Connection Code (CC)
(Part V of MGC)

23-24 October 2013

KeTTHA
KEMENTERIAN TENAGA, TEKNOLOGI HIJAU DAN AIR

Suruhanjaya Tenaga

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

Definition

Term	Definition
Connection	**The physical connection** of Plant, Apparatus or Equipment or a User System **to the Grid System or User System**.

Ref: The MGC 2010 Glossary and Definitions

TOC of CC

TOC of CC

TOC of CC

CC Appendix 1 – Format, Principles and Basic Procedure to be used for Preparation of Site Responsibility Schedules

CC Appendix 2, Part 1A – Typical Symbols Relating to Operation Diagrams

CC Appendix 2, PART 1B – Typical Symbols Relating to Gas Zone Diagrams

CC Appendix 2 Part 2 - Basic Principles and Non-Exhaustive List of Apparatus to be Included in Operation Diagrams

TOC of CC

CC Appendix 3 – Minimum Frequency Response Requirement Profile and Operating Range

CC Appendix 4 – Typical Technical Requirements of Low Frequency Relays for the Automatic Disconnection of Supply at Low Frequency

Objectives of CC

The objective of this CC is:

To define basic rules for Connection of a User's installations by which the GO, GSO or other User will be able to comply with the Grid Code, statutory and license obligations and these basic rules are consistent for all Users of similar category.

Scope

CC applies to:

1. Grid Owner
2. GSO
3. Single Buyer
4. Generators
5. Distributors
6. Network Operators
7. Directly Connected Customers
8. Parties seeking connection

Connection Principles

1. User seeking connection or to modify existing connection shall complete appropriate connection application form (provided by GO) and submit to GO and GSO
2. GO & GSO shall decide the connecting point and voltage level at which the User shall be connected to, taking into account User's view

Connection Process and Information Exchange

User shall provide:

1. Updated Planning Code data
2. Details of Protection Arrangements/Settings
3. Copies of all User's Safety Rules at User's site
4. Information to prepare site responsibility schedules
5. Operation Diagrams for all HV apparatus
6. Proposed name of User's site
7. Written confirmation on User's Safety Coordinators
8. A list of the telephone numbers for management representatives
9. A senior management representative to sign Site Responsibility Schedules
10. Information to prepare Site Common Drawings
11. A list of the telephone numbers for the Users facsimile machines
12. A list of persons Authorized for switching duties and testing.

Technical Design and Operational Criteria

Transmission System Performance Characteristics

1. Grid Frequency Variations

Frequency Range	Requirement
47.5Hz - 52Hz	Continuous operation is required.
47Hz - 47.5Hz	Operation for a period of at least 10 seconds is required each time the **Frequency** is below 47.5Hz.

2. Transmission System Voltage Variations
    1. Normal: ±5% (500kV), ±10% (275kV & 132kV)
3. Voltage Waveform Quality:
    1. THD ≤3%
    2. Phase unbalance: <1%
4. Load Unbalance: ≤ 1%

Technical Design and Operational Criteria

Transmission System Performance Characteristics

5. Voltage Fluctuations:
   1. Step change ≤ 1%
   2. Flicker Severity

Maximum Allowable Flicker Severity

Transmission System Voltage Level at which the **Fluctuating Load is Connected**	Absolute Short Term Flicker Severity ($\mathbf{P_{st}}$)	Absolute Long Term Flicker Severity ($\mathbf{P_{lt}}$)
500, 275 and 132kV	0.8	0.6
Less than 132kV	1.0	0.8

Technical Design and Operational Criteria

Requirements for User's and Connected Network Equipment at the Connection Point

1. Minimum Basic Impulse Insulation Level (BIL)

System Voltage (kV)	BIL (kV)
500	1550
275	1050
132	650

2. Meet and conform to relevant Technical Specification & Standards (MS, IEC, ISO, BS, etc)
3. GO to maintain a list of those Technical Specification.
4. Must have quality assurance to ISO 9000 series

Technical Design and Operational Criteria

Requirements for User's and Connected Network Equipment at the Connection Point

5. Connection involves generating units require:
   1. Circuit breaker at connection point and generator terminal
   2. Protection must meet the specified minimum requirements
   3. Signal for Revenue Meter – relevant Agreement & Metering Code
   4. There may be a requirement for special protection measures
   5. Relay settings must be co-ordinated across the connection point
   6. Remain operational on the Transmission System without tripping and adverse behavior during and after the auto reclosing.

System Voltage	High Speed Single-Pole	Delayed Three-Pole
500kV	500 to 750 millisecond	From 3 to 10 seconds
275kV	750 millisecond	From 3 to 10 seconds
132kV	Not applicable	From 3 to 10 seconds

Technical Design and Operational Criteria

Requirements for User's and Connected Network Equipment at the Connection Point

6. Connection involves Network Operator require:
   1. Fault clearance times on User's systems must be as Licence Standards
   2. Must be capable of operating continuously for faults on the transmission system
   3. Provide backup protection (co-ordinated)
   4. Relay settings must be co-ordinated across the connection point
   5. Remain operational on the Transmission System without tripping and adverse behavior during and after the auto reclosing.
   6. There may be a requirement for special protection measures
   7. To prove compliance by conducting tests

Technical Design and Operational Criteria

General Requirements for Generating Units

Generating units must have certain performance characteristics:

1. Reactive power (≤0.85Lagging, ≤0.95Leading)
2. Short Circuit Ratio ≥0.5
3. Maintain active power output under a range of Grid System conditions (Frequency & Voltage)
4. Black Start Capability – will be determined by GO/GSO

Technical Design and Operational Criteria

General Requirements for Generating Units

5. Control arrangements (Freq. & Voltage Control)
    1. Frequency response (primary, secondary & high freq.)
    2. Excitation system (static & fast response) shall equipped with PSS (capable of damping of oscillation for frequency 0.1Hz to 5.0Hz)
    3. Optimally tuned PSS shall provide damping ratio > 5% for inter-area and local mode of power system oscillation.
    4. PSS design report is required to submit to GO/GSO at least 3 months before commissioning
6. AGC and load following capability
7. Capable of withstanding specified NPS loadings

Technical Design and Operational Criteria

General Requirements for Generating Units

8. Neutral Earthing - higher voltage windings of transformers (≥132kV) connected to the Transmission System must be star connected & earthed
9. Frequency sensitive relays
    1. Trip the high voltage circuit breakers at 47.0 Hz
    2. Sustain at least 10 sec for 47.5Hz ≥ Freq > 47.0Hz.
10. House load Operation up to max. 2hours
    1. Ready to be re-synchronized to the Grid System
    2. Able to increase output

Technical Design and Operational Criteria

General Requirements for Generating Units

11. GSO shall specify the requirements for generating Unit cold, warm and hot start for the provision of Active Power Reserve.
12. Dispatch Ramp Rate – as specified by GSO
13. Primary and standby fuel stock
14. On-line fuel changeover
15. Loss of AC Power Supply up to 600ms - no tripping of the generator required
16. Generator & Power Station Monitoring Equipment

Technical Design and Operational Criteria

General Requirements for Generating Units

17. Special Provisions for Hydro and Induction Generators
    1. Hydro units – provide synchronous condenser mode may be required
    2. Induction generator – install power factor correction equipment may be required
18. To prove compliance by conducting tests

Technical Design and Operational Criteria

General Requirements for Distributors, Network Operators and Directly Connected Customers

1. Neutral Earthing - higher voltage windings of transformers (≥132kV) connected to the Transmission System must be star connected & earthed
2. Frequency Sensitive relays - facilitate automatic low Frequency disconnection of Demand

Technical Design and Operational Criteria

Communications Plant and Apparatus

Specific requirements for the following equipment:

1. Control Telephony
2. Operational Metering (SCADA)
3. Data Entry Terminal – info exchange
4. Facsimile Machines
5. Monitoring equipment – generator signals

Site Related Conditions

1. Responsibilities for safety
2. Provision of Site Responsibility Schedules
3. Provision of Operation and Gas zone diagrams
4. Site common drawings
5. Provisions of site access (GO & User)
6. Maintenance standards
7. Site operational procedures

Summary

1. The Connection Code is designed to provide basic rules for connection to Grid and/or User System
2. No connection is allowed to impose unacceptable effects on the Grid System or adversely affect other users
3. The GO/GSO determines the connection point in accordance to the Licence Standards

Information 1

Type of Form for the Connection Application:

1. Form A & Appendix A1 for Generator
2. Form B & Appendix B1 for Directly Connected Customer
3. Form C & Appendix C1 for Network Operator

Grid Connection Process

FORM A: GENERATORS

In accordance to the requirements of the latest Malaysian Grid Code, each Applicant seeking connection to or for modification(s) to an existing connection shall complete this connection application form called Form A to be sent to the Grid Owner and the GSO. For the purpose of this Form A, the Grid Owner is represented by the Planning Division of TNB.

The completed application form (Page 2 and 3 of this document and Appendix A1) should be returned to:

General Manager (Transmission Planning Department)
Transmission Division, Tenaga Nasional Berhad,
Level 1, NLDC Building,
129, Jalan Bangsar, 59200
Wilayah Persekutuan Kuala Lumpur

Email: grid_owner@tnb.com.my
Phone: (03) 2296 5566
Fax: (03) 2282 2906

The first data submitted with Form A will form as **Preliminary Project Data**. At later stage, upon positive progress of the project, the applicant is required to submit further data called **Committed Project Data** and subsequently **Contracted Project Data** as stated in PC.7 of The Malaysian Grid Code.

Upon receipt of an application for connection or a modification to a Connection Site, the Grid Owner shall carry out appropriate studies within three (3) months to recommend a connection arrangement to the Transmission System in compliance with The Malaysian Grid Code.

Where in the opinion of the Grid Owner that more detailed studies are necessary to ensure the security of the Grid System, the Grid Owner may request additional detail data from the applicant and the period for evaluation extended for up to an additional three (3) months, where necessary.

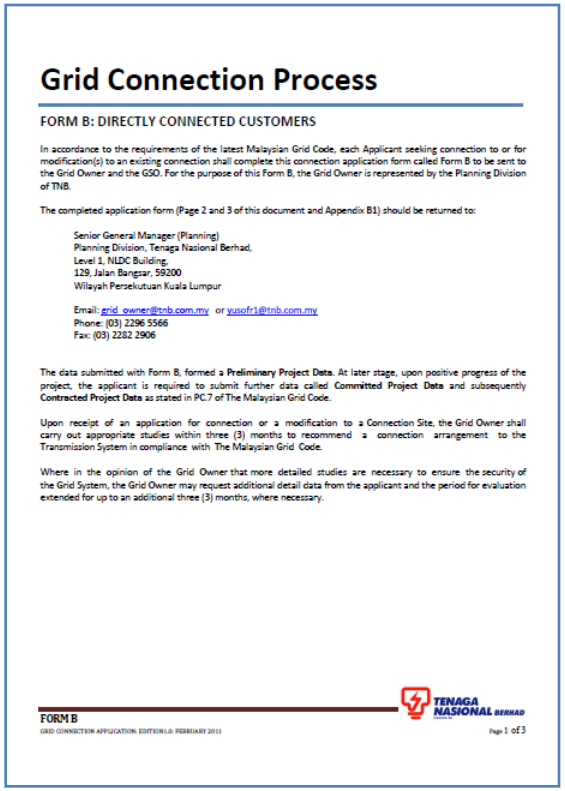
Please tick the appropriate submitted data upon submission of Form A - Appendix A1:

No.	Planning Data	Submitted Data
1	Preliminary Project Data	☐
2	Committed Project Data	☐
3	Contracted Project Data	☐
4	Estimated Registered Data	☐
5	Registered Data	☐

TENAGA NASIONAL BERHAD

FORM A
GRID CONNECTION APPLICATION, EDITION A.D. MARCH 2013
Page 1 of 3

Form A



Grid Connection Process

FORM B: DIRECTLY CONNECTED CUSTOMERS

In accordance to the requirements of the latest Malaysian Grid Code, each Applicant seeking connection to or for modification(s) to an existing connection shall complete this connection application form called Form B to be sent to the Grid Owner and the GSO. For the purpose of this Form B, the Grid Owner is represented by the Planning Division of TNB.

The completed application form (Page 2 and 3 of this document and Appendix B1) should be returned to:

Senior General Manager (Planning)
Planning Division, Tenaga Nasional Berhad,
Level 1, NLDC Building,
129, Jalan Bangsar, 59200
Wilayah Persekutuan Kuala Lumpur

Email: grid_owner@tnb.com.my or yusofr1@tnb.com.my
Phone: (03) 2296 5566
Fax: (03) 2282 2906

The data submitted with Form B, formed a **Preliminary Project Data**. At later stage, upon positive progress of the project, the applicant is required to submit further data called **Committed Project Data** and subsequently **Contracted Project Data** as stated in PC.7 of The Malaysian Grid Code.

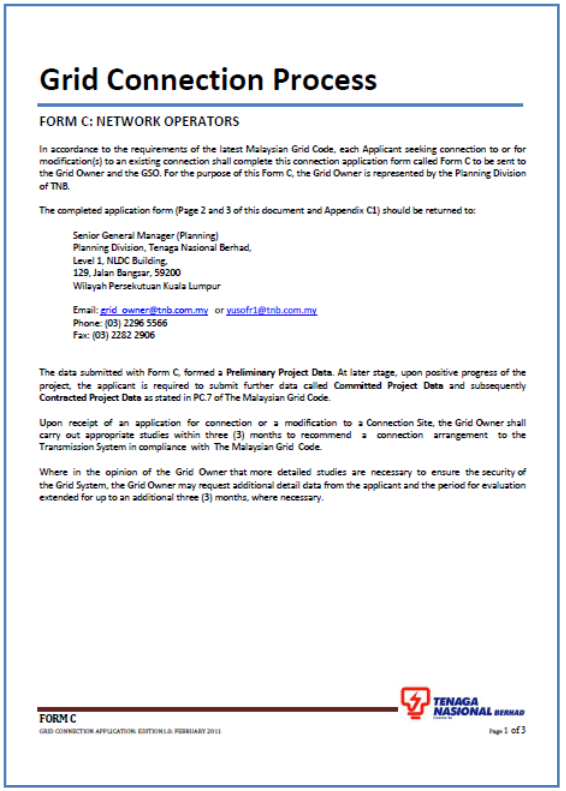
Upon receipt of an application for connection or a modification to a Connection Site, the Grid Owner shall carry out appropriate studies within three (3) months to recommend a connection arrangement to the Transmission System in compliance with The Malaysian Grid Code.

Where in the opinion of the Grid Owner that more detailed studies are necessary to ensure the security of the Grid System, the Grid Owner may request additional detail data from the applicant and the period for evaluation extended for up to an additional three (3) months, where necessary.

TENAGA NASIONAL BERHAD

FORM B
GRID CONNECTION APPLICATION EDITION 1.0: FEBRUARY 2011
Page 1 of 3

Form B



Grid Connection Process

FORM C: NETWORK OPERATORS

In accordance to the requirements of the latest Malaysian Grid Code, each Applicant seeking connection to or for modification(s) to an existing connection shall complete this connection application form called Form C to be sent to the Grid Owner and the GSO. For the purpose of this Form C, the Grid Owner is represented by the Planning Division of TNB.

The completed application form (Page 2 and 3 of this document and Appendix C1) should be returned to:

Senior General Manager (Planning)
Planning Division, Tenaga Nasional Berhad,
Level 1, NLDC Building,
129, Jalan Bangsar, 59200
Wilayah Persekutuan Kuala Lumpur

Email: grid_owner@tnb.com.my or yusofr1@tnb.com.my
Phone: (03) 2296 5566
Fax: (03) 2282 2906

The data submitted with Form C, formed a **Preliminary Project Data**. At later stage, upon positive progress of the project, the applicant is required to submit further data called **Committed Project Data** and subsequently **Contracted Project Data** as stated in PC.7 of The Malaysian Grid Code.

Upon receipt of an application for connection or a modification to a Connection Site, the Grid Owner shall carry out appropriate studies within three (3) months to recommend a connection arrangement to the Transmission System in compliance with The Malaysian Grid Code.

Where in the opinion of the Grid Owner that more detailed studies are necessary to ensure the security of the Grid System, the Grid Owner may request additional detail data from the applicant and the period for evaluation extended for up to an additional three (3) months, where necessary.

TENAGA NASIONAL BERHAD

FORM C
GRID CONNECTION APPLICATION EDITION 1.0: FEBRUARY 2011
Page 1 of 3

Form C

Information 2

Electricity Supply Application Handbook

- Free download from the website of TNB http://www.tnb.com.my/business/for-housing-developers-electrical-contractors.html

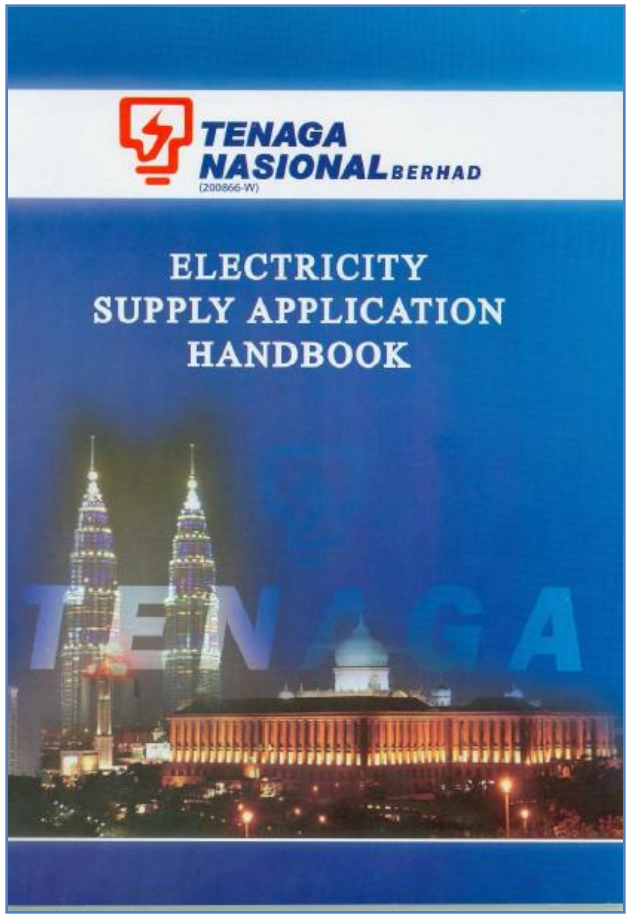


Table 3-1: Minimum supply schemes for various M.D levels

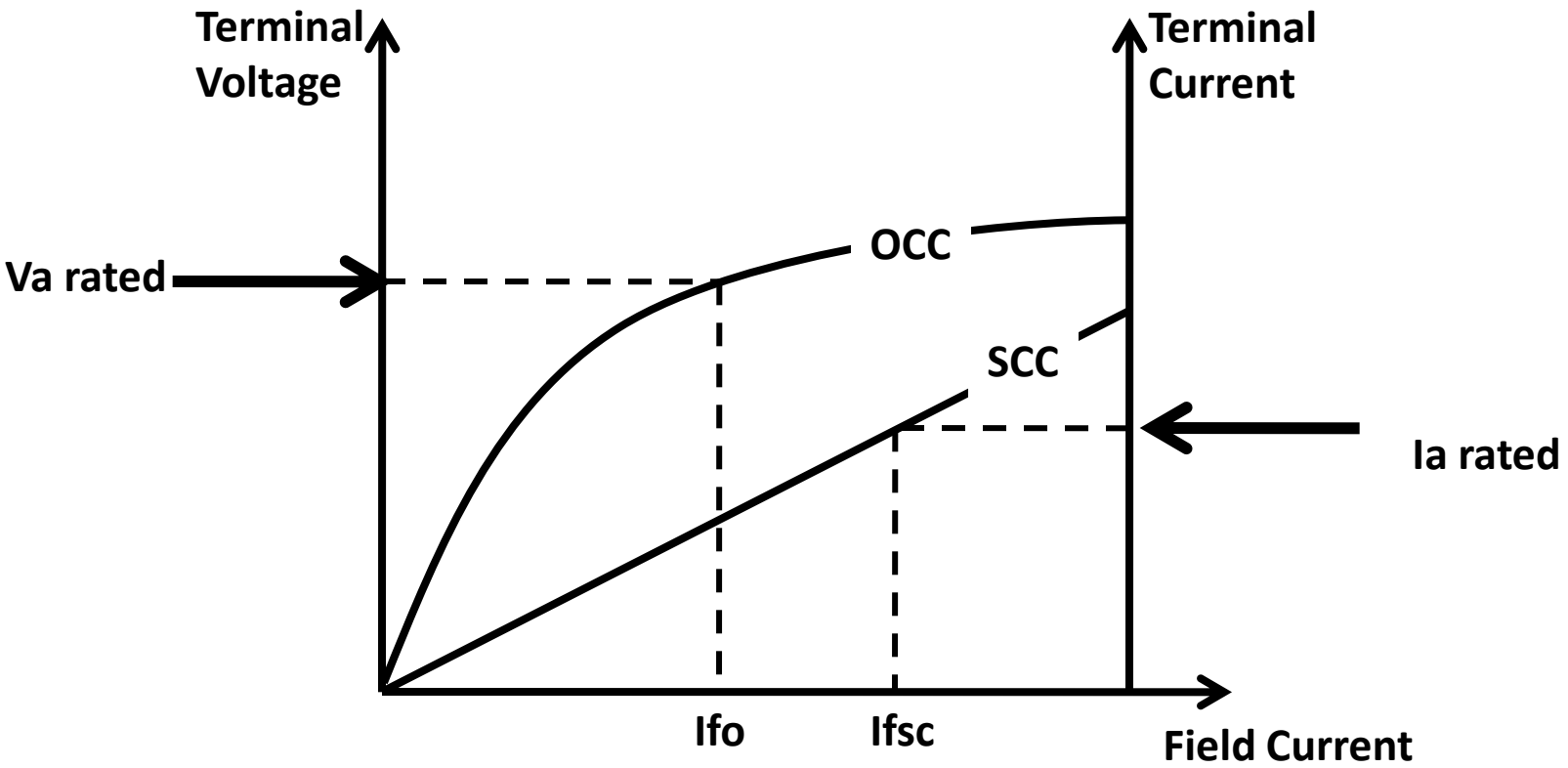
M.D ranges of individual consumer	Supply voltage	Minimum supply scheme
Up to 12 KVA	230V	Single phase overhead or underground services from existing LV network
>12kVA to 100kVA	400V	Three phase overhead or underground cable service from existing LV network subject to system capability study by TNB
>100kVA to 350kVA	400V	Underground cable service from feeder pillar or a new/existing substation, subject to system capability study by TNB
>350 kVA to 1000kVA	400V	Direct underground cable service from new substation
1000kVA up to <5000kVA	11kV	Directly fed through TNB 11kV switching station. An additional PPU land may need to be allocated subject to system capability study by TNB.
1000kVA up to 10000kVA	22kV	Directly fed through TNB 22kV switching station An additional PPU land may need to be allocated subject to system capability study by TNB'
5000kVA to 25000kVA	33kV	Directly fed through TNB 33kV switching station An additional PMU land may need to be allocated subject to system capability study by TNB'
25,000kVA to <100,000kVA	132kV , 275 kV	Directly fed through TNB 132kV or 275kV substation respectively. TNB shall reserve the absolute right to provide alternative arrangements after taking into consideration the location, economic and system security factor
100,000kVA and above	275 kV	Directly fed through TNB 275kV substation. TNB shall reserve the absolute right to provide alternative arrangements after taking into consideration the location, economic and system security factor

Example of Supply Scheme based on Maximum Demand (MD) level

Definition 1

Definition of Short Circuit Ratio (SCR):

$$SCR = \frac{\text{If @ Va rated (based on open circuit characteri stic curve)}}{\text{If @ Ia rated (based on short circuit characteri stic curve)}} = \frac{Ifo}{Ifsc}$$



Clarification 1

Minimum Frequency Response Requirement Profile and Operating Range

1. **CCA.3.2: Plant Operating Range**
   - The Minimum Generation level may be less than, but must not be more than, 65% of the Registered Capacity.
   - The Designed Minimum Operating Level must not be more than 55% of Registered Capacity.
2. **CCA.3.3: Minimum Frequency Response Requirement Profile**
   - Figure CCA.3.1 shows the minimum frequency response requirement profile diagrammatically for a 0.5 Hz change in Frequency.
   - Each Generating Unit and/or CCGT Module must be capable of operating in a manner to provide frequency response at least to the solid boundaries shown in the figure.
   - If the frequency response capability falls within the solid boundaries, the Generating Unit or CCGT Module is providing response below the minimum requirement which is not acceptable
3. **CCA.3.4: Testing of Frequency Response Capability**
   - The Primary Response capability (P) of a Generating Unit or a CCGT Module is the minimum increase in Active Power output between ten (10) and thirty (30) seconds after the start of the ramp injection as illustrated diagrammatically in Figure CCA.3.2.
   - The Secondary Response capability (S) of a Generating Unit or a CCGT Module is the minimum increase in Active Power output between thirty (30) seconds and thirty (30) minutes after the start of the ramp injection as illustrated diagrammatically in Figure CCA.3.2.
   - The High Frequency Response capability (H) of a Generating Unit or a CCGT Module is the decrease in Active Power output provided ten (10) seconds after the start of the ramp injection and sustained thereafter as illustrated diagrammatically in Figure CCA.3.3.

Clarification 1

Figure CCA.3.1 - Sample Minimum Frequency Response Requirement Profile for a 0.5 Hz Change from Target Frequency

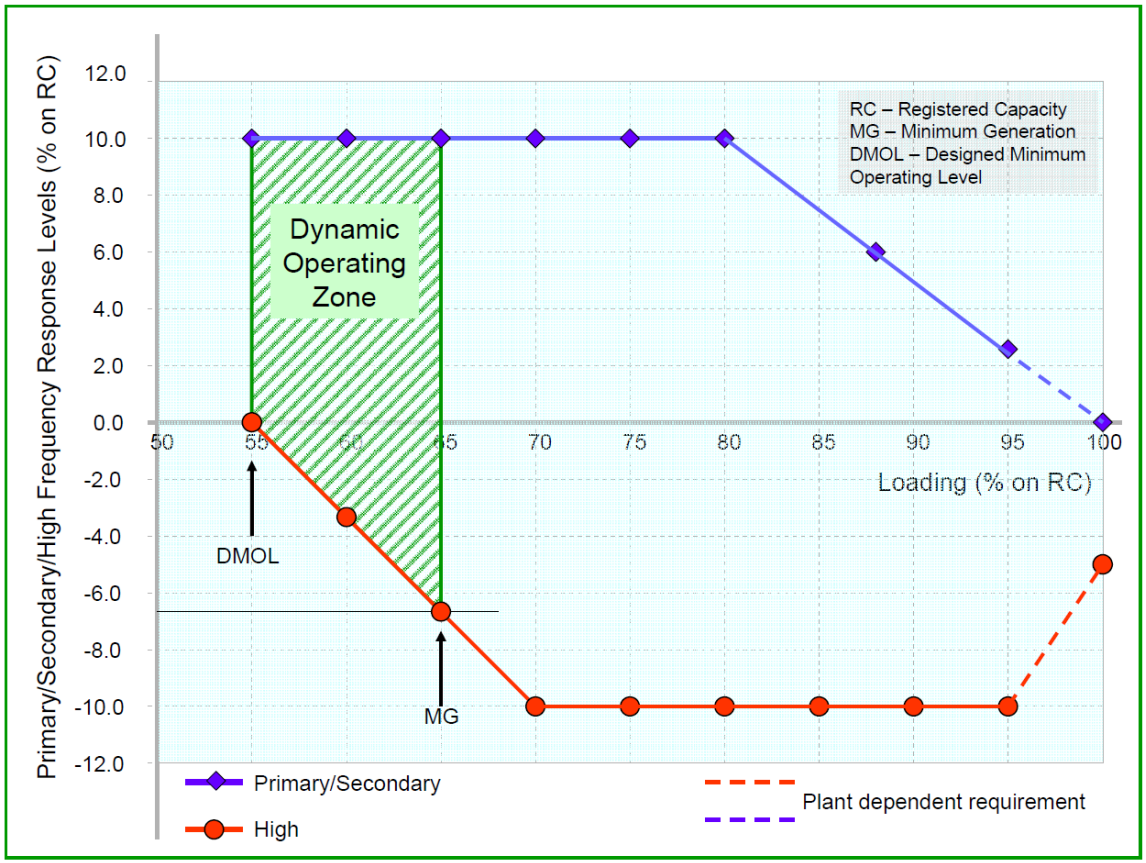


Figure CCA.3.2 - Interpretation of Primary and Secondary Response Values

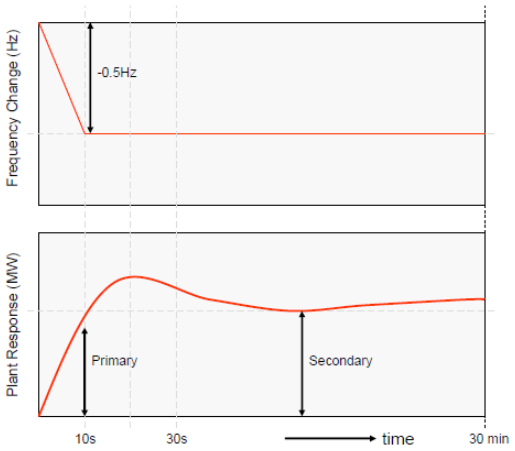
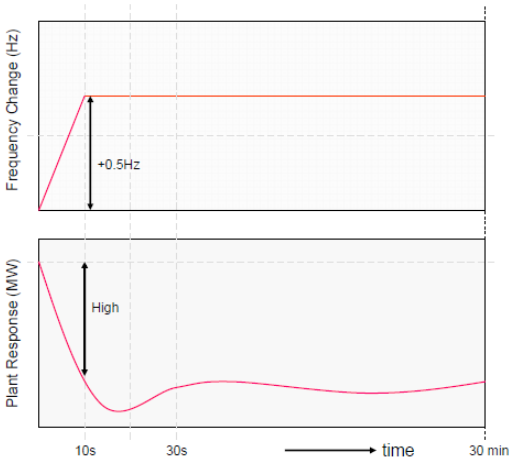


Figure CCA.3.3 - Interpretation of High Frequency Response Values



THANK YOU

KeTTHA
KEMENTERIAN TENAGA, TEKNOLOGI HIJAU DAN AIR

Suruhanjaya Tenaga

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