OHIO VALLEY ELECTRIC CORPORATION

2011 TRANSMISSION PLAN

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Prepared On OVEC's behalf by:
East Transmission Planning
American Electric Power

October 2011

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Foreword

American Electric Power (AEP) completed this Transmission Performance Appraisal on behalf of the Ohio Valley Electric Corporation (OVEC)

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Executive Summary

The Ohio Valley Electric Corporation (OVEC) system in the near-term planning horizon is projected to meet the requirements of both OVEC planning criteria and the applicable NERC Transmission Planning Standards.

Steady State studies examined performance of the planned OVEC system at the projected summer peak load levels and planned systems of 2016 and 2021. Transfer analysis examined incremental transfer capabilities for transfers into, out of, and across the OVEC system. Sensitivity analysis examined the changes in transfer capabilities resulting from varying the generation dispatches.

Based on review of network changes since the studies were performed in 2010, the stability and short circuit studies performed previously are deemed to still be current.

In light of the results documented in this 2011 assessment, the existing and planned OVEC system is expected to meet the NERC TPL standards without any transmission reinforcements or upgrades through 2021.

Introduction

This report provides an assessment of the OVEC transmission system as required by the NERC Transmission Planning Standards. This assessment, and the studies it documents, is also an integral part of the open planning process instituted in response to FERC Order 890.

System Description

The Ohio Valley Electric Corporation (OVEC) and its subsidiary, Indiana-Kentucky Electric Corporation (IKEC), were organized and their transmission systems constructed in the years 1952-1956. OVEC/IKEC was formed by 15 investor-owned electric utility companies (Sponsors) for the express purpose of supplying the electric power requirements of a single retail customer, the U.S. Department of Energy's (DOE) uranium enrichment project (Project) located near Portsmouth, Ohio. Due to the highly critical nature of the DOE load, stringent design criteria were adopted for planning and constructing the OVEC/IKEC System.

The entire OVEC/IKEC System is considered to be part of the bulk electric system, as it is primarily an EHV network. The system map, showing the configuration as presently planned to exist through the end of the 10 year planning horizon, appears below. The only non-EHV transmission facilities are 138 kV facilities associated with interconnections to the systems of several Sponsors. The OVEC system is highly interconnected. Interconnecting facilities consist of eight 345 kV lines, the high-side connections to four neighboring system 345/138 kV transformers, and three 138 kV lines. The strong internal EHV network and number of interconnections relative to the size of

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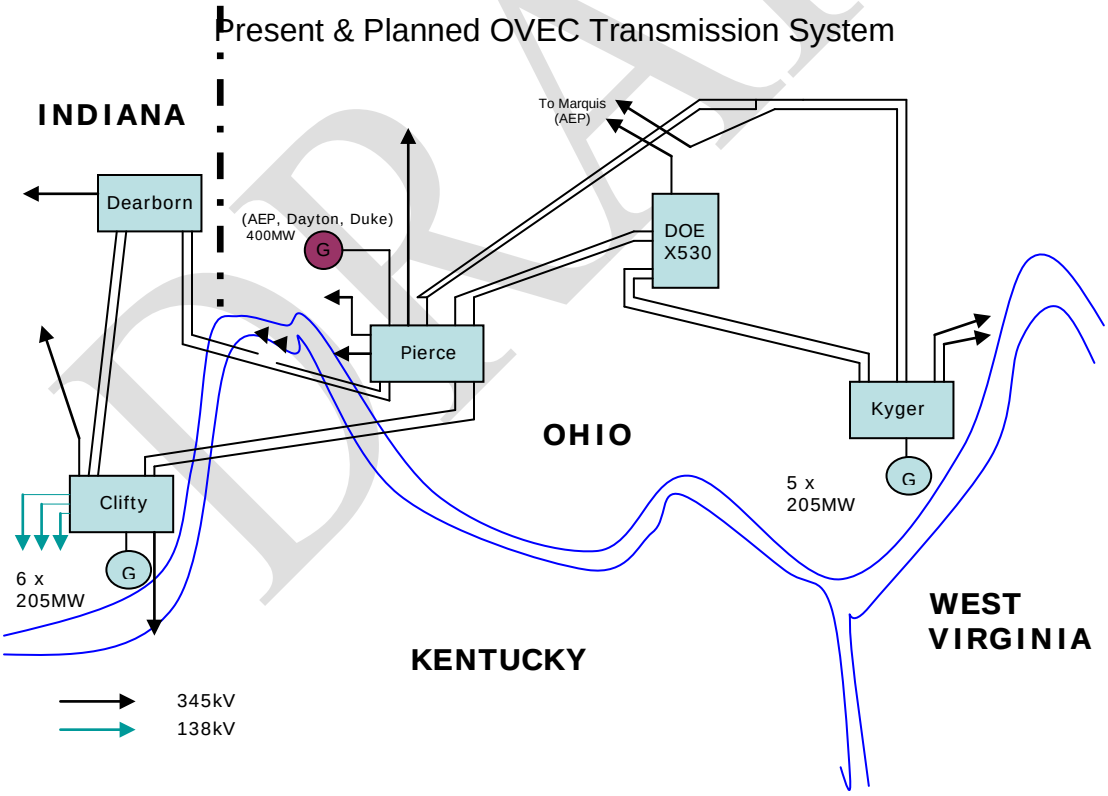
the system precludes a need to analyze sub areas within OVEC, or to use more detailed models than are used in regional studies.

The minimal DOE load today is served from the remaining DOE-owned 345 kV station (DOE X530) within the Project's boundaries. Two double-circuit tower 345kV lines and one single-circuit 345 kV line from OVEC/IKEC and Sponsors' stations supply this station. A second, similar station (DOE X533) was removed from service in November 2008. Reconnection of the lines (bypassing the former station site) was completed in December 2010. The OVEC/IKEC System has eleven generating units located at two plants with a total capacity of about 2300 MW. The 414 MW Beckjord Unit 6 (DEM/DPL/AEP) is also connected to the OVEC system at the Pierce station. Prior to September 2001, a portion of the OVEC generation was delivered to the DOE load based on the demand established in OVEC/IKEC's contract with DOE, and any remaining generation was sold to the Sponsors on an ownership participation basis. Since September 2001, all generation, with the exception of required operating reserves, has been made available to the Sponsors. Considering the strength of the generation and transmission system compared with the total load served and the transfers incurred in real time, it is reasonable to assume that OVEC does not require additional reactive compensation.



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Review of Recent Operating Conditions and System Changes

As outlined in Attachment M of the OVEC Tariff, the following factors are to be addressed in developing the OVEC transmission plan:

- Review of recent operating conditions, such as NERC Transmission Loading Relief events or MISO and PJM LMP binding constraints that may indicate developing reliability concerns on the OVEC system
  - *There were 3 TLR events declared during 2010 on the Trimble County-Clifty Creek 345 kV tieline. Two events in February lasted about 7 hours each. The third occurred in December, and lasted nearly 13 hours.*

- Requests for connection to OVEC facilities
  - *None*

- Requests for service into, out of, or through the OVEC Transmission system
  - *None*

- Projections of future load or generation changes within OVEC
  - *Minimal*

- Projections of OVEC major transmission equipment or systems approaching end-of-useful life
  - *Sixteen 345 kV Oil Circuit Breakers (OCB) and associated Protection & Control (P&C) equipment at Kyger Creek and two 345 kV OCB's at Dearborn.*

New Facilities

Replacement of antiquated circuit breakers and associated relays and controls at Kyger Creek continues. Replacement of the 17 original 330/345 kV Oil Circuit Breakers (Including 1 owned by AEP) is scheduled to be completed by the end of 2012.

At Dearborn, the station has two separate 345 kV buses. For several decades Bus #2 has only connected the Clifty Creek –Dearborn 345 kV circuit # 2 to the Dearborn – Buffington 345 kV interconnection with Duke. To address a number of concerns about the antiquated Dearborn CB's DA and DD, these breakers will be bypassed and retired as soon as possible, creating a Clifty Creek –Buffington 345 kV circuit which physically passes through the station site but without any switching at Dearborn. For network analysis purposes, the resulting Clifty Creek – Dearborn circuit will be functionally equivalent to the existing configuration.

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Abnormal Conditions

No extended periods of abnormal conditions are expected on the OVEC system..

Study Base Cases

Assumptions

The power flow models used for the steady state analyses represent the OVEC and adjacent transmission systems as planned for 2016 and 2021 Summer periods. The 2011 Summer RFC Seasonal Assessment model provides a reference point based on present-year conditions. The 2016 summer period represents the latter portion of the near-term (years 1-5) planning horizon. The 2021 summer period represents the latter portion of the longer-term (years 6-10) planning horizon.

Planning horizon models:

- **2016 Summer Peak Load** --The initial base case model for the 2016 summer peak load study was derived from the 2010 series MMWG 2016 summer peak load case. Conditions represented in this model include projected peak loads for the 2016 summer period, with all available facilities in service and anticipated firm transactions. Because the OVEC Transmission system consists entirely of 345 kV and 138 kV facilities, the OVEC system is fully represented in the MMWG power flow models. There are no additional OVEC transmission facilities expected to be in service for 2016 summer that were not represented in the MMWG models. For OVEC, key assumptions consist of an area load of 35 MW and a total generation of 2,000 MW delivered to the OVEC owners. In determining the level of OVEC- interchange to be modeled, it is assumed that the equivalent of one of the eleven OVEC generators is not available. Because the OVEC generation units are all of similar size, age, and operating history, the assumption is made that they will all be dispatched at similar levels.

  2021 Summer Peak Load --The initial base case model for the 2021 summer peak load study was derived from the 2010 series MMWG 2021 summer peak load case. Conditions represented in this model include projected peak loads for the 2021 summer period, with all available facilities in service and anticipated firm transactions. Because the OVEC Transmission system consists entirely of 345 kV and 138 kV facilities, the OVEC system is fully represented in the MMWG power flow models. There are no additional OVEC transmission facilities expected to be in service for 2021 summer that were not represented in the MMWG models. For OVEC, key assumptions consist of an area load of 35 MW and a total generation of 2,000 MW delivered to the OVEC owners. In

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determining the level of OVEC- interchange to be modeled, it is assumed that the equivalent of one of the eleven OVEC generators is not available. Because the OVEC generation units are all of similar size, age, and operating history, the assumption is made that they will all be dispatched at similar levels.

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Transfer Capability Analysis (FCITC)

The PTI/Siemens PSS/E and/or MUST analysis tools were used to screen for violations of performance criteria under various outage conditions. MUST was also used to determine First Contingency Incremental Transfer Capabilities (FCITCs) for 12 different transfer directions expected to affect flows into, out of or through the OVEC system. These FCITCs are not an indication of the transmission network capability to accommodate a specific transfer or transmission service request. However, they serve as a surrogate for a variety of possible operating conditions, and provide a means to evaluate the strength of the system as it is stressed by these varied conditions. The following transfer directions were studied:

From	To	2016 Summer Peak Load FCITC (MW)	Limit	2021 Summer Peak Load FCITC (MW)	Limit
OVEC	Sponsors*	100+	None	100+	None
Sponsors*	OVEC	250	Trimble County – Clifty Creek 345 kV	800 - 1200	Trimble County – Clifty Creek 345 kV
LGEE	DEM	100 - 200	Trimble County – Clifty Creek 345 kV	400-750	Trimble County – Clifty Creek 345 kV
DEM	LGEE	150+	None	150+	None
LGEE	AEP	50 - 150	Trimble County – Clifty Creek 345 kV	350 - 550	Trimble County – Clifty Creek 345 kV
AEP	LGEE	4000+	None	3300	Clifty Creek – Northside 138 kV
EKPC	DEM	200 - 400	Trimble County – Clifty Creek 345 kV	500+	None
EKPC	DAY	350- 400	Trimble County – Clifty Creek 345 kV	600+	None
TVA	ITC	400 - 500	Trimble County – Clifty Creek 345 kV	2200	Trimble County – Clifty Creek 345 kV
ITC	TVA	1500+	None	1500+	None
AMIL	DVP	800 - 950	Trimble County – Clifty Creek 345 kV	1700+	None
DVP	AMIL	650+	None	1000+	None
AMIL	PJM	650 - 800	Trimble County – Clifty Creek 345 kV	1700+	None

+ Not limited by transmission conditions at the value given (Generation Capacity Limit or tested transfer level)
*The deliveries involving the OVEC Sponsoring companies are allocated in the following manner:

AEP 61.45% (Includes Buckeye share)
AP 3.5%

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FE	11.5%	(Includes Peninsula share)
DEM	9.0 %	
DAY	4.9%	
SIGE	1.5%	
LGEE	8.15%	

The MUST sensitivity analysis capabilities were also used to determine the generation participation changes that would produce the worst FCITC results. In addition to providing insight into the variability of FCITC limitations for different generation dispatches, these analyses identify plants where future capacity changes could affect performance of the OVEC system. Where a range of FCITCs is provided, the range reflects both the FCITC result and the effects of the sensitivity analysis.

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Steady State Analysis Results

NERC Planning Standard TPL-001-1 Category A Conditions (No Contingencies)

- No OVEC facility loadings exceed the Normal ratings, and voltages are within criteria in the 2011 Summer reference model, the 2016 Summer near-term model, and the 2021 Summer long term model.

NERC Planning Standard TPL-002-1b Category B Conditions (Event resulting in the loss of a single element)

Approximately 5,000 Category B contingencies were simulated for each season studied.

No OVEC facility loadings exceed the Emergency ratings, and voltages are within criteria in all Category B contingency simulations based on the 2011 Summer reference model, the 2016 Summer near-term model, and the 2021 Summer long term model. There were 14 contingencies that failed to solve. Review of these contingencies shows that they are outages of 138 kV or subtransmission facilities located in the Beckley, WV and Ft Wayne, IN areas of AEP, far enough away from the OVEC system that they would not affect OVEC transmission conditions.

NERC Planning Standard TPL-003-0a System Performance Following Loss of Two or More Bulk Electric System Elements (Category C)

More than 11,000 Category C contingencies were simulated for each season studied..

No OVEC facility loadings exceed the Emergency ratings, and voltages are within criteria in all Category B contingency simulations based on the 2011 Summer reference model, the 2016 Summer near-term model, and the 2021 Summer long term model.

NERC Planning Standard TPL-004-0 Category D Conditions (Extreme event resulting in two or more (multiple) elements removed or cascading out of service)

Because most OVEC stations have a fully developed Breaker and half layouts, steady state simulation of most Category D events is already addressed under Category C. The exceptions that apply to the OVEC system include Category D contingency sub-types 8 and 9, which involve loss of one voltage level at a substation or switching station, including transformation, and subtype 10, which involves loss of all generating units at a station.

Approximately 45 station outage contingencies were simulated in studies performed in 2011. Eight of these outages are internal to OVEC, the remainder involve neighboring

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buses in the adjacent systems. No indication of cascading was identified in these simulations.

Short Circuit Assessment

Studies were performed in 2010 evaluating the expected short circuit interrupting duties relative to the capability of the existing and planned circuit breakers. Based on review of the system changes from the model used in the previous analysis, the previous results are still valid. The 2010 Studies showed that no OVEC circuit breakers are expected to be called upon to interrupt fault currents in excess of their capability. The lowest margins were found at Kyger Creek, on CBs which were replaced by the end of 2010 Replacement of additional antiquated breakers is continuing, and is scheduled to be completed by the end of 2012 The detailed studies are documented in a separate report, provided as Appendix D.

Stability Studies and Results

Studies were performed in 2010 to evaluate the stability performance of the Kyger Creek plant with the new transmission outlet configuration (bypassing the former DOE X533 site.) The plant performance was found to meet the requirements of both the OVEC Transmission Testing Criteria and NERC Reliability Standards. Based on review of the system changes from the model used in the previous analysis, the previous results are still valid. The 2010 studies were documented in a separate report, provided as Appendix E.

Operating Procedures/Special Protection Systems

OVEC has no Special Protection Systems. Operating procedures exist to reduce flows through the Clifty Creek-Carrolton 138 kV tieline between OVEC and E.On and the Kyger Creek-Sporn 345 kV tieline between OVEC and AEP. They are described in Part 5 of the OVEC response to FERC Form 715, and reproduced in Appendix B of this report.

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Appendices

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Appendix A – Testing Criteria

(Excerpt from the OVEC response to FERC FORM 715 - ANNUAL TRANSMISSION PLANNING AND EVALUATION REPORT)

4. TRANSMISSION TESTING CRITERIA

4.1 Steady State Testing Criteria

The planning process for OVEC/IKEC's transmission network embraces two major sets of testing criteria to ensure reliability. The first set includes all critical single and double contingencies. The second set includes more severe multiple contingencies (such as those described in ECAR Document No. 1) and is primarily intended to test the potential for system cascading.

For OVEC/IKEC transmission planning, the testing criteria are deterministic in nature; these outages serve as surrogates for a broad range of actual operating conditions that the power system will have to withstand in a reliable fashion.

4.1.1 Single and Double Contingencies

Contingencies include the forced or scheduled outage of generating units, transmission circuits, transformers, or other equipment. In general, a single contingency is defined as the outage of any one of these facilities. Due to the interconnected nature of power systems, testing includes outages of facilities in neighboring systems. A single facility is defined based on the arrangement of automatic protective devices. Generally, double circuit tower outages, breaker failures, station outages, common right-of-way outages, and other common mode failures have substantially lower probabilities of occurrence than the outage of a single transmission facility and are, therefore, not considered single contingencies.

Double contingencies, being a more severe test of system performance, are used as a surrogate for the significant uncertainties that are inherent in the planning process.

Operational planning studies consider up to two key outages in effect prior to the next (third) contingency. It is assumed that all operator adjustments required for the prior outages have been implemented. The number of prior outages depends on the strength of the transmission system and the number of variables to be considered in developing effective operating guidelines. Clearly, as the number of concurrent contingencies increases, it will become increasingly difficult to meet the required performance limits (see Section 3), even with special operating procedures.

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The number of outages actually occurring on the system can exceed the number assumed for study purposes. Operational planning engineers can evaluate those conditions, as needed.

4.1.2 Severe (ECAR Type) Contingencies

The more severe Reliability Assessment Criteria required in ECAR Document No. 1 are primarily intended to prevent uncontrolled area-wide cascading outages under adverse but credible conditions. OVEC/IKEC, as a member of ECAR, plans and operates its transmission system to meet the criteria of ECAR Document No. 1. However, new facilities would not be committed on the basis of local overloads or voltage depressions following the more severe ECAR type multiple contingencies unless those resultant conditions were expected to lead to widespread, uncontrolled outages.

In operational planning studies, the purpose of studying multiple contingencies and/or high levels of power transfers is to evaluate the robustness of the system. Where conditions are identified that could result in significant equipment damage, uncontrolled area-wide power interruptions, or danger to human life, operating procedures will be developed, if possible, to avoid or minimize the adverse effects. It is accepted that the defined performance limits could be exceeded on a localized basis during the more severe ECAR type multiple contingencies, and that there could be resultant minor equipment damage, increased loss of equipment life, or limited loss of customer load. Normally, operating procedures to mitigate uncontrolled area-wide power interruptions are only used on an interim basis until facility additions can be put in place to restore acceptable reliability levels.

4.2 Stability Testing Criteria

Stability testing covers the entire range of power system dynamics from "first swing" transient stability to the longer term oscillatory and steady-state stability. This testing is an essential complement to the steady state analysis embodied in the load flow testing described above.

Power plant transient stability is a very important consideration since loss of synchronism of a generating unit or an entire generating plant, in addition to compounding the disturbance by the loss of generators, can lead to equipment damage. When simulating system contingencies affecting power plant stability, various types of fault and network conditions are analyzed using the transient stability performance testing criteria outlined in Appendix C.

Steady-state and oscillatory stability performance problems may be initiated by a wide variety of contingencies or operating conditions on the transmission network. Therefore, a wide variety of network disturbances are considered when testing for steady-state and oscillatory stability problems.

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Acceptable performance limits for all types of stability performance are discussed in Section 3.

4.3 Power Transfer Testing Criteria

The power transfer capability between two interconnected systems (or sub-systems) with all facilities in service or with one or two critical components out of service, indicates the overall strength of the network. Many definitions of power transfer capability are possible, but uniformity is highly desirable for purposes of comparison. Furthermore, transfer capability, however defined, is only accurate for the specific set of system conditions under which it was derived. Therefore, the user of this information needs to be aware of the conditions under which the transfer capability was determined and those factors that could significantly influence the capability.

OVEC/IKEC has adopted the definitions of transfer capability, published by NERC in "Transmission Transfer Capability", dated May 1995. The most frequently used transfer capability definition is for First Contingency Incremental Transfer Capability (FCITC) and is quoted below from the referenced NERC publication:

First Contingency Incremental Transfer Capability

"FCITC is the amount of power, incremental above normal base power transfers, that can be transferred over the transmission network in a reliable manner, based on the following conditions:

1. For the existing or planned system configuration, and with normal (pre-contingency) operating procedures in effect, all facility loadings are within normal ratings and all voltages are within normal limits.

2. The electric systems are capable of absorbing the dynamic power swings, and remaining stable, following a disturbance that results in the loss of any single electric system element, such as a transmission line, transformer, or generating unit, and

3. After the dynamic power swings subside following a disturbance that results in the loss of any single electric system element as described in 2 above, and after the operation of any automatic operating systems, but before any post-contingency operator-initiated system adjustments are implemented, all transmission facility loadings are within emergency ratings and all voltages are within emergency limits."

First Contingency Total Transfer Capability (FCTTC) is similar to FCITC except that the base power transfers (between the sending and receiving areas) are added to the incremental transfers to give total transfer capability. ECAR has adopted guidelines for interpreting and applying the NERC transfer capability definitions, and OVEC/IKEC uses these guidelines in its internal studies as well.

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While the first contingency transfer capabilities are the most frequently used measure of system strength, transfer capabilities also can be calculated for "no contingency" and "second contingency" conditions.

In April 1996 the Federal Energy Regulatory Commission issued two rules -- Orders No. 888 and 889. Two aspects of these rules are "open access" to the transmission systems of integrated utilities and the posting of available transfer capability. The ability of a transmission system to permit power transfers is defined by several terms, namely:

Firm Available Transfer Capability (ATC)
Firm Total Transfer Capability (TTC)
Non-firm ATC
Non-firm TTC
Transmission Reliability Margin
Capacity Benefit Margin

The ATC/TTC values provide an indication of the ability of the transmission system to support transfers. Firm ATC is the level of additional transfer capability remaining in the physical network for further commercial activity over and above existing commitments for future time periods. The ATC/TTC values are calculated for transactions in both directions between OVEC/IKEC and directly connected control areas and for selected commercially viable through paths across the OVEC/IKEC System. ATC values are the lesser of network capability or contract path capacity (i.e., the total capability of interconnections to a neighboring control area). Firm TTC is determined by adding firm schedules and/or reservations to the ATC values.
Non-firm ATC are calculated in a manner similar to that used to calculate the firm values, except that both firm and non-firm transactions are included in the calculations.
TRM is the amount of transfer capability reserved to ensure that the transmission network is secure under a range of uncertainties in operating conditions. These uncertainties include generation unavailability, load forecast error, load diversity, unknown outages in neighboring systems, and variations in generation dispatch. The TRM is applied directly to facility ratings for calculations of firm ATC/TTC by adjusting the thermal rating of the critical facility(ies) down to 95% of the seasonal emergency capability. TRM is applied only to firm ATC calculations.

CBM is the amount of transfer capability reserved by Load Serving Entities to ensure access to generation from interconnected systems to meet generation reliability requirements. The total OVEC/IKEC CBM value is based upon generation reserve requirements. CBM is subtracted as a fixed MW amount from the firm OVEC/IKEC TTC import capability. The CBM is allocated among OVEC/IKEC's interfaces and the amount allocated to individual interfaces is based upon the lowest of: 1) the estimated long term generation reserve of the adjoining control area, 2) the transmission interconnection capability with each of the adjoining control areas, and 3) the FCTTC with each of the adjoining control areas. However, since the DOE Project load has been reduced to a very low level, the CBM for the OVEC System has been reduced to zero.

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OVEC/IKEC methodologies to calculate these values are consistent with the “NERC Available Transfer Capability” and the “ECAR TTC/ATC Calculation/Coordination” documents.

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Appendix B – Special Procedures & Contingencies

(Excerpt from the OVEC response to FERC FORM 715 - ANNUAL TRANSMISSION PLANNING AND EVALUATION REPORT)

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 138 kV 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.

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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.

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- 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 planned 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.

Multiple 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 NERC Category C or D contingencies for OVEC studies can be simulated by simply removing individual branches two at a time. NERC Category D contingencies resulting in complete station outages are also regularly tested. Most common power system analysis tools provide options to easily simulate these outages.

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Appendix C

Reference – 2011 Summer Category A Results

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     PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E      WED, OCT 19 2011  17:02
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2011 SUMMER ASSESSMENT FINAL
                      OUTPUT FOR AREA 206 [OVEC        ]
 BRANCH LOADINGS ABOVE 100.0 % OF RATING SET A:

 X--------- FROM BUS ----------X X---------- TO BUS -----------X       CURRENT(MVA)
   BUS# X-- NAME --X BASKV  AREA   BUS# X-- NAME --X BASKV  AREA CKT LOADING  RATING PERCENT

                                   * NONE *
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Reference – 2011 Summer Category B Results - Summary

Contingency Violation Summary

```
  PSS(tm)MUST  8.3.1 -- Managing and Utilizing System Transmission --  SAT, OCT 15 2011   8:33
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2011 SUMMER ASSESSMENT FINAL
Case.File   D:\JHR\OVEC\2011\Salam\Studies_2011\2011S\2011SUM-2010Series-Assessment-Final-Plus4_2.sav
Subsys.File D:\JHR\OVEC\2011\Salam\Studies_2011\2011S\Input_Files\ovec_11compl_inertia_1.sub
Monit.File  D:\JHR\OVEC\2011\Salam\Studies_2011\2011S\Input_Files\OVEC
combo.mon
Contin.File D:\JHR\OVEC\2011\Salam\Studies_2011\2011S\Input_Files\ovec+adjacent_singles_11_inertia_2_clx-1B.con
Exclud.File none



 *** Statistics on monitored constraints:

   Monitored Branches:    32
   Monitored Voltages:     8
       Contingencies :  4841

   *** Summary on Constraint Violations
***
 *** Violations with flow changes less  2.00 MVA or voltage change less  0.500 % ignored
 No System problems have been identified

 *** Contingency Results Summary. ***
 Total No. tested    = 4841   Total LF iterations 21348
  Converged          = 4827
  Voltage Collapse   =    7
  Not Converged      =    7



 ****** No violations encountered among selected monitored elements ******
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Reference – 2011 Summer Category B Results – Detailed list

Note: This list contains the contingencies identified in the Category B simulations as failing to converge. Review of their locations and characteristics (electrically remote from OVEC, and indicates that will they have little to no effect on powerflows and voltages on the OVEC system.

Contingency Analysis Detailed Report

```
  PSS(tm)MUST  8.3.1 -- Managing and Utilizing System Transmission --  TUE, OCT 18 2011   2:06
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2016 SUMMER PEAK CASE, FINAL
Case.File   D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\2016SUM-2010Series-Final_1.sav
Subsys.File D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\Input_Files\ovec_11compl_inertia_2_dem.sub
Monit.File  D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\Input_Files\OVEC
combo.mon
Contin.File D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\Input_Files\ovec+adjacent_singles_11_inertia_2_clx_NF.con
Exclud.File
none

 Detailed report on selected contingencies. Total 5537. Selected   14
 ------------------------------------------------------------------
```

```
 ******* Contingency   191 242565 05BRADL2     138 242618 05DAMERN     138 1

                -------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
242565 05BRADL2     138 2051250 242618 05DAMERN     138 2051250 1     24.40
```

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```
******* Contingency   359 242637 05FLATWO     138 242783 05RUTLED     138 1

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
242637 05FLATWO     138 2051250 242783 05RUTLED     138 2051250 1    -63.49
```

```
******* Contingency  1192 243201 05COY EQ     999 243405 05PIGEOV    69.0 99

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243201 05COY EQ     999 2051252 243405 05PIGEOV    69.0 2051252 99    14.65
```

```
******* Contingency  1193 243201 05COY EQ     999 246547 05MOOREZ    69.0 99

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243201 05COY EQ     999 2051252 246547 05MOOREZ    69.0 2051252 99    15.26
```

```
******* Contingency  1196 243202 05MOPKEQ     999 243345 05MOORPK     138 1

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243202 05MOPKEQ     999 2051252 243345 05MOORPK     138 2051252 1    -31.35
```

```
******* Contingency  1199 243203 05MOVLEQ     999 243346 05MOTTV      138 1

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
```

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```
243203 05MOVLEQ     999 2051252 243346 05MOTTV      138 2051252 1    -29.98
 ____________________________________________________________________________

 ******* Contingency  1200 243203 05MOVLEQ     999 243405 05PIGEOV    69.0 99

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243203 05MOVLEQ     999 2051252 243405 05PIGEOV    69.0 2051252 99    22.36

 ____________________________________________________________________________

 ******* Contingency  1327 243255 05BUSHZ      138 243345 05MOORPK     138 1

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243255 05BUSHZ      138 2051252 243345 05MOORPK     138 2051252 1     31.35

 ____________________________________________________________________________

 ******* Contingency  1355 243265 05COREY      138 243347 05MOTTVZ     138 1

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243265 05COREY      138 2051252 243347 05MOTTVZ     138 2051252 1    -21.26
 ____________________________________________________________________________

 ******* Contingency  1506 243346 05MOTTV      138 243347 05MOTTVZ     138 1

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243346 05MOTTV      138 2051252 243347 05MOTTVZ     138 2051252 1    -29.99

 ____________________________________________________________________________

 ******* Contingency  1553 243401 05INDPK     69.0 243412 05STURGI    69.0 1
```

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```
                -------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243401 05INDPK     69.0 2051252 243412 05STURGI    69.0 2051252 1      8.69
```

```
 ******* Contingency  1554 243401 05INDPK     69.0 246547 05MOOREZ    69.0 1

                -------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243401 05INDPK     69.0 2051252 246547 05MOOREZ    69.0 2051252 1    -23.75
```

```
 ******* Contingency  1564 243405 05PIGEOV    69.0 243411 05STUBED    69.0 1

                -------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243405 05PIGEOV    69.0 2051252 243411 05STUBED    69.0 2051252 1     21.45
```

```
 ******* Contingency  1570 243411 05STUBED    69.0 243412 05STURGI    69.0 1

                -------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243411 05STUBED    69.0 2051252 243412 05STURGI    69.0 2051252 1     18.92
```

DRAFT

Reference – 2011 Summer Category C Results - Summary

Contingency Violation Summary

```
  PSS(tm)MUST  8.3.1 -- Managing and Utilizing System Transmission --  SAT, OCT 15 2011  14:26
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2011 SUMMER ASSESSMENT FINAL
Case.File   D:\JHR\OVEC\2011\Salam\Studies_2011\2011S\2011SUM-2010Series-Assessment-Final-Plus4_2.sav
Subsys.File D:\JHR\OVEC\2011\Salam\Studies_2011\2011S\Input_Files\ovec_11compl_inertia_2z.sub
Monit.File  D:\JHR\OVEC\2011\Salam\Studies_2011\2011S\Input_Files\OVEC combo.mon
Contin.File D:\JHR\OVEC\2011\Salam\Studies_2011\2011S\Input_Files\subdblcont_11_compl.con
Exclud.File none



 *** Statistics on monitored constraints:

   Monitored Branches:    32
   Monitored Voltages:     8
       Contingencies : 11068

   *** Summary on Constraint Violations   ***
 *** Violations with flow changes less    2.00 MVA or voltage change less  0.500 % ignored
 No System problems have been identified

 *** Contingency Results Summary. ***
 Total No. tested    =11068   Total LF iterations 62605
  Converged          =11068
  Voltage Collapse   =    0
  Not Converged      =    0



 ****** No violations encountered among selected monitored elements ******
```

DRAFT

Reference – 2011 Summer Category D Results - Summary

Contingency Violation Summary

```
  PSS(tm)MUST  8.3.1 -- Managing and Utilizing System Transmission --  MON, OCT 31 2011  23:09
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2011 SUMMER ASSESSMENT FINAL
Case.File   D:\JHR\OVEC\2011\Salam\Studies_2011\2011S\2011SUM-2010Series-Assessment-Final-Plus4_2.sav
Subsys.File D:\JHR\OVEC\2011\Salam\Studies_2011\2011S\Input_Files\ovec_11compl_inertia_2.sub
Monit.File  D:\JHR\OVEC\2011\Salam\Studies_2011\2011S\Input_Files\OVEC combo.mon
Contin.File D:\JHR\OVEC\2011\Salam\Studies_2011\Input_files\station outage.con
Exclud.File none



 *** Statistics on monitored constraints:

   Monitored Branches:    32
   Monitored Voltages:     8
       Contingencies :    46

   *** Summary on Constraint Violations    ***
 *** Violations with flow changes less    2.00 MVA or voltage change less  0.500 % ignored
 No System problems have been identified

 *** Contingency Results Summary. ***
 Total No. tested    =   42   Total LF iterations 179
  Converged          =   42
  Voltage Collapse   =    0
  Not Converged      =    0



 ****** No violations encountered among selected monitored elements ******
```

DRAFT

2016 Summer Category A results

```
     PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS®E      TUE, OCT 18 2011   0:57
2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
2016 SUMMER PEAK CASE, FINAL
                     OUTPUT FOR AREA 206 [OVEC        ]
SUBSYSTEM LOADING CHECK (INCLUDED: LINES; BREAKERS AND SWITCHES; TRANSFORMERS) (EXCLUDED: NONE)
LOADINGS ABOVE 100.0 % OF RATING SET A (MVA FOR TRANSFORMERS, CURRENT FOR NON-TRANSFORMER BRANCHES):

X--------- FROM BUS ----------X X---------- TO BUS -----------X
  BUS# X-- NAME --X BASKV  AREA   BUS# X-- NAME --X BASKV  AREA CKT LOADING  RATING PERCENT

                                  * NONE *
```

DRAFT

2016 Summer Category B results

Contingency Violation Summary

```
  PSS(tm)MUST  8.3.1 -- Managing and Utilizing System Transmission --  SUN, OCT 16 2011   9:47
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2016 SUMMER PEAK CASE, FINAL
Case.File   D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\2016SUM-2010Series-Final_1.sav
Subsys.File D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\Input_Files\ovec_11compl_inertia_2_dem.sub
Monit.File  D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\Input_Files\OVEC
combo.mon
Contin.File D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\Input_Files\ovec+adjacent_singles_11_inertia_2_clx_NF.con
Exclud.File none



 *** Statistics on monitored constraints:

   Monitored Branches:    32
   Monitored Voltages:     8
       Contingencies :  5537

   *** Summary on Constraint Violations
***
 *** Violations with flow changes less    2.00 MVA or voltage change less  0.500 %
ignored
 No System problems have been identified

 *** Contingency Results Summary. ***
 Total No. tested    = 5537   Total LF iterations 18169
  Converged          = 5523
  Voltage Collapse   =    7
  Not Converged      =    7

 ****** No violations encountered among selected monitored elements ******
```

DRAFT

2016 Summer Category C results

Contingency Violation Summary

```
  PSS(tm)MUST  8.3.1 -- Managing and Utilizing System Transmission --  MON, OCT 17 2011   2:12
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2016 SUMMER PEAK CASE, FINAL
Case.File   D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\2016SUM-2010Series-Final_1.sav
Subsys.File D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\Input_Files\ovec_11compl_inertia_2_dem.sub
Monit.File  D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\Input_Files\OVEC
combo.mon
Contin.File
D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\Input_Files\subdblcont_11_compl.con
Exclud.File none


 *** Statistics on monitored constraints:

   Monitored Branches:    32
   Monitored Voltages:     8
       Contingencies : 11017

   *** Summary on Constraint Violations
***
 *** Violations with flow changes less    2.00 MVA or voltage change less  0.500 %
ignored
 No System problems have been identified

 *** Contingency Results Summary. ***
 Total No. tested    =11017   Total LF iterations 39462
  Converged          =11017
  Voltage Collapse   =    0
  Not Converged      =    0

 ****** No violations encountered among selected monitored elements ******
```

DRAFT

2016 Summer Category D results

Contingency Violation Summary

```
  PSS(tm)MUST  8.3.1 -- Managing and Utilizing System Transmission --  SAT, OCT 22 2011   5:26
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2016 SUMMER PEAK CASE, FINAL
Case.File   D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\2016SUM-2010Series-Final_1.sav
Subsys.File D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\Input_Files\ovec_11compl_inertia_2_dem.sub
Monit.File  D:\JHR\OVEC\2011\Salam\Studies_2011\2016S\Input_Files\OVEC
combo.mon
Contin.File D:\JHR\OVEC\2011\Salam\Studies_2011\Input_files\subdbl_cont_bus_11.con
Exclud.File none



 *** Statistics on monitored constraints:

   Monitored Branches:    32
   Monitored Voltages:     8
       Contingencies :    46

   *** Summary on Constraint Violations
***
 *** Violations with flow changes less    2.00 MVA or voltage change less  0.500 %
ignored
 No System problems have been identified

 *** Contingency Results Summary. ***
 Total No. tested    =   46   Total LF iterations
173
  Converged          =   46
  Voltage Collapse   =    0
  Not Converged      =    0

 ****** No violations encountered among selected monitored elements ******
```

DRAFT

2021 Summer Category A results

```
--------------------------------------------------------------------------------

     PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS/E      WED, OCT 19 2011  17:52
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2021 SUMMER PEAK CASE, FINAL
                      OUTPUT FOR AREA 206 [OVEC        ]
 BRANCH LOADINGS ABOVE 100.0 % OF RATING SET A:

 X--------- FROM BUS ----------X X---------- TO BUS -----------X       CURRENT(MVA)
   BUS# X-- NAME --X BASKV  AREA   BUS# X-- NAME --X BASKV  AREA CKT LOADING  RATING PERCENT

                                   * NONE *
```

DRAFT

2021 Summer Category B results – Summary

Contingency Violation Summary

```
  PSS(tm)MUST  8.3.1 -- Managing and Utilizing System Transmission --  WED, OCT 19 2011   8:15
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2021 SUMMER PEAK CASE, FINAL
Case.File   D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\2021SUM-2010Series-Final_2.sav
Subsys.File D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\Input_Files\ovec_11compl_inertia_2_dem.sub
Monit.File  D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\Input_Files\OVEC
combo.mon
Contin.File D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\Input_Files\ovec+adjacent_singles_11_inertia_2_clx_NF.con
Exclud.File none


 *** Statistics on monitored constraints:

   Monitored Branches:    32
   Monitored Voltages:     8
       Contingencies :  5545

   *** Summary on Constraint Violations
***
 *** Violations with flow changes less    0.00 MVA or voltage change less  0.000 %
ignored
 No System problems have been identified

 *** Contingency Results Summary. ***
 Total No. tested    = 5545   Total LF iterations 28580
  Converged          = 5532
           Non-diver =    1
      Adjustm.locked =    0
  Voltage Collapse   =    7
  Not Converged      =    6

 ****** No violations encountered among selected monitored elements ******
```

DRAFT

2021 Summer Category B results – Details

Contingency Analysis Detailed Report

```
  PSS(tm)MUST  8.3.1 -- Managing and Utilizing System Transmission --  WED, OCT 19 2011  21:04
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2021 SUMMER PEAK CASE, FINAL
Case.File   D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\2021SUM-2010Series-Final_2.sav
Subsys.File D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\Input_Files\ovec_11compl_inertia_2_dem.sub
Monit.File  D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\Input_Files\OVEC
combo.mon
Contin.File D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\Input_Files\ovec+adjacent_singles_11_inertia_2_clx_NF.con
Exclud.File
none

 Detailed report on selected contingencies. Total 5545. Selected   13
 -------------------------------------------------------------------


 ____________________________________________________________________________________

 ******* Contingency   191 242565 05BRADL2     138 242618 05DAMERN     138 1

                -------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
242565 05BRADL2     138 2051250 242618 05DAMERN     138 2051250 1     25.45


 ____________________________________________________________________________________

 ******* Contingency  1192 243201 05COY EQ     999 243405 05PIGEOV    69.0 99

                -------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243201 05COY EQ     999 2051252 243405 05PIGEOV    69.0 2051252 99    15.10


 ____________________________________________________________________________________

 ******* Contingency  1193 243201 05COY EQ     999 246547 05MOOREZ    69.0 99
```

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```
                ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243201 05COY EQ     999 2051252 246547 05MOOREZ    69.0 2051252 99    15.56
```

```
 ******* Contingency  1196 243202 05MOPKEQ     999 243345 05MOORPK     138 1

                ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243202 05MOPKEQ     999 2051252 243345 05MOORPK     138 2051252 1    -31.93
```

```
 ******* Contingency  1199 243203 05MOVLEQ     999 243346 05MOTTV      138 1

                ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243203 05MOVLEQ     999 2051252 243346 05MOTTV      138 2051252 1    -30.49
```

```
 ******* Contingency  1200 243203 05MOVLEQ     999 243405 05PIGEOV    69.0 99

                ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243203 05MOVLEQ     999 2051252 243405 05PIGEOV    69.0 2051252 99    22.74
```

```
 ******* Contingency  1327 243255 05BUSHZ      138 243345 05MOORPK     138 1

                ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243255 05BUSHZ      138 2051252 243345 05MOORPK     138 2051252 1     31.93
```

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```
******* Contingency  1355 243265 05COREY      138 243347 05MOTTVZ     138 1

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243265 05COREY      138 2051252 243347 05MOTTVZ     138 2051252 1    -21.93
```

```
******* Contingency  1506 243346 05MOTTV      138 243347 05MOTTVZ     138 1

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243346 05MOTTV      138 2051252 243347 05MOTTVZ     138 2051252 1    -30.50
```

```
******* Contingency  1553 243401 05INDPK     69.0 243412 05STURGI    69.0 1

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243401 05INDPK     69.0 2051252 243412 05STURGI    69.0 2051252 1      8.89
```

```
******* Contingency  1554 243401 05INDPK     69.0 246547 05MOOREZ    69.0 1

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243401 05INDPK     69.0 2051252 246547 05MOOREZ    69.0 2051252 1    -24.24
```

```
******* Contingency  1564 243405 05PIGEOV    69.0 243411 05STUBED    69.0 1

               ------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
```

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```
243405 05PIGEOV    69.0 2051252 243411 05STUBED    69.0 2051252 1     21.95
```

```
 ******* Contingency  1570 243411 05STUBED    69.0 243412 05STURGI    69.0 1

                -------- Branches to be opened -----
**      From Bus     ** Are Zon **      To Bus       ** Are Zon CT OutageFl
243411 05STUBED    69.0 2051252 243412 05STURGI    69.0 2051252 1     19.37
```

DRAFT

2021 Summer Category C results – Summary

Contingency Violation Summary

```
  PSS(tm)MUST  8.3.1 -- Managing and Utilizing System Transmission --  WED, OCT 19 2011   0:54
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2021 SUMMER PEAK CASE, FINAL
Case.File   D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\2021SUM-2010Series-Final_2.sav
Subsys.File D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\Input_Files\ovec_11compl_inertia_2_dem.sub
Monit.File  D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\Input_Files\OVEC
combo.mon
Contin.File
D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\Input_Files\subdblcont_11_compl.con
Exclud.File none


 *** Statistics on monitored constraints:

   Monitored Branches:    32
   Monitored Voltages:     8
       Contingencies : 11018

   *** Summary on Constraint Violations
***
 *** Violations with flow changes less    2.00 MVA or voltage change less  0.500 %
ignored
 No System problems have been identified

 *** Contingency Results Summary. ***
 Total No. tested    =11018   Total LF iterations 58406
  Converged          =11018
  Voltage Collapse   =    0
  Not Converged      =    0

 ****** No violations encountered among selected monitored elements ******
```

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2021 Summer Category D results – Summary

Contingency Violation Summary

```
  PSS(tm)MUST  8.3.1 -- Managing and Utilizing System Transmission --  MON, OCT 31 2011  23:26
 2010 SERIES, ERAG/MMWG BASE CASE LIBRARY
 2021 SUMMER PEAK CASE, FINAL
Case.File   D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\2021SUM-2010Series-Final_2.sav
Subsys.File D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\Input_Files\ovec_11compl_inertia_2.sub
Monit.File  D:\JHR\OVEC\2011\Salam\Studies_2011\2021S\Input_Files\OVEC
combo.mon
Contin.File D:\JHR\OVEC\2011\Salam\Studies_2011\Input_files\subdbl_cont_bus_11.con
Exclud.File none

 *** Statistics on monitored constraints:

   Monitored Branches:    32
   Monitored Voltages:     8
       Contingencies :    46

   *** Summary on Constraint Violations
***
 *** Violations with flow changes less    2.00 MVA or voltage change less  0.500 %
ignored
           I     Initial Violations            I
           I Base  Case   I Contingency cases   I
Constraint I Numb. Worst  I Numb.  Worst Contin I
  Type     I Viol   Viol  I  Viol   Viol Number I
  MVA flow I    -     ---     1    37.8    46   I

Number of contingencies with violations:
1

 *** Contingency Results Summary. ***
 Total No. tested    =   46   Total LF iterations
208
```

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```
 Converged          =   46
 Voltage Collapse   =    0
 Not Converged      =    0


****** No violations encountered among selected monitored elements ******
```

DRAFT

Appendix D

Ohio Valley Electric Corporation

2010 Short Circuit Assessment

DRAFT 2

East Transmission Planning
September 2010

AEP: America's Energy Partner℠

DRAFT

The OVEC Short Circuit Assessment

The OVEC short circuit assessment was performed using the Aspen OneLiner V11.5 Breaker Rating Module™. The study was based on the PJM 2011 Base Line Case with the OVEC circuit breaker data added to the model. For each OVEC transmission station/bus, the Highest Typical Operating Voltage (HTOV) expected to exist at that station/bus in the foreseeable future was determined. For the short circuit duty assessment, the 99th-percentile value of the bus voltages recorded during the past 12 months by the AEP State Estimator, or available from other suitable historical data source(s), is used. A listing of Circuit Breakers modeled in the study* and the applicable HTOV or "test voltage" is provided as **Attachment A**.

The results of the study are summarized in the tables included as **Attachment B**. The results of the study show no overdutied circuit breakers in the OVEC system. In summary, two circuit breakers are at 90.2 %, two at 91.2%, and four at 92.7% of their respective capabilities. These circuit breakers are all at Kyger Creek station. The breakers at the Kyger Creek 345 kV station are the original large-volume Oil Circuit Breaker (OCB) equipment. Most of the Kyger Creek breakers were manufactured in the mid-1950's. Replacement of most of these antiquated breakers has begun and is expected to continue through 2011. In Attachment B the duty on the circuit breakers listed as "new" reflects the duty expected on the replacement circuit breakers (based on the new breaker characteristics). The lone 345 kV OCB at Kyger Creek that is not presently scheduled for replacement is the 1962-vintage breaker "BB, which is owned by AEP. Short circuit duties expected on this breaker are 74.1 % of its capability.

After the circuit breakers are replaced at Kyger Creek Station, the highest duty expected on any OVEC circuit breakers will be 81.8% and 80.5% on 345 kV circuit breakers DB and DC, respectively, at the Dearborn Station.

*Breaker characteristics utilized for Circuit Breakers within the OVEC Balancing Authority Area, but owned by others, are the best available at the time of this study. Results documented here are provided for the benefit of the equipment owner to make their own determination as to the adequacy of the breaker interrupting capabilities. The equipment owner bears ultimate responsibility to ensure that the equipment continues to be suitable for the application, including any applicable NERC Reliability Standard Compliance requirements.

DRAFT

Attachment A

345 kV OVEC Circuit Breakers

STATION_NAME	SYM_PH	AMP	KV_EQ	MFG_CB	TYP	Cycle Trip	K Factor	S Factor	Sym kA	Asy kA	Voltage In kV Test	MVA	Momentary In Amps
Dearborn	DB	1600	345	GE	HVB362-50000	2	1.0	1.3	50.0	65.0	358.5	40755.2	130000.0
Dearborn	DC	1600	345	GE	HVB362-50000	2	1.0	1.3	50.0	65.0	358.5	40755.2	130000.0
Dearborn Jct	DA	1600	345	W	3300GW-2500	2	1.1	1.2	33.5	40.2	358.5	24930.9	86164.0
Dearborn Jct	DD	1600	345	W	3300GW-2500	2	1.1	1.2	33.5	40.2	358.5	24930.9	86164.0
DOE 530	212	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	215	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	218	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	222	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	225	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	226	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	228	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	232	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	235	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	238	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	242	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	245	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	248	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	252	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	255	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	258	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	262	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	265	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	268	1600	345	W	3300GW-2500	2	1.1	1.2	33.3	40.0	360.2	24930.9	86164.0
DOE 530	272	2000	345	ITE	362-GA-40-20C	2	1.0	1.3	40.0	52.0	360.2	32604.1	104000.0
DOE 530	275	2000	345	ITE	362-GA-40-20C	2	1.0	1.3	40.0	52.0	360.2	32604.1	104000.0
DOE 530	278	2000	345	ITE	362-GA-40-20C	2	1.0	1.3	40.0	52.0	360.2	32604.1	104000.0
DOE 530	282	2000	345	ITE	362-GA-40-20C	2	1.0	1.3	40.0	52.0	360.2	32604.1	104000.0
DOE 530	285	2000	345	ITE	362-GA-40-20C	2	1.0	1.3	40.0	52.0	360.2	32604.1	104000.0
Clifty Creek	A	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	B	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	C	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	D	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	DL	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	DL2	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	E	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	F	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	G	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	H	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	I	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	J	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	K	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	L	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	M	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0

Attachment A

345 kV OVEC Circuit Breakers

STATION_NAME	SYM_PH	AMP	KV_EQ	MFG_CB	TYP	Cycle Trip	K Factor	S Factor	Sym kA	Asy kA	Voltage in kV Test	MVA	Momentary in Amps
Clifty Creek	N	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	O	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	P	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
Clifty Creek	Q	3000	345	GECA	PK-4B63	2	1.1	1.3	63.9	83.0	357.1	51351.5	163800.0
CLIFTY CREEK (AEF	S	3000	345	GE-H	HVB362-50000-63	2	1.0	1.3	63.0	82.0	357.1	51414.2	163800.0
CLIFTY CREEK (AEF	R	3000	345	GE-H	HVB362-50000-63	2	1.0	1.3	63.0	82.0	357.1	51414.2	163800.0
Kyger Creek	A	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	A(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	B	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	B(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	C	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	C(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	E	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	E(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	F	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	F(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	G	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	G(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	H	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	H(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	I	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	I(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	J	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	J(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	K	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	K(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	L	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	L(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	M	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	M(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	N	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	N(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	O	1600	345	W	3300GW-2500	2	1.1	1.2	33.6	40.3	356.7	24930.9	86164.0
Kyger Creek	O(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	P	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	356.7	40755.2	130000.0
Kyger Creek	Q	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	356.7	40755.2	130000.0
Kyger Creek	AA	2000	345	W	3450GW-25000	3	1.1	1.2	33.6	40.4	356.7	24973.5	86216.0
Kyger Creek	AA(NEW)	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Kyger Creek	BB (AEP)	2000	345	W	3450GW-25000	3	1.1	1.2	33.6	40.4	356.7	24973.5	86216.0
Pierce (OVEC)	A	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	B	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	C	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0

Attachment A

345 kV OVEC Circuit Breakers

STATION_NAME	SYM_PH	AMP	KV_EQ	MFG_CB	TYP	Cycle Trip	K Factor	S Factor	Sym kA	Asy kA	Voltage in kV Test	MVA	Momentary in Amps
Pierce (OVEC)	D	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	E	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	F	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	G	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	H	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	I	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	J	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	K	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	L	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	M	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	P	3000	345	GE-H	HVB362-50000	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	R	3000	345	GECA	FX-22A	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0
Pierce (OVEC)	Q	3000	345	GECA	FX-22A	2	1.0	1.3	50.0	65.0	358.8	40755.2	130000.0

138 kV OVEC Circuit Breakers

STATION_NAME	SYM_PH	AMP	KV_EQ	MFG_CB	TYP	Cycle Trip	K Factor	S Factor	Sym kA	Asy kA	Voltage in kV Test	MVA	Momentary in Amps
Clifty Creek	AC	800	138	GE	HVB145-40000	3	1.0	1.3	40.0	52.0	144.9	13059.7	104000.0
Clifty Creek	AD	800	138	GE	HVB145-40000	3	1.0	1.3	40.0	52.0	144.9	13059.7	104000.0
Clifty Creek	AE	800	138	GE	HVB145-40000	3	1.0	1.3	40.0	52.0	144.9	13059.7	104000.0

Attachment B

DATE_TIME	VERSION	BASE_MVA	GEN_Z	PHASE_SHIFT	LOAD
Fri Sep 24 09:41:07 2010	11.5	100	SUBTRAN SIENT	YES	NO

BUS_NO	BUS	BREAKER	DUTY_P	DUTY_A	BKR_CAPA
24953	06CLIFTY 138.kV	AC	41.7	21701.6	52000.1
24953	06CLIFTY 138.kV	AD	38.5	20033.9	52000.1
24953	06CLIFTY 138.kV	AE	42.1	21912	52000.1
24952	06CLIFTY 345.kV	A	69.8	58450.2	83688.5
24952	06CLIFTY 345.kV	B	69.8	58450.2	83688.5
24952	06CLIFTY 345.kV	C	66.6	55700.7	83688.5
24952	06CLIFTY 345.kV	D	69.8	58450.2	83688.5
24952	06CLIFTY 345.kV	DL	73.8	55700.9	75516.7
24952	06CLIFTY 345.kV	DL1	67.9	55700.9	82000
24952	06CLIFTY 345.kV	DL2	73.8	55700.9	75516.7
24952	06CLIFTY 345.kV	E	69.8	58450.2	83688.5
24952	06CLIFTY 345.kV	F	66.6	55700.7	83688.5
24952	06CLIFTY 345.kV	G	69.7	58359.2	83688.5
24952	06CLIFTY 345.kV	H	69.7	58359.2	83688.5
24952	06CLIFTY 345.kV	I	66.6	55700.7	83688.5
24952	06CLIFTY 345.kV	J	66.6	55700.7	83688.5
24952	06CLIFTY 345.kV	K	65.8	55035.9	83688.5
24952	06CLIFTY 345.kV	L	66.6	55700.7	83688.5
24952	06CLIFTY 345.kV	M	66.6	55700.7	83688.5
24952	06CLIFTY 345.kV	N	64.6	54084.1	83688.5
24952	06CLIFTY 345.kV	O	66.6	55700.7	83688.5
24952	06CLIFTY 345.kV	P	66.6	55700.7	83688.5
24952	06CLIFTY 345.kV	Q	66.6	55700.7	83688.5
24952	06CLIFTY 345.kV	R	67	55700.7	83131
24952	06CLIFTY 345.kV	S	67.9	55700.9	82000
24952	06CLIFTY 345.kV	T	67.9	55700.9	82000
24958	06DEARBN 345.kV	DB	81.8	52747.8	64465.8
24958	06DEARBN 345.kV	DC	80.5	51866.3	64465.8
24959	06DEARJT 345.kV	DA	33.8	13569.4	40155.3
24959	06DEARJT 345.kV	DD	33.8	13569.4	40155.3
24955	06DOE530 345.kV	212	72.3	28888	39963
24955	06DOE530 345.kV	215	72.3	28888	39963
24955	06DOE530 345.kV	218	72.3	28888	39963
24955	06DOE530 345.kV	222	72.3	28888	39963
24955	06DOE530 345.kV	225	72.3	28888	39963
24955	06DOE530 345.kV	228	72.3	28888	39963
24955	06DOE530 345.kV	242	72.3	28888	39963
24955	06DOE530 345.kV	245	72.3	28888	39963
24955	06DOE530 345.kV	248	72.3	28888	39963
24955	06DOE530 345.kV	252	72.3	28888	39963
24955	06DOE530 345.kV	255	72.3	28888	39963
24955	06DOE530 345.kV	258	72.3	28888	39963
24955	06DOE530 345.kV	262	72.3	28888	39963

Attachment B

DATE_TIME	VERSION	BASE_MVA	GEN_Z	PHASE_SHIFT	LOAD
Fri Sep 24 09:41:07 2010	11.5	100	SUBTRAN SIENT	YES	NO

BUS_NO	BUS	BREAKER	DUTY_P	DUTY_A	BKR_CAPA
24955	06DOE530 345.kV	265	72.3	28888	39963
24955	06DOE530 345.kV	268	72.3	28888	39963
24955	06DOE530 345.kV	272	57.9	30082.6	52000
24955	06DOE530 345.kV	275	57.9	30082.6	52000
24955	06DOE530 345.kV	278	57.9	30082.6	52000
24955	06DOE530 345.kV	282	55.4	28814.8	52000
24955	06DOE530 345.kV	285	57.9	30082.6	52000
24951	06KYGER 345.kV	A	90.2	37653.2	41721.3
24951	06KYGER 345.kV	A (NEW)	61.6	40028.8	65000.1
24951	06KYGER 345.kV	AA	74.1	37161.4	50159.9
24951	06KYGER 345.kV	AA (NEW)	59.6	38744.3	65000.1
24951	06KYGER 345.kV	B	90.2	37653.2	41721.3
24951	06KYGER 345.kV	B (NEW)	61.6	40028.8	65000.1
24951	06KYGER 345.kV	BB	74.1	37161.4	50159.9
24951	06KYGER 345.kV	C	89.1	37161.4	41721.3
24951	06KYGER 345.kV	C (NEW)	59.6	38744.3	65000.1
24951	06KYGER 345.kV	D	92.7	38680.5	41721.3
24951	06KYGER 345.kV	D (NEW)	63.3	41144	65000.1
24951	06KYGER 345.kV	E	92.7	38680.5	41721.3
24951	06KYGER 345.kV	E (NEW)	63.3	41144	65000.1
24951	06KYGER 345.kV	F	89.1	37161.4	41721.3
24951	06KYGER 345.kV	F (NEW)	59.6	38744.3	65000.1
24951	06KYGER 345.kV	G	92.7	38680.5	41721.3
24951	06KYGER 345.kV	G (NEW)	63.3	41144	65000.1
24951	06KYGER 345.kV	H	92.7	38680.5	41721.3
24951	06KYGER 345.kV	H (NEW)	63.3	41144	65000.1
24951	06KYGER 345.kV	I	89.1	37161.4	41721.3
24951	06KYGER 345.kV	I (NEW)	59.6	38744.3	65000.1
24951	06KYGER 345.kV	J	89.7	37423.2	41721.3
24951	06KYGER 345.kV	J (NEW)	61.2	39770.4	65000.1
24951	06KYGER 345.kV	K	89.7	37423.2	41721.3
24951	06KYGER 345.kV	K (NEW)	61.2	39770.4	65000.1
24951	06KYGER 345.kV	L	89.1	37161.4	41721.3
24951	06KYGER 345.kV	L (NEW)	59.6	38744.3	65000.1
24951	06KYGER 345.kV	M	91.2	38066.4	41721.3
24951	06KYGER 345.kV	M (NEW)	62.2	40459.1	65000.1
24951	06KYGER 345.kV	N	91.2	38066.4	41721.3
24951	06KYGER 345.kV	N (NEW)	62.2	40459.1	65000.1
24951	06KYGER 345.kV	O	89.1	37161.4	41721.3
24951	06KYGER 345.kV	O (NEW)	59.6	38744.3	65000.1
24951	06KYGER 345.kV	P	47.2	38744.3	82000
24951	06KYGER 345.kV	Q	47.2	38744.3	82000
24957	06PIERCE 345.kV	A	72.4	47054.2	65000.1

Attachment B

DATE_TIME	VERSION	BASE_MVA	GEN_Z	PHASE_SHIFT	LOAD
Fri Sep 24 09:41:07 2010	11.5	100	SUBTRANSIENT	YES	NO

BUS_NO	BUS	BREAKER	DUTY_P	DUTY_A	BKR_CAPA
24957	06PIERCE 345.kV	B	69.5	45154.6	65000.1
24957	06PIERCE 345.kV	C	72	46777.2	65000.1
24957	06PIERCE 345.kV	D	72	46777.2	65000.1
24957	06PIERCE 345.kV	E	73.7	47883.7	65000.1
24957	06PIERCE 345.kV	F	73.7	47883.7	65000.1
24957	06PIERCE 345.kV	G	69.5	45154.6	65000.1
24957	06PIERCE 345.kV	H	74.3	48323.3	65000.1
24957	06PIERCE 345.kV	I	74.3	48323.3	65000.1
24957	06PIERCE 345.kV	J	73.6	47848.1	65000.1
24957	06PIERCE 345.kV	K	74.3	48323.3	65000.1
24957	06PIERCE 345.kV	L	74.3	48323.3	65000.1
24957	06PIERCE 345.kV	M	73.6	47848.1	65000.1
24957	06PIERCE 345.kV	P	66.8	43425	65000.1
24957	06PIERCE 345.kV	Q	66.1	42950.6	65000.1
24957	06PIERCE 345.kV	R	69.5	45154.6	65000.1

Appendix E

A stability study of an existing generating plant connected to the OVEC system is not needed unless the answer to at least one of the following statements is "YES":

1. The impedance or configuration of the transmission network in the vicinity of a generating plant connected to the OVEC system has been modified by addition, removal, or other change.

YES _____	NO__X___

2. Changes have been made to the steady-state or stability modeling or MW capability of any generating unit.

YES _____	NO ___X__

Is a stability study needed based on 1 or 2 above?

YES _____	NO ___X___

This assessment was completed for the period listed and completed the individual named below.

2012 - 2016

Dates covering this assessment

R. J. O'Keefe

Name

10-21-2011

Date of assessment

Version History

REVISION	DATE	REVISED/REVIEWED BY	PURPOSE
1.0	**08/30/10**	**JHR, GWB, RJM, SRC, JAD**	**Original Issue**

Ohio Valley Electric Corporation

Kyger Creek Plant

Stability Performance Study

Of Final DOE Station Configurations

Advanced Transmission Studies and Technologies
September 2010

AEP: America's Energy Partner℠

1. INTRODUCTION

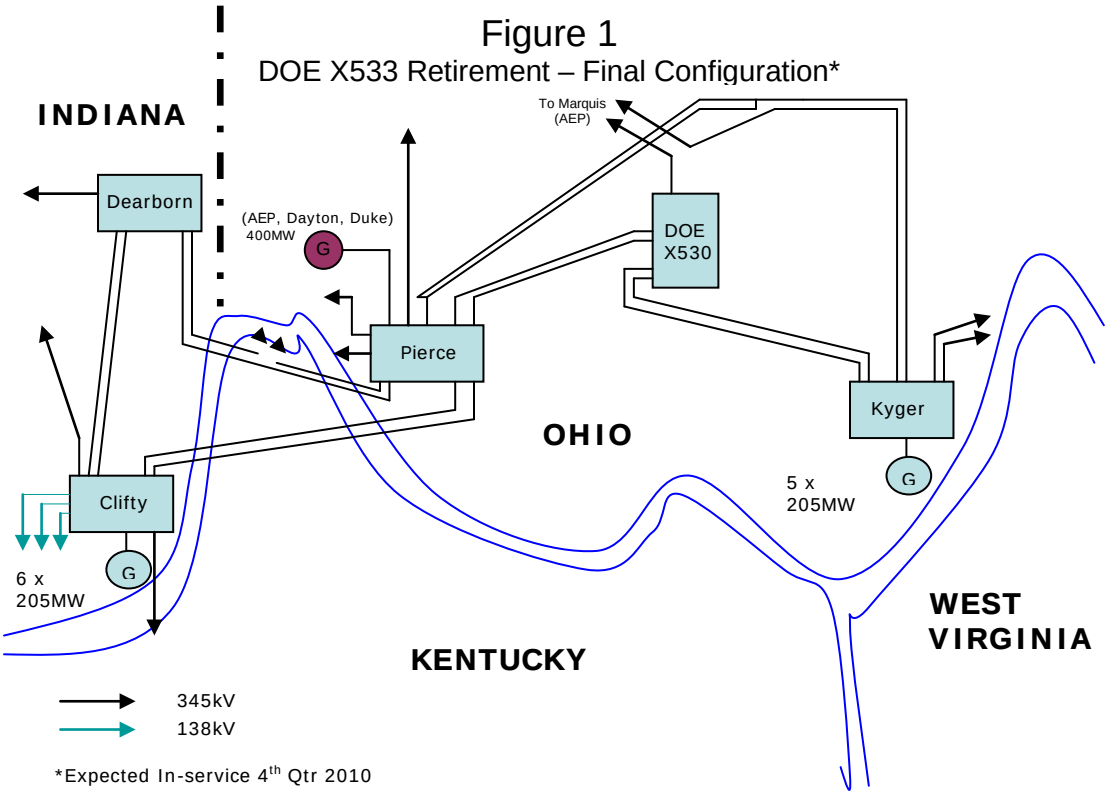
This study was undertaken to evaluate the stability performance of Ohio Valley Electric Corporation's (OVEC) Kyger Creek Plant following permanent changes to transmission interconnections at the Department of Energy's (DOE) X530 and X533 345 kV Stations. These changes are expected to be placed in service during the 4th quarter of 2010.

2. OVERVIEW OF GENERATION/TRANSMISSION FACILITIES

The generation capability at the Kyger Creek Plant is 1,025 MW winter net and is the sum of five similar units each rated at 205 MW winter net.

The final transmission configuration in the vicinity of DOE's X530 and X533 345 kV stations that was the subject of this study is as follows: Kyger Creek – X533 circuit 1 of the 345 kV double circuit tower (DCT) line is now routed directly to Marquis 345 kV from the X533 site (also utilizing the former X533-Marquis line, but without the series reactor) and Kyger Creek – X533 circuit 2 now connects to X533 – Pierce DCT line as a 6-wire DCT line from the X533 site to Pierce 345 kV Station. The X530 345 kV Station has been returned to the configuration that existed prior to the start of construction at Marquis and the 2008 interim reconfigurations.

The final configuration is also shown in Figure 1. The X533 Station no longer exists as a station and the entire DOE load of approximately 35 MW is now served from the X530 Station.



3. TESTING CRITERIA

AEP / OVEC transient stability criteria for 345 kV connected generation facilities shown in Table 1 below specify the conditions and events for which stable operation is required (see OVEC FERC Form 715 filing, Part 4). In addition, satisfactory damping of generator post-disturbance power oscillations is required.

These testing criteria are applied in time domain simulations to evaluate the stability performance of a generation facility. For each disturbance, the resulting transmission system response is simulated and then analyzed to assess the impact of the disturbance scenarios on the proposed generators and the surrounding system. A one cycle margin to instability is present in the stability results designated as acceptable reported in this study.

Although beyond the scope of the AEP / OVEC stability testing criteria, a double circuit tower (DCT) line outage was considered in this study as a valid and credible fault disturbance scenario.

TABLE 1

AEP / OVEC Stability Testing Criteria for 345 kV Connected Generation

Prefault System Condition		Fault Disturbance Scenario
All Transmission Facilities in Service	2A	Permanent single phase to ground fault with breaker failure. Fault clearing by backup breakers.
	2B	Permanent three phase to ground fault with unsuccessful HSR if applicable. Fault cleared by primary breakers.
	2C	Three phase line opening without fault.
One Transmission Facility Out	2D	Permanent three phase to ground fault with unsuccessful HSR, if applicable. Fault cleared by primary breakers.
	2E	Three phase line opening without fault.
Two Transmission Facilities Out	2F	Temporary three phase to ground fault with successful HSR, if applicable.
	2G	Three phase line opening without fault.

Where, Criteria 2A = NERC TPL Table 1 Category C6-9
Criteria 2B = NERC TPL Table 1 Category B1-3
Criteria 2C = NERC TPL Table 1 Category B1-3
Criteria 2D = NERC TPL Table 1 Category C3
Criteria 2E = NERC TPL Table 1 Category C3

The DCT line outages simulated in this study may be considered as a combination of NERC Category C3 and C5 contingencies. In this study, a prior outage of a DCT line is followed by another DCT line outage. The other NERC TPL category contingencies are either not applicable or would be less severe.

4. STUDY SCOPE and DATA

With reference to the above stability testing criteria, and in consideration of double circuit tower (DCT) faults and outages, the cases to be simulated were determined and are listed in Table 2 below. These cases all involved three-phase primary cleared faults or non-fault initiated tripping. Phase-to-ground delayed clearing faults were not simulated due to the station configuration at Kyger Creek 345 kV which is such that outage of further transmission elements does not occur, thus making these disturbance scenarios less severe.

Unsuccessful high speed reclosing (HSR) of faulted transmission lines was simulated in all three-phase fault cases. All primary fault clearing was assumed to be 3.5 cycles from fault initiation. The Kyger Creek Plant was dispatched at its winter net capacity of 1,025 MW unless otherwise indicated. The AEP 2009 series BCD 2015 Summer ERAG / MMWG base case was used in this study.

5. STUDY RESULTS

The study results for each stability simulation case are indicated in Table 2 below.

Each case consists of a prior double circuit tower (DCT) outage out of the Kyger Creek 345 kV Station followed by three-phase fault and trip, or non-fault initiated trip, of a second DCT. The Kyger Creek Plant is thus connected by one remaining DCT post-contingency in each case. Each of these cases is beyond the severity of the stated stability criteria in Section 3 above. The acceptable stability results from these cases indicate that less severe cases consistent with the criteria would also have acceptable stability.

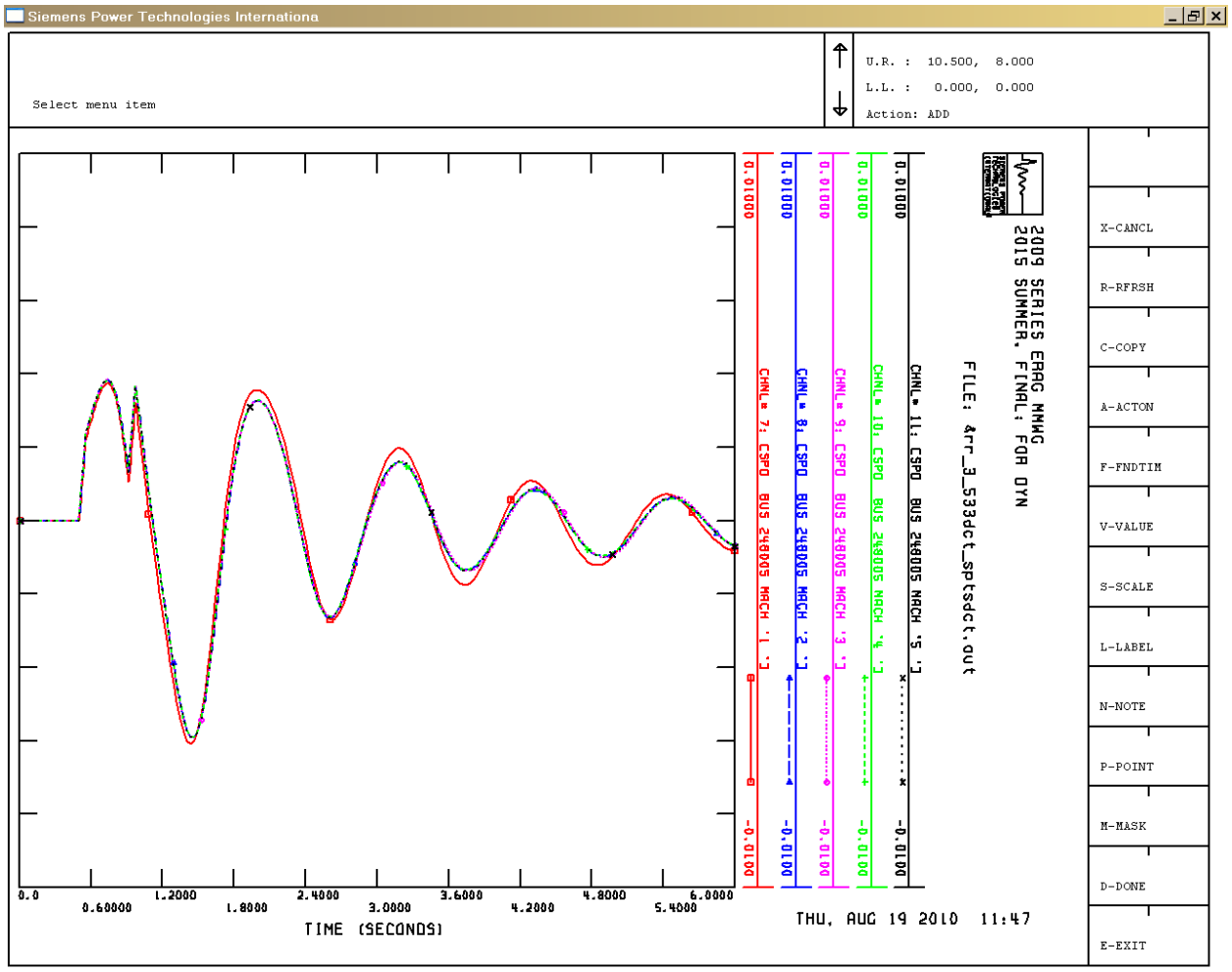
Plots of the dynamic simulation cases with three-phase faults are attached below.

6. CONCLUSION

The Kyger Creek Plant exhibits acceptable stability with the final configuration at DOE's X530 and X533 345 kV stations for Criteria 2A through 2E without a need for curtailment.

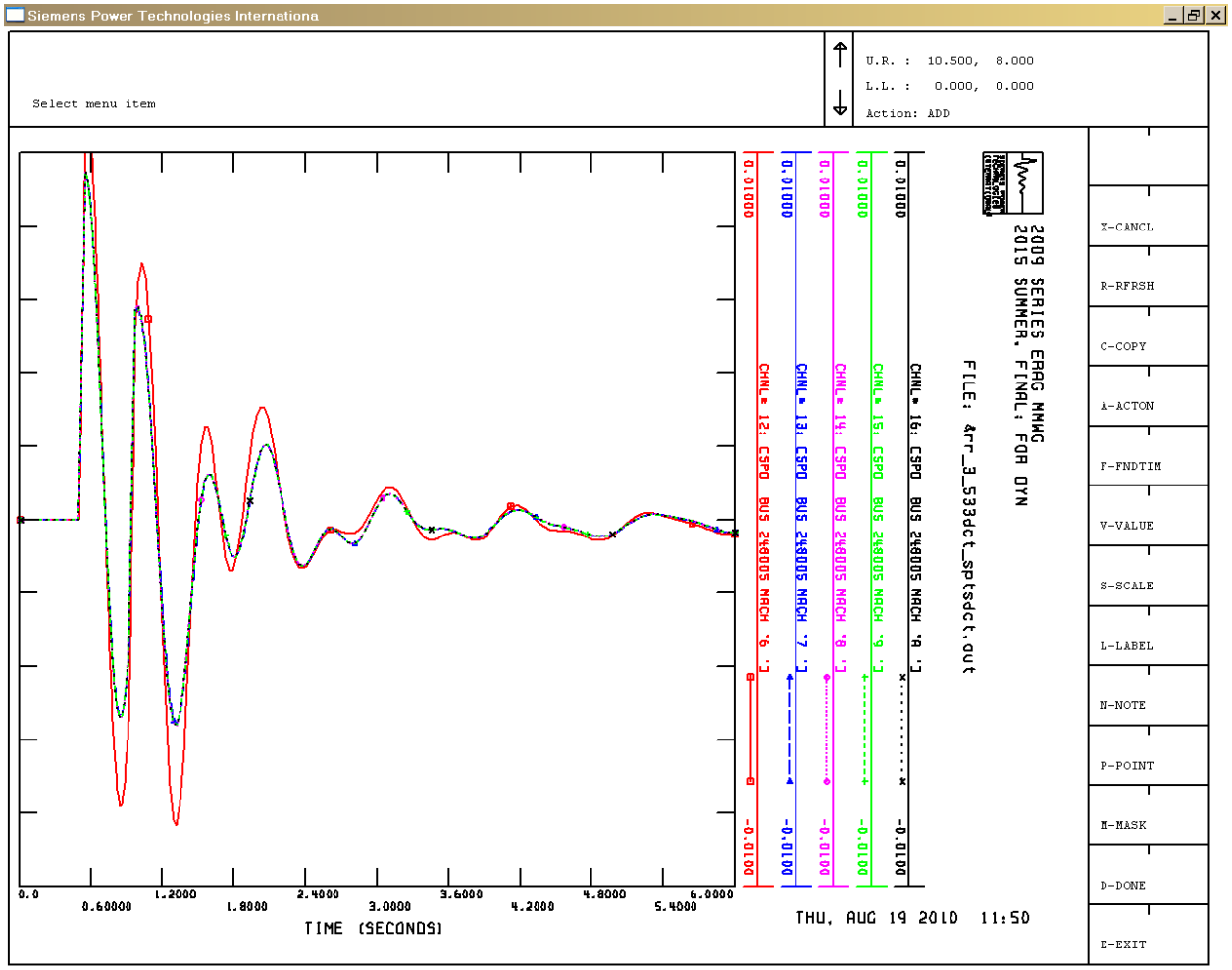
TABLE 2

Case Number	Prior Outage	Outaged Line	MW	Fault Type	Result
Case 1	Kyger Ck – X533 345 kV DCT	Kyger Ck – Sporn / Tristate 345 kV DCT	1025	3 Phase w/ HSR	Stable
Case 2	Kyger Ck – X533 345 kV DCT	Kyger Ck – Sporn / Tristate 345 kV DCT	1025	No Fault	Stable
Case 3	Kyger Ck – X530 345 kV DCT	Kyger Ck – Sporn / Tristate 345 kV DCT	1025	3 Phase w/ HSR	Stable
Case 4	Kyger Ck – X530 345 kV DCT	Kyger Ck – Sporn / Tristate 345 kV DCT	1025	No Fault	Stable
Case 5	Kyger Ck – X530 345 kV DCT	Kyger Ck – X533 345 kV DCT	1025	3 Phase w/ HSR	Stable
Case 6	Kyger Ck – X530 345 kV DCT	Kyger Ck – X533 345 kV DCT	1025	No Fault	Stable



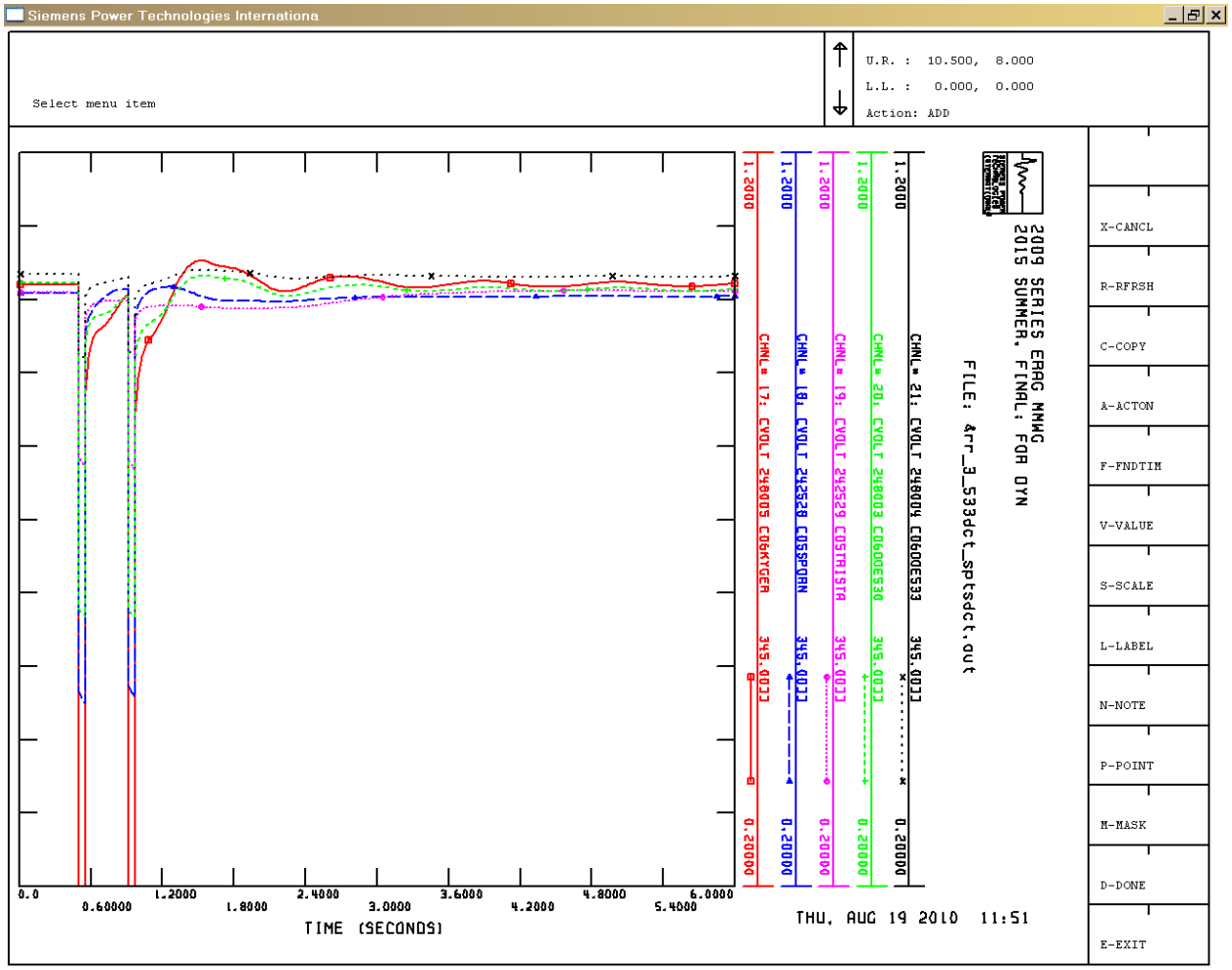
Kyger Creek Plant Per Unit Speeds

Case 1 – Prior outage of Kyger Creek – X533 345 kV DCT. Fault and trip Kyger Creek – Sporn/Tristate 345 kV DCT with unsuccessful HSR.



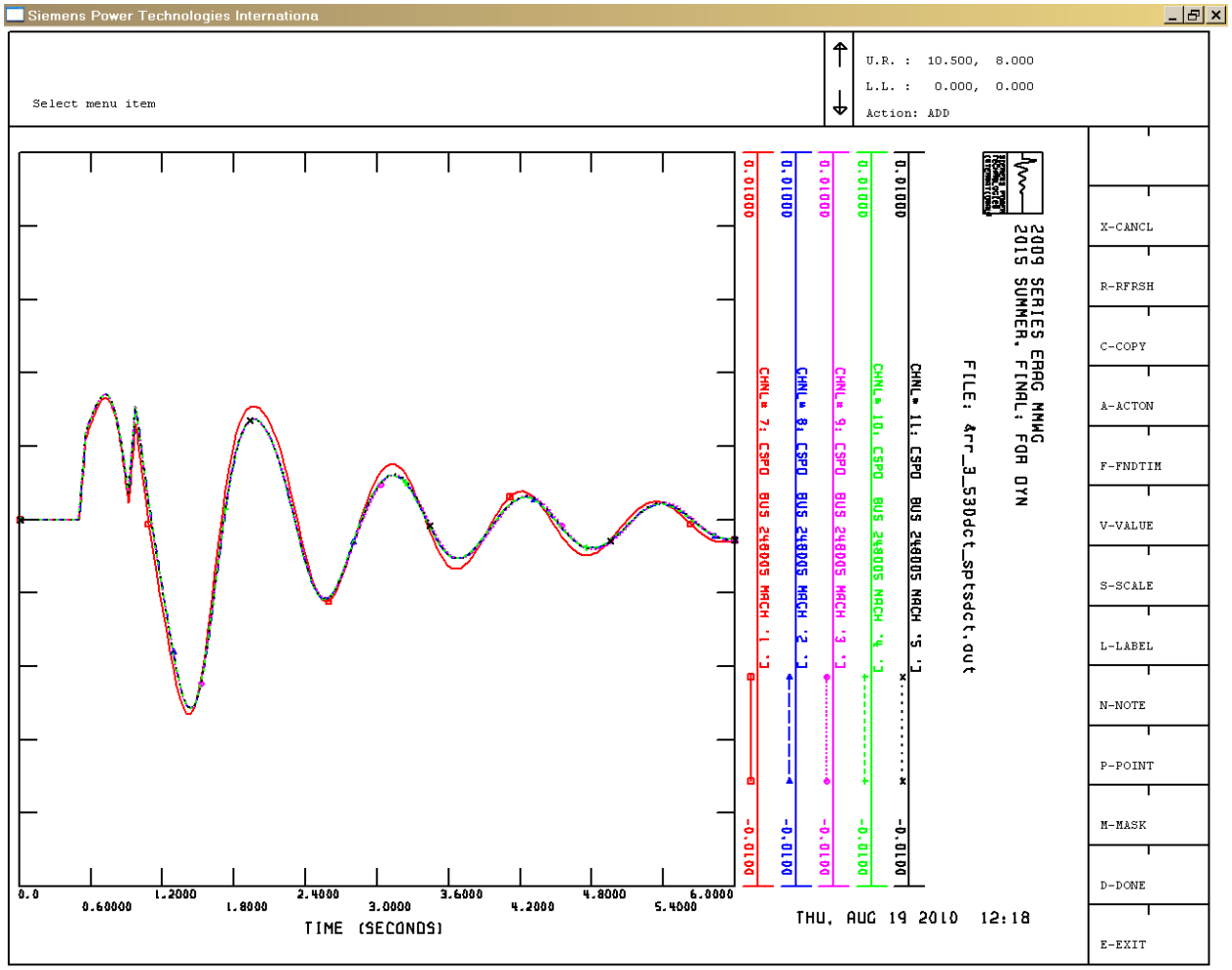
Kyger Creek Plant Per Unit Speeds

Case 1 – Prior outage of Kyger Creek – X533 345 kV DCT. Fault and trip Kyger Creek – Sporn/Tristate 345 kV DCT with unsuccessful HSR.



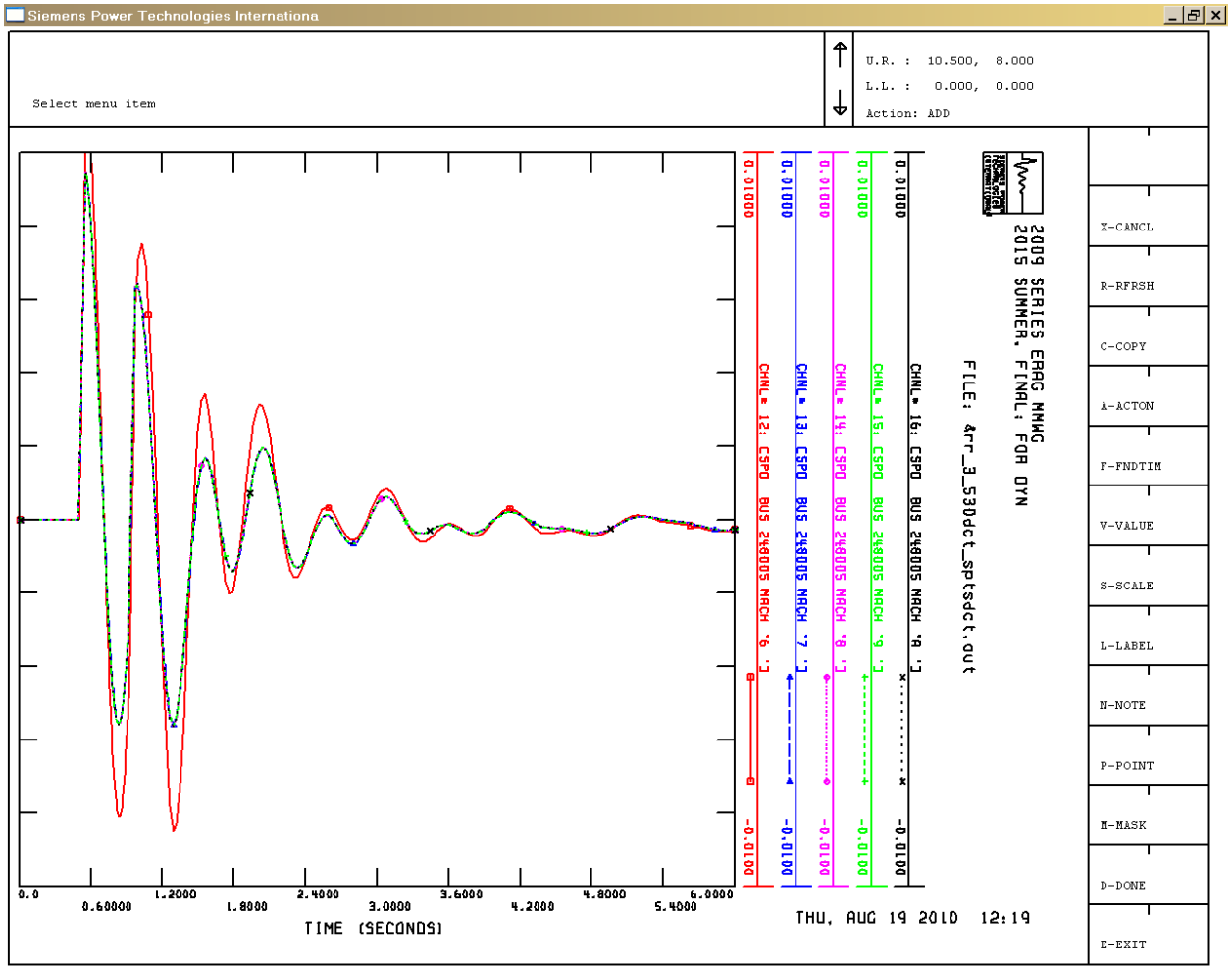
Per Unit Station Voltages

Case 1 – Prior outage of Kyger Creek – X533 345 kV DCT. Fault and trip Kyger Creek – Sporn/Tristate 345 kV DCT with unsuccessful HSR.



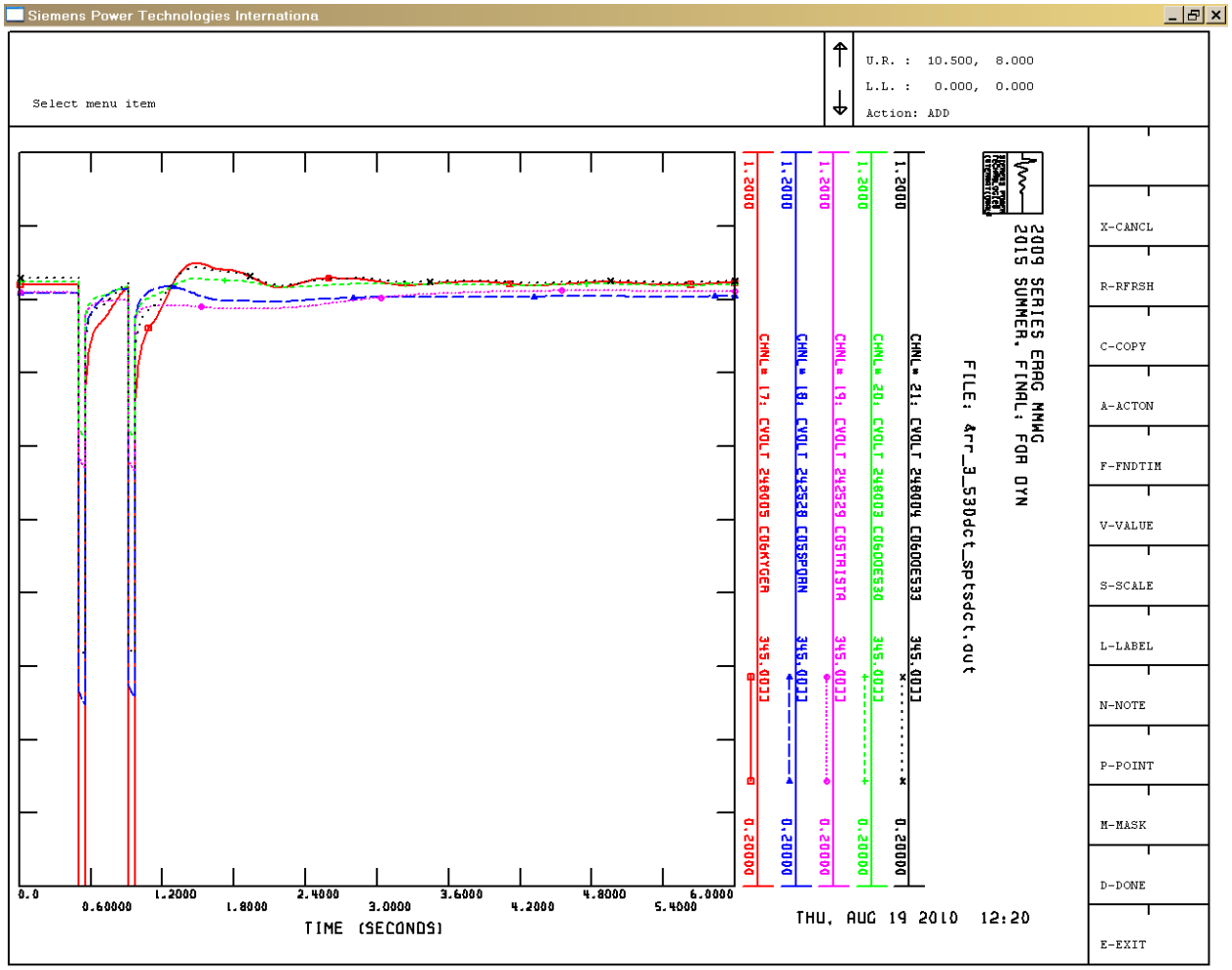
Kyger Creek Plant Per Unit Speeds

Case 3 – Prior outage of Kyger Creek – X530 345 kV DCT. Fault and trip Kyger Creek – Sporn/Tristate 345 kV DCT with unsuccessful HSR.



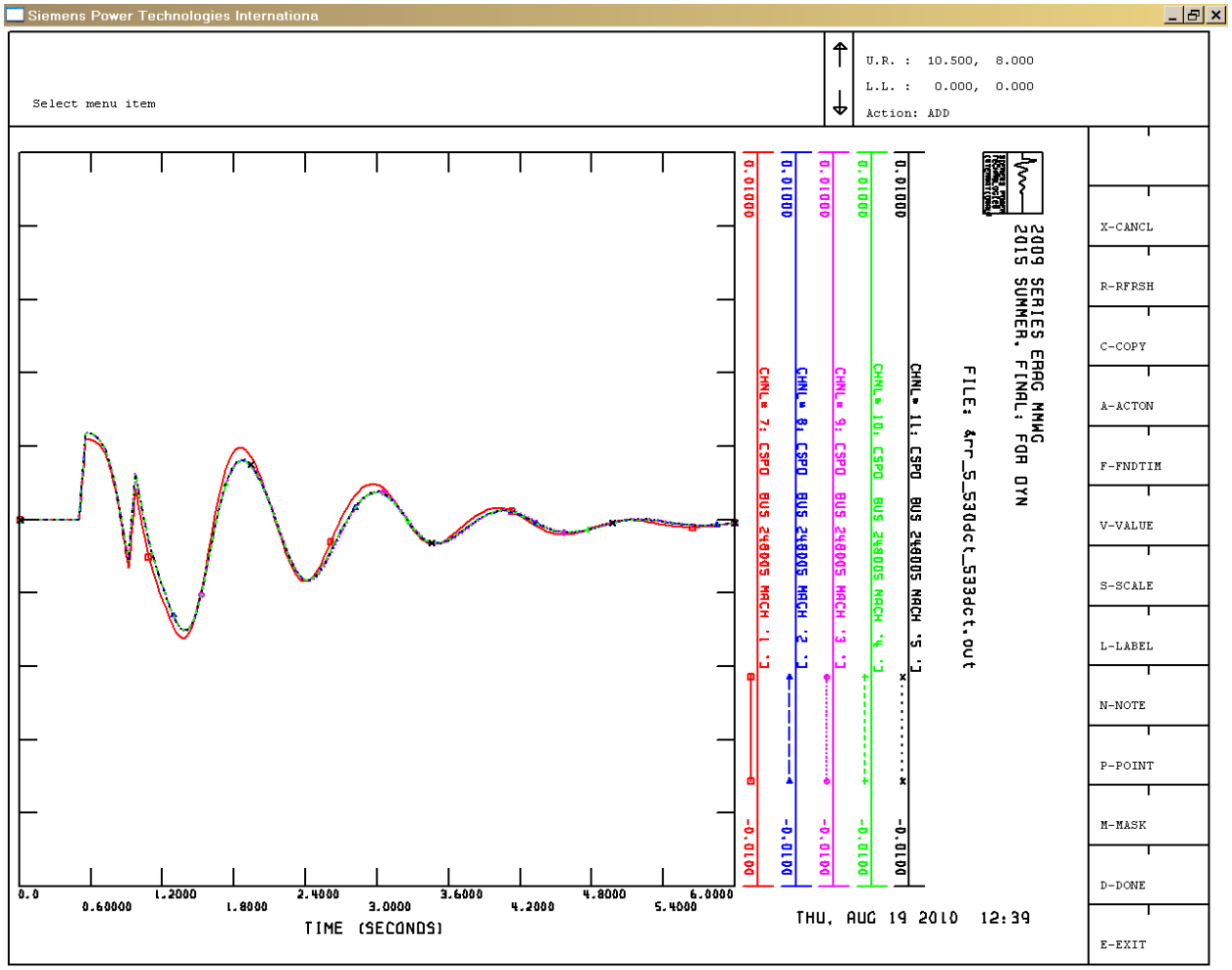
Kyger Creek Plant Per Unit Speeds

Case 3 – Prior outage of Kyger Creek – X530 345 kV DCT. Fault and trip Kyger Creek – Sporn/Tristate 345 kV DCT with unsuccessful HSR.



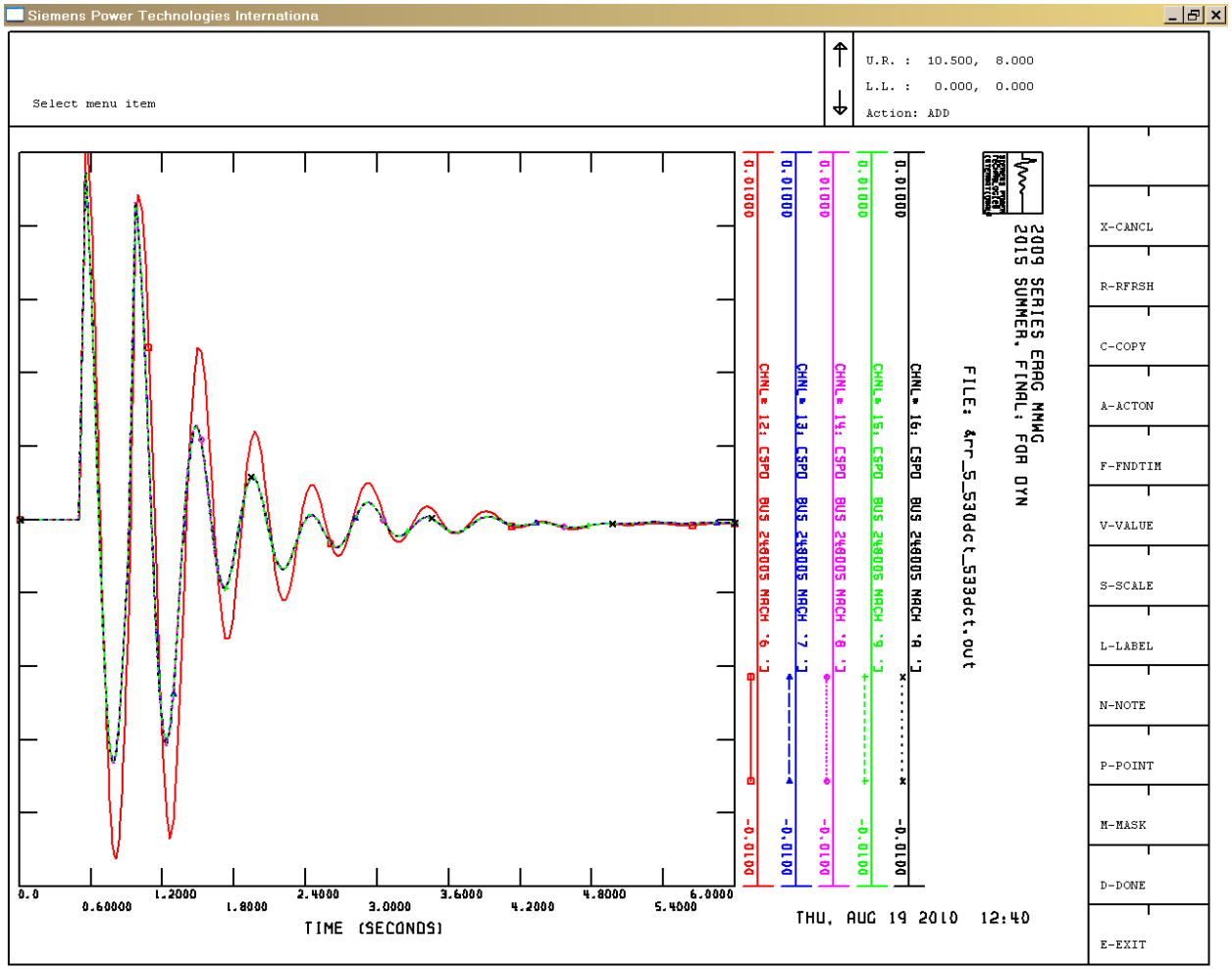
Per Unit Station Voltages

Case 3 – Prior outage of Kyger Creek – X530 345 kV DCT. Fault and trip Kyger Creek – Sporn/Tristate 345 kV DCT with unsuccessful HSR.



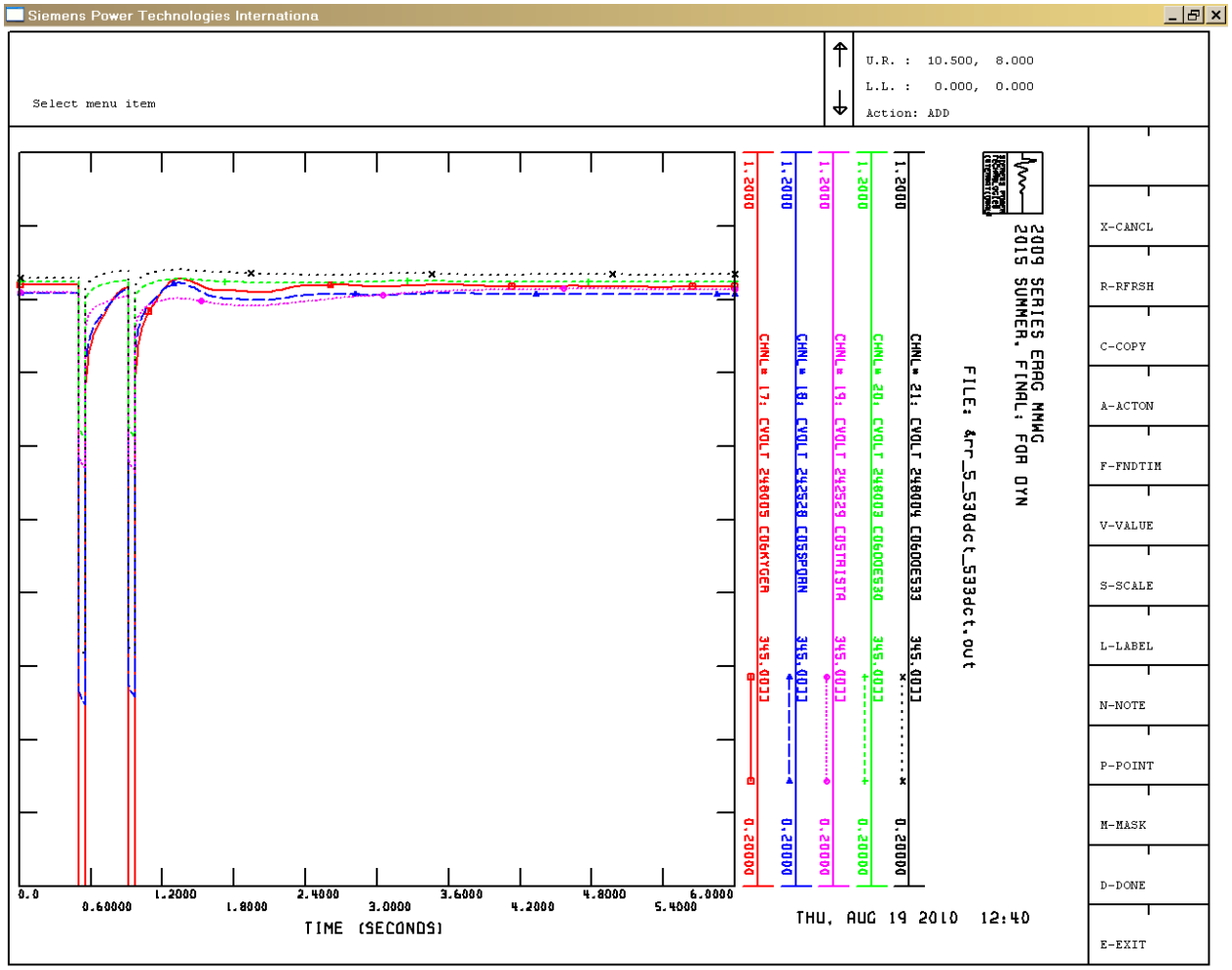
Kyger Creek Plant Per Unit Speeds

Case 5 – Prior outage of Kyger Creek – X530 345 kV DCT. Fault and trip Kyger Creek – X533 345 kV DCT with unsuccessful HSR.



Kyger Creek Plant Per Unit Speeds

Case 5 – Prior outage of Kyger Creek – X530 345 kV DCT. Fault and trip Kyger Creek – X533 345 kV DCT with unsuccessful HSR.



Per Unit Station Voltages

Case 5 – Prior outage of Kyger Creek – X530 345 kV DCT. Fault and trip Kyger Creek – X533 345 kV DCT with unsuccessful HSR.