1] This report should be read in conjunction with the *CLASS Trial Substation Methodology Report*, which together with report, delivers evidence 2 above.

2 INTRODUCTION

The Customer Load Active System Services (CLASS) project is funded via Ofgem's Low Carbon Networks (LCN) second tier funding mechanism. Electricity North West received formal notification of selection for funding on 21 December 2012. The project is due for completion by 30 September 2015.

CLASS is investigating how reactive power flow and demand response change when voltage is varied through Primary transformer taps. It is assessing opportunities for:-

i. reducing network peak demand and so defer network reinforcement
ii. providing frequency control through demand response
iii. managing National Grid network voltages through reactive power absorption

Extensive CLASS trials are planned to assess whether the objectives above can be achieved. During these trials, tap positions of parallel Primary transformers will be changed simultaneously and staggered to observe the response of system loads at different times of the day and throughout the annual load cycle. Trial results will enable evaluation of the applicability of the CLASS techniques.

During the CLASS trials, voltage regulation techniques will be applied to manage voltage at the Primary substation. This will in turn cause changes in voltages downstream on the network. However, the changes in voltage downstream are unlikely to be of exactly the same magnitude as that at the Primary substation. Strategic monitoring is therefore required to measure the changes and impacts across the trial area.

This report[2] describes and applies a robust methodology to identify locations for monitoring equipment to record voltage, power and power quality, across the whole network and throughout the CLASS trials.

[2] In this report, Primary substations are defined as those having voltage ratios of 132kV or 33kV to 11kV or 6.6kV. The acronym HV is used throughout this report to mean 11kV or 6.6 kV.

3 MONITORING OBJECTIVES

Monitoring in CLASS is necessary to provide insight on a number of issues, including:-

- Extent of the benefits of CLASS
- How/when CLASS would be best applied
- Effect on network capacity
- Impact on customers

It is therefore important that appropriate locations for monitoring equipment are identified, to enable those effects to be thoroughly assessed. Specifically, monitoring will be undertaken at (a) Electricity North West's 132kV interface with the Grid, (b) the 11/6.6kV side of Primary substations and on the HV system; and (c) on the LV system. This is illustrated in

Figure 1.

Additional monitoring to assess the effects of the CLASS trial will be undertaken through existing monitoring equipment on Electricity North West's network. This monitoring equipment have been installed as part of Electricity North West's other Low Carbon Network (LCN) fund projects, namely the LV Network Solutions project and the Capacity to Customers (C_2C) project[3].

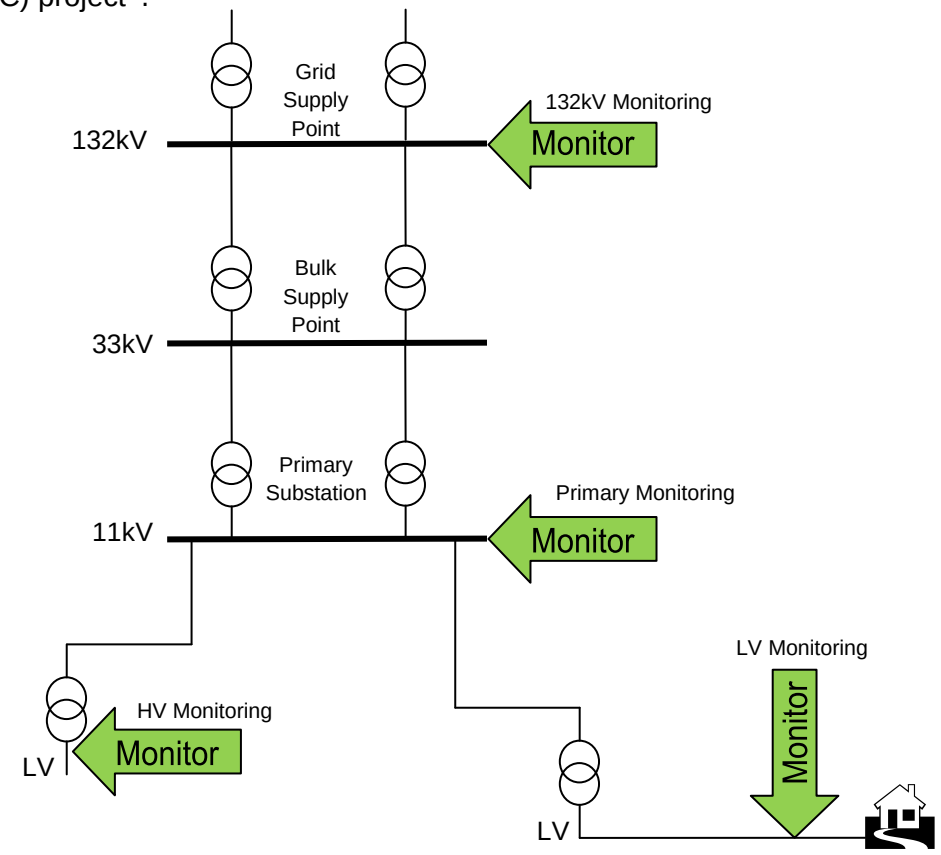


Figure 1: Illustration of CLASS monitoring requirements

[3] https://www.ofgem.gov.uk/electricity/distribution-networks/network-innovation/low-carbon-network-fund/first-tier-projects/electricity-north-west-limited

4 132KV MONITORING

Amongst other things, CLASS will investigate whether various Frequency Response services can be provided to the National Electricity Transmission System Operator (NETSO). As such, it is important to measure what effect the CLASS techniques have at the Grid interface.

To this end, monitoring will be undertaken at all interface points between Electricity North West and National Grid.

There is currently Central Volume Allocation (CVA) metering using transducers installed at the 132kV interfaces between the Electricity North West's network and the National Grid system. These interfaces are also known as Grid Supply Points (GSPs).

For the purpose of the CLASS trials, which is essentially a 'proof of concept', existing instrumentation at all 132kV Grid Interfaces is expected to suffice. However, in any wider deployment of the CLASS techniques, these measurements would need to be of higher accuracy.

5 PRIMARY SUBSTATION MONITORING

Assessing the change in demand observed at a Primary substation (typically 33/11kV or 33/6.6kV) resulting from a change in voltage resulting from Primary transformer tapping, is an important learning point for CLASS. Furthermore, CLASS will assess the effect on circulating reactive power that can be achieved by staggering the taps of parallel Primary transformers. Voltage and current monitoring at the Primary substation is essential to provide the data to analyse both of the above.

All of Electricity North West's Primary substations have voltage, current. MW and MVAr transducers installed. As part of CLASS, it is proposed to replace these units (at those Primaries in the CLASS trials), with an ALSTOM iSTAT i5MT transducer for both (T11/T12) primary transformers at each CLASS site.

These transducers take in 3 phase AC voltage information from 11/6.6kV:110v T11/T12 voltage transformers (VT) and their respective red & blue phase metering current transformers (CT) of approximately 2000:5A rating (dependent on transformers rating and secondary voltage level). Using three phase voltage inputs and two phases of current inputs utilises the two wattmeter measurement method which is valid for balanced or unbalanced loads. The transducers send large volumes of information regarding voltage, current, frequency, MW, MVAr and power-factor of the T11/T12 Primary transformers secondary side to the Nortec Envoy 3G transmitter via an RS485 output on I/O 4. The data sent via the RS485 link is at a sub-second time resolution and sub volt/ampere magnitude granularity. In addition these transducers are required to send MW/MVAr information to the Telecontrol RTU (SCADA Outstation) via business as usual 0-20mA DC wiring from I/O 1 & I/O 2 outputs. The transducers are powered from a separate fused 110v DC power supply.

Primary HV monitoring, using updated transducers will be undertaken at all 60 Primaries included in the trial.

6 HV SYSTEM MONITORING

HV monitoring will be installed at 10 locations to enable assessment of the effects of CLASS techniques on the downstream network. Cost constraints and practical difficulties in installing HV monitoring equipment at distribution substations, means that HV monitoring will actually occur at the LV side of distribution transformers.

One of the CLASS trials will involve automatic tapping of transformers at 10 Primary substations. During this specific trial, taps will be automatically stepped to reduce voltage and demand when the frequency falls below the threshold setting. The 10 Primary substations where this trial will be undertaken, were chosen based upon the type of tap control relays already installed and their location (indoor preferred).

7 LV SYSTEM MONITORING

7.1 LV System Monitoring Location Selection Methodology

A range of LV monitoring is required throughout the trial. This understanding is vital for interpretation and cross-checking the customer survey results. It should be noted however, that the only expected impact on a customer's power quality is voltage magnitude. Harmonics and flicker are not expected to be affected. The LV monitoring will seek to verify this.

Monitors will be installed at 45 LV locations as part of the CLASS trial. This is in addition to 10 HV locations (LV side of HV/LV distribution substations as discussed in section 6). Therefore, there will be 55 monitoring sites on the LV network.

55 locations for LV monitoring have accordingly been identified in this report. Additionally, a further five sites have been identified as 'contingencies', ie, in the event that any of the current 55 are deemed impractical. This may arise for example, if site surveys conclude that the General Packet Radio Service (GPRS) data service required for communicating with the monitoring equipment is not be suitable. Additionally, some locations may not be suitable for the monitoring cabinet due to issues arising from land conditions, ownership or public inconvenience.

The LV monitoring site selection process has concentrated on locations where customers are expected to have the lowest existing voltages, and hence have low tolerance for voltage changes. Key to the CLASS techniques is that voltage must remain within statutory limits.

7.2 Description of the LV monitoring site selection methodology

The methodology for identifying suitable LV monitoring locations is summarised in Figure 2 below. Each step is discussed in detail in the subsequent subsections.

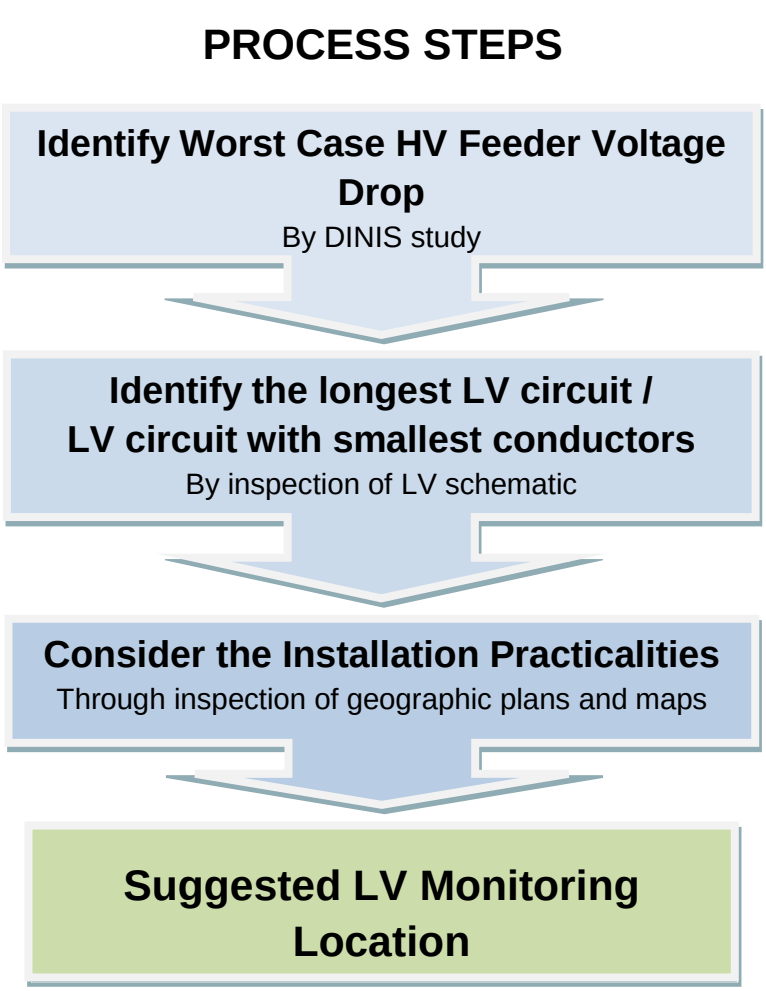


Figure 2 : LV Monitoring Location Selection Methodology

7.2.1 Step 1: Identify Worst Case HV Feeder Voltage Drop

It is assumed that the LV customer with the lowest voltage will be supplied via a distribution substation at the end of a HV feeder where the voltage drop is greatest. This is based on the assumption that all distribution substations operate on the same fixed tap.

For each Primary substation in the CLASS trial, a Distribution Network Information System (DINIS) study was conducted to identify the distribution substation with the greatest HV voltage drop relative to the Primary.

7.2.2 Step 2: Identify the longest LV circuit / circuit with smallest conductors

It is assumed that the customers most likely to experience the greatest voltage drops will be those at the end of the longest LV feeders. The schematic for the LV system identified as having the worst HV voltage drop (in step 1 above) was used to identify the longest LV feeder. Conductor size was also considered when identifying an appropriate LV feeder, as smaller conductors with greater impedances result in greater voltage drops.

In some cases, the distribution substation identified as having the worst HV voltage drop in step 1 was found to supply only a single customer, supply a very limited LV network, and in some cases, supplied a network on private land only. These distribution substations were excluded as LV monitoring locations, and in these cases, the distribution substation next along the same HV circuit was selected.

7.2.3 Step 3: Consideration of Installation Practicalities

In order to connect monitoring equipment to an underground cable (as normally necessary in urban areas), it is necessary to install a smart joint on the cable. The actual monitoring equipment itself is housed in an LV cabinet (above ground) adjacent to the smart joint.

Ideally, the cabinet should be installed in a public right of way where Electricity North West has statutory rights. Space, avoidance of obstruction and land ownership were therefore considered when identifying locations for monitoring equipment.

The monitoring devices will be fitted to an LV pole in rural areas, where such areas are supplied by overhead lines rather than underground cable.

7.3 Sites selected

A detailed list of the 45 LV monitoring locations for the CLASS trial can be found in Appendix A table A.1.

Table A.1 also identifies the 10 HV monitoring locations corresponding to the Primaries where the frequency control trials will be undertaken.

Table A.1 identifies 23 locations where monitoring equipment already exists, and which will be utilised within the CLASS trial. This monitoring equipment has been installed as part of Electricity North West's other Low Carbon Network (LCN) fund projects, namely the LV Network Solutions project and the Capacity to Customers (C_2C) project.

Overall, the selection ensures that there will be at least one LV monitoring location for each of the Primary substations included in the CLASS trial, using either existing monitors or the proposed new monitors.

Table A.2 shows the locations for the LV monitoring equipment that will be installed for CLASS.

A detailed information sheet has been created for each of the monitoring locations. An example sheet is shown at Appendix B.

The following information for each location is provided:-

- Distribution substation name
- Distribution substation number
- Identifier for the LV circuit
- Conductor type at the suggested monitoring point
- Description of the suggested monitoring point

- Co-ordinates of the suggested monitoring location
- Screen shots of:-
    - LV schematic
    - ESCAR geographic plan
    - Google map showing local area
    - Google street map of suggested monitoring location if available

8 CONCLUSIONS

To maximise the learning from CLASS, a robust methodology has been developed and applied to identify suitable sites for the CLASS monitoring equipment.

The outcome of this process is summarised as follows:

- 132kV monitoring is to be ongoing at all grid interfaces using existing monitoring equipment
- To collect data at Primary substation level, monitoring will be undertaken at all 60 primaries in the CLASS trials.
- 10 HV monitoring locations have been selected to match up to the 10 Primaries selected for frequency response trials. However, 12 additional HV monitoring locations from the C_2C project will be utilised to provide data for CLASS.
- The selection ensures that there will be at least one LV monitoring location for each of the Primary substations included in the CLASS trial, using either existing monitors or the proposed new monitoring equipment.

The monitoring location selection and methodology for the CLASS trials is considered to be robust, and is expected to provide a sufficient amount of data to assess the CLASS hypotheses and enable further analyses and learning.

APPENDIX A – CLASS LV MONITORING LOCATIONS

Table A.1: LV Monitoring

Primary Substation included in CLASS Trial	CLASS LV monitoring to be installed	CLASS HV monitoring to be installed	Existing LV Network Solutions project monitoring to be utilised	Existing C_2C LV monitoring to be utilised
ASHTON-Golborne			yes	
ANNIE PIT	yes			
AVENHAM	yes			
BAGULEY	yes	yes		
BAMBER BRIDGE				
BELGRAVE	yes			
BLACKFRIARS	yes	yes		
BLACKPOOL	yes			
BOLLINGTON	yes			
BRIDGEWATER	yes			
BUCKSHAW	yes			
BURROW BECK	yes			
CAMPBELL ST			yes	
Central Manchester	yes	yes		
CARR ST	yes			
Cecil St				
CHAMBERHALL	yes			
CHASSEN RD	yes			
CHATSWORTH ST				yes
CLEVELEYS	yes			
DENTON EAST	yes			
DICKINSON ST				yes
DIDSBURY	yes			
DOUGLAS ST	yes			
DROYLSDEN EAST			yes	yes
EGREMONT	yes			
FALLOWFIELD	yes	yes		
GOLBORNE		yes	yes	
GOWHOLE	yes			
GREEN LANE-Altrincham	yes			
GRIFFIN				yes
HARWOOD			yes	
HEADY HILL	yes			
HYDE	yes			
HYNDBURN RD	yes	yes		
IRLAM	yes	yes		
KINGSWAY	yes			
KIRKBY STEPHEN	yes			
KITT GREEN	yes			
LEVENSHULME	yes			
LITTLEBOROUGH	yes			
LONGSIGHT	yes	yes		

Primary Substation included in CLASS Trial	CLASS LV monitoring to be installed	CLASS HV monitoring to be installed	Existing LV Network Solutions project monitoring to be utilised	Existing C_2C LV monitoring to be utilised
LOSTOCK	yes			
MIDDLETON JUNCTION		yes	yes	
MOSS SIDE (Longsight)	yes			
OPENSHAW	yes			
ROMILEY	yes	yes		
S.W.MACCLESFIELD			yes	
SKELMERSDALE	yes			
STUART ST	yes			
TARLETON	yes			
TRAFFORD PARK NORTH	yes			
TRINITY	yes			
UPHOLLAND	yes			
VICTORIA PARK			yes	
WESTGATE	yes			
WILLOWBANK	yes			
WILMSLOW			yes	
WINIFRED RD			yes	
WITHINGTON	yes			
TOTAL	**45**	**10**	**10**	**4**

APPENDIX A – CLASS LV MONITORING LOCATIONS

Table A.2 : Suggested LV Monitoring Locations

Primary Substation Name	Chosen Distribution Substation	Distribution Substation Number	LV Feeder Description	Cable Type at Suggested Monitoring Location	Suggested LV Monitoring Location	Suggested Monitoring Location Co-ordinates
ASHTON-Golborne	WHEATLEA ROAD	211388	HOTEL	240XC	CAXTON CLOSE, WIGAN WN3 6XU	356762 402529
ANNIE PIT	SMITHS FACTORY SALTERBECK	621665	POOLE ROAD	4C 0.06 CU	NR STREET LAMP IN PAVEMENT ON GARNET CRESCENT OPP No.s 29 and 31 near to junction with Topaz Terrace	299450 526361
AVENHAM	WESTCLIFFE TERRACE	418219	WESTCLIFFE TERRACE	3C 95 SAC XC TP	IN PAVEMENT OPP 43 WESTCLIFFE TERRACE BACK GATE	353307 428914
BAGULEY	MOSSDALE ROAD	171548	MOSSDALE RD	4C 0.04 UA	IN PAVEMENT ON MOORCROFT RD OPP 58 AT THE CORNER OF BUTTON LANE	381004 390474
BELGRAVE	CURLEW ST	310894	WAY 3 WILDING AVE LINK BOX 705			
BLACKFRIARS	ALBERT PARK OFF GT CLOWES ST	165102	ALBERT PARK RD	3C 0.12 AS	IN PAVEMENT OPP NO 3 CROFT ST NEAR STREET LAMP	382496 400097
BLACKPOOL	BANK ST FLATS	423444	WAY 2 UG BOX 437			
BOLLINGTON	PRIEST LANE	335738	WILMSLOW RD	4X 95 AC ABC	POLE 01 ON BLACKHURST BROW	387891 378944
BRIDGEWATER	ATWOOD ST BRDG WAT BSMT	166093	PRINCESS ST	4C 0.25	IN PAVEMENT OPP NO. 88 PRINCESS STREET	384320 397571
BUCKSHAW	DAWSON LANE O/D	414143	WAY 2 DAWSON LN			
BURROW BECK	MOSS LANE	641139	MOSS LANE	4C 0.15 CU	INSTALL IN THE GRASS VERGE	345275 454387

Primary Substation Name	Chosen Distribution Substation	Distribution Substation Number	LV Feeder Description	Cable Type at Suggested Monitoring Location	Suggested LV Monitoring Location	Suggested Monitoring Location Co-ordinates
	THURNHAM				OPPOSTE BARBERS COTTAGE ON MOSS LANE	
CAMPBELL ST	SUMMERFIELD RD	238455	MANCHESTER RD (FARSIDE)	4C 0.06	IN PAVEMENT OPPOSITE TASKERS NIGHTCLUB ON MANCHESTER RD	372755 407597
CARR ST	WARDLEY HALL LANE, WALKDEN	217505	WARDLEY HALL LANE	4C 0.2 SAC	IN PAVEMENT OPP NO. 64 WARDLEY LANE	375365 401770
CENTRAL MANCHESTER	ALTRINCHAM ST	166141	WAY 2 LONDON RD/ MANCUNIAN WAY			
CHAMBERHALL	PARK FARM	232231			SUGGEST THAT MONITORING IS INSTALLED AT THE DISTRIBUTION TRANSFORMER IN THIS CASE	380144 416049
CHASSEN RD	WOODHOUSE ROAD	166226	NURSERY RD M41	4C 0.1 AS	IN THE PAVEMENT ON THE CORNER OF NURSERY RD AND LABURNUM RD OPP NO. 3	375669 395744
CHATSWORTH ST	DUNCAN STREET	618031	ST VINCENT / KEITH ST	4C 0.15 CU	INSTALL IN THE PAVEMENT OPP NO. 3 KEITH ST	319594 469182
CLEVELEYS	OSBORNE RD, FLEETWOOD	423346	WESTBORNE RD (WEST NEARSIDE)	4C 0.06	IN PAVEMENT OPP NO. 91 GREEN DRIVE	331377 444386
DENTON EAST	DENBIGH ROAD	171523	LANCASTER RD/DENBIGH RD	4C 0.2 SAC	IN PAVEMENT ON WARWICK RD OPP NO. 11	392860 394033
DICKINSON ST	HOLIDAY INN, HULME ST	168345	OXFORD ST	4C 0.25	IN PAVEMENT OPP NO. 74 OXFORD ST	384105 397526
DIDSBURY	NORVIEW DRIVE, DIDSBURY	171991	TANFIELD DRIVE	4C 0.06 UA	IN PAVEMENT OPP NO. 64 TANFIELD RD	384639 389471
DOUGLAS ST	COMPASS ROAD OFF CHAIN CAUL WAY	417210	ADMIRAL WAY	3C 300 SAC XC TP	IN PAVEMENT OPPOSITE STRATSTONE	349926 429628

Primary Substation Name	Chosen Distribution Substation	Distribution Substation Number	LV Feeder Description	Cable Type at Suggested Monitoring Location	Suggested LV Monitoring Location	Suggested Monitoring Location Co-ordinates
DROYLSDEN EAST	WEST DRIVE, DROYLSDEN	172129	ASHDALE CRESCENT (GOING NORTH FROM SUBSTN)	4C 0.06	IN PAVEMENT OPP NO. 105 ASHDALE CRESCENT	389893 398453
EGREMONT	PARK STEET	621047	ONLY ONE CIRCUIT FROM PMT	35 SAC PC	IN GRASS VERGE OPP LOWTHER HOUSE ON A5086 PARKSIDE RD, FRIZINGTON	303478 516289
FALLOWFIELD	HEALD GROVE	171810	MOSS LANE EAST M14	4C 0.25 AS	PAVEMENT OUTSIDE 386 MOSS LANE EAST (NR FAIRBANK AVE)	384496 395712
GOLBORNE	COLLIERS TENEMENTS PMT	216260	OLD CARR HOUSE WA3	0.1	EAST LANCASHIRE HOUSE, OPPOSITE OLD CARR HOUSE	365111 397580
GOWHOLE	LITTLE HAYFIELD, GLOSSOP RD	331815	ON CIRCUIT (SECTION GOING SOUTH)	4 X 95 ABC	ON POLE 12, OTHERWISE AT LV SIDE OF DISTRIBUTION SUB	403542 387776
GREEN LANE-Altrincham	WOOD RD	171867	FRAMINGHAM RD M33	4C 0.25 D	IN THE PAVEMENT NR THE JUNCTION OF FRAMINGTON RD AND BROOKLANDS RD	379040 390149
GRIFFIN	MIRE ASH					
GRIFFIN	REVIDGE RD					
HARWOOD	HOOVER LTD	231780	MEADOW LANE (FARSIDE)	3C 95 SAC XC TP	IN PAVEMENT ON MEADOW LANE NEAR ENTRANCE TO WAREHOUSE	374969 409480

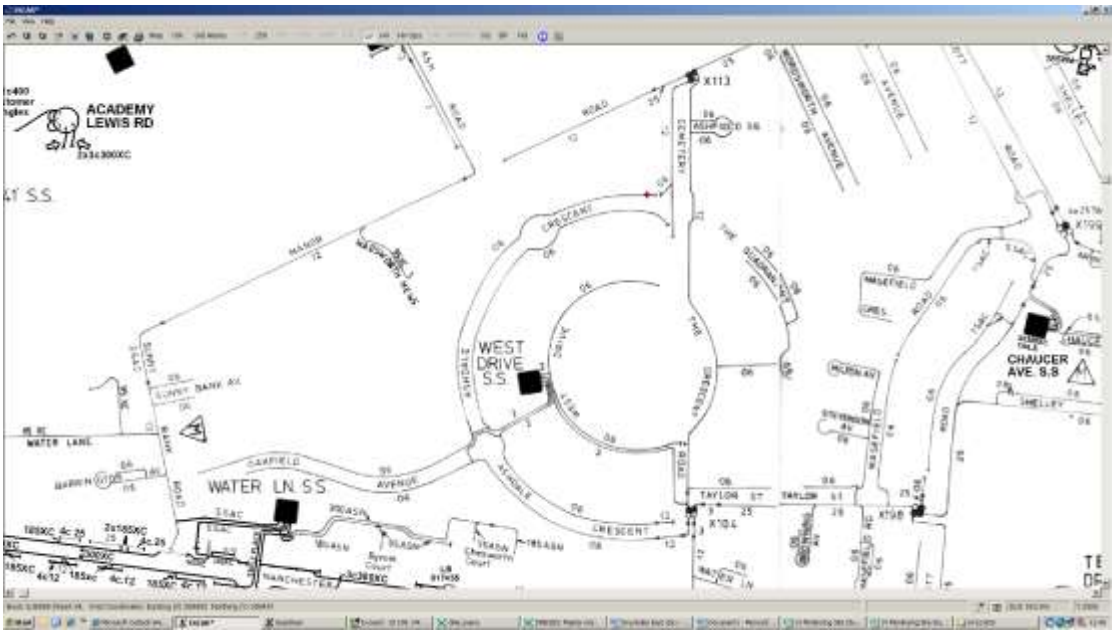
Primary Substation Name	Chosen Distribution Substation	Distribution Substation Number	LV Feeder Description	Cable Type at Suggested Monitoring Location	Suggested LV Monitoring Location	Suggested Monitoring Location Co-ordinates
					DEPOT CAR PARK	
HEADY HILL	ST MICHAEL, HEYWOOD	232157	NORDEN ROAD	3C 95 SAC ASN	IN PAVEMENT OPP 27 BEECHFIELD	386081 412558
HYDE	HYDES FARM, COMPSTALL	320704	ONE CIRCUIT	3C 95 SAC XC	ON THE ROAD OF THE LV CIRCUIT GOING NORTH	396596 391768
HYNDBURN RD	SCAITCLIFFE ST	451930	SCAITCLIFFE ST	4C 0.06	IN PAVEMENT AT THE CORNER OF WILLOWS LANE AND SCAITCLIFFE ST	375526 428575
IRLAM	BARTON GRANGE FM	168036	BARTON GRANGE	35 SAC PC	IN THE TRACK NR TO SUBSTATION	372813 396084
KINGSWAY	CHARELS BABBAGE	329089	WAY 2 PLOT D			
KIRKBY STEPHEN	GAYTHORN BUNGALOW	662008	ONLY ONE SHORT FEEDER	3W 0.05 HDC	PMT	364278 512427
KITT GREEN	ATHLETICS ARENA ADJ ATHLETICS ARENA	211236	ATHLETICS ARENA	3C 240 SAC XC TP	IN PAVEMENT OUTSIDE SPORTS CENTRE. NEED TO BE FLEXIBLE AS LAND MIGHT BE PRIVATELY OWNED	356723 405639
LEVENSHULME	WESTCROFT ST	172037	BAYSWATER RD			
LITTLEBOROUGH	STANSFIELD MEADOWS 16 DRAKE ST L/B	314548	DRAKE ROAD (WEST OUT OF SUB)	5C 0.06	IN PAVEMENT OPP NO. 49 DRAKE RD	394407 417962
LONGSIGHT	MELROSE APARTMENTS	172599	HATHERSAGE RD M13 0EJ	4C 0.25	PAVEMENT OUTSIDE VARSITY BAR AT JUNCTION OF HATHERSAGE RD AND OXFORD RD	385016 395847
LOSTOCK	SNOWDEN DRIVE	231397	DOUGLAS CLOSE	4C 0.2 SAC	IN PAVEMENT OPP NO. 14 DOUGLAS AVENUE	364218 412021
MIDDLETON	TOUCHET HALL RD,	327053	TOUCHET HALL	3C 185 SAC	IN PAVEMENT ON TOUCHET HALL RD	388638 407745

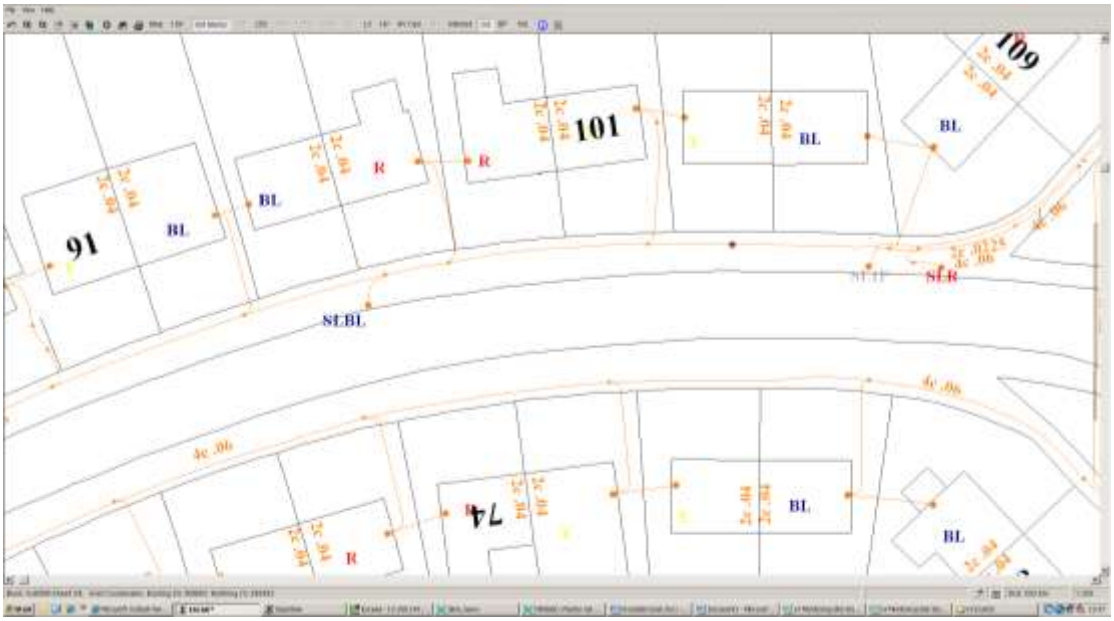
Primary Substation Name	Chosen Distribution Substation	Distribution Substation Number	LV Feeder Description	Cable Type at Suggested Monitoring Location	Suggested LV Monitoring Location	Suggested Monitoring Location Co-ordinates
JUNCTION	MIDDLETON		RD NORTH	ASN	OPP STAKE HILL INDUSTRIAL ESTATE AND NEAR GATE 2 OF YODEL	
MOSS SIDE (Longsight)	SPRING BRIDGE	171949	SPRING BRIDGE RD FARSIDE	4C 0.12	PAVEMENT OUTSIDE NO. 3 HIGHBURY RD M16 8PT	383471 394152
OPENSHAW	CADMIUM WALK	172409	COLLIN AVE	3C 300 SAC XC	IN PAVEMENT OPP NO. 71 TO 81 COLLIN AVE	388395 395626
ROMILEY	MAYFIELD RD	333821	COMPSTALL RD	5C 0.06	IN THE PAVEMENT OPPOSITE 177 COMPSTALL RD, ROMILEY SK6 5HA	396597 389999
S.W. MACCLESFIELD	NORTH RODE STN NORTH RODE	331935	ONE FEEDER ONLY	4C 95 SAC XC	IN PAVEMENT OPP FIRST HOUSE ON STATION RD	390059 366750
SKELMERSDALE	BRANDRETH DELPH, PARBOLD	415312	BRANDRETH DELPH	3C 95 SAC ASN	IN PAVEMENT OPP NO. 18 BRANDRETH DELPH	349633 411461
STUART ST	REPTON AVE, DROYLSDEN	172115	BRISTOW ST	4C 0.06	IN PAVEMENT OPP NO. 51 N CRESCENT	388736 399100
TARLETON	CARR LANE, CARR LANE MUCH HOOLE	417164	ONE CIRCUIT ONLY	5X 0.06 CU	ON POLE 482203	348181 422892
TRAFFORD PARK NORTH	TENAX ROAD	166922	TOWARDS MOORINGS RD	3C 300 SAC XC	IN PAVEMENT OFF THE TENAX CIRCLE ROUNDABOUT OPPOSITE ARCO	378705 397574
TRINITY	NEW QUAY ST	165990	WATER ST			
UPHOLLAND	CLIFTON ROAD, OFF AVON ROAD, BILLINGE	211618	CLIFTON RD	4C 0.1	IN PAVEMENT OPP NO. 11 CARR MILL ROAD	352971 399880
VICTORIA PARK	JENKINSON ST	178392	HIGHER ORMOND ST	3C 0.25 SAC	OUTSIDE CAVENDISH HOUSE ON THE CORNER OF HIGHER ORMOND ST	384242 397007

Primary Substation Name	Chosen Distribution Substation	Distribution Substation Number	LV Feeder Description	Cable Type at Suggested Monitoring Location	Suggested LV Monitoring Location	Suggested Monitoring Location Co-ordinates
WESTGATE	CHAPEL LANE OVERTON	641885	BAZIL LANE	4C 0.06 PLA	INSTALL IN THE GRASS VERGE OPPOSTE BARBERS COTTAGE ON MOSS LANE	343942 457328
WILLOWBANK	FINLAND RD STAKEHILL, MIDDLETON	327608	ONE CIRCUIT ONLY	3C 240 SAC AC	IN PAVEMENT ON TOUCHET HALL RD OPP PSV	389330 407737
WILMSLOW	MOOR LANE, WILMSLOW	332286	MOOR LANE (FARSIDE)	4C 70 AC	IN PAVEMENT OPP NO. 14 MOORFIELD DRIVE	383077 380177
WINIFRED RD	STATION ROAD	337132	OLD CARR HOUSE WA3	3C 185 SAC XC	PAVEMENT NEAR THE CAR PARK ON STATION RD IN CENTRE OF STOCKPORT	389318 390044
WITHINGTON	HATHERSAGE ROAD	178268	BAX ROAD	3C 185 SAC XC TP	IN PAVEMENT OPP NEW APARTMENTS ON BAX ROAD (CONNECT ON EITHER OF THE CABLES ALONGSIDE EACH OTHER)	385687 395960

APPENDIX B – SAMPLE OF LV MONITORING LOCATION INFORMATION SHEET

Primary	**Droylsden East**
Distribution Sub	West Drive Droylsden (172129)
Longest LV feeder	Ashdale Crescent (going North from the substation)
Cable type at suggested monitoring location	4c 0.06
Suggested LV monitoring point address	In the pavement opposite No. 105 Ashdale Crescent
Co-ordinates	389893 398453




109
101
91
74
BL
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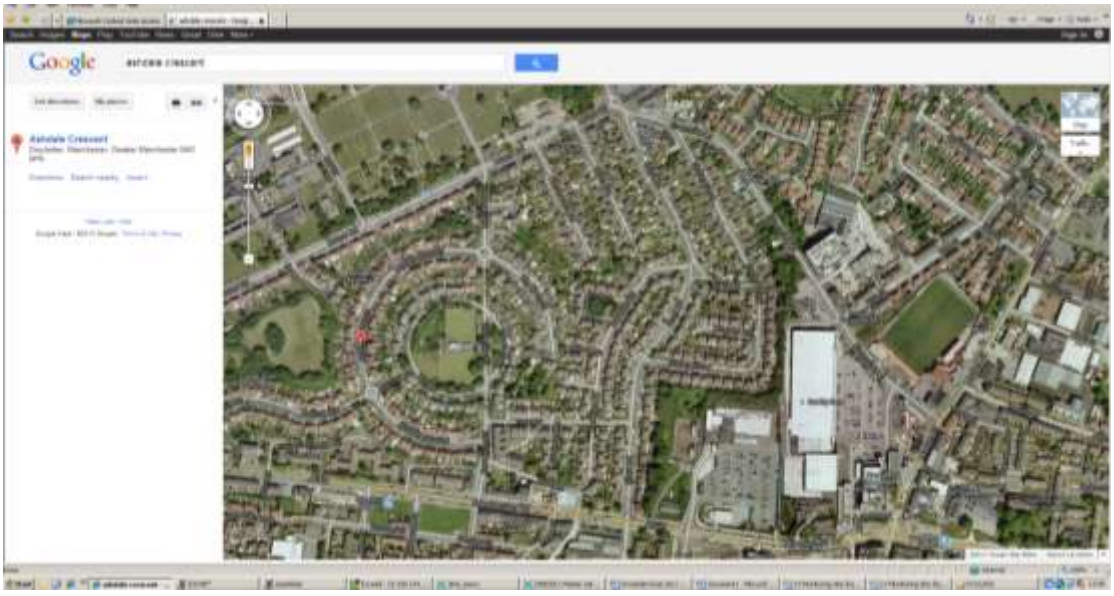
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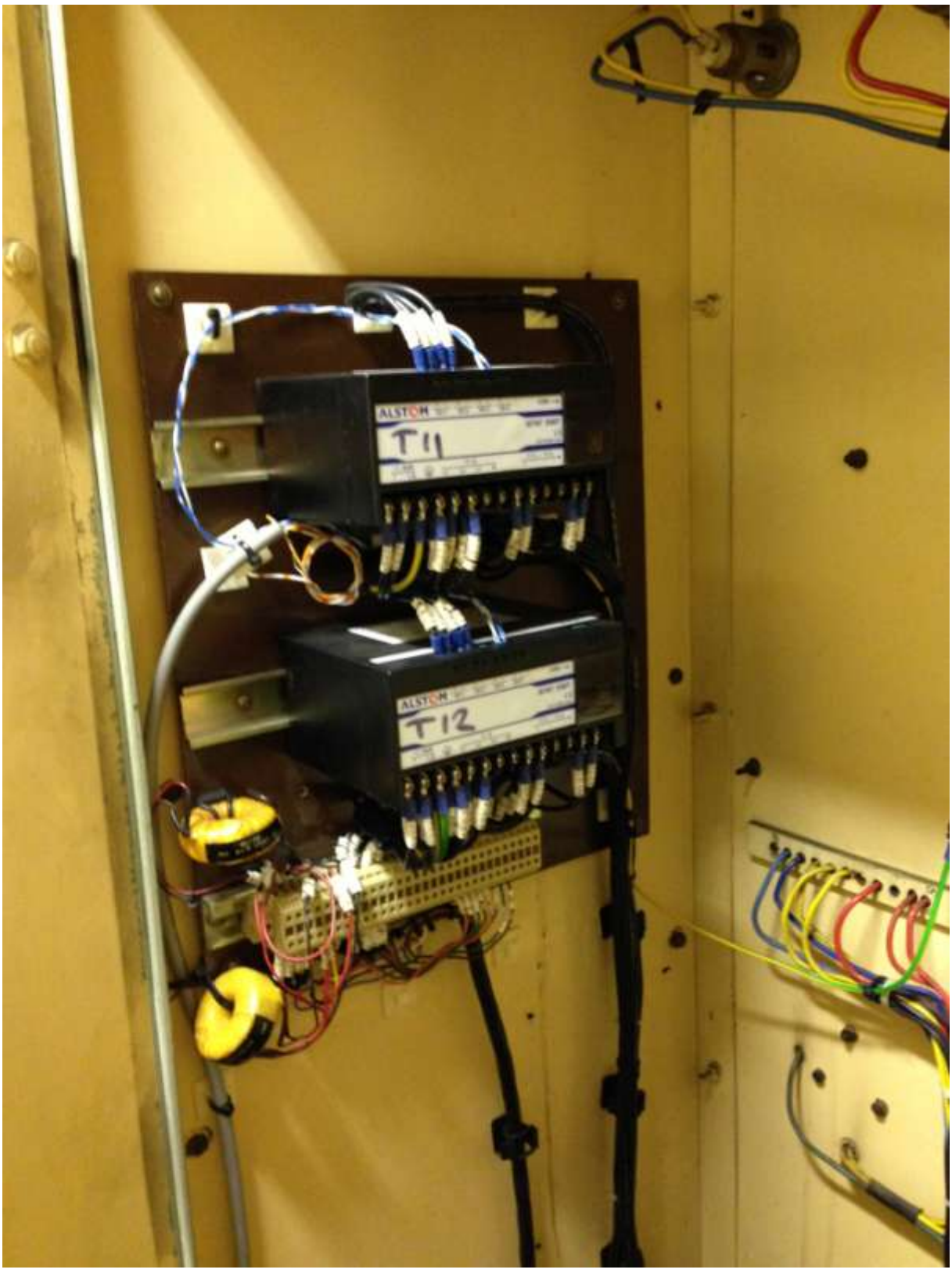
APPENDIX C – PRIMARY SITE MONITORING; T11/T12 ISTAT TRANSDUCERS



Wiring shown above can be simplified into five main areas

1) 110v DC power supply (J201/ J202)
2) AC inputs from 11/6.6kV:110v T12 VT (E15B/E35B/E55B)
3) AC inputs from T12 2000:5A red & blue phase metering CTs (D13B/D19/D53B/D59)
4) DC 0-20mA outputs to telecontrol RTU (SCADA) MW/MVAr (X71B/X72B/X73B/X74B)
5) RS485 digital data outputs to Nortec Envoy unit and T11 ISTAT(4 blue/white wires)

   NB During early installations it was found that the relatively short runs of RS485 used did not require any termination resistors and in fact the use of termination resistors led to communications dropping out or not starting at all. This may be due to the maximum length of RS485 being in the order of 1500m and the average length of RS485 connection in CLASS being less than 10m.


ENVOY
Panasonic