OFFICE OF UTILITIES REGULATION
Regulating Utilities for the Benefit of All

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PREPARATION AND PROMULGATION OF ELECTRICITY SECTOR CODES

Transmission Code

Work Shop 2

WEDNESDAY JULY 20, 2016

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Contents

1. BACKGROUND

Electricity Codes - original documents

- Electricity Generation Code 2013 - currently in use (promulgated and implemented by the OUR)
- DRAFT JPS Distribution Code V1 - 2011 Sept 9 Final - Not Promulgated
- DRAFT JPS Transmission Code V1 2011 Sept 9 Final - Not Promulgated

http://www.our.org.jm/ourweb/sectors/electricity-codes-original-documents

DRAFT of New Electricity Code Book - 2016 July 13

- Introduction - Electricity Code Book OUR - CARCEP Rev02A - 2016 July 13 draft
- Dispatch Code Book OUR - CARCEP Rev_02A - 2016 July 13 draft
- Distribution Code OUR - CARCEP rev02A 2016 July 13 draft
- Generation Code Book OUR - CARCEP Rev02A - 2016 July 13 draft
- Electricity Sector Supply Code OUR - CARCEP Comments Rev02A - 2016 July 13 draft
- Transmission Code Book OUR - CARCEP comments Rev02A - 2016 July 13 draft

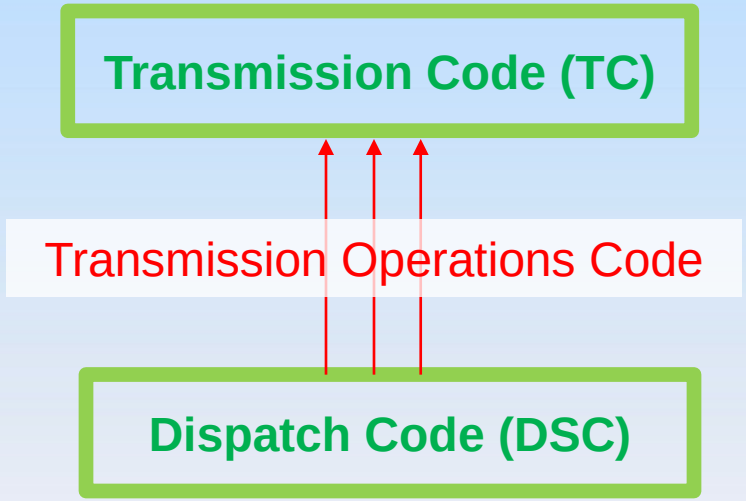
http://www.our.org.jm/ourweb/sectors/draft-new-electricity-code-book-2016-july-13

2. TC - Code Migration

Original September 9, 2011 Transmission Code	New Draft July 13, 2016 Jamaica Electric Utility Sector Grid Code Chapters
TGD : Transmission Glossary and Definitions TGC : Transmission General Conditions	Introduction to Book of Codes
TPC : Transmission Planning Code TCC: Transmission Connection Code TMC: Transmission Metering Code	Transmission Code (TC)
TOC: Transmission Operations Code TDRG: Transmission Data Registration Code	Dispatch Code (DSC)

2. TC - Code Migration cont'd

New Draft July 13, 2016
Jamaica Electric Utility Sector
Grid Code Chapters



3. TC Code Additions

TC 9 METHOD OF CONNECTION

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TC 9.2 **Variable Renewable Power Plant Connection Condition**

- TC 9.2.1 VRPP Automatic Voltage Regulation (AVR) & Fast Voltage Control
- TC 9.2.2 VRPP Grid Connected Transformer Configuration
- TC 9.2.3 VRPP Reactive Power Requirements
- TC 9.2.4 Voltage Flicker
- TC 9.2.5 VRPP Harmonic Distortion
- TC 9.2.6 VRPP Phase Imbalance & Negative Sequence Handling
- TC 9.2.7 VRPP Data Requirements& Studies
- TC 9.2.8 VRPP Resource Forecasts
- TC 9.2.9 VRPP Signals, Communications and Controls

Generation Specific

TC 4 TRANSMISSION SYSTEM SECURITY STANDARDS

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TC 4.4 Load Power Factor
TC 4.5 Thermal Loadings
TC 4.6 Spinning Reserve
TC 4.7 Fault Levels
TC 4.8 Frequency Criteria

- TC 4.8.2 Generator Frequency Requirements
- TC 4.8.3 Generator Governor – Primary Frequency Response (PFR)

Generation Specific

TC 4.9 Network Stability
TC 4.10 Transmission System Resiliency

TC 3 – LONG-TERM TRANSMISSION NETWORK PLANNING

3a. VRPP Connection Condition - AVR

TC 9.2 **Variable Renewable Power Plant Connection Condition**

TC 9.2.1 VRPP Automatic Voltage Regulation (AVR) & Fast Voltage Control

VRPP must be capable of operating in a voltage control mode to maintain the voltage at the Point of Interconnection to stay at a set point provided by SYSTEM OPERATOR to the VRPP. The voltage setting requirement shall be within the normal operating range of the system (+/- 10% of nominal). The following is a guideline of possible specifications of the AVR, however SYSTEM OPERATOR will dictate the specifications to the VRPP based on their technology and location.

VRPP must respond to a sudden voltage decrease/increase with the corresponding fast positive sequence fundamental frequency reactive current output controllers. However, to fulfil these requirements at the Point of Interconnection, is at the discretion of the System operator and based on the appropriate system studies whether other VAr equipment like STATCOM close to the Point of Interconnection are installed for VAr generation with fast voltage control of dynamic nature.

3a. VRPP Connection Condition - Transformer

TC 9.2 **Variable Renewable Power Plant Connection Condition**

TC 9.2.2 VRPP Grid Connected Transformer Configuration

VRPPs shall provide on-load tap-changing (OLTC) facilities the VRPP Plant central Grid Connected power transformer. All VRPPs shall coordinate with JPS on the design specification for the performance of the tap-changing facility of the Grid Connected Transformer.

The VRPP Grid Connected Transformers connection configuration must be pre- approved in writing by JPS.

Tap changing steps shall be proposed to JPS and pre-approved for the project, and shall be designed to ensure that the VRPP units can comply with section TC 6 of the TC requirements.

3a. VRPP Connection Condition -VAr Support

TC 9.2 **Variable Renewable Power Plant Connection Condition**

TC 9.2.3 VRPP Reactive Power Requirements

It must be possible to operate the VRPP plant in reactive power control mode, and follow any operating point within the range cos φ = 0.95 leading under-excited (inductive) to cos φ = 0.9 lagging over-excited (capacitive)

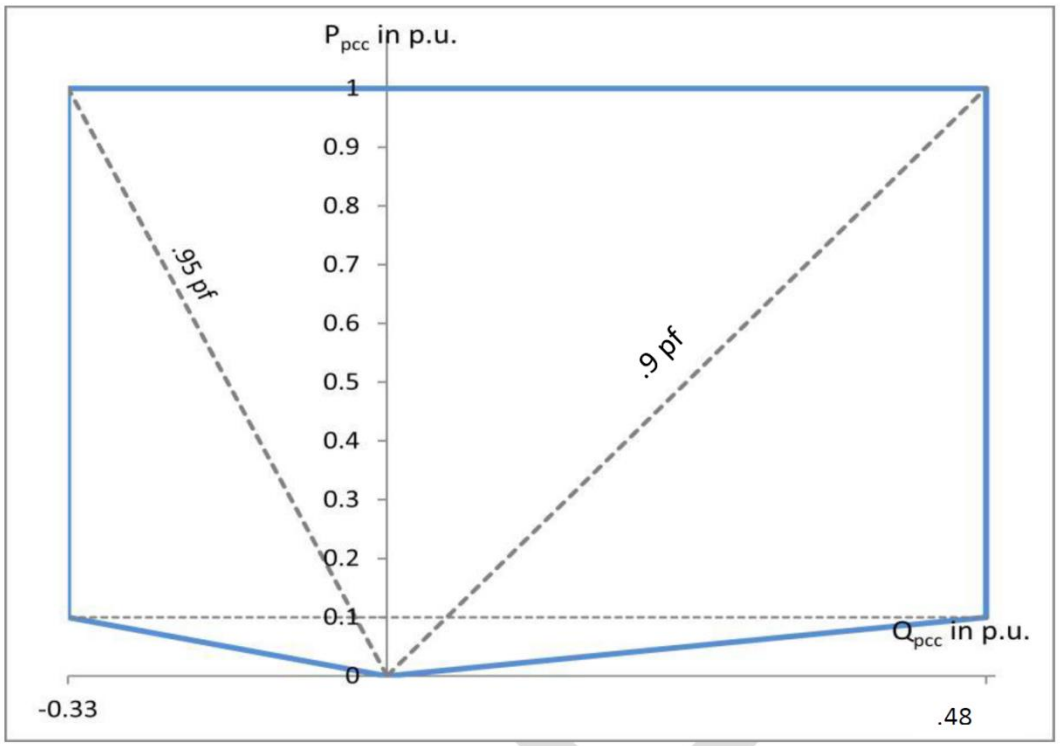


Figure TC 9.2 - Minimum PQ Diagram to be Fulfilled by VRPP plant

Additionally the full lagging reactive capability of 0.9 pf of the VRPP registered capacity (generally being the same as the rated nameplate capacity) shall be made available at 100% to 90% of the nominal voltage. The full leading reactive capability of 0.95 pf of the rated VRPP capacity shall be made available at 100% to 110% of the nominal voltage.

The reactive support must be dynamic in nature for the equivalent of the rated plant (sum of VRPP) capacity, and the rest of the reactive support may be provided by automatically switched capacitors or better at the point of interconnection.

3a. VRPP Connection Condition – Flicker, Harmonics

TC 9.2 **Variable Renewable Power Plant Connection Condition**

TC 9.2.4 Voltage Flicker

Voltage Flicker is the rapid change in voltage that distorts or interferes with the normal sinusoidal voltage waveform of the Transmission Network.

VRPPs are not allowed to introduce significant Voltage Flicker on the Transmission Network as measured at the Point of Interconnection. In setting and analyzing Voltage Flicker limits, the appropriate standards should be applied.

TC 9.2 **Variable Renewable Power Plant Connection Condition**

TC 9.2.5 VRPP Harmonic Distortion

Table TC 9.2 –Total Harmonic Voltage Distortions

Voltage Level	Acceptable Voltage Harmonic Distortion Levels
69 kV	a Total Harmonic Distortion of 6.5% with no individual harmonic greater than 5%
138 kV and higher	a Total Harmonic Distortion of 2% with no individual harmonic greater than 1.5%

3a. VRPP Connection Condition - Forecast

TC 9.2 **Variable Renewable Power Plant Connection Condition**

TC 9.2.8 VRPP Resource Forecasts

Resource forecasts shall be provided by the VRPP. These forecasts, if required, shall be provided in a format and timescale as specified by JPS, and by means of an electronic interface in accordance with the reasonable requirements of JPS's data system.

JPS may also require, and VRPP accommodate, that forecasting be provided through one central forecasting provider of JPS choice in order to improve the quality of the forecast.

VRPPs shall engage fully with JPS to ensure that the necessary information is available to JPS for the production of wind or solar generation forecasts with the appropriate level of accuracy by JPS.

i. VRPPs shall submit their MW availability declarations whenever changes in VRPP availability occur or are predicted to occur. These declarations shall be submitted by means of an electronic interface in accordance with the reasonable requirements of JPS's data system.

From GC:

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.

3b. System Security – Generator PFR requirement

TC 4 TRANSMISSION SYSTEM SECURITY STANDARDS

TC 4.8.3 Generator Governor – Primary Frequency Response (PFR)

In Primary Frequency Response mode, the PFR control system shall have the capabilities as displayed in the Power-Frequency Response Curve below, where the power and frequency ranges required for points A, B, C, D, and E shall be defined by JPS.

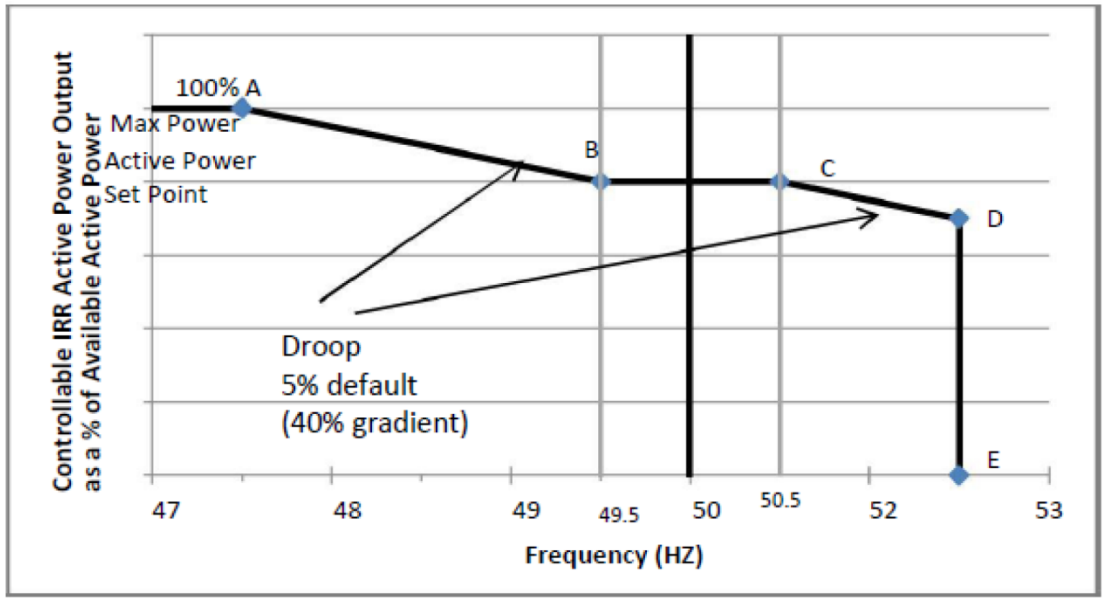


Figure TC 4.8.1 –Curve 1 Power-Frequency Response Curve

…the power and frequency ranges required for points A, B, C, D, and E shall be defined by JPS.

All GENERATORs in operation must reduce their instantaneous active power output when the system frequency is more than 50.03 Hz as shown.

Points A, B, C, D and E depend on a combination of the Transmission System Frequency, Active Power and Active Power Control Set-point settings, and may be different for each GENERATOR depending on system conditions and GENERATOR location. Points

4. TC- Transmission Planning

TC 3 – LONG-TERM TRANSMISSION NETWORK PLANNING

TC 4 – Transmission System Security Standards

TC 5 – Planning Procedures

TC 6 – Data Requirements

Notes:

- Long-Term Transmission Network Planning is New.
- Transmission Operations Planning Code will likely be migrated in back to TC from Dispatch Code
- Refer Generation Interconnection Studies to Planning

4. TC - Long Term Transmission Network Planning

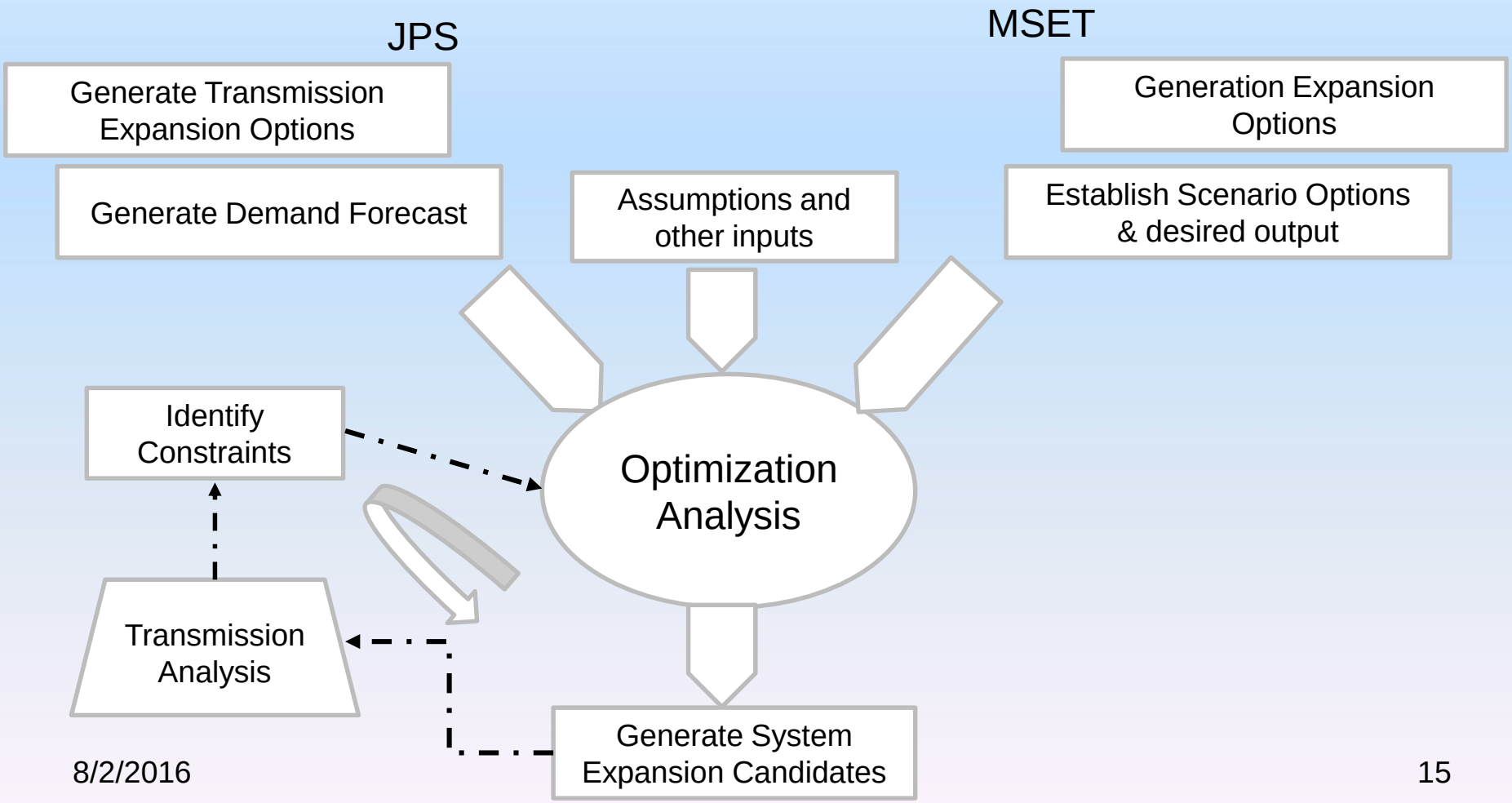
The EA section 7 provides that the Minister shall be responsible for planning the development of the system, which planning shall include:

(a) integrated resource planning;
(b) the collection of data from electricity sector participants;
(c) consultations with the Office, the Single Buyer and other electricity sector participants; and
(c) the conduct of any relevant forecast.

This provision further requires that the planning process for transmission and distribution, consider the location of renewable and other generation sources, taking into account the potential for electrification of rural areas. The provision also requires that all *License* holders must comply with a request made by the Minister for information for the purposes of executing his planning responsibility under this section and failure to comply with a request under this subsection, without reasonable cause, shall be an offence.

4. TC - Long Term Transmission Network Planning

Hypothetical Simplified partial activity



5. Future rule on Net Billing, Power Wheeling & Auxiliary Interconnections

Once the rule is issued, TC must be revised to support the integration of the programs (through Grid Code Review Panel)

- Data registration, recording and communication providing transparency to Transmission
- Integration of impact of programs on Transmission Operation Planning
- Establish process for periodic evaluation of programs

6. Key Issues, Next Steps

Incorporate migration of transmission related operational planning from Dispatch Code
Incorporate Input from Stakeholders. Recommend that Stakeholders review the new code additions, and review the planning sections
Consider consolidating Transmission Planning under one singe section. Same for Transmission Connection
Consolidate generation connection technical and performance requirements between Transmission, Distribution, and Generation
Planning Code – awaiting revisions: -Include MSET input on Long Term Transmission Planning -Include Transmission Operations Planning code -Include placeholder for transmission constrained economic analysis for System Operator Planning -Ensure Code coordinates folding Generation Interconnection Studies into Transmission Planning, and addresses study of full impact on system cost
Validate that all definitions and acronyms are defined and consistent with the rest of GC; review all references to code, sections and tables, numbering and captions. Insert TOC, page numbers, Appendices.

7. Takeaways

AT THE HEEL OF THE GRID CODE- RECOMMENDATIONS:

Develop Interconnection Procedures for Generators at the Transmission Level
Standardize data forms for generator interconnection applications
Develop detailed protocols on IRP process: data requirements and submittal from stakeholders to MSET, verification of assumptions, iterations between MSET and stakeholders to arrive at optimal plans, protocols on adoption of the plan, triggers for restudy, deviation from plan etc.
Recommend MSET and JPS procure the same software tool for Generation and Transmission System Expansion optimization
Develop code to establish transparency of distribution system user data to transmission system operation and planning (historical data, real time data)

END