

JAMAICA ELECTRIC UTILITY SECTOR

GENERATION CODE

DISCLAIMER

This is a draft document and is a work in progress. The document is in the process of preparation and editing and as such Table of Contents, page numbering, appendixes, glossary will be added or modified as appropriate based on stakeholders review comments.

This draft document is for review only by the OUR and Stakeholders. It should not be relied upon by any other party or parties or used for any other purpose.

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The data, conclusions and recommendations will remain draft until the documents have gone through the review process and is approved by the legally authorized entities.

GC 1 SCOPE

This Generation Code sets out the procedures and principles governing the operation of the Jamaica Electricity System and all interconnected Generation Facilities.

GC 2 CONNECTION CONDITIONS

Connection Conditions specifies the normal method of connection and the minimum technical, design and operational criteria which must be complied with by any Generator and prospective Generators.

Additionally, details specific to each Generator's connection may be set out in a separate Connection Agreement or in some cases, the relevant Power Purchase Agreement. The Connection Conditions set out in the Code shall be read in conjunction with either or both of these Agreements as relevant. In the event that, there is any conflict between the provisions of the Code and any Connection Agreement and/or Power Purchase Agreement and the said Connection Agreement and/or Power Purchase Agreement was signed before the present Code came into effect, then, the provisions of the Connection Agreement and/or Power Purchase Agreement will supersede the Code. The foregoing, all Connection Agreements and/or Power Purchase Agreements shall be read in conjunction with the Code in force at any material time and in accordance with Sub-section 2.1 of this Code.

GC 2.1 Method of Connection

The method of connection shall be determined on the basis of several technical and economic factors which include:

- i) Proximity to System Grid;
- ii) Generating Unit (MW) rating or Generating Facility (MW) capacity;
- iii) Supply voltage;
- iv) Reliability considerations;
- v) Auxiliary power supply;
- vi) Substation configuration
- vii) Protection systems/devices; and

viii) Costs

It will not be technically or economically practicable to achieve uniformity of the method of connection. In all cases however, Prudent Utility Practice will guide the method adopted.

The method chosen by the Generator shall be reviewed and approved by the System Operator on the grounds of System security, stability and safety.

GC 2.1.1 Interconnection Point

The Generating Unit(s) shall be interconnected to the System Grid via a Substation. The Interconnection Point shall normally be on the High Voltage side (Grid side) of the generator step-up transformer and will demarcate the boundary of responsibility between the Generator and the System Operator.

Generators, with capacity of 60 MW or more shall be interconnected to the switchyard/substation to satisfy the N-1 security criteria. This implies that the loss of any single Transmission element connecting a Generator to the Transmission System shall not result in a loss of generating capacity greater than 60 MW.

The finalized number of Interconnection Points shall be determined by a system analysis study at the time of interconnection to the system.

The Generator shall be responsible for all costs related to interconnection to the Grid.

GC 2.1.2 Supply Voltage

The voltage level at which the Generating Unit(s) are connected to the System Grid will be dependent on but not limited to the size and number of units and the other factors that determine the Interconnection Point.

Subject to other technical considerations, Generating Units with a Rated Capacity of 10 MW or above shall be connected to the Transmission System at 69 kV or 138 kV.

Generating Units with a Rated Capacity of below 10 MW may be connected to either the Transmission System at 69 kV or 138 kV or the primary Distribution System at 24 kV or less.

Embedded Generating Facilities with Rated Capacity between 1MW and 10MW may be interconnected via a dedicated feeder recloser from the Substation to the Facility.

GC 2.1.3 Configuration of Generation Substations

All Generation Substations shall have the capability to disconnect or separate, from the System Grid, any transmission line and Generating Unit which is interconnected to the Substation.

For reasons of ensuring safety and reliability of operation, Generation Substations with more than three transmission lines and Generating Units interconnected to them shall be of a 'breaker and a half' configuration. The size of the Generating Units shall be considered for applicability of the breaker and a half requirement. The Substation shall be equipped with all requisite protection measures necessary to meet the System Operator's System protection standards as set out in GC 2.2.4.

GC 2.2 Generator Performance Standards and Technical Criteria

GC 2.2.1 Technical Standards

All components of the connection shall be constructed, installed and tested in accordance with the current edition at the time of construction of the following codes and standards, or their international equivalents and Prudent Utility Practice:

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASCE	American Society for Civil Engineers
ASME	American Society for Mechanical Engineers
ASNT	American Society for Non-Destructive Testing
ASTM	American Society for Testing Materials
AWS	American Welding Society
UL	Underwriters Laboratory
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Organization for Standardization

NBC	National Building Code (Jamaica)
NIST	National Institute of Standards and Technology
NEC	National Electric Code
NEMA	National Electric Manufacturers Association
NESC	National Electric Safety Code
NETA	National Electric Testing Association
NFPA	National Fire Protection Association
SSPC	Steel Structures Painting Council
BSJ	Bureau of Standards Jamaica
NEPA	National Environmental Planning Agency (Jamaica)
OSHA	Occupational Safety and Health Administration

GC 2.2.2 Performance Standards

Each Generating Unit interconnected to the System Grid shall be required, as a minimum, to meet the following performance standards:

Sustained operation at any Load within the loading limits within the System frequency range of 49.5 Hz to 50.5 Hz;

- i) Emergency operation within the Generator loading limits and within the system frequency range of 48.0 Hz to 52.5 Hz;
- ii) Maintain normal rated output at the System Grid normal voltages specified in Sub-section 2.3 of this Code;
- iii) Sustained operation at the rated Power Factor set out in the relevant and appropriate Interconnection Agreement; and
- iv) Grid Interconnection Criteria (Appendix E)

GC 2.2.3 Station Capabilities

- i) Synchronizing Facilities

Each Generating Unit shall be equipped with synchronizing facilities to ensure Synchronization with the System Grid. Two independent synchronizing facilities,

preferably one automatic and one manual shall be provided, however, the primary must be automatic. The Synchronization facilities shall include a synchronism check relay to support synchronization under the following range of conditions:

- a) System Grid frequency within the limits 48.0 to 52.5 Hz; and
 - b) System Grid voltages within the limits specified in Sub-section 2.3.
- ii) Auxiliary Supply

Each Generating Unit shall have the facility to provide its auxiliary supply during normal operation. Each Generator shall provide the facility to connect to the System Grid for an incoming station service supply from the System Operator.

- iii) Automatic Frequency Response

It is required that dispatchable Generating Units have continuously fast acting response automatic governor and excitation control systems to control the Generating Unit's power output and voltage levels without instability of operation within the operating range of the unit.

- iv) Governor Response Capability

The droop characteristics from no load to full load for Generating Units shall be adjustable in the range of (0 - 5%).

- v) Black Start Capability and Dead Bus Control

Some Generating Units shall be designated to have Black Start Capability primarily considering their type and location on the system. This shall enable Generators to restart their facilities without incoming supply from the System Grid, connect to a Dead Bus, and supply load as necessary; once on line Generators are required to be in frequency sensitive mode so as to vary with load changes. In the event of the Generator "black starting" the Grid, the Generator may act, temporarily upon the provision of instructions from the System Operator.

The specification of the Black Start Generating Unit shall be a subject of the Interconnection Agreement (normally contained in the PPA as a Schedule) between the System Operator and the Generator.

Where a Generator has a facility with a capacity of 60MW (excluding intermittent renewables with high and rapid variability) or greater, at least one source of Black Start supply shall be located at the site. Black Start facilities shall be routinely tested by the Generator to ensure satisfactory operation. The System Operator shall have the right to require the Generator to demonstrate the performance of

the Black Start Capability. At a minimum, the Generator is required to provide a formal report to the System Operator twice a year, detailing the results of the Black Start generator test. One of these reports must be based on a test done in May of that year and shall be submitted to the System Operator before June 1 (the official start of the hurricane season). A failed event shall automatically trigger the reporting of that black start test event by the relevant Generator to the System Operator. A further report is also to be immediately submitted by the Generator to the System Operator upon subsequent successful maintenance and operation of said black start generator.

vi) Fuel Supply Capability (Thermal Plants only)

The Generator shall at its own expense construct and maintain fuel supply infrastructure sufficient to store at least eighteen (18) days of fuel requirement at normal rated output subject to the provisions of Sub-section 4.1.4.

GC 2.2.4 Protection Requirements

- i) Protective systems shall be provided in accordance with the Technical Standards set out in GC 2.2.1 and Prudent Utility Practice as generally accepted in the power industry.
- ii) All protective relaying equipment shall comply with the appropriate Technical Standards.
- iii) At a minimum, the following protection schemes shall be provided subject to the exigencies of the relevant generation technology including inter alia;
 - AC generators (Reference is made to IEEE Guidelines 37.102.2006)
 - a) Loss of Excitation (Under-reactance type)
 - b) Differential current protection (for generator phase-to-phase fault)
 - c) Negative phase sequence protection (for unbalanced load operation)
 - d) Stator ground fault protection (for generator phase-to-ground faults)
 - e) Reverse power protection
 - f) Backup protection in the event of circuit breaker failure to operate.
 - g) Over- and under-frequency
 - h) Over- and under-voltage

- i) Thermal over-load
- j) Rotor (or field) ground fault protection

Transformers (Reference is made to IEEE Guidelines 37.91.2000)

- a) Differential current protection for generator step-up transformers
- b) HV/LV phase and ground overcurrent protection (for station service/unit auxiliary transformers)
- c) Buchholz and/or Sudden pressure (gas relay)
- d) Over excitation protection (for generator step-up transformers)
- e) Backup protection in the event of circuit breaker failure to operate for generator step-up transformers
- f) Over-temperature protection (winding and oil)

Interconnection

- a) Differential (line current high-impedance) for Phase and earth faults.
- b) Backup interconnection protection in the event that external phase and earth faults are not cleared by remote protection system.
- c) Backup protection in the event of circuit breaker failure to operate.
- iv) The protection requirements for the HV interconnection with System Grid will depend on the connection voltage and the Substation configuration. The detailed arrangements for each Generating Facility are set out in the respective Interconnection Agreement. In all cases it should be ensured that each Generating Unit or Facility can be separated from the System Grid as rapidly as possible in the event of a sustained electrical fault on either side of the Interconnection Point. The speed of separation shall be determined by the Interconnection Criteria.
- v) The protective relaying systems shall provide the levels of sensitivity, speed and reliability as required by the System Operator. The operation of all protection schemes shall be coordinated with the operation of the System Operator's equipment.

The Generator shall submit the following design data for prior approval by the

System Operator:

- a) Protection and Metering single line diagrams;
- b) Tripping logic diagrams;
- c) AC and DC schematic diagrams for the interconnection and Generating Unit protection schemes;
 - i. Setting calculations and setting lists for the interconnection and Generating Unit protection schemes including opening/closing time for major circuit breakers; and
 - ii. Rating and Transfer Function data as required for computer simulation of the Generating Unit(s). This shall include data on the generator(s), transformer(s), automatic voltage regulator(s) and prime mover governor.

Substation Equipment single line diagram.

GC 2.2.5 Energy Storage Connection Requirements (Reserved)

GC 2.3 System Operator Performance and Technical standards

Grid Frequency

The normal operating frequency of the System Grid shall be controlled by the System Operator to be within 50.0 Hz \pm 0.2 Hz.

For the avoidance of doubt, generators shall be designed for sustained operation within the frequency limits as specified in GC 2.2.2 (i) and for restricted time based operation within the emergency frequency limits as specified in GC 2.2.2 (ii).

Grid System Voltage

The nominal operating voltages on the system grid shall be;

- a. 138 kV and 69 kV on the transmission System; and
- b. 24 kV, 13.8 kV, 12 kV, 6.9 kV, 4 kV on the Distribution System.

The Normal Operating voltages shall be within:

- a. $\pm 5\%$ at the Generator Bus;
- b. $\pm 5\%$ on the Transmission System;

The contingency (abnormal) operating voltages shall be within:

- $\pm 5\%$ at the Generator Bus;
- $\pm 10\%$ on the Transmission System

Short Circuit Levels

The system shall be designed to withstand both symmetrical and asymmetrical short circuit conditions at the Generating Unit Substation for fault levels as specified in the appropriate Technical Standards as set out in GC 2.2.1.

GC 2.4 Other rights vested with the System Operator

GC 2.4.1 Inspection of Generating Plant by System Operator

The System Operator retains the right to inspect any aspect of the Generator's plant in so far as that plant is pertinent to the provision of capacity and/ or energy to the System Grid, or to the safe and secure operation of the System Grid, in order to verify the correct operation of all equipment including controls, circuit breakers, relays (and relay settings), metering and telemetering. Prior to exercising its right to inspect the Generator's facilities and Metering System, the System Operator shall give the Generator two (2) working days' notice and provide adequate reason for the inspection.

The Generator shall keep records to provide verification of tests and maintenance in accordance with agreements between the System Operator and Generator.

GC 2.4.2 Disconnection of Generator by the System Operator

The System Operator retains the right to disconnect any Generating Facility from the System Grid thereby isolating equipment, without prior notice under the following circumstances:

- i) in cases of System Emergency;

- ii) during system restoration following partial or complete loss of power;
- iii) if at any time the Generating Facility is being operated outside acceptable operating parameters in a manner which violates the Connection Conditions set out in the Code or which is likely to cause any of the following:
 - a. A safety risk to personnel;
 - b. Risk to stability or security of the System Grid or Other Generating Units;
 - c. Any behavior causing sustained operation outside the normal System Grid operating frequency and voltages as stated under Sub-section 2.3.

Notwithstanding the forgoing in the event of any material breach of Connection Conditions which prevents the System Operator from meeting its Licence obligations, the System Operator may disconnect after using best commercial efforts to give notice to the Generator.

GC 3 OPERATIONAL METERING

Adequate Metering Systems consistent with the technical specifications of this GC shall be installed by the Generator. The Metering System shall comprise a Primary and Backup Metering System and shall be designed, financed and installed by the Generator. The System Operator shall own and maintain the Primary Metering System while the Generator shall own and maintain the Backup Metering System.

GC 3.1 Technical Standards for Operational Metering

GC 3.1.1 Location of Metering Equipment

- i. Both Primary and Backup Metering Systems shall be installed to accumulate the outputs and/or inputs at the High Voltage side of the generator step-up transformer.
- ii. Each meter shall have its own current transformer (CT) and potential transformers (PT) and necessary independent systems to function effectively.
- iii. For Generators less than 100 kW, metering requirements of the Standard Offer Contract in addition to the provisions of GC 3.2.4 of this Code shall apply.

GC 3.1.2 Metering Standards

- a) Instrument transformers shall conform to ANSI Standards C12.11 and C57.14

Class 03 and shall have sufficient capacity to supply the burden produced by the wiring and metering equipment.

- b) The current transformers secondary winding used for metering purposes shall supply only the metering equipment and associated systems. Notwithstanding the foregoing each current transformer may have other secondary windings that may be used for purposes other than metering.
- c) Potential transformers' secondary windings may be used for metering and other purposes provided that the total loading does not exceed one half the rating of the transformer.
- d) Any metering and accumulating equipment shall have sufficient accuracy so that any error resulting from such equipment shall not exceed $\pm 0.5\%$ of full scale ("Allowable Error").

GC 3.1.3 Sealing, Field testing and Inspection of Metering Systems

Meters and associated instrument transformer boxes or enclosures shall be sealed by and at the expense of the Generators at the respective meters. The type of seal shall be approved by the System Operator.

For wiring used only for metering purposes, solid metallic conduit runs shall be used to enclose the wiring connecting the instrument transformers and the related accumulating and metering equipment. Any boxes or enclosures or other devices used to join two or more sections of conduit shall be securely covered, fastened and sealed with seals approved by the System Operator.

If the wiring used for metering must pass through a panel, panel board or switchgear structure, it shall be fastened together and cabled as a unit separate and apart from the rest of the wiring.

At its own expense, the Generator shall provide any terminal blocks that may be used along the length of the metering conductors within a panel, panel board or switchgear with covers or strips that limit access to the respective connections and said covers or strips shall be affixed with a seal approved by the System Operator. Boxes or enclosures shall be sealed with pre-numbered seals approved by the System Operator.

Seals shall not be broken by anyone except the System Operator's personnel when the meters are to be inspected, tested or adjusted. The System Operator shall

notify the Generator in advance of such inspection, testing or adjustment, and the Generator has the right to have a representative present.

Before the commissioning of any Generating Unit, the System Operator shall test the Metering System for correct wiring and accuracy, using equipment whose accuracy is equal to or better than that of the individual meters. Individual meter components found to be inaccurate before commissioning shall be returned to the Generator for replacement. Malfunctions identified after full acceptance of the Metering System shall be the responsibility of the individual owners.

The System Operator shall test the Metering System within ten (10) days after:

- i. The detection of a difference larger than the Allowable Error in the readings of the meters;
- ii. The repair of all or part of a meter caused by the failure of one or more parts to operate in accordance with the specifications; and/or
- iii. Each anniversary of the commissioning date of the unit. If any errors in the readings of the meters are discovered by such testing, the Party owning those meters shall repair, recalibrate or replace those meters and shall give the other Party reasonable advance notice so that the Party receiving notice may have a representative present during any such corrective activity.

GC 3.2 Meter Reading Procedures

GC 3.2.1 Parameters for Meter Reading

The Generator shall provide and install appropriate equipment and shall make continuous recordings on appropriate magnetic media or equivalent of the Net Energy Output and Dependable Capacity if applicable, of the Generating Unit(s).

The parameters to be metered shall be subjected to the Interconnection Agreement between the Generator and the System Operator, and may consist of but not limited to any or all of the following parameters:

- 1) Active energy (MWh) OUT;
- 2) Active energy (MWh) IN;
- 3) Reactive energy (MVARh) First Quadrant;
- 4) Reactive energy (MVARh) Fourth Quadrant;
- 5) Active Power Demand (MW) OUT;
- 6) Active Power Demand (MW) IN;
- 7) Reactive Power Demand (MVAR) First Quadrant; and
- 8) Reactive Power Demand (MVAR) Fourth Quadrant.

GC 3.2.2 Frequency of Reading

The Demand interval shall be (15) minutes and shall be set to start at the beginning of the hour,. Demand shall be calculated by averaging the respective parameters over the stated Demand Interval.

The System Operator shall read the appropriate meters to prevent clock drift. The clocks shall be checked and reset as agreed by the Parties. If readings are obtained remotely, copies of the data produced by the computer which initiates the reading protocol can be made and provided to the Generator if requested.

GC 3.2.3 Control Procedures

The System Operator shall inform the Generator at least 24 hours prior to reading the meters and the Generator shall have the right to have a representative to witness such readings.

For the Demand actually experienced throughout the billing period, the meters shall be equipped with a mass memory module of a minimum of 3 months which shall record the parameters in GC 3.2.1.

GC 3.2.4 Metering Requirements for Generators <100 kw

For small Generating Facilities with rated capacity below 100 kW the full metering requirements in Sub-section 3.1 may be reduced. These Facilities will be permitted to be metered using separate import and export meters. The terms and conditions of this arrangement shall be guided by the Standard Offer Contract (SOC).

The metering equipment shall be a bi-directional device or a smart meter having the capability of mass memory, remote reading and power quality monitoring. Specification of the meter shall be provided by the System Operator and the Qualifying Entity shall purchase the metering equipment which shall be owned and maintained by the System Operator.

GC 3.3 Reconciliation Procedures

If the Primary Metering System is known to be inaccurate or otherwise functioning improperly, then the Backup Metering System shall be used during the period that

the Primary Metering System is not in service and the provisions described in Sub-section 3.2 shall apply to the reading for the Backup Metering System.

If the Primary Metering System is found to be inaccurate by more than the Allowable Error or to otherwise have functioned improperly during the previous Month, then the correct amount of Net Energy Output and Dependable Capacity for the actual period during which inaccurate measurements, if any, were made shall be determined as follows:

- i) First, the reading of the Backup Metering System shall be utilized to calculate the correct amount of Net Energy Output and Dependable Capacity, unless a test of such Backup Metering System, as required by either Party, reveals that the Backup Metering System is inaccurate by more than the Allowable Error or is otherwise functioning improperly;
- ii) and If the Backup Metering System is not within the acceptable limits of accuracy or is otherwise functioning improperly, then the Generator and the System Operator shall jointly prepare a reasonable estimate of the correct reading on the basis of all available information and such guidelines as may have been previously agreed to between the Generator and the System Operator. This estimate shall take into account but not be limited to Dispatch Instructions as recorded in the System Control Center dispatch log and meter readings, remote or manual.

GC 3.4 Resolution of Disputes over Recorded Metering Data

If the System Operator and the Generator fail to agree upon an estimate for the correct reading within a reasonable time (as specified in the relevant PPA) of the Dispute being raised, then the matter may be referred for arbitration by either Party in accordance with the relevant PPA.

GC 4.0 MERIT ORDER SYSTEM

The System Operator shall establish a Merit Order based on the real or contracted Variable Operating Cost component of each Generating Unit or Complex, whichever is applicable.

The Variable Cost of each Generating Unit or Complex is the sum of the Variable Operating & Maintenance Cost (VOM) and the Fuel Cost. In mathematical form:

Merit Order Cost (\$/MWh) = Fuel Cost (\$/MBTU) x Full Load Heat Rate (MBTU/MWh) + VOM (\$/MWh)

This information allows the System Operator to rank the Generating Units in the order of their Full Load Point cost of operation.

Refer to Section DSC 9.0 of the Dispatch Code for details of the Merit Order System

GC 5 NON-CENTRALLY DISPATCHED PLANT

Non Dispatchable Generating Units shall operate as agreed upon between the System Operator and the Generator. The System Operator shall inform such Generators where there is a need for outage on the Generating Unit or of any incident which would affect the operations or safety of the Generating Unit. During an Emergency, or where there is life and property at risk, the System Operator and/or the Generator reserves the right to disconnect and so isolate any Generating Unit without prior notification. However, both parties must communicate immediately once the risk has been neutralized, to inform of the action taken and why it was necessary to take such action without prior notice.

The Generator shall communicate with the System Control Engineer on matters of switching and Synchronization during normal operations and in the event of System Emergency.

GC 5.1 Communication and Reporting

The Generator is required to provide information as requested, pertaining to the operation of their Generating Unit(s).

GC 5.1.1 Designated Contact Persons

The System Operator shall at all times have a person designated as the System Control Engineer.

Each Generator shall at all times have a person designated as the Generating Unit Controller in charge of operation and control of each Generating Unit.

GC 5.1.2 System Control Center Record of Dispatch

A record of events shall be kept at the System Control Center, which shall include, but not be limited to:

- i. All instructions regarding switching, voltage control and Generating Unit operation;
- ii. Deviations in frequency outside the normal range;
- iii. Each operation or sequence of operations of circuit breakers, disconnectors and earthing switches under the control of the System Control Engineer and, where appropriate, alarms and protection indications; Transformer tap changers instructed or operated by the System Control Engineer;
- iv. The synchronization or taking off-line of Generating Units;
- v. Details of the application and removal of main short and grounds and other safety precautions, including the issue and cancellation of safety documents and HV live line working certificates, by the System Control Engineer or his designate as required by the System Operator's safety rules;
- vi. The commissioning, taking out of service or re-commissioning of plant and apparatus, including automatic switching systems, protection and changes to relay settings, together with relevant details;
- vii. The failure, or change of state, of plant or apparatus on the System Grid together with relevant details;
- viii. The failure of plant or apparatus affecting the availability of Generating Unit(s), together with relevant details;
- ix. The location and identification of switchgear for which a risk of trip is expected;
- x. Generating Units which are not operating in the frequency sensitive mode;
- xi. Any significant abnormal or dangerous occurrence in operation including incidents involving the use of emergency public service;
- xii. Any interruption and restoration of supply together with relevant details;
- xiii. Details of the System Operator System load reductions, restorations and Demand control;
- xiv. System/ standard time deviation at 7:30 a.m. Eastern Standard Time and 9:30 p.m. Eastern Standard Time or as may be required.

GC 5.1.3 Generator Operations Log

The Generator shall maintain an accurate and up-to-date Operations Log. The purpose of this Operations Log is to record significant events, plans, requests and instructions. Entries into the Operations Log should be made on a daily basis and should include, as necessary, the following:

- i) Dispatching Instructions and times of receipt of such instructions from the System Control Engineer;
- ii) Time of implementation of instructions;
- iii) Any request from the Generator to the System Control Engineer which

includes:

- a) Scheduled outages;
 - b) Forced outages;
 - c) Load adjustments;
 - d) Maintenance Outages;
 - e) Emergencies of any kind affecting the operation of the Generating Facility and Daily available Capacity.
 - f) Names and status of all personnel on each shift;
 - g) Daily midnight readings of the fuel used and in stock;
- iv) Statements relating to abnormal running conditions of Generating Unit(s) and auxiliaries;
- v) All Real (kW) and Reactive (KVAR) Power at half hour intervals, frequency and voltage, at the 69 kV busbar and 138 kV busbar at half hour intervals, unit auxiliary and station busbar voltage and real and reactive power; any units connected at the distribution level should record similar information at the connected busbar.
- vi) Generating Facilities operating on an energy-only basis with installed capacity below 15MW may not be manned at all hours and hence may not record these parameters immediately at every half hour. For these types of Generators, adequate SCADA infrastructure shall be put in place by the Generator for remote monitoring of said parameters by the Generator and System Operator, as well as local real time data capture and storage of the above parameters by the Generator.
- vii) Time of trip-out or removal of Generating Units from service and the time of return to service; and Visits by factory inspectors to the Generating Facility.

GC 5.1.4 Fuel Supply Agreement

The Fuel Supply Agreement shall:

- i) Demonstrate a dependable and sufficient fuel supply;
- ii) Detail the infrastructure installed for delivery of the fuel from the central storage point to the plant gate;
- iii) Provide mitigating strategies in the event of natural disaster affecting the supply of fuel delivery to Jamaica;
- iv) Detail Fuel Transportation Agreement; and
- v) Detail alternative fuel supply arrangements and infrastructure requirements.

All Generators shall be required to:

- a) Obtain and maintain reliable supply of fuel (on-site storage exclusive to the Generating Facility) of quality and quantity sufficient to generate the

Dependable Capacity and the Net Energy Output requirements of their Generating Facilities for a period of at least eighteen (18) days and the minimum inventory level should be 7-10 days. Note that the System Operator must canvas the Generators to obtain the inventory levels and advise the Generator to evaluate available options if the levels are below required levels or trending negatively for uninterrupted operations. The System Operator shall seek permission via an application to the OUR to trigger an emergency plan.

- b) Provide the System Operator the Fuel Supply Plan; as duly approved by the OUR, in consultation with the System Operator.
- c) Only enter into fuel supply arrangements consistent with the Fuel Supply Plan.

GC 5.1.5 Generator Scheduling & Dispatching Tools

The System Operator is required to ensure consistency and objectivity in the decision-making mechanisms used. These mechanisms may be in the form of standardized procedures and/or computational systems.

The System Operator is responsible for updating the System Control Policy & Procedures as required, due to changes in the system characteristics or international best practices, where it has relevance to the Jamaican Electric Power Grid. Documentation of the procedures followed in making System operations decisions must be promulgated to individual Generators after ratification by the OUR.

The tools used to assist in the Generator Scheduling and Dispatch optimization process must be based on an internationally accepted optimization algorithm. The tools must be used in accordance with its intended design and the System Operator is responsible for ensuring that it is functional and accurate.

GC 5.1.6 Generation Forecast and Dispatch

All VRPPs shall cooperate with System Control Center by providing generation forecasts that JPS shall use to schedule the demand energy and dispatch the necessary units to operate the system reliably.

GC 5.1.7 Variable Resource Forecasting

JPS requires the VRPP to provide quality resource forecast from reputable and industry proven methods, and or in accordance with requirements that will be dictated by JPS in the transmission Interconnection Agreement or other agreement between JPS and the VRPP. The forecast should provide the following information:

Medium-Term Forecast: a rolling hourly resource forecast submitted to JPS for the next 168 hours. The rolling hourly forecast means the forecast must be provided on an hourly basis.

Short-Term Forecast: JPS reserves the right to also request a rolling 5-minute resource forecast to be submitted to JPS and/or the centralized forecasting vendor for the next 6 hours.

The System Operator is required to consolidate forecasting functions in a single provider to assure uniformity of quality and improved forecasting prediction capacity, and to share the costs among the users.

The forecasts shall be provided to the System Operator through web service or ftp (File Transfer Protocol) site delivery in a format to be agreed upon with the System Operator. The System OPERator reserves the right to request a specific file format that the VRPP must accommodate

GC 5.1.8 Transparency and Fairness

In order to assure transparency and fairness while being cognizant of the confidentiality provisions in individual contracts, the following outlines how and what type of information will be shared among stakeholders in the generation market. Unless explicitly stated otherwise in the document, the following shall prevail:

- I. **The Regulator:** The OUR shall be allowed access to any and all available information it requires from both the individual Generators or Complex, and the System Operator. Periodically as agreed between the System Operator and the OUR, Technical Reports will be compiled by the System Operator and provided to the OUR, and will contain information from the logged system parameters as agreed from time to time.
- II. **Individual Generator:** The System Operator is required to provide, in a timely manner, individual Generators with any technical system information that affects the operation of interconnected Generating Units for example, fault information should be shared with all Generators, with due consideration of the specific confidentiality provisions contained in

each PPA and Licence.

- III. **System Operator:** The System Operator shall have timely access to all information it reasonably requires from the individual Generators.

GC 5.1.9 New Technologies

New generation technologies that have parameters not covered by this Code may be given consideration for inclusion to the Grid. However, the OUR, in full consultation with the System Operator, shall first provide written approval of the technical compatibility of the technology with the Grid, before the new technology can be interconnected.

GC 6 GENERATOR MAINTENANCE PLANNING

GC 6.1 Long Term Maintenance

GC 6.1.1 Planning Horizon

The System Operator shall develop an overall generation maintenance plan for three (3) years in advance. The first year shall be sufficiently detailed with less detail for the following years 2 and 3. The plan which shall incorporate statutory maintenance requirements shall be reviewed annually and updated as may be necessary.

To achieve this objective, Generators shall submit to the System Operator on or before the first day of July of each year a rolling three year plan for the scheduled maintenance requirement for their facility beginning in January of the following year. The System Operator shall submit the finalized, overall generation maintenance plan to the OUR by January 1 of each year and each Generator shall submit its final generation maintenance plan to the OUR by January 1 of each year.

The System Operator shall schedule both long and short term Maintenance Outages in a non-discriminatory manner as far as System security constraints reasonably allow. Both System Operator and Generator shall ensure that interconnection and other related facilities are maintained within the periods stipulated for scheduled maintenance of the Generating Facility, given the relevant technical constraints.

GC 6.1.2 Annual Commitment of Maintenance Program

Generators shall submit to System Operator on or before the first day of July of each Year, a schedule (the 'Maintenance Schedule') describing the proposed availability of the Generating Facility for each Month of the twelve (12) Month period beginning with January of the following Year. The Maintenance Schedule shall indicate the Generators' preferred dates and durations of all scheduled maintenance. In developing the plan the System Operator shall take into account the manufactures recommendations for maintenance of the plant.

The System Operator shall notify Generators in writing whether the scheduled maintenance periods requested on the Maintenance Schedule are acceptable. The System Operator shall have the right to request the Generators to conduct scheduled maintenance during periods other than those indicated in the Maintenance Schedule, provided that the period specified by the System Operator shall be as close as reasonably practicable to the periods requested by the Generators, shall be of equal duration as the periods requested by the Generator and shall be within the range of time periods identified by the Generator as the range of time periods within which such scheduled maintenance must be performed in accordance with the manufacturer's recommendations for the Generating Facility.

GC 6.1.3 Changes to the Committed Maintenance Schedules

Committed Generating Unit Maintenance Schedules shall be strictly adhered to unless unanticipated circumstances may mean interruption of supply to customers or a compromise in System security if the Maintenance Schedule is not adjusted. Under such circumstances both the System Operator and the Generator shall make best efforts to reschedule the outage as follows:

- i) System Operator may upon five (5) days prior notice request Generator to reschedule a scheduled maintenance provided, however, that System Operator shall not request that scheduled maintenance be rescheduled to a time that is outside of the range of time periods identified by the Generator as the range of time periods within which such scheduled maintenance must be performed in accordance with the manufacturers recommendations for the Generating Facility;
- ii) Generator may, upon five (5) days prior written notice, request that it be permitted to conduct additional scheduled maintenance for a period not

identified in the Maintenance Schedule if the maintenance to be conducted cannot be postponed until the next period of scheduled maintenance identified on the Maintenance Schedules without damaging or otherwise threatening the Generating Facilities. Generator's request shall also identify the range of time periods within which such additional scheduled maintenance shall be performed in order to avoid damaging or otherwise threatening the Generating Facilities. System Operator may upon three days prior written notice, request Generator to reschedule such additional scheduled maintenance; provided, however, that System Operator shall not request that such additional scheduled maintenance be rescheduled to a time that is outside of the time periods identified by the Generator as the range of time period within which such additional scheduled maintenance shall be performed in order to avoid damaging or otherwise threatening the Generating Facilities.

- iii) If the Generator is inside a scheduled maintenance period and requires an extension of the maintenance period, the System Operator shall have the right to review and determine if the extension can be accommodated or the extended work period is to be classified as Forced Outage.

GC 6.2 Short term Outage Program

For short term outages Generators shall give the System Operator at least two (2) hours' notice prior to taking the Generating Facilities out of service.

The granting of such outages shall be at the sole discretion of the System Operator.

testing and shall reserve the right to have a representative present during any such tests.

GC 6.3 Standard Tests

This section addresses procedures for testing and monitoring of Generating Units for purposes of determining available Capacity and, if relevant, operating characteristics in accordance with the commercial and technical conditions of Power Purchase Agreements. An Independent Engineer shall be required for the commissioning of new Generating Facilities.

GC 6.3.1 Test Prior to First Synchronization

- I. Mandatory Tests that may be carried out at the Factory prior to Equipment delivery at the Site of the New Generator Facility
 - a) Automatic Voltage Regulator (AVR) setting up and adjusting with the Generator running at rated load;
 - b) prime mover governor control checks;
 - c) open and short circuit tests on the generator as per IEC 60034 or equivalent under the standard bodies of GC 2.2.1; and
 - d) Governor tests for units not allowed to perform full load rejection tests under GC 6.3.2 (viii)
In each instance, the Generator shall provide the System Operator with the results of all such tests, within a reasonable time of the test being completed.
- II. Tests that shall be completed at the Site of New Generating Facility
 - a) Grounding test at the generator switchyard;
 - b) functional testing and timing of High Voltage switchgear in the Substation;
 - c) voltage phasing checks between the Substation to which the Generating Unit is connected and the System Grid;
 - d) primary and/or secondary injection tests and functional tests to prove the calibration and function of all electrical protection schemes installed for the Generating Unit(s) and the Facility.
 - e) Frequency Relaying Test to confirm that the plant relays are configured adequately and per frequency criteria sub – section TC 3.8. of the Transmission Code Relaying Requirements. This functionality test is required to ensure that the Generating Unit will not disconnect from the grid during the specified frequency range and delay to trip times provided within Sub-section TC 3.8.2 of the Transmission Code.
 - f) There are no trend requirements for these tests. However, the necessary SCADA and Control equipment should be online and operational to be able to perform these tests as JPS will need to confirm the position (Open/Close) of breakers during the test at the System Control Center.

Upon completion of each test the Generator shall within forty eight (48) hours provide the System Operator with two (2) copies of the results of such tests.

The System Operator shall have the right to request additional testing if, in its

judgment verified by an Independent Engineer, any test results are not satisfactory for establishing the purpose for which the test was intended. Such additional testing shall be performed at the Generator's expense.

The Generator shall confirm to the System Operator the programme for any test as specified or advise of any adjustments thereto, not less than five (5) days prior to the commencement.

GC 6.3.2 Tests after First Synchronization

After the Pre-Synchronization tests as defined in Sub-section 6.2 and prior to the commissioning date, and under such subsequent conditions as defined by Power Purchase Agreements, Generator shall carry out the following tests at the Generator's expense:

I. Dependable Capacity

The Generator shall test the Dependable Capacity of the Generating Unit. The test shall be performed according to ASME, IEEE, ISO, and NEMA standards or to equivalent standards of GC 2.2.1. If any such standards are inconsistent in any respect, the test shall be performed in accordance with the most stringent standard.

II. Reliability Run

The Generator shall test the Reliability of the Generating Units in accordance with industry standards based on the type of plant and established international codes for the industry.

III. Automatic Voltage Regulator (AVR) Droop

The Generator shall test the AVR to demonstrate control of the Generating Unit voltage over the range of plus or minus five (± 5) percent of rated voltage with a droop characteristic of plus or minus one half (± 0.5) percent.

Voltage ride through tests

The Generator shall determine whether the Generating Units are capable of detecting and riding through voltage dips without tripping and to provide the necessary support to the grid in terms of active power and reactive current injection as given in Sub-section TC 6.3.2 of the Transmission Code.

IV. Governor Operation

The Generator shall demonstrate that the speed governor for each Generating Unit operates over its range, the droop being adjustable from two (2) percent to five (5) percent.

Primary Frequency Response (PFR) Test

The PFR Test will be carried out by the VRPP to assess the ability of the VRPP controller to provide frequency support to the JPS Transmission Grid. The PFR Test will be carried out by the VRPP to verify that the VRPP is capable to either increase output or decrease output in real-time when the system frequency is outside the 50 \pm 0.5 Hz range. The VRPP shall conduct the test based on the procedures below and show compliance with **Sub-section TC 6.2.3 of the Transmission Code.**

V. Reactive Capacity

The Generator shall test each Generating Unit's capability to operate at rated voltage and frequency at power factors and under reactive conditions according to the technology used. Where synchronous generators are used, the minimum capabilities shall be as follows:

100% output : 0.80 lag; 0.99 lead

vi) Short-term Load Capability

The Generator shall test each Generating Unit's capability to operate at a maximum safe load of one hundred and ten percent (110%) of the Required Dependable Capacity for at least one (1) hour. Where the Generating Unit cannot undergo a "Rapid Start", this unit must also be able to operate at a minimum safe load of at least zero (0) percent of the Dependable Capacity (0 MW) for one (1) hour.

vii) Response of Unit to Step Load Changes

For prime mover technologies that allow controllable load changes, the Generator shall test the capability of each Generating Unit to increase load by steps.

viii) Full Load Rejection

The Generator shall test the capability of each Generating Unit and auxiliaries to withstand 'Partial Load Rejection,' while remaining in a safe condition and without initiating a trip of the Generating Unit. Where a Generating Unit cannot undergo a Rapid Start, the Generator shall also test and prove the capability for each Generating Unit to withstand 'Full Load Rejection' while remaining in a safe condition and without initiating a trip of the Generating Unit.

Where a Co-Generator may determine that a Full Load Rejection test may cause a severe disruption of the Co-Generator's process operations, then a Partial Load Rejection test at a load value capable of being managed by its process operations shall be conducted instead.

ix) Thermal Performance Tests

The Generator shall test the Heat Rate of each Generating Unit.

Heat Rate is computed by dividing the total British thermal unit (Btu) content of fuel consumed for electricity generation by the resulting net kilowatt-hour generation. The Basis of the value should always be expressed as either Lower Heating Value (LHV) or Higher Heating Value (HHV). The basis of the heating value provided shall be consistent with the relevant contractual arrangements and the capability of the generation technology employed.

The Heat Rate data for each Generating Unit is necessary to determine its variable fuel operating cost. All contracts for new generating capacity shall have a guaranteed Heat Rate curve or point.

The Heat Rate Tests for each Generating Unit, not having a guaranteed curve or point, shall normally be conducted at least twice annually or as stipulated by contract. The schedules for the Heat Rate Test for all Dispatchable Generating Units shall be developed by the Grid Operator at least one Month before the end of the preceding Year. The Heat Rate Test schedules may be adjusted within the Year to accommodate unforeseen circumstances, subject to agreement between the Generator and the Grid Operator. Such schedules for Heat Rate Test shall be submitted to the OUR by the Grid Operator.

The Heat Rate Test shall be conducted at a minimum of four (4) output levels from the minimum output level to the maximum output level for each Generating Unit.

The Heat Rate information obtained from Heat Rate Tests together with the

guaranteed Heat Rates (for units to which this is applicable) shall be used as one of the inputs to the Generator Scheduling and Dispatch optimization process.

If the System Operator has sufficient reasons to believe that the Heat Rate of a Generating Unit which does not have a guaranteed curve or point, has changed significantly within the Month or since the last test (due to rehabilitation, damage etc.) the Grid Operator may request the Generator to conduct a Heat Rate Test in accordance with the JPS Heat Rate Testing Policy (in the case of JPS owned generators) or other approved policy (in the case of non-JPS generators) and update the Heat Rate curve for such a Generating Unit. All cost associated with the Heat Rate test shall be the responsibility of the Generator.

The Generator may request a heat rate test of its own unit if it can provide information to substantiate that it has made improvements in the performance of its Unit(s). No more than two such requests will be accommodated within any calendar year.

Heat Rate Tests for all Generating Units, including those of the Grid Operator, shall be coordinated (mutually agreed date) by the System Control Engineer. The Grid Operator shall reserve the right to witness all such tests.

The OUR shall be advised and duly notified beforehand when such tests are contemplated and carried out and reserves the right to witness all such tests.

In the case of Independent Power Producers, the information on which the Generating Units will be ranked shall be based on the contractually agreed performance or such other criteria as established through the Power Purchase Agreement between the Generator and the Grid Operator.

The System Operator shall have the right to request additional testing if, in its judgment verified by an Independent Engineer, any test results are not satisfactory for establishing the purpose for which the test was intended. Such additional testing shall be performed at the Generator's expense. The results of the immediately prior test shall govern until the additional test is completed. The results of the additional test shall supersede the prior test for all purposes commencing on the day following the additional test.

The Generator shall notify the System Operator of the proposed programme for any test specified in this Section, or advise of any adjustments thereto, not less than five (5) days prior to the proposed commencement of the relevant test. Upon receiving such notice, the System Operator shall have the right to reschedule the commencement of such test; provided that the rescheduled commencement shall not be more than three (3) days before the proposed commencement nor more

than ten (10) days after the proposed commencement. The System Operator shall be entitled to have representatives present for the purpose of observing any such test. The OUR shall be notified beforehand by the Generator of all test programmes and shall have the right to have Officers present for the purpose of observing any such test.

Upon completion of each test specified in this Section, The Generator shall promptly provide the System Operator with two (2) copies of the results of such test, which shall be copied to the OUR; provided that the Generator shall submit all such test results to the System Operator no later than ninety (90) days after the commissioned date of the relevant Generating Unit or Facility.

GC 6.4 Co-Generators

Co-Generators Generating Units shall be required to perform all tests as listed in Sub-section 5.2.

GC 6.5 Variable Renewable Power Plant Connected to the Transmission or Distribution Network (VRPP)

VRPPs connected to either the Transmission or Distribution network, section shall be required to perform all tests as listed in Sub-section 5.2 in addition to the following tests listed below.

Meteorological Data, applies to PV and WF:

- a. Wind Speed
- b. Wind Direction
- c. Air Temperature
- d. Air Pressure
- e. Solar Irradiance

GC 6.5.1 Maximum Reactive Power Capability Test

The purpose of this test is to confirm the ability of the VRPP to operate to the limits of the reactive power capability curve for VRPPs as indicated in Figure Transmission Code 6.7 of the Transmission Code, section Transmission Code 6.3 and also to establish the limits of the VRPP reactive power capability at the MV bus. The test shall be completed for both the export of reactive power from the VRPP as well as the import of reactive power to the VRPP. The point of measurement for compliance will be the VRPP Interconnection Point. This test should be undertaken at different levels of active power to confirm that the range is within the capability characteristic at the given level of power. This test will be

carried out at a time when the actual MW Output of the VRPP is greater than 80% of Registered Capacity and 95% of the VRPP Generating Units are in service.

The test should be carried out to determine both:

- a. The Maximum Lagging Reactive (Exporting) capability of the VRPP and
- b. The Maximum Leading Reactive (importing) capability of the VRPP

GC 6.5.2 Voltage Flicker Measurements

The purpose of this test is to confirm the ability of the VRPP to operate within the limits specified in Transmission Code Sub-section **TC 6.4**. Voltage Flicker during normal system operation. This test shall take place for a period of one week after all generating units have been individually commissioned. During the period of measurement, there shall be some period of time, if not all the time, during which 100% of the VRPP Generating Units are in service and providing active power.

GC 6.5.3 Harmonic Distortion Measurements

The purpose of this test is to confirm the ability of the VRPP to operate within the Harmonics limits specified in the Transmission Code Sub-section **TC 6.5** for normal system operation. This test shall take place for a period of xx days after all generating units have been individually commissioned and it may be run at the same period of the voltage flicker measurements. During the period of measurement, there shall be some period of time, if not all the time, during which 100% of the VRPPs are in service and providing active power.

GC 6.6 Testing of Metering System

These testing procedures are outlined in Section 2 of this Code.

GC 6.7 Parameters Monitoring

For modeling of the Grid, Generators shall be required to periodically (5-10 years) submit the Generator operating parameters to determine if there is any decay which should be modeled.

Generators shall carryout routine and prototype response tests on excitation systems and governor systems (unit frequency response) for new power stations coming on-line or power stations at which major refurbishment or upgrades of these systems have taken place. Routine review is required of all power stations at least once every five (5) years.

GC 7 Monitoring and Control

This section outline the means and methods by which system operators and grid participants will be able monitor and control individual generating plant and the power system on a whole. It sets out the responsibilities of each of the parties, and the communication systems requirements through which the necessary information and dataset will be provided.

GC 7.1 Remote Monitoring

(a)The System Operator may require the generator to, within a reasonable time of notice being given in writing:

- I. install remote monitoring equipment ("RME") adequate to enable the System Operator to remotely monitor performance of a generator (including its dynamic performance) where this is reasonably necessary in real time or with small delay for control, planning or security of the power system; and (2) upgrade, modify or replace any RME already installed in a power station provided that the existing RME is, in the reasonable opinion of the System Operator, no longer fit for the intended purpose.

(b) Input Information to RME may include, (without limitation) the following:

1. Status Indications
 - i. generator circuit breaker open/closed;
 - ii. remote generator control on/off;
 - iii. remote generator control high limit reached;
 - iv. remote generator control low limit reached; and
 - v. generator operating mode;

2. Alarms
 - i. generator circuit breaker tripped by protection;
 - ii. urgent and non-urgent alarms
 - iii. Measured Values
 - iv. Generator active power;
 - v. Generator reactive power;
 - vi. Generator stator/terminal voltage;
 - vii. Generator remote generation control high limit value;
 - viii. Generator remote generation control low limit value; and
 - ix. Generator remote generation control rate limit value.

Such other input information reasonably required by the System Operator.

GC 7.2 Remote Control

The System Operator may require the generator to, within a reasonable time after giving notice in writing: (a) install remote control equipment ("RCE") that is adequate to enable the System Operator to remotely control:

- i. the active power output of any generator; and
- ii. the reactive power output of any generator; and

Any RCE already installed in a power station to be upgraded, modified or replaced, by notice in writing to the relevant generator provided that the existing RCE is, in the reasonable opinion of the System Operator, no longer fit for its intended purpose.

Unless agreed otherwise, the relevant generator will be responsible for the following actions at the request of the System Operator:

- i. activating and de-activating RCE installed in relation to any generator; and
- ii. setting the minimum and maximum levels to which, and a maximum rate at which, the System Operator will be able to adjust the performance of any generator using RCE.

GC 7.2.1 Communications Equipment

Generator shall provide electricity supplies for RME and RCE installed in relation to his generators capable of keeping such equipment available for at least eight hours following total loss of supply at the Point of Common Coupling for the relevant generator.

Generator shall provide communications paths (with appropriate redundancy) from the RME or RCE installed at any of his generators to a communications interface in a location reasonably acceptable to JPS at the relevant power station or generation control centre.

The Generator shall provide, the telecommunications equipment as specified in Schedule 5 of the Generation Code. The selection and installation of items to be provided by the Generator in accordance with the prior written approval of JPS, which approval shall not be unreasonably conditioned, withheld or delayed.

GC 7.2.2 Governor System

Each generator shall have a governor system which includes facilities for both speed and load control except where approved by the System Operator.

Outlined below are the operating characteristics of the speed governor system of each generator, with regards to their **Power Frequency Response** curve of Transmission Code 6.1 (curve to be relocated to main document of Transmission Code). The power and frequency ranges of which will be set by JPS for each generator.

Generator shall normally operate each generator in a mode (e.g. “boiler-follow” or “load control” mode for thermal units) in which it will respond with a change in loading for changes in power system frequency according to the performance requirements set out in the following paragraphs.

The generator shall notify the System Operator whenever any generator is operated in a mode (e.g. “turbine-follow” mode) where the generator is unable to respond as set out in the following paragraphs.

Overall response of a generator for system frequency excursions shall be settable and be capable of achieving an increase in the generator's active power output of 2 % per 0.1 Hz reduction in system frequency for any initial output up to 85% of rated output and a reduction in the generator's active power output of 2% per 0.1 Hz increase in system frequency provided the latter does not require operation below technical minimum. For initial outputs above 85% of rated output response capability shall be able to achieve a linear reduction in response down to zero response at rated output, and the generator shall use reasonable endeavours to ensure that the generator responds in accordance with this requirement.

The Generators shall be capable of achieving an increase in output of at least 5% of their rating for operation below 85% of output. For operation above 85% of rated load, the required increase will be reduced linearly with generator output from 5% to zero at rated load. The generator will not be required to increase output above rated load. Generators shall be capable of achieving a decrease in output of at least 10% of their rating for operation at all levels above their technical minimum loading level as advised in the registered bid and offer data.

The dead band of a generator (being the sum of the increase and the decrease in system frequency before a measurable change in the generator's active power output occurs) shall be less than 0.1 Hz.

The frequency response and deadband values may be varied by the generator with the approval of the JPS under the connection agreement.

For any frequency disturbance a generator shall achieve at least 90% of the maximum response to power generation expected according to the droop characteristic within 60 seconds and the new output shall be sustained for 30 seconds.

When a generator is operating in a mode such that it is insensitive to frequency variations (including pressure control or turbine follower for a thermal generator), the generator shall apply a deadband of not greater than 0.25 Hz to ensure that the generator will respond for frequency excursions outside the normal operating frequency band.

Generator shall adjust the governor system of a generator to ensure stable performance under all operating conditions with adequate damping. The criterion

for adequate damping is that following a step change in the governor speed feedback signal the load transient oscillations have a minimum damping ratio of 0.4 and the steady state response is within plus or minus 20 per cent of the ideal response having regard to loading rates and deadband.

The generator shall advise JPS of data regarding the structure and parameter settings of all components of the governor control equipment, including the speed/load operator, actuators (for example hydraulic valve positioning systems), valve flow characteristics, limiters, valve operating sequences and steam tables for steam turbine (as appropriate) in sufficient detail to enable the JPS to characterise the dynamic response of these components for short and long term simulation studies. These data shall include a control block diagram in suitable form and proposed settings for the governor system for all expected modes of governor operation.

These parameter settings shall not be varied without prior approval of the JPS.

GC 7.2.3 Voltage Support

JPS has the responsibility to monitor and control the system voltages. Therefore, JPS may issue a new voltage set-point to the Generator concerning scheduled voltage support requests. JPS will maintain a performance log for all Generators acknowledgments of such requests and a response is deemed provided that it is completed within five (5) minutes of the issuance of such request.

Generator shall ensure that the excitation control system of a synchronous generator is capable of:

- a. limiting generator operation at all load levels to within generator capabilities for continuous operation;
- b. controlling generator excitation to maintain the short-time average generator stator voltage at highest rated level which shall be at least 5% above the nominal stator voltage (and is usually 10% above the nominal stator voltage);
- c. maintaining adequate generator stability under all operating conditions including providing power system stabilising action if fitted with a power system stabiliser; providing five second ceiling excitation voltage at least twice the excitation voltage required to achieve maximum continuous rating at nominal voltage; and
- d. unless otherwise agreed by the JPS, providing reactive current compensation settable for boost or droop. Generator shall ensure that each new synchronous generator is fitted with a fast acting excitation control system utilising modern technology. Each excitation control system shall provide voltage regulation to within 0.5% of the selected setpoint value.

Each synchronous generator shall incorporate a power system stabiliser circuit which modulates generator field voltage in response to changes in power output

and/or shaft speed and/or any other equivalent input signal approved by the System Operator except where specifically advised by the System Operator that a power system stabiliser is not required. The stabilising circuit shall be responsive and adjustable over a frequency range which shall include frequencies from 0.1 Hz to 2.5 Hz.

A minimum performance requirement that shall be established by JPS for each for generators which have an a.c. exciter, rotating rectifier or static excitation system, in accordance with acceptable international standards such as the IEEE and IEC, with consideration given to:

1. One per unit is that field voltage required to produce nominal voltage on the air gap line of the generator open circuit characteristic (Refer IEEE Standard 115-1983 - Test Procedures for Synchronous Machines).
2. Rated field voltage is that voltage required to give nominal generator terminal voltage when the generator is operating at its maximum continuous rating. Rise time is defined as the time taken for the field voltage to rise from 10% to 90% of the increment value.
3. Negative field current is not required.

The Generator shall obtain the prior approval of the JPS for the structure and parameter settings of all components of the generator excitation control system, including the voltage regulator, power system stabiliser, power amplifiers and all excitation limiters.

The Generator shall not change, correct or adjust the structure and settings of the excitation control system in any manner without prior written notification to JPS. The JPS may then require the Generator to conduct generator tests to ensure compliance with previous test and standards. JPS shall have the opportunity to witness these tests, if wishes to do so.

The System Operator may require the Generator to alter generator excitation control system settings from time to time. The cost of altering the settings and verifying subsequent performance shall be borne by the Generator, provided alterations are not made more than once in each 18 months for each generator. If more frequent changes are requested the person making that request shall pay all costs on that occasion.

Excitation limiters shall be provided by the Generator on each generator for under excitation and over excitation where the generator has over or under excitation protection which can trip the generator and may be provided for voltage to frequency ratio. Each generator shall be capable of stable operation for indefinite periods while under the control of any excitation limiter. The Generator shall

ensure that excitation limiters do not detract from the performance of any stabilising circuits and that they have settings applied which are co-ordinated with all protection systems.

GC 7.2.4 LVRT/HVRT

LVRT and HVRT monitoring at the Interconnection Point shall be enforced by the System Operator through on site disturbance recording. For verification of the behaviour of the VRPP plant with installed Active Power equal to or above 10 MW in the case of real voltage dips or voltage swells, a disturbance recorder must be installed at the Interconnection Point of the VRPP plant. The aim of this monitoring/recording is to ensure that the VRPP units behave in the same manner as shown in the VRPP simulations and/or tests, and meet the Transmission Code for LVRT and HVRT.

After a real event (voltage dip or voltage swell), the behaviour of the VRPP plant may be checked by JPS for compliance based on the measurements available from the recording unit.

GC 7.2.5 Generation Dispatch and Shutdown Signal

JPS reserves the right to send dispatch instructions to VRPPs, via phone or SCADA as per the VRPP's SCADA signals list, to reduce its output due to system reliability.

In the event that JPS is required to shut down and disconnect a VRPP from the JPS Transmission System:

On-Line VRPPs must be able to commence their shutdown sequence within five (5) minutes of receipt of a Dispatch Instruction from JPS. The shutdown sequence shall be completed as soon as practical, but no longer than ten (10) minutes from the receipt of a Dispatch Instruction from JPS.

If the JPS Transmission System condition requires breaker or switch operations to disconnect a non-MW producing VRPP from the system, the disconnection shall be completed as soon as practical, but no longer than ten (10) minutes from the receipt of a Dispatch Instruction from JPS. Once disconnected from the JPS Transmission System, a VRPP shall wait for instructions from System Control Center before reconnecting the system to the network. The VRPP shall complete as soon as practical, but no longer than ten (10) minutes, the required switching to return the system to a normal configuration after receiving the new Dispatch Signal from JPS to do so.

After providing prior notice to JPS, a VRPP plant may disconnect from the Transmission System at any time, if reasonable and practical, in the case that the condition or manner of operation of the JPS Transmission System poses an immediate threat of injury or material damage to any person or equipment of the VRPP Units and/or project substation.

GC 7.2.6 Additional Monitoring and Control Requirements for VRPPs

In addition to the above where applicable, the following meteorological data will be required for wind and solar PV plants:

- a. Wind Speed
- b. Wind Direction
- c. Air Temperature
- d. Air Pressure
- e. Solar Irradiance

GC 8 UNFORESEEN CIRCUMSTANCES AND SYSTEM EMERGENCIES

GC 8.1 Unforeseen Circumstances

If circumstances arise which are not addressed by the Code, the System Operator, shall, to the extent practicable in the circumstances, consult promptly and in good faith with all affected Parties in an effort to reach agreement as to the required course of action. If such agreement cannot be reached in the time available the System Operator shall refer the matter to the OUR with a view to determining the course of action to be taken.

Whenever the OUR makes a determination, it shall do so having regard, wherever possible, to the views expressed by the Generators and the System Operator, in any event, to what is reasonable in the circumstances. Each Generator and the System Operator shall comply with the instructions given to it by the OUR as a consequence of such a determination, provided that the instructions are consistent with the technical parameters set out in the Code, the respective Licences and PPAs. The OUR shall promptly refer all unforeseen circumstances and any determinations to the Generation Code Review Panel for consideration.

GC 8.2 Force Majeure

All Parties should note that the provisions of the Code may be suspended in whole, or in part, pursuant to any directions or orders given by the OUR in situations of

Force Majeure.

GC 9 GENERATION INTERCONNECTION STUDIES

Power system analysis studies shall be conducted by JPS or third party consultant pre-approved by JPS, according to the Study Guidelines outlined in the Transmission Code and using a suitable power system software such as PSS/E and DigSILENT. The final results and the used models, including the validated user model have to be handed over to the System. The studies must demonstrate the capability of the plant to meet all the grid code requirements outlined in this chapter. The Plant model shall comprise all facilities necessary for the generation of power from the Generator(s) to be integrated in the system model.

The following power system studies are to be conducted:

- Load Flow Studies
- Short Circuit Studies
- Transient Stability Studies
- Steady-State Stability Analysis
- Voltage Stability Analysis

In addition to the above and due to the intermittent nature of the VRPP, additional power system studies as outline below but not limited to should be done:

- Voltage Flicker
- Harmonic Analysis
- Phase Imbalance
- Medium and Long Term Stability Study or Quasi Dynamic analysis

In addition, the VRPP is required to provide at a minimum the data required in Schedule.

GC 10 NOTICES

Notices and Communique relating to the Code should be directed to the following contact details:

Entity	Contact	Address	Phone	Fax	Email
OUR					
JPS					
JEP					
JPPC					
Jamalco					
Wigton Windfarm					
Jamaica Broilers					
West Kingston Power Partners					
Small Generators Nominee (<15 MW)					

APPENDIX A
Schedules to Generation Code

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SCHEDULE A: REQUIRED COMMUNICATION EQUIPMENT

The Communication Systems used for System Operations are in two basic forms –VHF Radio for general operational communications (including mobile units), and a point-to-point telephone system for Substations and Generating Stations operation. For switching operations, the primary form of communication is radio while the secondary communication is telephone. For all other operations, telephone is the primary form of communication and radio is the secondary form. Proper use of these facilities is described in detail in the Grid Operator’s Policies and Procedures Manual for System Operation. However the following principles are especially noteworthy:

The VHF radio system should be operated in accordance with stipulated protocols.

Transmitter/receiver sets are located at all District offices, Power Stations, major Substations and in the Generator’s Operating vehicles

Communication equipment should be properly maintained and any malfunction of such equipment be reported to System control promptly

In the event of loss of communication (including Public Telephone facilities) between a generating station and System Control, the Generator’s management must assume full direction and control of the Station. All actions taken and their corresponding times must be logged and reported to system control as soon as communication is restored. In any such event the first priority is safety and then system integrity. The Generator shall not change the operations and shall maintain the last dispatch while maintaining safety.

SUPERVISORY CONTROL AND DATA ACQUISITION

The Supervisory Control And Data Acquisition (SCADA) System is currently used to monitor and record status and analogue values at relevant data collection points throughout the system. Required points for monitoring include circuit breakers, switches, potential transformers and current transformers.

The SCADA system performs constant scanning of all data points and logs a status update every two seconds, unless a significant non-transient change occurs that results in a monitored value exceeding its predefined limits, in which case the resolution of the data recorded is in milliseconds. It is therefore necessary that the monitoring/control devices

installed at the Generating Station be capable of sub second response to a degree equal to or better than that of the System's SCADA equipment.

REQUIRED COMMUNICATION EQUIPMENT

Each Generator shall install and maintain at each Generating Station at its sole cost and expense:

- i) Compatible Remote Terminal Units ("RTUs") to allow interfacing of SCADA status and analog signals from the generating station to the centralized SCADA system at system control, specifically transmitting:
 - a) Three phase values of watts, vars, voltage, and current as well as busbar frequency
 - b) Status (open, closed) of the relevant circuit breakers
- ii) Adequate Power Line Carrier Channels to System Control Centre for the purpose of tele-metering, protection and telecommunications.
- iii) An extension of System Control Centre PBX System in the Generating Units control room to facilitate (hotline) voice communication between the Generator control room and System Control Centre.
- iv) Telecommunications facilities such as Internet and landline telephones in the Generating Units control room to transmit and receive telecopies/facsimiles and electronic mail to and from System Control Centre respectively.
- v) UHF and VHF radio equipment to permit voice communication between the Generating Unit control room and System Control Centre.
- vi) Microwave equipment to transmit data to System Control Centre.
- vii) A synchronized digital GPS Clock to allow time stamping of all analog and status communications especially those logged by the Sequence of Events recorder.

SCHEDULE B: LOAD SHEDDING SCHEME

CURRENT SETTING OF UNDER-FREQUENCY RELAYS

The Under-Frequency Relay set points as at the date of this document are as follows:

Stage	Under-Frequency Relay Setting
0	49.35
1	49.2
2	48.9
3	48.5
4	48.1

SCHEDULE C: RESERVE MARGIN POLICY

SPINNING RESERVE POLICY:

SYSTEM OPERATION POLICIES AND PROCEDURES

CLIENT: JAMAICA PUBLIC SERVICE COMPANY LIMITED

Ref. No. 8 Page: 1 of 1

SUBJECT: OPERATING SPINNING RESERVE POLICY

Effective Date: _____

	Responsibility	Reference		
<p>The following details the company's spinning reserve policy.</p> <p>A minimum spinning reserve capacity of 30 MW should be planned to meet the daily system demand.</p> <p>Consistent with the above policy, the following measures should be adopted:</p> <p>a) The Old Harbour units (OH2, OH3, OH4) and Hunts Bay B6 steam unit are to be limited to a maximum of 85% of their Maximum Continuous Rating (MCR). The difference between the reserve allocated by the above restrictions and the stipulated 30 MW operating spinning reserve is to be allocated across the system by means of an economic optimization process.</p> <p>b) Under normal circumstances a gas turbine should not be started with the spinning reserve above 30 MW. However, if the margin should fall below 30 MW, a gas turbine can be used to assist in maintaining a margin of spare plant.</p> <p>c) Gas Turbines should be used for quick load restoration following operation of under frequency relays. (At least two of the non-derivative GTs (GTs 6, 7, 8, 9, 11) should be on reserve standby for this purpose, unless they are required to meet the demand.</p> <p>d) No single generator should be allowed to carry more than 27.7% of the total demand. This is in keeping with the system overload protection of 33%. Provisions for this is made in the ELD programme.</p>	<p>Operation Planning Engineer</p> <p>System Control Engineer</p> <p>System Control Engineer</p> <p>System Control Engineer/Logan Operations Manager</p> <p>Operations Planning Engineer/System Control Engineer</p>	<p>Section 7.2</p>		
<p>Approved By <i>Ricardo Case</i></p> <p>4/09/05</p>	<p>Status Active</p>	<p>First Effective Dec 2006</p>	<p>Supersedes Apr 03</p>	<p>Reviewed By Ricardo Case</p>

SCHEDULE D: EXISTING GENERATING SYSTEM

Unit	Capacity (MW)	Technology	Fuel Type	Location	Remarks
RF#1	20.0	Slow Speed Diesel	HFO	Rockfort	
RF#2	20.0	Slow Speed Diesel	HFO	Rockfort	
OH#1	30.0	Steam	HFO	Old Harbour	Out of service
OH#2	60.0	Steam	HFO	Old Harbour	
OH#3	65.0	Steam	HFO	Old Harbour	
OH#4	68.5	Steam	HFO	Old Harbour	
HB#B6	68.5	Steam	HFO	Hunt's Bay	
GT#5	21.5	ADO Fired Gas Turbine	ADO	Hunt's Bay	
GT#10	32.5	ADO Fired Gas Turbine	ADO	Hunt's Bay	
GT#3	21.5	ADO Fired Gas Turbine	ADO	Bogue	
GT#6	14.0	ADO Fired Gas Turbine	ADO	Bogue	
GT#7	14.0	ADO Fired Gas Turbine	ADO	Bogue	
GT#8	14.0	ADO Fired Gas Turbine	ADO	Bogue	
GT#9	20.0	ADO Fired Gas Turbine	ADO	Bogue	
GT#11	20.0	ADO Fired Gas Turbine	ADO	Bogue	
Bogue Combined Cycle	114.0	ADO-CCGT	ADO	Bogue	
Maggotty	6.0	Run of River Hydro		Maggotty	
Lower White River	4.75	Run of River Hydro		White River	
Upper White River	3.19	Run of River Hydro		White River	
Roaring River	4.05	Run of River Hydro		Roaring River	
Rio Bueno "A"	2.5	Run of River Hydro		Rio Bueno	
Rio Bueno "B"	1.1	Run of River Hydro		Rio Bueno	
Constant Spring Hydro	0.75	Run of River Hydro		Constant Spring	
JPPC - IPP	60.0	Slow Speed Diesel	HFO	Rockfort	
JEP - IPP	124.2	Medium Speed Diesel	HFO	Old Harbour	
WKPP - IPP	65.5	Medium Speed Diesel	HFO	Hunts Bay	
Wigton Wind Farm I	20.7	Wind Turbines		Wigton	Energy only
Wigton Wind Farm II	18.0	Wind Turbines		Wigton	Energy only
Munro College	0.25	Wind Turbine		Munro	
JPS Munro Wind	3.0	Wind Turbines		Munro	
Jamaica Broilers	as-available	Slow Speed Diesel	HFO	Spring Village	
JAMALCO	11.0	Steam - Cogen	HFO	May Pen	
JAMALCO	as-available	Alternative		St Jago, Clarendon	

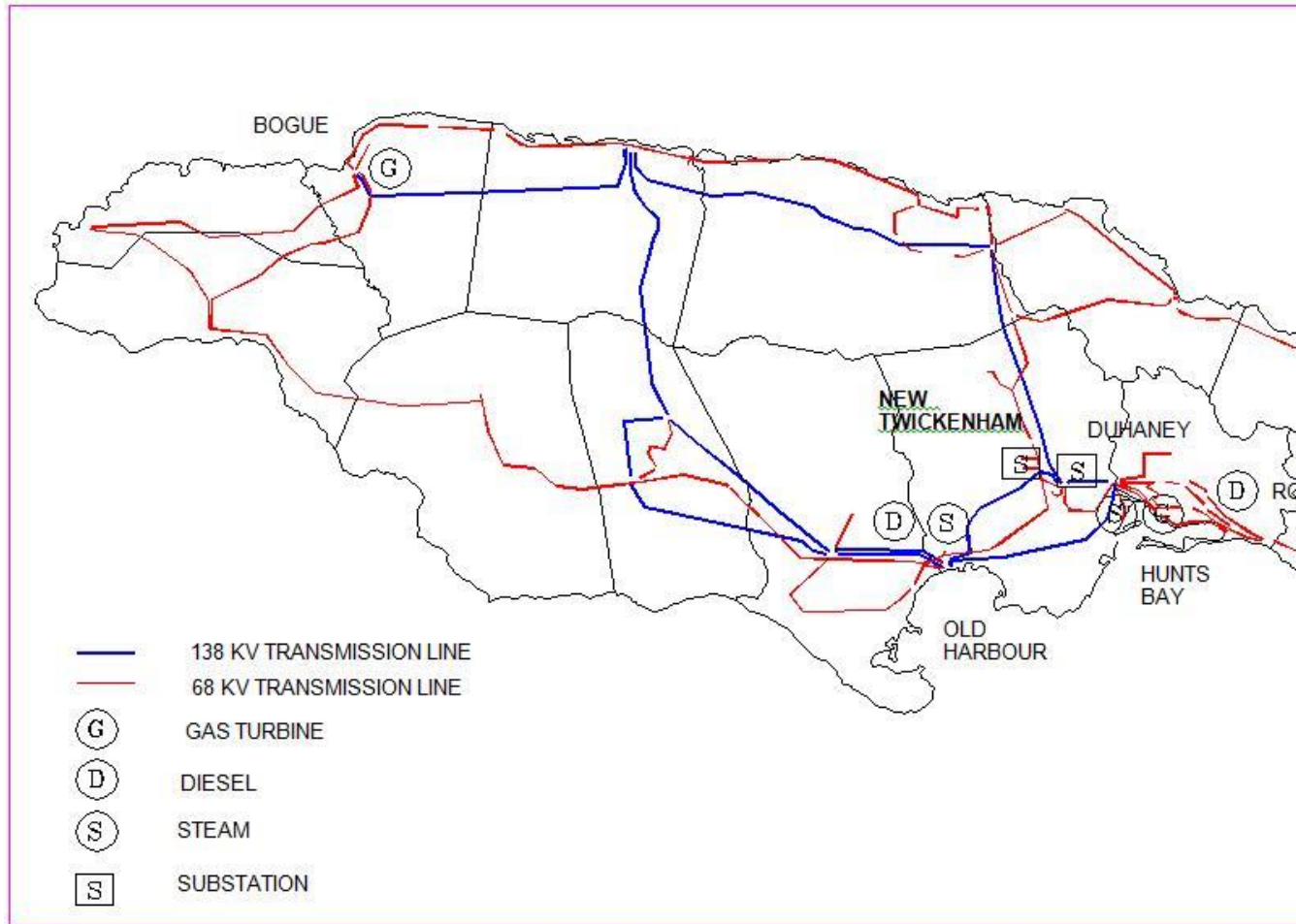
ADO Automotive Diesel Oil
 GT Gas Turbine
 HB Hunts Bay
 HFO Heavy Fuel Oil
 IPP Independent Power Producer
 JEP Jamaica Energy Partners

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JPPC Jamaica Private Power Company
OH Old Harbour
RF Rockfort
WKPP West Kingston Power Partners

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LAYOUT OF JAMAICA'S GENERATION AND TRANSMISSION SYSTEM



SCHEDULE E: GRID OPERATOR INTERCONNECTION CRITERIA

GENERATING UNIT(S) CONNECTED TO THE JAMAICAN TRANSMISSION SYSTEM

	Category	System Operations Criteria/Parameters	Plant/Generator Design Criteria	Comments
Transmission System Security	Interconnection Voltage	Generating Unit(s) at rated capacity >10MW shall be connected to the Transmission system at 69kV or 138kV.		The Grid Operator on basis of System Security and Safety shall determine the interconnection voltage
	Reliability of Generating Unit(s) Grid Connection Points	All substations shall have the capability to disconnect or separate, from the System Grid, any transmission line and/or generating unit that is interconnected to the substation.	Substations (including Generation substations) with more than three (3) transmission lines or generating units shall be of a "breaker and a half configuration".	
	Loss of Generation	For the loss of one transmission element there shall be no loss of generation > 60MW.	The loss of any single transmission element connecting a generating unit(s) shall not result in a loss of generation greater than 60MW. Therefore generation greater than 60MW shall be designed on the N-1 principle.	

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	Category	Operations Mode	Unit	System Operations Criteria/ Parameters	Plant/Generator Design Criteria	Comments
Plant Performance	Frequency	Nominal	Hz	50	Generating plant and auxiliary apparatus shall be designed to operate at this nominal frequency (continuous operation).	Intermittent and type generating maintain active p per the turbine/ power curve cha
		Normal Operating Band	Hz	49.5 – 50.5	Maintain constant Active Power output at any load point. Generating plant and auxiliary apparatus shall be designed to operate in this range.	
		Abnormal	Hz	48.5 – 49.5 50.5 – 52.5	Maintain constant Active Power output at any load point. Plant and Apparatus shall be designed to operate in this range (continuous operation)	Intermittent and type generating define the limitat generating unit(s) criteria for revie by the Grid Oper
			Hz	48.0 – 48.5	Maintain, for at least one (1) second, Active Power within 95% and 100% of output loading levels before abnormal frequencies occurred. Generating plant and auxiliary apparatus shall be designed to operate in this range.	
			Hz	<48.0	Generator trip settings shall be as agreed with the Grid Operator.	
	Voltage	Nominal	KV	69kV or 138kV	Reactive power output shall be fully available under steady state conditions.	
		Normal Operating Band (± nominal kV)	%	± 5%	Reactive power output shall be fully available under steady state conditions (continuous operation). The Generating Unit shall not be affected by voltage changes in this operating band.	Generating plant reactive power s induction genera provide their full power compensation w specified voltage bands (normal a
		Abnormal	%	± 10%	Reactive power output shall be fully available under steady state conditions	

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	Category	Operations Mode	Unit	System Operations Criteria/ Parameters	Plant/Generator Design Criteria	Comments
Voltage Dips (Fault Ride Through Capability)	Abnormal	% of nominal bus kV		10% to 90%	<p>(continuous operation) as per the capability curve of the plant. The Unit(s) and auxiliaries shall not lose synchronism or trip by voltage changes in this operating band.</p> <p>VOLTAGE DIPS OF DURATION ≤ 120ms The generating unit(s) shall remain stable and connected to the system without tripping or losing synchronism for transmission voltage dips less than or equal to 120ms in duration.</p> <p>VOLTAGE DIPS OF DURATION > 120ms For transmission voltage dips occurring due to system disturbances greater than 120ms (6 cycles) in duration the generating unit(s) shall:</p> <p>During Voltage Dip</p> <ol style="list-style-type: none"> 1. Remain transiently stable and connected to the system for at least 1 second without tripping/losing synchronism. 2. Provide Active Power output during voltage dips at least in proportion to the retained balanced voltage at the Interconnection Point. <p>Immediately After Voltage Dip</p> <ol style="list-style-type: none"> 3. Restore Active Power output at the Interconnection Point to 90% of nominal levels (available immediately before the occurrence of the dip) within 1 second of restoration of steady state voltage conditions. That is, within the normal voltage operating band of 69kV ± 5% 	See FIGURE A for Ride Through (L

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	Category	Operations Mode	Unit	System Operations Criteria/ Parameters	Plant/Generator Design Criteria	Comments
	Negative Phase - Sequence Component of phase voltage	Normal	%	<1%	Sustained operation at any load (continuous operation)	
	(Unbalance loading withstand capability)	abnormal	%	≤2%	Sustained operation at any load (continuous operation)	
	Negative Phase - Sequence Component of phase voltage cont'd (Unbalance loading withstand capability)	faults			Generating unit shall withstand, without tripping, the negative phase sequence loading incurred by clearance of a close-up phase-to-phase fault by system back-up protection on the Transmission System.	The Grid Operator relay settings up
	Plant Output	Normal	MW	Rated Generating Unit output shall be provided in the Interconnection or Power Purchase Agreement.	Supply rated Active Power (MW) at any point between limits 0.85 pf lagging and 0.95 pf leading at generator terminals. Reactive power output shall be fully variable between these limits.	Intermittent and type generating maintain Active output as per the turbine/generator characteristics.
	Synchronisation	Normal			<ol style="list-style-type: none"> 1. Synchronise and parallel/load transfer with grid without causing voltage fluctuation at Interconnection Point >±5% of voltage at Interconnection Point. 2. Synchronise to Grid within voltage ±5% of nominal and frequency 50±0.5Hz 	
		Abnormal			Synchronise to Grid within voltage	

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	Category	Operations Mode	Unit	System Operations Criteria/ Parameters	Plant/Generator Design Criteria	Comments
					±10% of nominal and frequency 50±0.5Hz	
Controls	Frequency Control	Normal			<p>Each generating unit shall be capable of contributing to frequency control by continuous modulation of Active Power supplied to the Transmission system.</p> <p>The unit shall be fitted with a fast-acting speed governing system that shall have an overall speed droop characteristic of five (5) percent or less.</p> <p>The speed governor deadband shall be no greater than 0.1 Hz.</p>	<p>Applicable on a C basis for intermi renewable type g plant.</p> <p>The droop settin</p>
	Voltage Control	Normal			<p>Each generating unit shall be capable of contributing to voltage control by continuous changes to the Reactive Power supplied to the Transmission system.</p> <p><u>Automatic Voltage Regulator:</u> Deadband: not exceeding 0.5% Controls: Capability to control voltage continuously between 90% and upper limit of rated voltage of the generator from no load to full load. This range shall be covered linearly in approximately 1 minute.</p>	Applicable on a C basis for intermi renewable type g plant.
	Excitation Control	Normal			<p>Provide Constant Terminal voltage control of the synchronous generating unit without instability over the entire operating range of the unit</p>	Applicable on a C basis for intermi renewable type g plant.
Excitation Control (cont'd)	Normal			<p>Excitation System (Large Signal Response):</p> <p>Voltage Response Time: less than 0.1</p>		

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	Category	Operations Mode	Unit	System Operations Criteria/ Parameters	Plant/Generator Design Criteria	Comments
					second for a voltage step change not to exceed 5% in terminal voltage Ceiling Voltage: minimum 160% of generator rated load field voltage.	
Protection	Generator Protection	Abnormal		Protect against: <ul style="list-style-type: none"> <input type="checkbox"/> Loss of Excitation <input type="checkbox"/> Under Excitation <input type="checkbox"/> Unbalanced Load Operation <input type="checkbox"/> Stator Phase Faults and Earth Faults <input type="checkbox"/> Reverse Power <input type="checkbox"/> Unit Over and Underfrequency <input type="checkbox"/> <u>Thermal Overload</u>: Stator Over Temperature, <input type="checkbox"/> Generator Overspeed <input type="checkbox"/> Restricted Earth Fault 	Meet system protection requirements for all synchronous generating units.	Protection requirements for asynchronous generators reviewed and approved by Grid Operator.
	Generating Unit Step Up Transformer (GSU)			Protect against: <ul style="list-style-type: none"> <input type="checkbox"/> Phase and earth faults (HV and LV) within the GSU zone <input type="checkbox"/> Transformer Tank Sudden pressure, <input type="checkbox"/> Differential Current <input type="checkbox"/> Backup protection if 	Meet system protection requirements for all GSU.	

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	Category	Operations Mode	Unit	System Operations Criteria/ Parameters	Plant/Generator Design Criteria	Comments
				failure of the plant local breaker to operate		
				<ul style="list-style-type: none"> ○ The plant owner to provide breaker fail signal to Grid Operator switchyard 		
	Interconnection Protection	Abnormal		Protect against: <ul style="list-style-type: none"> □ Phase and Earth Faults (tie-lines, bus) □ Failure of Grid Operator (JPS) remote 	Meet system protection requirements at Interconnection Point.	Protective system at the Interconnection shall be designed and tested to achieve sensitivity and successful fault clearing. Re-approved by the (JPS).
				protection to clear grid phase and earth faults (b/up protection) <ul style="list-style-type: none"> ○ Grid Operator (JPS) to provide breaker fail signal to generator owner switchyard □ Failure of plant local breaker to operate (breaker fail) 		

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	Category	Operations Mode	Unit	System Operations Criteria/ Parameters	Plant/Generator Design Criteria	Comments
				protection) oThe generator owner to provide breaker fail signal to Grid Operator (JPS) switchyard		
Fault Clearing Times	Transmission bus (point of grid interconnection)	Maximum time	Milli-seconds (ms)	To be provided in Power Purchase Agreement (PPA) documents. In the absence of the requirement in PPA documents, fault clearing time (from fault inception to arc extinction) shall not be slower than: 69kV – 120ms 138kV – 100 ms	Meet or exceed system fault clearing times. The generating unit shall remain transiently stable and connected to the system without tripping for a close-up solid three phase fault or any unbalanced short circuit fault on the Transmission System up to the maximum total fault clearance time. During the period of the fault the generating unit shall generate maximum reactive current without exceeding the transient rating limit of the generating unit.	
Fault Levels	Transmission bus (point of grid interconnection)		Amps (A)	To be provided in Power Purchase Agreement (PPA) documents.	The maximum fault levels at the grid Interconnection Point shall be below 80% of the interrupting capacity of substation and plant apparatus determined using generator transient impedances.	

The owner of the Generating Unit(s) is required to submit to the Grid Operator all Generating Unit and G Up (GSU) transformer parameters upon completion of plant, apparatus and equipment designs.