

**PUBLIC**

WESM Manual

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# **CONSTRAINT VIOLATION COEFFICIENTS (CVC)**

## **Issue 4.0**

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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.
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Document Identity: WESM-CVC-004  
Issue: 4.0  
Reason for Issue: Amendments in the prioritization of CVC as approved by the PEM Board as General Amendments  
Approval Date: 29 September 2014  
Publication Date: 19 November 2014  
Effective Date: 04 December 2014



## Document Approval

Author:	MO Subcommittee	Date:	16 June 2005
Technical Review:		Date:	
Quality Review:		Date:	
RCC Approval:	Interim Rules Change Committee	Date:	04 August 2005 06 July 2006 14 November 2006 21 February 2014
PEM Board Approval:		Date:	17 August 2005 06 July 2006 17 November 2006 27 February 2014 29 September 2014

## 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. 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
2.0	0.0	MO Subcom	07/06/06	To reflect the PEM Board approved amendments in the CVC prioritization order that will enable the Market Operator and the Trading Participants to readily and effectively address under generation scenario and/or transmission line overloading encountered in the system.
3.0	--	PEMC-MO	02/19/2014	To reflect the amendments in the CVC



# Wholesale Electricity Spot Market

Constraint Violation Coefficients

WESM-CVC-004

EFFECTIVE DATE: 04 December 2014

				prioritization order that is consistent with the operational priorities of system operations in cases of insufficient supply prior to the integration of the reserves in the commercial operations of the WESM.
4.0	--	PEMC-TOD	08/04/2014	Re-submission of approved urgent amendments as general amendments, with further revisions to the values in the CVC priority table.

## Reference Documents

Document ID	Document Title
	WESM Rules
WESM-AP-003	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
	Compliance to DOE Directives Documents on Reserve Market (DOE DC No.DC2013-12-0027; DC2014-03-0009)



## Table of Contents

1.0	Introduction.....	1
1.1	About this Document .....	1
1.2	Purpose .....	1
1.3	Scope .....	1
1.4	Intended Audience.....	1
1.5	Conventions.....	1
1.6	Background .....	2
2.0	Definition of Terms .....	3
3.0	Responsibilities.....	4
4.0	Constraint Violation Coefficient in the MDOM.....	4
5.0	Constraint Violation Coefficient for Nodal Energy Balance Equations (Nodal VoLL).....	5
6.0	Constraint Violation Coefficient Development.....	6
7.0	Constraint Violation Coefficient Application Strategy in the WESM.....	7
8.0	Constraint Violation Coefficients Table.....	8
9.0	Constraint Violation Coefficient Review and Audit.....	11
10.	Constraint Violation Coefficient Publication and Application.....	11



## 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 (CVC) specified in the “WESM Rules”. Where there is discrepancy between the provisions in this document, Market Manuals 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 aim to:

- 1.2.1 Provide the criteria in determining 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 (MO), System Operator (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, 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* including all Parts thereto that are italicized have the meanings ascribed thereto in “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.), SO (snapshot, reserve requirement, etc.) and Trading Participants (offers, bids, etc.). In some instances, combination of these inputs does not allow the MDOM to produce a feasible solution.

Under WESM Rules 3.6.2.1, to allow the MDOM to find a solution which satisfies all constraints, if such a solution exists, constraint violation coefficients (CVCs) will be incorporated in the MDOM. As provided for in the objective of the MDOM (WESM Rules 3.6.1.3), 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 section 3.6.2.3, 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 Section 3.6.2.1 (c), 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 section 3.10. As provided for in WESM Rules Section 3.10.5, if the prices are believed to be in error, as a result of load shedding or for any other reason (as obviously 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. 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. 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 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 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 subsequent revisions and issuances.

## 4.0 Constraint Violation Coefficient in the MDOM

The following will constitute the CVC in the MDOM:

- (a) 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. Operationally interruptible loads can be compensated by sufficient dispatchable reserves and hence will not provide significant risk in the power system even if the interruptible load requirement is not met.
- (b) Deficit Dispatchable Reserve - This signals insufficient dispatchable reserve, when the dispatchable reserve that may be scheduled is below the dispatchable reserve requirements. Deficit dispatchable reserve may be compensated by sufficient interruptible load.
- (c) Deficit Regulating Reserve – This signals insufficient regulation reserve when the regulation reserve that may be scheduled is below the regulation requirements. It is of utmost importance that this type of service be always available, even in cases of insufficient supply in compensating for the energy requirement.
- (d) Deficit Contingency reserve – This signals insufficient contingency reserve, when the contingency reserve that may be scheduled is below the contingency requirements.





- (e) 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 an artificial nodal violation.
- (f) Over Generation – This signals the risk of shutting down generators to avoid system over frequency. WESM defines 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. Over generation is the opposite of deficit or under generation.
- (g) 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.
- (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.
- (i) Transmission Constraint Group (TCG) Constraint – This signals risks to the power transfer capability between regions in the transmission system. TCGs pertain branch groups or interconnection between regions in the power system.
- (j) Nodal VoLL - This signals risks to localized shedding of load due to line or transformer loading limitations.

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

As provided for by 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, at present, is difficult 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 MSC.

## 6.0 Constraint Violation Coefficient Development

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

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

6.2 Gradation Levels between CVCs

The initial value of the Deficit Interruptible Load, which is of the lowest priority, was set at CVC of 100,000, an assigned value that is far from any values that may be derived in the WESM. As such, the priority order shall start at the original value for Deficit Interruptible Load with 100,000.

Sufficient grading in between CVCs are made so that the pre-defined order of violation priority is maintained, and to resolve possible dispatch conflicts between the different constraint types should they occur simultaneously. Section 8 details the priority order of the CVC and their corresponding CVC values.



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

- 7.1 During Market Trial and prior to commercial operation of the WESM, the MO will utilize the recommended CVC prices.
- 7.2 The MO will continuously endeavor 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 Trading Participants to facilitate marginal overloads, as maybe necessary.
- 7.3 Prior to the start of the Commercial Operation, 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	CVC	Definition	Action to be Undertaken
9	Deficit Interruptible Load Reserve	100,000	Insufficient capacity to meet the Interruptible Reserve Requirement	Same function as Dispatchable reserve
8	Deficit Dispatchable Reserve	200,000	Insufficient capacity to meet Dispatchable Reserve Requirements	The contingency reserve when depleted cannot be replenished by Dispatchable Reserve if not sufficient
7	Deficit Contingency Reserve	300,000	Insufficient capacity to meet Contingency Reserve Requirements	Delayed restoration of affected automatic load dropping (ALD) feeders due to loss of generation if contingency reserve is insufficient.
6	Contingency	400,000	Violation in pre-defined contingency limits during single-outage conditions (n-1)	Implement necessary re-dispatch and possible manual load dropping to prevent overloading on the remaining lines or transformers



# Wholesale Electricity Spot Market

Constraint Violation Coefficients

EFFECTIVE DATE: 04 December 2014

WESM-CVC-004

Priority	Constraint Violation Coefficient Name	CVC	Definition	Action to be Undertaken
5	Nodal Value of Lost Load	800,000	Deficiency in supply due to localized violations on line or transformer loading limitations	Marginal overloads (i.e., <110% for 1 hour) should be addressed to eliminate possible overloading on the remaining lines or transformers during contingency occurrence, otherwise, drop local loads.
4	Over Generation	(1,000,000)	The total minimum generation in the system exceeds the total demand	Identify generating units to be shutdown to eliminate excess capacity.
	Under Generation	1,000,000	The demand exceeds the total maximum generation in the system	Implement Manual load dropping to ensure the balance of supply and demand.
3	Deficit Regulating Reserve	1,300,000	Insufficient capacity to meet Regulating Reserve Requirements	Larger frequency excursions are expected without regulating reserve. Lower power quality of service.
2	TCG Constraint	1,400,000	Import/Export constraints between areas.	Possible overloading should be addressed by Re-dispatch generation and drop load if necessary.



# Wholesale Electricity Spot Market

Constraint Violation Coefficients

EFFECTIVE DATE: 04 December 2014

WESM-CVC-004

Priority	Constraint Violation Coefficient Name	CVC	Definition	Action to be Undertaken
1	Base Case Constraint	1,500,000	Thermal loading limit violations of lines or transformers	Possible overloading should be addressed by Re-dispatch generation and drop load if necessary.



## 9.0 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 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

- 10.1 During the Market Trials and Prior to the start of the commercial operation of the WESM, the MO will notify all participants of the CVCs used in the MDOM and publish the CVCs in the WESM website.
- 10.2 Reports pertaining to the review and audit of the CVCs will be published in the WESM website upon completion.
- 10.3 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.
- 10.4 Any revision or changes pertaining to the CVCs in the MDOM will take effect 7 days after its publication in the WESM website.