Notice of market rule modification

Paper No.	EMC/RCP/23/2005/250
Rule reference:	A6.D.22, A6.D.3, A6.D.9
Proposer:	Market Administration, EMC
Date received by EMC:	04 Oct 05
Category allocated:	1
Status:	Approved by EMA
Effective Date:	30 Dec 05

Summary of proposed rules change:

This proposal is principally a plain English re-write of Appendix 6D.22 of Chapter 6 of the Market Rules. It corrected the rules for logical flow, appropriate terminology and clarity.

Date considered by Panel:	21 Nov 05
Date considered by EMC Board:	30 Nov 05
Date considered by Energy Market Authority:	22 Dec 05

Proposed Rule Modification:

See attached.

Reasons for rejection/Reasons for referral back to Panel (if applicable):

Paper Number	**EMC/BD/07/2005/14(c)**
RCP Paper	**EMC/RCP/23/2005/250**
Subject	**Re-Write of Appendix 6D.22**
For	**Approval**
Prepared by	**Poa Tiong Siaw** **Senior Economist**
Vetted by	**Paul Poh** **Senior Vice President, Market Administration**
Date of Meeting	**30 November 2005**

Executive Summary

The existing text of Section D.22 of Appendix 6D of the Market Rules, which governs loss calculation correction, is poorly drafted. This paper assesses and concludes that the proposed re-write of Section D.22 of Appendix 6D gives it logical flow, clarity and readability in plain English drafting. This proposal was considered and endorsed by the Technical Working Group (TWG). The RCP supported the proposal and recommends that the EMC Board adopt it.

1. Introduction

This paper assesses the re-write of Section D.22 of Appendix 6D of the Market Rules. Because these rules are part of the Market Clearing Engine's (MCE) formulation, it was considered by the Technical Working Group (TWG) on 18 October 2005.

2. Background

This proposal concerns the transmission flow-loss model used by the Market Clearing Engine (MCE).

2.1 The Transmission flow-loss Model

As stated in the Market Rules, the transmission flow-loss model used in the MCE is mathematically described as follows:

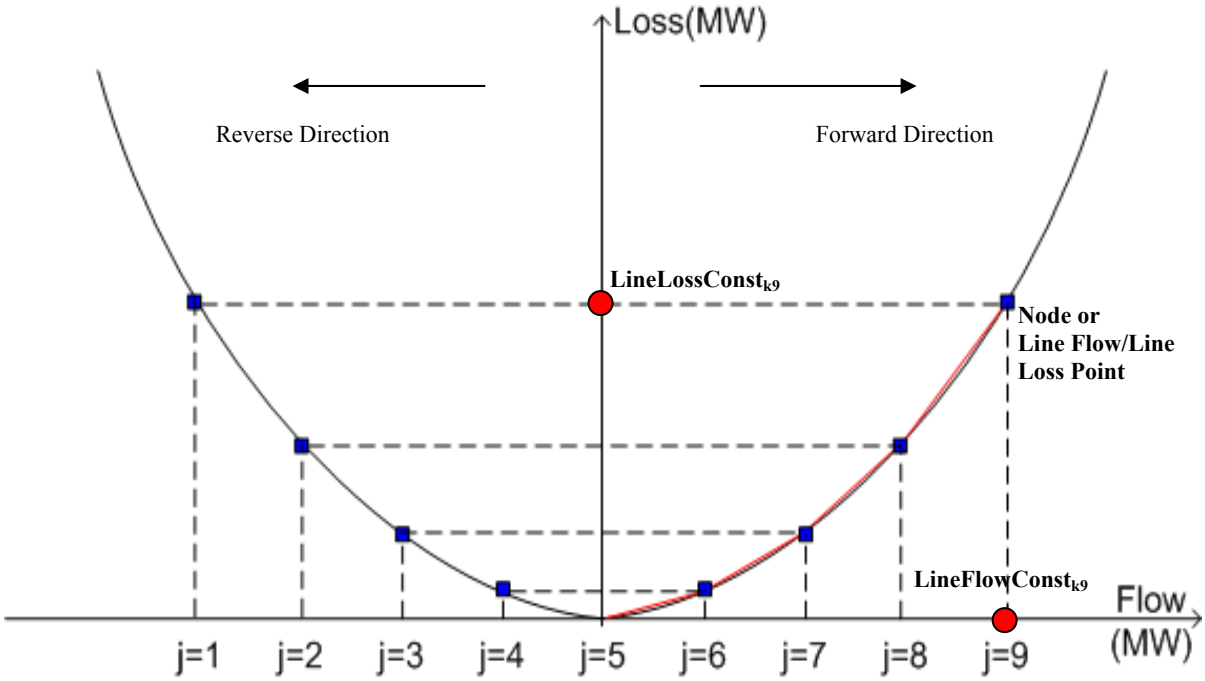
$$\text{LineFlow}_k = \sum_{j \in \text{DISCRSUB}_k} \text{LineFlowConst}_{k,j} \times \text{Weight}_{k,j} + \text{DeficitWLineFlow}_k - \text{ExcessWLineFlow}_k$$

$$\text{LineLoss}_k = \sum_{j \in \text{DISCRSUB}_k} \text{LineLossConst}_{k,j} \times \text{Weight}_{k,j}$$

$$\sum_{j \in \text{DISCRSUB}_k} \text{Weight}_{k,j} = 1$$

The physical relationship between flow and loss on a power line is defined by a quadratic (non-linear) function. Losses increase at the squared rate of flow. Since the MCE employs a linear program, it cannot directly model this relationship. Thus linear segments connecting line flow/line loss points are used to approximate the quadratic relationship. Figure 1 below illustrates the relationship between flow and loss on a power line.

Figure 1: MCE's Linear Approximation of Quadratic Flow-Loss relationship of a power line

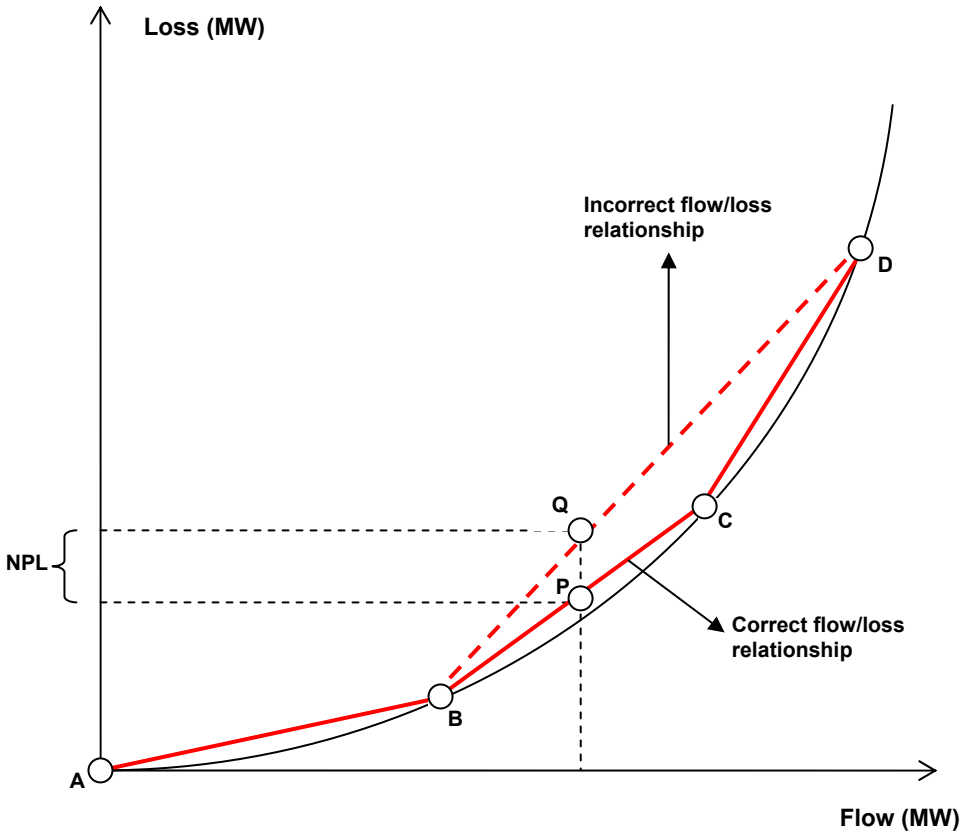


Specifically, the MCE approximates the quadratic curve in Figure 1 using eight piece-wise linear segments connected via **nine Line Flow/Line Loss Points (hereafter called nodes)** (i.e., the discretisation subset for the line, DISCRSUB). It can be proven that the optimal solution is always derived from a maximum of two nodes. Accordingly, the most efficient solution would lie on a line joining two adjacent nodes, i.e. on any red line shown in Figure 1. Note that when there are fixed losses, the Y-intercept will not be at the origin. For simplicity of illustration, we ignore fixed losses.

2.2 Non-physical Losses and the need to correct for them

When energy price is positive, the MCE (which maximises Net Benefit) will seek to minimise losses because losses are a cost and lowers Net Benefit. However, during periods of negative prices for energy, the MCE may seek to maximise losses and thus calculate higher losses for a given level of flow on a power line. This is because losses now increase the value of the Net Benefit in the objective function. Hence, the calculated flow-loss combination would lie outside any straight line between two adjacent nodes. Eg. Line BD in Figure 2 below. When this happens, we say that there are non-physical losses (NPL), given by the difference between loss at point Q (observed loss) and loss at point P (expected loss) in Figure 2. The implication of using a schedule with non-physical losses is that some generation units would be over-dispatched – because higher losses have been calculated.

Figure 2: Presence of NPL



The MCE is programmed to accept non-physical losses if:

1. A line violation penalty is triggered; or
2. The resulting system-wide losses are below a pre-determined threshold.

Otherwise, the MCE has to re-define the DISCRSUB (the set of nine nodes) for each line and re-solve the linear program. This process is called “Loss Calculation Correction”. There is also a limit placed on the number of times the MCE can be solved for the purpose of loss calculation correction. The purpose of the Loss Calculation Correction is to reduce NPL so as to produce a schedule that minimises over-dispatch of generators.

The detailed methodology of loss calculation correction is attached in **Annex 2**.

3. Problem Definition

Section D.22 of Appendix 6D governs the loss calculation correction process. The existing rules are poorly drafted, i.e.:

1. They are not structured logically;
2. Some terms used are improper and ambiguous; and
3. Actual loss calculation correction procedure is not clearly described

As a result, it would be extremely difficult for a reader to understand the logical process of "loss calculation correction" and the objectives of the mathematical formulations presented.

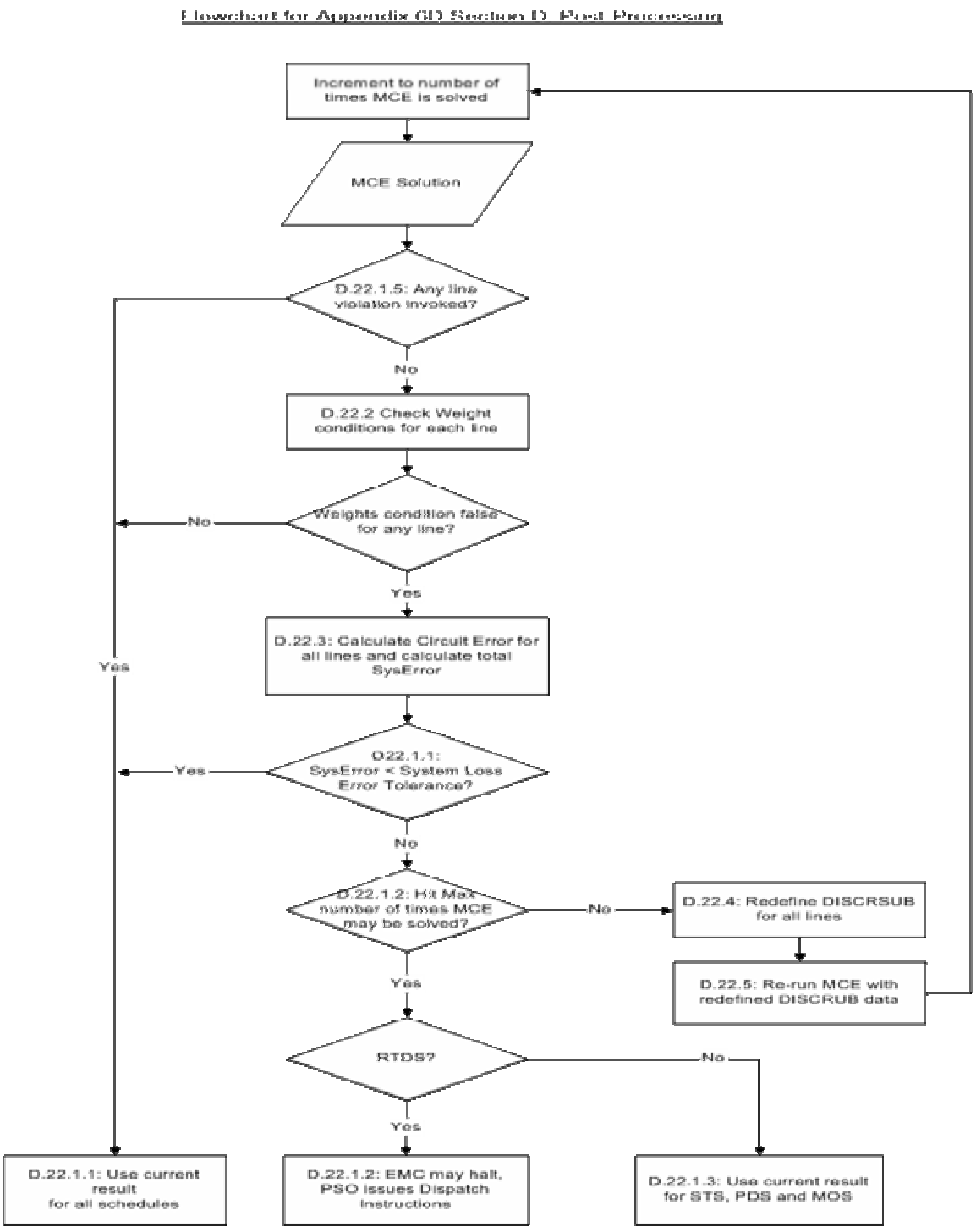
3.1 The Rules in Detail

Each solution of the MCE is checked for the presence of non-physical losses. If detected, non-physical losses are tolerated only if one of the following conditions holds:

a. Some type of line violations is invoked; or
b. The associated system losses (of the solution) is within a pre-determined tolerance level; or
c. The number of times the MCE is re-run for the purpose of loss calculation correction has reached a pre-determined limit.

Otherwise, the calculation of loss on each line has to be repeated by the MCE after redefining the DISCRSUB. Section D.22 of Appendix 6D of the Market Rules describes this process of "loss calculation correction".

Figure 3: Existing Rules Mapped to Logical Flow of Loss Calculation Correction



The logical flow for the loss calculation adjustment process is described in Figure 3. As shown by the numbering of each existing rule in the diagram, the existing text of Section D.22 of Appendix 6D does not follow the logical flow of the process.

3.2 Poor drafting of the existing text of Section D.22 of Appendix 6D

3.2.1 Lack of Logical Flow

This is obvious from Figure 3, where the numbering of the existing rules do not follow the logical flow of the process. The existing rules start off with identifying when an MCE solution maybe accepted under certain circumstances. A reader would have to read six paragraphs before coming to know how non-physical losses are actually detected. Logically, the process should be as follows:

1. Detection of non-physical losses
2. Identification of circumstances when an MCE solution may be accepted.
3. Loss calculation correction method

The existing rules start with point 2, then 1 and 3.

Solution

The proposed new draft has arranged the sections in a logical sequence that reflects the flow in Figure 4.

3.2.2 Improper/Ambiguous use of terms

Section D.22.4 of the existing rules uses terms such as “forward direction limit” and “reverse direction limit”, which are not applicable all the time. For instance, after loss calculation correction has been made, it is possible that all line flow/line loss points are defined only within the space of forward direction or reverse direction. In the former, it then does not make sense to adjust the “reverse direction limit” because “reverse direction” no longer exist in the “forward direction” solution space.

The existing D.22.4 also uses the words “outer points of the line loss function”, which are terms not defined in the Market Rules. Used in isolation, it is not clear to the reader that the words mean the outer nodes of the linear approximation to the quadratic curve in Figure 1.

Solution

The proposed new draft removed the terms “forward direction limit” and “reverse direction limit”. It describes the process by making direct reference to the line flow/line loss points (which are defined in Appendix 6D.3) being adjusted. The use of line flow/line loss point terminology is also consistent with the definitions of $DISCRSUB_k$ (Section D.2 of Appendix 6D), $NumPoints_k$ and $AdditionalNumPoints_k$ (Section D.3 of Appendix 6D).

3.2.3 Unclear instructions

In the existing D.22.3, the instruction to calculate and check the variable SysError is not explicit. In the existing D.22.4.1 and D.22.4.2, the instruction to find line flow/line loss point *i* is also not explicit.

Solution

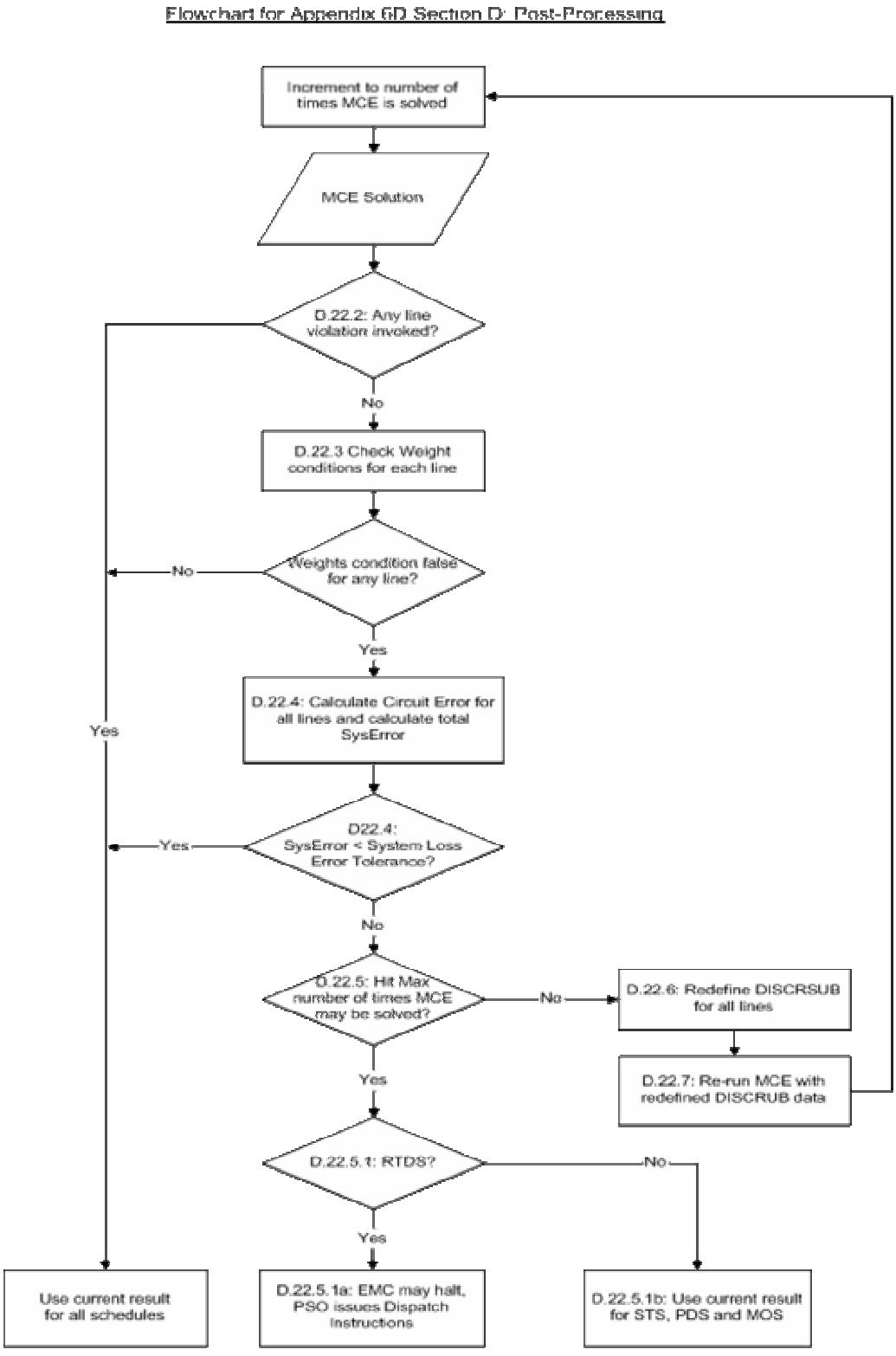
Describe the detailed steps in plain English to complement the mathematical formulations.

4. Analysis of Proposed Re-write

The new text proposed has the following improvements over the existing Market Rules:

a. It is logically and systematically arranged (see Figure 4 below);
b. It clarifies the purpose behind mathematical formulations used for loss calculation correction; and
c. It is written in plain English.

Figure 4: Re-written Rules Mapped to Logical Flow of Loss Calculation Correction



The arrangement (numbering) of the proposed re-written rules exactly follows the logical flow.

5. Conclusion

The proposed re-write of Section D.22 of Appendix 6D of the Market Rules should replace the existing draft so as to realize the benefits of logical flow, clarity and plain English drafting.

6. Impact on market systems

There would be no impact on any market system.

7. Implementation process

This rule change can be implemented immediately.

8. Consultation

We have *publish*ed the proposed text of *modification*s on the *EMC* website for comments. No comment was received for consideration.

9. Legal sign off

Text of rule modification has been vetted by EMC's external legal counsel whose opinion is that the proposed text of Section D.22 of Appendix 6D of the Market Rules:

1. Reflects the objectives of the proposed modifications described in this rule change paper;
2. Is legally effective; and
3. Is legally consistent with other parts of the Market Rules.

10. Technical Working Group Deliberation

The TWG met to deliberate on this proposal on 18 October 2005. All TWG members unanimously agreed with the conclusion of this paper and endorsed the re-written text of Section D.22 of Appendix 6D and the associated rule changes.

11. Recommendations

The RCP unanimously recommend that the EMC Board:

a. **adopt** EMC's proposal to re-write Section D.22 of Appendix 6D of the Market Rules and the associated rule changes as set out in Annex 1 of this paper;

b. **seek** the Authority's approval of this rule modification proposal; and

c. **recommend** that the rule modification proposal come into force **one business day** after the date on which the approval of the Authority is published by the EMC.

Annex 1: Re-Write Of Section D.22 of Appendix 6D: Post-Processing

Proposed Drafting	**Mapping to Existing Rules**
SECTION D: POST-PROCESSING **D.22 LOSS CALCULATION CORRECTION** D.22.1 The *EMC* shall set and *publish* the following values: D.22.1.1 the system loss error tolerance; and D.22.1.2 the maximum number of times the equations in section C ("the linear program") may be solved for the purpose of loss calculation correction under section D.22 for any given *dispatch period* in any given run of the *market clearing engine*. The *EMC* may update and re-*publish* these values as required.	**D.22.1.4** **Changes for clarification:** The existing sections D.22.1.2 and D.22.1.3 refer to "the number of repetitions of the procedures in this section D.22" and the existing sections D.22.1.4 refers to "maximum number of iterations for the loss calculation correction". These expressions are more accurately described as references to the number of times the equations in section C (i.e. the linear program) may be solved for the purpose of loss calculation under section D.22.
D.22.2 After each solution of the linear program, the *EMC* shall carry out the procedures in sections D.22.3 to D.22.7 to the extent provided in those sections. However, the *EMC* shall not do so if any of the line violation variables, $\text{ExcessLineFlowForward}_k$, $\text{ExcessLineFlowReverse}_k$,	**D.22.1, D.22.1.5**

Proposed Drafting	**Mapping to Existing Rules**
DeficitWLineFlow$_k$ or ExcessWLineFlow$_k$, for any *dispatch network line k* is greater than zero.	**Substantive Rule Change:** (i) The second sentence contains a rule change to the effect that when a line violation is present, EMC "shall not" proceed with loss calculation correction. The existing section D.22.1.5 merely states that the EMC "need not" proceed with loss calculation correction. **Changes for clarification:** (i) The first sentence of this new section D22.2 contains a rule change that is intended to clarify that it is the EMC's obligation under the existing section D22.1 to carry out the procedures in the new sections D.22.3 to D.22.7. (ii) The new section D22.2 also corrects the following errors in the existing section D22.1.5: (a) the variables

Proposed Drafting	**Mapping to Existing Rules**
	"DeficitLineFlowWeight$_k$" and "ExcessLineFlowWeight$_k$" in the existing section D.22.1.5 should be "DeficitWLineFlow$_k$", and "ExcessWLineFlow$_k$" respectively; and (b) all four variables should be expressed in Arial font as provided in the existing section D.1.1.2. (iii) The new section D22.2 further clarifies that the variables set out therein are "line violation variables" and that those variables relate to a *dispatch network line k.*
D.22.3 Subject to section D.22.2, if the following condition: $\text{Weight}_{k,j} = 0$ or $\text{Weight}_{k,i} = 0$ $\{k, j, i \mid j, i \in \text{DISCRSUB}_k, \text{where } k \in \text{LINES}, i > j + 1\}$, is false for any pair of non-adjacent line flow/line loss points *i* and *j* on any *dispatch network line k*, section D.22.4 shall apply. Otherwise, the *EMC* may accept the current solution of the linear program.	**D.22.2** **Changes for clarification:** (i) The new section D.22.3 clarifies that the steps in the new section D.22.3 should follow

Proposed Drafting	**Mapping to Existing Rules**
	sequentially after the steps in the new section D.22.2 above. (ii) The new section D.22.3 clarifies that the examination of the Weight variables in the existing section D.22.2 is solely for the purpose of determining whether the condition in this new section D.22.3 is true or false; and is also intended to change the reference to the "pairs of non-adjacent weights on a single *dispatch network line*" in the existing section D.22.2 to a more accurate reference, i.e. "any pair of non-adjacent line flow/line loss points *i* and *j* on any *dispatch network line k"*. (iii) The new section D.22.3 clarifies that the EMC is permitted to accept the current solution of the linear program if the condition in this section is true, and that the remaining loss calculation correction procedures in the

Proposed Drafting	**Mapping to Existing Rules**
	succeeding sections need not be carried out by the EMC in such a case.
D.22.4 Subject to section D.22.3, the total erroneous losses in the solution of the linear program, SysError, shall be calculated and checked as follows: $\text{SysError} = \sum_k \text{CircuitError}_k$ where: $\text{CircuitError}_k = \text{LineLoss}_k - \text{ActualLoss}_k$ $\text{ActualLoss}_k = \text{LineLossConst}_{k,i} + \frac{\text{LineFlow}_k - \text{LineFlowConst}_{k,i}}{\text{LineFlowConst}_{k,i+1} - \text{LineFlowConst}_{k,i}} \times (\text{LineLossConst}_{k,i+1} - \text{LineLossConst}_{k,i})$ $\left\{ i,k \mid i \in \text{DISCRSUB}_k, \text{where } k \in \text{LINES}, \; i = \text{Max}\left(j \mid j < N(DISCRSUB_k), \; \text{LineFlowConst}_{k,j} \le \text{LineFlow}_k \right) \right\}$ If SysError is less than the system loss error tolerance established by the *EMC* under section D.22.1.1, the *EMC* may accept the current solution of the linear program. Otherwise, section D.22.5 shall apply.	**D.22.3, D.22.1.1** **Changes for clarification:** (i) The new section D.22.4 clarifies that the existing sections D.22.3 and D.22.1.1 are to be read together and should follow sequentially after the steps in the new section D.22.3 above. (ii) It is not necessary to state that the EMC shall use the results of the current solution of the linear program for production of the relevant *real-time dispatch schedule, short-term schedule, pre-dispatch schedule* or *market outlook scenario*.

Proposed Drafting	**Mapping to Existing Rules**
D.22.5 Subject to section D.22.4, if the number of times the linear program has been solved for the purpose of loss calculation correction for a given *dispatch period* in a given run of the *market clearing engine*: D.22.5.1 is equal to the maximum number established by the *EMC* under section D.22.1.2, and that run of the *market clearing engine* is to produce: a. a *real-time dispatch schedule,* the *EMC* may halt the process of loss calculation correction and the provisions of section 9.1.2.2 of Chapter 5 and section 9.3.2B of Chapter 6 shall apply; or b. a *short-term schedule*, *pre-dispatch schedule* or *market outlook scenario*, the *EMC* may accept the current solution of the linear program; or D.22.5.2 is less than the maximum number established by the *EMC* under section D.22.1.2, sections D.22.6 and D.22.7 shall apply.	**D.22.1.2, D.22.1.3** **Changes for clarification:** (i) The new section D.22.5.1 clarifies that the existing section D.22.1.2 applies to a case where the relevant run of the *market clearing engine* is to produce a *real-time dispatch schedule* and that the existing section D.22.1.3 applies to a case where the relevant run of the *market clearing engine* is to produce a *short-term schedule*, *pre-dispatch schedule* or *market outlook scenario*. (ii) The new section D.22.5.2 is intended to clarify that the procedures in the new sections D.22.6 and D.22.7 follow sequentially after the procedures in the new section D.22.5.

Proposed Drafting	**Mapping to Existing Rules**
D.22.6 Subject to section D22.5, for each *dispatch network line k*, the ordered set of line flow/line loss points in set DISCRSUB$_k$ shall be adjusted according to sections D.22.6.1 and D.22.6.2. D.22.6.1 Line flow/line loss point *i* shall be identified such that: $\{i \mid i \in \text{DISCRSUB}_k, \text{where } k \in \text{LINES}, i = \text{Max}(j \mid \text{LineFlowConst}_{k,j} < \text{LineFlow}_k + \text{SysError})\}$. If there is no line flow/line loss point $j \in$ DISCRSUB$_k$ where $j > i$, no adjustment shall be made. Otherwise, all line flow/line loss points $j \in$ DISCRSUB$_k$ where $j > i$ shall be discarded and a new line flow/line loss point with line loss and line flow given by LineLossConst′$_{k,i+1}$ and LineFlowConst′$_{k,i+1}$ shall be defined: $\text{LineFlowConst}'_{k,i+1} = \text{LineFlow}_k + \text{SysError}$ $\text{LineLossConst}'_{k,i+1} = \text{LineLossConst}_{k,i} + \frac{(\text{LineFlow}_k + \text{SysError}) - \text{LineFlowConst}_{k,i}}{(\text{LineFlowConst}_{k,i+1} - \text{LineFlowConst}_{k,i})} \times (\text{LineLossConst}_{k,i+1} - \text{LineLossConst}_{k,i})$ D.22.6.2 Line flow/line loss point *i* shall be identified such that: $\{i \mid i \in \text{DISCRSUB}_k, \text{where } k \in \text{LINES}, i = \text{Min}(j \mid \text{LineFlowConst}_{k,j} > \text{LineFlow}_k - \text{SysError})\}$. If there is no line flow/line loss point $j \in$ DISCRSUB$_k$ where $j < i$, no adjustment shall be made. Otherwise, all line flow/line loss points $j \in$ DISCRSUB$_k$ where $j < i$ shall be discarded and a new line flow/line loss point with line loss and line flow given by LineLossConst′$_{k,i-1}$ and LineFlowConst′$_{k,i-1}$ shall be defined:	**D.22.4, D.22.4.1, D.22.4.2** **Changes for clarification:** (i) The opening words of this new section D.22.6 are intended to clarify that the procedures in this new section D.22.6 follow sequentially after the procedures in the new section D.22.6. (ii) Changes made are explained in section 3.2.2 and 3.2.3 of the rule change paper.

Proposed Drafting	**Mapping to Existing Rules**
$\text{LineFlowConst}'_{k,i-1} = \text{LineFlow}_k - \text{SysError}$ $\text{LineLossConst}'_{k,i-1} = \text{LineLossConst}_{k,i} + \frac{(\text{LineFlow}_k - \text{SysError}) - \text{LineFlowConst}_{k,i}}{(\text{LineFlowConst}_{k,i-1} - \text{LineFlowConst}_{k,i})} \times \left(\text{LineLossConst}_{k,i-1} - \text{LineLossConst}_{k,i}\right)$	
D.22.7 The re-defined set of line flow/line loss points determined in section D.22.6 for each *dispatch network line* shall be used to re-solve the linear program.	**D.22.5** **Changes for clarification:** The new section D.22.7 clarifies that the results derived from the procedures in section D.22.2 to D.22.6 (i.e. the re-defined set of line flow/line loss points determined in section D.22.6 for each *dispatch network line*) shall be used to resolve the next solution of the linear program for the purposes of loss calculation correction.

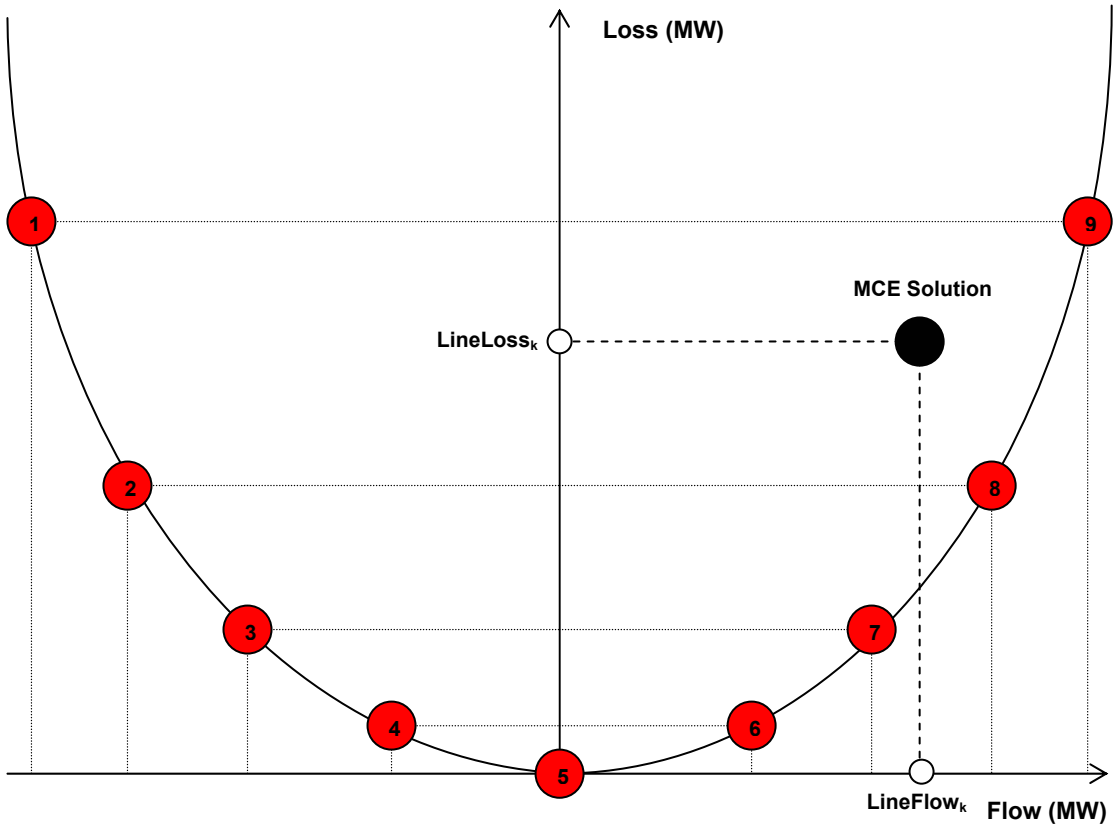
Associated Rule Changes

Existing Rules (1 January 2005)		**Proposed Change**	**Reason for change**
Appendix 6D.9			
D.9.2 The *EMC* shall determine $NumPoints_k$, the number of loss points needed for each *dispatch network line k*, except for the artificial *dispatch network lines* added pursuant to sections D.6.5 or D.8.2.		D.9.2 The *EMC* shall determine $NumPoints_k$, the number of line flow/line loss points required in the set $DISCRSUB_k$ in order to define the linear approximation of the quadratic loss curve ~~needed~~ for each *dispatch network line k*, except for the artificial *dispatch network lines* added under ~~pursuant to~~ sections D.6.5 or D.8.2.	To clarify the use of the line flow/line loss points. Refer to section D2, Appendix 6D.
Appendix 6D.3 Parameters			
$ActualLoss_k$	The *dispatch network line* loss calculated for *dispatch network line k* after the linear program is solved, in the event that it is suspected that the linear program has not calculated the *dispatch network line* loss correctly. Calculated in accordance with section D.21.3.	The *dispatch network line* loss calculated for *dispatch network line k* after the linear program is solved, in the event that it is suspected that the linear program has not calculated the *dispatch network line* loss correctly. Calculated in accordance with section D~~.21.3~~.22.4.	To reflect the new numbering in the re-drafted text.
$CircuitError_k$	The difference between the *dispatch network line* loss calculated within the linear program and the *dispatch network line* loss calculated after the linear program	The difference between the *dispatch network line* loss calculated within the linear program and the *dispatch network line* loss calculated after the linear program	To reflect the new numbering in the re-drafted text.

Existing Rules (1 January 2005)		**Proposed Change**	**Reason for change**
	has solved for *dispatch network line k*. Calculated in accordance with section D.21.3.	has solved for *dispatch network line k*. Calculated in accordance with section D~~.21.3~~.22.4.	
SysError	The total across the dispatch network of all of the differences between the line losses calculated within the linear program and the line losses calculated after the linear program has solved. Calculated in accordance with section D.21.3.	The total across the dispatch network of all of the differences between the line losses calculated within the linear program and the line losses calculated after the linear program has solved. Calculated in accordance with section D~~.21.3~~.22.4.	To reflect the new numbering in the re-drafted text.

Annex 2: Illustration of the Loss Calculation Correction Procedure

Suppose an MCE solution produces the following flow-loss value for Line k:



<u>Step 1: Detect Presence of Non-physical Losses</u>

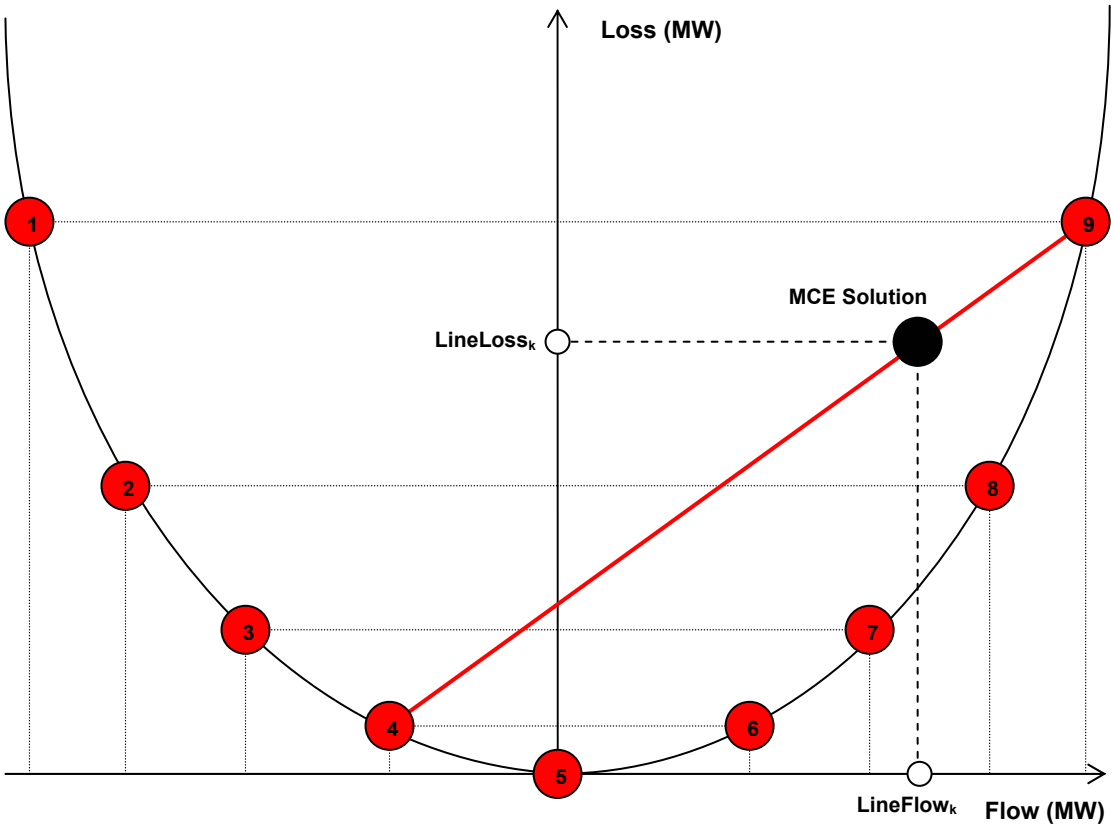
Given that:

$$\text{LineFlow}_k = \sum_{j \in \text{DISCRSUB}_k} \text{LineFlowConst}_{k,j} \times \text{Weight}_{k,j} + \text{DeficitWLineFlow}_k - \text{ExcessWLineFlow}_k$$

and

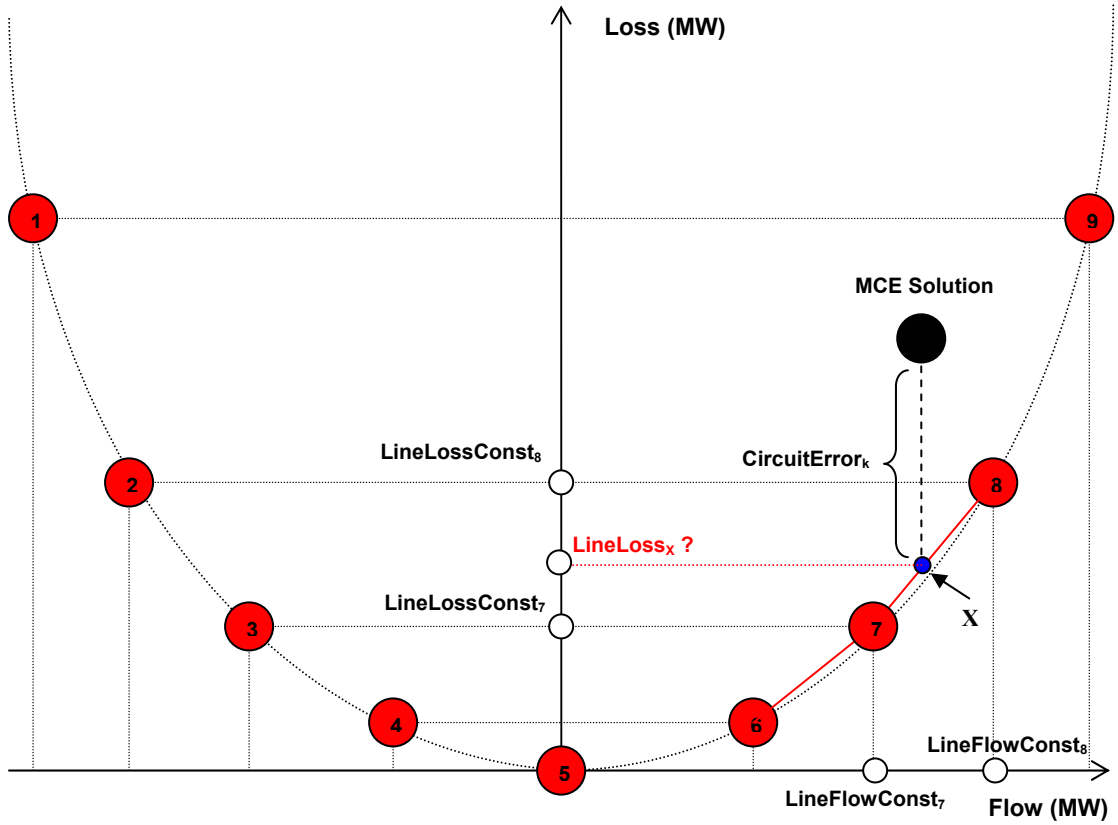
$$\text{LineLoss}_k = \sum_{j \in \text{DISCRSUB}_k} \text{LineLossConst}_{k,j} \times \text{Weight}_{k,j}$$

The MCE checks, as part of post-processing, if the Weight for any pair of non-adjacent nodes is positive. If the weight allocated to any pair of non-adjacent nodes is positive, non-physical losses is present. Using the above example, the weights for Node 4 and 9 would be positive:



Note that the solution lies on the straight line joining Nodes 4 and 9 which are non-adjacent to each other. It does not lie on a line joining any 2 adjacent nodes.

Step 2: Determine the Value of Circuit Error ($CircuitError_k$) and System Error (SysError)



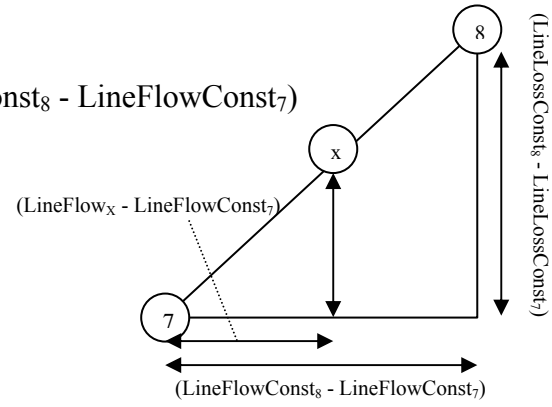
Given that $LineFlow_k$, $LineFlowConst_7$, $LineFlowConst_8$, $LineLossConst_7$ and $LineLossConst_8$ are all known, we can use simple trigonometry to derive $LineLoss_X$, the expected line loss[1] at the given $LineFlow_k$.

$LineLoss_X$ =

[($LineFlow_X$ - $LineFlowConst_7$) / ($LineFlowConst_8$ - $LineFlowConst_7$)

x ($LineLossConst_8$ - $LineLossConst_7$)]

+ $LineLossConst_7$



The non-physical loss for Line k,

$CircuitError_k$ = $LineLoss_k$ (the observed line loss) - $LineLoss_X$ (the expected line loss)

[1] In Section D.22 of Appendix 6D, this is referred to as Actual Loss.

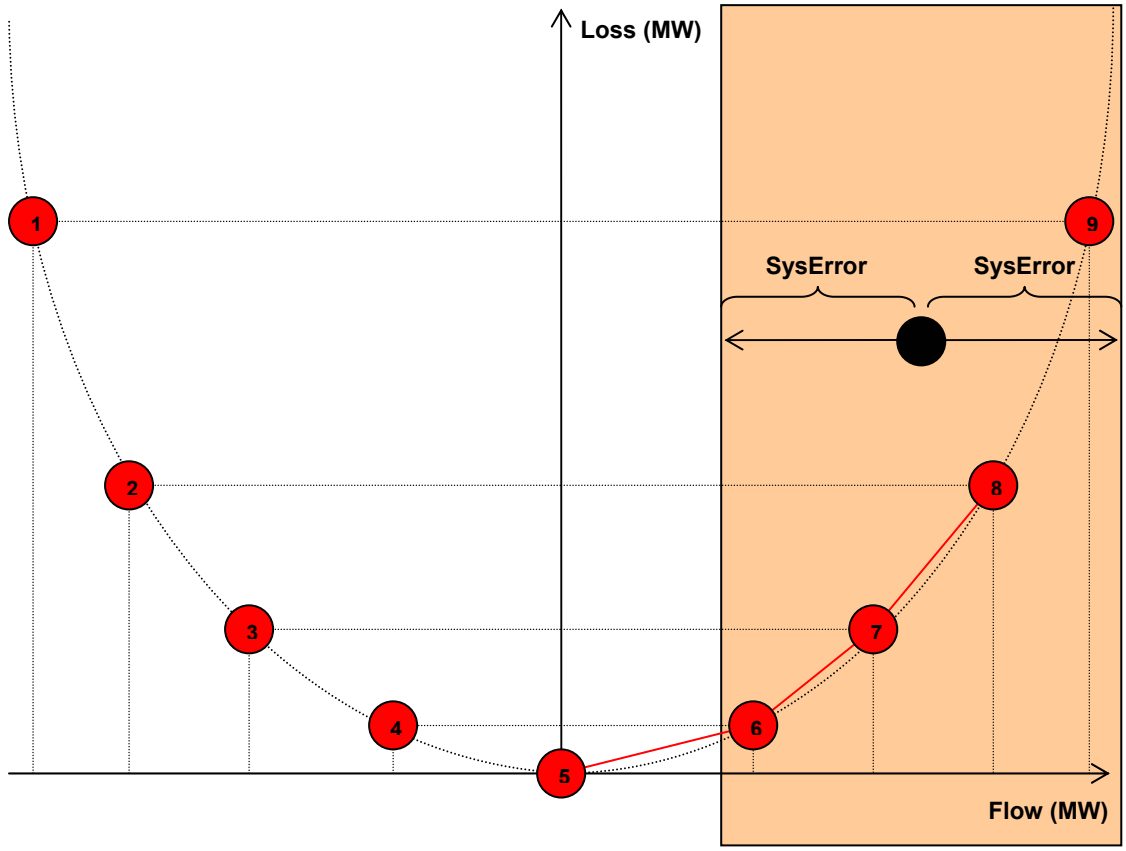
The summation of circuit errors across all lines becomes the System Loss Error (**SysError**). If the System Loss Error is less than the set tolerance level, no loss calculation correction needs to be carried out.

SysError = $\sum$**CircuitError**$_k$

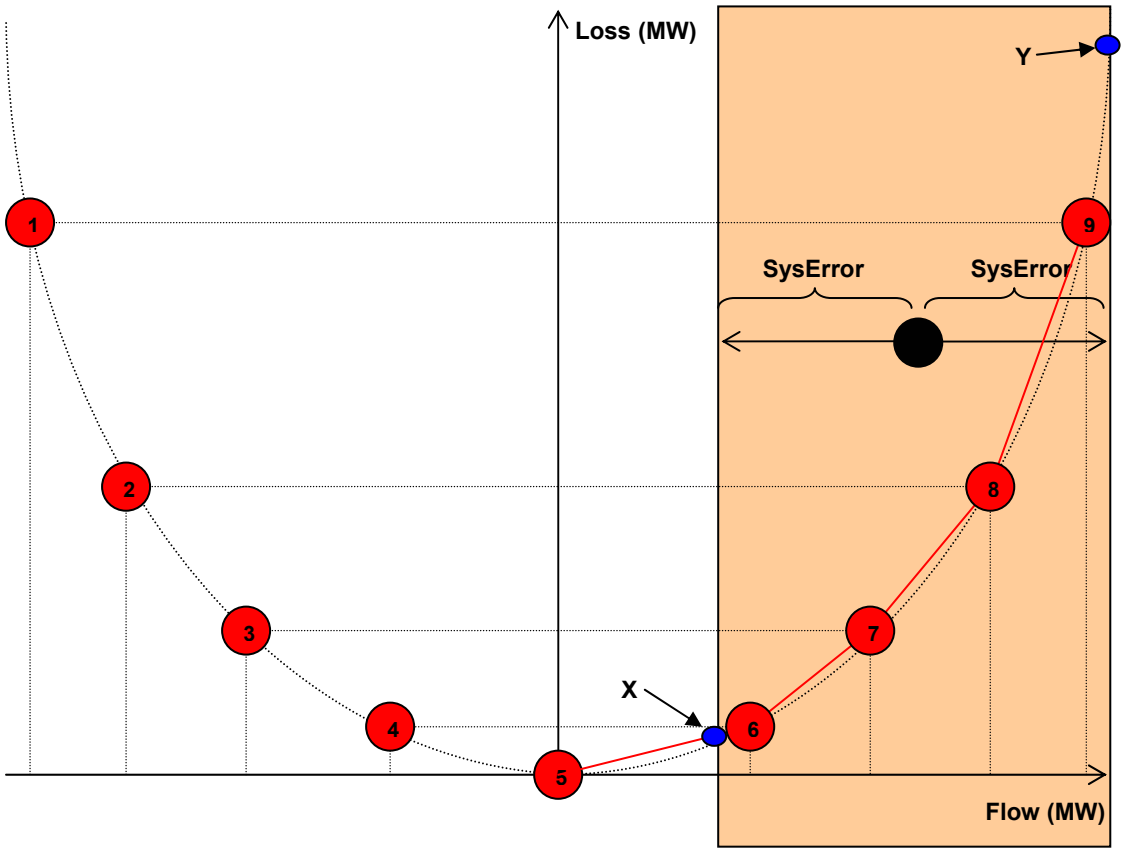
If the SysError is greater than the set tolerance level (and the maximum number of MCE run done for loss calculation correction methodology is not reached), the following process will take place:

Step 3: Loss Calculation Correction

Step 3.1: Add to and subtract from LineFlow$_k$ the value of SysError to establish the new domain for DISCRSUB$_k$. See the shaded portion in the diagram below:



Step 3.2: Discard Line Flow/Line Loss Points (or Nodes) outside the new domain and establish new nodes at the left and right limits.



The existing $DISCRSUB_k$ (defined by Nodes 1-9) will be re-defined and reside within the new domain. The new left and right limits will be adjusted as follows:

For the new left limit:
If the node immediately to the right of X (Node 6 in this case) is the existing left limit, it will not be adjusted. Otherwise, point X will become the new left limit.

For the new right limit:
If the node immediately to the left of Y (Node 9 in this case) is the existing right limit, then it will not be adjusted. Otherwise, point Y will become the new right limit.

All nodes outside the new left and right limits are discarded from the new $DISCRSUB_k$.

In this example, the new left limit is point X while the right limit remains at Node 9. The new $DISCRSUB_k$ will then only contain the nodes X, 6, 7, 8 and 9.

Step 3.3: Calculate the line flow/line loss values at the new limits.
The next step is to calculate the flow-loss values of the left and right new limits if they have been re-defined. Here, the same technique in Step 2 applies.

Illustrating using the example:

$LineFlow_x$ is already given by $LineFlow_k$ – SysError

Therefore:

$LineLoss_X$ =

$[(LineFlow_X - LineFlowConst_5) / (LineFlowConst_6 - LineFlowConst_5)$

$x\ (LineLossConst_6 - LineLossConst_5)]$

$+ LineLossConst_5$

Step 3.4: Re-run the MCE with the re-defined $DISCRSUB_k$