



PUBLIC

WESM Manual

---

# CONSTRAINT VIOLATION COEFFICIENTS (CVC) Issue 1.0

---

Abstract

This document covers the determination of the Constraint Violation Coefficient to be used by the Market Dispatch Optimization Model and the corresponding procedures and policies to be applied in the WESM.

Document Identity: WESM-CVC-001  
Revision: 0.1  
Issue: 1.0  
Reason for Issue: Final  
Effective Date: August 17, 2005



## Document Approval

|                     |                                |       |           |
|---------------------|--------------------------------|-------|-----------|
| Author:             | MO Subcommittee                | Date: | 6/16/2005 |
| Technical Review:   |                                | Date: |           |
| Quality Review:     |                                | Date: |           |
| WESM RCC Approval:  | Interim Rules Change Committee | Date: | 8/4/2005  |
| PEM Board Approval: |                                | Date: | 8/17/05   |

## Document Change History

| Issue No. | Revision No. | Modifier  | Date       | Synopsis/Reason for Change  |
|-----------|--------------|-----------|------------|---|
| 0.0       | 0.0          | MO Subcom | 06/16/2005 | New Document  |
|           | 0.1          | MO Subcom | 07/25/2005 | Revised/deleted some sections.<br>Change over-generation CVC price to be the same as under generation.                                |
| 1.0       | 0.0          | MO Subcom | 08/04/05   | Revised to incorporate comments of RCC  |
| 1.0       | 0.1          | MO Subcom | 8/18/05    | Revised to make clerical corrections and to revise CVC priority order by setting over-generation and under-generation at same rank 3. |
|           |              |           |            |   |
|           |              |           |            |   |
|           |              |           |            |   |
|           |              |           |            |   |
|           |              |           |            |   |



## Related Document

| Document ID   | Document Title                             |
|---------------|--|
|               | WESM Rules                                 |
|               | Price Determination Methodology            |
|               | Compliance to ERC directives document      |
| WESM-SSRG-000 | System Security and Reliability Guidelines |
| WESM-EP-000   | Emergency Procedures (Draft)               |
| WESM-DP-001   | MO-SO Dispatch Protocol                    |
|               | MCo Issue Paper - VoLL and CVC             |

## Distribution List

| Copy Number | Organization | Name of Recipient |
|-------------|--------------|-------------------|
|             |              |                   |
|             |              |                   |
|             |              |                   |
|             |              |                   |
|             |              |                   |
|             |              |                   |
|             |              |                   |
|             |              |                   |
|             |              |                   |
|             |              |                   |
|             |              |                   |



## Table of Contents

| <b>Section</b> | <b>Description</b>   | <b>Page</b> |
|----------------|--|-------------|
| 1              | Introduction   | 5           |
| 1.1            | About this Document  | 5           |
| 1.2            | Purpose  | 5           |
| 1.3            | Scope  | 5           |
| 1.4            | Intended Audience  | 5           |
| 1.5            | Conventions  | 5           |
| 1.6            | Background   | 5           |
| 2.             | Definition of Terms  | 6           |
| 3              | Responsibilities   | 7           |
| 4.             | Constraint Violation Coefficient in MDOM   | 8           |
| 5.             | Constraint Violation Coefficient for Nodal Energy Balance Equations (Nodal VoLL) | 9           |
| 6              | Constraint Violation Coefficient Development                                     | 10          |
| 7              | Constraint Violation Coefficient Application Strategy in the WESM                | 11          |
| 8              | Constraint Violation Coefficients Table  | 12          |
| 9              | CVC Review and Audit   | 14          |
| 10             | CVC Publication and Application  | 14          |



## 1.0 Introduction

### 1.1 About this Document

This document provides the market procedures and associated penalty values to be used as constraint violation coefficients in the WESM Market Dispatch Optimization Model (MDOM). This documentation provides more detailed descriptions of the requirements for Constraint Violations Coefficients (the “CVC”) specified in the WESM Rules. Where there is discrepancy between the provisions in this document and the WESM Rules, the WESM Rules will prevail. Standards and policies referenced or appended will provide a supporting framework.

### 1.2 Purpose

This document aims to:

- 1.2.1 Provide the criteria in determining the CVC.
- 1.2.2 Provide the mechanism in the revision, publication and approval of the CVC penalty price values.
- 1.2.3 Define the responsibilities of the Market Operator (the “MO”), System Operator (the “SO”) and Trading Participants in relation to the CVC to be used in the MDOM.

### 1.3 Scope

This document covers the determination of the CVC and the basic procedures and policies to be applied regarding the CVC’s.

### 1.4 Intended Audience

This manual is intended for use by the MO, the SO, the Trading Participants and their representatives and other parties, as appropriate.

### 1.5 Conventions

The standard conventions to be followed in this *manual* are as follows:

- 1.5.1 Terms and acronyms used in this *manual* that are italicized have the meanings ascribed thereto in the WESM Rules;
- 1.5.2 Double quotation marks are used to indicate titles of publications, legislation, forms and other documents.
- 1.5.3 Any procedure-specific convention(s) will be identified within the specific document itself.

### 1.6 Background

The MDOM determines the optimal dispatch schedule and nodal prices considering the different inputs from the MO (load forecast, network model, etc.), the SO (snapshot, reserve requirement, etc.) and the Trading Participants (offers, bids, etc.). In some instances, the



combination of these inputs does not allow the MDOM to produce a feasible solution.

Under the WESM Rules clause 3.6.2.1, to allow the MDOM to find a solution which satisfies all constraints, if such a solution exists, constraint violation coefficients (the “CVCs”) will be incorporated in the MDOM. As provided for in the objective of the MDOM as set in WESM Rules clause 3.6.1.3, the CVCs are the basis for the cost of constraint violation.

To enable the MDOM to find a solution, it will treat system/nodal energy balance requirement constraint, regional energy import/export constraint, regional reserve constraint and transmission line limit constraint as soft constraints (i.e., constraints that maybe violated) which are associated with prices (P/MWh) corresponding to the cost of constraint violation and thereby signal risks to the power system.

To ensure that the constraint violation is prioritized, the associated prices of the CVCs must be set in an appropriate manner such that constraints resulting in the lowest reduction in the capability of the network, load or generating units will occur first. It is also important that the CVC prices have sufficient grading in between them so that the violation priority is maintained and resolve possible conflicts between the different constraint types.

Further, as provided in WESM Rules clause 3.6.2.3, the CVC for the nodal energy balance constraint will be known as the nodal value of lost load and *may vary* from node to node, *and/or* be set so as to reflect load shedding priorities.

It should also be noted, as provided for in WESM Rules clause 3.6.2.1 (c), the CVCs should be set so as to ensure that the prices produced by the MDOM will be appropriate in all the circumstances, taking into consideration the processes defined in WESM Rules clause 3.10. As provided for in WESM Rules clause 3.10.5, if the prices are believed to be in error, as a result of load shedding or for any other reason (as in the case where the CVC prices were applied by the MDOM in the nodal prices), the MO may issue a pricing error notice, in which case the ex-post prices determined will also serve as ex-ante prices.

## 2.0 Definition of Terms

- 2.1 Constraint Violation Coefficient – Coefficients set by the *Market Operator* in accordance with clause 3.6.2. The *Market Operator* is to ensure that, if constraints will be violated, such violation will occur in appropriate priority order.
- 2.2 CVC Price – Amount in Pesos/MWh associated with a particular Constraint Violation Coefficient.



- 2.3 Deficit Interruptible Load Reserve – CVC for insufficient Interruptible demand to meet the Interruptible Load Reserve Requirement. It also corresponds to regional reserve constraint.
- 2.4 Deficit Dispatchable Reserve – CVC for insufficient capacity to meet Dispatchable Reserve Requirements. It also corresponds to regional reserve constraint.
- 2.5 Over Generation – CVC for system condition whereby the generation in the system exceeds the total demand. This is also known as excess generation. It also corresponds to system energy balance constraint.
- 2.6 Deficit Regulating Reserve – CVC for insufficient capacity to meet Regulating Reserve Requirements. It also corresponds to regional reserve constraint.
- 2.7 Deficit Contingency Reserve – CVC for insufficient capacity to meet Contingency Reserve Requirements. It also corresponds to regional reserve constraint.
- 2.8 Contingency Constraint – CVC for violating pre-defined contingency limits during single-outage conditions. It also corresponds to transmission limit constraint.
- 2.9 Value of Lost Load – CVC for nodal energy balance equation or localized deficiency in supply due to line or transformer loading limitations.
- 2.10 Under Generation – CVC for system condition where the demand exceeds the total maximum generation in the system. This is also known as deficit generation. It also corresponds to system energy balance constraint.
- 2.11 Base Case Constraint – CVC for violating the thermal loading limit of lines and/or transformers. It also corresponds to transmission limit constraint.
- 2.12 TCG Constraint – CVC power transfer limits. It corresponds to regional energy import/export constraint.
- 2.13 Soft Constraints – constraints pertaining to system and nodal energy balance requirement, regional energy import/export, regional reserve and transmission line limit which are allowed to be violated in the Market Dispatch Optimization Model such that the optimization process will produce a solution.

Other terms used in this document will conform to the definition of terms under the WESM Rules and the Philippine Grid Code (PGC).

## 3.0 Responsibilities

- 3.1 The MO will be responsible for the development, validation, maintenance, publication and revision of this document in coordination with the Trading Participants and the System Operator.



- 3.2 The SO will provide the necessary information and references for subsequent revisions and validation of this document.
- 3.3 The Trading participants will provide the necessary information and references for subsequent revisions and validation of this document.
- 3.4 The PEM Board will be responsible for the approval of this document and its subsequent revisions and issuances.

## 4.0 Constraint Violation Coefficient in the MDOM

The following will constitute the CVCs in the MDOM:

- (a) Over Generation – This signals the risk of shutting-down generators. The WESM Rules define excess generation as generation which may be scheduled to occur in excess of load requirements, even though market energy prices have fallen to the market price floor, and will be dealt with in accordance with clause 3.9.8 of the WESM Rules.
- (b) Under Generation – This signals the risk of load shedding in the system, as this signifies load is greater than the amount of energy injected to the system.
- (c) Deficit Regulating Reserve – This signals insufficient regulation reserve when the regulation reserve that may be scheduled is below the regulation requirements. Where there is a trade-off decision between interrupting supply though shedding load or shutting down generation, it would be better to accept lower reserve margins. Therefore, the constraint violation coefficient for deficit regulation reserve should be lower than that for nodal VoLL or deficit generation.
- (d) Deficit Contingency reserve – This signals insufficient contingency reserve, when the contingency reserve that may be scheduled is below the contingency requirements. Similar to the deficient regulation reserve, the constraint violation coefficient for deficit contingency should be lower than that for deficit generation.
- (e) Deficit Dispatchable Load Reserve - This signals insufficient dispatchable reserve, when the dispatchable reserve that may be scheduled is below the dispatchable load requirements. Similar to the deficient regulation and contingency reserves, the constraint violation coefficient for deficit dispatchable load should be lower than that for deficit generation.
- (f) Deficit Interruptible Load Reserve - This signals insufficient interruptible load reserve, when the interruptible load reserve that may be scheduled is below the interruptible load requirements. Similar to the deficient regulation, contingency and dispatchable reserves, the constraint violation coefficient for deficit interruptible load reserve should be lower than that for deficit generation.



- (g) Transmission Constraint Group (TCG) Constraint – This signals risks to the power transfer capability between regions in the transmission system. The TCGs pertain to branch groups or interconnection in the power system (e.g, Leyte-Luzon HVDC link). As this CVC signals possible violation to import/export between areas, it is related to the over generation or under generation between areas and, hence, may have the same value as the over/under generation CVC.
- (h) Base Case Constraint – This signals the security risk resulting from transmission line or transformer overflow. Generally, the deficiency leading to a line flow violation could alternatively result in a nodal violation – load could be shed at the receiving end rather than violating the flow limits. In reality, the best way to manage this risk is for load to be shed at the receiving end of the line rather than risking overloading the lines to a point where it is burnt-out resulting in greater disruption to the transmission system and the economy. Consequently, the constraint violation coefficient for excess line flow should be higher than that for deficit generation.
- (i) Contingency Constraint - This signals the risk resulting from transmission line overflow during single outage conditions. Similar to base case constraint, deficiency leading to a line flow violation could alternatively result in a nodal violation – load could be shed at the receiving end rather than violating the flow limits. Consequently, the constraint violation coefficient for contingency constraint should be lower than the value of Base Case constraint.
- (j) Nodal VoLL - This signals risks to localized shedding of load due to to line or transformer loading limitations. As it is more appropriate to violate reserve margins than shed load, Nodal VoLL should be higher than reserve CVCs.

## 5.0 Constraint Violation Coefficient for Nodal Energy Balance Equations (Nodal VoLL)

As provided for in the WESM Rules, the CVC for nodal energy balance equations will be represented by the Nodal Value of Lost Load. Nodal VoLL can be defined for each resource node in the Market Network Model as per WESM Rules Section 3.6.2.3 (b). As such, this can be varied from node to node, depending on the appropriate Value of Lost Load or the price that customers associate with unsupplied unit of energy for a particular node considering the nature of their load and duration of interruption of energy supply.

In other electricity markets, VoLL is commonly used for specifying the price bounds and constraint violation coefficients. Therefore, to apply VoLL pricing, the value of lost load must be determined. In determining an appropriate value for VoLL, two conditions must be met:

- The value of VoLL must not be so low to discourage investment in capacity



- The value of VoLL must not be so high that customers would prefer to be curtailed rather than pay for the VoLL price

It is highly apparent that pricing energy based on VoLL in the WESM is difficult at present due to lack of market-based information and a lack of an efficient demand side response. In this regard, it is recommended that pending acquisition of sufficient market-based information and demand side response, nodal VoLL be fixed, initially, for all the market trading nodes and be subject to further study by MO together with the Market Surveillance Committee.

## 6.0 Constraint Violation Coefficient Development

Based on Section 4 above and in consultation with SO, the following will be the initial priority order of the CVCs in an ascending manner:

- 6.1.1 TCG Constraint
- 6.1.2 Base Constraint
- 6.1.3 Deficit Generation/ Over Generation
- 6.1.4 VoLL
- 6.1.5 Contingency Constraint
- 6.1.6 Deficit Contingency Reserve
- 6.1.7 Deficit regulating Reserve
- 6.1.8 Deficit Dispatchable Reserve
- 6.1.9 Deficit Interruptible Load

### 6.2 Penalty Price Level

The initial economic estimate used in the determination of VoLL for the WESM pegged the value of lost load at P100,000/MWh. However, considering the priority order on the application of CVC and in order to provide sufficient grading in between them so that the pre-defined order of violation priority is maintained and to resolve possible dispatch conflicts between the different constraint types, it is proposed that this value (P100,000) be associated instead with deficit interruptible load which is the least priority. To provide sufficient grading between the penalty prices, it is proposed that a grading equivalent to P100,000 be also used. Section 8 details the priority order of the CVC and their corresponding penalty price.



## **7.0 Constraint Violation Coefficient Application Strategy in the WESM**

- 7.1 During the market trials and prior to the commercial operation of the WESM, the MO will utilize the recommended CVC prices indicated in this document.
- 7.2 The MO will continuously endeavour to verify the robustness and applicability of the CVC price levels and provide appropriate revisions to this document. Including the applicability of multi-level CVCs in coordination with SO and the Trading Participants to facilitate marginal overloads, as maybe necessary.
- 7.3 Prior to the start of commercial operations, the MO will recommend the final CVC price levels subject to the approval of the PEM Board.
- 7.4 During the start of the commercial operation, the Nodal Value of Lost Load for all resource nodes maybe uniform for each reserve region or transmission system pending the build up of market-based information from which relevant analysis and studies pertaining to the level of VoLL for each trading node can be established.



### 8.0 Constraint Violation Coefficients Table

The following table lists the Constraint Violation Coefficient names and their corresponding price and order of priority. The corresponding action by SO regarding the CVC is also indicated.

| Priority | Constraint Violation Coefficient Name | Price (P/MW) | Definition  | SO Action   |
|----------|---------------------------------------|--------------|---|---|
| 9        | Deficit Interruptible Load Reserve    | 100,000      | Insufficient Interruptible demand to meet Reserve Requirement                     | This is not a problem if Dispatchable reserve is met. Otherwise resort to mandatory load dropping.  |
| 8        | Deficit Dispatchable Reserve          | 200,000      | Insufficient capacity to meet Reserve Requirements (n-2)                          | This is not a problem if Interruptible reserve is met. Otherwise resort to mandatory load dropping. |
| 7        | Deficit Regulating Reserve            | 400,000      | Insufficient capacity to meet Reserve Requirements                                | Larger frequency excursions are expected without regulating reserve. Lower quality of service.      |
| 6        | Deficit Contingency Reserve           | 500,000      | Insufficient capacity to meet Reserve Requirements (n-1)                          | Automatic load dropping will cover for loss of generation if contingency reserve is insufficient.   |
| 5        | Contingency                           | 600,000      | Violation in pre-defined contingency limits during single-outage conditions (n-1) | If risk involves system collapse or islanding, implement necessary re-dispatch and load dropping.   |



# Wholesale Electricity Spot Market

Constraint Violation Coefficients

WESM-CVC-001

|   |                                      |                       |   |   |
|---|--------------------------------------|-----------------------|---|---|
| 4 | Nodal Value of Lost Load             | 700,000               | Localized deficiency in supply due to line or transformer loading limitations   | Marginal overloads (i.e., <10% for 1 hour) should be allowed. Otherwise drop local loads.   |
| 3 | Under Generation/<br>Over Generation | 800,000/<br>(800,000) | Under generation is when the demand exceeds the total maximum generation in the system<br><br>Over generation is when the the total minimum generation in the system exceeds the total demand | Where there is under generation, immediately implement mandatory load dropping as necessary<br><br>Where there is over generation, identify "Must-Run Units" and shut down other units to eliminate excess capacity |
| 2 | Base Case Constraint                 | 900,000               | Thermal loading limit violations of lines or transformers   | Marginal overloads (i.e., <10% for 1 hour) should be allowed. Re-dispatch generation and drop load.   |
| 1 | TCG Constraint                       | 1,000,000             | Import/Export constraints between areas.  | Immediately implement re-dispatch and/or load dropping as necessary.  |



## 9. Constraint Violation Coefficient Review and Audit

- 9.1 The Market Operator in coordination with the WESM Technical and Market Surveillance Committees will review the CVC penalty costs values and the order of prioritization in the MDOM, including the nodal Value of Lost Load (VoLL) every 6 months from the start of the commercial operations. The review will take into consideration the build-up of market based transaction information.
- 9.2 The Market Operator in coordination with the WESM Technical and Market Surveillance Committees will prepare the necessary report and provide recommendation to the PEM Board for any changes that should be made on the penalty cost values and order of prioritization.
- 9.3 During the market trials and prior to the start of the commercial operations of the WESM, an independent auditor elected by the PEM Board will verify the correctness and applicability of the constraint violation coefficient prices and order of prioritization.

## 10. Constraint Violation Coefficient Publication and Application

- 11.1 During the market trials and prior to the start of the commercial operations of the WESM, the MO will notify all participants of the CVCs used in the MDOM and publish the CVCs in the WESM website.
- 11.2 Reports pertaining to the review and audit of the CVCs will be published in the WESM website upon completion.
- 11.3 Should the PEM Board approve any changes in the CVCs, the MO will publish the approval and resolution of the PEM Board in the WESM website.
- 11.4 Any revision or changes pertaining to the CVCs in the MDOM will take effect 7 days after its publication in the WESM website.