OHIO VALLEY ELECTRIC CORPORATION

OVEC MODELING ASSUMPTIONS – ADDITIONAL DETAIL

May 11, 2009

INTRODUCTION

This document facilitates independent conduct of simulations matching those used in OVEC/IKEC planning studies. It draws on information already presented in the OVEC/IKEC responses to FERC Form 715, but includes additional details, to meet the intent of FERC Order 890. It does not, however, remove the requirement that access to Critical Energy Infrastructure Information be restricted.

KEY MODELING ASSUMPTIONS

The computer models used in transmission planning studies necessarily differ widely in dimensions and details to suit the scope of each study. Power flow models are developed to represent system operation during highly stressed periods such as peak load conditions and heavy power transfers that simulate emergency and opportunity power sales. System dynamics and short circuit computer models are also used, depending on the specific analysis, to complement the power flow models. Using these computer models, transmission system performance is assessed by simulating disturbances to identify system strengths and weaknesses. In general, the following assumptions are used in conducting various types of transmission planning studies.

The OVEC/IKEC system is used primarily by OVEC for bulk power sales of OVEC generated power to the OVEC owners. A single internal load customer, the DOE, is served by off system generation. This load varies little over a 24-hour period. OVEC/IKEC System active load (MW) forecasts are based on projections developed by the DOE; and are assumed to be the same for typical peak and off-peak study scenarios. DOE loads are projected to be minimal for the foreseeable future. Reactive power (MVAR) loads are based on the customer’s calculated power factors for the projected loads and or recent historical data. Power transfer levels modeled in base cases for analysis of the OVEC/IKEC System vary from one study to another depending on the particular focus of the study. The NERC Multi-Regional Modeling Working Group (MMWG) load flow base cases generally model only committed firm power transfers. ReliabilityFirst cases, which are derivatives of the NERC cases, may be modified to include additional recently experienced biases. Base cases used in OVEC/IKEC's studies are derived from these regional models. Additional sensitivity cases may be used to assure that potential system bottlenecks are identified. The sensitivities most commonly studied involve alternative assumptions about the status or operating level of generation at electrically nearby generating plants, and high levels of transfers, used to simulate parallel flow conditions reflecting recent experience. These scenarios are discussed in more detail later in this document.

All of the OVEC/IKEC generating units are generally dispatched, except for those out of service for maintenance, since all or most of their generation is usually required for sales to Sponsors. The modeled generation output of each of OVEC/IKEC’s two power plants is based on the plant’s capacity relative to the total OVEC/IKEC generation capacity.

Base cases model all transmission facilities in service except for known scheduled maintenance, long-term construction outages, or long-term forced outages. These known outages are normally only reflected in operational planning studies. Because it is impractical and unnecessary to represent all interconnected systems in detail, the type of planning study dictates the extent of the interconnected network representation. Thus, an interconnection study involving the bulk transfer of power between two power systems not only would require sufficient detail of the bulk transmission in each participating system, but also would include sufficient detail and/or equivalent representation of other interconnected systems to assure proper analysis of critical elements.

Accurate modeling of neighboring systems is essential in any study of the OVEC/IKEC transmission system. Neighboring company information is obtained from the latest regional or interregional study group models, the RFC base cases, the NERC MMWG load flow library, or the Sponsors themselves. Sufficient detail is retained to simulate all outages and changes in generation dispatch that are contemplated in the particular study. To the extent OVEC/IKEC planning study needs overlap with available RFC Study models, the RFC models will be the preferred starting point for OVEC/IKEC planning study models.

With the power flow base cases described above, the study engineer develops scenarios, which are surrogates for a wide range of possible conditions. Numerous facility outages and power transfers occur daily in the interconnected network. It would be impractical to simulate all such conditions in planning studies. To establish a manageable set of base case scenarios, historical data and experience are employed. Although history is not a perfect indicator of the future, it provides valuable information to benchmark the base case models. For future power flow base cases, further adjustments are made to reflect forecasted load levels, expected facility changes, and projected power transfers, as well as emerging trends that will affect historical power flow patterns.

The power flow models described above are the most frequently used models for transmission planning studies. Transient stability and short circuit studies are also used to evaluate the system performance during and immediately following various fault conditions on the transmission system. The network configurations used in the load flow models also provide a starting point for transient stability and short circuit studies. In addition, for transient stability studies, additional impedance data and electro-mechanical detail of generators and their controls are included.

TRANSMISSION PLANNING ASSESSMENT PRACTICES

On an annual basis, base case power flow models are developed for the OVEC/IKEC system, representing the summer peak, winter peak, off-peak, and light load conditions. These models are developed to represent the composite transmission/generation system into the future, although not for every year or season.

On an as needed basis, system reliability studies are performed for the OVEC/IKEC system to determine future system performance and needs. Such studies analyze the effect of single contingency outages of transmission lines, transformers, and generation units. In addition, the effects of less probable contingencies are also analyzed. These less probable contingencies involve outages such as loss of all generating units at a station, loss of all transmission lines on a common right-of-way, and other events resulting in loss of two or more components. These studies follow the practices outlined in the NERC Reliability Standards, the Reliability*First* Corporation Standard and the Transmission Planning Reliability Criteria described in Part 4.

It should be recognized that the transfer capability values developed in the system studies performed for the OVEC/IKEC system and others are based upon a collection of “snapshots” which includes many variables and assumptions. Many of these variables (load, generation dispatch, unit outages, etc.) will be different under actual system conditions than were simulated in the models. In addition, the transmission system models used in these analyses represent only normal firm transactions. Normal firm transactions are those transactions that are considered to be part of normal base system loadings for the condition being analyzed. Other transfers, such as emergency power or economy energy transfers, are excluded even though they may be provided for in contractual arrangements.

SOLUTION OPTIONS

AC power flow solutions used in OVEC/IKEC planning study simulations assume that TCUL transformers are allowed to regulate, Switched Shunts are allowed to change state, and Area Interchange control is enforced for both tielines and loads. At present, there are no known Phase Angle Regulator, DC Lines or FACTS devices close enough to the OVEC/IKEC system to significantly affect study results. However, where such devices are included in the base case models used for OVEC planning studies, they are allowed to adjust to maintain the specified conditions.

Sensitivity and Incremental Transfer Capability studies

In addition to analysis of OVEC/IKEC system performance under projected "base case" conditions (including evaluation of subsequent contingencies as specified in NERC Standards TPL-001 through TPL-004) OVEC/IKEC planning studies routinely include evaluation of system performance under various alternative scenarios. Note that system limitations identified in simulations based on these alternative scenarios may not indicate a need for system reinforcement. Rather, they provide additional insight into the margins which may exist on the OVEC/IKEC system to withstand conditions beyond those presently forecasted, and to identify facilities of potential future concern. These sensitivity scenarios may include:

Generation Sensitivities

Unavailable generation at:

- DEM – Beckjord 138 kV (largest unit)
- AEP – Sporn 138 kV (largest unit)
- E.On – Ghent 138 kV

Additional Generation dispatched at:

- E.On – Buckner Road 345 kV

Higher or lower generation levels at other units identified as critical to the performance of the OVEC/IKEC transmission system by the Siemens PSS™ MUST tool Generation Sensitivity analysis.

Incremental Transfer Capability Studies

- OVEC Exports to the Sponsors (proportional to ownership)
- Transfers from one OVEC Sponsor directly connected to the OVEC system to another (whether or not they are directly connected to OVEC.)

Additional transfers that serve as surrogates for large long distance transfers that may bias flows across the Eastern Interconnection in the vicinity of OVEC. Because these transfers serve as surrogates for a multitude of transactions and/or internal generation dispatch changes which may occur, the transfer simulations utilize simplified generation changes in both source and sink areas – existing on-line generation is raised or lowered in proportion to its output in the base case. Effects of changes in individual unit and/or plant dispatch is analyzed as part of the contingency analysis or Generation Sensitivities discussed previously. The specific Source-Sink area pairs may change over time, as changes are seen in generation reserve levels, differences in economics between various fuel or generation types, market structures, etc. Examples of such transfers used in recent analyses include:

West to east transfers:

- Ameren Illinois to PJM (Classic)
- Ameren Illinois to Virginia Power

South to North transfers

- TVA to Michigan (ITC/METC)

As a result of the inherent uncertainty involved with transmission system modeling and evaluation, the transfer capability values developed in such analyses should only be taken as a guide to transmission system performance during emergency conditions because normal conditions may be materially different from those modeled in such studies. Transfer capability between control areas may also be limited by contract path requirements and arrangements. Any request for transmission service would need to be evaluated on a case-by-case basis.

The following sections provide documentation of modeling techniques that are employed in the assessment of the OVEC/IKEC system performance. Section A provides documentation of operating procedures employed in the assessment of OVEC/IKEC system performance. Section B provides a description of contingencies that are typically used for testing system performance.

A. SPECIAL PROCEDURES

This section describes operating procedures that have been developed to mitigate problems identified on the transmission system and special modeling techniques used in the assessment of OVEC/IKEC system performance. Unless otherwise stated, these operating procedures are anticipated to be applicable indefinitely. As a result, they should be modeled in screening studies that evaluate future system performance. The procedures described herein generally are implemented to reduce facility loadings to within equipment thermal capabilities or to insure that adequate voltage levels or steady state stability margins are maintained.

Clifty Creek-Carrolton 138 kV (OVEC-E.On)

Past operating experience indicates that the Clifty Creek – Carrolton 138kV tieline between OVEC and E.On may become heavily loaded anticipating loss of either Ghent Unit 1 (E.On) or Spurlock-N. Clark 345 kV (EKPC). Loading concerns would likely occur during periods of high north-to-south transactions, especially if these transfers coincide with high output at Trimble County (E.On) and reduced output at other E.On plants. If necessary, OVEC has agreed to open the Clifty Creek 345/138 kV transformer T-100A at the request of the PJM Reliability Coordinator to relieve the loading concerns.

Kyger Creek - Sporn 345 kV (OVEC-AEP)

Past operating experience indicates that the Kyger Creek - Sporn 345 kV tieline between OVEC and AEP may become heavily loaded by high levels of west-to-east transactions, especially if these transfers coincide with reduced output at any of several AEP plants east of this tieline. AEP and OVEC have agreed to open the Kyger Creek - Sporn 345 kV circuit, when necessary. However, opening this tieline will increase loadings on other OVEC-AEP tielines. Conditions on these facilities may restrict use of this procedure.

Kyger Creek Stability constraints

Following the de-energization of the DOE-owned X533 station, the Kyger Creek stability performance meets performance criteria, assuming that the four remaining outlets are all in service, as well as both X530 to Pierce circuits. During an outage of any one of the following: Kyger-Sporn, Kyger-X530 #1 or #2, or X530-Pierce #1 or #2 circuits, stability performance with full output from all 5 Kyger Creek units would not be acceptable for some subsequent Double-Circuit-Tower (DCT) line contingencies. Acceptable stability performance with the prior outage of one of the above named circuits can be maintained if Kyger Creek output is reduced by the equivalent of one Kyger Creek unit.

Pierce 345/138 kV

The Pierce 345/138 kV transformers T-A and T-B (switched together) and TB-18 (switched separately) are owned by Duke Energy (Cinergy) but connected to the OVEC Pierce station. Before the addition of TB-18 prior to the summer of 2008, transformers T-A and T-B were frequently exposed to heavy loading for some system conditions. In the event

Pierce T-A or T-B experienced loadings exceeding their emergency ratings, if local conditions permit, Duke Energy would reconfigure the Beckjord 138 kV bus to optimize the effect of on-line Beckjord generation in reducing the Pierce 345-138 kV transformer flows, or remove the transformers from service. Depending on conditions at the time, opening one or more OVEC 345 kV circuits terminating at Pierce was also employed, at the request of the MISO or PJM Reliability Authorities. TLR declared on the appropriate flowgates also provides relief when needed. Following failure of T-B in September 2008, Duke has made plans to replace both T-A and T-B with a single unit similar to TB-18 by 2009 summer. Until then, if needed, portions of the procedures previously used for T-A and T-B may be employed to reduce flows on TB-18.

The areas of concern described above are those identified in the most recent performance appraisals conducted, based on the best available knowledge of interconnected system development, and expected operating conditions. The results of appraisals assuming different system conditions can be considerably different.

B. CONTINGENCY LIST

The following is a description of the contingencies that have been simulated in recent appraisals of the OVEC/IKEC system performance, to meet the requirements of the ECAR Compliance Program. This list is not exhaustive, but is designed to screen OVEC/IKEC system performance to verify that ECAR reliability criteria are being met and that OVEC system performance will not cause widespread cascading of the interconnected network.

Single Contingencies

Each branch within OVEC or the systems of OVEC's immediate neighbors (AEP, Cinergy, Dayton, and LGEE).
Each OVEC tieline,
Each Dayton tieline

The OVEC (and DOE-owned stations within the OVEC Balancing Authority area) are primarily of the "breaker and a half" configuration. Therefore, single contingencies can generally be represented by individually removing each branch or generator represented in the powerflow model. Exceptions from this statement include the following:

- Clifty Creek 345/138 kV transformation – The in-service Clifty Creek transformer T-100A does not have automatic switching between the transformer and the 138 kV bus. Forced outages of this transformer also de-energize the Clifty Creek 138 kV bus, opening the ties to Carrolton(E.On), Northside(E.On) and Miami Fort(DEM) until the transformer low-side disconnect can be manually opened and the bus restored.

- Dearborn(OVEC)-Tanners Creek(AEP) 345 kV bus extension – The in-service 345 kV tie between these adjacent OVEC and AEP stations is protected as a bus extension rather than a transmission line. Normal clearing of a fault on the tie or the #1 Tanners Creek bus will also trap the Tanners Creek (AEP) – East Bend (DEM) tie, as well as the Dearborn-Clifty Creek #1 and Dearborn – Pierce circuits.

- The OVEC/IKEC generators are cross-compound machines. Future modeling refinements to increase compatibility between steady state and dynamics models, will have each shaft represented individually. Representing a change in dispatch or status of a single unit will require changes to both HP and LP machines in the model. Furthermore, installation of FGD systems now underway at both Clifty Creek and Kyger Creek plants will create the possibility of some common-mode FGD equipment trips that would remove up to 3 units at each plant. Therefore, simulating single generator contingencies should include both single units (both shafts) and 3 units.

Double Contingencies

All combinations of branches connected to any OVEC bus, or two layers out from any OVEC bus, augmented by any branches identified in the Single Contingency analysis above. Similar to the discussion in the Single contingency section, the “breaker and a half” configuration present at most OVEC stations means that (neglecting, for screening purposes, the manual system adjustments allowed between the individual “Category B” contingencies in NERC Category C3 contingencies) most types of double contingencies for OVEC studies can be simulated by simply removing individual branches two at a time. Most common power system analysis tools provide options to easily simulate such scenarios.

Other Scenarios

Appraisals of the OVEC system performance also take into consideration the effects changing generation levels at key plants on the OVEC and neighboring systems may have on OVEC facilities.