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Procedures for System Modeling: Data Requirements & Facility Ratings

Prepared by the SS-37 Working Group on Base Case Development for the Task Force on System Studies.

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1.0 Introduction

Actual and forecast data of all the components including load are required to analyze study and plan the interconnected electric system. The detailed data of system components will be maintained and updated by the purchasers, sellers, marketers, and load-serving entities and provided to NPCC accurately and timely as needed for system analysis and distribution. This data may be required on an aggregated independent system operator, power pool, individual system, or on a dispersed substation basis for system modeling and reliability analysis.

Complete, accurate, and timely data is needed for system analyses to ensure the adequacy and security of the interconnected transmission systems, to meet projected customer demands, and to determine the need for system enhancements or reinforcements. The SS-37 Working Group, as directed by Task Force on System Studies, will collect data and develop a library of base case models for each year. The typical schedule along with roles and responsibilities of each SS-37 member is as per Table 1 in Appendix A.

System analyses include steady-state, transient, and dynamic simulations of the electrical networks. Data requirements for such simulations include information on system components, system configuration, customer demands, and electric power transactions.

Knowledge of facility ratings is essential for the reliable planning and operation of the inter-connected transmission systems. Such ratings determine the acceptable electrical duties on equipment, before, during, and after system contingencies.

1.1 Applicable NERC Reliability Standards

The NERC Compliance Program includes the following standards, which apply to the Regional Reliability Organizations for which NERC has compliance assessment responsibility.

MOD-014 Development of Steady-State System Models
MOD-015 Development of Dynamics System Models

This plan applies to those Regions in the Eastern Interconnection that have chosen to utilize the MMWG (Multiregional Modeling Working Group) to meet these requirements.

2.0 System Modeling

The NERC Reliability Standards, MOD-014 and MOD-015, state the following purposes.

MOD-014
To establish consistent data requirements, reporting procedures, and steady state system models to be used in the analysis of the reliability of the interconnected transmission systems.

MOD-015
To establish consistent data requirements, reporting procedures, and dynamics system models to be used in the analysis of the reliability of the interconnected transmission systems.

The NPCC Base Case Development (BCD) Working Group (SS-37) will develop a library of base case load flow and dynamic models each year for internal use by NPCC, its members, and NERCMMWG. The NPCC Task Force on System Studies (TFSS), to meet the needs of the members and other groups will establish the individual cases, which collectively comprise the library, each year. This annual development of base cases will serve as the main vehicle by which system data is collected and disseminated for internal use by NPCC and its members. It is expected that the system(s) conducting a study may find it necessary to expand and/or update the representation of system conditions and facilities in the area of particular concern.[1]

The NERC MMWG maintains a system dynamics database. NPCC will ensure that the MMWG database is updated annually such that the load flow cases and the dynamics data submitted to MMWG are compatible.

The system modeling in the BCD load flow cases is intended to be such that realistic events and conditions can be simulated using analytical software which NPCC has adopted as its current standard. While the data from these cases may be used by other software programs, no attempt is made by NPCC to ensure that the system modeling provided in these cases is such that commercially available software, other than its current standard, will realistically simulate system events.

Short circuit analysis is generally not required for interregional reliability studies. Therefore NPCC will not collect, maintain, or distribute, short-circuit data cases to its members or to NERC. Short circuit analysis studies are normally carried out on an Area or individual company basis. This procedure stipulates that facility owners must maintain short-circuit data and Areas and Companies shall maintain short-circuit models. The data and models should be provided to members on request. The interchange of short circuit data is currently required by NPCC procedures to permit modeling of neighboring systems[2]. NPCC will maintain a list of contacts from who short-circuit equivalents may be obtained for Area and/or Company systems. SS-37 will be responsible for maintaining this list.

2.1 Base Case Development Data Requirements

Load flow and dynamics data shall be submitted to NPCC annually by Areas and Companies to facilitate base case development. Generation and Transmission Facility Owners will be responsible to provide data for the Base Case Development (BCD). Submissions for this purpose shall be consistent with the modeling guidelines provided in the MMWG Procedural Manual notwithstanding the following:

2.1.1 The ratings of all static equipment must be consistent with the documentation available from facility owners as required by the NERC Planning Standard FAC-008 and in accordance with the procedures herein. The ratings included in each specific case shall be appropriate to the case (summer, winter, etc.).

2.1.2 The load flow cases provided by the Areas must have system loads and dispatches appropriate to the specific case (summer, winter etc) as defined in the MMWG Procedural Manual. The load and dispatch conditions will be the Areas best available forecast of expected conditions. Areas on each side of a tieline will agree transfers between those Areas, on a case-by-case basis.

2.1.3 Each Area, for the purpose of preparing load flow cases for stability analysis, will provide appropriate files with the cases submitted to facilitate conversion of loads and generators and the netting of generators with load as required for transient stability studies. The files are to be based on the areas best available data concerning load characteristics and will be reviewed and updated

every three years as part of the triennial review process

2.1.4 The ratings of generation equipment must be consistent in all submissions from case to case. Only the real and reactive power set points, voltage set points, and station service loads should change unless physical re-rating of the equipment is anticipated.

2.1.5 The modeling of generators, plants and generator step-up transformers (GSU) must be consistent from case to case. This applies to the unit ratings, the representation of GSU, Pmax, Pmin, and the dynamics modeling.

2.1.6 Representation Of Units and Plants – Units at a particular bus may be lumped together and represented as one unit when they have the same electrical and control characteristics. Units that are lumped together should be rated less than 50 MVA each and the units lumped together at any location should have a combined rating of not more than 300 MVA. Units or plants rated less than 20 MVA may be netted with loads. The netting or lumping of units and plants in excess of the guidelines above is acceptable only when such representations are deemed acceptable for systems studies in the judgment of the Areas affected.

2.1.7 Generator step-up transformers should be represented explicitly as transformers. Correct impedance data, derived from test data, should be used for GSU impedance. Data for generator step-up transformers should include effective tap ratios and per unit impedance.

2.1.8 The representation of AC transmission lines and circuits (overhead and underground) should include nominal voltage, line charging, line shunt equipment, and ratings consistent with procedures and appropriate to the case.

2.1.9 Transformers shall be modeled in accordance with the application guide of the software program, adopted as NPCC's current standard, and the best available equipment data. Regulated bus and voltage set points shall be included where

the devices are operated in automatic mode. Tap changer tables should be included only where they are judged necessary for the studies for which the base cases may be used.

2.1.10 Units not dispatched must be modeled with a status of “0”, or off-line, in the power flow model.

2.1.11 The modeling and ratings of tie lines provided should be agreed to by all of the owners of the facilities.

2.1.12 Each year, for the purpose of base case development, each Area will submit loadflow cases to NPCC in a standard format as agreed upon by the working group. One file shall be provided for each BCD case under development. The provider of such data will ensure that the representation of generators and the generator bus names are consistent with the previous years BCD cases. Any changes from the previous year should be noted in a “readme" file provided by the provider.

2.1.13 Each year, for the purpose of base case development, each Area will submit dynamics data to NPCC in the form as agreed upon by the working group. This data will include all appropriate files for dynamic simulation. Instructions should be also provided in the form of a “read-me” file to guide the user in creating dynamics cases from these files and merging the data with that from other areas. Each Area will also provide dynamics data updates, in the form of updates that facilitate updating the dynamics case such that it is made compatible with the remaining BCD cases in the set.

2.1.14 Each Area, after NPCC has merged the loadflow and dynamics data into preliminary BCD cases, will review the BCD loadflow cases for correctness and test the dynamics data by simulating limiting events within their system.

2.2 Data Requirements of Facility Owners

Generation and Transmission Facility Owners must develop, and maintain data for their facilities suitable for load flow and dynamics modeling and analysis as required by the NPCC Working Groups. Facilities owners must also develop and maintain short-circuit data. Facility owners must provide this data, in a suitable format, on request. Data provided by facility owners must comply with the NERC MMWG Procedural Manual and the procedures herein.

Some typical data required for load flow and dynamics modeling to conduct studies and analysis are as follows:

Generation Facility Owners:

2.2.1 Bus (substation and switching station): names, nominal voltage, and location.

2.2.2 Generating Units (including synchronous condensers, pumped storage, etc.): location, minimum and maximum ratings (gross real and reactive power), regulated bus and voltage set point, maintenance requirements as appropriate to the analysis, station service and auxiliary loads, and dynamics data.

2.2.3 Transformer (voltage and phase-shifting): nominal voltages of windings, impedance, tap ratios (voltage and/or phase angle or tap step size), regulated bus and voltage set point, normal and emergency ratings, and maintenance requirements as appropriate to the analysis.

2.2.4 Detailed unit-specific dynamics data for generators, excitation systems, voltage regulators, turbine-governor systems, power system stabilizers, relays and protection equipment (out of step, over-speed, etc), and other associated generation equipment. This includes complete and accurate models of controls suitable for integration with the analytical software. In no case shall other than unit-specific data be used for generator units installed after 1990.

2.2.5 Typical manufacturer's dynamics data, based on units of similar design and characteristics, may be used when unit-specific dynamics data cannot be obtained.

2.2.6 Positive, negative, zero sequence and mutual impedance.

Transmission Facility Owners:

2.2.7 Bus (substation and switching station): names, nominal voltage, and location.

2.2.8 AC Transmission Line or Circuit (overhead and underground): nominal voltage, impedance, line charging, nominal and emergency ratings based on the most limiting element in the

circuit, maintenance requirements as appropriate to the analysis, and metering locations.

2.2.9 Transformer (voltage and phase-shifting): nominal voltages of windings, impedance, tap ratios (voltage and/or phase angle or tap step size), regulated bus and voltage set point, normal and emergency ratings, and maintenance requirements as appropriate to the analysis.

2.2.10 Reactive Compensation (shunt and series capacitors and reactors): nominal ratings, impedance, percent compensation, connection point, and controller device.

2.2.11 Detailed dynamics data for all other facilities of significance and pertinent to dynamic simulations such as static-var compensators, Facts devices, Phase Angle Regulators, synchronous motors, HVdc facilities, relays, loads etc. Data must include complete and accurate control models suitable for integration.

2.2.12 Models of protective relay characteristics on all major interfaces and available on request for all transmission facilities.

2.2.13 Positive, negative, zero sequence and mutual impedance.

2.3 Data Requirements of Load-Serving Entities, Purchasers/Sellers/Marketers

Load-serving entities shall provide actual and forecast demands for their respective customers for steady state and dynamics system modeling in a timely manner.

Purchasers, sellers, marketers, and load-serving entities shall provide their existing and future contracted firm (non-recallable reserved) capacity transactions (including sources, sinks, amounts, duration, associated transmission, etc.) for steady-state and dynamics system modeling in a timely manner.

3.0 Facilities Ratings

The NERC Reliability Standard, FAC-008, Facility Ratings Methodology, states the following purpose.
To ensure that Facility Ratings used in the reliable planning and operation of the Bulk Electric System (BES) are determined based on an

established methodology or methodologies.

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Compliance with the above standard is provided for by the following procedure:

3.1 Facility owners shall document the methodology for determining facility ratings, including delineation and justification of assumptions, standards, and practices used in establishing the ratings. The documentation must state the ratings and their basis applicable to each of the six base case model types (summer peak, winter peak etc) as defined in the MMWG Procedural Manual.[3] This document must be maintained and provided to NPCC on request.

3.2 Facility owners shall provide facility ratings (applicable normal and emergency) for all facilities required for system modeling (as defined in this Procedure) to NPCC appropriate for base case development as requested in a timely fashion. The requirement to submit data to NERC is being fulfilled through the NPCC base case development effort.

3.3 The rating of a system facility (e.g., transmission line, transformer, etc.) shall not exceed the rating of the most limiting series element in the circuit or path of the facility, including terminal connections and associated equipment.

3.4 In cases where protection systems and control settings constitute a loading limit on a facility, this limit shall become the rating for that facility.

3.5 Ratings of jointly owned facilities shall be coordinated and provided on a consistent basis. The ratings submitted shall be agreed to through the consensus of the facility owners.

3.6 Facility ratings should be based on or adhere to applicable national electrical codes and electric industry rating practices consistent with good engineering practice.

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References:

[2] NPCC Reference Manual, Document A-5, "Bulk Power System Protection Criteria", Section 2.4.8, Draft of Document A-5 dated January 27, 1998.

[3] NERC MMWG Procedural Manual, Revision No. 21, April 27, 2005, Appendix V: "Power Flow Modeling Guideline".

[4] NERC MMWG Procedural Manual, Revision No. 21,April 27, 2006, Appendix II: "Dynamics DataSubmittal Requirements and Guidelines".

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[6] **Applicable NERC Reliability Standards**

FAC-008, Facility Ratings Methodology
MOD-014, Development of Steady-State System Models
MOD-015,Development of Dynamics System Models

APPENDIX A

TABLE – 1

SCHEDULE & RESPONSIBILITIES

Each year the SS-37 Working Group, as directed by the TFSS, will develop a library of base cases for the following year. MMWG Base Cases will be derived from this set as judged appropriate. A written description of the cases and procedures used to derive the MMWG Bases Cases from the BCD cases will be provided with the Base Case library by SS-37. The schedule and responsibilities necessary to achieve this are as follows:

TASK	DEADLINE	RESPONSIBILITY
Establish and release BCD/MMWG List of Cases	March	TFSS
Assign tasks to each SS-37 member to participate in the development and testing of base cases	SS-37 Meeting April	All
Establish and release Interchange Schedule & Tie Line Summary	May	SS-37, Each area Rep.
Areas submit near term base case data files to NPCC.	June	Each Area Rep.
Areas submit long term base case data files to NPCC	July	Each Area Rep
NPCC provide "BCD-Trial 1" cases to Areas	One week after submittals from Areas	NPCC, SS-37
Specify necessary revisions to be made to "BCD-Trial 1"cases.	One week after "BCD-Trial 1"	NPCC, Each Area Rep.
Update Dynamics Data and test BCD cases with and without faults	August	NPCC, Each Area Rep as assigned
Release BCD Library for subsequent year	December 31st	NPCC, SS-37
Submit data to MMWG as per their schedule	Presently starting June-December	NPCC