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A SURVEY OF PUBLICLY AVAILABLE TRANSFER CAPABILITY DATA

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ABSTRACT

This paper summarizes the transmission system data resources used to construct a North American network representation modeled in the Spot Market Network (SMN) model developed at Argonne National Laboratory (ANL). The data, largely available through various FERC Form 715 reports, are used to construct a network representation capable of modeling interarea transfer opportunities between modeled systems. A brief introduction of the SMN model and the desired level of transmission detail is first described. Next, various data resources that report published transfer capabilities essential to model operation are introduced. Modifications or adaptations of individual published network topologies are described, which are supported through extensive examinations of alternate data sources, as well as through discussions with knowledgeable operations experts or regional staff. The method of obtaining the current SMN network formulation is finally presented to illustrate the integration of regional and subregional network detail into the North American SMN transmission representation.

1 INTRODUCTION

It is now one year since the Federal Energy Regulatory Commission (FERC) began collecting transmission information from qualifying transmitting utilities through FERC Form'715 as a result of the National Energy Policy Act of 1992. Collected data is intended to provide independent power producers (IPPs) and non-utility generators (NUGs) with an initial indication of available transfer capabilities concerning a specific area of interest. Form 715 data provide public transmission information by mandating the reporting of relevant transmitting utility power flow base cases, maps and diagrams, transmission planning reliability criteria, assessment practices, and system performance indicators. While specifications for Form 715 appear to be well defined, differences exist in the level of detail provided by reporting companies and reporting agencies. Among the data reported from power flow analyses and system contingency studies are nonsimultaneous interarea transfer capabilities, which are critical for SMN network development.

From industry's perspective, IPPs and NUGs are likely to find reported information useful in assessing initial generation siting alternatives. For policy and analysis purposes, ANL used published transfer capabilities to expand a regional network representation [1] into a pool-level network representation consistent with the North American Electric Reliability Council (NERC) data provided in the Electricity Supply and Demand report and various OE-411 reports submitted by each NERC Region. Transfer capability information is further verified through direct conversations with regional NERC and utility staff to qualify modeling assumptions and typical operating conditions.

The paper focuses on the various aspects of using publicly available transmission data resources to construct a transmission network model. In particular, the paper summarizes ANL's experiences regarding the overall impact of the Form 715 initiative and the related efforts of NERC regions and transmitting utilities in meeting the reporting requirements. A large number of reporting companies and reporting agencies throughout the United States are included in the survey. The resulting diversity in the type and level of detail found among reports submitted by different systems and regions is summarized. Several instances are discussed where proprietary data resources became available to the public as a direct result of the Form 715 filing requirements. Several instances are also cited indicating additional cooperation among various utilities and NERC Regions who openly support a willingness to further qualify published data to resolve special data circumstances or to provide clarifying comments.

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2 MOTIVATION FOR IMPROVED NETWORK REPRESENTATION

Last year, ANL introduced and described the SMN model and illustrated a regional generation siting example [1]. At that time, the network representation implemented in the SMN model was at the regional level. However, ANL modeling objectives often require more detailed system representations, which directly necessitates more detailed transmission system characteristics. This section describes the subregional layout of the desired representation. The reader is referred to [1] for additional background about the SMN model formulation and a typical example on its use.

Many studies conducted at ANL are centered around serving the needs of various federal agencies and commissions. For example, in a study performed for the U.S. Nuclear Regulatory Commission (NRC) [2], a convenient subregional representation of various U.S. utilities is used to aggregate individual utilities into a subregional representation. This representation consists of twenty-seven areas (shown in Figure 1), which partition the contiguous U.S. The focus of studies performed at ANL for NRC and other sponsors is often on subregional transactions as defined by the *NERC Electricity Supply and Demand* defined boundaries [3] with some additional disaggregation as provided by various OE-411 reports. These areas, although different from what might be considered *tight* power pools, are often generically referred to as *power pools* in the context of ANL modeling efforts.

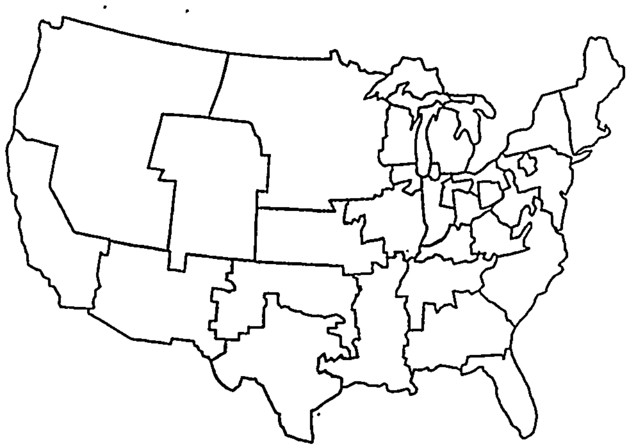

Figure 1 Modeled Power Pool Boundaries.

The SMN network representation presently follows the pool-level definitions to avoid data overload and to meet the demands of ANL program activities. This representation is also adequate for the recent needs of the Department of Energy (DOE) Office of Fossil Energy. The complete network developed for DOE is comprised of thirty-two nodes that cover pools defined in the contiguous United States, Canada, and Mexico. This network representation defines the overall scope of ANL's transmission data search. The following sections describe how the North American network representation for DOE was developed from diverse data resources.

3 TRANSFER CAPABILITY DATA RESOURCES

A brief description of the various regional data resources is presented in this section. General comments are followed by specific instances where FERC Form 715 directly impacted the public availability of some data. Collectively these data resources are used to fully characterize the North American transmission network at the pool level as defined and required by various sponsors supporting the work and effort conducted at ANL.

3.1 NERC Winter/Summer Assessments

Various parties continually observe power system responses and transfer capabilities at the regional level. In some cases these regions correspond to tight power pools, but in several instances the data represents aggregated NERC region transfer capabilities. Section 3.3 discusses data resources used to achieve pool-level resolution for North America comprising the contiguous United States, Canada, and Mexico.

Using individual regional data and reports summarizing the efforts of various interregional study groups, the *NERC Winter/Summer Assessments* [4] represent nonsimultaneous transfer capabilities for interregional boundaries. These reports have been a valuable source of transfer capability data since the mid 1980s. The *NERC Winter/Summer Assessments* represent monthly peak transfer capabilities between interconnected regions on a noncoincidental basis. First Contingency Incremental Transfer Capability (FCITC) limits represented in this report reflect the modeling efforts of all nine coordinating NERC regions. As a result of the shared cooperation among the NERC regions, a high degree of data consistency is observed because of similar modeling objectives and methodologies.

3.2 NERC Interregional Study Groups

The NERC assessments rely on detailed transmission data included in the various interregional studies (the MACC-ECAR-NPCC (MEN) study [5] is one example). Each report examines the interconnected characteristics of all involved regions. Where appropriate, regions outside of the main study area are typically represented as network equivalents that portray the remaining system details in a simplified representation. Each study group investigates specific contingencies and typical operating conditions based on operating experiences and power flow simulations. Various reports summarize peak seasonal transfer capabilities between adjacent interconnected regions. The following list identifies each of the NERC interregional study groups:

- MEN -- MAAC-ECAR-NPCC
- VEM -- VACAR-ECAR-MACC
- MET -- MAIN-ECAR-TVA
- MMS -- MAPP-MAIN-SPP
- MST -- MidSouth-Southern-TVA
- W-SP -- WSCC-SPP
- W-M -- WSCC-MAPP
- E-SP -- ERCOT-SPP

The interregional study groups follow an effective modeling procedure presently supported by the Multi-Regional Modeling Working Group (MMWG), a NERC engineering committee. The MMWG study covers all regions comprising the Eastern Interconnection. The group conducts several different load flow scenarios (e.g. varying seasonal conditions, and 1, 2, 5, and 10 year forecasts) under one integrated simulation framework. Advantages of this effort include consistent load level assumptions and a consistent bus naming and numbering scheme. The MMWG methodology is described in greater detail in [6].

3.3 Impacts of FERC Form 715

Because of the more recent interests in transmission open access, non-utility generators (NUGs) and independent power producers (IPPs) are requesting better information regarding system transfer capabilities in order that interested parties may understand, among other things, potential advantages and disadvantages of alternative generator siting options. A key resource to NUGs and IPPs was the introduction of a new Federal Energy Regulatory Commission (FERC) filing requirement. Initiated on April 1, 1994, FERC Form 715 [7] offers the general public additional transmission planning information including the following key highlights:

Part 1. Identification and Certification
Part 2. Power Flow Base Cases
Part 3. Transmitting Utility Maps and Diagrams
Part 4. Transmission Planning Reliability Criteria
Part 5. Transmission Planning Assessment Practices
Part 6. Evaluation of Trans. System Performance.

While FERC Form 715 contains useful network information, the level of aggregation does not lend itself to pool-level characterizations. Because of this, the interregional study reports have provided greater assistance in preparing the network formulations although sometimes supplemented by FERC Form 715 data, as needed. However, there are some other advantages of FERC Form 715 data collection as described below.

Initially, the MEN and VEM [8] studies were only obtained by non-members through a proprietary agreement with the Allegheny Power Service Corporation. However, the VEM report has since become public domain information through the FERC Form 715 submittal by the Southeastern Electric Reliability Council (SERC) [9]. Unlike VEM, the MEN studies are not released to FERC, so these reports remain confidential. The same is true of the MMS and MET interregional studies. However, summaries of the transmission detail available in these interregional reports are found in other published Mid-America Interconnected Network (MAIN) reports as noted below. As described in Section 4, these alternative data resources are used to characterize the network capabilities for regions while maintaining confidentiality for their working group reports.

The Southwest Power Pool (SPP) publishes seasonal *Peak Operating Studies* [10] that represent the transfer capabilities between subregional interfaces within the SPP region. Similar documents, like the seasonal *MAIN Transmission Assessments* [11], illustrate the subregional transfer capabilities within MAIN. While the SPP information was available before the activation of FERC Form 715, the MAIN document is now available to the public because of the Form 715 filing requirement. Both documents address most of the aggregated information provided in the MMS and MET interregional studies.

FERC Form 715 also effected the availability of transmission information in the Western Systems Coordinating Council (WSCC). WSCC publishes a yearly *Path Rating Catalog* [12] that illustrates the transfer capabilities of various network interfaces within the WSCC region. Previously only available to WSCC members, this information now can be used to represent the subregional transfer characteristics of the WSCC in a manner similar to other areas of the country.

In the East Central Area Reliability Coordination Agreement (ECAR), FERC Form 715 made the *1994 Summer Assessment of Transmission System Performance* [13] report available to provide detailed transfer capability information at the control area level. This report offers the transmission detail necessary to model the transfer capabilities between involved ECAR control areas. But like all of the aforementioned data resources, published transfer capabilities represent nonsimultaneous conditions, which is a particularly important assumption when modeling between interconnected control areas.

In addition, FERC Form 715 opened public access to various utility-level transmission information [e.g., 14, 15]. Detailed load flow base cases conducted by utilities to perform regional, subregional and internal system analyses are typically submitted. Load flow information is provided on disk in varying formats including Power Technologies, Inc. PSS/E and the WSCC formats. In essence, very detailed transmission data is now publicly available, so a broad spectrum of transmission detail is available ranging from regional studies down to detailed utility network representations. However, recall that these base cases only reflect specific instances of generation, demand, and transmission conditions, which may not be seasonally coincidental. They are by no means a mechanism to represent all situations encountered on a daily basis by practicing control areas. As a result, the same is true of the nonsimultaneous transfer capabilities determined by these studies.

4 APPLICATION OF DATA RESOURCES TO IMPROVE THE PRESENT NETWORK REPRESENTATION

The present SMN network formulation is derived from many of the data sources listed above. This section specifically identifies and describes which resources are used to construct the most recent network representation. In a few instances, documented information required adjustments to accommodate variations in network topology or to verify questionable transfer capabilities. These modifications were validated through conversations with regional or utility staff to assure proper interpretations of reported data and proposed alterations.

The motivation behind improving network details is to formulate an accurate transmission network representation that corresponds to the power pool boundaries defined in Section 2. Groups of utilities are aggregated into these power pools to obtain the appropriate match between system loads and generation from units most likely and most capable of responding to those loads. To complete the pool representations, interpool transfer capabilities must be assessed to capture the effects of transactions with neighboring systems. The following discussion addresses the methodology used to achieve the pool-level network representation from the available data resources identified above.

The *NERC 1993 Summer Assessment* [4] is used to obtain an initial representation of the United States and Canada. This data supports a power pool representation for the Northeast and SERC and a regional network representation for remaining parts of the U.S. The Canadian network representation is adequately portrayed at the subregion-level utilizing this data resource. Thus, direct use of the *NERC 1993 Summer Assessment* permits adequate transfer capability modeling for the following regions: Canada, New England Power Pool (NEPOOL), New York Power Pool (NYPP), Mid Atlantic Area Council (MAAC), SERC - Virginia-Carolinas (VACAR), SERC - Tennessee Valley Authority (TVA), SERC - Southern, SERC - Florida, Mid-Continent Area Power Pool (MAPP), and the Electric Reliability Council of Texas (ERCOT).

The Southwest Power Pool network requires more detail in order to model the subregional transfer capabilities that the *NERC 1993 Summer Assessment* does not address. The *1993 Summer Peak Operating Study* [10] is used to enhance the transmission detail in the SPP region. Four SPP subregions presented in the document are converted into three subregions with guidance from details in the report and through several telephone conversations with SPP regional staff. Basically, two subregions are collapsed into one new subregion in an effort to represent the entire SPP region as three pools corresponding to the same convention for SPP used in *NERC Supply and Demand* reports [3]. Transfer capabilities and additional network modifications were verified with SPP regional staff.

Network detail within the WSCC region is expanded to represent four power pools, which are the same subregions as identified by NERC [3]. The initial network representation is obtained from the WSCC OE-411 report [16]. This report provides 1993 peak summer total transfer capabilities and identifies base energy transfers between interconnected subregions. The base transfers are subtracted from the total transfer capabilities to yield an incremental transfer capability — a representation consistent with the Eastern Interconnection modeling approach. Adjustments are made to the OE-411 network representation to account for differences in representing the Rocky Mountain area of WSCC. Modifications are validated by referencing the *WSCC 1994 Path Rating Catalog* [12], which provides transmission detail for critical transmission interfaces in the WSCC region. Further decisions regarding the final transfer capability are confirmed by several utilities in the Colorado/Wyoming area. Collectively, these data resources provide sufficient detail to characterize base transfers and incremental transfer capabilities for WSCC at the subregional level.

Transfer capabilities between the U.S. and Mexico are based on the WSCC OE-411 report and the *WSCC 1994 Path Rating Catalog*. These capabilities represent an overall aggregate capability for international transactions. If additional detail is eventually required (such as separating the Baja region from the rest of Mexico), one additional resource for this detail is the *United States/Mexico Electricity Trade Study* [17].

The MAIN region is expanded to the pool level by using additional network detail obtained from the *1994 MAIN Summer Transmission Assessment Study* [11]. Comparisons between 1994 and 1993 transfer capabilities are published, so that 1993 values were clearly represented and identified in the 1994 report. The resulting MAIN representation consists of three subregions where two of the four subregions identified in the MAIN report are reduced into one subregion.

The ECAR region is the last area to be expanded to the pool level. Data requirements for the expansion are provided by the *1994 Summer Assessment of Transmission System Performance* [13] supported by discussions with ECAR staff. A total of seven subregions are represented, which is substantially less than the total number of control areas represented in the ECAR report. However, considerable network adjustments occurred to bring the published network data in alignment with the pool definitions adopted by ANL. The ECAR staff and ECAR transmission maps were very helpful in validating these necessary adjustments.

5 SUMMARY

The SMN model is integrated under the Argonne Production, Expansion, and Exchange (APEX) [18] model for electrical systems. A consistent user interface supports a single look and feel that offers an intuitive model development environment. Incremental network expansion facilities are built into the SMN model to foster network enhancements that easily build on existing representations as additional transmission data resources become available. Because of these enhanced user interface capabilities, changes to the network parameters and structure are performed easily and quickly.

The network representation described in this paper is enhanced as a direct result of data released through the filing requirements of FERC Form 715. The original network representation reported in [1] was easily modified once the necessary data resources became available. Considering the modeling objectives and requirements of various ANL sponsors, the unit inventory data represented in APEX, and the desired aggregation of the power pool definitions, the SMN model supports the desired network detail needed to simulate and study diverse interarea energy transactions. The modeling environment supports the efforts of the ANL user community.

Developers of the SMN model rely heavily on the availability of nonsimultaneous transfer capabilities between interconnected systems. The developers are also aware of the underlying assumptions from which these numbers are derived. The authors wish to express a word of thanks to the various utility and regional staff who assisted in providing clarifying remarks and further stressed the dynamics of several interties. This information contributed significantly to making improvements to the network formulation. The authors appreciate their cooperation and willingness to address our concerns.

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