Ekta Sareen
Senior Regulatory Economist
Network Rail
Kings Place, 90 York Way
London N1 9AG

Jashim Uddin (on behalf of London Midland)
Planning & Regulation Assistant
Network Rail
Kings Place, 90 York Way
London N1 9AG

Friday 1 February 2013

Dear Jashim

Re: London Midland EC4T Proposed Metering Rules Change

This letter sets out our response to London Midland's proposal to disaggregate AC losses mark-ups by ESTA (Electricity Supply Tariff Area) in CP4 - we would like to thank London Midland for the opportunity to comment on its proposal.

In addition, Annex A sets out our latest estimates of losses. Annex B sets out some detail on the history of ESTAs and how they are designed, and Annex C sets out current ESTA definitions. Annex D explains how ESTA boundaries might change during CP5 as a result of increased electrification, and Annex E provides an illustration of these.

1. Summary

The key points of our response are summarised below:

- We have carried out a substantial programme of work to better understand what drives losses on the EC4T (Electric Current for Traction) system. The purpose of the work was to inform the approach to charging for transmission losses for CP5;

- Much of this work is 'leading edge' and very complex. It is clear that there are many drivers of losses on the EC4T network;

- The DC report concluded that transmission losses were lower than we originally considered them to be. We consider that the analysis set out in the DC report is sufficiently robust for billing purposes. We are proposing to set two different losses mark-ups for Merseyrail (ESTA M) and the southern DC area (ESTA U) for CP5;

- As required by ORR, the AC losses report estimated losses by ESTA. These numbers are indicative. We do not consider that these are sufficiently robust for billing purposes, at this stage. Therefore we support the continuation of a single AC losses mark-up for CP4 and CP5;

- All the analysis we have carried out for the AC and DC losses reports, is based on gross consumption. Irrespective of whether losses are disaggregated by ESTA or not, the losses figures will need to be adjusted to reflect the fact that they do not take account of regenerative braking. We propose continuing to bill on the basis of a

losses figure applied on electricity consumption net of regenerated energy for CP4 and CP5;

- We are committed to continuing to improve our understanding of electricity losses on gross and regenerated energy during CP5;

- It is important to note that ESTA boundaries are likely to change considerably as a result of significant investment in new electrification of the network. We consider the uncertainty that this will create, also supports the proposal to continue to apply a single losses mark-up for AC for CP4 and CP5; and

- We consider that the above approach will provide the industry with certainty and stability for the next six years, in a way which is equitable to both metered and non-metered electricity users.

2. Our work to estimate losses

Over the last few years, we have carried out a substantial programme of work to better understand what drives losses on the EC4T system. In September 2012 (and updated in January 2013) we set out our latest analysis on what we estimate to be the actual losses on the network. The original purpose of the work was to inform the approach to charging for transmission losses in CP5.

We consider that much of this work is 'leading edge' and incredibly complex. As we discussed in both our losses reports: "*It has been established that there are many variables that can contribute to electrical losses which make it difficult to scientifically calculate an absolute figure for losses".* These include; energy consumption, geographical area, line design, gradients, electrical infrastructure design and condition, weather, timetable, driving style, train design and length. Some of these factors relate to particular ESTAs while others are not directly ESTA related.

2.1 Extrapolation of losses

As required by ORR, the AC losses report estimated losses by ESTA. These numbers are indicative. The latest AC extrapolation is illustrated in Table 1 in Annex A[1]. It demonstrates the relationship between electrical demand (MWh/STK) and losses on the basis of the demand and track length in each ESTA to create a national weighted average loss. It should be noted that, in developing such a table, we do not have sufficient knowledge regarding the 'repeatability' of it due to the variability of losses and asset types. This issue was also identified by the report carried out by the independent reporter[2] (AMCL), commissioned by ORR. Our current knowledge of losses is based on the pattern of overall usage across the existing network across 24 hours and 365 days a year.

Currently, we do not consider that these estimates are sufficiently robust for billing purposes, at this stage. For this reason, we support the continuation of a single AC losses mark-up for

[1] This was produced by summating the range of variable (I^2R) losses and fixed losses with the final column providing a train 'losses mark-up' value for input into the metered billing process. The figure in the table assumes no regenerative braking i.e. average on gross power consumption.

[2] AMCL, (Dec 2012), 'EC4T Transmission Losses (AC & DC) Estimate Review'

CP4 and CP5.

2.2 DC losses

In January 2013, we also published our latest estimates of losses on the DC network. Our analysis concluded that the transmission losses were lower than we originally considered them to be. The report also extrapolated losses across the two DC ESTAs. Given the very different designs of these two networks, the different vehicle types and operating patterns - we are proposing to apply separate mark-ups for ESTA U and ESTA M in CP5. The extrapolation of DC losses is set out in Tables 2 and 3 in Annex A.

2.3 Regenerative braking

We would also like to point out that all of the analysis we have carried out for the AC and DC losses reports, is based on 'gross' consumption. Irrespective of whether losses are disaggregated by ESTA or not, the losses mark-ups proposed will need to be adjusted to reflect the fact that they do not take account of regenerative braking. This is because we propose continuing to bill on the basis of a losses mark-up applied on electricity consumption net of regenerated energy for CP4 and CP5. The proposed adjustments to the mark-ups are set out in the final column of Tables 1, 2 and 3 in Annex A. They have been calculated based on the current average regenerative braking discounts which are used for modelled bills, which are:

- 15% for DC; and
- 18% for AC (based on an average of the three discounts used currently: 16%, 18% and 20% depending service frequency).

The calculations are as follows:

- Adjusted losses mark-up for DC (southern): $\frac{17.01\%}{(1-15\%)} = 20.01\%$
- Adjusted losses mark-up for DC (Merseyside): $\frac{11.56\%}{(1-15\%)} = 13.60\%$
- Adjusted losses mark-up for AC: $\frac{3.85\%}{(1-18\%)} = 4.70\%$

This approach will be discussed in more detail in our forthcoming conclusions document on electricity charges. We propose to continue to investigate the losses experienced on energy returned to the EC4T network by regenerative braking. By CP6 are aiming to have sufficiently robust information to move to being able to apply losses mark-ups separately to gross and regenerated energy.

3. Conclusion

In our AC losses report we identified that the disaggregation of AC losses by ESTA provided a useful benchmark on how the losses may vary across the AC network with load. We are committed to continuing to improve our understanding of electricity losses on gross and

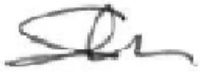
regenerated energy during CP5.

It is important to note that ESTA boundaries are likely to change considerably as a result of significant investment in new electrification of the network. We consider the uncertainty that this will create, supports the proposal to continue to apply a single losses mark-up for AC for CP4 and CP5. In addition, we also support different losses mark-ups for the two DC networks.

We consider that our proposed approach will provide the industry with certainty and stability for the next six years, in a way which is equitable to both metered and non-metered electricity users.

If you would like to discuss any aspect of this response, please contact me in the first instance.

Yours sincerely,



Ekta Sareen
Senior Regulatory Economist, Network Rail

ANNEX A – EXTRAPOLATION OF LOSSES[3]

Table 1: AC national weighted average losses

MWh per STK	AC ESTAs	Total STK - km	I^2R energy loss range	Average Fixed energy loss	Median energy loss	Losses mark-up %	Losses mark-up % with regen[4]
0 – 100	D, F	633	1.2% - 1.4%	3.36%	4.66%	4.89	5.96
100 – 200	A,B,C,E,I,J,N,S	2885	1.4% - 1.6%	2.56%	4.06%	4.2	5.16
200 – 300	G,H,Q,V	1535	1.6% - 1.8%	2.02%	3.72%	3.86	4.71
300 – 400	O,P,R	1516	1.8% - 2.0%	1.21%	3.11%	3.21	3.91
400 – 500	T	661	2.0% - 2.2%	1.2%	3.30%	3.41	4.16
					National Weighted Average	3.85	4.70

Table 2: DC national weighted average losses (ESTA U)

Range (MWh per STK)	DC Area [approx. 3,554 STK]	Average I^2R energy loss	Average Fixed energy loss	HV Distribution Network energy loss	Losses mark-up %	Losses mark-up % with regen[5]
300 – 400	Kent	10	3.54	1	17.01	20.01%
400 – 500	Sussex					
300 – 400	Wessex					

Table 3: DC national weighted average losses (ESTA M)

Range (MWh per STK)	DC Area [approx. 221 STK]	Average I^2R energy loss	Average Fixed energy loss	HV Distribution Network energy loss	Losses mark-up %	Losses mark-up % with regen
300 – 400	Mersey Rail	6.3	3.06	1	11.56	13.60%

[3] The losses mark-ups proposed will need to be adjusted to reflect the fact that they do not take account of regenerative braking.

[4] This assumes that 18% of energy is regenerated (this is the average of the three AC regenerative braking discounts used in CP4).

[5] This assumes that 15% of energy is regenerated (this is equivalent to the DC regenerative braking discount used in CP4).

ANNEX B - ELECTRICITY SUPPLY TARIFF AREAS

Background

ESTAs (Electricity Supply Tariff Areas) are used to charge train operators for Electric Current for Traction (EC4T). The areas are primarily defined by the physical electrical boundaries, between GSPs (Grid Supply Points). On the AC overhead line system, GSPs are in insulated sections known as 'neutral' sections. It is possible, through switching, to extend feeding areas to cover maintenance and/or operational outages of adjacent GSPs. Most GSPs have two separate circuits which effectively back each other up. Where a single circuit GSPs are used, an adjacent GSP acts as a back-up. Where possible, ESTA boundaries are located between two double circuit GSPs.

The DC systems are continuous at the DC third rail so it is not possible to specify boundaries by way of neutral sections. The DC systems are supplied from a high voltage AC distribution network which operates with breaks between GSPs. The breaks, however, are often moved due to operational requirements which in turn change the feeding areas. For this reason the DC systems are not split across ESTA boundaries.

In general, AC ESTAs are set as far as practicable to isolate an operator's consumption. In practice, other passenger and freight operators are likely to run through the same area. For example, in the Leeds area ESTA there are only two main operators, Northern Rail and East Coast but it covers 90+% of Northern Rail's consumption on the whole of the East Coast Main Line.

Another consideration is the location of timing points, known as stannox - these are used to determine train mileage for modelled operators. In a few cases the same stannox is used to identify locations where both AC and DC electrification systems also exist, for example Euston station. This means that, although the electrification system consumption can be identified separately (AC or DC), the train mileage cannot be separated out. This is particularly pertinent for ESTA T where Euston to Camden use the same stannox.

Each ESTA is designated with an alphabetic code where each GSP traction load feeds a section of railway and has a distance measured in STK (Standard Track Kilometres), therefore grouping the relevant GSPs to make up the ESTAs.

Extrapolation of losses by ESTA

The extrapolation process of the DC electrification losses detailed in the DC losses report[6] has been aligned with the EC4T billing system (which splits the AC and DC networks into ESTAs) to provide individual loss assessments for the two DC networks of the Southern area and Mersey Rail. The report concludes that this disaggregation is appropriate because of the very different designs of the two networks and the different vehicle types and operating patterns.

The extrapolation process of the AC electrification losses detailed in the AC losses report[7]

[6] Network Rail (Jan 2013), 'Updated Estimate of DC Losses', accessible here: http://www.networkrail.co.uk/WorkArea/DownloadAsset.aspx?id=30064784498

[7] Network Rail (Jan 2013), 'Updated Estimate of AC Losses', accessible here: http://www.networkrail.co.uk/WorkArea/DownloadAsset.aspx?id=30064784497

has also been closely aligned with the EC4T billing system.

Cross ESTA boundary feeding

Occasionally it is necessary to alter the normal feeding arrangements such that one GSP feeds across an ESTA boundary to cover for an adjacent GSP. Such occurrences can be identified from graphs of the daily energy consumption of the relevant GSPs. It is not possible to measure the amount of energy transferred unless a significant amount of new metering is installed. The data can be estimated with reasonable accuracy by looking at the consumption patterns of the surrounding weeks of data.

In 2011/12 there was one incident of cross boundary feeding which affected 0.17% of the total traction energy (ESTA G to ESTA I). In 2010/11 there were four incidents accounting for 0.07% (ESTAs A to C; G to I; J to G and S to E). This was adjusted in the billing arrangements.

ESTA boundary changes

ESTAs are also used to determine distribution and transmission rates for train operators. Distribution charges vary by GSP and transmission rates vary by distribution company area but the charge is dependent also on demand at the GSP. These charges could be passed on to operators according to their consumption at each GSP but even with full metering a very large amount of data processing would be required. The current number of ESTAs gives a reasonable compromise between data processing and localised charging. With more metering it may even be sensible to reduce the number of ESTAs in some parts of the country.

Boundary changes are normally required if a new GSP is introduced in such a way as to change the location of the boundary neutral section. This reflects the physical alteration to the EC4T network. These changes may be permanent or transitory. To ensure operators are correctly charged for their EC4T usage, the changes to the ESTA boundaries within the billing system have to be synchronised with the physical change and can occur at any time during the control period. Tthe changes to ESTA boundaries cannot be deferred to coincide with the end of the control period.

Currently we carry out the following actions when implementing a boundary change:

(a) confirm details of the change and the proposed changeover date and time;

(b) confirm which neutral section(s) will form the new boundary/boundaries based on train operator operating patterns and supply point normal feeding areas;

(c) implement updates to OTMDS and TRUST (to be implemented at the same time as the actual physical network change); then

(d) send revised ESTA definitions to the affected parties.

Going forward, we propose to add two additional steps:

(e) inform the entire industry through the TESG of revised ESTA definitions; then

(f) publish revised definitions on the NR website.

We consider that this process may take four to six weeks.

Once the changes have been made, the systems will allocate the correct energy data / mileage data to the correct ESTA and the incoming consumption data will also be allocated correctly from the date of the change. Delivery charges can be allocated to each ESTA after the event.

We consider that ESTAs sometimes have particular attributes that affect losses such as geographic area and electrical infrastructure. If we were to disaggregate losses by ESTA we would need to identify those factors and decide how to apportion them every time an ESTA boundary changes. For example, an ESTA extended with new electrification may benefit from an average reduction in losses whereas an existing ESTA with increased electric traffic may increase losses. This is an example of the uncertainty associated with losses, and the risk that fixing losses by ESTA might cause.

ANNEX C – List of ESTAs

The table below contains descriptions of the ESTAs (Version 2.3, 14 March 2011).

ESTA	Traction electricity Geographic Area / Tariff Zone	Description
M	Merseyside	Comprises the Merseyside third rail electrified system between Liverpool, Southport, Ormskirk, Kirkby, Hunts Cross, Ellesmere Port, Chester, New Brighton and West Kirby
N	Midland Main Line	Comprises the overhead line electrified routes from London St Pancras, Farringdon and Moorgate (Midland) to Bedford
O	London Tilbury & Southend	Comprises the overhead line electrified London Tilbury and Southend routes from Fenchurch Street to Shoeburyness via Laindon, Rainham and Chafford Hundred; the route from Barking to Forest Gate Junction; and the route between Gas Factory Junction and Bow Junction
P	Great Eastern	Comprises the electrified Great Eastern Main Line routes from Liverpool Street to Bow Junction, Upminster, Southend Victoria, Southminster, Braintree, Sudbury, Clacton, Walton-on Naze, Harwich Town and Norwich; the West Anglia route from Liverpool Street to Hackney Downs station; the Lea Valley Line between Stratford and Coppermill Junction, and the ac & dc section of the North London Line route between Stratford and York Way neutral section (north of Kings Cross). There is a boundary with TfL on the curve between Dalston Junction and the North London Line
Q	West Anglia	Comprises the electrified West Anglia routes from Hackney Downs station to Chingford, Enfield Town, Hertford East, Stansted Airport, Cambridge and Kings Lynn and the electrified route between Cambridge Junction (on the East Coast Main Line near Hitchin) and Cambridge
R	East Coast Main Line South	Comprises the electrified East Coast Main Line from Kings Cross to the neutral section at Tallington (between Peterborough and Grantham), the electrified route between Moorgate and Finsbury Park; the electrified route between Canonbury West Junction and Finsbury Park; and the Kings Cross Incline between Camden Road East Junction and Freight Terminal Junction.
A	East Coast Main Line Central	Comprises the electrified East Coast Main Line between the neutral sections at Tallington (between Peterborough and Grantham), South Kirkby and Hambleton Junction (between Doncaster and York).
B	East Coast Main Line North	Comprises the electrified East Coast Main Line between the neutral sections at Hambleton Junction (between Doncaster and York) and Chathill (between Alnmouth and Belford).
C	East Coast Main Line Leeds	Comprises the electrified East Coast Main Line between the neutral section at South Kirkby and Leeds, Bradford and Skipton.
S	Scotland Glasgow	Comprises the electrified routes in Scotland between the neutral sections at Coatbridge, Rutherglen, Bishopton, Lochwinnoch, Carstairs and Auchengray (between Edinburgh & Carstairs).
D	Scotland East	Comprises the electrified routes in Scotland between the neutral sections at Chathill (between Alnmouth and Belford), Auchengray (between Edinburgh & Carstairs) and Haymarket.
E	Scotland North & West	Comprises the electrified routes in Scotland on the North Clyde bounded by the neutral sections at Coatbridge, Rutherglen and Haymarket, the routes from Bishopton neutral section to Gourock & Wemyss Bay and the routes from Lochwinnoch neutral section to Ayr & Largs.
F	Scotland WCML	Comprises the electrified routes in Scotland between the neutral sections at Penrith and Carstairs.

ESTA	Traction electricity Geographic Area / Tariff Zone	Description
T	West Coast Main Line South	Comprises the West Coast Main Line routes from Euston to the neutral sections at Berkswell and Nuneaton; the third rail electrified lines from Euston to Watford Junction; the West London Line to midway between North Pole Junction and the Westway Road Bridge; the North London Line between South Acton and York Way (north of Kings Cross) and the route between the Primrose Hill tunnels and Camden Road.
G	West Coast Main Line Central	Comprises the West Coast Main Line routes between Nuneaton and Liverpool bounded by the neutral sections at Nuneaton, Queensville (Stafford), Stone – Colwich, Stone - Norton Bridge, Kidsgrove, Chelford and Parkside (moved from Weaver Junction June 09).
H	West Coast Main Line West Midlands	Comprises the West Coast Main Line routes around Birmingham between the neutral sections at Berkswell and Queensville (Stafford).
I	West Coast Main Line Manchester	Comprises the West Coast Main Line routes between Manchester and Stone bounded by the neutral sections at Stone – Colwich, Stone - Norton Bridge, Kidsgrove, Chelford
J	West Coast Main Line North	Comprises the West Coast Main Line routes between Parkside (moved from Weaver Junction June 09) and Penrith (neutral sections).
U	Southern	Comprises all third rail electrified routes south from Farringdon, Cannon Street, Charing Cross, London Bridge, Waterloo and Victoria, to the Network Rail/Eurotunnel boundary; the Network Rail/HS1 boundaries at Ebbsfleet & Fawkham Jn; the West London Line to the south of North Pole junction and west to, Reading, Basingstoke and Weymouth; and the North London Line between Richmond and Acton Central. There are boundaries with TfL at East Putney, Gunnersbury-Turnham Green and New Cross Gate. There are boundaries with non-electrified routes at: Dorchester South Jn, Worgret Jn, Hamworthy, Totton Jn (West), Redbridge Jn, 600m south of Northam Jn, Easleigh East Jn, Worting Jn, Basingstoke GW Jn, Reading Spur Jn, The following routes are not electrified within the above area: Wokingham Jn to Aldershot Jn South; Shalford Jn to Reigate (Level Crossing); Hurst Green Jn to Uckfield; Ore (582935, 111118, ATH 81m 225yds) to Ashford ‘d’ Jn; Old Kew Jn & New Kew Jn to South Acton Jn; Angerstein Jn to Angerstein Wharf; Hoo Jn to Grain;
V	Great Western	Comprises the electrified route from Paddington to Heathrow Airport
W	High Speed 1	St Pancras International to Eurotunnel Boundary

3.1 Notes:

1. there is a section of overhead line at Ashford International Station that is fed by HS1 but the same piece of track also has 750V dcelectrification which forms part of ESTA U.

ANNEX D: FUTURE ELECTRIFICATION AND ESTAS IN CP5

During CP5 there will be a number of electrification projects that will result in the need for changes to ESTA boundaries and/or the total number of ESTAs.

An explanation of changes that are scheduled to take place during CP5, are explained below. It also suggests the impact that these changes may have on ESTA boundaries.

Manchester Area

The existing Parkside (ESTA J) supply will initially feed Liverpool to Manchester and Manchester to Blackpool and would most logically be added to ESTA J.

A new supply point at Stalybridge is being constructed to feed the Transpennine route but would have boundaries with ESTAs C, I and J so could be included in any of these.

The Leeds to York section can be added to either ESTA B or C depending on feeding.

Thameslink (north of London) and London to Sheffield

A new supply point is proposed in the King's Cross area which will feed both the East Coast line (ESTA R) and Midland Main line (ESTA N).

Other supply points will be required for the new electrification.

One possibility is to include the new King's Cross supply point in ESTA R and use ESTA N for the new electrification.

Crossrail

Crossrail poses particular problems as the tunnel section will be TfL's responsibility and the sections either side will be Network Rail's. The electrical boundaries of these sections will be very close to the tunnel mouths. It will be very difficult to identify consumption in the TfL section because of the 5 minute time stamping of the data. A train exiting the tunnel just after a 5 minute sample starts could, for example, be 5 miles away when the next sample is taken. The second sample would have position information but the first sample would not, making it very difficult to accurately identify the consumption in the tunnel section.

The simplest way to remove such errors is to make the Crossrail running area (or the majority of it) into its own ESTA (probably V). This would cover the routes from Shenfield and Abbey Wood (east of London) to Maidenhead and Heathrow (west of London).

ESTA P would be reduced in size by removing the Shenfield to London section.

Great Western

If all stock on the new Great Western electrification is metered then the whole area could be covered by one new ESTA from the boundary with the supply point nearest to London (see Crossrail section above).

If the stock for the Cardiff Valley lines is not metered then it may be sensible to specify one ESTA for South Wales and one for the English section.

Other

Walsall to Rugeley can be added to ESTA H without difficulty.

Glasgow to Edinburgh & Stirling can be added to ESTA E as most services will be Scot rail services (as are most of ESTA E services now).

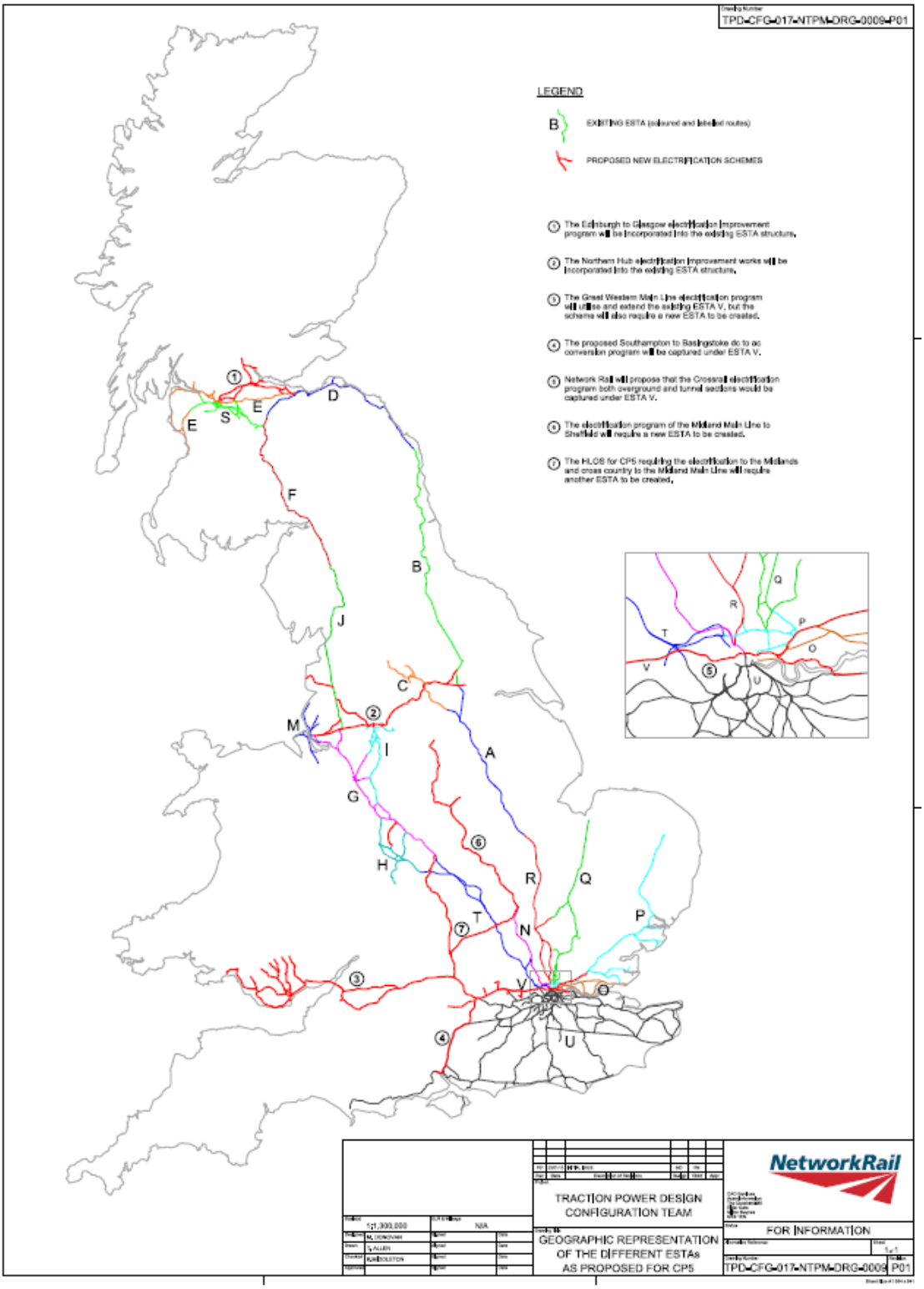
Other changes may be necessary once the electrical feeding plans for the Southampton to Coventry / Bedford become clearer.

Agreement to new/changed ESTAs should not delay the electrification projects.

Providing the above process is followed, there will not be any data issues (i.e. all grid, train metered & unmetered consumption will be recorded in the correct ESTAs.

The following CP5 ESTA map and legend shows the proposed electrification projects currently scheduled to take place during CP5.

ANNEX E - Scheduled electrification and ESTA boundaries



LEGEND

EXISTING ESTA (coloured and labelled routes)

PROPOSED NEW ELECTRIFICATION SCHEMES

1. The Edinburgh to Glasgow electrification improvement program will be incorporated into the existing ESTA structure.

2. The Northern Hub electrification improvement works will be incorporated into the existing ESTA structure.

3. The Great Western Main Line electrification program will utilise and extend the existing ESTA V, but the scheme will also require a new ESTA to be created.

4. The proposed Southampton to Basingstoke dc to ac conversion program will be captured under ESTA V.

5. Network Rail will propose that the Crossrail electrification program both overground and tunnel sections would be captured under ESTA V.

6. The electrification program of the Midland Main Line to Sheffield will require a new ESTA to be created.

7. The HLOS for CP5 requiring the electrification to the Midlands and cross country to the Midland Main Line will require another ESTA to be created.