



Working to Perfect the Flow of Energy

PJM Manual 21

Rules and Procedures for Determination of Generating Capability

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Prepared by

System Planning Department

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PJM Manual 21

**Rules and Procedures for Determination of
Generating Capability**

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Approval

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Thomas Falin, Manager

Resource Adequacy Planning

Revision History

Revision 09 (05/01/2010)

Added requirement to document cases where unit winter ratings are less than summer ratings.

Clarified language regarding correction of observed test data to rated site ambient conditions.

Changes to Appendix B to specify that, in the calculation of an intermittent resource's capacity value, any hours during which PJM directed the resource to reduce its output are excluded.

Introduction

Welcome to the ***PJM Manual for Rules and Procedures for Determination of Generating Capability***. In this Introduction, you will find the following information:

- What you can expect from the PJM Manuals in general (see “*About PJM Manuals*”).
- What you can expect from this PJM Manual (see “*About This Manual*”).
- How to use this manual (see “Using This Manual”)

About PJM Manuals

The PJM Manuals are the instructions, rules, procedures, and guidelines established by the PJM for the operation, planning, and accounting requirements of the PJM and the PJM Energy Market. The manuals are grouped under the following categories:

- Transmission
- PJM Energy Market
- Generation and transmission interconnection
- Reserve
- Accounting and Billing
- PJM administrative services
- Miscellaneous

For a complete list of all PJM Manuals, go to www.pjm.com and select “Manuals” under the “Documents” pull-down menu.

About This Manual

Purpose

The ***PJM Manual for Rules and Procedures for Determination of Generating Capability*** is one of a series of manuals within the Reserve group of manuals. These rules and procedures for determining the capability of generating units on the systems of the PJM Interconnection have been adopted to provide uniformity for planning, operating, accounting and reporting purposes, and have been designed to meet the following requirement in the coordinated operation of the PJM Interconnection:

- Net Capability of generating units installed in, scheduled for installation in or transacted into the PJM Control Area is required for planning and reporting purposes and for use in accounting for deficiencies of a Party to obligations under the Operating and Reliability Assurance Agreements of PJM.

The rules and procedures recognize the difference in types of generating units involved as resources within the PJM Installed Capacity processes and the relative ability of units to maintain output at stated capability over a specified period of time. Factors affecting such ability include fuel availability, stream flow for hydro units, reservoir storage for hydro and pumped storage units, mechanical limitations, system operating policies.

The ***PJM Manual for Rules and Procedures for Determination of Generating Capability*** consists of the two sections and three attachments. The sections are listed in the table of contents beginning on page ii.

Intended Audience

The intended audiences for the PJM Manual for Rules and Procedures for Determination of Generating Capability are:

- *PJM Board of Managers* - The PJM Board members are responsible for the administration and approval of the forecast obligation and techniques for its determination.
- *PJM Markets and Reliability Committee (MRC)* - Members are responsible for the review and submittal of the obligations to the PJM Board of Managers.
- *PJM Market Implementation Committee (MIC)* – Members initiate and develop proposals to advance and promote competitive wholesale electricity markets in the PJM region for consideration by the Markets and Reliability Committee.
- *PJM Planning Committee* - Members are responsible for reviewing PJM Capacity Adequacy Planning staff recommendations on reserve requirement matters and the parameters used in their determination.
- *PJM Capacity Adequacy Planning Staff* - PJM staff are responsible for the compilation, review and processing of the season capability verification tests as well as the continual collection and review of generating unit event and performance records via the Generating Availability Data System (GADS).
- *PJM Market Services* – PJM Staff are responsible to assess generation resource rating test failure penalties under the RPM process.
- *Parties to Other PJM Agreements* - The staffs of these Parties are responsible for supplying load and generator data in the required format and time period to assist in the calculation and submittal of required quantities.

- *Generator Availability Analyzers* - Industry personnel charged with reviewing and interpreting the impacts of generator unavailability on the reliability and markets of their respective systems.

References

There are several references to other documents that provide background or additional detail. The PJM Manual for ***Rules and Procedures for Determination of Generating Capability*** does not replace any information in these reference documents. The following documents are the primary source of specific requirements and implementation details:

- Amended and Restated Operating Agreement of PJM Interconnection, L.L.C.
- PJM Reliability Assurance Agreement
- PJM Open Access Transmission Tariff (OATT)
- PJM Manual for Pre-Scheduling Operations (M-10)
- PJM Manual for Generator Operational Requirements (M-14D)
- PJM Manual for Load Forecasting and Analysis (M-19)
- PJM Manual for Generator Resource Performance Indices (M-22)
- PJM Manual for Billing (M-29)
- PJM Manual for Definitions and Abbreviations (M-35)
- PJM eGADS User Guide

Section 1: Requirements

1.1 Using This Manual

We believe that explaining concepts is just as important as presenting procedures. This philosophy is reflected in the way we organize the material in this manual. We start each section with an overview. Then we present details, procedures or references to procedures found in other PJM manuals. The following provides an orientation to the manual's structure.

1.2 What You Will Find In This Manual

- A table of contents that lists two levels of subheadings within each of the sections
- An approval page that lists the required approvals and a brief outline of the current revision
- Sections containing the specific guidelines, requirements, or procedures including PJM actions and PJM Member actions
- A section at the end detailing all previous revisions of this PJM Manual

1.3 Installed Capacity (ICAP)

Installed Capacity (ICAP) of a generation resource is defined as the summer net dependable capability of a unit as determined in accordance with **PJM Manual M-21, Rules and Procedures for Determination of Generation Capability**, and within the injection right limits of the bus to which it is connected.

Occasions Requiring Submittal of Verification Test

- A. Seasonal verification tests for all PJM capacity resources are to be submitted for both Summer (June-July-August test period) and Winter (December-January-February test period) seasons.
- B. A previously conducted verification test is to accompany any capacity modification increasing the claimed net dependable capability of a facility.
- C. A previously conducted verification test is to accompany any return of a facility from a "mothballed" state.
- D. A previously conducted verification test is to accompany any existing facility being included in the PJM capacity markets for the first time or returning to the PJM capacity markets after an absence.

- E. Tests for newly constructed units may be conducted after inclusion in the PJM capacity markets but must be completed within 30 days of the start of commercial operation.

Injection Right Limitations

All increases in capability are subject to limitations of injection rights to the bus to which the facility is currently or about to be connected to as verified by the Interconnection Planning Department of the Office of the PJM Interconnection.

Late Data Submittal Charges

1. In accordance with Schedule 6 (Plans to Meet Capacity Obligations), Schedule 12 (Data Submittals) and Schedule 13 (Data Submission Charges) of the Reliability Assurance Agreement, a data submission charge of \$ 500/day can be applied to any data not submitted in accordance with published deadlines. The current deadlines for seasonal verification test result submittal are September 30 for the June-July-August summer test period and March 31 for the December-January-February winter test period.

Impacts of Test Results

1. **Successful Test Result** –A successful test result is one in which the Corrected Net Test Capacity is equal to or greater than the claimed installed capacity for the applicable season.
2. **Failed Test** – A failed test is one in which the Corrected Net Test Capacity is below the claimed installed capacity for the applicable season. This case will result in a forced outage in the amount of the difference between the claimed installed capacity and the Corrected Net Test Capacity being applied to the facility in question retroactive to the beginning of the test period of the seasonal test and lasting until either a) a successful test is conducted, b) a reduction in the claimed installed capacity of the facility, or c) the beginning of the next test period. Examples of the application using the summer test period are:
 - a) A notice of a Capacity Modification (CAPMOD) is received and approved for reducing the Claimed installed capacity of the facility to the Corrected Net Test Capacity effective August 31. A forced outage as described above is entered for the facility from June 1 through August 30 and ended as the CAPMOD begins.
 - b) The beginning of the next test period. No test out-of-period (beyond the June-July-August window) or CAPMOD are received. A forced outage as

described above is applied to the facility from June 1 through November 30 (December 1 begins the winter test period).

3. **Failure to Submit Test** - Failure to submit a seasonal test, unless exempted by GADS support personnel, will result in a full forced outage being applied to the facility in question retroactive to the beginning of the applicable test period and will remain in effect until either a test is conducted or the next test period begins. For example, a facility not submitting a test for the summer period will have a full forced outage applied retroactive to June 1 of the year of the test period through November 30 of that same year (the day before December 1, the beginning of the Winter Test period), unless a test is received prior to December 1. The results of this outage will be applied going forward and no retroactive adjustments to PJM Markets will be made.

Section 2: Net Capability

2.1 General

1. Net Capability shall mean the number of megawatts of electric power which can be delivered by an electric generating unit or station of a system after its date of commercial operation without restriction by the owner under the conditions and criteria specified herein and shall be determined as the gross output of the unit or station less power used for unit auxiliaries and other station use required for electrical generation and any power required to serve host process load.
2. Without restriction means that Net Capability values so determined are available for utilization at the request of the PJM Interconnection Office (IO) for supply of operating capacity and energy before any operating procedures are placed in effect anticipatory to a voltage reduction on the PJM system except as such utilization may at times be limited in duration by water or fuel availability.
3. The determination of the Net Capability of a combined-cycle unit will depend on the structure of the complete unit and its components. The steam turbine and combustion turbines shall adhere to the existing guidelines set forth in this reporting manual. In the case of thermally dependent components, the determination of the Net Capability shall require the operation of both combustion turbine and steam components simultaneously. The output of the components can be netted to determine the combined-cycle unit net capability.
4. The determination of the Net Capability of a steam unit shall recognize the use of any procedures for increasing unit output such as turbine over-pressure, boiler overrating, cycle modification or any others which are normally utilized in operation.
5. The determination of Net Capability for a combustion turbine unit shall be consistent with the owner system policy with respect to maximum outputs.
6. The determination of Net Capability for a hydro or pumped storage unit shall recognize the head available giving proper consideration to operating restrictions and the reservoir storage

program during a normal cycle at the probable time of the PJM peak.

7. The determination of the Net Capability of a nuclear unit shall recognize its nuclear fuel management program and any restrictions (except as noted in 14) imposed by regulatory authority.
8. The Net Capability of a planned steam or combined-cycle unit shall be based on the manufacturer's guarantee or estimate of performance. The Net Capability of a planned combustion turbine or combined-cycle unit shall give recognition to the elevation of the unit location, the type of fuel available for use, and owner system policy with respect to the maximum output. The Net Capability of a planned hydro unit shall be based on the owner system's estimate of head in accordance with 6.
9. After a unit is in operation, its Net Capability shall be based on current operating performance or test results. Both Summer and Winter Net Capability values shall be confirmed annually. If adequate data is available from normal operation to confirm Net Capability values during the seasonal peak period, no test is required. Units for which the foregoing data is not available shall be tested to confirm Summer and Winter Net Capability values. When a known change occurs in the Net Capability of a unit, or is indicated by operating data or test results, it shall become effective as soon as possible except as noted in 13.
10. The Net Capability of a unit shall not be reduced to reflect unplanned deratings or temporary capacity restrictions provided it is the intention of the owner to restore the reduced capability. The time of this restoration may depend on availability of parts and scheduling of the outage required for repairs. If the owner does not intend to restore the reduced capability by the end of the next Delivery Year, a reduced Net Capability value may become effective at the request of the owner. The owner shall make the required changes via the Capacity Modifications (Cap Mod) process of the PJM Capacity Market.
11. All or any part of a unit's capability that can be sustained for a number of hours of continuous operation commensurate with PJM load requirements, specified as 12 hours, shall be considered as unlimited energy capability. All or any part of a unit's capability shall be considered as limited energy capability only for those periods in which it does not meet the foregoing

criteria for sustained operation. Such limited energy capability will be used to meet the energy requirements of PJM and depending on the extent to which it meets these requirements such capability may be reduced as provided in Schedule 9 of the Reliability Assurance Agreement (RAA).

12. Each generation owner shall be responsible for the determination and reporting of Summer and Winter Net Capability values. The first notification is through completion of Attachment N of the Open Access Transmission Tariff (Form of Feasibility Study Agreement) and sending this application to the System Planning Department of PJM. The second notification, if approval is received, is via the Cap Mod procedures of the PJM Capacity Market. The Capacity Adequacy Planning Department of the PJM RTO shall be responsible for the establishment of test procedures required to confirm such values including any amount which could be treated as limited energy capability.
13. The Net Capability reported for a unit following its date of commercial operation shall in no case exceed an amount determined by the owner in accordance with items 1 and 9 above but for PJM accounting purposes may initially be less than that amount. The extent of any such reduction in reported capability may be determined by the company in such manner as will permit the most effective use of its own resources.

2.2 Summer Net Capability

1. The Summer Net Capability of each unit or station shall be based on summer conditions and on the power factor level normally expected for that unit or station at the time of the PJM summer peak load.
2. Summer conditions shall reflect the 50% probability of occurrence (approximated by the mean) of ambient site conditions at the time of the PJM summer peak load. Conditions shall be based on plant records or local weather bureau records of the past 15 years, updated at 5 year intervals. When local weather records are not available, the values shall be estimated from the best data available.
3. For fossil and nuclear steam units, summer conditions shall mean, where applicable, the probable condenser intake water temperature at the time of the PJM summer peak load . Conditions shall include the expected temperature of once-

through or open cooling systems as well as the performance of cooling towers under expected ambient conditions.

4. For combustion turbine units, summer conditions shall mean, where applicable, the probable ambient air temperature and humidity condition experienced at the unit location at the time of the annual summer PJM peak.
5. The determination of the Summer Net Capability of hydro and pumped storage units shall be based on operational data or test results taken once each PJM delivery year at any time during the year. The same operational data or test results can be used for the determination of the Winter Net Capability.
6. For combined-cycle units, summer conditions shall mean where applicable, the probable intake water temperature of once-through or open cooling systems and/or the performance of cooling towers and combustion turbines under expected ambient conditions at the unit location at the time of the annual summer PJM peak.

2.3 Winter Net Capability

1. The Winter Net Capability of each unit or station shall be based on winter conditions and on the power factor level normally expected for that unit or station at the time of the PJM winter peak load. The winter rating shall be equal to or greater than the summer rating unless documentation is supplied to support the exception.
2. Winter conditions shall reflect the 50% probability of occurrence (approximated by the mean) of ambient site conditions at the time of the PJM winter peak load. Conditions shall be based on plant records or local weather bureau records of the past 15 years, updated at 5-year intervals. When local weather records are not available, the values shall be estimated from the best data available.
3. For fossil and nuclear steam units, winter conditions shall mean, where applicable, the probable condenser intake water temperature at the time of the PJM winter peak load. Conditions shall include the expected temperature of once-through or open cooling systems as well as the performance of cooling towers under expected ambient conditions.

4. For combustion turbine units, winter conditions shall mean, where applicable, the probable ambient air temperature and humidity condition experienced at the unit location at the time of the annual winter PJM peak.
5. The determination of the Winter Net Capability of hydro and pumped storage units shall be based on operational data or test results taken once each PJM delivery year at any time during the year. The same operational data or test results can be used for the determination of the Summer Net Capability.
6. For combined-cycle units, winter conditions shall mean where applicable, the probable intake water temperature of once-through or open cooling systems and/or the performance of cooling towers and combustion turbines under expected ambient conditions at the unit location at the time of the annual winter PJM peak.

Appendix A: Net Capability Verification Guidelines

A.1 PURPOSE

These guidelines are to supplement the requirements set forth in the PJM Rules and Procedures For Determination of Generating Capability (Green Book) by setting forth requirements for Net Capability verification, reporting and review of results to assure uniform and consistent compliance.

A. Philosophy of Net Capability Verification

1. Responsibility

- (a.) Generation owners are responsible to comply with these requirements at their own expense
- (b.) Test forms are to be submitted to the Capacity Adequacy Planning Department (CAPD) of the PJM Office of the Interconnection via eGADS system.

2. Exceptions and Deviations.

- (a.) Exceptions to and deviations from these Net Capability verification guidelines shall be by CAPD approval. These exceptions shall be made in writing prior to the end of the test window for known occurrences such as environmental restrictions and fuel limitations.

B. Net Capability Verification

- 1. Net Capability verification is to demonstrate the maximum Net Capability of each unit. If that Net Capability was not demonstrated during the verification window, a reduction or derating in eGADS shall be enacted to account for the deficiency.
- 2. Both Summer and Winter Net Capability shall be confirmed annually during the verification windows that correspond to the seasonal peak periods:
 - (a.) Summer verification window shall be the first day of June through the last day of August.
 - (b.) Winter verification window shall be the first day of December through the last day of February. Alternatively, data used to satisfy the summer net capability test may be

used to satisfy the winter test requirements after adjustment to the appropriate ambient winter conditions.

3. If adequate data is available from normal operation to confirm Net Capability values and to satisfy the reporting requirements during the seasonal verification window, no test is required. Units for which the foregoing data is not available shall be tested to confirm Summer and Winter Net Capability values. A test shall include any unit brought on-line or a unit that is on-line and its mode of operation altered for the specific purpose of capability verification.
4. The duration of verification tests or operational data shall be two (2) hour average for nuclear, fossil steam and combined-cycle units, one (1) hour for hydro, pumped storage, simple cycle combustion turbine, and diesel units.
5. If a unit does not meet its stated Summer or Winter Net Capability due to a temporary condition, that existed prior to the conduct of the test, the deficiency shall be covered by the appropriate outage/reduction(s) from the date of the problem. If a capability deficiency is uncovered during this verification, a reduction covering the deficiency shall be coded retroactive to June 1 or December 1 for summer and winter verification windows, respectively.
6. Net Capability verification is required outside of the verification period when an outage or reduction in eGADS occurred prior to or during the verification period which prevented demonstration of maximum Net Capability. The Net Capability shall be demonstrated by either operating performance data or test result.

C. Reporting

Reporting is accomplished through the PJM eGADS reporting system as described in Appendix B: PJM Net Capability Verification Test User of **PJM eGADS User Guide I**

Appendix B: Calculating Capacity Values for Intermittent Capacity Resources

B.1 PURPOSE:

This appendix describes the procedure for the calculation of capacity values for all intermittent capacity resources such as wind and photovoltaic generators.

B.2 DEFINITIONS

1. Capacity Value for an intermittent capacity resource represents that amount of generating capacity, expressed in MW, that it can reliably contribute during summer peak hours and which can be offered as unforced capacity into the PJM capacity markets.
2. “Capacity Factor” for an intermittent capacity resource is a factor based on historical operating data and/or the Class Average Capacity Factor, and is used in the calculation that determines an intermittent capacity resource’s Capacity Value.
3. The intermittent capacity resource’s “Net Maximum Capacity” is the manufacturer’s output rating less the Station Load where “Station Load” refers to the amount of energy that is consumed to operate all auxiliary equipment and control systems.
4. Intermittent capacity resources with three or more years of applicable operational data are referred to as “Mature.” Those with fewer than three years of data are “Immature.”
5. “Class Average Capacity Factor” is a factor that is used only in the calculations for the Capacity Value of an immature intermittent capacity resource. Class average capacity factors shall be determined and periodically updated by PJM based upon review of operating data for similar units and/or engineering studies for future installations.
6. “Hourly output” is the average of the metered outputs, in MW, integrated over a one-hour period.
7. “Summer Day” is defined as any day from June 1 through August 31, inclusive.

8. "Summer Period" is the period from June 1 through August 31, inclusive.
9. "Peak Hours" are those ending 3, 4, 5, and 6 PM Local Prevailing Time.
10. "Summer Peak Hours" means all "Peak Hours" for all of the "Summer Days".
11. "Summer Calculation Hours" means all "Summer Peak Hours" for which PJM did not direct the resource to reduce its output.

B.3 CALCULATION PROCEDURE

1. General Approach - The calculation of a capacity value for a particular intermittent capacity resource for a particular year is performed by first computing its unique single year capacity factors for each of the prior three summers. An intermittent resource may consist of a number of individual generating units metered and interconnected at a single point. Groups of wind turbines meeting these criteria are referred to as wind energy projects. Those single year capacity factors are based upon operating data for each of those summers, or in the case of an immature intermittent capacity resource, the single year capacity factor is assigned the value of the Class Average Capacity Factor for each summer where there is no or incomplete data. The mean of single year capacity factors for each of the prior three years results in a Capacity Factor representative of the three prior years. That Capacity Factor, when multiplied by the current Net Maximum Capacity yields the current capacity value for that intermittent capacity resource. This two step process accommodates any changes in the Net Maximum capacity that may have occurred during the prior three summers of operation. A detailed outline of this approach (addressing both mature and immature intermittent capacity resources) is as follows:
 - A. Sum all of the "hourly outputs" for each of the summer calculation hours in the year that is three years prior to the current year.
 - B. Then, for each of those same summer calculation hours, sum the Net Maximum Capacity values.
 - C. The quotient of the summed summer calculation hour outputs (a) divided by the summed summer calculation hour Net Maximum Capacities (b) will yield a single year capacity factor for that year.

- D. If there is no or incomplete operating data for one or more of the summers (immature Intermittent capacity resource) then the single year capacity factor for each of those years is assigned the value of the Class Average Capacity Factor.
- E. Repeating steps (A) through (D) above for each of the two intervening years (current year minus 2, and current year minus 1) will generate two more single year capacity factors, one for each of those years.
- F. The Capacity Factor to be used in the current year is the mean (arithmetic average) of the three single year capacity factors calculated in steps (C) and (D) above.
- G. Capacity factors shall be calculated annually following the summer peak period and be applicable for the delivery year beginning the following June.
- H. Currently effective class average capacity factors are 13% for wind and 38% for solar units.
- I. Owners of immature intermittent units may substitute an alternate class average capacity factor with suitable documentation and approval by PJM.
- J. The current Capacity Value is then calculated by multiplying the applicable Capacity Factor from (G) above by the current Net Maximum Capacity of the intermittent capacity resource.

Revision History

Revision 08 (01/01/2010)

Revisions approved by stakeholders at November 30, 2009 MRC meeting and awaiting FERC approval by February 1, 2010 (received FERC approval in January, 2010):

Removed all references to the Winter Net Capability Test Exemption Program.

Revision to Appendix A allowing submission of ambient weather-adjusted data from the summer verification test in place of an actual winter verification test.

Revision 07 (06/01/2008)

Clarification of capacity verification testing corrections to average ambient conditions described in Section 2.

Clarification of test duration requirements for various unit types in Appendix A.

Revision to Appendix B to add Solar Class Average Capacity Factor of 38%.

Elimination of Appendix B-1 and combination of wind and solar calculation methodology into Appendix B. Update to list of Manuals.

Revision 06 (04/01/2008)

Revision to Appendix B-1 to indicate change of Wind Class Average Capacity Factor to 13%.

Clarification of existing practices regarding performance of seasonal verification tests.

Revision 05 (06/01/07)

Revisions for the implementation of the Reliability Pricing Model and general clean-up.

Added Section 1: Requirements

Added Definition of **Installed Capacity (ICAP)**

Data Submittal: Added Occasions Requiring Submittal of Verification Test

Data Submittal: Added reference to need to adhere to injection right limitations when increases in Installed Capacity (ICAP) are requested

Appendix A: Part B-4 Added Duration of Test or Operational Status to Satisfy Test Requirements

Revision 04 (08/15/05)

- Removed all references to Non-Utility Generators (NUGs)
- Included references and links to Winter Net Capability Test Exemption section of PJM Manual for Pre-scheduling Operations (M-10)
- Removed all data input instructions and sample forms from part C, Reporting of Appendix A: Net Capability Verification Guidelines and inserted link to Appendix B: PJM Net Capability Verification Test User Manual of PJM eGADS User Manual (M-23)

Revision 03 (04/30/04)

Attached two files:

- The first is Appendix B which addresses Intermittent Capacity Resources in general.
- The second is Appendix B-1. This addresses Capacity calculations for wind generation which is the first intermittent capacity resource under the category of Intermittent Capacity Resources.

Revision 02 (11/21/03)

Changed all references from “*PJM Interconnection, L.L.C.*” to “*PJM.*”

Renamed Exhibits I.1 through 10.1 to Exhibit 1 through Exhibit 5.

Reformatted to new PJM formatting standard.

Renumbered pages to consecutive numbering.

Revision 01 (08/23/00)

Manual updated to reflect use of eCapacity system and to remove Available Capability, Limited Energy Resources and Transmission Limitations sections. These will be addressed in sections of the PJM Manual for *Installed Capacity: Generation Data Systems* dealing with generation availability. Appendices A and B of the 10/14/98 version have also been removed since they dealt with Limited Energy and Transmission Limitation procedures.

Revision 00 (10/14/98)

This is the first release of the PJM Manual for Rules and Procedures for Determination of Generating Capability (Green Book) under new format.