WEM Procedure – Developing Limit Advice

WEM Reform Implementation Group (WRIG) 1 October 2020

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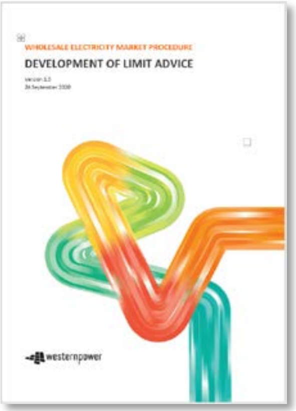
WEM Procedure – Developing Limit Advice

Structure of the WEM Procedure – Developing Limit Advice is as follows:

- Overview
  - Relationship with the WEM Rules
  - Definitions and interpretation
  - Related documents
- Overview of Limit Advice
  - Thermal Network limit advice
  - Non-thermal Network limit advice
- Developing Thermal Network Limit Advice
- Developing Non-Thermal Network Limit Advice
- Maintaining and Updating Limit Advice
- Supporting Information and Data



Overview of Limit Advice

- WEM Procedure: Development of Limit Advice is made in accordance with clauses 1.33.1(b) and 2.27A.11(a) of the WEM rules
- Purpose of the procedure is to document the processes to be followed by Western Power and the matters it must consider in developing and updating limit advice, including the approach taken by Western Power in applying a Limit Margin, Wholesale Market Objectives and good electricity industry practice
- Applies to Western Power as a Network Operator
- Related AEMO WEM Procedures
    - Limit Advice Provision, Constraint Formulation, Congestion information resource, IMS interface, Network modelling data, Power system security

Overview of Limit Advice

What is a network limit?

- Mathematical expression, either a number or equation, defining the power transfer capability across network elements. Western Power must develop two forms of limit advice – thermal network limits and non-thermal network limits
- Note - Procedure expected to be modified to include a third form of limit advice which is related to RCM limit advice.

Thermal network limit

- Network Limits that describe the maximum capacity for electrical throughput of a particular network element due to temperature or related effects

  For example: Transmission line EP-ST current rating (summer) = 1063 amps

Non-thermal network limit

- Limits that are not thermal limits - Network limit equations that describe the maximum power that can be transmitted to prevent network voltage or stability problems during network normal or following contingencies
- For example, an equation to maintain network voltage within acceptable limits following a contingency might be of the form:

  WKT MW Import ≤ constant + A1.X1 + A2.X2 + A3.X3 + … + An.Xn – limit margin

  Where An is a coefficient and Xn is variable which could include items like active power flow, reactive power flow, output from a generator, number of generators in service, etc.

Developing Thermal Network Limits

- When electricity is transferred along a path, such as between two zone substations, it passes through various equipment such as cables, conductors, switchgear, busbars, transformers, etc.
- All equipment that electricity flows through has a rating which is the amount of power that can safely be transferred through that equipment to prevent equipment damage, or in the case of a transmission line, prevent violation of minimum conductor clearances.
- Equipment ratings are based on various factors such Australian/International standards, guidelines for the installed equipment and good industry practice.
- The thermal limit is established through identifying the equipment with the lowest rating in the electricity path.
- Thermal limits are provided to AEMO for approximately 256 transmission lines and 408 transformers and applicable busbars.
- Thermal limits for a network element may be different depending on which direction the power flows and for different seasons

408 transformers

Site ID	Equipment ID	ALTLIMIT Time	Equip. Type	1 pu KV	Rating Unit	NORM IN
A	A504T1 LV	SUM	TRANS	22	AMP	886
A	A504T1 LV	WIN	TRANS	22	AMP	1012
A	A508T2 LV	SUM	TRANS	22	AMP	784
A	A508T2 LV	WIN	TRANS	22	AMP	844
A	A512T3 LV	SUM	TRANS	22	AMP	790
A	A512T3 LV	WIN	TRANS	22	AMP	895
ALB	ALB519T3 LV	WIN	TRANS	22	AMP	900
ALB	ALB503T1 LV	SUM	TRANS	22	AMP	789
ALB	ALB503T1 LV	WIN	TRANS	22	AMP	927
ALB	ALB510T2 LV	SUM	TRANS	22	AMP	999
ALB	ALB510T2 LV	WIN	TRANS	22	AMP	1012
ALB	ALB519T3 LV	SUM	TRANS	22	AMP	787
AMT	AMT516T2 LV	WIN	TRANS	22	AMP	1195
AMT	AMT505T1 LV	SUM	TRANS	22	AMP	1012
AMT	AMT505T1 LV	WIN	TRANS	22	AMP	1125
AMT	AMT516T2 LV	SUM	TRANS	22	AMP	1080
AMT	AMT524T3 LV	SUM	TRANS	22	AMP	1021
AMT	AMT524T3 LV	WIN	TRANS	22	AMP	1173
APM	APM506T3 LV	SUM	TRANS	22	AMP	805
APM	APM506T3 LV	WIN	TRANS	22	AMP	844
APM	APM512T1 LV	SUM	TRANS	22	AMP	805
APM	APM512T1 LV	WIN	TRANS	22	AMP	844
BCH	BCH504T1 LV	SUM	TRANS	22	AMP	1000
BCH	BCH504T1 LV	WIN	TRANS	22	AMP	1000
BCH	BCH512T2 LV	SUM	TRANS	22	AMP	1019
[illegible]	[illegible]	[illegible]	[illegible]	22	AMP	1128

256 transmission lines

Equipment ID	Site ID	Line Description	# Connections	ALTLIMIT Time	Equip. Type	1 pu KV	Rating Unit	NORM IN
A-OP81	A	A 509 OP81 CURRENT	2	SUM	Line	132	AMP	623
A-OP81	A	A 509 OP81 CURRENT	2	WIN	Line	132	AMP	737
NT-A81	A	A 501 NT81 CURRENT	2	SUM	Line	132	AMP	1180
NT-A81	A	A 501 NT81 CURRENT	2	WIN	Line	132	AMP	1180
ALB-KOJ81	ALB	ALB 810 KOJ81 CURRENT	2	SUM	Line	132	AMP	310
ALB-KOJ81	ALB	ALB 810 KOJ81 CURRENT	2	WIN	Line	132	AMP	310
ALB-MBR81	ALB	ALB 804 MBR81 CURRENT	2	SUM	Line	132	AMP	230
ALB-MBR81	ALB	ALB 804 MBR81 CURRENT	2	WIN	Line	132	AMP	230
AMT-CTE81	AMT	AMT 801 CTE81 CURRENT	2	SUM	Line	132	AMP	920
AMT-CTE81	AMT	AMT 801 CTE81 CURRENT	2	WIN	Line	132	AMP	1093
SF-AMT81	AMT	AMT 808 SF81 CURRENT	2	WIN	Line	132	AMP	1180
SF-AMT81	AMT	AMT 808 SF81 CURRENT	2	SUM	Line	132	AMP	1080
APJ-OLY91	APJ	APJ OLY91 CURRENT	2	SUM	Line	330	AMP	380
APJ-OLY91	APJ	APJ OLY91 CURRENT	2	WIN	Line	330	AMP	380
PNJ-APJ81	APJ	APJ 810 PNJ81 CURRENT	2	SUM	Line	132	AMP	622
PNJ-APJ81	APJ	APJ 810 PNJ81 CURRENT	2	WIN	Line	132	AMP	737
SNR-WGP-APJ81	APJ	APJ 804 SNR/WGP81 CURRENT	2	SUM	Tie	132	AMP	807
SNR-WGP-APJ81	APJ	APJ 804 SNR/WGP81 CURRENT	2	WIN	Tie	132	AMP	958
APM-MYR71	APM	APM 708 MYR71 CURRENT	2	WIN	Line	66	AMP	780
APM-MYR71	APM	APM 708 MYR71 CURRENT	2	SUM	Line	66	AMP	699
SF-APM71	APM	APM 701 SF71 CURRENT	1	SUM	Line	66	AMP	906
SF-APM71	APM	APM 701 SF71 CURRENT	1	WIN	Line	66	AMP	1075
BCH-H81	BCH	BCH 808 H81 CURRENT	2	SUM	Line	132	AMP	920
BCH-H81	BCH	BCH 808 H81 CURRENT	2	WIN	Line	132	AMP	1093
NT-BCH81	BCH	BCH 802 NT81 CURRENT	2	SUM	Line	132	AMP	920
NT-BCH81	BCH	BCH 802 NT81 CURRENT	2	WIN	Line	132	AMP	1093
BCT-NB81	BCT	BCT 808 NB81 CURRENT	2	SUM	Line	132	AMP	817
BCT-NB81	BCT	BCT 808 NB81 CURRENT	2	WIN	Line	132	AMP	924
BCT-NT81	BCT	BCT 801 NT81 CURRENT	2	SUM	Line	132	AMP	817
BCT-NT81	BCT	BCT 801 NT81 CURRENT	2	WIN	Line	132	AMP	924
KEM-BDP81	BDP	BDP 801 KEM81 CURRENT	2	SUM	Line	132	AMP	581
KEM-BDP81	BDP	BDP 801 KEM81 CURRENT	2	WIN	Line	132	AMP	648
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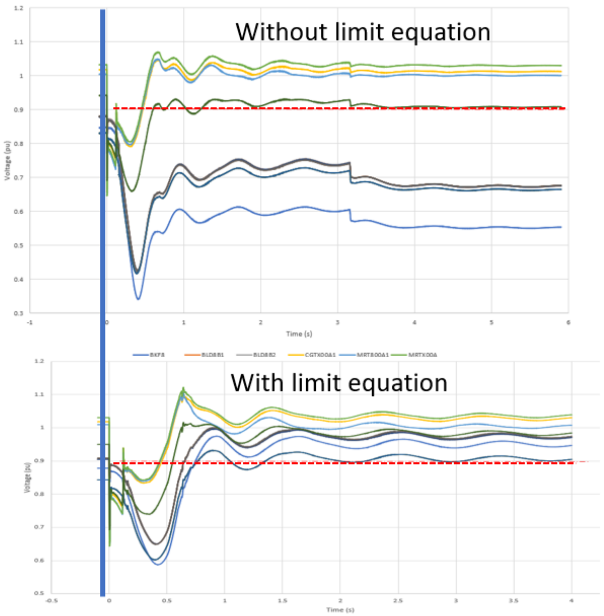
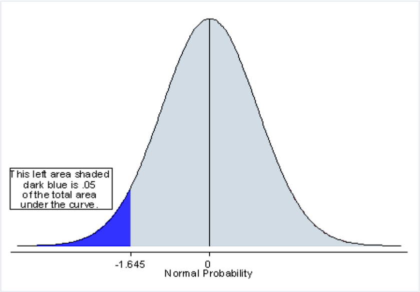
Developing Non-thermal network limits

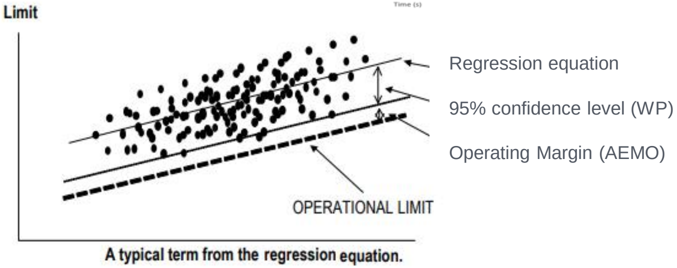
- The power transfer into or out of regions of the network may have limits to prevent network voltage or stability problems. Limit equations are developed and provided to AEMO to ensure stability is maintained for various load and generation scenarios and network voltages for system normal and following contingencies.
- Load flow simulation under various conditions (1000s of simulations) to identify power transfer limit to maintain stability
- Develop limit equation to ensure stability maintained at a 95% confidence interval (limit margin) – standard industry practice.
- Limit equation provided to AEMO to formulate constraint equation
- Limit advice is published in the AEMO constraint library



Each equation solves a specific network voltage or stability technical requirement – such as:

- Post contingency voltage > 0.9pu
- Post contingency voltage < 1.1pu
- Post contingency voltage step change < +6%
- Post contingency voltage step change > -10%
- Transient rotor angle criterion
- Oscillatory rotor angle stability
- Short term voltage stability
- Temporary overvoltage criterion
- Long term voltage criterion (QV analysis)





Maintaining, Updating, Publishing and Reviews of Limit Advice

- Western Power must use its reasonable endeavours to ensure that all necessary limit advice is complete, current and accurate at the time it is provided to AEMO and updated as soon as practicable where it identifies significant changes that may affect any limit advice
  - Types of changes that could impact include new generators, new loads, changes to generator models, network augmentations, revised forecasts, revised generator performance, decommissioned plant, modified network protection schemes
- Western Power must advise AEMO if limit advice is inaccurate or incomplete
- Publication - Limit Advice, including Limit Equations and Limit Advice Inputs are provided to AEMO which are then published in the Constraints Library
- Western Power is required to provide AEMO or ERA in a reasonable timeframe information required for their functions or reviews.
- The ERA reviews the effectiveness of Limit Advice provided by Western Power including the appropriateness of any Limit Margins and the appropriateness of the Market Procedure

WEM Procedure Consultation

- The WEM Procedure Limit Advice Development will be circulated shortly
- Please provide feedback or any direct any queries to Western Power
  - RegulatoryReforms@westernpower.com.au
  - Attention – Mark McKinnon (Market & Operations Stream Lead)

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