

# **A GUIDE TO PROVIDING INTERRUPTIBLE LOAD IN SINGAPORE'S WHOLESALE ELECTRICITY MARKET**

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## A. INTRODUCTION

Reserve is 'spare' energy available that generators can provide within a short period of time. When a generator or generators trips suddenly, the other running generators can provide this 'spare' energy (reserve) into the system to meet the energy consumed so that the system frequency (50Hz) stays within an acceptable range.

Generally, when a generator trips, there is less energy available in the system to meet the same demand. This causes the frequency of the system to fall. Lowering of the system frequency past a certain limit will set off a 'chain tripping' reaction of non-dispatchable loads and in the worst case all other generators in the system and lead to total system blackouts. Hence, maintaining the frequency within an acceptable range is critical for system security. The way to ensure this is to have sufficient reserve so as to cover the single largest dispatched energy quantity (e.g. if the largest energy quantity from a single generator in the system is 350 MW, then the reserve needed in the system is at least 350 MW. Such a generator is also referred to as 'risk setter' since it sets the risk to be covered by reserves from other generators.)

**Classification of Reserve:** Due to individual plant characteristics, not all generators can respond in the same way to a drop in frequency. There are three reserve classes established for the purpose of: i) arresting a fall in the frequency; ii) restoring the frequency; and iii) replacing energy or reserve lost, all as a result of the forced outage of a generation facility. Thus, depending on the time required to respond, the reserves are classified into primary, secondary and contingency reserves with response times of 8 seconds, 30 seconds and 10 minutes respectively. The system-wide requirement for each class of reserves is set separately.

Historically, the reserves have been provided by generators alone wherein imbalances between demand and supply due to loss of generation have been restored by increasing the output of the rest of the generators in the system. However, in recent years, some other electricity markets have restored this imbalance by allowing load facilities to voluntarily interrupt their consumption of energy to match the reduced supply (following a contingency situation). This service is called Interruptible Load (IL).

The reduction in the consumption of energy by a load facility (to "provide" reserve) restores the demand and supply imbalances in the system. An imbalance in the demand supply situation could occur due to sudden loss of generation.

In Singapore's wholesale electricity market, an IL will be allowed to offer in all or any of the three reserve market (i.e. primary, secondary and contingency). Providers of IL therefore compete with generators to provide reserve. Such IL may be provided by a load facility of a direct market participant (DMP) or, where the load facility is not owned by a market participant, through a retailer who is a market participant. In the latter, where IL is provided through a retailer, the Energy Market Company (EMC) will have no direct contractual relationship with the owner of the load facility being a non-market participant, and thus, as between the EMC and the retailer, such retailer will be treated as contracting with the EMC as principal (and not as agent of the owner of the load facility) and will be responsible to the EMC for compliance with the market rules in respect of that load facility and the provision of IL. The DMP or retailer must register all load facilities with the EMC as 'load registered facility (LRF)' of the DMP or retailer before that load facility may offer or provide IL in the reserve market. The LRF can be connected at any voltage to the grid.

Such DMP or a retailer (and not the LRF) will be paid the reserve price for the class of reserve that is scheduled to provide the IL in accordance with the Market Rules. There is no payment for activation. Providers of IL also do not pay for reserve cost. Reserve costs are only allocated to generators injecting energy into the grid.

## **B. BENEFITS OF ALLOWING INTERRUPTIBLE LOAD TO PROVIDE RESERVE**

The introduction of IL for reserve in the Singapore wholesale electricity market is expected to benefit consumers in the long run. Opening up the reserve market to participation from loads brings about the following benefits:

- The security of supply will be increased as the existing reserves by generators are supplemented by reserves from load facilities. Moreover, there is diversification in the form of reserve available since the characteristic of this type of reserve is different than the one offered by the generators. While the generators offer reserve by *providing the ability* to increase their energy output, the load facilities, in contrast, *provide the ability* to reduce their energy consumption to offer as reserve.
- With its ability to instantaneously reduce its consumption, as opposed to steadily ramping the generators, load facilities assist in rapidly restoring the supply and demand balance.
- The expansion of the reserve markets increases competition, which in turn puts a downward pressure on prices. Furthermore, due to the availability of more reserve, the market clearing software has more flexibility in scheduling reserve. This means that, IL could be used to free up generation capacity, which in turn could result in additional availability of energy. Hence, energy prices could potentially also face downward pressure.
- The availability of an additional source of reserve also helps to smoothen out volatility in prices.

## **C. FACTORS AFFECTING RESERVE FROM INTERRUPTIBLE LOAD PROVIDERS**

As different types of reserves will be provided by IL Providers, a load facility needs to adhere to special requirements in order to be able to participate in the Singapore wholesale electricity market. This is to ensure that stability of the power system is not compromised. One special requirement is to *limit the possibility* of load facilities unable to provide scheduled load reduction when activated. On the other hand, separate arrangement is needed to *limit* a situation of excessive load reduction in a particular area since such excess load reduction could induce unstable voltage situation in that region. The following sections detail on these requirements.

## Reserve Provider Groups

The Power System Operator (PSO) is required by the Market Rules to establish reserve provider groups, the minimum performance standards required of each group and the piece-wise linear effectiveness functions of each group. These reserve provider groups reflect how “good” the different groups of generation and load facilities are at providing the reserve that they are scheduled to provide. Thus, those generation and load facilities that provided 100% of their scheduled reserve when needed will be in a different group from those that only provided 50%. The Market Clearing Engine (MCE) takes into account the expected responses so as to ensure that enough reserve is scheduled (and determines lower prices for those who respond less reliably). These groupings and parameters shall be reviewed by the PSO at least annually in consultation with the relevant market participants.

Generation and load facilities with similar Reserve Effectiveness (RE) shall be in the same reserve provider group. Performance of each generation and load facility in providing their scheduled MW reserve (for each reserve class) during actual system disturbances or verification tests shall be used to derive the RE for the generation and load facility.

### **Procedure for defining reserve provider group**

#### Reserve effectiveness function:

For each actual system disturbance event or verification test, the performance of each generation and load facility is computed using a linear function, as shown below.  $RE_n$  is defined as: -

$$\text{Reserve Effectiveness } (RE_n) = \frac{(\text{Actual response})_n}{(\text{Expected response})_n}$$

Where

Actual Response refers to the measured MW reserve provided by each Load Facility via its MRA (Monitoring-Recording-Activation device) during system disturbance or verification test. In the absence of measurement from the MRA for load facilities, the PSO shall assume Zero response; and

Expected Response refers to the expected response (from load facilities), which shall be the scheduled reserve with respect to actual system frequency recorded by the PSO.

n refers to the respective system disturbance or verification test event.

Registered generation and load facilities with similar RE will then be grouped in the same reserve provider group. The following groups are adopted in assigning each generation and load facility to the respective reserve provider group for all reserve classes:

Reserve Provider Group	Range of Overall Reserve Effectiveness	Effectiveness function to the MCE (Market Clearing Engine)
A	$RE \geq 0.9$	0.95
B	$0.8 \leq RE < 0.9$	0.85
C	$0.7 \leq RE < 0.8$	0.75
D	$0.6 \leq RE < 0.7$	0.65
E	$0.5 \leq RE < 0.6$	0.55

### Implication of being assigned to a reserve provider group

The reserve provider group determines the amount of money received as payment for providing that class of reserve. For example, *primary reserve* from reserve provider group A will receive a higher payment (0.95 x reserve price for primary reserve x quantity scheduled) than reserve providers in group B (0.85 x reserve price for primary reserve x quantity scheduled). This is also the case for secondary and contingency reserves.

### Assigning load facilities to reserve provider groups

#### New Load Facilities:

All newly registered load facility shall be assigned to Reserve Provider Group “A” for all eligible class of reserves.

#### Existing Load Facilities:

- a. Primary and Secondary Reserve Classes: For each existing load facility, Actual response is obtained from MRA measurements during past system disturbance events, while the Expected response is obtained from the scheduled reserve with respect to actual system frequency recorded by the PSO.
- b. Contingency Reserve Class: For contingency reserve, the Actual response of each load facility shall be based on the MW response measured at 10 minutes after receipt of instruction from PSO during system disturbance event, while Expected response shall be the scheduled reserve for the load facility.

### 1. Reserve Provider Zones for Load Facility

The PSO is required by the Market Rules to establish reserve provider zones, and the maximum allowable limit of reserve from load facilities that can be scheduled by the MCE for each zone. These reserve provider zones reflect how “much” reserve the different zones of load facilities can be scheduled to provide. These limits are necessary to ensure that system voltages stay within allowable ranges as specified in the Transmission Code. The MCE takes into account the maximum allowable limit so as to

ensure that reserve scheduled would not be entirely from a single zone. The same limit for each zone shall apply to all three classes of reserves that can be scheduled from all load facilities in that zone.

Currently, the allowable limits range from 23% to 100% of total estimated load in a zone, or approximately more than 70MW. These limits are much larger than potential reserve from load facilities in each Zone. PSO shall review these reserve provider zones limit at least annually taking into consideration load growth, and changes in transmission and generation configuration in these zones.

All registered load facilities providing reserve shall be assigned to their respective reserve provider zones according to their source of electricity supply. i.e. which 230kV substation supplies the load facility. These assignments may change from time to time should there be significant reconfiguration of transmission system.

## **2. Reserve Class Limit for Load Facility**

As voluntary provision of reserve by load facilities is new to the Singapore power system, precautionary measures are taken during its initial implementation stage for the following reasons: i) The performance of interruptible load facilities for reserve has never been tested; ii) Uncertainty in IL reserve capability due to the varying nature of most loads throughout the day; and iii) the new IL regime affects the existing Under Frequency Relay (UFR) load-shed scheme used to re-stabilise the power system after major system disturbance.

In consideration of the above and the fact that the UFR load-shed scheme is the last resort in preventing power system collapse especially when there is simultaneous tripping of multiple generating units, the scheduling of reserve from load facilities is carefully moderated by setting limits on each class of reserve scheduled from load facilities.

PSO will review these limits for all reserve classes at least annually taking into consideration actual performance of load facilities in delivering scheduled reserves, system demand growth, changes in the UFR load-shed scheme, etc.

System studies conducted by the PSO concluded that for any dispatch period, the sum of all scheduled primary, secondary and contingency reserve from load facilities should not exceed 10%, 20% and 30% of the respective total system reserves requirement. This is to ensure the security and stability of the system would not be compromised in the event that these load facilities failed to deliver their scheduled primary reserve during a contingency event.

#### **D. ACTIVATION OF INTERRUPTIBLE LOAD**

For load facility, the IL Provider shall operate its load facility and associated UFR/MRA device according to the real-time dispatch schedule of reserve produced by the EMC, unless the PSO overrides the dispatch instruction explicitly via phone, fax or email.

When an IL Provider does not receive any dispatch schedule from the EMC, or any dispatch instruction from the PSO for the current dispatch period, it shall use the last dispatch instruction received for the purpose of operating its load facilities with regard to provision of reserves.

For load facilities that have been scheduled to provide primary reserve, the IL Provider shall ensure that its UFR/MRA device is set to trip the designated circuit breaker automatically and instantaneously when system frequency falls below 49.4Hz.

For load facilities that have been scheduled to provide secondary reserve, the IL Provider shall ensure that its UFR/MRA device is set to trip the designated circuit breaker automatically and instantaneously when system frequency falls below 49.7Hz for at least 30 seconds.

For load facilities that have been scheduled to provide contingency reserve, the IL Provider shall ensure that its dispatch coordinator is able to receive Alphanumeric Message Paging from the PSO on activation of contingency reserve. (Dispatch coordinators of all IL Providers would receive an Alphanumeric Message Paging from the PSO.)

Upon receipt of the Alphanumeric Message Paging, dispatch coordinators of load facilities scheduled to provide contingency reserve should first access the EMC trading website to confirm that the same message appears in advisory notice for the same or subsequent dispatch period. Only dispatch coordinators of load facilities scheduled to provide contingency reserve must proceed to reduce, within 10 minutes of an advisory notice issued, its load by the amount of contingency reserve scheduled.

IL Providers should ensure that their load facilities' UFR/MRA devices and designated circuit breakers/load-management devices are operational for all dispatch periods that the load facilities have been scheduled to provide reserves. Measurements such as power, frequency, status of designated circuit breakers, etc., before and after activation must be recorded by the MRA device. MRA records in internal memory must then be transferred to portable data medium (e.g. floppy disc, etc.) in ASCII/Excel format and submitted to the PSO within 24 hours of activation. These records must clearly indicate the MRA's identity and should be secured & tampered proof. Such measurements are required of all the three classes of reserve.

Restoration of interrupted load by dispatch coordinators of load facilities can only be effected after receipt of clearance from the PSO, typically within 30 minutes of interruption. Dispatch coordinators of all IL Providers would receive an Alphanumeric Message Paging from the PSO.

Upon receipt of the Alphanumeric Message Paging, dispatch coordinators of load facilities that provided reserves (whether automatically for primary and secondary reserves, or manually for contingency reserve) must first access the EMC trading

website to confirm that same message appears in advisory notice for the same or subsequent dispatch period before proceeding with restoration of interrupted load to its load facilities.

## **E. COMPLIANCE MONITORING**

### **Introduction**

The PSO is required under Market Rules to report a non-compliance issue. A non-compliance issue can be either an event of non-compliance with the PSO's directions, dispatch instructions or a breach of the Market Rules especially with regards to operation of the PSO controlled system. When the PSO has detected an alleged non-compliance event, the PSO will: -

- a. notify the non-compliant party that an event of non-compliance has been observed;
- b. require the non-compliant party to explain the reason for the non-compliance; and
- c. request that the behaviour leading to the non-compliance be corrected.

Alternatively, if a transmission licensee, any generation licensee or IL Provider has become aware that the operation of its transmission facilities, generation facilities or load facilities will deviate significantly from the directions or dispatch instructions issued by the PSO, the transmission licensee, generation licensee or IL Provider shall promptly inform the PSO.

The PSO shall refer the non-compliance to the Market Assessment Unit of the EMC and the Market Surveillance and Compliance Panel. In such cases, the PSO will ensure that the EMC's Market Assessment Unit and the Market Surveillance and Compliance Panel have full access to records, information or data in the possession or control of the PSO.

### **Criteria for measuring compliance**

- IL Provider shall ensure that each of its load facilities complies with the directions or dispatch instructions issued in respect of the facilities, except as may otherwise be permitted under the Market Rules.
- Transmission licensee, any generation licensee or IL Provider that expects its facilities to operate in a manner that, for any reason, differs materially from the directions or dispatch instructions issued to it by the PSO, shall so notify the PSO as soon as possible.
- Compliance with a direction or dispatch instruction for a transmission, generation or load facilities is not required if such compliance would endanger the safety of any person, damage equipment, or violate any applicable law. The Transmission licensee, generation licensee or IL Provider for a transmission, generation or load facility that departs from directions or dispatch instructions for any such reasons, shall so notify the PSO.
- If the failure by a transmission, generation or load facility to comply with a direction or dispatch instruction endangers the reliability of the power system, the PSO shall

declare the facility to be non-conforming and shall take any action allowed or any other provision of the market rules as the PSO determines appropriate.

### **Unable to provide adequate reserve**

A load facility is deemed unable to provide adequate reserve (i.e. non-compliance with PSO's direction or dispatch instruction) as scheduled/instructed, if the load facility

- a. fails to deliver its scheduled reserve within the required time frame after a contingency event;
- b. restore its interrupted load before PSO gives clearance.

### **Failure to curtail load**

Market Participant with load facilities or Transmission licensee is deemed to have failed to curtail load (non-compliance with PSO' direction) if the following occurs:

- a. failed to disconnect designated loads immediately by automatic UFRs during a contingency event; or
- b. failed to reduce demand as instructed by the PSO during an emergency operating state; or
- c. restored load that has been shed before the PSO gives its consent.

## **F. HOW TO PARTICIAPTE IN THIS SCHEME?**

Load facilities need to register to provide IL by completing the "Load Facility Registration" form available on EMC website

([http://www.emcsg.com/grids/emc\\_template\\_aq.asp?id=272&area=4&currentsection=9580](http://www.emcsg.com/grids/emc_template_aq.asp?id=272&area=4&currentsection=9580)) and send it to EMC. There is no application fee. As part of application approval procedure, the PSO will have to ensure that a load facility meets some technical requirements. These are in addition to the EMC requirements as listed in the form. The technical requirements are as follows:

### **1 Communication Protocol**

Each IL Provider shall nominate (and make known to the PSO) a dispatch coordinator (or its substitute) for its load facilities that are connected to the PSO controlled grid. The dispatch coordinator shall promptly report to the PSO any actual or planned change in status of any of its load facilities that affect the operation of the PSO controlled grid. Such communication by the dispatch coordinator shall normally be made by telephone (or fax) to the PSO's system control staff.

- Each IL Provider who has established a control room/centre for its load facilities shall install, maintain and operate at least one voice communication link between its control room/centre and the PSO's control centers (PSCC & BCC). The voice link shall consist of one dedicated telephone line and shall be used for operational purposes only.
- Similarly, each IL Provider who has established a control room/centre for its load facilities shall install, maintain and operate a facsimile machine within its control

room/centre, with a dedicated telephone line and number, and used for operational purposes only.

- An IL Provider must ensure that its dispatch coordinator is contactable via telephone, cellular telephone or alphanumeric pager at all times and responds promptly to the PSO dispatch instruction such as activation of scheduled reserve from its load facilities.
- All IL Providers must ensure that its dispatch coordinator is able to access EMC's trading website at all times. This is essential for the confirmation of:
  - reserve scheduled by EMC for its load facilities;
  - activation (for contingency reserve only) by PSO (via advisory notice) of reserves provided by its load facilities;
  - restoration permitted by PSO (via advisory notice) of load of its load facilities interrupted earlier.

Dispatch coordinator of load facilities connected to the PSO controlled grid shall report the following contingencies promptly and directly to the PSO:

- significant change in its load facility's reserve capability;
- automatic removal from service of its load facilities;
- unavailability of any load facilities that have been scheduled to provide reserve;
- mal-function of its Monitoring-Recording-Activation device for any of its load facilities.

Reports to the PSO shall also include the timings of the incidents.

Such communication by the dispatch coordinator of load facilities shall be made by voice (i.e. telephone/hand phone) and followed by fax/email to the PSO's system control staff. Dispatch coordinator of load facilities shall inform the PSO of restrictions on its load facility in the PSO controlled system, if any. If load facility circuit breakers are within the jurisdiction of another Market Participant, that Market Participant shall be advised as soon as conditions permit.

Dispatch coordinators of load facilities shall advise the PSO of any extraneous factors that may affect the operation of the PSO controlled system. (For example, directions received from other government authorities (i.e. fire and police). Any change in such conditions shall likewise be communicated.

An IL Provider who has operational control of portions of the PSO controlled system shall abide by any communication requirements specified by the PSO.

## **2 Test requirements for providing Interruptible Load**

### **Primary and secondary reserve capability tests**

#### Description and Purpose of Test:

An IL Provider that intends to provide primary and secondary reserve via its load facility shall conduct site tests to verify the primary and secondary reserve release capabilities of its load facility. These tests would determine whether the load facility meets the requirement for registration as Interruptible Load Facility as detailed in the Transmission Code, Market Rules & System Operation Manual. The test method involves the injection

of a test frequency signal into devices such as Under Frequency Relay (UFR) or Monitoring-Recording-Activation (MRA) device with contact output. The UFR/MRA and designated circuit breaker’s trip coil should be activated at the pre-set frequency and timer settings.

The series of site tests to be performed by load facilities is shown in Table 8.3, and the profile of the frequency signal to be accomplished by the injection is shown in Figure 8.2.

Figure 8.2: Test frequency to be injected into UFR/MRA device

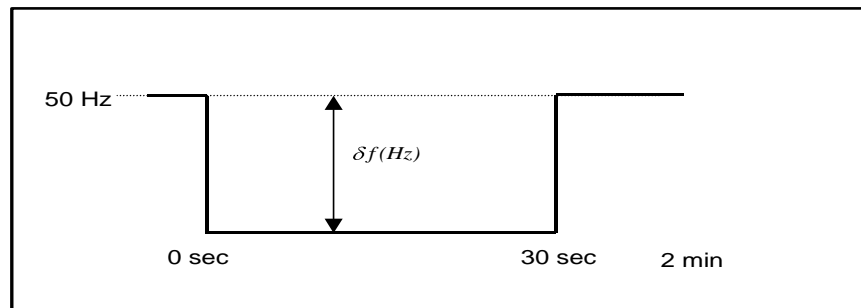


Table 8.3: Series of site tests to be performed

Test Number	Test Item	UFR/MRA Activation Setting	Frequency Deviations $\delta f$ (Hz)
1	Primary Reserve Test	49.4 Hz Timer: $\leq 1$ second	0.60
2	Secondary Reserve Test	49.7 Hz Timer: $\leq 30$ seconds	0.30

An IL Provider shall submit alternative proposal(s) for the PSO’s consideration if there are significant technical difficulties to comply with the above verification method.

Site witnessing by PSO: This will be decided by PSO on a case by case basis

Measurements/Data to be submitted:

- a. Name of Interruptible Load Provider
- b. Owner name of Interruptible Load Facility
- c. Site address of Interruptible Load Facility
- d. Reserve Class: Primary / Secondary
- e. Test Frequency record
- f. Active power record
- g. Relay contact status (Open/Closed) record
- h. Designated Circuit Breaker status (Open/Closed)

- i. Half-hourly load profile of Interruptible Load Facility for the immediate past 3 months (by Meter or MRA device) controlled by the Designated Circuit-Breaker.

The IL Provider shall be responsible for the installation, testing, commissioning and subsequent maintenance of MRA device associated with its load facilities. The proper functioning of the MRA device including the associated monitoring and controlling wiring to the load facilities must be certified by a Licensed Electrical Worker. Any subsequent changes to the MRA device or its associated wiring shall be re-certified by a Licensed Electrical Worker.

The MRA device must have at least the following capability:

- a. Frequency and timer activated digital output contacts that can be pre-set at a frequency of 48Hz to 52Hz in 0.05Hz steps and timer of 0 second to 60 seconds in 0.5 second steps;
- b. Continuous recording of analogue measurement and digital status for all signal channels even in the event of power disruption;
- c. Non-volatile internal memory that can store signals of all channels for least 30 second before and 30 minutes after the start of each activation;
- d. Power and Frequency measurement shall have accuracy of at least 0.01MW and 0.05Hz respectively;
- e. Signals shall be sampled no slower than the rate of 1 sec for each channel;
- f. MRA records in internal memory must be transferable to portable data medium (e.g. floppy disc, etc.) in ASCII/Excel format. These records must clearly indicate the MRA's identity and should be secured & tampered proof.

Softcopy of MRA records should be submitted via email or floppy disk.

Hardcopy records/plots should be legible, identifiable, properly labeled, and should have appropriate scaling. These results and test report should be certified by a Licensed Electrical Worker and submitted together with interruptible load facility Standing Capability Data form as required by the registration process.

#### Criteria of Assessment

The test results shall be assessed based on performance standard and standing capability data requirement in the Market Rules and System Operation Manual. For a load facility to be accepted as a provider of primary or secondary class of reserve, other than meeting its declared standing capability data, it must achieve the following:

- a. for primary reserve, activation of UFR/MRA and designated circuit breaker Trip Coil instantly (<1sec) whenever test frequency falls below preset level of 49.4 Hz;
- b. for secondary reserve, activation of UFR/MRA and designated circuit breaker Trip Coil instantly whenever test frequency is below the preset level of 49.7 Hz for at least 30 seconds.
- c. Half-hourly load profile shall have minimum energy withdrawal of 0.1MW for each half-hourly period.
- d. UFR/MRA device comply with specifications in this section.

### Re-Test of Load Registered facilities

PSO may, from time to time test the IL Provider's reserve release capability by issuing testing directives.

PSO may request for additional testing and inspection of the load registered facilities, in its reasonable opinion, under the following circumstances:

- a. result of test by the IL Provider is unsatisfactory;
- b. following a change in reserves capability of load facility, the associated MRA device or its connections;
- c. after an event of default.

### **Contingency Reserve capability test**

#### Description and Purpose of Test:

IL Provider that intends to provide contingency reserve via its load facility shall conduct site tests to verify the contingency reserve release capabilities of its load facility. These tests would determine whether the load facility meets the requirement for registration as Load Registered Facility as detailed in the Transmission Code, Market Rules and System Operation Manual.

To start the test, an IL Provider that intends to provide contingency reserve would receive an Alphanumeric Message Paging from the PSO.

Upon receipt of the Alphanumeric Message Paging, the IL Provider should first access the EMC trading website to confirm that the same message appears as in advisory notice for the same dispatch period. The IL Provider should start recording from the initiation time (T1) and proceed to activate Trip Coil of the designated circuit breaker (or designated load-management device) within 10 minutes and record the activation time (T2).

Site witnessing by PSO: This will be decided by the PSO on a case by case basis

#### Measurements/Data to be submitted:

- a. Name of Interruptible Load Provider
- b. Owner name of Interruptible Load Facility
- c. Site address of Interruptible Load Facility
- d. Reserve Class: Contingency
- e. Active Power Record
- f. Initiation time (T1) and Activation time (T2)
- g. Designated Circuit Breaker status (Open/Closed) or Designated Load-Management Device operation status
- h. Half-hourly load profile of Interruptible Load Facility for the immediate past 3 months (by Meter or MRA device) controlled by the Designated Circuit-Breaker/Load-Management device

The IL Provider shall be responsible for the installation, testing, commissioning and subsequent maintenance of MRA device associated with its load facilities. The proper functioning of the MRA device including the associated monitoring and controlling wiring to the load facilities must be certified by a Licensed Electrical Worker. Any subsequent

changes to the MRA device or its associated wiring shall be re-certified by a Licensed Electrical Worker.

The MRA device must have at least the following capability:

- a. Power measurement shall have accuracy of at least 0.01MW;
- b. Signals shall be sampled no slower than the rate of 30 seconds for each channel;
- c. Continuous recording of analogue measurement and digital status for all signal channels even in the event of power disruption;
- d. Non-volatile internal memory that can store signals of all channels for least 10 minutes before and 30 minutes after the start of each activation;
- e. MRA records in internal memory must be transferable to portable data medium (e.g. floppy disc, etc.) in ASCII/Excel format. These records must clearly indicate the MRA's identity and should be secured & tampered proof.

Softcopy of MRA records should be submitted via email or floppy disk.

Hardcopy records/plots should be legible, identifiable, properly labeled, and should have appropriate scaling. These results and test report should be certified by a Licensed Electrical Worker and submitted together with "Interruptible Load Facility Standing Capability Data" form as required by the registration process.

#### Criteria of Assessment

The test results shall be assessed based on performance standard and standing capability data requirement in the Market Rules and System Operation Manual. For a load facility to be accepted as a provider of contingency class of reserve, other than meeting its declared standing capability data, it must achieve the following:

- a. The IL Provider responded within 10 minutes to PSO's initiation of contingency reserve capability test on its load facility. Response time should be  $(T2 - T1)$  as recorded by the PSO ( $T1$ ) and MRA ( $T2$ ) respectively.
- b. Half-hourly load profile shall have minimum energy withdrawal of 0.1MW for each half-hourly period.
- c. MRA device comply with specification in this section.

#### Re-Test of Load Registered facilities

PSO may, from time to time, test the IL Provider's reserve release capability by issuing testing directives.

PSO may request for additional testing and inspection of the load registered facilities, in its reasonable opinion, under the following circumstances:

- a. result of test by the IL Provider is unsatisfactory;
- b. following a change in reserves capability of load facility, the associated MRA device or its connections;
- c. after an event of default.

## **G. GLOSSARY OF TERMS USED**

*Interruptible Load Provider:* A market participant who is willing to provide interruptible load. Such a market participant can be a retailer or a direct market participant.

*Load Facility:* Load facility is a facility which draws energy from the transmission system. This facility could be an office building, industrial plant, chiller plant etc.

*Load Registered Facility (LRF):* means a load facility that has been registered with EMC as a registered facility to provide reserve.

*PSO:* Power System Operator means the Authority (EMA) acting in its capacity as the person responsible for ensuring the security of supply of electricity to consumer and arranging for the secure operation of the transmission system as described in subsection 3(3) (e) of the Electricity Act.

## **H. CONTACTING EMC**

For more information on this scheme, please contact Wang Jing ([jing.wang@emcsg.com](mailto:jing.wang@emcsg.com)) or Paul Poh Lee Kong ([paul.poh@emcsg.com](mailto:paul.poh@emcsg.com)) from Market Administration team at 67793000.