



Alberta Electric System Operator
Loss Factor Calculation Methodology
Effective January 01, 2009

Teshmont Consultants LP
1190 Waverley Street
Winnipeg, Manitoba
Canada R3T 0P4

Report No	1706-10000-1
Issued	2008/12/3
Revision	1
Revised	2008/1/6

DISCLAIMER

This report was prepared under the supervision of Teshmont Consultants LP (“Teshmont”), whose responsibility is limited to the scope of work as shown herein. Teshmont disclaims responsibility for the work of others incorporated or referenced herein. This report has been prepared exclusively for the Alberta Electric System Operator (AESO) and the project identified herein and must not be reused or modified without the prior written authorization of Teshmont. This report shall not be reproduced or distributed except in its entirety.

REVISION RECORD

Rev. 0	2008/12/3	Report originally issued
Rev. 1	2008/1/6	Editorial changes

Alberta Electric System Operator

Loss Factor Calculation Methodology – Effective January 01, 2009

Table of Contents

	Page
1 Introduction	1
2 Summary of Changes	1
2.1 Losses Outside of the AIES Transmission Area.....	2
2.2 Bus Classification	2
2.3 Loss Factor Compression.....	3
2.4 Implementation Changes	4
3 Methodology	4
3.1 System Partitioning.....	4
3.2 Raw Loss Factor Calculation	6
3.3 Group Loss Factors.....	9
3.4 Loss Factor Normalization.....	10
3.5 Loss Factor Compression.....	11

Alberta Electric System Operator

Loss Factor Calculation Methodology – Effective January 01, 2009

1 INTRODUCTION

In November 2003, the Alberta Department of Energy (ADOE) issued the Transmission Development Policy Paper which proposed several significant changes to how the AESO would manage the future development of Alberta's Interconnected Electric System (AIES). In August 2004, the ADOE issued the Transmission Regulation. Section 19 of this regulation described a new process and standard for the determination of Loss Factors assigned to generators connected to the AIES.

On December 21, 2004, Teshmont prepared a report in four parts which recommended a mathematical process for determining generator, opportunity services and intertie loss factors that would be compliant with the requirements of the August 2004 regulations. The recommended methodology was implemented in software (version 1) delivered to the AESO in 2005 for calculation of 2006 loss factors and was subsequently modified (version 2) in 2006 to add features to the software GUI interface reducing the potential for data entry errors.

On April 11, 2007, the Transmission Regulations were revised, with changes to be effective from January 1, 2009. The main changes to the regulations as they affect loss factor calculations were:

- To treat intertie imports as equivalent generators at the connecting busses of the AIES.
- To charge both imports and exports for losses on the AIES transmission from the connecting bus to the border
- To exclude exports from paying for AIES losses.
- To treat demand opportunity service loads as negative generators
- To increase the limits for loss factor compression, and set them to fixed values

This report describes the loss factor calculation methodology as implemented in version 3 of the AESO Loss Factor Application software, to be used by AESO for 2009 and future loss factor calculations. The methodology and implementation are compliant with the April 2007 regulations.

2 SUMMARY OF CHANGES

A number of changes have been made to the methodology as compared with that used prior to 2009. The Loss Factor Application, which implements the methodology, has been modified

accordingly, and additional improvements have been made to enhance performance, scalability, and maintainability.

2.1 Losses Outside of the AIES Transmission Area

Previously, load flows used in loss factor calculations were intended to consist primarily of the Alberta Interconnected Electrical System, but included a small number of British Columbia busses. Power flows on interties connecting the AIES with other power systems were manually set to approximately zero when preparing the load flows. The losses on the modelled BC transmission network were small and hence did not affect the loss factor calculations for the facilities of the AIES system.

Load flows developed for 2009 loss factor calculations could have non zero flows across the interties, so losses in the non-AIES system could be more significant. Including those losses will affect the calculation of loss factors for AIES facilities. To eliminate the influence of non-AIES losses, ac interconnections to non-AIES facilities are replaced by equivalent generation at the AIES interconnecting bus. While this could be accomplished within the individual load flows themselves, a feature was added to the loss factor software to carry out the replacement automatically for all load flows conditions. With this feature in place, the base case load flows are no longer limited to primarily the AIES system. The feature can also be used for sensitivity analysis of loss factors for sub-sets of the AIES system.

The Loss Factor Application calculates loss factors only for subsystems of interest. Power flows into or out of the subsystem of interest are replaced with equivalent generation. Loss factor calculations are done based on a reduced admittance matrix, which is adjusted to compensate for removal of the external system. Losses on transmission lines connecting point-of-delivery busses to the external system are not included in loss factor calculations.

2.2 Bus Classification

The general intention of the Transmission Regulation is that generators, but not loads, should be responsible for the cost of losses. However, there are a few exceptions or complications to this general rule that must be accounted for in the loss factor methodology. The concepts of bus classification and assigned and unassigned power are introduced as means for treating the complexities inherent in the regulations.

Every bus involved in a loss factor calculation must have a classification. The classification of a bus determines the way in which loss factors are calculated for that bus, and the method for calculating its assigned and unassigned power, which are inputs to the calculation. “Assigned power” (*Pass*) is power to which charges or credits for losses are applicable, while “unassigned power” (*Pun*) is not subject to such charges or credits. The general rule is that generation is assigned and loads are unassigned. Some busses, classified SPR&D, are not responsible for the cost of losses despite having generation. For these busses, generation is treated as negative load.

Generating stations may have “behind-the-fence” load, which is designated in the input load flows as different from general system load. Such load must be assigned, in contrast to system load, which is unassigned.

The new methodology includes changes to the classification system. Table 2.1 lists bus classifications and describes how they affect loss factor calculations under the new methodology.

Table 2.1

Classification	Treatment
Generator	Generation is assigned and system load is unassigned: $Pass = Pgen$ and $Pun = Pload$. The Loss Factor Application permits the user to adjust power assignment for individual generator busses, provided that $Pass - Pun = Pgen - Pload$. If behind-the-fence load exists, it is assigned.
Demand opportunity service (DOS)	Raw loss factors for DOS busses are calculated like those of generator busses. Before normalization, the signs of adjusted raw loss factors for DOS busses are reversed.
Small power research and development (SPR&D)	By default, generation is not assigned: $Pass = 0$ and $Pun = Pload - Pgen$. Both system and behind-the-fence load are unassigned. At each stage of the calculations, loss factors of zero are assigned to SPR&D busses.
Import	Import busses are now treated like generator busses. Generation and equivalent generation are assigned by default.
Export	This classification was used in prior versions of the methodology but is now obsolete as exports will no longer pay for AIES losses.
Non-designated	By default, non-designated busses are treated in the same way as generator busses.

Adjustment of the default assignment behaviour is not typical, but may be appropriate for a few specific busses.

2.3 Loss Factor Compression

A change has been made to the algorithm for compressing loss factors in the 2009 methodology, as required by the Alberta Transmission Regulation [1]. Formerly, the minimum and maximum permissible loss factors were calculated by applying scale factors to the average loss factor. In accordance with regulations, the limits have been changed to fixed values, which are currently $\pm 12\%$. In other aspects, the loss factor compression algorithm remains the same.

2.4 Implementation Changes

Version 3 of the Loss Factor Application incorporates a number of performance improvements to the calculation engine as a whole, and specifically to the routines for calculating raw loss factors.

Prior versions of the application have done calculations using an external program, Matlab. A Matlab process would be created and supplied with instructions and data for performing the loss factor calculations. The current version no longer relies on Matlab, but rather uses a compiled library made specifically for doing loss factor calculations. This change reduces memory requirements, eliminates other overhead associated with interacting with Matlab, and simplifies installation of the application.

The routines for calculating raw loss factors have been improved in the current version of the Loss Factor Application. The algorithm remains unchanged, but changes have been made to its implementation. Matrix inversion routines used for the purpose of solving linear systems of equations have been replaced with routines for solving the linear systems directly. Additionally, the solution algorithm used is optimized for the type of matrix (a sparse complex matrix) that would typically be encountered in loss factor calculations. These changes have resulted in a substantial reduction in calculation time.

3 METHODOLOGY

The complete algorithm for calculating 2009 and future loss factors is described in the following sub-sections. There are a number of stages involved in the calculation of a set of annual loss factors. A series of load flows are prepared, typically including ones representing high, medium, and low load levels for the four seasons. For each load flow, the admittance matrix of the represented system is reduced to include only busses for which loss factors are to be calculated, and this reduced admittance matrix is used to calculate “raw loss factors” for each bus. The raw loss factors for each set of load flows representing a season, referred to as a “group”, are combined using a weighted averaging procedure. Annual loss factors are produced from group loss factors using a normalization procedure which weights them by seasonal loss volume. Finally, the normalized annual loss factors are compressed to ensure that they fall within the limits permitted by regulation.

3.1 System Partitioning

When beginning with data for a system that includes some busses for which loss factors must be calculated, and other busses for which loss factors are not needed, system partitioning is performed. The purpose of the system partitioning procedure is to reduce the number of computations required in later stages of loss factor calculations. The results of this procedure are a reduced admittance matrix and equivalent generation values for each boundary bus. The complete procedure is implemented as Algorithm 1, with required data listed in Table 3.1.

Table 3.1

Name	Description	Dimensions	Units
Inputs			
Y'	Admittance matrix of full system	$N \times N$	[S] p.u.
$B'(k)$	Function from row or column index to bus number which associates admittance matrix values with bus numbers. $k \in [1, N]$, integer.		n/a
X	Set of numbers of busses for which loss factors are not needed (external busses)	$ X < N$	n/a
v'	Bus voltages for full system	$N \times 1$	[V] p.u.
$Branches(a,b)$	Yields a set of branch IDs for all branches from bus a to bus b		n/a
$Ybr(a,b,s)$	Branch admittance of the branch from bus a to bus b with branch ID s , where $s \in Branches(a,b)$		[S] p.u.
$Ysh(a,b,s)$	Shunt admittance of the branch from a to b with branch ID s , as seen at bus a		[S] p.u.
Outputs			
Y	Admittance matrix of retained system	$Nr \times Nr$	[S] p.u.
$B(k)$	Function from row or column index to bus number. $k \in [1, Nr]$, integer.		n/a
v	Retained bus voltages	$Nr \times 1$	[V] p.u.
A	Adjustment values for further loss factor calculations. A_k is the equivalent generation at boundary bus $B(k)$ required to compensate for removal of the “external” system.	$Nr \times 1$	[MVA]
Fi	Intertie flag; values are limited to $Fi_k = 1$ if $B(k)$ is an intertie or $Fi_k = 0$ if it is not	$Nr \times 1$	n/a

Algorithm 1

1. Define the retained flag Fr as $Fr_k = \begin{cases} 1, & B'(k) \notin X \\ 0, & B'(k) \in X \end{cases}$ for $k \in [1, N]$
2. Define the intertie flag Fi as $Fi_k = \begin{cases} 1, & Fr_{B^{-1}(B(k))} \cdot \sum_{m \in X} |Branches(B(k), m)| > 0 \\ 0, & otherwise \end{cases}$
for $k \in [1, Nr]$
3. Produce an ordered list from the set of busses in the retained system, $\{B'(k) \mid k \in [1, N] \text{ and } B'(k) \notin X\}$. The function B is a relation containing all unique ordered pairs (k, b) where k is an index into this ordered list and b is the element of the ordered list found at position k . The number of retained busses is Nr .
4. Find the retained admittance matrix,

$$Y_{k,l} = Y'_{B^{-1}(B(k)),B^{-1}(B(l))} - \delta_{k,l} Fi_k \sum_{m \in X} \left[\sum_{s \in \text{Branches}(B(k),m)} Ybr(B(k),m,s) + Ysh(B(k),m,s) \right]$$

where $j, k \in [1, Nr]$

5. Calculate the retained bus voltages, $v_k = v'_{B^{-1}(B(k))}$ for $k \in [1, Nr]$.

6. Find the additional equivalent generation A_k at each bus $B(k)$.

$$A_k = -Fi_k \sum_{m \in X} \left[\sum_{s \in \text{Branches}(B(k),m)} [v_k Ysh(B(k),m,s) - (v'_{B^{-1}(m)} - v_k) Ybr(B(k),m,s)]^* v_k \right] \cdot MVABASE.$$

The expression above assumes that all branches are free of phase shifters. If a branch had a phase shifter, the $(v_k - v'_{B^{-1}(m)})$ term in the above expression would need to be adjusted accordingly. The Loss Factor Application makes this adjustment as required by (additional) input data.

3.2 Raw Loss Factor Calculation

For each solved load flow provided to the Loss Factor Application, raw loss factors are calculated after the system partitioning procedure has been applied to the load flow. The raw loss factor procedure is an implementation of the 50% area load adjustment method with corrected R matrix, as described in [2]. The procedure is implemented as Algorithm 2, with required data listed in Table 3.2.

Table 3.2

Inputs			
Y	Admittance matrix	$Nr \times Nr$	[S] p.u.
v	Bus voltage	$Nr \times 1$	[V] p.u.
$Pass'$	Assigned real power for each bus	$Nr \times 1$	[MVA]
Pun'	Unassigned real power for each bus	$Nr \times 1$	[MVA]
dP	Per-bus user adjustment to assigned power	$Nr \times 1$	[MVA]
A	Adjustment to generation on boundary busses ($A_k = 0$ if $B(k)$ is not a boundary bus)	$Nr \times 1$	[MVA]
Qn	Net reactive power supplied by each bus, as calculated by load flow solver	$Nr \times 1$	[MVAR]
Fi	Intertie flag	$Nr \times 1$	n/a
Fa	“Assigned” flag. A value of 1 indicates that generation at the bus, including equivalent generation added to compensate for system reduction, should be considered assigned. A value of 0 indicates that such generation should be considered negative unassigned power.	$Nr \times 1$	n/a
$Fsprd$	“Small power research and development” flag. If the flag value is 1, the loss factor at the corresponding bus should be set to zero.	$Nr \times 1$	n/a

Outputs			
<i>LF</i>	Loss factor for each bus	$Nr \times 1$	n/a
<i>SF</i>	Shift factor	Real number	n/a

Algorithm 2

- Correct the admittance matrix. First, find the current: $i = Yv$. Then, make corrections to the diagonals of the original admittance matrix:

$$Y_{c_{k,l}} = Y_{k,l} + j\delta_{k,l} \left[Fi_k \frac{\text{Im}(i_k^* v_k)}{|v_k|^2} + (1 - Fi_k) \frac{Qn_k}{|v_k|^2 \cdot MVABASE} \right].$$

The corrections are based on net reactive power as calculated by the load flow solver for all diagonal elements except those corresponding to intertie busses in order to permit the closest possible numerical agreement with prior versions of the methodology and software. If the

corrections were simply $Y_{c_{k,l}} = Y_{k,l} + j\delta_{k,l} \frac{\text{Im}(i_k^* v_k)}{|v_k|^2}$ then numerical differences due to

“mismatch” from the load flow solver would ultimately cause slight disagreement with loss factors produced by prior implementations of the methodology, which used Qn to make the corrections. However, Qn values for boundary busses, as provided by the load flow solver, do not reflect changes in net reactive power at those busses which may be necessary to compensate for parts of the system removed in the system partitioning stage of calculations.

- Adjust the assigned and unassigned power for each bus by adding equivalent generation to compensate for system reduction. $Pass = Pass' + A \circ Fa$ and $Pun = Pun' - A \circ (1 - Fa)$.
- Let $fv(Pa, Y, v) = [Pa^T WY^{-1}W^*]^T$ and $fs(Pa, Y, v, Pb) = fv(Pa, Y, v)^T Pb$, where Pa, Pb , and v are $N \times 1$ column vectors, Y is an $N \times N$ matrix, and W is an $N \times N$ matrix with $W_{k,l} = \delta_{k,l} / v_k$. Let $gv(Pa, Y, v) = (fv(Pa, Y, v) + fv(Pa, Y^T, v)) / 2$. Similarly, $gs(Pa, Y, v, Pb) = (fs(Pa, Y, v, Pb) + fs(Pa, Y^T, v, Pb)) / 2$. Calculate $a = \text{Re}(gs(Pun, Yc, v, Pun))$, $b = -2\text{Re}(gs(Pass - Pun, Yc, v, Pun) + gs(Pun, Yc, v, dP)) + \sum_k Pun_k \cdot MVABASE$, and $c = \text{Re}(2gs(Pass - Pun, Yc, v, dP) + gs(dP, Yc, v, dP)) - \sum_k dP_k \cdot MVABASE$.
- Find r , the root of the polynomial $ax^2 + bx + c$ with the smallest absolute value. Then, $s = 1 + r$.
- Calculate Pn , the elements of which are $Pn_k = Pass_k + dP_k - s \cdot Pun_k$
- Calculate $x = gv(Pn, Yc, v) / MVABASE$ and $C = \frac{2\text{Re}(gs(Pn, Yc, v, s \cdot Pun))}{s \sum_k Pun_k \cdot MVABASE}$

-
7. Calculate the raw loss factors, $LF_k = \frac{\text{Re}(x_k) - C/2}{1 - C} \cdot (1 - Fsprd_k)$
8. Find the shift factor, $SF = \frac{\sum_k (1 - LF_k)(Pass_k + dP_k) - s \cdot Pun_k}{\sum_k Pass_k + dP_k}$.
- This shift factor is applied to all (non-SPR&D) loss factors.
-

3.2.1 Adjusted Raw Loss Factors

The AESO Loss Factor Application uses the term “adjusted raw loss factor” to distinguish a shifted loss factor from an un-shifted one. The adjusted raw loss factors are simply

$$LFS_k = LF_k + (1 - Fsprd_k)SF.$$

3.2.2 Zero-impedance Tied Busses

The system for which loss factors are to be found may include one or more sets of busses that are interconnected by zero-impedance ties. The methodology as implemented assumes that only one bus in each such set will have an associated row and column in the initial admittance matrix (and consequently, that the admittance matrix will have no infinite or “very large” entries). This bus is referred to as the “representative bus” for the zero-impedance tied set.

Zero-impedance connected sets of busses must be accounted for in the system partitioning procedure. When calculating the correction to the diagonal element of the retained admittance matrix that corresponds to a representative bus which is also a boundary bus, or when calculating the equivalent generation adjustment for that bus, branches that connect any bus in the zero-impedance connected set to an external bus should be treated as originating from the representative bus. The retained and excluded parts of the original system should not be connected by any zero-impedance ties.

When calculating raw loss factors, the representative bus of a zero-impedance connected set should be treated as the source of all generation, load, and net reactive power supplied at any bus to which it is connected by a zero-impedance tie. For example, the net reactive power of the representative bus, for the purpose of calculations, is the sum of the net reactive power of each bus in the zero-impedance tied set, including the representative bus, as found in the solved load flow. Busses other than the representative bus are excluded entirely from the calculations. All busses in a zero-impedance connected set have identical loss factors.

3.3 Group Loss Factors

The Loss Factor Application provides the user with the capability of associating multiple load flows into a group, and finding group loss factors. The group loss factor for a bus is simply the weighted average of loss factors for that bus over each load flow in the group. Algorithm 3 gives the complete details. Required data is listed in Table 3.3.

Table 3.3

Inputs		
<i>B</i>	List of bus numbers. Each bus number exists in at least 1 load flow.	$Nb \times 1$
$LF(b,x)$	Loss factors. $LF(b,x)$ is the adjusted raw loss factor calculated for bus b in load flow x , or zero if the bus does not exist in that load flow.	
$Exists(b,x)$	Function that yields 1 if bus b exists in the load flow identified by x , and zero otherwise.	
<i>Vg</i>	Volume data [MWh]. Vg_k is the volume associated with bus B_k for the group comprised of the load flows identified by X .	$Nb \times 1$
<i>X</i>	List of load flow identifiers.	$Nlf \times 1$
<i>w</i>	Load flow weights. All weights must be real numbers greater than zero.	$Nlf \times 1$
<i>Vtl</i>	User-provided total loss volume [MWh]. Must be a real number greater than zero.	
<i>Fsprd</i>	“Small power research and development” flag. A bus must have the same SPR&D status for all load flows in a group.	$Nb \times 1$
<i>Fdos</i>	“DOS bus” flag. A bus must have the same DOS status for all load flows in a group.	$Nb \times 1$
Outputs		
$LFg, LFsg$	Group loss factors, un-shifted and shifted respectively.	$Nb \times 1$
<i>SFg</i>	Group shift factor.	Real number

Algorithm 3

1.	Calculate un-shifted group loss factors, using
	$LFg_k = \text{sgn}\left(\frac{1}{2} - Fdos_k\right) \left(\sum_{l=1}^{Nlf} w_l LF(B_k, X_l) \right) / \left(\sum_{l=1}^{Nlf} w_l \cdot Exists(B_k, X_l) \right)$
2.	Find the group shift factor, $SFg = \frac{Vtl - \sum_{k=1..Nb} Vg_k \cdot LFg_k}{\sum_{k=1..Nb} (1 - Fsprd_k) Vg_k}$
3.	Calculate shifted group loss factors, given by $LFsg_k = LFg_k + (1 - Fsprd_k) SFg$

A discussion of methods for determining appropriate weights is found in [3]. The algorithm for producing weighted loss factors is unchanged compared to the prior methodology.

3.4 Loss Factor Normalization

Loss factors from all groups are combined to find a single loss factor for each bus using a normalization procedure. The normalized loss factor for a bus is essentially the average group shifted loss factor weighed by group-specific loss volume or simple average if all volumes are zero. The normalization procedure is implemented as Algorithm 4, with required data listed in Table 3.4.

Table 3.4

Inputs		
B	List of bus numbers. Each bus number exists in at least 1 group. (May be different from the bus number list for any individual group).	$Nb \times 1$
Y	List of group identifiers.	$Ng \times 1$
$LFsg(b,y)$	Shifted group loss factors for bus b in group y .	
$Vg(b,y)$	Volume in [MWh] for bus b in group y , or zero if bus b does not exist in group y . All volumes must be non-negative.	
$Fsprd(b,y)$	“Small power research and development” flag.	
Outputs		
Vt	Volume total [MWh]. The total volume of each bus excludes volumes associated with groups in which that bus is an SPR&D bus.	$Nb \times 1$
LFn	Normalized loss factors.	$Nb \times 1$

Algorithm 4

1.	Find bus volume totals, $Vt_k = \sum_{l=1..Ng} (1 - Fsprd(B_k, Y_l)) Vg(B_k, Y_l)$
2.	Calculate normalized loss factors for all busses in the list. Normalized loss factors for busses that are not classified SPR&D in all groups in which they exist are
	$LFn_k = \begin{cases} \frac{1}{Vt_k} \sum_{l=1..Ng} (1 - Fsprd(B_k, Y_l)) Vg(B_k, Y_l) LFsg(B_k, Y_l) & Vt_k > 0 \\ \frac{\sum_{l=1..Ng} LFsg(B_k, Y_l)}{Ng - \sum_{l=1..Ng} Fsprd(B_k, Y_l)} & Vt_k = 0 \end{cases}$
	If a bus is classified SPR&D in all groups, the above formula cannot be used. Its normalized loss factor is zero.

3.5 Loss Factor Compression

The final phase in loss factor calculations calls for normalized loss factors to be compressed. The compression procedure is as in [4], except that fixed compression limits are used rather than ones dependent upon the average loss factor. The compression procedure is implemented as Algorithm 5, with required data listed in Table 3.5.

Table 3.5

Inputs		
LFn	Normalized loss factors	$N \times 1$
Vt	Total loss volumes [MWh]	$N \times 1$
$LFph, LFpl$	Highest and lowest permissible loss factor, respectively	Real numbers
Outputs		
LFc	Compressed loss factors	$N \times 1$

Algorithm 5

1. Calculate the required truncation for each loss factor, $T_k = LFn_k - \min\{LFph, \max\{LFpl, LFn_k\}\}$. Define a flag to track which busses have truncated loss factors: $Ft_k = |\text{sgn}(T_k)|$.
2. Find the truncated loss factors, applying a shift to non-truncated loss factors to compensate for truncation: $LFst_k = (LFn_k - T_k) + (1 - Ft_k)SFt$, where $SFt = \frac{\sum T_k Vt_k}{\sum (1 - Ft_k) Vt_k}$.
Let $LFsth$ and $LFstl$ be the highest and lowest shifted loss factors with $Ft_k = 0$.
3. Calculate $A = \frac{\sum (1 - Ft_k) LFst_k Vt_k}{\sum (1 - Ft_k) Vt_k}$
4. Calculate $s = \min\left\{1, \frac{LFph - A}{LFsth - A}, \frac{LFpl - A}{LFstl - A}\right\}$
5. Find the compressed loss factors, $LFc_k = Ft_k LFst_k + (1 - Ft_k)(A + s(LFst_k - A))$

References

- [1] *Transmission Regulation AR 86/2007*. Alberta, Canada, Minister of Energy. April 11, 2007.
- [2] *Loss Factor Methodologies Evaluation, Part 1 – Determination of ‘Raw’ Loss Factors and Load Flow Shift Factors*, tech. report 558-10000, Teshmont Consultants LP, Winnipeg, May 22, 2007.
- [3] *Loss Factor Methodologies Evaluation, Part 2 – Conversion of Power to Energy Loss Factors*, tech. report 558-10000, Teshmont Consultants LP, Winnipeg, December 30, 2005.
- [4] *Loss Factor Methodologies Evaluation, Part 3 – Loss Factor Compression*, tech. report 558-10000, Teshmont Consultants LP, Winnipeg, December 30, 2005.
- [5] *Loss Factor Methodologies Evaluation, Part 4 – Determination of Opportunity Service ‘Raw’ Loss Factors*, tech. report 558-10000, Teshmont Consultants LP, Winnipeg, December 30, 2005.