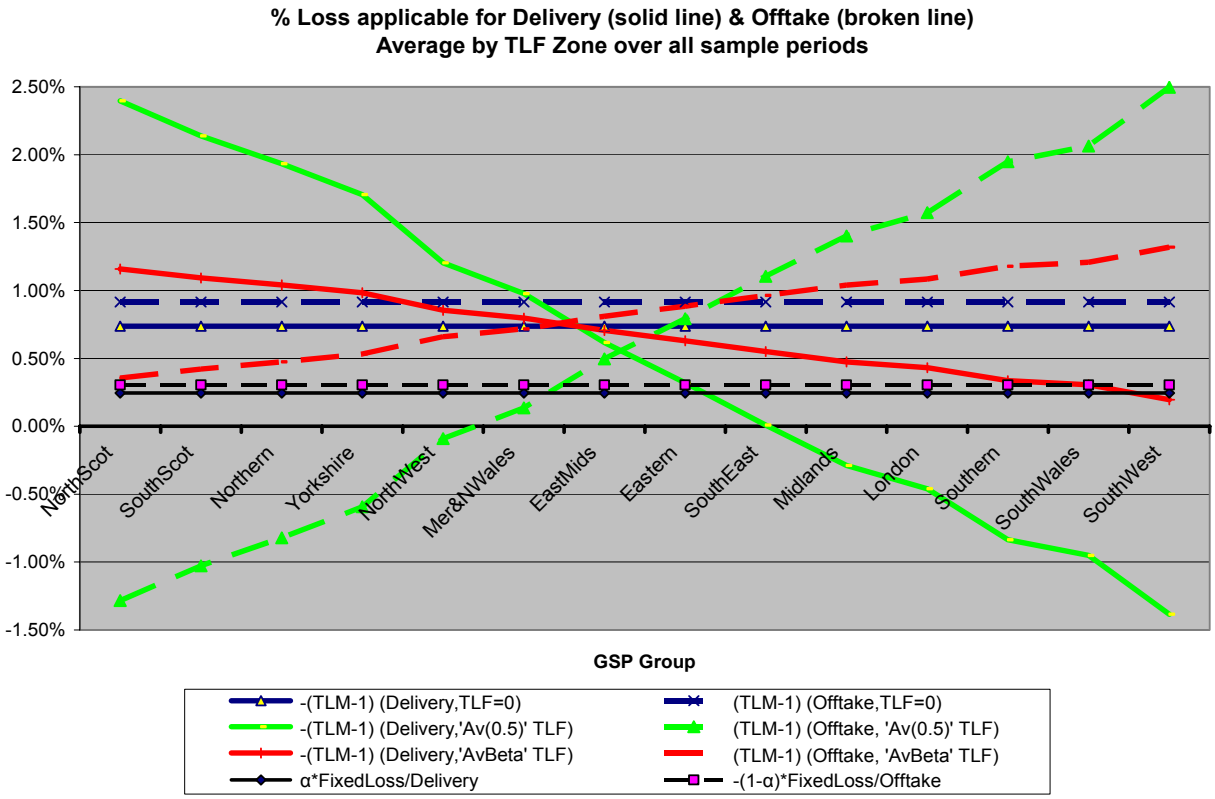
Graphical Representation of Proposed Zonal Scaling



The chart above was created using preliminary data from Modification Proposal P198 analysis conducted by Elexon and Siemens PTI, together with alternative scaling as proposed by this proposal. The data include several levels of averaging and should be taken as indicative only. The data is averaged over the period 1 April 2005 to 31 January 2006, and the zone axis is ordered according to TLF values.

The solid lines represent various components of transmission losses effectively allocated to BM Units in delivering Trading Units (generation), the dashed lines the same components for BM Units in offtaking Trading Units (demand).

Positive values represent losses which will ultimately be paid for by delivering or offtaking BM Units as percentages of metered volumes, although in practice these losses are imposed under the BSC by scaling metered volumes.

The lower horizontal lines (black) indicate an estimate of the total volume of fixed losses (assumed to be about 200MW, or about 0.6% of total flows), with 45% allocated uniformly to delivering Trading Units, and 55% allocated uniformly to offtaking Trading Units.

The higher horizontal lines (blue) indicate the total volume of losses, fixed plus variable, about 1.6% in total, again with 45% (about 0.7% of total flow) allocated uniformly to delivery, and 55% (about 0.9%) to offtake. These are the loss allocation values currently applicable.

The highly sloped lines (green) indicate average values in each zone of -(TLM-1) obtained from preliminary P198 analysis using annual average zonal TLFs. These values will give the same overall allocation of losses 45% to delivery and 55% to offtake in accordance with the BSC equations, and the lines are shifted from TLF values from P198 analysis to achieve this.

The less sloped lines (red) represent average values in each zone of –(TLM-1) obtained using annual average zonal TLFs obtained from P198 analysis, but scaled such that the lowest allocation of losses to any BM Unit is no less than that BM Unit's uniform share of fixed losses (at about 0.3% in the analysis above). BM Units with this lowest allocation effectively have no allocation of variable losses. The scaling of TLF values to achieve this result is performed in conjunction with a shift of the lines in accordance with the BSC equations such that 45% of total (and fixed) losses continue to be allocated to delivery and 55% to offtake. The scaled lines do not intersect exactly with the horizontal fixed loss lines because of the various levels of averaging approximation in this analysis.

Under the current arrangements, uniform loss allocations of about 0.7% for generation and 0.9% for demand occur.

Under P182, initial analysis suggests allocations in the range about -1.5% to 2.5% depending on zone.

Under this proposal, initial analysis suggests allocations in the range about +0.2% to +1.3% dependent on zone. Note the key feature that no negative losses are allocated. The smallest allocation is that of a uniform positive share of fixed losses. Positive amounts of variable losses, varying according to zone, are added to this to give the total loss allocation per unit of volume in each zone.

In both P198 and this proposal, the variation between zones is larger than the variation between delivery and offtake.

A number of variations in detail are possible for achieving the general principle of the proposed scaling. These can be considered as part of the modification assessment. For example, the constraint of no negative variable losses could be applied:

- To delivery and offtake separately in each settlement period. This would require a central systems software change.

- As an average of historic values of scaling factor which achieve the desired result for historic data and are applied to future data (as for P198 historic TLFs and averaging). Application to delivery and offtake separately would require a central systems change. Application as a single average value applicable to both delivery and offtake would not require central systems changes.

Equations for proposed scaling

Current BSC equations

Given measured flows and measured total losses and **any** values of TLF applicable to individual flows, the current BSC equations can be considered to adjust all TLFs applicable to delivery by a uniform shift in value Δ so that when applied to all delivery flows the adjusted TLFs produce net flow adjustments which match a fixed fraction (α) of total losses (TL). Inidividual flows and their associated TLF are given subscript z according to zone here for simplicity, but could equally be given subscript ij for BM Unit. A similar shifting applied to the TLFs applicable to offtake produces net flow adjustments matching the remaining fraction of total losses.

$\Sigma^{+}((TLF_z+\Delta^{+}).QM^{+}_z) = -\alpha.TL \quad = \Sigma^{+}((TLM_z-1).QM^{+}_z)$
$\Sigma^{-}((TLF_z+\Delta^{-}).QM^{-}_z) = -(1-\alpha).TL \quad = \Sigma^{-}((TLM_z-1).QM^{-}_z)$

From which, on rearranging:

$\Delta^{+} = (-\alpha.TL - \Sigma^{+}_z(TLF_z.QM^{+}_z)) / \Sigma^{+}_z(QM^{+}_z) = TLMO+$ **, and**
$\Delta^{-} = (-(1-\alpha).TL - \Sigma^{-}_z(TLF_z.QM^{-}_z)) / \Sigma^{-}_z(QM^{-}_z) = TLMO-$

The 'shifting' has two components:

- **$-\Sigma$(TLF.QM)** which in isolation would cause values of adjusted TLF to be distributed about a notional 'centre of delivery' (flow weighted mean) value where, if all delivery were subject to that value, the net adjustment for losses would be zero.
- **-fraction.TL** which when combined with the previous adjustment causes the net adjustment for losses to be the desired fraction of actual total losses. If taken in isolation, it adjusts the net adjustment due to the raw TLFs by the desired fraction of actual total losses.

The actual values of TLF can be anything and have no bearing on the overall result. If raw TLFs were distributed about zero, the raw 'centre of delivery' would be zero and no net loss adjustment would be made by virtue of TLFs. Shifting all TLFs by the desired fraction of total losses would bring about the desired recovery. If raw TLFs were distributed about 1000, say, a shift of -1000-(**α.TL)** to all the TLF values would give the desired recovery.

Proposed Scaling for no negative losses

This would apply a constraint to the values of TLF used in the BSC equations, such that the **minimum** amount of losses attributed to any individual flow would be no less than that arising from a uniform allocation of fixed losses. The smallest amount of variable losses attributed to any flow would be zero, with no negative allocation of variable losses to any flow.

Loss attributed to each flow ≥ that flow's uniform share of fixed losses

If TLFs (from whatever source) cause this constraint to be breached, the values of all TLFs would be scaled so that it is just satisfied. If TLFs do not breach the constraint, the values would not need to be scaled.

For example, in the hypothetical case of two delivery BM Units with different raw TLFs such that one of the BM Units is attributed an amount of losses less than it's share of fixed losses, both delivery TLFs would be scaled such that that BM Unit would be allocated only

it's uniform share of 45% of fixed losses, and the other BM Unit would be allocated it's uniform share of 45% fixed losses plus all the 45% of variable losses attributable to delivery.

For the general case, applied to delivery and offtake separately in a settlement period, and recalling that loss adjustments are equal and opposite to the allocation of actual loss they represent:

$$\mathbf{max_z(QM^+_z.(\beta^+.TLF_z + \Delta^+))} = max_z[QM^+_z.(TLM^+_z - 1)] \leq \mathbf{-QM^+_z.\alpha.FL / \Sigma^+_z(QM^+_z)}$$
$$\mathbf{max_z(QM^-_z.(\beta^-.TLF_z + \Delta^-))} = max_z[QM^-_z.(TLM^-_z - 1)] \leq \mathbf{-QM^-_z.(1-\alpha).FLj / \Sigma^-_i(QM^-_z)}$$

where β^+ and β^- are scaling factors to satisfy the constraint.

The most favourable adjustment for losses for a delivering (positive) flow is a uniform share of fixed losses.
The most favourable adjustment for losses for an offtaking (negative) flow is a uniform share of fixed losses.

Eliminating flow from either side of the equations, noting that QM^- is negative, so 'max' becomes 'min' for offtaking flows and the sign of the inequality changes:

$$\mathbf{max_z(\beta^+.TLF_z + \Delta^+) \leq -\alpha.FL / \Sigma^+_z(QM^+_z)}$$
$$\mathbf{min_z(\beta^-.TLF_z + \Delta^-) \geq -(1-\alpha).FL / \Sigma^-_z(QM^-_z)}$$

Rearranging the equations, substituting for Δ^+ , Δ^- (=TLMO+ and TLMO-) from above with all references to TLF multiplied by the appropriate β, and noting that β^+, β^- , Δ^+ , Δ^- are constants for all zones in any given snapshot:

For delivery

$$\beta^+.max_z(TLF_z) + (-\alpha.TL - \Sigma^+_z(\beta^+.TLF_z.QM^+_z)) / \Sigma^+_z(QM^+_z) \leq -\alpha.FL / \Sigma^+_z(QM^+_z)$$
$$\beta^+.max_z(TLF_z).\Sigma^+_z(QM^+_z) - \alpha.TL - \Sigma^+_z(\beta^+.TLF_z.QM^+_z)) \leq -\alpha.FL$$
$$\beta^+.[max_z(TLF_z).\Sigma^+_z(QM^+_z) - \Sigma^+_z(TLF_z.QM^+_z)] \leq -\alpha.(FL-TL))$$

$$\mathbf{\beta^+ \leq \alpha.VL / [max_z(TLF_z).\Sigma^+_z(QM^+_z) - \Sigma^+_z(TLF_z.QM^+_z)]}$$

For offtake:

$$\beta^-.min_z(TLF_z) + (-(1-\alpha).TL - \Sigma^-_z(\beta^-.TLF_z.QM^-_z)) / \Sigma^-_z(QM^-_z) \geq -(1-\alpha).FL / \Sigma^-_z(QM^-_z)$$
$$\beta^-.min_z(TLF_z).\Sigma^-_z(QM^-_z) - (1-\alpha).TL - \Sigma^-_z(\beta^-.TLF_z.QM^-_z)) \leq -(1-\alpha).FL$$
$$\beta^-.[min_z(TLF_z).\Sigma^-_z(QM^-_z) - \Sigma^-_z(TLF_z.QM^-_z)] \leq -(1-\alpha).(FL-TL))$$

$$\mathbf{\beta^- \leq (1-\alpha).VL / [min_z(TLF_z).\Sigma^-_z(QM^-_z) - \Sigma^-_z(TLF_z.QM^-_z)]}$$

If the right hand side of these expressions is greater than one, then scaling factors of 1 would satisfy the inequality, and no scaling of TLFs is required. The values of TLF would not produce negative allocations of losses.

If the right hand side of these expressions is less than one, then scaling factors with this value are the largest scaling factor which would satisfy the inequality, and would be applied to the 'input' TLFs to prevent negative allocations of losses without unnecessarily reducing the allocation.

If the scaling factors were applied strictly as above, separately for delivery and offtake in each settlement period, a change to central system software would be required.

A simplification for convenience of application under the BSC, avoiding the need for central system software change, would be to use an average value of **β** for all TLFs determined from historical analysis of a sample of snapshots. This would breach the constraints described above slightly and systematically in individual periods and between delivery and offtake (while maintaining the 45%/55% overall split). Over time, the effect of the deviation in individual periods would tend to cancel. This approach is similar to the approximations in the determination of TLF suggested for P198, which may be acceptable to participants under P198 and under this proposal. The effect of such an approximation on the scaling factors above is likely to be much less than the effect of such approximations on the values of TLF itself under P198.

Adjusted TLF = TLFz * **β,**

where $\beta = \text{Average}\ \{(\alpha\ VLj\ /\ [Max^{+}[TLFz_j]*\Sigma^{+z}(QM^{+z}{}_j) - \Sigma^{+z}(TLFz_j*QM^{+z}{}_j)])\ ,$
$((1-\alpha)VLj\ /\ [Min^{-}[TLFz_j]*\Sigma^{-z}(QM^{-z}{}_j) - \Sigma^{-}{}_i(TLFz_j*QM^{-z}{}_j)])\}$
over sample periods.

Initial analysis using indicated annual average zonal TLFs produced during P198 assessment, together with averaging of settlement period data from 1 April 2005 to 31 January 2006 provided by Elexon indicates average scaling factors of about 0.25. Application of this scaling factor to the P198 indicated annual average zonal TLFs would on average over the period satisfy the proposed constraint of no negative losses.