PART VII:
Scheduling and Dispatch Codes

SDC3: FREQUENCY AND INTERCONNECTOR TRANSFER CONTROL

By :

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24 January 2014

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KEMENTERIAN TENAGA, TEKNOLOGI HIJAU DAN AIR

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The Malaysian Grid Code Awareness Programme Funded by Akaun Amanah Industri Bekalan Elektrik (AAIBE)

SDC3: Frequency and Interconnector Transfer Control

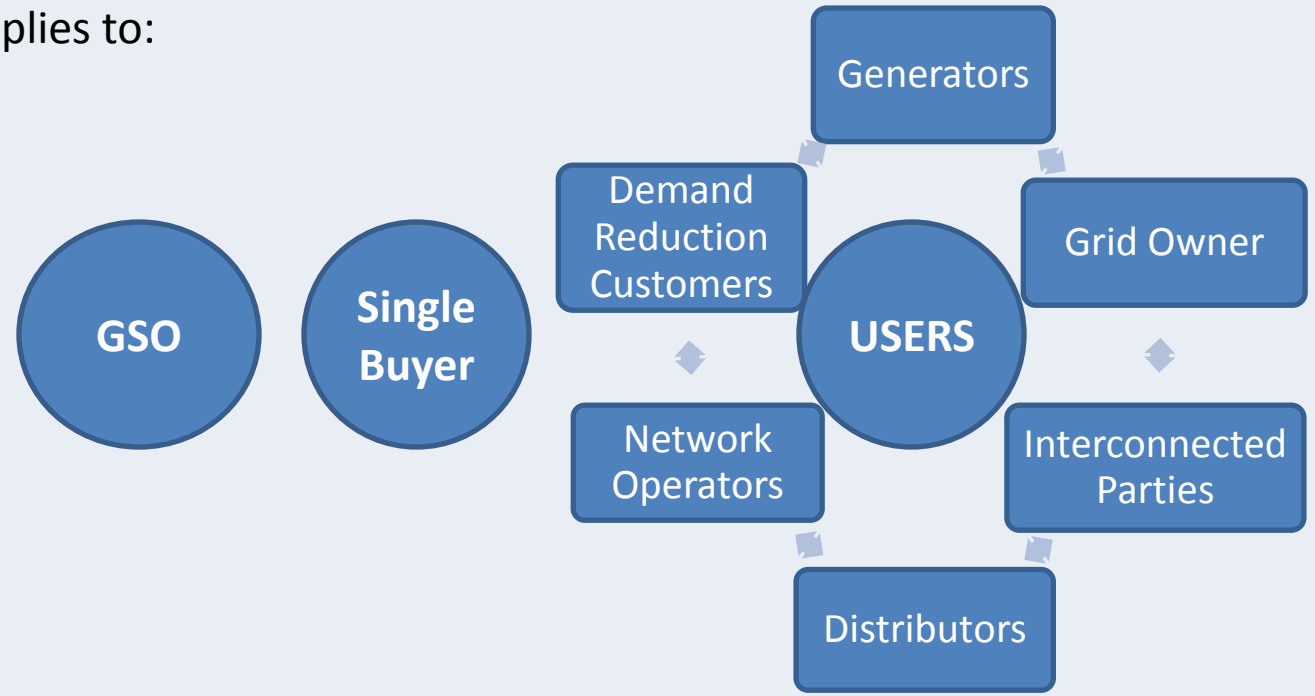
CODE	SDC 3.1
	INTRODUCTION
SDC3.1.1	Procedure for the GSO to implement; 1. Frequency control ▪ AGC ▪ Dispatch of CDGUs 2. Control of Demand/Load 3. Also determined by the consequences and effectiveness of generation Scheduling and Dispatch. Accordingly, SDC3 is complementary to SDC1 and SDC2.

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.2
	OBJECTIVES
SDC3.2.1	The procedure for the GSO to undertake Frequency Control • to meet the **statutory requirements** • manage **tie line control** in accordance with relevant Agreements with Interconnected Parties.

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.3
	SCOPE
SDC3.3.1	Applies to:



SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.4
	RESPONSE FROM GENERATING PLANT
SDC3.4.1	Each CDGU must at all times have the **capability** to provide response to changes in Frequency.
	CDGU able to provide **Primary Response** and/or **Secondary Response** and/or **High Frequency Response** when instructed by the GSO.
	CDGU response during recovery to Target Frequency must **not be countermanded** by a Generator or the Generating Unit control System.
	It can be done only on **safety grounds** (relating to either personnel or plant) or to ensure the integrity of the Generating Unit.

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.4
	AGC CONTROL
	AGC analyses the data like generation, load, losses, sales, purchases and system frequency and compute ACE (area control error).
	AGC send signals electronically via SCADA to selected CDGUs to adjust the set points.
	▪ 3 control modes for AGC operation: ▪ Constant frequency control (CFC) ▪ Constant net interchange control (CNIC) ▪ Tie-line bias control (TLBC)

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.4
	AREA CONTROL ERROR (ACE)
	ACE = dT + 10 x *B* x df where • dT = deviation in power transfer (Actual Net interchange – Schedule Net interchange) • df = deviation of frequency • *B* = dependency between deviation of power and system frequency
	Note: ACE is calculated in about eight second intervals by computers in the dispatch centre.

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.5
	DEMAND CONTROL
	The GSO may utilise **Demand Reduction** by Low Frequency Relay for **Frequency Control**.
	The agreed range of Low Frequency Relay settings to be applied, the **amount of Demand Reduction** to be available and will instruct the Low Frequency Relay initiated response to be placed in or out of service.

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.5
	LOAD SHEDDING SCHEME
	Automatic demand shedding •Under Frequency Load Shedding (UFLS) •Under Voltage Load Shedding (UVLS)
	Manual demand shedding •Transmission Emergency Manual Load Shedding Scheme (LSR) •Distribution Rotational Demand shedding

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.6
	RESPONSE TO HIGH FREQUENCY
	Each Synchronised CDGU is to provide **High Frequency Response**, is required to reduce Active Power output in response to an increase in System Frequency.
	The **rate of change** of Active Power output with respect to Frequency up to 50.5 Hz shall be in accordance with the provisions of the relevant Agreement between the GSO and each Generator.
	Hydro units have a **droop setting** of 2% while Thermal and Gas Turbines droop setting is set at 4% and shall response accordingly during Frequency disturbance.
	In events System Frequency is **at 50.5 Hz or above**, the Synchronised CDGU reduce output at a minimum rate of **2 percent (%) per 0.1 Hz** deviation of System Frequency above that level. Such reduction is to be achieved **within five (5) minutes** of the rise to or above 50.5 Hz

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.7
	PLANT OPERATING BELOW MINIMUM GENERATION
	Steady state operation below Minimum Generation is not expected and GSO should not unreasonably withhold the Generating Unit below the Minimum Generation.
	All reasonable efforts should be made by the Generator to **avoid tripping**, provided that the System Frequency is **below 52Hz**.
	If the System Frequency is at or **above 52Hz**, tripping could not be avoided as the Generator may act to protect the Generating Plant.
	The GSO may include instruction to **trip CDGUs** to return the Frequency below 50.5Hz and ultimately to Target Frequency.

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.8
	GENERAL ISSUES
	The Generator will **not be in default** of any existing Dispatch instruction if it is following the provisions of SDC3.4, SDC3.6 or SDC3.7.
	All response and actions taken by the CDGUs during High frequency **be informed** as soon as possible (within 5 (five) minutes) directly by telephone.
	The GSO to ensure that during High frequency, **Externally Interconnected Party** transferring Power shall **reduce transfer** at a rate equivalent to (or greater than) the CDGUs operating in Frequency Sensitive Mode.

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.9
	FREQUENCY AND TIME CONTROL
SDC 3.9.1	The GSO will endeavour to control the system frequency within the statutory limits of **49.5Hz and 50.5Hz** by specifying changes to Target Frequency and by Generation Dispatch.
SDC 3.9.2	The GSO will endeavour to control electric clock time to within plus or minus ten **(10) seconds.**

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.9
	TIME ERROR
	Time error accumulated when frequency deviates from 50 Hz, and depends on magnitude and length of time of the deviation.
	E.g. If frequency decreases to 49.9 Hz for 1 hour, electric clock will run slower by 7.2 seconds.

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.9
	FREQUENCY CONTROL
	Longer term "generation–demand" balance is maintained by • Commitment or De-commitment of Units - done ahead of time according to SDC1 and SDC2 whilst maintaining sufficient reserves. • Changes to Generation Dispatch Level - minute to minute matching of demand. Short-term or sudden demand – generation imbalances are addressed by the following measures. • Free-Governor Action • AGC } - small deviation in frequency • Load Shedding Scheme - large reduction in frequency

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.9
	FREQUENCY CONTROL
	Other measures and special defense scheme also employed to enhance frequency control . • TNB-PGL Interconnection - natural assist. Limited only by Interconnection Capacity. • TNB-EGAT HVDC Frequency Limiter Control - assist of up to 450 MW from EGAT. • Automatic Synch Cond. to Gen. Changeover - frequency triggered assist from Hydro units • Direct Hydro Interstart Scheme - direct start of PGAU units when JMJG trips

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.10
	INTERCONNECTOR TRANSFER CONTROL
	Any mutually agreed transfer of Power and/or Energy shall **remain** at the agreed transfer level when System Frequency is between **49.5Hz and 50.5Hz**.
	If the frequency falls **below 49.5Hz** power transfers from the Transmission System (**export**) into an Externally Interconnected Party will be **reduced to zero** as soon as is reasonably practical.
	In any case it must be accepted that at or below this frequency an Externally Interconnected Party (**import**) **may have disconnected** the connection for preservation of its own system. The GSO must be aware of this possibility and plan Target Frequency and Generation Dispatch accordingly.

SDC3: Frequency and Interconnector Transfer Control

CODE	SDC 3.10
	INTERCONNECTOR TRANSFER CONTROL
	The **TNB-PGL** inter-connectors are assigned to trip out at **49.1 Hz**.
	Steel Mills are also form part of the UFLS scheme with the feeders assigned to trip out at **49.2 Hz**
	Tripping out of transmission feeders to **co-generation plants** are carried out at **49.1 Hz**.

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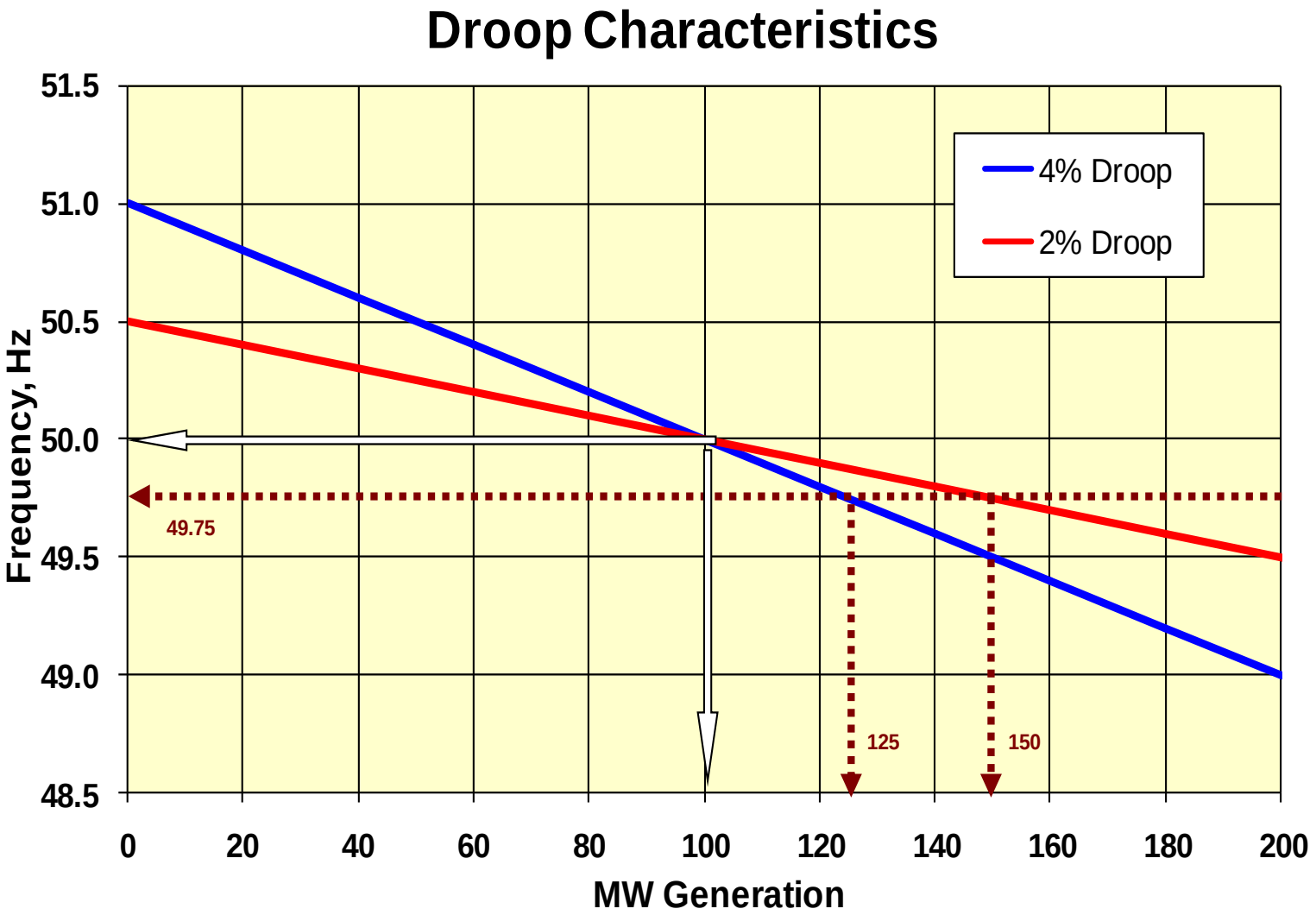
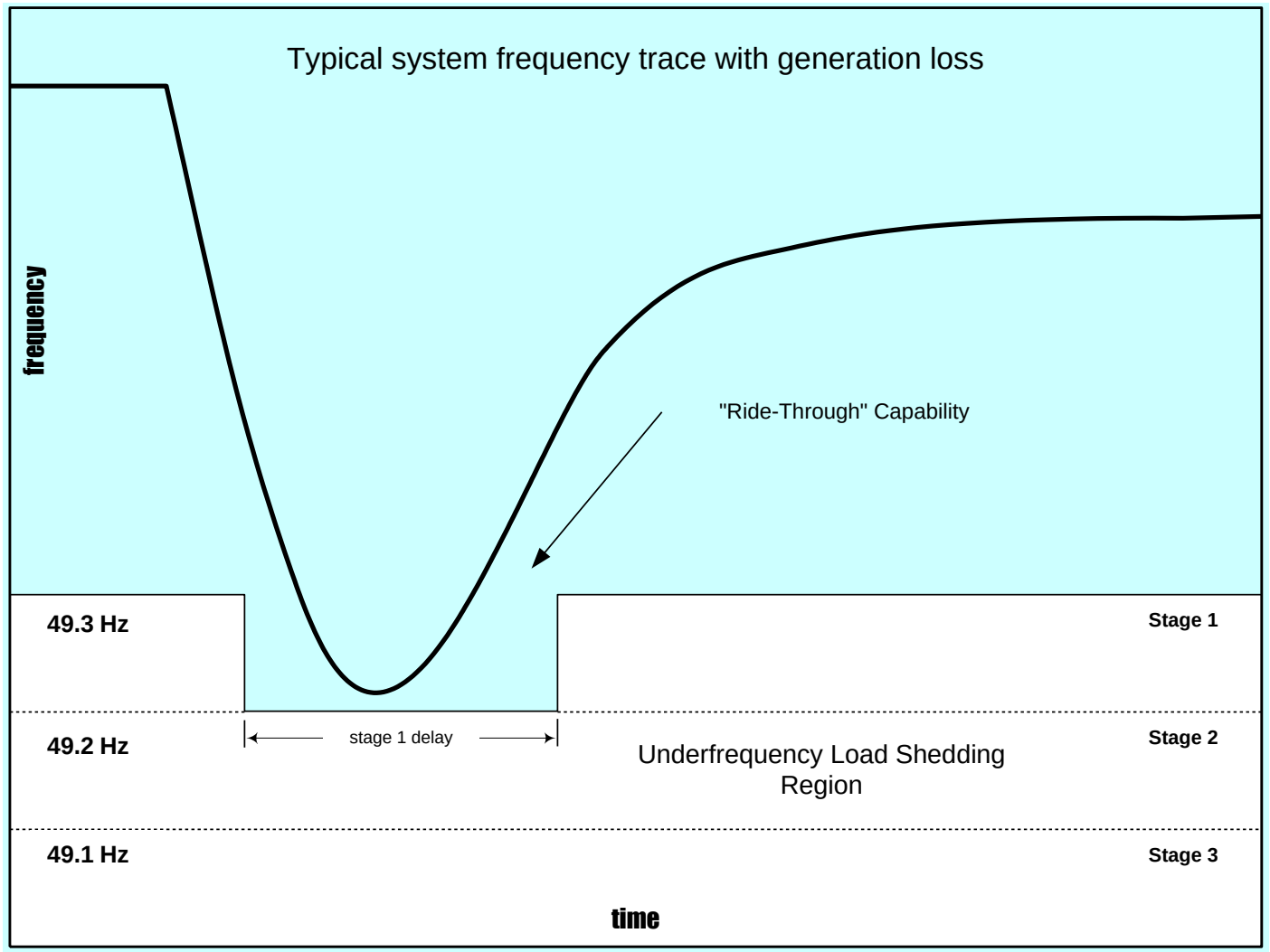
APPENDIX


Droop Characteristics
51.5
51.0
50.5
50.0
49.5
49.0
48.5
Frequency, Hz
4% Droop
2% Droop
49.75
125
150
0
20
40
60
80
100
120
140
160
180
200
MW Generation

APPENDIX


Typical system frequency trace with generation loss
frequency
"Ride-Through" Capability
49.3 Hz
Stage 1
stage 1 delay
49.2 Hz
Stage 2
Underfrequency Load Shedding Region
49.1 Hz
Stage 3
time

Automatic Load Shedding – UFLS

Load Interruption quantum by region

Region	Quantum (MW)
North (P.Pinang, Kedah, Perlis, Perak)	1,995
East (Pahang, Kelantan, Terengganu)	602
Central (Selangor, K.Lumpur)	3,243
South (N. Sembilan, Johor , Melaka)	2,551
Total	**8,391**

Automatic Load Shedding – UVLS

Load Interruption quantum by region

Region	Quantum (MW)
North (P.Pinang, Kedah, Perlis, Perak)	447
East (Pahang, Kelantan, Terengganu)	-
Central (N. Sembilan, Selangor, K.Lumpur)	1,069
South (Johor , Melaka)	346
Total	**1,862**

Transmission Manual Load Shedding – LSR

Load Interruption quantum by region

Region	Quantum (MW)
North (P.Pinang, Kedah, Perlis, Perak)	469
East (Pahang, Kelantan, Terengganu)	363
Central (Selangor, K.Lumpur)	972
South (N. Sembilan, Johor , Melaka)	997
Total	**2,801**

APPENDIX

Distribution Rotational Load Shedding Scheme

Load Interruption quantum by region

LOAD SHEDDING SUMMARY FOR EASTERN AREA

STATE	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6
KELANTAN	33	65	96	134	164	193
TERENGGANU	29	59	89	120	151	181
PAHANG	38	80	120	160	203	241
TOTAL	**100**	**204**	**305**	**414**	**517**	**616**

LOAD SHEDDING SUMMARY FOR NORTHERN AREA

STATE	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6
PENANG	47	97	143	195	256	313
PERAK	28	52	79	103	129	152
KEDAH/PERLIS	30	57	85	110	120	138
TOTAL	**106**	**207**	**307**	**408**	**505**	**604**

LOAD SHEDDING SUMMARY FOR SOUTHERN AREA

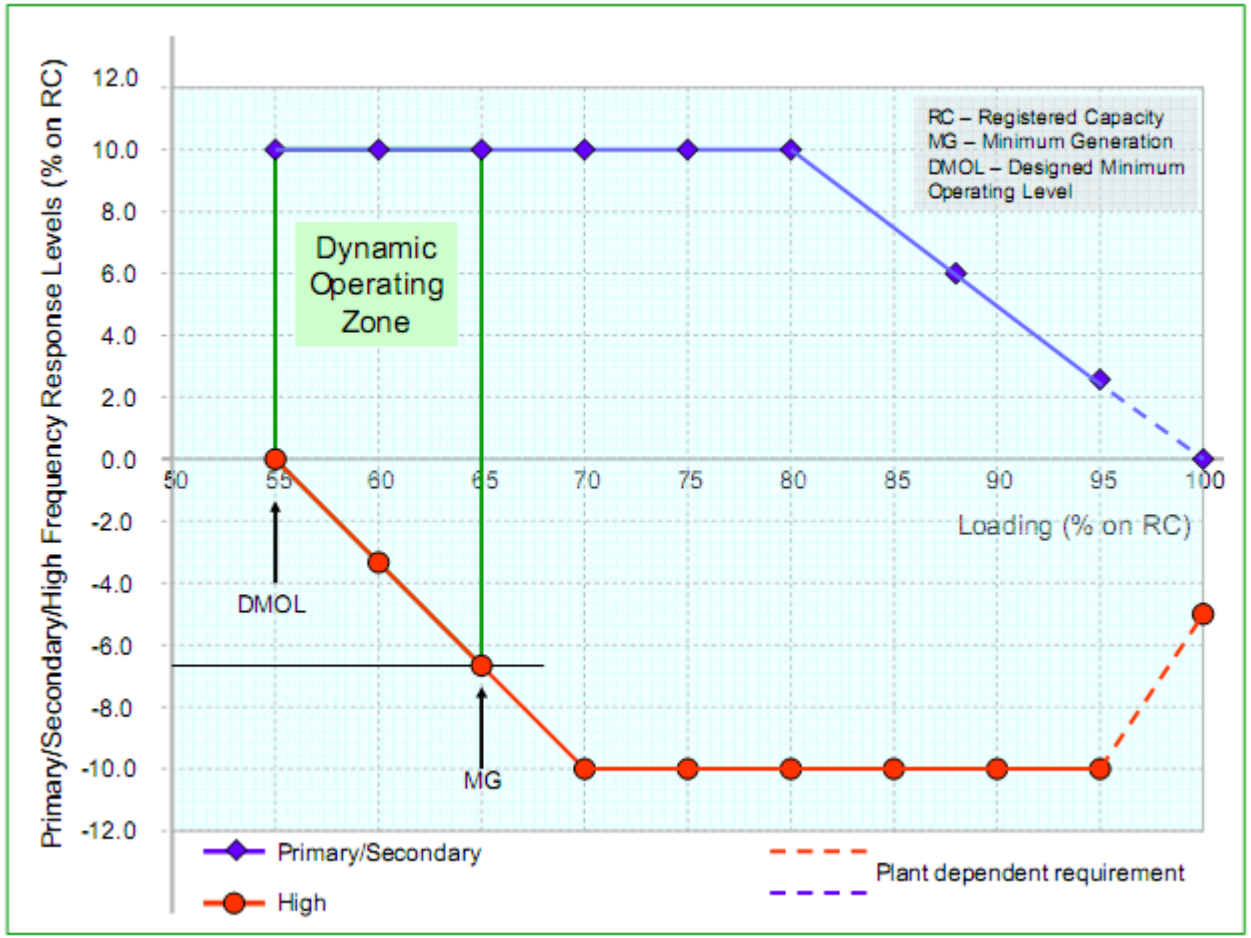
STATE	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6
JOHOR	41	70	109	208	321	430
NEGERI SEMBILAN	35	87	131	131	131	131
MELAKA	31	49	72	72	72	72
TOTAL	**107**	**207**	**312**	**410**	**523**	**632**

LOAD SHEDDING SUMMARY FOR CENTRAL AREA

STATE	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6
WILAYAH PERSEKUTUAN/KL	86	179	292	381	468	510
SELANGOR	117	202	314	413	509	606
TOTAL	**202**	**380**	**606**	**793**	**977**	**1116**

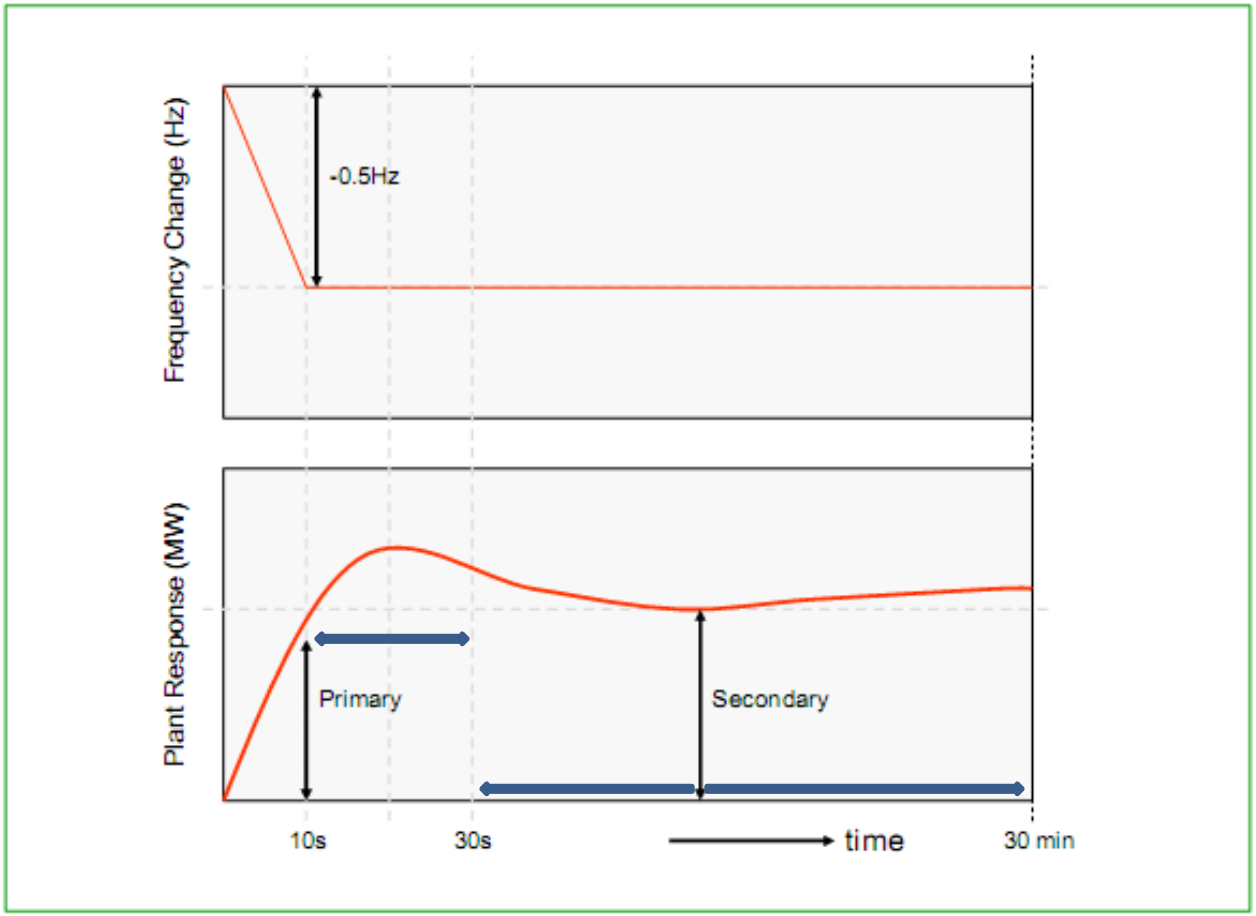
APPENDIX

Sample Minimum Frequency Response Requirement Profile for a 0.5 Hz Change from Target Frequency



APPENDIX

Interpretation of Primary and Secondary Response Values



APPENDIX

Interpretation of High Frequency Response Values