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Independent Review of Leakage Model Modification Consultation No.2

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Executive Summary

Distribution Network Operators (DNOs) utilise a spreadsheet based leakage model to estimate leakage from their networks, and the establishment of this model is an obligation within the 2008 – 13 Gas Transporters' Licences. The outputs from this model have an impact on DN performance under both the Shrinkage and Environmental Emissions incentives.

National Grid Gas Distribution has an obligation under Special Condition E9 of its GT Licence to establish a Leakage Model and to consult with relevant shippers and other interested parties on any proposed modifications to it. The established National Leakage Model comprises a spreadsheet model and methodology documentation.

Special Condition E9 specifies that the Leakage Model shall facilitate the achievement of the accurate calculation of gas leakage from LDZs. Pursuant to this requirement, National Grid are proposing improvements to the Leakage Model to improve the accurate calculation of gas in respect of Low Pressure Service leakage.

Special Condition E9 also requires that when Leakage Model changes are proposed, an Independent Expert is appointed to review the Leakage Model and the proposed allowed leakage volumes and report on this review.

This report has been produced in order to provide an independent review to comply with the requirements of the modifications process.

Following completion of the review, the following opinions can be stated:

A] The proposal to use the last 3 years of mains replacement mains lengths, service relays and transfers data to estimate the numbers of services within the categories 'Steel services connected to metallic mains' and 'PE services connected to metallic mains' is considered to be a reasonable methodology for identifying these populations that would produce a more accurate reflection of service leakage.

B] The proposal to use data from the 2002/03 National Leakage Tests to estimate the service populations within the 'Steel services connected to PE mains' and 'PE services connected to PE mains' categories is considered to be a reasonable methodology for identifying these populations.

C] The proposal to take account of service transfers within the leakage model by subtracting the number of service transfers from the 'PE service connections to metallic mains' category is considered to be an effective method for establishing this category change, that would produce a more accurate reflection of service leakage within the service leakage estimate.

D] With the exception of some minor observations identified within Section 6, the Leakage Model methodology document SHR-PRC-4001 Version 1.2 is considered to correctly reflect the proposed modification to service leakage estimation.

E] With the exception of some minor observations identified within Section 7, tests undertaken on formulae contained within Version 1.4 of the Leakage Model spreadsheet in relation to the proposed revised service leakage estimation methodology have not identified any inconsistency with the methodology.

F] The proposed baseline leakage volumes for 2010/11 as identified within Appendix B.3 of the consultation document are considered to have been estimated correctly in accordance with the proposed revised methodology for establishing service populations.

G] The proposed baseline leakage volumes for 2011/12 and 2012/13, are considered to have been estimated correctly in accordance with the proposed revised methodology for estimating the change in service leakage associated with service transfers.

H] As the proposed modification is purely a change to the leakage modelling process, revision of the environmental emissions baselines as defined within Annex P of National Grid's DN Operator's Gas Transporter Licence is considered to be appropriate in the event that the proposed modification is to be implemented.

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1 Introduction

Distribution Network Operators (DNOs) utilise a spreadsheet based leakage model to estimate leakage from their networks, and the establishment of this model is an obligation within the 2008 – 13 Gas Transporters' Licences. The outputs from this model have an impact on DN performance under both the Shrinkage and Environmental Emissions incentives.

The DNOs used the latest leakage assessment details available at the time of the Price Control Review negotiations, which was that for the 2006/07 formula year, to produce forward leakage projections for the 2008 -13 Price Control Period. These projections were used by the Regulator to determine appropriate baseline leakage values for the two incentives. The current leakage model contains one amendment to that used in the determination of the leakage and shrinkage baseline values, and was the subject of Leakage Model Modification No.01.

National Grid Gas Distribution has an obligation under Special Condition E9 of its GT Licence to establish a Leakage Model and to consult with relevant shippers and other interested parties on any proposed modifications to it. The established National Leakage Model comprises a spreadsheet model and methodology documentation.

Special Condition E9 specifies that the Leakage Model shall facilitate the achievement of the accurate calculation of gas leakage from LDZs. Pursuant to this requirement, National Grid are proposing improvements to the Leakage Model to improve the accurate calculation of gas in respect of Low Pressure Service leakage.

Special Condition E9 also requires that when Leakage Model changes are proposed, an Independent Expert is appointed to review the Leakage Model and the proposed allowed leakage volumes and report on this review.

This report has been produced in order to provide an independent review to comply with the requirements of the modifications process.

2 Current Leakage Model

The current leakage model that is used by National Grid includes estimates of leakage that arise within the following categories:

- Low Pressure Mains
- Low Pressure Services
- Medium pressure Mains and Services
- Above Ground Installation (AGI) Leakage
- Above Ground Installation Working Losses (Routine Venting)
- Interference Damage

Statistically robust leakage rates for low pressure mains and services were originally established in 1992 by undertaking National Leakage Tests that provided leakage rates for all representative material types and diameter groupings. These leakage rates were updated in 2002 when a further National Leakage Test programme was undertaken, and these rates are used for leakage calculations within the current leakage model.

In 2009, the low-pressure service methodology was updated to take account of replacement of steel services with PE services. However, the scope of this previous modification was limited to include service replacement from 2006/07 onwards, as this was the 'base year' on which the leakage allowances for the incentives were based. The original model assumptions were based on the relative populations of steel and PE services that existed at the time of the 1992 National Leakage Tests. As there was known to have been a significant amount of service replacement carried out in the intervening years up to 2006/07 that had not been accounted for, the original assumptions were out of date. The model change was progressed through the process outlined within Special Condition E9 of the GT Licences and was subject to consultation as 'Leakage Model Modification Consultation No. 01'.

3 Estimation of Service Leakage for period 2002 - 2009

The leakage model used for estimating leakage prior to the 2009 'Leakage Model Modification Consultation No. 01' was based upon the following data and assumptions:

3.1 Service Leakage Rates

The service leakage rates established in the 2002 National Leakage Tests were categorised within 4 individual categories based upon the material of the service and the material of the main. These are identified as follows:

- Metal service connected to metal main 10.6m³/annum/service leakage
- PE service connected to metal main 2.2m³/annum/service leakage
- Metal service connected to PE main Zero leakage
- PE service connected to PE main Zero leakage

The leakage rates associated with these service categories are defined as 'per service' rates and are therefore not dependent upon the individual length of each service.

3.2 Assumptions within the 'pre 2009' leakage model

There were a number of assumptions relating to individual network populations of services that enable an estimate of the number of services within the 4 individual service categories to be included within the leakage model. These assumptions were identified as follows:

- The number of services within a network is deemed to be the same as the number of connected consumers.
- For an 'all PE' mains network, all services are PE
- For mixed material networks, two thirds of services are PE
- The number of metallic services attached to PE mains is calculated by multiplying the assumed number of metallic services by 0.187097.
- PE services are evenly distributed between PE and metallic mains on a length weighted basis.

Within the leakage model, the number of services attached to 'all PE' networks were identified as 'excluded services' and were not included within the subsequent service split calculation.

Each year when the model was used to produce a leakage estimate, the same data sources and assumptions were applied to determine the service populations within the 4 individual service categories for each network.

4 Estimation of Service Leakage for period 2009 – 2012

Following the acceptance and implementation of the revised methodology contained within the 2009 'Leakage Model Modification Consultation No. 01', the service estimation methodology within the leakage model for the period 2009 onwards was amended to include the following additional steps [that would provide improved accuracy in relation to the service leakage estimate from 31st March 2007 onwards] to account for service replacement activity.

A] Establish a fixed number of metallic services for each LDZ when the baseline numbers were applicable (i.e. 31st March 2007) based upon the assumption that one third of all services on a mixed material network are metallic.

B] Establish a fixed number of metallic services for each network when the baseline numbers were applicable (i.e. 31st March 2007) based upon the assumption that one third of all services on a mixed material network are metallic.

C] Based upon the number of metallic services replaced within the LDZ since the baseline value was established, calculate the percentage of metallic services replaced for the LDZ for the year.

D] Apply this percentage reduction in services to the fixed metallic service population of each network to determine a revised total of metallic services within each network.

E] Calculate the PE service population for each network by subtracting the value determined in D] from the total number of services within the network.

F] Apply the same assumptions as within the current estimation methodology to determine the service populations within the 4 individual service categories for each network.

5 Proposed Service Leakage Estimation Methodology

The implementation of the revised methodology for service leakage estimation contained within the 2009 'Leakage Model Modification Consultation No. 01', effectively 'fixed' the number of metallic services assumed at the time the incentive allowances were set in 2006/07 and subtracted from this the cumulative number of services replaced in subsequent years. However, the assumed populations in 2006/07 were themselves based on the relative populations of steel and PE services that existed at the time of the 1992 National Leakage Tests.

Leakage Model Modification Consultation No.2 proposes a methodology that is designed to more accurately reflect the service populations within networks and also to address a current inaccuracy associated with PE services that are transferred due main replacement.

5.1 Service Populations

The proposal to establish current service populations is:

To use the latest three years mains replacement mains lengths, service relays and transfers data to determine the proportion of each type of service connection to metallic mains over this period for each LDZ and to deem this representative of the overall population of service connections to metallic mains for the

LDZ. The level of replacement done over a three year period provides a substantial sample of connections, which will lead to a statistically valid estimate of the population; details are provided in Appendix A

All service connections to PE mains have zero leakage and therefore the steel/PE service mix of such connections does not matter for leakage derivation purposes. For completeness, it is proposed to utilise data on the mix from the 2002/03 National Leakage Tests (NLT) as outlined in Appendix A. This will establish new values for the four service categories for the base year, which will be 2010/11. For the subsequent years, the population values will be derived from these base year values along with the known year-on-year service replacement and relay numbers, in the same manner as at present. The methodology is set out in detail within a worked example contained within Appendix B.

5.2 Service Transfers

The proposal to address leakage reduction associated with service transfers is:

Following the establishment of new service populations for the base year, 2010/11, the leakage model will have an estimate of the number of services in each of the four categories:

- *▯ Steel service connections to metallic mains*
- *▯ PE service connections to metallic mains*
- *▯ Steel service connections to PE mains*
- *▯ PE service connections to PE mains*

The current model takes account of re-laid services each year by subtracting these from the number of 'steel service connections to metallic mains' category but does not take into account transferred services in a year. There appears no good reason to ignore transferred services. It is proposed, therefore, that the annual updating methodology should include the impact of transferred services; this being achieved by subtracting the number of service transfers from the 'PE service connections to metallic mains' category. The number of service re-lays and transfers will be added to the 'PE service connections to PE mains' category.

6 Review of proposed service leakage estimation methodology

6.1 Establishment of Service Populations

The assumptions within the current leakage model regarding the percentages of the 4 service types within mixed metallic networks have their origins in the 1992 National Leakage Test observations for these categories. The proposed methodology references data from mains replacement projects undertaken by National Grid from the last 3 years that includes 6219 km of replaced main from a population of non PE main of approximately 43,000km remaining. The numbers of service relays and service transfers associated with these projects are stated by National Grid as being included within the regulatory reporting to Ofgem.

By using the service transfer and service renewal data from this sample of metallic mains, which represents approximately 12% of the metallic mains population, an estimation of the numbers of services within the categories '▯ Steel services connected to metallic mains' and '▯ PE services connected to metallic mains' can be produced in relation to the remainder of the metallic mains population.

As part of the review, the diameter groupings for the metallic mains within the total National Grid population were examined in relation to the diameter groupings associated with the mains replacement work undertaken during the same 3 year period to assess the extent to which these groupings were representative of the remainder of the metallic mains population. The diameter groupings identified were considered to be reasonably reflective of the metallic mains population to which the proposed methodology would apply.

The proposal to use data from the 2002/03 National Leakage Tests to estimate the service populations within the 'Steel services connected to PE mains' and 'PE services connected to PE mains' categories is considered to be a reasonable methodology for identifying these populations. These values were confirmed as 1.80% and 98.20% respectively. Although the 2002/03 National Leakage Tests established that there was a zero leakage rate for both these service categories, it is considered that maintaining these as separate categories would be good practice in order to maintain consistency of approach to recording.

The proposed revised methodology for establishing service populations within networks is considered to be a reasonable process that would improve the accuracy of the service leakage calculation within the Leakage Model.

6.2 Service Transfers

Following the leakage model amendments associated with 'Leakage Model Modification Consultation No. 01', the current leakage model takes account of the number of service renewals that are undertaken each year. However, when a metallic main is replaced by a PE main and a steel service connected to that metallic main is transferred to the PE main, the service category changes from 'PE service connected to metallic main' to 'PE service connected to PE main'. This will result in the leakage rate relevant to the service category changing from 2.2m³/annum/service to zero. However, this service category change that is relevant to mains replacement is not reflected within the current leakage model.

The proposal to take account of this change within the leakage model by subtracting the number of service transfers from the 'PE service connections to metallic mains' category is considered to be an effective method for establishing this category change, and is also considered to produce a more accurate reflection of leakage within the leakage model.

6.3 Leakage Model Methodology document

As part of this review, the revised Leakage model methodology document SHR-PRC-4001 Version 1.2 was assessed to ensure that the proposed modification to service leakage was correctly reflected.

The following observations were made regarding this document:

A] Section 3.2.2 identifies the following elements:

No. Steel Service connections to metallic mains	[Baseline No.] – [Number of services replaced in LDZ since 2010/11] x [% of total number of steel-metal services in LDZ]
No. PE Service connections to metallic mains	[Baseline No.] – [Number of services transferred in LDZ since 2010/11] x [% of total number of PE-metal services in LDZ]

It is considered that the descriptions for [% of total number of steel-metal services in LDZ] and [% of total number of PE-metal services in LDZ] would benefit from expansion to provide additional clarity. However, tests undertaken on formulae within Version 1.4 of the Leakage Model spreadsheet have confirmed consistency with the methodology outlined in the consultation document.

B] Section 3.2.1 identifies the percentage of steel service connections to PE mains and PE service connections to PE mains as 1.75% and 98.25% respectively. However, these values as defined within Leakage Model Modification No. 2 (See Appendix A) were identified as 1.8% and 98.2% respectively. As both of these service categories have a zero leakage rate, there would be no impact on leakage as a result of this discrepancy.

With the exception of the above observations, the revised Leakage Model methodology document is considered to correctly reflect the proposed modification.

7 Validation of calculations within the revised leakage model

As part of the review process, the revised service leakage estimation methodology outlined within 'Leakage Model Modification Consultation No.2' was compared with the formulae contained within Version 1.4 of the Leakage Model spreadsheet.

Tests were undertaken to validate the model against the methodology document, which identified the following observations:

A] Section 3.1.1. The table lists a MEG Benefit calculation. The calculation is not included within the model in a verifiable form, but the values derived from the equation can be found in the MEG sheet which is used for the MEG calculations.

C] Section 3.2.1. The table lists "The leakage model used for setting the baselines assumed that any network with a PE proportion greater than 99.5% is All-PE". This figure is not used for calculation within this version of the model.

D] Section 3.2.1. An inconsistency was identified within Sheet 'EA Low Pressure', where the 'Identified total (All PE excl)' was using 5% as a selection value rather than 3% as being used within the other Low Pressure Sheets.

E] As part of the review, baseline values from the 'Baseline No. \$' worksheet were recalculated using an 'Implementation Check' worksheet. A script was created to compare the stored calculated values to the baseline values used in the model. This script revealed some minor problems with rounding for many of the baseline values. These rounding errors were not considered to be significant.

8 Modification Impact Assessment

On the basis that the methodology for determining service populations as defined within 'Leakage Model Modification Consultation No.2' is considered to be a reasonable process that will improve the accuracy of the service leakage calculation within the Leakage Model, and that the methodology has been implemented correctly within Version 1.4 of the Leakage model spreadsheet, the proposed baseline leakage volumes for 2010/11 as identified within Appendix B.3 of the consultation document (see Appendix C) are considered to have been calculated correctly in accordance with the proposed revised methodology.

With regard to the proposed baseline leakage volumes for 2011/12 and 2012/13, these are considered to have been calculated correctly in accordance with the proposed revised methodology. The actual impact may vary depending upon the mains replacement workload and service transfer activity undertaken within each LDZ. However, it is perceived that any potential variation would be unlikely to be significant due to the low volumes involved.

As the proposed modification is purely a change to the leakage modelling process, revision of the environmental emissions baselines as defined within Annex P of National Grid’s DN Operator’s Gas Transporter Licence is considered to be appropriate in the event that the proposed modification is to be implemented.

9 Additional Observations

The following additional observations have been made that are not considered to have an impact on the validity of the proposed model modification:

9.1 Leakage Model Modification Consultation No.2 Document

Within B.1.1 iii) the number of steel services in each low pressure network = the number of steel services per km of metallic main x the length of metallic main in the network.

This should read:

iii) the number of steel services connected to metallic mains = the number of steel services per km of metallic main x the length of metallic main in the network.

Within B.1.1 iv) the number of PE services in each low pressure network = the number of PE services per km of metallic main x the length of metallic main in the network

This should read:

iv) the number of PE services connected to metallic mains = the number of PE services per km of metallic main x the length of metallic main in the network.

Within B.1.2 - Summary Table

The summary table is included as shown below:

No. Steel service connections to metallic mains	No. PE service connections to metallic mains	No. PE service connections to PE mains	No. steel service connections to PE mains	No. steel service connections to PE mains
10,752	11,264	36,634	671	59,321

The final column heading should read ‘Total No. of service connections’.

10 Conclusions

Following completion of the review of Leakage Model Modification Consultation No.2, the following opinions can be stated:

A] The proposal to use the last 3 years of mains replacement mains lengths, service relays and transfers data to estimate the numbers of services within the categories 'Steel services connected to metallic mains' and 'PE services connected to metallic mains' is considered to be a reasonable methodology for identifying these populations that would produce a more accurate reflection of service leakage.

B] The proposal to use data from the 2002/03 National Leakage Tests to estimate the service populations within the 'Steel services connected to PE mains' and 'PE services connected to PE mains' categories is considered to be a reasonable methodology for identifying these populations.

C] The proposal to take account of service transfers within the leakage model by subtracting the number of service transfers from the 'PE service connections to metallic mains' category is considered to be an effective method for establishing this category change, that would produce a more accurate reflection of service leakage within the service leakage estimate.

D] With the exception of some minor observations identified within Section 6, the Leakage Model methodology document SHR-PRC-4001 Version 1.2 is considered to correctly reflect the proposed modification to service leakage estimation.

E] With the exception of some minor observations identified within Section 7, tests undertaken on formulae contained within Version 1.4 of the Leakage Model spreadsheet in relation to the proposed revised service leakage estimation methodology have not identified any inconsistency with the methodology.

F] The proposed baseline leakage volumes for 2010/11 as identified within Appendix B.3 of the consultation document are considered to have been estimated correctly in accordance with the proposed revised methodology for establishing service populations.

G] The proposed baseline leakage volumes for 2011/12 and 2012/13, are considered to have been estimated correctly in accordance with the proposed revised methodology for estimating the change in service leakage associated with service transfers.

H] As the proposed modification is purely a change to the leakage modelling process, revision of the environmental emissions baselines as defined within Annex P of National Grid's DN Operator's Gas Transporter Licence is considered to be appropriate in the event that the proposed modification is to be implemented.

Appendix A Data used for determining baselines

GDN	Length of main replaced (km)	Number of Relays	Number of Transfers	Relays /km	Transfers /km
East of England	2,156	90,053	95,468	42	44
London	1,071	44,180	33,615	41	31
North West	1,783	79,465	55,842	45	31
West Midlands	1,199	60,801	41,609	51	35

National Grid mains replacement data for last 3 year period

Number of Tests	Length of Main Tested (km)	Number PE Services	Number Steel Services	Total number Services	PE Service %	Steel Service %
81	7,039	770	14	784	98.20%	1.80%

Service type connected to PE mains from 2002/03 National Leakage Tests

Appendix B Worked example to determine network service populations

For Cambridge network in Eastern (EA) LDZ, which is part of East of England Network:

Metallic Length = 256km; Total Number Services = 59,321

Number Steel Service Connections to Metallic Mains = Relays/km x Metallic Length
= 42 x 256 = 10,752

Number PE Service Connections to Metallic Mains = Transfers/km x Metallic Length
= 44 x 256 = 11,264

Total no. service connections to metallic mains = 10,752 + 11,264
= 22,016

Total no. service connection to PE mains = 59,321 – 22,016
= 37,305

Number PE service connections to PE mains = 37,305 x 98.2%
= 36,634

Number steel service connections to PE mains = 37,305 x 1.8%
= 671

No. steel service connections to metallic mains	No. PE service connections to metallic mains	No. PE service connections to PE mains	No. steel service connections to PE mains	Total No. of services in network
10,752	11,264	36,634	671	59,321

Appendix C Proposed Revised Baseline Volumes

GDN	LDZ	2010/11 – Service Leakage (GWh)			Impact of taking account of service transfers (GWh)		Combined Impact (GWh)	
		Current Model	Revised Model	Change	2011/12	2012/13	2011/12	2012/13
National Grid Gas Distribution	EA	47.2	35.2	12.0	0.3	0.6	12.3	12.6
	EM	69.7	45.3	24.4	0.4	0.8	24.8	25.2
	NT	75.1	43.8	31.4	0.2	0.4	31.6	31.8
	NW	78.1	60.8	17.3	0.4	0.8	17.7	18.1
	WM	57.2	53.6	3.6	0.3	0.6	12.3	12.6

GDN	LDZ	Original Baselines		Revised Baselines	
		2011/12	2012/13	2011/12	2012/13
National Grid Gas Distribution	EA	268	267	256	254
	EM	380	378	355	353
	NT	368	364	336	332
	NW	455	450	437	432
	WM	371	367	367	363

Proposed Baseline Volumes using revised methodology