Energy Market Company

Notice of Market Rules Modification

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Proposer:	Henry Gan, EMC
Date received by EMC:	18 July 2006
Category allocated:	2
Status:	Approved by EMA
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Summary of proposed rule modification:

Under the current Market Rules, when a constraint for an entity is violated, additional constraints associated with the same entity may be violated up to the same level without increasing the applicable violation penalty (i.e., without reducing the objective function value).

This rule change proposal is to have a violation penalty incurred for every constraint violation.

Date considered by Rules Change Panel:	5 September 2006
Date considered by EMC Board:	5 October 2006
Date considered by Energy Market Authority:	25 October 2006

Proposed rule modification:

See attached paper.

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

Energy Market Company

PAPER NO.	:	**EMC/BD/05/2006/03(b)**
RCP PAPER NO.	:	**EMC/RCP/28/2006/259**
SUBJECT	:	**INCURRENCE OF GROUP VIOLATION PENALTIES**
FOR	:	**DECISION**
PREPARED BY	:	**JANICE LEOW** **ECONOMIST**
REVIEWED BY	:	**PAUL POH LEE KONG** **SVP, MARKET ADMINISTRATION**
DATE OF MEETING	:	**5 OCTOBER 2006**

Executive Summary

This paper assesses the rule modification proposal by EMC to modify the linear program formulation so that every constraint violation used by the Market Clearing Engine (MCE) will incur a penalty to the objective function of the linear program. Currently, once a constraint is violated, other constraints associated with the same entity may be violated up to the same amount without incurring further penalty. The purpose of the proposal is to prevent this from occurring so that constraints are only violated when necessary. Testing on a prototype MCE with the formulation changes showed that problem cases would be resolved and "normal" cases would be unaffected. EMC estimates that the required MCE formulation changes can be implemented within two months. The Technical Working Group has endorsed the proposed formulation changes. The RCP recommends that the EMC Board **adopt** the rule modification proposal and ancillary rule modifications.

1. Introduction

This paper assesses EMC's rule modification proposal to amend the linear program formulation given in Section D.21 of Appendix 6D of the Market Rules (see Annex 1), and the ancillary rule modifications to Appendix 6D and 6J of the Market Rules (see Annex 2).

2. Background

Market Schedules (containing the scheduled quantities of Energy, Reserve and Regulation for each Registered Facility, and the associated prices of Energy, Reserve and Regulation) are determined by running the Market Clearing Engine (MCE) to solve the linear program specified in Appendix 6D of the Market Rules.

The linear program is set up as a problem of maximising the net benefit from fulfilling the required quantities of Energy, Reserve and Regulation, subject to a variety of line, facility and security constraints. With the large number of constraints, a solution to the linear program may sometimes not exist. To allow the MCE to find a solution in such a situation, many constraints are defined as "soft". This allows constraints to be violated at the cost of incurring a high penalty to the objective function *NetBenefit* of the linear program.

NetBenefit = Benefit from Energy scheduled
– Cost of Energy scheduled
– Cost of Reserve scheduled
– Cost of Regulation scheduled
– Violation penalties (i.e., costs of constraint violations)

Constraint violations incur high penalties to reduce the value of *NetBenefit* so that the MCE will minimise the use of violations in maximising *NetBenefit*. In certain situations, however, there are violations that would not incur penalties to reduce *NetBenefit*, so the MCE may use such violations even though they are not strictly necessary. The following describes how the current set-up of linear program allows this to occur.

Constraint violations

Typically, a constraint is a limit on a variable (or some combination of variables) to at least a certain value (see equation (1)), to at most a certain value (see equation (2)), or to exactly a certain value (see equation (3)). To allow a constraint to be violated, it is made "soft" by the addition of one or more "slack" variables (called "violation variables"). The following shows how three generic soft constraints are formulated by the addition of violation variables *Deficit1*, *Excess2*, *Deficit3* and *Excess3*.

	Typical underlying constraint	**Formulation as soft constraint**
(1)	Variable1 ≥ Value1	Variable1 + Deficit1 ≥ Value1
(2)	Variable2 ≤ Value2	Variable2 – Excess2 ≤ Value2
(3)	Variable3 = Value3	Variable3 + Deficit3 – Excess3 = Value3

(In the Market Rules, violation variables are easily recognisable as their names begin with either "Deficit" or "Excess", depending on whether a violation of its associated underlying constraint means that the variable being constrained falls short of or exceeds its targeted constrained value. Note: violation variables are non-negative.)

When a violation variable takes on a positive value, it is a violation of the underlying constraint by that positive value. In equation (1), *Deficit1* denotes the amount that variable *Variable1* has fallen short of the constrained value *Value1*. A value of 5 for *Deficit1* means that *Variable1* has fallen short of *Value1* by 5. In equation (2), *Excess2* denotes the amount that variable *Variable2* has exceeded the constrained value *Value2*. A value of 3 for *Excess2*

means that *Variable2* has exceeded *Value2* by 3. *Deficit3* and *Excess3* in equation (3) have analogous meanings.

(As Energy shortage and surplus violations are treated differently, the remainder of this paper does not apply to them.)

Violation penalties

There are soft constraints for five types of entities: lines, the Reserve requirement for a Reserve Class, the Regulation requirement, facilities, and the security constraint.

Violation variables for each entity are grouped together in a "violation constraint group". Table 1 shows the grouping of violation variables into violation constraint groups for each type of entity.

Table 1: Violation constraint groups and violation penalty schedules

Type of entity	Violation constraint groups	Violation variables in each violation constraint group (Number)	Violation penalty block price and quantity	
Line	1 group for each line	ExcessLineFlowForward, ExcessLineFlowReverse, DeficitWLineFlow, ExcessWLineFlow (4)	2.2 × VoLL	10,000 MW
Reserve	3 groups – 1 for each Reserve Class	DeficitReserve (1)	Primary Reserve: 0.9 × VoLL Secondary Reserve: 0.8 × VoLL Contingency Reserve: 0.7 × VoLL	2,000 MW
Regulation	1 group	DeficitRegulation (1)	0.6 × VoLL	2,000 MW
Facility	1 group for each facility	ExcessRawReserve, ExcessResGen, ExcessResGenSegment1, ExcessResGenSegment2, ExcessResGenSegment3, ExcessResRamp, ExcessResPropRamp, ExcessRegGen, DeficitRegGen, ExcessRegRamp, ExcessUpRampRate, ExcessDownRampRate, DeficitMulti, ExcessMulti, ExcessLineFlowForward, ExcessLineFlowReverse, DeficitWLineFlow, ExcessWLineFlow (18)	20 × VoLL	10,000 MW
Security	1 group	DeficitSecurity (1)	6 × VoLL	10,000 MW

Violations for different types of entities incur penalties at different rates, given by the different violation penalty block price and quantity schedules[1] (see Table 1). Violation penalty block prices (which are in multiples of VoLL[2]) are increasing in how undesirable violations for the entity types are. This provides the MCE with a priority order for using violations. For instance, between a 1 MW *ExcessLineFlowForward* violation for a line (which would incur a 2.2 × VoLL penalty) and a 1 MW *ExcessRawReserve* violation for a facility (which would incur a 20 × VoLL penalty), the MCE would use the cheaper line violation.

When a violation penalty is incurred, it is incurred for a violation constraint group. That is, all violations that the MCE uses for a given entity are considered together and used to determine a single "group violation penalty".

Each violation constraint group has a "group violation variable". Currently, each group violation variable picks up the largest violation variable in the violation constraint group (i.e., largest violation used for the entity). For a given entity, say *Entity X*, the group violation variable *ViolationGroupBlock(Entity X)* would be set to at least as large as each of the violation variables (e.g., *Deficit1*, *Excess2*, etc.) in its violation constraint group, through a series of constraints such as that shown in equations (4a), (4b), etc.

(4a) ViolationGroupBlock(Entity X) ≥ Deficit1

(4b) ViolationGroupBlock(Entity X) ≥ Excess2

etc. …

The group violation variable is the quantity used for determining, in combination with the relevant violation penalty block price and quantity schedule, the group violation penalty:

Group violation penalty for Entity X = (Violation penalty block price for Entity X's entity type) × ViolationGroupBlock(Entity X)

An example

Suppose the violation variables in the violation constraint group for Generation Registered Facility (GRF) *GRF Y* were as follows.

Violation variable	Value	Violation variable	Value
ExcessRawReserve	**7**	ExcessResGen	0
ExcessResGenSegment1	0	ExcessResGenSegment2	**4**
ExcessResGenSegment3	0	ExcessResRamp	0
ExcessResPropRamp	0	ExcessRegGen	0
DeficitRegGen	0	ExcessRegRamp	0
ExcessUpRampRate	0	ExcessDownRampRate	**5**
DeficitMulti	0	ExcessMulti	0
ExcessLineFlowForward	**3**	ExcessLineFlowReverse	0
DeficitWLineFlow	0	ExcessWLineFlow	0

[1] For each entity type, there is a schedule of violation penalty block prices and quantities for determining the applicable violation penalty. A violation up to the first violation penalty block quantity will incur a penalty at the rate given by the first violation penalty block price. Higher violation amounts will incur incremental penalty at the violation penalty block price for the relevant violation penalty block quantity. Only a single violation penalty block price and quantity is specified for each entity type at present.

[2] VoLL (or Value of Lost Load) is currently set as $5,000.

Constraining the violation variable *ViolationGroupBlock(GRF Y)* to at least the largest of these violation variables, and maximisation of *NetBenefit* (which implies minimisation of violation penalties) by the MCE, would give the following results:

ViolationGroupBlock(GRF Y) = 7 (i.e., largest violation variable in violation constraint group)

Violation penalty for GRF Y = (Violation penalty block price for Facilities)
× ViolationGroupBlock(GRF Y)
= (20 × VoLL) × 7
= 140 × VoLL

NetBenefit = … – 140 × VoLL

The problem

As a group violation penalty is incurred based on the largest violation for the entity, an initial violation would allow additional constraints associated with the same entity to be violated up to the same level without reducing *NetBenefit*.

Observe in the above example that once the violation variable *ExcessRawReserve* is set to 7, all other violation variables in the violation constraint group may take on values up to 7 without increasing the group violation variable *ViolationGroupBlock(GRF Y)* and thus without reducing *NetBenefit*. (Note that these other violation variables are *allowed* but not *required* to take on a positive value.)

When such additional violations are used, the resultant Market Schedules become even more infeasible and, in the case of Real-Time Schedules, will more likely require overriding by the PSO.

3. Analysis

3.1. Proposed solution

EMC has proposed that the linear program formulation be changed so that every violation used by the MCE would incur a penalty to *NetBenefit*. This involves redefining the constraints on group violation variables so that each picks up the sum of all violations for the relevant entity (rather than the largest violation for that entity). So, for the *Entity X* mentioned earlier, the series of equations (4a), (4b), etc. would be replaced by a single equation (4) as shown below.

(4) ViolationGroupBlock(Entity X) ≥ Deficit1 + Excess2
+ [all other violation variables for Entity X]

With the modified formulation, every violation variable would add to the group violation variable, so every violation would incur a penalty to reduce *NetBenefit*. This would ensure that additional violations would only be used when they are necessary.

The group violation variables for the Reserve requirement for each Reserve Class, the Regulation requirement, and the security constraint are not affected by this modification proposal since there is only one violation variable in each of the corresponding violation constraint groups.

3.2. Testing

A prototype MCE was developed with the linear program formulation changes described and tests were run to confirm that the problem of violations that do not reduce *NetBenefit* would be addressed, but solutions would otherwise not be affected.

Test (1): Problem case

Background

In the Real-Time Schedule produced by the MCE for Period 2 of 10 November 2005, violations that did not reduce *NetBenefit* were observed for a GRF (*GRF A*). The initial violation was from its scheduled Energy *Generation(GRF A)* falling short of the minimum end-of-dispatch period generation level *GenerationEndMin(GRF A)*. Further violations were from the sum of its scheduled Energy, Regulation and Reserve for each Reserve Class exceeding the respective maximum capacities given in its Energy Offer *ReserveGenerationMax(GRF A)*.

MCE inputs for GRF A	**Value**
Initial generation level	281.57 MW
Components of Energy Offer:	
Ramp-down rate	5 MW/minute
Total quantity offered	80 MW
Maximum combined capacity for Energy, Regulation and Reserve for each Reserve Class (ReserveGenerationMax(GRF A))	**80 MW**
Minimum end-of-dispatch period generation level given initial generation level and ramp-down rate in Energy Offer (GenerationEndMin(GRF A))	**131.57 MW**
MCE outputs for GRF A	**Value**
Scheduled Energy (Generation(GRF A))	**80 MW**
Scheduled Regulation (Regulation(GRF A))	0 MW
Scheduled Primary Reserve (RawReserve(GRF A, Primary))	30 MW
	110 MW

As it is not possible to schedule a GRF for more Energy than what it offered (since the constraint in section D.15.1.2 of Appendix 6D is "hard"), *Generation(GRF A)* was constrained to 80 MW. Given this and *GenerationEndMin(GRF A)*, the Down Ramp Constraint for *GRF A* had to be violated. The violation amount *ExcessDownRampRate(GRF A)* was 51.57 (131.57 minus 80) MW (not higher so *NetBenefit* was maximised).

§D.19.2 of App 6D	**Down Ramp Constraint:**	
	Generation(GRF A) **(80)**	80
	+ ExcessDownRampRate(GRF A)	+ **51.57**
	≥ GenerationEndMin(GRF A) **(131.57)**	= 131.57

However, the Reserve Generation Max Constraints for *GRF A* were also violated for all Reserve Classes as *GRF A* was scheduled for all three Reserve Classes. *RawReserve(GRF A, Primary)*, for instance, was 30 MW, making the violation amount in the Reserve Generation Max Constraint for Primary Reserve *ExcessResGen(GRF A, Primary)* 30 MW.

§D.17.2.4 of App 6D	**Reserve Generation Max Constraint:**	
	Generation(GRF A) **(80)**	80
	+ RawReserve(GRF A, Primary)	+ **30**
	+ Regulation(GRF A)	+ 0
	– ExcessResGen(GRF A, Primary)	– **30**
	≤ ReserveGenerationMax(GRF A) **(80)**	= 80

Violation of the Down Ramp Constraint meant that the group violation variable for *GRF A ViolationGroupBlock(GRF A)* was set to 51.57 MW (not higher so *NetBenefit* was maximised). But this allowed additional constraint violations for *GRF A* up to the value of 51.57 MW because these would not increase *ViolationGroupBlock(GRF A)* and thus would not reduce *NetBenefit*.

§D.21.1.15 of App 6D	**Excess Down Ramp Constraint:**	
	ViolationGroupBlock(GRF A)	**51.57**
	≥ ExcessDownRampRate(GRF A)	= **51.57**
§D.21.1.8 of App 6D	**Excess Reserve Generation Constraint:**	
	ViolationGroupBlock(GRF A)	**51.57**
	≥ ExcessResGen(GRF A, Primary)	≥ **30**

Test results

In the prototype MCE, formulation captured by the existing sections D.21.1.7 to D.21.1.17D of Appendix D was replaced with that of the proposed section D.21.5. In a re-run of the problem case using the prototype MCE, there were no longer violations of the Reserve Generation Max Constraints for GRF A for all Reserve Classes (e.g., *ExcessResGen(GRF A, Primary)* was 0).

New §D.21.5 of App 6D	**Facility Constraint:**	
	ViolationGroupBlock(GRF A)	**51.57**
	≥ ExcessDownRampRate(GRF A)	= **51.57**
	+ ExcessResGen(GRF A, Primary)	+ 0
	+ [other violations variables for GRF A]	+ 0

Thus, only the necessary violation of the Down Ramp Constraint for *GRF A* occurred. Reserve prices were higher because the current MCE had incorrectly used cheap Reserve offered by *GRF A*. Had an actual contingency occurred in the dispatch period, because *GRF A* would have been at its scheduled generation level of 80 MW, it would not have been in a position to provide its scheduled quantities of Reserve. Without cheap Reserve from *GRF A*, the prototype MCE had to use more expensive Reserve from other GRFs. This in turn led to a lower *NetBenefit* value, and incidentally more expensive energy being used but less expensive regulation being freed up.

MCE outputs		**Current MCE**	**Prototype MCE**
System	USEP	$129.45	$147.54
	Primary Reserve Price	$4.61	$52.57
	Secondary Reserve Price	$0.02	$0.09
	Contingency Reserve Price	$0.09	$0.54
	Regulation Price	$40.43	$39.00
	Violation amount incurring penalty	51.57 MW	51.57 MW
	NetBenefit	$187,572,676.64	$187,572,121.47

MCE outputs		Current MCE	Prototype MCE
GRF A	Scheduled Energy	80 MW	80 MW
	Scheduled Regulation	0 MW	0 MW
	Scheduled Primary Reserve	**30 MW**	**0 MW**
	Scheduled Secondary Reserve	**30 MW**	**0 MW**
	Scheduled Contingency Reserve	**51.57 MW**	**0 MW**

Test (2): "Normal" cases

Although there was no reason to believe that "normal" runs without violations would be affected by the formulation changes, a day of re-runs were performed on the prototype MCE as a check. Real-Time Schedules for each period of 24 May 2006 were obtained using the prototype MCE and compared with the results obtained from the current MCE. The results from all prototype MCE runs lined up with the original results from the current MCE.

Test (3): Other violation cases

To check that the formulation changes worked correctly, a number of cases with other types of violations (besides facility violations) were created and tested under the current and prototype MCEs. These cases were made by either:

a. increasing the requirements of energy, regulation, primary reserve, secondary reserve, or contingency reserve; or

b. reducing the line limit.

As expected, the results from the current and prototype MCEs were the same for the cases in (a). The results for the line violation case in (b) were similar to that of the facility violation problem case in Test (1). The current MCE used an additional violation (that did not reduce *NetBenefit*) on the line with the artificially created violation, but the prototype MCE eliminated the opportunity for this to occur.

4. Conclusion

Under the current linear program formulation, once a constraint is violated, other constraints associated with the same entity may be violated up to the same amount without reducing the objective function value.

EMC's proposal to modify the way in which group violation penalties are incurred would prevent violations that do not reduce objective function value from occurring so that constraints would only be violated when necessary. Tests of the proposed modified formulation have shown that problem cases are addressed but other cases (with no violations or no "free-riding" violations) are not affected.

5. Impact on market systems

This rule modification proposal involves changes to MCE formulation, specifically formulation relating to group violation variables.

6. Implementation process

EMC estimates that the implementation process consisting of the following activities would require approximately 6-7 weeks.

Time required	Activity
2 weeks	User acceptance testing
2 weeks	Parallel runs of current and modified MCEs
2-3 weeks	Audit

EMC has begun user acceptance testing and parallel runs of current and modified MCEs so that this change can be fully implemented before EMC's IT systems code freeze (due to a re-platform of servers) on 1 November 2006.

The cost of implementation is covered by the MCE maintenance contract already catered for in EMC's budget.

7. Consultation

We have published the rule modification proposal on the EMC website for comments. No comments have been received for consideration.

8. Legal sign off

EMC's external legal counsel has indicated that because of the technical nature of the rule modification proposal he is unable to provide a legal signoff.

9. Technical Working Group deliberations

As this rule modification proposal involves MCE formulation changes, it was referred to the Technical Working Group (TWG).

At its 11th Meeting on 21 August 2006, the TWG considered and **endorsed** the rule modification proposal and ancillary rule modifications.

10. Recommendations

The RCP unanimously recommends that the EMC Board:

a. **adopt** the rule modification proposal to amend the linear program formulation given in Section D.21 of Appendix 6D of Chapter 6 of the Market Rules, and the ancillary rule modifications, as set out in the Annex 1 and Annex 2;

b. **seek** the Authority's approval for the rule modification proposal and ancillary rule modifications; and

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

Annex 1: Rule modification proposal

Existing rules – Appendix 6D of Chapter 6 (Release: 1 July 2006)	Proposed rules	Reasons for modification
D.21 VIOLATION GROUP CONSTRAINTS D.21.1.1 Excess Line Flow Forward Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSLIN}_{y(k)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessLineFlowForward}_k$ $\{k \in \text{LINES}, k \notin \text{ARTIFICIALLINES}\}$ D.21.1.2 Excess Line Flow Reverse Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSLIN}_{y(k)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessLineFlowReverse}_k$ $\{k \in \text{LINES}, k \notin \text{ARTIFICIALLINES}\}$ D.21.1.3 DeficitWLineFlow Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSLIN}_{y(k)}} \text{ViolationGroupBlock}_{y,j} \geq \text{DeficitWLineFlow}_k$ $\{k \in \text{LINES}, k \notin \text{ARTIFICIALLINES}\}$ D.21.1.4 ExcessWLineFlow Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSLIN}_{y(k)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessWLineFlow}_k$ $\{k \in \text{LINES}, k \notin \text{ARTIFICIALLINES}\}$	**D.21 VIOLATION GROUP CONSTRAINTS** D.21.1 Line Flow Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSLIN}_{y(k)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessLineFlowForward}_k$ $+ \text{ExcessLineFlowReverse}_k + \text{DeficitWLineFlow}_k + \text{ExcessWLineFlow}_k$ $\{k \in \text{LINES}, k \notin \text{ARTIFICIALLINES}\}$	To cause a violation penalty to be incurred for each constraint violation on a given line (excluding artificial lines).
	D.21.2 Line Flow Constraint (applies only to a re-run of the *market clearing engine* under section 10.2.3A.2 and section 10.2.5B of Chapter 6): $\sum_{j \in \text{VIOLATIONGROUPBLOCKSLIN}_{y(k)}} \text{ViolationGroupBlock}_{y,j} \geq \text{DeficitWLineFlow}_k$ $+ \text{ExcessWLineFlow}_k$ $\{k \in \text{LINES}, k \notin \text{ARTIFICIALLINES}\}$	This is required by the existing section D.16.4.3 so that line flows exceeding line capacities do not incur violation penalties in the said case of a re-run of the market clearing engine.

Existing rules – Appendix 6D of Chapter 6 (Release: 1 July 2006)	Proposed rules	Reasons for modification
D.21.1.5 Deficit Reserve Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSRES}_{y(c)}} \text{ViolationGroupBlock}_{y,j} \geq \text{DeficitReserve}_{c}$ $\{c \in \text{RESERVECLASSES}\}$	D.21.3 Deficit Reserve Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSRES}_{y(c)}} \text{ViolationGroupBlock}_{y,j} \geq \text{DeficitReserve}_{c}$ $\{c \in \text{RESERVECLASSES}\}$	Numbering change only.
D.21.1.6 Deficit Regulation Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSREG}_{y(regulation)}} \text{ViolationGroupBlock}_{y,j} \geq \text{DeficitRegulation}$	D.21.4 Deficit Regulation Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSREG}_{y(regulation)}} \text{ViolationGroupBlock}_{y,j} \geq \text{DeficitRegulation}$	Numbering change only.
	D.21.5 Facility Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g)}} \text{ViolationGroupBlock}_{y,j} \geq \text{FacilityReserveViolation}_{g}$ $+ \text{FacilityRegulationViolation}_{g} + \text{FacilityRampViolation}_{g}$ $+ \text{FacilityMultiUnitViolation}_{g} + \text{FacilityLineFlowViolation}_{g}$ $\{g \in \text{ENERGYOFFERS}\}$	To cause a violation penalty to be incurred for each constraint violation relating to a given facility. The new intermediate variables are specified in sections D.21.5.1 to D.21.5.5.
D.21.1.7 Excess Raw Reserve Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g(r))}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessRawReserve}_{r}$ $\{g,c \mid c \in \text{RESERVECLASSES}, \text{g} \in \text{OFFERS}\}$ D.21.1.8 Excess Reserve Generation Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessResGen}_{r(g,c)}$ $\{g,c \mid c \in \text{RESERVECLASSES}, g \in \text{OFFERS}\}$	D.21.5.1 Facility Reserve Constraint: $\text{FacilityReserveViolation}_{g} = \sum_{c \in \text{RESERVECLASSES}} \text{ExcessRawReserve}_{r(g,c)}$ $+ \sum_{c \in \text{RESERVECLASSES}} \text{ExcessResGen}_{r(g,c)}$ $+ \sum_{c \in \text{RESERVECLASSES}} \text{ExcessResGenSegment1}_{r(g,c)}$ $+ \sum_{c \in \text{RESERVECLASSES}} \text{ExcessResGenSegment2}_{r(g,c)}$ $+ \sum_{c \in \text{RESERVECLASSES}} \text{ExcessResGenSegment3}_{r(g,c)}$ $+ \sum_{c \in \text{RESERVECLASSES}} \text{ExcessResRamp}_{r(g,c)} + \sum_{c \in \text{RESERVECLASSES}} \text{ExcessResPropRamp}_{r(g,c)}$ $\{g \in \text{ENERGYOFFERS}\}$	The set ‘OFFERS’ in the existing rules should be ‘ENERGYOFFERS’.

Existing rules – Appendix 6D of Chapter 6 (Release: 1 July 2006)	Proposed rules	Reasons for modification
D.21.1.8A Excess Reserve Generation Segment 1 Constraint $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessResGenSegment1}_{r(g,c)}$ $\{g,c \mid c \in \text{RESERVECLASSES}, g \in \text{OFFERS}\}$ D.21.1.8B Excess Reserve Generation Segment 2 Constraint $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessResGenSegment2}_{r(g,c)}$ $\{g,c \mid c \in \text{RESERVECLASSES}, g \in \text{OFFERS}\}$ D.21.1.8C Excess Reserve Generation Segment 3 Constraint $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessResGenSegment3}_{r(g,c)}$ $\{g,c \mid c \in \text{RESERVECLASSES}, g \in \text{OFFERS}\}$ D.21.1.9 Excess Reserve Ramp Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessResRamp}_{r(g,c)}$ $\{g,c \mid c \in \text{RESERVECLASSES}, \text{g} \in \text{OFFERS}\}$ D.21.1.10 Excess Reserve Proportion Ramp Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessResPropRamp}_{r(g,c)}$ $\{g,c \mid c \in \text{RESERVECLASSES}, \text{g} \in \text{OFFERS}\}$		
D.21.1.11 Excess Regulation Generation Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessRegGen}_{l(g)}$ $\{ g \in \text{OFFERS}\}$	D.21.5.2 Facility Regulation Constraint: $\text{FacilityRegulationViolation}_{g} = \text{ExcessRegGen}_{l(g)} + \text{DeficitRegGen}_{l(g)} + \text{ExcessRegRamp}_{l(g)}$ $\{g \in \text{ENERGYOFFERS}\}$	The set ‘OFFERS’ in the existing rules should be ‘ENERGYOFFERS’.

Existing rules – Appendix 6D of Chapter 6 (Release: 1 July 2006)	Proposed rules	Reasons for modification
D.21.1.12 Deficit Regulation Generation Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g)}} \text{ViolationGroupBlock}_{y,j} \geq \text{DeficitRegGen}_{l(g)}$ $\{ g \in \text{OFFERS} \}$ D.21.1.13 Excess Regulation Ramp Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessRegRamp}_{l(g)}$ $\{ g \in \text{OFFERS} \}$		
D.21.1.14 Excess Up Ramp Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessUpRampRate}_{g}$ $\{ g \in \text{ENERGYOFFERS}, g \notin \text{INTERTIEENERGYOFFERS} \}$ D.21.1.15 Excess Down Ramp Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g)}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessDownRampRate}_{g}$ $\{ g \in \text{ENERGYOFFERS}, g \notin \text{INTERTIEENERGYOFFERS} \}$	D.21.5.3 Facility Ramp Rate Constraint: $\text{FacilityRampViolation}_{g} = \text{ExcessUpRampRate}_{g} + \text{ExcessDownRampRate}_{g}$ $\{ g \in \text{ENERGYOFFERS}, g \notin \text{INTERTIENERGYOFFERS} \}$	The set ‘OFFERS’ in the existing rules should be ‘ENERGYOFFERS’.
D.21.1.16 Deficit Multi-unit Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g(s))}} \text{ViolationGroupBlock}_{y,j} \geq \text{DeficitMulti}_{s}$ $\{ s \in \text{MULTIUNITCONSTRAINTS} \}$ D.21.1.17 Excess Multi-unit Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g(s))}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessMulti}_{s}$ $\{ s \in \text{MULTIUNITCONSTRAINTS} \}$	D.21.5.4 Facility Multi-unit Constraint: $\text{FacilityMultiUnitViolation}_{g} = \sum_{s \in \text{MULTIUNITCONSTRAINTS}} \text{DeficitMulti}_{s(g)} + \sum_{s \in \text{MULTIUNITCONSTRAINTS}} \text{ExcessMulti}_{s(g)}$ $\{ g \in \text{ENERGYOFFERS} \}$	New function s(g) defined in section D.5. ‘g’ in the existing rules refers to elements within the set ‘ENERGYOFFERS’.

Existing rules – Appendix 6D of Chapter 6 (Release: 1 July 2006)	Proposed rules	Reasons for modification
D.21.1.17A Excess Connection Line Flow Forward Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g(k))}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessLineFlowForward}_k$ $\{k \in \text{ARTIFICIALLINES}, k \notin \text{ARTIFICIALLINES3}\}$ D.21.1.17B Excess Connection Line Flow Reverse Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g(k))}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessLineFlowReverse}_k$ $\{k \in \text{ARTIFICIALLINES2}\}$ D.21.1.17C Deficit Connection W Line Flow Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g(k))}} \text{ViolationGroupBlock}_{y,j} \geq \text{DeficitWLineFlow}_k$ $\{k \in \text{ARTIFICIALLINES2}\}$ D.21.1.17D Excess Connection W Line Flow Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSFAC}_{y(g(k))}} \text{ViolationGroupBlock}_{y,j} \geq \text{ExcessWLineFlow}_k$ $\{k \in \text{ARTIFICIALLINES2}\}$	D.21.5.5 Facility Connection Line Flow Constraint: $\text{FacilityLineFlowViolation}_g = \sum_{k_1 \in \text{ARTIFICIALLINES1}} \text{ExcessLineFlowForward}_{k_1(g)}$ $+ \sum_{k_2 \in \text{ARTIFICIALLINES2}} \text{ExcessLineFlowForward}_{k_2(g)}$ $+ \sum_{k_2 \in \text{ARTIFICIALLINES2}} \text{ExcessLineFlowReverse}_{k_2(g)}$ $+ \sum_{k_2 \in \text{ARTIFICIALLINES2}} \text{DeficitWLineFlow}_{k_2(g)}$ $+ \sum_{k_2 \in \text{ARTIFICIALLINES2}} \text{ExcessWLineFlow}_{k_2(g)}$ $\{g \in \text{ENERGYOFFERS}\}$	New function k(g) defined in section D.5. 'g' in the existing rules refers to elements within the set 'ENERGYOFFERS'.
D.21.1.18 Deficit Security Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSSEC}_{y(s)}} \text{ViolationGroupBlock}_{y,j} \geq \text{DeficitSecurity}_s$ $\{s \in \text{SECURITYCONSTRAINTS}\}$	D.21.6 Deficit Security Constraint: $\sum_{j \in \text{VIOLATIONGROUPBLOCKSSEC}_{y(s)}} \text{ViolationGroupBlock}_{y,j} \geq \text{DeficitSecurity}_s$ $\{s \in \text{SECURITYCONSTRAINTS}\}$	Numbering change only.
D.21.1.19 Violation Group Block Constraint: $\text{ViolationGroupBlock}_{y,j} \leq \text{ViolationGroupBlockMax}_{y,j}$ $\{j,y \mid j \in \text{VIOLATIONGROUPBLOCKS}_y, \text{where } y \in \text{VIOLATIONGROUPS}\}$	D.21.7 Violation Group Block Constraint: $\text{ViolationGroupBlock}_{y,j} \leq \text{ViolationGroupBlockMax}_{y,j}$ $\{j,y \mid j \in \text{VIOLATIONGROUPBLOCKS}_y, \text{where } y \in \text{VIOLATIONGROUPS}\}$	Numbering change only.

Existing rules – Appendix 6D of Chapter 6 (Release: 1 July 2006)	Proposed rules	Reasons for modification
D.21.1.20 Violation Penalties Constraint: $\text{ViolationPenalties} \geq \sum_{j \in \text{VIOLATIONGROUPBLOCKS}} (\text{ViolationGroupPenalty}_{y,j} \times \text{ViolationGroupBlock}_{y,j})$	D.21.8 Violation Penalties Constraint: $\text{ViolationPenalties} \geq \sum_{j \in \text{VIOLATIONGROUPBLOCKS}} \left(\text{ViolationGroupPenalty}_{y,j} \times \text{ViolationGroupBlock}_{y,j}\right)$	"ViolationGroupPenalty" should be formatted in ordinary text not Arial font, since it is a parameter set outside the linear program, not a variable in the linear program.

Annex 2: Ancillary rule modifications

<table>
<tr><th>Existing rules – Chapter 6 (Release: 1 July 2006)</th><th>Proposed rules (Deletions represented by strikethrough text and additions (and formatting changes) underlined)</th><th>Reasons for modification</th></tr>
<tr><td>APPENDIX D – MARKET CLEARING FORMULATION</td><td>APPENDIX D – MARKET CLEARING FORMULATION</td><td></td></tr>
<tr><td>D.2 SETS
…
<table><tr><td>DAMPINGGENERATORS</td><td>The set of all energy offers which are associated with generation registered facilities that are considered likely to decrease their generation output as a result of the frequency drop during a primary contingency. A subset of OFFERS. The set of generation registered facilities that this applies to is supplied by the PSO in accordance with Appendix 6G section G.5.12.</td></tr></table></td><td>D.2 SETS
…
<table><tr><td>DAMPINGGENERATORS</td><td>The set of all energy offers which are associated with generation registered facilities that are considered likely to decrease their generation output as a result of the frequency drop during a primary contingency. A subset of ENERGYOFFERS. The set of generation registered facilities that this applies to is supplied by the PSO in accordance with Appendix 6G section G.5.12.</td></tr></table></td><td>The set ‘OFFERS’ in the existing rules should be ‘ENERGY-OFFERS’</td></tr>
<tr><td>D.4 VARIABLES
…</td><td>D.4 VARIABLES
…
<table><tr><td>FacilityLineFlowViolation$_g$</td><td>The total MW violation of connection line flow constraints associated with the generation registered facility that energy offer g is for.</td></tr><tr><td>FacilityMultiUnitViolation$_g$</td><td>The total MW violation of the multi-unit constraints associated with the multi-unit facility that energy offer g is for.</td></tr><tr><td>FacilityRampViolation$_g$</td><td>The total MW violation of the ramping constraints associated with the generation registered facility that energy offer g is for.</td></tr><tr><td>FacilityRegulationViolation$_g$</td><td>The total MW violation of the regulation constraints associated with the generation registered facility that energy offer g is for.</td></tr><tr><td>FacilityReserveViolation$_g$</td><td>The total MW violation of the reserve constraints associated with the generation registered facility that energy offer g is for.</td></tr></table></td><td>New intermediate variables created for section D.21.5.</td></tr>
</table>

Existing rules – Chapter 6 (Release: 1 July 2006)	Proposed rules (Deletions represented by strikethrough text and additions (and formatting changes) underlined)	Reasons for modification
	…	Typographical error.
ViolationGroupBlock$_{y,j}$ — The block *j* MW violation attributed to VIOLATIONGROUP$_y$.	ViolationGroupBlock$_{y,j}$ — The block *j* MW violation attributed to ~~VIOLATIONGROUP$_y$~~ violation constraint group *y*.	
D.5 FUNCTIONS	**D.5 FUNCTIONS**	
…	…	
	k(g) — References the *dispatch network line* *k*∈ARTIFICIALLINES1∪ARTIFICIALLINES2 that connects the *generation registered facility* associated with *energy offer g* to the dispatch network.	New
	…	
	s(g) — References the multiunit constraint *s* associated with the *multi-unit facility* that the *energy offer g* is for.	New
	…	
y(k), y(c), y(g) y(s), y(regulation) — References the violation group associated with line *k*, the reserve requirement for reserve class *c*, the *generation registered facility* associated with offer *g*, security or multiunit constraint *s* or the regulation requirement, respectively.	*y(k), y(c), y(g), y(s), y(regulation)* — References the violation group associated with line *k*, the *reserve* requirement for *reserve class c*, the *generation registered facility* associated with *energy offer g*, the security or multiunit constraint *s* or the *regulation* requirement, respectively.	Formatting errors. The reference to 'offer' should be to '*energy offer*'.
D.6 DISPATCH NETWORK DERIVATION	**D.6 DISPATCH NETWORK DERIVATION**	
…	…	
D.6.5.2 Add an artificial *dispatch network line* connected to the *artificial dispatch network node* described in D.6.5.1, and the default bus for the *generation unit* described in section D.7.2 or D.7.3, as the case may be. The artificial *dispatch network lines* used for this purpose shall not include constraint D.16.2.3, 21.1.1, 21.1.2, 21.1.3 and 21.1.4, and shall have a conventional direction defined to be from the artificial *dispatch network node* to the default bus, and shall use a negative value specified by *EMC* for the parameter LineMaxReverse$_k$, and a value determined by the *EMC* for all such artificial *dispatch network lines* as LineMaxForward$_k$.	D.6.5.2 Add an artificial *dispatch network line* connected to the *artificial dispatch network node* described in D.6.5.1, and the default bus for the ~~*generation*~~ *generating unit* described in section D.7.2 or D.7.3, as the case may be. The artificial *dispatch network lines* used for this purpose shall not include constraints in sections D.16.2.3~~, 21.1.1, 21.1.2, 21.1.3 and 21.1.4~~ and D.21.1, and shall have a conventional direction defined to be from the artificial *dispatch network node* to the default bus, and shall use a negative value specified by *EMC* for the parameter LineMaxReverse$_k$, and a value determined by the *EMC* for all such artificial *dispatch network lines* as LineMaxForward$_k$.	Typographical error. Reference update.

Existing rules – Chapter 6 (Release: 1 July 2006)	Proposed rules (Deletions represented by strikethrough text and additions (and formatting changes) underlined)	Reasons for modification
D.8 REPRESENTATION OF MULTI-UNIT FACILITIES … D.8.2 The *generation registered facility* that is a *multi-unit facility* shall be connected to the dispatch network at an artificial *dispatch network node*, which in turn is connected to each of the nodes where the constituent *generation units* are connected, and such connection shall be achieved by the use of additional *dispatch network lines*, with a conventional direction defined to be from the artificial *dispatch network node* to the connection nodes. However, dispatch network lines used for this purpose shall not include constraints D.16.2.1, D.16.2.3, D.16.3.1, D.16.3.2, D.16.3.3, D.21.1.1, D.21.1.2, D.21.1.3 and D.21.1.4 for that line.	**D.8 REPRESENTATION OF MULTI-UNIT FACILITIES** … D.8.2 The *generation registered facility* that is a *multi-unit facility* shall be connected to the dispatch network at an artificial *dispatch network node*, which in turn is connected to each of the nodes where the constituent ~~*generation*~~ *generating units* are connected, and such connection shall be achieved by the use of additional *dispatch network lines*, with a conventional direction defined to be from the artificial *dispatch network node* to the connection nodes. However, *dispatch network lines* used for this purpose shall not include constraints in sections D.16.2.1, D.16.2.3, D.16.3.1, D.16.3.2, D.16.3.3~~, D.21.1.1, D.21.1.2, D.21.1.3 and D.21.1.4~~ and D.21.1 for that line.	Typographical error. Formatting error. Reference update.
D.14 OBJECTIVE FUNCTION D.14.1 The NetBenefit is maximised, where: D.14.1.1 $\text{NetBenefit} = \sum_{\{j,p \mid j \in \text{PURCHASEBIDBLOCKS}_p, \text{where } p \in \text{BIDS}\}} \text{PurchaseBidPrice}_{p,j} \times \text{PurchaseBlock}_{p,j}$ $- \sum_{\{j,g \mid j \in \text{GENERATIONOFFERBLOCKS}_g, \text{where } g \in \text{OFFERS}\}} \text{GenerationOfferPrice}_{g,j} \times \text{GenerationBlock}_{g,j}$ $- \sum_{\{j,r \mid j \in \text{RAWRESERVEBLOCKS}_r, \text{where } r \in \text{RAWRESERVEOFFERS}\}} \text{ReserveOfferPrice}_{r,j} \times \text{RawReserveBlock}_{r,j}$ $- \sum_{\{j,l \mid j \in \text{REGULATIONOFFERBLOCKS}_l, \text{where } l \in \text{REGULATIONOFFERS}\}} \text{RegulationOfferPrice}_{l,j} \times \text{RegulationBlock}_{l,j}$ $- \sum_{\{j,n \mid j \in \text{EXCESSGENERATIONBLOCKS}_n, \textit{where } n \in \text{NODES}\}} \text{ExcessGenerationPenalty}_{n,j} \times \text{ExcessGenerationBlock}_{n,j}$ $- \sum_{\{j,n \mid j \in \text{DEFICITGENERATIONBLOCKS}_n, \textit{where } n \in \text{NODES}\}} \text{DeficitGenerationPenalty}_{n,j} \times \text{DeficitGenerationBlock}_{n,j}$ – ViolationPenalties	**D.14 OBJECTIVE FUNCTION** D.14.1 The NetBenefit is maximised, where: D.14.1.1 $\text{NetBenefit} = \sum_{\{j,p \mid j \in \text{PURCHASEBIDBLOCKS}_p, \text{where } p \in \text{BIDS}\}} \text{PurchaseBidPrice}_{p,j} \times \text{PurchaseBlock}_{p,j}$ $- \sum_{\{j,g \mid j \in \text{GENERATIONOFFERBLOCKS}_g, \text{where } g \in \underline{\text{ENERGY}}\text{OFFERS}\}} \text{GenerationOfferPrice}_{g,j} \times \text{GenerationBlock}_{g,j}$ $- \sum_{\{j,r \mid j \in \text{RAWRESERVEBLOCKS}_r, \text{where } r \in \text{RAWRESERVEOFFERS}\}} \text{ReserveOfferPrice}_{r,j} \times \text{RawReserveBlock}_{r,j}$ $- \sum_{\{j,l \mid j \in \text{REGULATIONOFFERBLOCKS}_l, \text{where } l \in \text{REGULATIONOFFERS}\}} \text{RegulationOfferPrice}_{l,j} \times \text{RegulationBlock}_{l,j}$ $- \sum_{\{j,n \mid j \in \text{EXCESSGENERATIONBLOCKS}_n, \textit{where } n \in \text{NODES}\}} \text{ExcessGenerationPenalty}_{n,j} \times \text{ExcessGenerationBlock}_{n,j}$ $- \sum_{\{j,n \mid j \in \text{DEFICITGENERATIONBLOCKS}_n, \textit{where } n \in \text{NODES}\}} \text{DeficitGenerationPenalty}_{n,j} \times \text{DeficitGenerationBlock}_{n,j}$ – ViolationPenalties	The set 'OFFERS' in the existing rules should be 'ENERGYOFFERS'.
D.16 TRANSMISSION … D.16.4 Relaxation of Line Constraints … D.16.4.3 Constraint in D.21.1.1 and D.21.1.2 shall not apply.	**D.16 TRANSMISSION** … D.16.4 Relaxation of Line Constraints … D.16.4.3 The constraint in section D.21.2 shall apply in place of the constraint in section D.21.1. ~~Constraint in D.21.1.1 and D.21.1.2 shall not apply.~~	Reference update.

<table>
<tr><th>Existing rules – Chapter 6 (Release: 1 July 2006)</th><th>Proposed rules (Deletions represented by strikethrough text and additions (and formatting changes) underlined)</th><th>Reasons for modification</th></tr>
<tr><td>APPENDIX J – PRICE LIMITS AND CONSTRAINT VIOLATION PENALTIES</td><td>APPENDIX J – PRICE LIMITS AND CONSTRAINT VIOLATION PENALTIES</td><td></td></tr>
<tr><td>…
<table>
<tr><th>Variable used in MCE formulation</th><th>Violation Penalty Block Prices</th><th>Violation Penalty Block Quantities</th></tr>
<tr><td>…</td><td>…</td><td>…</td></tr>
<tr><td>ExcessLineFlowForward$_k$
ExcessLineFlowReverse$_k$
DeficitWLineFlow$_k$
ExcessWLineFlow$_k$</td><td>2.2 * VoLL</td><td>10,000 MW</td></tr>
<tr><td>…</td><td></td><td></td></tr>
<tr><td>ExcessRawReserve$_r$
ExcessResGen$_r$
ExcessResRamp$_r$
ExcessResPropRamp$_r$
ExcessRegGen$_l$
DeficitRegGen$_l$
ExcessUpRampRate$_g$
ExcessDownRampRate$_g$
DeficitMulti$_s$
ExcessMulti$_s$
ExcessRegRamp$_l$</td><td>20 * VoLL</td><td>10,000 MW or 10,000 MW/sec as applicable</td></tr>
</table></td><td>…
<table>
<tr><th>Variable used in MCE formulation</th><th>Violation Penalty Block Prices</th><th>Violation Penalty Block Quantities</th></tr>
<tr><td>…</td><td>…</td><td>…</td></tr>
<tr><td>ExcessLineFlowForward$_k$
ExcessLineFlowReverse$_k$
DeficitWLineFlow$_k$
ExcessWLineFlow$_k$
<u>where {$k \in$ LINES, $k \notin$ ARTIFICIALLINES}</u></td><td>2.2 * VoLL</td><td>10,000 MW</td></tr>
<tr><td>…</td><td></td><td></td></tr>
<tr><td>ExcessRawReserve$_r$
ExcessResGen$_r$
<u>ExcessResGenSegment1$_r$</u>
<u>ExcessResGenSegment2$_r$</u>
<u>ExcessResGenSegment3$_r$</u>
ExcessResRamp$_r$
ExcessResPropRamp$_r$
ExcessRegGen$_l$
DeficitRegGen$_l$
<u>ExcessRegRamp$_l$</u>
ExcessUpRampRate$_g$
ExcessDownRampRate$_g$
DeficitMulti$_s$
ExcessMulti$_s$
<s>ExcessRegRamp$_l$</s>
<u>ExcessLineFlowForward$_k$</u></td><td>20 * VoLL</td><td>10,000 MW <s>or 10,000 MW/sec as applicable</s></td></tr>
</table></td><td>This violation penalty block price and quantity should only apply to violations of lines that are not artificial lines.

All units for violation penalty block quantities should be MW.

Missing facility violation variables for this violation penalty block price and quantity.

Violation variables re-ordered for improved clarity.</td></tr>
</table>

Existing rules – Chapter 6 (Release: 1 July 2006)	Proposed rules (Deletions represented by strikethrough text and additions (and formatting changes) underlined)			Reasons for modification
	$\underline{ExcessLineFlowReverse_k}$ $\underline{DeficitWLineFlow_k}$ $\underline{ExcessWLineFlow_k}$ $\underline{\text{where } \{k \in ARTIFICIALLINES1 \cup ARTIFICIALLINES2\}}$			