Low Pressure Service Modification Proposal Variance Analysis

Summary

The Low Pressure (LP) Service Modification Proposal seeks to address an outstanding modelling issue with regard to the number of service connections to metallic mains. The original methodology resulted in an erroneous year-on-year increase in the number of service connections to metallic mains. The proposed methodology uses data on the mains replacement programme submitted to Ofgem in the DNs' Regulatory Reporting Pack to provide an estimate of the service populations at a point in time (2010/11) and takes account of actual movement in populations moving forward. The original methodology applied the same service population assumptions across all LDZs whereas the proposed methodology provides an LDZ specific estimate. Each LDZ reflects an old British Gas 'region', each of which would have had a different policy for replacing services. Therefore, the impact of moving to the new methodology is expected to vary between LDZs.

The analysis in this document shows a good correlation between the LDZs' modelled change and actual impact, R^2=0.95, once the major factors influencing the outcome of the model change have been taken into account.

In general:

- The number of service connections to metallic mains is reduced due to the inherent flaw in the original modelling assumptions, leading to a general reduction in calculated service leakage.
- However, for some LDZs this impact can be outweighed by that from an increase in estimated Steel service connections, as seen in NE and SE LDZs; this occurs because the associated leakage rate is 4.8 times greater than for PE service connections.
- The greater the reduction in estimated Steel service connections, the greater the leakage reduction associated with the model change.

Background

The Low Pressure (LP) Service Modification Proposal seeks to address an outstanding modelling issue with regard to the number of service connections to metallic mains. The leakage model considers LP services in four categories[1]:

- Steel service connections to metallic mains;
- PE service connections to metallic mains;
- Steel service connections to PE mains; and
- PE service connections to PE mains

The assumptions in the original methodology dated from the early 1990s. The assumptions were:

- One third of all services are metallic
- Approximately 18.7% of all metallic services are connected to PE mains

[1] The 2002/03 National Leakage Tests (NLT) determined leakage rates of 10.59m^3/annum@30mbarg for Steel service connections to metallic mains, 2.19m^3/annum@30mbarg for PE service connections to metallic mains and a zero leakage rate for connections to PE mains.

- 81.3% are connected to metallic mains
- PE service connections are apportioned by the relative length of metal/PE main

The outcome of applying these assumptions was that number of service connections to metallic mains per km increased year-on-year[2]; see example in Appendix A. In 2009, a change to the leakage model was made such that the number of metallic services was fixed at the modelled 2006/07 level and service replacement from that point onwards was taken into account; however, this change did not correct for the intervening years between this date and the initial application of the original assumptions.

The proposed modification uses data gathered from the mains replacement programme (MRP) to estimate the number of Steel and PE service connections to metallic mains[3]; the number and type of service connections determined from analysis of the MRP data is deemed representative of the remaining service population. This data was applied to the 2010/11 mains population as a number of services per km of metallic main to establish an estimate of the relative service populations in that year and the year-on-year service replacement from that date is to be taken into account.

In order to understand and evaluate the impact on individual LDZs of the move to the latest proposed modelling method, it is necessary to take account of the starting point, i.e. the relative service populations that stem from the original modelling assumptions.

In addition, the impact will vary depending on a number of other factors:

- Length of metallic main (MRP service data applied as number of services/km)
- The pressure at which the systems operate (leakage rates are per service at 30mbarg)
- The Calorific Value of the gas in the individual LDZs (the leakage model calculates leakage as a volume that is converted into an energy value)

Analysis

The proposed modification to the LP service estimation is to use data from the mains replacement programme. Data from three years is used to determine an average number of Steel and PE service connections per km of metallic main. However, the leakage rate for each of these categories is different and, hence, the impact that the revised service populations have on the calculated leakage will be dependent on the relevant leakage rate. Therefore, in order to evaluate the impact on an LDZ basis it is necessary to weight the change in service population assumptions[4] by the leakage rates:

- $Savg = SSteel,New - SSteel,Orig \times RSteel,Metal + SPE,New - SPE,Orig \times RPE,MetalRSteel,Metal + RPE,Metal$

Where:

S_{avg} is the average change in number of services/km metallic main weighted by leakage rate

[2] The total number of service connections to metallic main was broadly stable, but the length of metallic main decreased by around 3% per annum due to mains replacement.
[3] See Leakage Model Modification No.2 on the joint office website for details.
[4] The difference between the current leakage model service populations in 2010/11 and the revised estimate based on the MRP data.

$S_{Steel,New}$ is the number of Steel services per km of metallic main determined from the analysis of the DNs' RRP submissions

$S_{Steel,Orig}$ is the number of Steel services per km of metallic main determined from the 2010/11 leakage models

$S_{PE,New}$ is the number of PE services per km of metallic main determined from the analysis of the DNs' RRP submissions

$S_{PE,Orig}$ is the number of PE services per km of metallic main determined from the 2010/11 leakage models

$R_{Steel,Metal}$ is the leakage rate determined from the 2002/03 NLT for Steel service connections to metallic mains (10.59m^3/annum@30mbarg)

$R_{PE,Metal}$ is the leakage rate determined from the 2002/03 NLT for PE service connections to metallic mains (2.19m^3/annum@30mbarg)

The impact of setting a revised baseline to the 2010/11 service populations has been estimated and published; however, in order to compare LDZs it is necessary to take account of the other factors indicated above.

Example calculation for EA LDZ; see Appendix B for data:

Weighted average change in number of services per km of metallic main is:

$$Savg=42-60\times10.59+44-65\times2.1910.59+2.19$$

$$Savg=-18.5$$

This represents a net reduction in the weighted average number of service connections to metallic mains and, therefore, you would expect a net reduction in leakage.

The normalised[5] impact of applying the revised methodology is:

$$Impact\ per\ km=Published\ Impact\times39\ MJ/m3Actual\ CV\times30\ mbargActual\ ASPLength\ of\ Metallic\ Main$$

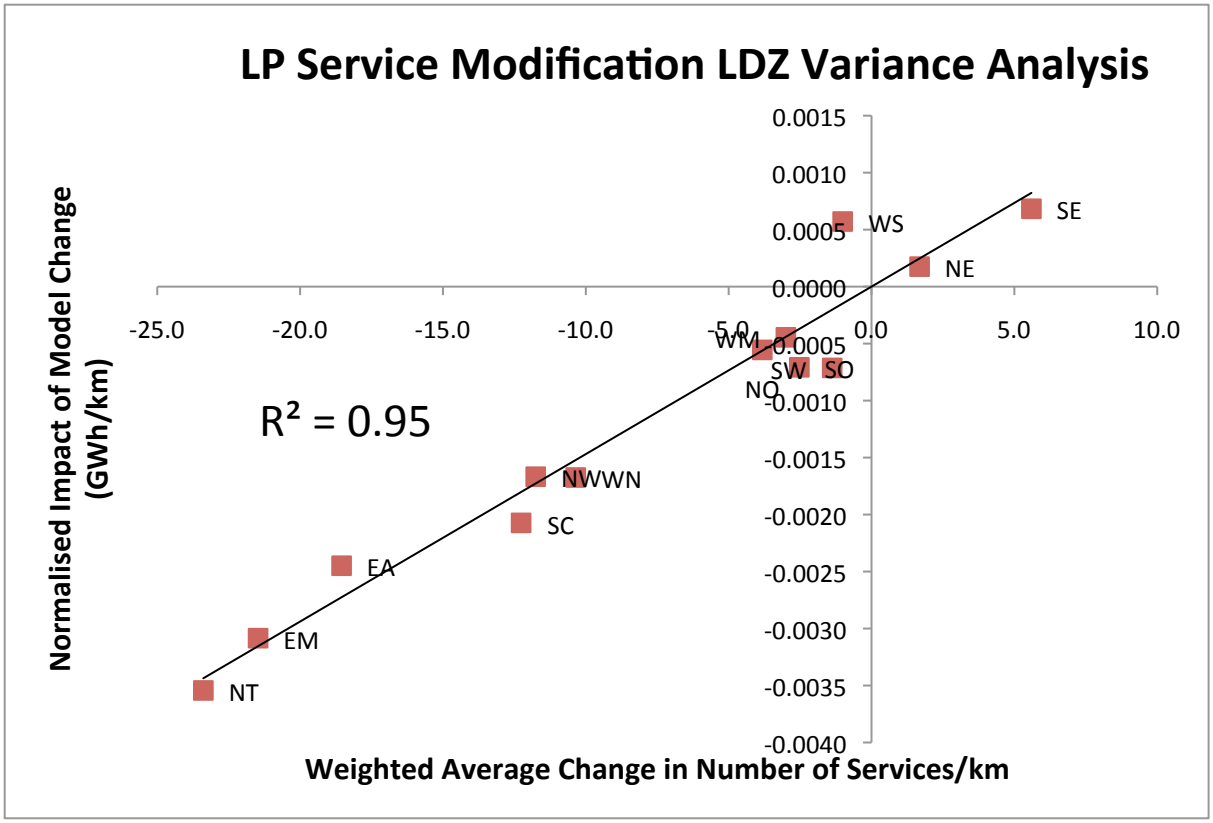
$$Impact\ per\ km=-16\times39\ MJ/m339.41\ MJ/m3\times30\ mbarg29.37\ mbarg6,604$$

$$Impact\ per\ km=-0.0024GWh$$

This represents a reduction in calculated leakage.

Plotting the data for each LDZ gives:

[5] CV normalised to 39MJ/m^3 and Average System Pressure to 30mbarg



As can be seen from the graph above, the greater the reduction in the weighted average number of services per km of metallic main the greater the normalised impact (negative values indicate a reduction in calculated leakage). There is a good correlation between the LDZs when the major factors are taken into account. The actual impact of moving to the new model will be dependent on the factors for the individual low pressure networks of which there are in the order of two thousand across all LDZs. By applying the normalisation at an LDZ level some variation is to be expected.

Considering the two extremes of the LDZs, NT and SE:

LDZ	Original Model Service Populations			Revised Model Service Populations			Leakage Weighted Change in No. of Services/km	Impact Normalised for CV, Pressure and Mains Length (GWh/km)
	Steel Services /km	PE Services /km	Service Density /km	Steel Services /km	PE Services /km	Service Density /km		
NT	60	75	135	41	31	73	-23.4	-0.0035
SE	51	75	126	67	30	97	5.6	0.0007

As can be seen from the data above, for both LDZs, there is the expected reduction in service density associated with the model change[6]; however, this is much greater in NT (135 – 73 = 62services/km) than SE[7] (126 – 97 = 29services/km). There is a significant reduction in Steel service connections to

[6] This is as a consequence of the original model assumptions erroneously leading to an increase in the number of service connections to metallic mains.

[7] The service density in SE (97/km) is greater than than all other LDZs, see Appendix B, apart from SC, which would limit the impact that moving to the new model would have, whereas NT (73/km) has the lowest service density.

metallic main in NT LDZ and, hence, the model change has a greater impact. There is an increase in Steel service connections in SE, which outweighs the reduction in the overall total number of connections. The original model assumptions were applied uniformly across all LDZs whereas the revised model provides an LDZ specific estimate, so some variation between the LDZs would be expected as service density and historic service replacement policy would differ by LDZ.

Appendix A Effect of the Original Service Assumptions on Service Populations (Example)

The table below illustrates the effect that the original LP service model assumptions had on the estimated number of service connections to metallic mains:

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
No. Customers	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Total Length (km)	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Metal Main (km) [Reducing 3%p.a.]	20.0	19.4	18.8	18.3	17.7	17.2	16.7	16.2	15.7	15.2	14.7	14.3	13.9	13.5	13.1	12.7
PE Main (km)	10.0	10.6	11.2	11.7	12.3	12.8	13.3	13.8	14.3	14.8	15.3	15.7	16.1	16.5	16.9	17.3
PE Main Proportion	0.33	0.35	0.37	0.39	0.41	0.43	0.44	0.46	0.48	0.49	0.51	0.52	0.54	0.55	0.56	0.58
No. Steel Services *[1/3]*	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
No. PE Services *[2/3]*	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
No. Steel Services to PE *[18.7%]*	187	187	187	187	187	187	187	187	187	187	187	187	187	187	187	187
No. Steel Service to Metal *[81.3%]*	813	813	813	813	813	813	813	813	813	813	813	813	813	813	813	813
No. PE Services to PE Mains *(No. PE Services x PE Main Proportion)*	667	707	745	783	820	855	889	923	955	986	1,017	1,046	1,075	1,103	1,130	1,156
No. PE Services to Metal Mains *(Total Number - Sum Above)*	1,333	1,293	1,255	1,217	1,180	1,145	1,111	1,077	1,045	1,014	983	954	925	897	870	844
Connections to metallic mains:																
No. Steel Services/km	41	42	43	45	46	47	49	50	52	53	55	57	59	60	62	64
No. PE Services/km	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67	67
Total No. Services/km	**107**	**109**	**110**	**111**	**113**	**114**	**115**	**117**	**119**	**120**	**122**	**124**	**125**	**127**	**129**	**131**

As can be seen from the table above, the original model assumptions lead to the estimated number of steel service connections to metallic mains per km increasing year-on-year. Clearly, this is not a true reflection of reality.

Appendix B Analysis Data

LDZ	Network	Impact (GWh)	10/11 Calorific Value (MJ/m^3)	10/11 Length Metallic Main (km)	10/11 ASP (mbarg)	2010/11 Original Model (v1.3) Connections to Metallic Mains				Revised Service Connections to Metallic Mains[8]			Leakage Weighted Change in Number of Services/km	Impact Normalised for CV, Pressure and Mains Length (GWh/km)
						Steel Services	PE Services	Steel Services/ km	PE Services/ km	Steel Services /km	PE Services/ km	Service Density /km		
EA	EoE	-16.0	39.41	6,604	29.37	395,490	429,005	60	65	42	44	86	-18.5	-0.0024
EM	EoE	-24.4	39.48	7,564	30.99	475,960	509,188	63	67	42	44	86	-21.5	-0.0031
NT	LN	-27.4	39.35	8,739	26.31	528,348	655,337	60	75	41	31	73	-23.4	-0.0035
NW	NW	-17.3	39.20	11,082	27.94	578,593	697,071	52	63	45	31	76	-11.8	-0.0017
WM	WM	-3.6	39.30	8,913	27.03	415,007	643,751	47	72	51	35	85	-3.0	-0.0004
NE	NGN	1.4	40.08	6,905	33.74	272,224	410,084	39	59	47	33	80	1.7	0.0002
NO	NGN	-3.5	40.17	5,440	33.76	229,787	320,076	42	59	43	31	74	-3.8	-0.0006
SC	SC	-12.3	39.94	6,155	28.24	347,363	411,244	56	67	44	55	99	-12.3	-0.0021
SE	SO	6.5	39.10	10,359	27.49	524,625	778,434	51	75	67	30	97	5.6	0.0007
SO	SO	-4.5	39.24	6,542	28.97	329,745	411,136	50	63	55	27	82	-2.5	-0.0007
SW	WWU	-4.4	39.28	6,119	29.76	291,356	370,390	48	61	50	41	91	-1.4	-0.0007
WN	WWU	-1.6	39.23	852	33.02	48,854	56,134	57	66	50	41	91	-10.4	-0.0017
WS	WWU	1.9	39.29	2,962	33.44	144,679	221,462	49	75	54	44	98	-1.0	0.0006

See main text for details of the calculations.

[8] See RRP data in Appendix C

Appendix C Mains Replacement Programme data as reported via the Regulatory Reporting Pack (RRP)

LDZ	2010/11			2009/10			2008/09			Total Length (km)	Total No. of Re-lays	Total No. of Transfers	Average Re-lays /km	Average Transfers /km	Total /km
	Lay (km)	Re-lays	Transfers	Lay (km)	Re-lays	Transfers	Lay (km)	Re-lays	Transfers						
EA	698	30,395	30,327	703	28,695	32,399	754	30,963	32,742	2,156	90,053	95,468	42	44	86
EM	698	30,395	30,327	703	28,695	32,399	754	30,963	32,742	2,156	90,053	95,468	42	44	86
NT	350	16,034	7,600	394	17,853	11,432	327	10,293	14,583	1,071	44,180	33,615	41	31	73
NW	553	23,429	17,053	603	26,332	19,253	626	29,704	19,536	1,783	79,465	55,842	45	31	76
WM	356	18,974	10,592	413	21,715	14,987	430	20,112	16,030	1,199	60,801	41,609	51	35	85
NE	317	15,641	10,572	329	14,947	11,049	325	14,939	10,592	971	45,527	32,213	47	33	80
NO	276	11,921	8,892	270	10,806	7,762	273	12,830	8,645	819	35,557	25,299	43	31	74
SC	303	12,868	14,462	282	13,534	14,943	295	12,476	18,562	880	38,878	47,967	44	55	99
SE	395	27,064	8,097	437	27,700	9,971	363	24,947	18,065	1,195	79,711	36,133	67	30	97
SO	277	16,611	7,062	312	19,116	7,813	263	10,983	7,954	852	46,710	22,829	55	27	82
SW										757			50	41	91
WN										131			50	41	91
WS										404			54	44	98

The table above shows the details of the DNs' mains replacement programmes for the three years 2008/09 to 2010/11.

A 're-lay' is a service that was Steel but which was replaced during the replacement of the main[9]; in the proposed methodology, the number of 're-lays'/km is deemed representative of the number of Steel services per km for the remaining metallic mains population.

A 'transfer' is a PE service that was reconnected to the replacement main; in the proposed methodology, the number of 'transfers'/km is deemed representative of the number of PE services per km for the remaining metallic mains population.

[9] It is 'policy' not to reconnected steel services following mains replacement

Values relating to service populations for WWU LDZs have been estimated to give a split between the LDZs that are more reflective of actual within LDZ variance rather than using the RRP data reported at DN level.