TRANSMISSION INTERCONNECTION STUDY

By

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For

Enviro Power, LLC
Star Fire Project

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DRAFT

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1.0 EXECUTIVE SUMMARY

Enviro Power, LLC authorized Sargent & Lundy to perform a Transmission Interconnection Study for a generation Project (hereafter referred to as "Project") at the Star Fire mine and also to propose alternate conceptual designs and cost estimates for the Project's interconnection with AEP grid.

The Star Fire mine is located near Hazard City in east Kentucky. As shown in Exhibit B-1, the closest transmission facilities to the mine are Beaver Creek 138 kV substation and Baker-Broadford 765 kV transmission line. The distance between the Star Fire mine and Beaver Creek substation is about 25 miles. The closest distance between the mine and Baker-Broadford 765 kV transmission line is almost the middle point between the Baker and Broadford substation and it is 26 miles away from the Star Fire mine. The Star Fire site is tapped to 138 kV substation (Harbert Metering) that is fed by a 138 kV transmission line connected to Beaver Creek 138 kV substation The line is also tapped to feed Yellow Mountain and Consolidate Coal Tap 138 kV substations. The 138 kV line has a normal rating of 143 MVA for the line segment connecting Beaver Creek with Consolidated Coal Tap substations and 258 MVA normal rating for the line segments between Consolidated Coal Tap and Herbert Metering substations.

This study evaluates the transmission interconnection for two Project's generation Options:

500 MW Project's Generation Tapped to the 138 kV System

The Project's generation of 500 MW is tapped to Harbert Metering 138 kV bus In addition to the existing 138 kV transmission line between Harbert Metering and Beaver Creek, a new double circuit 138 kV transmission line connecting Harbert Metering substation to Beaver Creek is needed to carry the power to load centers in the region. The double circuit 138 kV transmission line is about 25 miles long and each circuit is assumed to have a normal rating of 258 MVA

The power flow solutions show that the new generation does not create any new overloads in the AEP system and ECAR region except for the overload in Beaver-Creek – Consolidated Coal Tap 138 kV line. The line is overloaded to 120 % of its 143 MVA normal rating. The line overload is also above the line 151 MVA long term rating. The interconnection of the Project's generation to the 138 kV system requires the reconductoring of Beaver Creek – Consolidated Coal Tap 138 kV line to increase its MVA normal rating similar to the Consolidated Coal Tap – Harbert Metering line segments normal rating.

The power flow solution and Exhibits B-9 and B-10 show that the 500 MW Project's generation is carried through the 138 kV system to load centers approximately as the following:

- 210 MW north and north east of Beaver Creek substation
- 120 MW to load centers south west of Beaver Creek substation
- 140 MW to load centers around and south of Beaver Creek substation

- 20 MW to load centers (including Star Fire mine) north west of Beaver Creek substation.

The effect of the Project's generation on the transmission security has been studied by evaluating the system security with single line outages in the surrounding area of the Project's generation. None of the evaluated contingencies create overloads that require hardware mitigation. The outage of Clinch River – Lebanon 138 kV line creates an overload in Clinch Field -Fletchers Ridge 138 kV line The line is overloaded to 104% of its normal rating The overload can be mitigated by running back the Project's generation from 500 MW to 390 MW

1000 MW Project's Generation Tapped to the 138 kV System

The Project's generation of 1000 MW is tapped to Baker-Broadford 765 kV line at an equal distance between Baker and Broadford substations. A new double circuit 345 kV transmission line and two 345/765 kV transformers are required to carry the Project's generation to neighboring load centers and electric utilities The double circuit 345 kV transmission line is about 30 miles long and each circuit is of 1000 MVA normal rating. The 345/765 kV transformers are assumed to have a normal rating of 500 MVA.

The new generation does not create any new overloads in the AEP system and ECAR region The Project's generation is carried through the 765 kV lines and then through the 138 kV system to load centers located in the north and north east of Beaver Creek substations. Also the Project's generation increases AEP exports to neighboring utilities.

Single circuit outage condition results also show that the Project's generation does not create overloads that are not created by the same contingencies when tested with the base case without the Project's generation.

The impact of proposed future generation projects on the Project's generation has been also evaluated and results show the proposed future projects have no major impact on the transmission system when evaluated with the Project's generation.

Conceptual transmission and substation designs are developed and evaluated to connect the Project's generation with the existing power grid. Two interconnection options are developed for the 500 MW Project's generation and another two interconnection options are also developed for the 1000 MW Project's generation at the Star Fire site.

500 MW Generation: Option A

This interconnection option, Exhibit B-24, is evaluated in Section 5.3. The cost estimate for this interconnection is based on

- Building a new 138-kV switchyard at the plant, 5 breaker ring bus.

- Upgrading the existing transmission line to Beaver Creek.
- Building a new double circuit 138-kV transmission line to Beaver Creek. It is preferable on a reliability basis to build on an independent corridor.
- Building a new 3 breaker 138 kV ring bus at Beaver Creek substation to connect the new double circuit to the grid.

The cost for this interconnection option is estimated to be $11,700,000. This interconnection option has the lowest cost of all the interconnection options and it allows the Project's generation to reach local loads in the Project's surrounding area. This interconnection limits the Project's generation to a practical limit of 500 MW.

500 MW Generation: Option B

This interconnection option, Exhibit B-25, is developed to examine the impact of tapping the Beaver Creek – Cedar Creek 138 kV line to the Broadford – Baker 765 line to examine the possibility of providing wider market to for the 500 MW Project's generation. The cost estimate for this interconnection is based on:

- Building a new 138-kV switchyard at the plant, 5 breaker ring bus
- Upgrading the existing transmission line to Beaver Creek.
- Building a new double circuit 138-kV transmission line to Beaver Creek. It is preferable on a reliability basis to build on an independent corridor.
- Building a new 3 breaker 138 kV ring bus at Beaver Creek substation to connect the new double circuit to the grid.
- Build a new substation at the junction of the existing 138-kV and the existing 765-kV transmission lines located approximately 10 miles east of Beaver Creek. The substation consists of a 138-kV breaker, a 138-765-kV transformer and a 3 breaker 765-kV ring bus.

The cost for this interconnection option is estimated to be $25,250,000. This case allows the Star Fire Project to access the 138-kV transmission grid and the 765-kV transmission grid In addition to the extra cost of Option B compared to option A, this option will also give the power flowing in the 765 kV line an access to the local load centers.

1000 MW Generation: Option A

This interconnection option, Exhibit B-28, is evaluated in Section 5.4. The cost estimate for this interconnection is based on

- Building a new 345-kV switchyard at the plant, 6 breaker ring bus
- Building a new double circuit 345-kV transmission line to the existing 765-kV transmission corridor utilizing existing corridors.
- Building a new substation at the junction of the existing 765-kV transmission lines The substation consists of a 4 breaker 345-kV ring bus, 2, 345-765-kV

transformers and a 4 breaker 765-kV ring bus.

The cost for this interconnection option is estimated to be $44,900,000. The cost estimate is based on the cost estimates of hardware equipment shown in Table A-9. This case allows the Star Fire Project to access the existing 765-kV transmission grid.

1000 MW Generation: Option B

This option, Exhibit B-29, may be considered as a second stage of the Project to increase the generation capacity of Option A from 500 MW to a 1000 MW The cost estimate for this interconnection is based on:

- Building a new 345-kV switchyard at the plant, 3 breaker ring bus.
- Building a new single circuit 345-kV transmission line to the existing 765-kV transmission corridor utilizing existing corridors.
- Building a new substation at the junction of the existing 765-kV transmission lines. The substation consists of a 345-kV breaker, 1, 765-kV transformer and a 3 breaker 765-kV ring bus

The cost for this interconnection option is estimated to be $ 30,625,000. This option allows the expansion of the 500 MW generation Option A to 1000 MW of which 500 MW can access the 765-kV transmission grid. However, any outage on this option single circuit 345 kV transmission line or the 345/765 transformer will require running back the Project's generation from 1000 MW to 500 MW.

2.0 PURPOSE / SCOPE

2.1 PURPOSE

The purpose of this report is to document a Transmission Interconnection Study for Enviro Power's coal fire CFB generation project ("Project") in the Star Fire mine located in Eastern Kentucky near Hazard, KY. The study also evaluates the technical and cost considerations for alternate conceptual designs for connecting the Project's generation to the American Electric Power (AEP) grid.

2.2 SCOPE

The scope of this study includes the following:

- Perform base case load flow calculations without the Project's generation to identify existing congestion issues (abnormal voltages, line/ transformers overloads) in the Project's surrounding area.

- Perform load flow calculations with 500 MW Project's generation connected to the 138 kV system to identify new congestion issues that do not exist in the base case without the Project's generation. Necessary upgrades to mitigate the identified congestion issues will be determined
- Perform load flow calculations with 1000 MW Project's generation connected to the 765 kV system to identify new congestion issues that do not exist in the base case without the Project's generation. Necessary upgrades to mitigate the identified congestion issues will be determined.
- Perform single contingency screening in the Project's surrounding area for the two Project's generation options (500 MW and 1000 MW) to identify congestion issues and to determine the necessary additional upgrades (if any) required to mitigate the identified congestion issues during contingencies. The amount of generation runback necessary to resolve the overload problem will be quantified, where applicable.
- Evaluate the impact of proposed future generation projects in the surrounding region on the Project's generation.
- Propose alternate conceptual designs to connect the Project's generation to AEP grid including needed grid reinforcements. Also budgetary cost estimates for the specified conceptual designs will also be provided.

The power system database published by ECAR in response to Federal Energy Regulatory Commission (FERC) Form 715 requirements is used to perform the computer simulations. The summer peak of year 2003 is chosen as the base case for this study.

The scope of this work does not include the evaluation of the impact of the Project's generating plant on system stability and short circuit levels. The need to replace circuit breakers at existing substations is beyond the scope of this analysis. Also the scope does not include evaluating the impact of single contingencies with planned outages whose overloads mitigation may require the redispatch of ECAR generation based on established generation dispatch procedures. These issues can only be addressed by the utility in their System Impact Study.

3.0 INPUT DATA / ASSUMPTION

3.1 INPUT DATA

3 1.1 East Center Area Reliability (ECAR) Document No 1, " Reliability Criteria for Evaluation and Simulated Testing of the ECAR Bulk Power Supply Systems" [7.3] The document defines standards to adhere to in order to insure reliable transmission performance in ECAR region.

3 1.2 This study relies exclusively on data available from public sources. The main source of data for power system configuration and system loading is the power

system database published by ECAR in response to the FERC Form 715 requirements. Hence, the load flow input database for year 2003 Summer Peak of the ECAR region was downloaded from FERC Filing Form 715 web page [7.2].

3.1 3 The configuration of the 138 kV, 162 kV, 345 kV, 500 kV and 765 kV systems of the region was obtained from maps published by ECAR [7.4], [7.5] and from the information contained in the FERC database.

3.2 ASSUMPTIONS

The ECAR data file published by FERC reflects the anticipated system loading and configuration for the year 2003.

4.0 METHODOLOGY AND ACCEPTANCE CRITERIA

4.1 METHODOLOGY

PowerWorld Simulator computer program [7.1] is used to perform all power flow studies in this report and to determine the impact of the Project's generation on the transmission system. This program can directly execute power flow data files that are downloaded from the FERC Web page.

The following methodology is followed in this study:

- The transmission network in the Project's surrounding area is screened by running power flow studies without the Project's generation. The transmission line and transformer loadings are monitored to detect any possible violations under normal conditions.

- The Project's 500 MW generation is added at the interconnection point (Harbert Metering 138 kV substation) with the necessary upgrades and transmission line additions.

- Due to the 2800 MW expected generation deficiency in portions of ECAR region [7 5], the proposed generation addition is dispatched against ECAR imports/exports rather than against other existing generation in the region In other words, the new capacity addition is dispatched against the slack bus of the system. The slack bus* of the ECAR system is located in TVA region (bus name is "2N BFN" and its number is 18136).

* A reference bus which compensates for the difference between system generation and load plus losses

- After adding the new generating capacity, the transmission network is screened by running power flow studies. The transmission line and transformer loadings are monitored throughout the system to detect any possible violations under normal conditions that have not existed in the base case without the Project's generation and occur as a result of adding the Project's generation.

- The impact of the Project's generation on the transmission system is evaluated by running a series of power flow studies in order to reflect immediate transmission line outages around the proposed new generation. Also the study determines the derated MW (generation run back) output of the new generation, which will preserve the system security during single transmission line contingencies or required network modifications and upgrades to correct system weak points.

- The Project's 1000 MW generation is to tapped to the Baker-Broadford 765 kV line with the necessary upgrades and transmission line additions. The above evaluation steps are repeated for this generation option.

- The impact of proposed future generation projects that are not included in ECAR 2003 Summer Peak database are evaluated by running power flow cases and monitoring the transmission system in each case. Each power flow case includes the Project's generation with a proposed generation project.

- Alternate conceptual designs to interconnect the Project's generation to AEP gird are proposed and evaluated based on their cost estimate and technical merits.

4.2 ACCEPTANCE CRITERIA

The acceptance criteria for installing the new generation is to preserve the system steady state security, i.e. keep voltages between 0.95 and 1.05 per unit, and line flows in the transmission lines and transformers under their normal limits as indicated by Standard 1 in [7.3]. The normal limits of transformers and-transmission lines are contained as part of the ECAR power flow database [7.2].

The acceptance criteria used in evaluating the Project's generation impact on the transmission system is to preserve the system steady state security under single contingency conditions. Standard 2 of [7.3] indicates that under single contingency line and equipment loading shall be within the applicable rating (long term emergency rating). The line and equipment long term emergency ratings are contained as part of the ECAR power flow database [7 2]. Any single contingency that causes an overload that is within the long term emergency rating will be alleviated by running back the Project's generation or changing the network configuration. Overloads that are above their long term emergency rating will require a hardware mitigation solution to alleviate the overload.

5.0 EVALUATION

5.1 Project Location

The Star Fire mine is located near Hazard city in east Kentucky Exhibit B-1 shows a geographical map of the region surrounding the Star Fire mine as obtained from the Resource Data International database POWERmap database[7.6]. As shown in the map, The closed transmission facilities to the mine are Beaver Creek 138 kV substation and Bakr-Broadford 765 kV transmission line. The distance between the Star Fire mine and Beaver Creek substation is about 25 miles. The closest distance between the mine and Baker-Broadford 765 kV transmission line is almost the middle point between the Baker and Broadford substation and it is 26 miles away from the Star Fire mine. The distance between the mine and Big Sandy (baker) substation is about 65 miles. Beaver Creek substation is also about 10 miles west of the AEP 765 kV lines between Broadford and Baker 765 kV substations.

The 500 MW Project's generation option will be evaluated by tapping it to the Harbert Metering (05HARBER) 138 kV substation that is modeled in the ECAR database. The substation is fed by a 138 kV transmission line connected to Beaver Creek 138 kV substation. The line is also tapped to feed Yellow Mountain (05YELLMT) and Consolidate Coal Tap (05CONSTP) 138 kV substations. The 138 kV line has a normal rating of 143 MVA for the line segment connecting Beaver Creek with Consolidated Coal Tap substations and 258 MVA normal rating for the line segments between Consolidated Coal Tap and Herbert Metering substations. The Harbert Metering substation includes a 12 MW load as modeled in ECAR database. The Beaver Creek substation is the major 138 kV AEP substation in the Start Fire area. The substation includes six 138 kV transmission lines that carry the power from neighboring area generation stations to feed load centers around Beaver Creek. The 1000 MW Project's generation option will be evaluated by tapping the generation to the Baker-Broadford 765 kV line The line normal rating in ECAR database is 4164 MVA.

5.2 Transmission Evaluation for the Base Case without the Project's Generation

The Project's generation at the Star Fire mine will be interconnected to the AEP transmission grid. AEP is a member of ECAR and its generation and transmission systems must be in compliance with ECAR reliability standards. Therefore, this study is based on the power flow model of the ECAR filing of the FERC 715, which includes in its model all ECAR members ECAR system load, generation and losses in the base case power flow solution are:

System Load: 531858.1 MW

System Generation: 545160.0 MW
Losses: 10608.12 MW
MW shunts: 2693.9 MW

The AEP control area load, generation, interchange and losses are:

AEP area load: 23506.99 MW
AEP area generation: 24735.79 MW
AEP area interchange: 530.99 MW (export)
AEP area losses: 697.86 MW

ECAR 2003 Summer peak database includes new generation records that are not included in the ECAR 2000 Summer Peak database. The new generation records are in the database to model future generation projects. Table A-1 shows the list of new generation records in the ECAR 2003 database.

The power flow database representing AEP area is divided into several zones. Each zone usually includes substations, loads and generations in the same geographic area. The Beaver Creek 138 kV substation is located south of AEP-KP zone that is defined in the ECAR database. The zone total generation and load are:

AEP-KP generation: 260 MW
AEP-KP load: 1334.7 MW
AEP-KP losses. 34.87 MW

The AEP-KP generation consists of the Big Sandy generation plant that is located north of the zone. Most of the load centers in AEP-KP zone are located in the north and north east of the zone. Table A-2 and Exhibit B-2 approximately show the locations of the load centers in the AEP-KP zone with respect to Beaver Creek substation. The load in AEP-KP zone is served by power flowing into the zone from generation located in neighboring zones as shown in the Exhibit B-3. Most of the power flowing into this zone comes from AEP-AP zone whose generation resources include an 800 MW plant in Baker substation located north of AEP-KP zone and a 690 MW generation plant in Clinch River substation located south east of AEP-KP zone The generation and load balance in the AEP-KP zone shows that there is a potential local load market for future generation project in that area.

Exhibit B-4 shows the base case power flows in Beaver Creek 138 kV transmission lines. The exhibit shows both the line MW flows (in black) and the line MVA ratings (in italic) Table A-3 lists Beaver Creek 138 kV transmission lines and their normal and long term emergency MVA limits. The total of the summer normal ratings (more conservative than the winter rating) of Beaver Creek lines is 1006 MVA This total does not include the rating of the Beaver Creek – Consolidated Coal Tap (first line in Table A-3). Taking into account first contingency requirements and necessary upgrades and line additions between Star Fire and Beaver Creek substations, the ratings of the Beaver Creek 138 kV lines show that the lines can carry the 500 MW Project's generation in Start Fire mine to load centers in the surrounding region.

Exhibit B-5 shows the base case power flows in the 138 kV system in the Star Fire mine surrounding area without the Project's generation. Exhibit B-6 also shows power flows in the 138 kV lines and 765 kV lines in the east Kentucky region. Table A-4 shows the substation names associated with the buses shown in the exhibits included in this report.

Table A-5 shows Transmission lines/transformers with loadings above 100% of their normal ratings in ECAR region The power flows in the 138 kV lines around the Beaver Creek substation are all below their normal ratings. Only three lines in AEP-KP zone are loaded above 80% of their normal limes

- Stinnett (AEP) – 5PINEVIL (TVA) 161 kV tie line between AEP and TVA is 97 % loaded at 172 MVA normal rating.
- Stinnett – Leslie 161 kV line is 80 % loaded at 182 MVA normal rating.
- Tri State – Kenova 138 kV line is 83 % loaded at 258 MVA normal rating.
- Tri State – Chadwick 138 kV line is 99% loaded at 220 MVA rating.

These base case overloads are listed here for information only and the impact of the Project's generation on these equipment are observed in this study.

Finally, Exhibit B-7 shows AEP interchanges with neighboring electric utilities in the base case without the Project's generation. Table A-6 includes a summary of the AEP Interchanges with neighboring control areas and definitions of the control area acronyms are also included. In addition to the loads in AEP, loads in AEP neighboring utilities can be markets for the Project's generation. However, the Project's generation market accessibility, that is not in the scope of this study, to other utilities depends on the transfer capabilities of the interfaces between the electric utilities.

5.3 Transmission Evaluation for 500 MW Project's Generation Tapped to the 138 kV System

The Project's generation of 500 MW is tapped to Harbert Metering 138 kV substation. A new double circuit 138 kV transmission line connecting Harbert Metering to Beaver Creek is created and added to the database. The new transmission line should have a normal rating that is sufficient to carry the Project's generation during normal conditions. In addition, the transmission connection should be capable of handling single contingencies within its long term emergency rating, and minimize the magnitude of generation dispatch limitation due to these contingencies. The transmission line is about 25 miles long and each circuit is assumed to have a 258 MVA normal rating and impedance of 0 01267 per unit resistance and 0.08401 [7.7] per unit reactance. The line ratings, parameters and X/R ratio are consistent with the ratings and parameters of other 138 kV lines in the Project's surrounding area.

Exhibit B-8 shows the power flow solutions with the Project's generation in the Beaver Creek 138 kV lines The power flow solutions show that the new generation does not create any new overloads in the AEP system and ECAR region except for the overload in Beaver-Creek – Consolidated Coal Tap 138 kV line. The line is overloaded to 120 % of its 143 MVA normal rating The line overload is also above the line 151 MVA long term rating. The interconnection of the Project's generation to the 138 kV system requires the reconductoring of the Beaver Creek – Consolidated Coal Tap 138 kV line to increase it MVA normal rating similar to the Consolidated Coal Tap – Harbert Metering line segments normal rating. Exhibit B-9 and B-10 show the power flows in Beaver Creek 138 kV lines and the 138 kV system with Beaver Creek – Consolidated Coal Tap 138 kV line rating upgrade.

Table A-7 shows transmission lines/transformers with loadings above 100% of their normal ratings in ECAR region. All the overloads (except the Beaver Creek – Consolidated Coal Tap 138 kV line overload) that are shown in this table also exist in the power flow solution for the base case without the Project's generation (Table A-5).

The transmission losses in the transmission line between Beaver Creek and Harbert Metering (the Project's site) substations are:

- Harbert Metering – Beaver Creek 138 kV line (circuit 1): 3.0 MW and 20.0 MVAR losses
- Harbert Metering – Beaver Creek 138 kV line (circuit 2): 3.0 MW and 20.0 MVAR losses
- Harbert Metering – Yellow Mountain 138 kV line: 1.2 MW and 7 0 MVAR losses
- Yellow Mountain – Consolidated Coal Tap 138 kV line· 0.5 MW and 2.8 MVAR losses
- Consolidated Coal Tap – Beaver Creek 138 kV line: 1.8 MW and 10.5 MVAR losses.

The Project's generation has a positive impact on the loading of the following AEP-KP zone transmission lines that are congested in the base case without the Project's generation:

- Stinnett (AEP) – 5PINEVIL (TVA) 161 kV tie line between AEP and TVA is 53 % loaded at 172 MVA normal rating (97% loaded at the base case without the Project's generation)
- Stinnett – Leslie 161 kV line is 39 % loaded at 182 MVA normal rating (80 % loaded at the base case without the Project's generation)

The power flow solution and Exhibits B-9 and B-10 show that the 500 MW Project's generation is carried through the 138 kV system to load centers approximately as the following:

- 210 MW north and north east of Beaver Creek substation
- 120 MW to load centers south west of Beaver Creek substation
- 140 MW to load centers around and south of Beaver Creek substation
- 20 MW to load centers (including Star Fire mine) north west of Beaver Creek substation.

The 500 MW Project's generation reduces power flows into the AEP-KP zone from the surrounding zones. It mainly reduces the power flowing from AEP-AP zone from 835 MW in the base case without the Project's generation to 449 MW as shown in Exhibit B-11. Also the Project's generation increases the AEP exports to neighboring utilities and decreases its imports as shown in Table A-6 The net AEP interchanges has increased from 530 MW export in the base case without the Project's generation to 1034 MW export.

The effect of the Project's generation on the transmission security has been studied by evaluating the system security with single line outages in the surrounding area of the Project's generation. The most limiting single contingencies are:

- **Beaver Creek – Topmost 138 kV line outage**: The outage creates an overload in the Stinnett (AEP) – 5PINEVIL (TVA) 161 kV tie line between AEP and TVA. The line is overloaded to 123 % of the 172 MVA normal rating as shown in Exhibit B-12. The overload is above the line 172 MVA long term emergency rating of the line (the line normal and emergency rating are the same in ECAR database). However, in the base case without the Project's generation the contingency causes the same line to be overloaded to 132% of its normal rating and an 102% overload in Stinnett – Leslie 161 kV line that is not created when the contingency occurs with the Project's generation, as shown in Exhibit B-13. The overloads caused by this contingency should not be considered for mitigation because higher overloads are created by the contingency in the base case without the Project's generation.
- **Stinnett-Leslie 161 kV line Outage:** The most limiting element of this outage is the overload in Beaver Creek –Topmost 138 kV line. The line is overloaded to 128% of the 153 MVA normal rating as shown in Exhibit B-14. The overload is 2 MVA above the long term emergency limit However in the base case without the Project's generation the contingency causes the same line to be overloaded at 126% of its normal rating, , as shown in Exhibit B-15. The overloads caused by this contingency should not be considered for mitigation because almost the same overloads is created by the contingency in the base case with and without the Project's generation.
- **Clinch River – Lebanon 138 kV line**: The outage creates an overload in Clinch

Field - Fletchers Ridge 138 kV line. The line is overloaded at 104% of its normal rating as shown in Exhibit B-16. The overload is within the 192 MVA long term emergency rating of the line. The overload can be mitigated by running back the Project's generation to 390 MW as shown in Exhibit B-17.

Finally the 500 MW Project's generation has also been evaluated by dispatching the generation against AEP generation and not ECAR imports and exports. The power flow solutions show that dispatching the Project's generation against the AEP generation has minimal impact on the power flowing in the Project's surrounding area.

5.4 Transmission Evaluation for 1000 MW Project's Generation Tapped to the 765 kV System

The Project's generation of 1000 MW is tapped to Baker-Broadford 765 kV line at an equal distance between Baker and Broadford substations The Project's generation is connected to the 765 kV line by double circuit 345 kV transmission line and two 345/765 kV transformers that are added to the database. The new transmission line should have a normal rating that is sufficient to carry the Project's generation during normal conditions. In addition, the transmission connection should be capable of handling single contingencies within its long term emergency rating, and minimize the magnitude of generation dispatch limitation due to these contingencies. The double circuit 345 kV transmission line is about 35 miles long and each circuit is assumed to have a normal rating of 1000 MVA. The 345/765 kV transformers must have a minimum normal rating of 500 MVA.

Exhibit B-18 shows the power flow solution in the 765 kV and 138 kV systems in the Project's surrounding area. The power flow solutions show that the new generation does not create any new overloads in AEP system and ECAR region. Table A-8 shows Transmission line/transformer with loadings above 100% of their normal ratings in ECAR region. All the overloads that are shown in this table already exist in the power flow solution for the base case without the Project's generation (Table A-5).

The 1000 MW Project's generation increases the loading of Bearskin (AEP) – Bearskin (VP) 138 kV line to 100% of its 60 MVA normal rating. The line is 92% loaded at base case without the Project's generation. The reactance of the line of the line in the database is 0.00001 per unit (0 00194 ohm). Assuming that 0.8 ohm/mile is the reactance of the 138 kV line [7 7], the estimated length of the line is 13 feet and this is indication that the line is short line section connecting two buses within Bearskin substation. The cost of reconductoring the line, if required, to reduce its load will not be substantial

The 1000 MW Project's generation reduces power flows into AEP-KP zone from the surrounding zones. It mainly reverses the power flowing from AEP-AP zone into AEP-KP zone from 835 MW to 126 MW power flowing out of AEP-KP zone to AEP-AP zone as shown in Exhibit B-19 Also the Project's generation increases AEP exports to neighboring utilities and decreases its imports as shown in Table A-6. The net AEP interchanges has increased from 530 MW export in the base case without the Project's generation to 1034 MW export.

The effect of the Project's generation on the transmission security has been studied by evaluating the system security with single line outages in the surrounding area of the Project's generation. The most limiting single contingencies are:

- **Broadford – Jacksons Ferry 765 kV line Outage:** The outage of this line creates the following overloads as shown in Exhibit B-20.
  - Broadford – Smyth 138 kV line is overloaded to 136 % of its 209 MVA normal rating The overload is within the line 346 MVA long term emergency rating of the line. The contingency at the base case without the Project's generation overloads the same line to 126 % of its normal rating.
  - Smyth – Atkins 138 kV line is overloaded to 124 % of its 209 MVA normal rating. The overload is within the 346 MVA long term emergency rating of the line. The contingency at the base case without the Project's generation overloads the same line to 114 % of its normal rating.

  No hardware mitigation is required to mitigate the above overloads since the overloads are within the long term emergency rating. The overloads caused by this contingency can be alleviated by opening Broadford – Baker 765 kV line as shown in Exhibit B-21.

- **Big Sandy – Baker 138/345 kV transformer:** The outage of this line creates an overload in the Tri State – Chadwick 138 kV line as shown in Exhibit B-22. The line is overloaded to 123% of the 220 MVA normal rating. The overload is within the line 309 MVA long term emergency rating of the line. The contingency at the base case without the Project's generation overload the same line to 120 % of its normal rating as shown on Exhibit B-23 No mitigation is recommended here because the contingency creates almost the same overloads in the base case with and without the Project's generation.

Finally the 1000 MW Project's generation has also been evaluated by dispatching the generation against AEP generation and not ECAR imports and exports. The power flow solutions show that dispatching the Project's generation against the AEP generation has minimal impact on the power flowing in the Project's surrounding area.

5.5 Impact of Proposed Future Generation Projects on the Project's generation

In addition to the new the generation projects that are shown in Table A-1 and are included in the ECAR 2003 Summer Peak case, the impact of proposed future generation projects, that are not included in the ECAR 2003 Summer Peak database, on the Project's generation have been studied by running power flow cases. Each case includes a proposed generation project with the Project's generation. The following is a list of proposed generation projects as obtained from the Resource Data International Web page [7.6] and their impacts on the Project's generation:

- Project Developer: East Kentucky Power Coop Inc.
  - Plant name: Hazard
  - State: Kentucky
  - City: Hazard
  - Capacity: 250 MW
  - Online date: 2003
  - Effect on the Project's generation: No effect
- Project Developer: Dynergy, Inc
  - Plant name: Dynergy-Bluegrass
  - State: Kentucky
  - City: Buckner
  - Capacity: 324 MW
  - Online date: 2001
  - Effect on the Project's generation: No effect
- Project Developer: Enron Capital and Trade Resources Corporation
  - Plant name: Calvert
  - State: Kentucky
  - City: Calvert
  - Capacity: 500 MW
  - Online date: 2000
  - Effect on the Project's generation: No effect
- Project Developer: Cogentrix, Inc
  - Plant name. Bedford
  - State: Indiana
  - City: Bedford
  - Capacity: 500 MW
  - Online date: 2002
  - Effect on the Project's generation: No effect
- Project Developer: DPL Energy, Inc.
  - Plant name: Dark County
  - State: Ohio
  - City: Greenville
  - Capacity: 200 MW
  - Online date: 2000
  - Effect on the Project's generation: No effect
- Project Developer: Global Energy, Ltd
  - Plant Name: Lima Project

  - State: Ohio
  - City: Lima
  - Capacity: 540 MW
  - Online date: 2002
  - Effect on the Project's generation: Increases the loading in Bearskin (AEP) – Bearskin (VP) 138 kV line to 100% of its normal rating. Also it increases the loading on Twin Branch (AEP) – Kline (AEP) to 100% of its normal rating.
- Project Developer: LS Power, L.L.C
  - Plant name: Columbus
  - State: Indiana
  - City: Columbus
  - Capacity: 800 MW
  - Online date: 2002
  - Effect on the Project's generation: Increases the loading in Bearskin (AEP) – Bearskin (VP) 138 kV line to 101% of its normal rating.
- Project Developer: Duke Energy North America
  - Plant name: Desoto
  - State: Indiana
  - City: Desoto
  - Capacity: 640 MW
  - Online date: 2001
  - Effect on the Project's generation: Increases the loading in Bearskin (AEP) – Bearskin (VP) 138 kV line to 100% of its normal rating.
- Project Developer: Columbus Power Partners
  - Plant name: Columbus
  - State: Ohio
  - City: Coulombs
  - Capacity: 220 MW
  - Online date: 2001
  - Effect on the Project's generation: No effect
- Project Developer: Toledo Edison Co
  - Plant name: Defiance
  - State: Ohio
  - City: Defiance
  - Capacity: 390 MW
  - Online date: 2000
  - Effect on the Project's generation: No effect
- Project Developer: Dominion Energy, Inc.
  - Plant name: Wood County
  - State: Ohio

- City. Luckey
- Capacity: 600 MW
- Online date: 2002
- Effect on the Project's generation. Increases the loading in Bearskin (AEP) – Bearskin (VP) 138 kV line to 100% of its normal rating.

5.6 Transmission Grid Connection: Conceptual Designs and Cost Estimates

The results of the Transmission Interconnection Study for the Project's generation described in the previous sections show that it is feasible to interconnect a 500 MW Project's generation to the 138 kV system or a 1000 MW Project's generation to the 765 kV system. The cost of the Project's interconnection to the AEP grid is another factor that should be considered.

It was determined that it would be desirable for the Project's generation to connect to the Beaver Creek, 138-kV substation and/or AEP's 765-kV transmission line. The 765-kV transmission line is an attractive option since it provides a larger market for the Project's generation. The 765-kV line and the 138-kV substation are the nearest facilities to the Project. The use of existing facilities and corridors will be the most economical option for the Project.

The Beaver Creek substation is located approximately 25 miles east of the Star Fire site. A single circuit 138-kV transmission line that has a terminal at Beaver Creek serves the Project area. The transmission line corridor passes within 2 miles of the Star Fire site.

Conceptual transmission and substation designs are developed and evaluated to connect the Project's generation with the existing power grid. Two interconnection options are developed for the 500 MW Project's generation and another two interconnection options are also developed for the 1000 MW Project's generation at the Star Fire site.

5.6.1 500 MW Generation: Option A

This interconnection option, Exhibit B-24, is evaluated in Section 5.3. The cost estimate for this interconnection is based on:

- Building a new 138-kV switchyard at the plant, 5 breaker ring bus. 2.0 m
- Upgrading the existing transmission line to Beaver Creek. 3.0 m
- Building a new double circuit 138-kV transmission line to Beaver Creek. It is preferable on a reliability basis to build on an independent corridor 13.0
- Building a new 3 breaker 138 kV ring bus at Beaver Creek substation to connect the new double circuit to the grid. 1.5

19.5

The cost for this interconnection option is estimated to be $11,700,000. The cost estimate is based on the cost estimates of hardware equipment shown in Table A-

9.

This interconnection option has the lowest cost of all the interconnection options and it allows the Project's generation to reach local loads in the Project's surrounding area. This interconnection limits the Project's generation to a practical limit of 500 MW.

5.6.2 500 MW Generation: Option B

This interconnection option, Exhibit B-25, is developed to examine the impact of tapping the Beaver Creek – Cedar Creek 138 kV line to the Broadford – Baker 765 line to examine the possibility of providing wider market to for the 500 MW Project's generation. The cost estimate for this interconnection is based on:

- Building a new 138-kV switchyard at the plant, 5 breaker ring bus 2.0
- Upgrading the existing transmission line to Beaver Creek. 3.0
- Building a new double circuit 138-kV transmission line to Beaver Creek. It is preferable on a reliability basis to build on an independent corridor. 13.00
- Building a new 3 breaker 138 kV ring bus at Beaver Creek substation to connect the new double circuit to the grid. 1.5
- Build a new substation at the junction of the existing 138-kV and the existing 765-kV transmission lines located approximately 10 miles east of Beaver Creek. The substation consists of a 138-kV breaker, a 138-765-kV transformer and a 3 breaker 765-kV ring bus. 4.0 2.1 5.0

30.6

The cost for this interconnection option is estimated to be $25,250,000 The cost estimate is based on the cost estimates of hardware equipment shown in Table A-9. This case allows the Star Fire Project to access the 138-kV transmission grid and the 765-kV transmission grid.

The power flow solutions show that tapping the Beaver Creek – Cedar Creek 138 kV line to the Broadford-Baker 765 kV line will allow the power flowing in the 765 kV line to access load centers in Beaver Creek surrounding area as shown in Exhibits B-26 and B-27. Exhibit B-26 shows that 124 MW is flowing into the Cedar Creek substation all of which is coming from the Beaver Creek substation that carries the Project's generation When tapping Beaver Creek – Cedar Creek line to the 765 kV line, Exhibit B-27, 190 MW flow is flowing into Cedar Creek substation of which only 56 MW coming from Beaver Creek substation and 134 MW coming from the power flowing into the Broadford-Baker 765 kV line. In addition to the extra cost of Option B compared to option A, this option will also give the power flowing in the 765 kV line an access to the local load centers.

5.6.3 1000 MW Generation: Option A

This interconnection option, Exhibit B-28, is evaluated in Section 5.4. The cost estimate for this interconnection is based on:

- Building a new 345-kV switchyard at the plant, 6 breaker ring bus.
- Building a new double circuit 345-kV transmission line to the existing 765-kV transmission corridor utilizing existing corridors.
- Building a new substation at the junction of the existing 765-kV transmission lines. The substation consists of a 4 breaker 345-kV ring bus, 2, 345-765-kV transformers and a 4 breaker 765-kV ring bus.

The cost for this interconnection option is estimated to be $44,900,000. The cost estimate is based on the cost estimates of hardware equipment shown in Table A-9. This case allows the Star Fire Project to access the existing 765-kV transmission grid.

This interconnection option has the highest cost of all the interconnection options but it allows the development of a generation project of a 1000 MW capacity instead of the 500 MW limitation when the Project's generation is connected to the 138 kV system This interconnection also allows the Project's generation to reach both the local load centers and load centers in neighboring zones and regions.

5.6.4 1000 MW Generation: Option B

This option, Exhibit B-29, may be considered as a second stage of the Project to increase the generation capacity of Option A from 500 MW to a 1000 MW. The cost estimate for this interconnection is based on:

- Building a new 345-kV switchyard at the plant, 3 breaker ring bus.
- Building a new single circuit 345-kV transmission line to the existing 765-kV transmission corridor utilizing existing corridors.
- Building a new substation at the junction of the existing 765-kV transmission lines The substation consists of a 345-kV breaker, 1, 765-kV transformer and a 3 breaker 765-kV ring bus

The cost for this interconnection option is estimated to be $ 30,625,000. The cost estimate is based on the cost estimates of hardware equipment shown in Table A-9. This option allows the expansion of the 500 MW generation Option A to 1000 MW of which 500 MW can access the 765-kV transmission grid. However, any outage on this option single circuit 345 kV transmission line or the 345/765 transformer will require running back the Project's generation from 1000 MW to 500 MW

Table A-11 shows a summary of the interconnection options discusses in this section.

6.0 LIMITATIONS

The results of this report are entirely based on the FERC 715 power flow database for the generation dispatching and transmission line representations. Conclusions of the interconnection study, which will be performed by ComEd once the generation plans are filed, may be different than the conclusions of this study if a different dispatching strategy is adopted and/or a different transmission network is represented.

Also the results of this study are limited by it scope that does not include the evaluation of the impact of the Project's generating plant on system stability, short circuit level, and the need to replace circuit breakers at existing substations is beyond the scope of this analysis. Also the scope does not include the impact of evaluating the impact of single contingencies with planned outages whose overloads mitigation require the redispatch of ECAR generation based on established generation dispatch procedures These issues can only be addressed by the utility in their System Impact Study.

7.0 REFERENCES

7 1 PowerWorld Simulator V5.0

7 2 Federal Energy Regulatory Commission (FERC) Filing Form 715 web page at: "http://www.ferc fed.us/electric/F715/Form715 htm".

7 3 East Central Area Reliability (ECAR) Document No. 1, "Reliability Criteria for Evaluation and Simulated Testing of the Bulk Electric Systems", July 1998

7.4 ECAR Transmission Map.

7.5 ECAR,"ECAR2003Summer Assessment of Transmission System Performance", May 1999.

7 6 Resource Data International, POWERmap datbase.

7.7 Westinghouse Electric Corporation, " Electrical Transmission and Distribution Reference Book", 1964.

7 8 Resource Data International, Energy Insight Web site, "http://hood.resdata.com/insight/MIND/Power/merch_plant/plantby.asp"

Appendix A: LIST OF TABLES

Table A-1: ECAR 2003 Summer Peak Database New Generation (Not included in ECAR 2000 Base Case)

Utility	Generator Bus	Substation Name	MW Output	MW Max
American Electric Power (AEP)	05UNDS-A	Dument*	110	135
American Electric Power (AEP)	05UNDS-A	Dument*	110	135
American Electric Power (AEP)	05UNDS-B	Jefferson*	110	135
American Electric Power (AEP)	05UNDS-B	Jeffereson*	110	135
American Electric Power (AEP)	05UNDS-C	Hanging Rock*	110	135
American Electric Power (AEP)	05UNDS-C	Hanging Rock*	110	135
American Electric Power (AEP)	05UNDS-D	Marysville*	110	135
American Electric Power (AEP)	05UNDS-D	Marysville*	110	135
American Electric Power (AEP)	05UNDS-E	Breed*	110	135
American Electric Power (AEP)	05UNDS-F	Olive*	110	135
American Electric Power (AEP)	05UNDS-G	Ohio Center*	110	135
American Electric Power (AEP)	05UNDS-H	South Canton*	110	135
First Energy Corporation (FE)	02BEAVER	Beaver 138 kV	425	525
East Kentucky Power Cooperative (EKPC)	20JKSMIT	J.K. Smith Substation 138 kV Substation	82	108
East Kentucky Power Cooperative (EKPC)	20JKSMIT	J.K. Smith Substation 138 kV Substation	436	436
East Kentucky Power Cooperative (EKPC)	20JKSMIT	J.K. Smith Substation 138 kV Substation	82	108
East Kentucky Power Cooperative (EKPC)	20JKSMIT	J.K. Smith Substation 138 kV Substation	82	108

* Closest Substation (Generator Substation is not designated)

Table A-2: AEP-KP Zone Load Centers and Locations with Respect to Beaver Creek Substation

Bus Name	Substation Name	MW Load	MVAR Load	Location
05BEC2EQ	BEAVER CREEK	26.54	8.54	Beaver Creek
05ALLEN	ALLEN	13.48	4.06	Beaver Creek
05LACKES	LACKEY	10.16	1 47	Beaver Creek
05SPRINK	SPRING CREEK	1.67	1.04	Beaver Creek
05BEC1EQ	BEAVER CREEK	0.37	3 58	Beaver Creek
05BELLET	BELLEFONTE	58 49	21.24	North
05DEWEY	DEWEY	28.96	6.34	North
05B SAN	BIG SANDY	16.29	4.16	North
05CHAVI	CHAVIES	3.36	1.03	North
05B SAND	BIG SANDY	2.68	1.38	North
05MIDDLR	MIDDLE CREEK	2.51	2.23	North
05THMAEQ	THELMA	1.64	-2.52	North
05PRINCS	PRINCESS	-1.21	7.26	North
05BEN2EQ	BELLEFONTE	236.63	-31.83	North
05CHADWK	CHADWICK	147.18	56.03	North
05KYELEC	KENTUKY ELECTRIC STEEL	30.24	-15.02	North
05CANNOB	CANNONSBURG	19.29	8.6	North
05BONNYN	BONNYMAN	19 19	6.17	North
05BUSSYV	BUSSEYVILLE	18.46	9.59	North
05BELLF1	BELLEFONTE	18.07	10 87	North
05THELMA	THELMA	16.84	13.57	North
05KENWDP	KENWOOD	16.25	0.82	North
05BETSYL	BETSY LANE	15.89	12 51	North
05BELHAV	BELHAVEN	13 7	5.92	North
05HITCHI	HITCHINS	12.85	4.79	North
05COMBS	COMBS	12.41	4 44	North
05BEYLEQ	BETSY LAYNE	11.71	5.68	North
05JACKS	JACKSON	10.79	- 3.86	North
05FALCON	FALCON	10.23	3 58	North
05HADDI	HADDIX	10.19	3.86	North
05COALT	COALTON	10 02	3 78	North
05HAYWAR	HAYWARD	9.46	3.53	North
05GRAYSO	GRAYSON	8.93	3 19	North
05OLIVEL	OLIVE	8.47	3.15	North
05PRESTB	PRESTONSBURG	8.37	5.22	North
05HUBTWN	HUBBARDSTOWN	8 11	3.36	North
05INDEX	INDEX	7 79	2.57	North
05EPRESS	EAST PRESTONSBURG	6.51	1.49	North
05SILOA	SILOA	5 99	2.65	North

05GRAYSB	GRAYS BRANCH	4.38	0.76	North
05GRAHN	GRAHN	2 68	1.01	North
05BEN5EQ	BELLEFONTE	-29.32	7.8	North
05FULLER	FULLERTON	13.81	8.81	North
05JOCREQ	JOHNS CREEK	63.65	31.22	North East
05INEZ	INEZ	33.96	6.94	North East
05LOVELY	LOVELY	29.84	5.1	North East
05STONE	STONE	22 89	16.67	North East
05HATFLD	HATFIELD	18.05	25.92	North East
05FLEMI	FLEMING	74 29	4.36	South East
05CERCEQ	CEDAR CREEK	40.25	19.68	South East
05DORTO	DORTON	22 02	7.94	South East
05BEEFHI	BEEF HIDE	2.98	1 86	South East
05VICCO	VICCO	10.22	4.01	South West
05LESLI	LESLIE	30 04	8.59	South West
05HAZAR2	HAZARD	26.22	4.01	South West
05HAZRD1	HAZARD	24.07	11.15	South West
05BECKHA	BECKHAM	22.93	5 93	South West
05SHAMRK	SHAMROCK	19.69	9.17	South West
05STINNE	STINNETT	18.02	2.6	South West
05TOPMOS	TOPMOST	4.21	3.77	South West
05HAZAR-	HAZARD	4.19	1.29	South West
05SPICEW	SPICEWOOD	0.72	0.38	West
05HARBER	HARBERT METERING	11.75	1.17	West
05CONSOL	CONSOLIDATED COAL	4.65	0.6	West

Table A-3: AEP Beaver Creek substation 138 kV Transmission Lines

Transmission Line	Normal Limit (MVA)		Long Term Emergency Limit (MVA)	
	Summer	Winter	Summer	Winter
Beaver Creek – Consolidated Tap	143	143	151	151
Beaver Creek – Betsy Lane	220	280	269	316
Beaver Creek – Cedar Creek	305	386	410	466
Beaver Creek – Topmost	153	203	194	228
Beaver Creek – Dorton	185	191	200	249
Beaver Creek – Fremont	143	143	165	186

Table A-4: Bus – Substation Name Translation

Bus Name	Substation Name
05ABINGD	ABINGDON
05AMOS 765	AMOS
05AXTON 765	AXTON
05BAKER 765	BAKER
05BAKER 345	BAKER
05BEAVRC 138	BEAVER CREEK
05BECKHA 138	BECKHAM
05BROADF 500	BROADFORD
05BROADF 765	BROADFORD
05CEDARC 138	CEDAR CREEK
05CLNCHR 138	CLINCH RIVER
05CLOVRD 765	CLOVERDALE
05CONSOL 138	CONSOLIDATED COAL
05CONSTP 138	CONSOLIDATED COAL TAP
05COPPER	COPPER RIDGE
05CULLOD 765	CULLODEN
05DEWEY 138	DEWEY
05DORTON 138	DORTON
05DORTON 138	DORTON
05FLEMIN 138	FLEMING
05FLMGTN 138	FLEMINGTOWN
05FREMO1 138	FREMONT
05FREMO2 138	FREMONT
05HANG R 765	HANGING ROCK
05HARBER 138	HARBERT METERING
05HAZARD 161	HAZARD
05HAZRD1 138	HAZARD
05HAZRD2 138	HAZARD
05J FERR 765	JACKSONS FERRY
05JEFRSO 765	JEFFERSON
05JOHNSC 138	JOHNS CREEK
05JOSHU 765	JOSHUA FALLS
05LEBANO	LEBANON
05LESLIE 161	LESLIE
05MARQUI 765	MARQUIS
05MEADWV	MEADOWVIEW
05NPROCT 765	NORTH PROCTORVILLE
05SEXTON	SEXTON
05SPICEW 138	SPICEWOOD
05STINNE 161	STINNETT

05THELMA 138	THELMA
05TOPMOS 138	TOPMOST
05TRISTA 345	TRISTATE
05VICCO 138	VICCO
05WYOMIN 765	WYOMING
05YELLMT 138	YELLOW MOUNTAIN
11ALCALD 345	ALCALDE 345 kV BUS
11BRWN N 345	BROWN NORTH 345 kV BUS
11GHENT 345	Ghent 345 kV bus
11PINEV 161	PINEVILLE SWITCHING STATION 161 kV BUS
11PINEVI 345	PINEVILLE 345 kV BUS
8 SULLIVIA 500	SULLIVAN

Table A-5: Base Case Line and Transformer Limit Violations

From Number	To Name	Crt.	Limit	Percent	Units	From Area Name	To Area Name	Base kV
MOTTS #1	MOTTS TP	1	362.3	100.6	Amps	AE	AE	69
MIDDLE#1	MID#3 CT	1	41	210	MVA	AE	AE	69
CEDAR 2	CEDR#2CT	1	24	100.8	MVA	AE	AE	23
05REEDUR	05TORREY	1	799.1	107 3	Amps	AEP	AEP	138
05DESOTO	05JAY	1	774	100.9	Amps	AEP	AEP	138
08M.FTGT	08MFGT17	1	90	101.4	MVA	CIN	CIN	138
07RAMSEY	08N ALB	1	368.2	108.9	Amps	HE	CIN	69
08ROCKVL	08SDCUTJ	1	120	109.5	MVA	CIN	CIN	138
08CNITJ1	08SDCUTJ	1	130	101 6	MVA	CIN	CIN	138
08BUFTN1	08BUFFM1	1	100	113.1	MVA	CIN	CIN	138
08CAY2	08CAYUGA	1	550	103	MVA	CIN	CIN	345
08WARREN	08WARREN	1	100	107.8	MVA	CIN	CIN	138
18MORROW	18MORW 1	1	55	134.7	MVA	CONS	CONS	138
18SE SYD	18SE 3G	1	215	102.8	MVA	CONS	CONS	345
19HINES	19HINES	1	406	105.1	MVA	DECO	DECO	230
CECIL 3	CECIL	1	99	108.5	MVA	DP&L	DP&L	230
02BLUBEL	02BLUBEL	PL	80	105.3	MVA	FE	FE	138
02NY Q12	02NURSER	2	50	107.9	MVA	FE	FE	138
02BAYSHO	02 IRONV	1	912	100 5	Amps	FE	FE	138
02 IRONV	02 IRONV	1	204	102.4	MVA	FE	FE	138
02SHNROK	02SHINRO	1	67	112.4	MVA	FE	FE	138
02MASURY	02MASURY	1	67	102	MVA	FE	FE	138
07RAMSEY	07CORYDN	1	292.9	106.3	Amps	HE	HE	69
07ECKY_T	07BUECLR	1	192.5	113.6	Amps	HE	HE	69
07WHIT_J	07IRELND	1	192.5	113.4	Amps	HE	HE	69
07G-TOWN	07G-TOWN	1	72	117	MVA	HE	HE	138
07MRM_TP	07MRM_D	1	192.5	130.9	Amps	HE	HE	69
07MRM_TP	07CARLIL	1	192.5	131	Amps	HE	HE	69
05MOREHE	11RODBRN	1	276.1	114.3	Amps	AEP	LGEE	69
11RODBRN	11RODBRN	1	33	116 3	MVA	LGEE	LGEE	138
05WAVERL	06SARGNT	1	949.7	101 7	Amps	AEP	OVEC	138
10NEWTVL	10NEWTVL	1	67	116.6	MVA	SIGE	SIGE	138
10NEWTVL	10NEWTVL	2	60	130.2	MVA	SIGE	SIGE	138

Table A-6: AEP MW Interchanges with Neighboring Control Areas

Control Area	Base Case Without the Project's generation	500 MW Project's Generation Tapped to the 138 kV System		1000 MW Project's Generation Tapped to the 765 kV System	
	MW* Interchange	MW* Interchange	MW** Change	MW* Interchange	MW** Change
Carolina Power & Light Co.-East (CPLE)	-257.7	-242.0	15.7	-219.3	38.4
Carolina Power & Light Co.-West(CPLW)	125.0	142.1	17.1	142.9	17.9
Duke Power (Duke)	-317.9	-254 5	63.4	-156.0	161 9
Virginia Power (VP)	-328.9	-316.7	12.2	-295.1	33.8
Tennessee Valley Authority (TVA)	-1153.8	-948.6	205.2	-847 0	306.8
Allegheny Power (AP)	398.6	425.0	26.4	448.3	49 7
First Energy Corporation (FE)	1282.9	1293.7	10.8	1304 9	22
Ohio Valley Electric Corporation (OVEC)	203.1	220.9	17.8	267.8	64 7
Cinergy Corporation (CIN)	451.1	449.9	-1.2	473.9	22.8
Dayton Power & light (DPL)	-980.0	-967 4	12.6	-939.7	40.3
Louisville Gas & electric (LGEE)	-178 6	-177.6	1	-168.8	9.8
Duquesne Light Company (DLCO)	275.1	276.9	1.8	278.1	3
Indianapolis Power & Light (IPL)	-297.2	-288.6	8.6	-274.8	22.4
Northern Indiana Public Service (NIPS)	395.1	408.1	13	422.6	27.5
Consumers Energy (CONS)	711.2	700.9	-10.3	687.5	-23 7
East Kentucky Power Cooperative (EKPC)	-1.0	19 0	20	3.5	4.5
Indiana Municipal Power Agency (IMPA)	122.1	122.2	0.1	122.4	0 3
Ameren (AMRN)	79.0	116.3	37.3	157.2	78.2
Illinois Power (IP)	55.9	68.8	12.9	81.7	25.8
Commonwealth Edison (NI)	-53.1	-14.4	38.7	29.8	82.9
Net MW Interchange	530.1	1034.2	503.1	1519.9	989

*Positive Interchange: Power Flow Out of AEP area (export)
*Negative Interchange: Power Flow into AEP Area (import)

** Positive MW Change: Increase in export when base case interchange is export or decrease in import when base case interchange is import

** Negative MW Change: Decrease in export when base case interchange is export or increase in import when base case interchange is import.

Table A-7: 500 MW Project's Generation Tapped to the 138 kV System: Line and Transformer Limit Violations

From Name	To Name	Crt	Limit	Percent	Units	From Area Name	To Area Name	Base kV
MOTTS #1	MOTTS TP	1	362.3	100 6	Amps	AE	AE	69
CEDAR 2	CEDR#2CT	1	24	100 8	MVA	AE	AE	23
MIDDLE#1	MID#3 CT	1	41	210	MVA	AE	AE	69
05DESOTO	05JAY	1	774	100.5	Amps	AEP	AEP	138
05REEDUR	05TORREY	1	799.1	107 4	Amps	AEP	AEP	138
08ROCKVL	08SDCUTJ	1	120	109.4	MVA	CIN	CIN	138
07RAMSEY	08N ALB	1	368.2	108 3	Amps	HE	CIN	69
08CNITJ1	08SDCUTJ	1	130	101.4	MVA	CIN	CIN	138
08BUFTN1	08BUFFM1	1	100	113 1	MVA	CIN	CIN	138
08WARREN	08WARREN	1	100	107.9	MVA	CIN	CIN	138
08M.FTGT	08MFGT17	1	90	101 4	MVA	CIN	CIN	138
08CAY2	08CAYUGA	1	550	103	MVA	CIN	CIN	345
18SE SYD	18SE 3G	1	215	102.7	MVA	CONS	CONS	345
18MORROW	18MORW 1	1	55	134 7	MVA	CONS	CONS	138
19HINES	19HINES	1	406	105.1	MVA	DECO	DECO	230
CECIL 3	CECIL	1	99	108 5	MVA	DP&L	DP&L	230
02SHNROK	02SHINRO	1	67	112.4	MVA	FE	FE	138
02BLUBEL	02BLUBEL	PL	80	105.3	MVA	FE	FE	138
02NY Q12	02NURSER	2	50	107.9	MVA	FE	FE	138
02BAYSHO	02 IRONV	1	912	100.5	Amps	FE	FE	138
02MASURY	02MASURY	1	67	102	MVA	FE	FE	138
02 IRONV	02 IRONV	1	204	102.4	MVA	FE	FE	138
07WHIT_J	07IRELND	1	192.5	115 6	Amps	HE	HE	69
07G-TOWN	07G-TOWN	1	72	116.8	MVA	HE	HE	138
07RAMSEY	07CORYDN	1	292.9	106.3	Amps	HE	HE	69
07ECKY_T	07BUECLR	1	192 5	113.6	Amps	HE	HE	69
07MRM_TP	07MRM_D	1	192.5	130.9	Amps	HE -	HE	69
07MRM_TP	07CARLIL	1	192.5	131	Amps	HE	HE	69
05MOREHE	11RODBRN	1	276 1	111.4	Amps	AEP	LGEE	69
11RODBRN	11RODBRN	1	33	117	MVA	LGEE	LGEE	138
05WAVERL	06SARGNT	1	949.7	102	Amps	AEP	OVEC	138
10NEWTVL	10NEWTVL	1	67	116.1	MVA	SIGE	SIGE	138
10NEWTVL	10NEWTVL	2	60	129.6	MVA	SIGE	SIGE	138

Table A-8: 1000 MW Project's Generation Tapped to the 765 kV System: Line and Transformer Limit Violations

From Name	To Name	Crt	Limit	Percent	Units	From Area Name	To Area Name	Base kV
CEDAR 2	CEDR#2CT	1	24	100.8	MVA	AE	AE	23
MOTTS #1	MOTTS TP	1	362.3	100.6	Amps	AE	AE	69
MIDDLE#1	MID#3 CT	1	41	210	MVA	AE	AE	69
05REEDUR	05TORREY	1	799.1	107.4	Amps	AEP	AEP	138
05DESOTO	05JAY	1	774	100 1	Amps	AEP	AEP	138
4BEARSKN	05BEARSK	1	251	100.7	Amps	VP	AEP	138
05TRISTA	05CHADWC	1	920.4	100.4	Amps	AEP	AEP	138
08CLRMT1	08CLRMT2	1	711.2	100	Amps	CIN	CIN	138
08M.FTGT	08MFGT17	1	90	101.4	MVA	CIN	CIN	138
08WARREN	08WARREN	1	100	108	MVA	CIN	CIN	138
08BUFTN1	08BUFFM1	1	100	113.1	MVA	CIN	CIN	138
08CAY2	08CAYUGA	1	550	103	MVA	CIN	CIN	345
08CNITJ1	08SDCUTJ	1	130	101	MVA	CIN	CIN	138
07RAMSEY	08N ALB	1	368.2	107.4	Amps	HE	CIN	69
08ROCKVL	08SDCUTJ	1	120	109	MVA	CIN	CIN	138
18SE SYD	18SE 3G	1	215	102.6	MVA	CONS	CONS	345
18MORROW	18MORW 1	1	55	134.7	MVA	CONS	CONS	138
19HINES	19HINES	1	406	105.1	MVA	DECO	DECO	230
CECIL 3	CECIL	1	99	108.5	MVA	DP&L	DP&L	230
02BLUBEL	02BLUBEL	PL	80	105.3	MVA	FE	FE	138
02BAYSHO	02 IRONV	1	912	100.6	Amps	FE	FE	138
02NY Q12	02NURSER	2	50	107.9	MVA	FE	FE	138
02 IRONV	02 IRONV	1	204	102.4	MVA	FE	FE	138
02MASURY	02MASURY	1	67	102	MVA	FE	FE	138
02SHNROK	02SHINRO	1	67	112.3	MVA	FE	FE	138
07WHIT_J	07IRELND	1	192.5	118.9	Amps	HE	HE	69
07RAMSEY	07CORYDN	1	292.9	106.2	Amps	HE	HE	69
07G-TOWN	07G-TOWN	1	72	116.8	MVA	HE	HE	138
07ECKY_T	07BUECLR	1	192.5	113 7	Amps	HE	HE	69
07MRM_TP	07MRM_D	1	192.5	130.9	Amps	HE	HE	69
07MRM_TP	07CARLIL	1	192.5	131	Amps	HE	HE	69
05MOREHE	11RODBRN	1	276.1	105.8	Amps	AEP	LGEE	69
11RODBRN	11RODBRN	1	33	112.8	MVA	LGEE	LGEE	138
05WAVERL	06SARGNT	1	949.7	102	Amps	AEP	OVEC	138
10NEWTVL	10NEWTVL	1	67	115.3	MVA	SIGE	SIGE	138
10NEWTVL	10NEWTVL	2	60	128 7	MVA	SIGE	SIGE	138

Table A-9: Cost Estimate

AEP COSTS

ITEM	COST ($)
New 138-kV Switchyard at Plant, 3 breaker ring bus	1,500,000
New 138-kV Switchyard at Plant, 5 breaker ring bus	2,000,000
New 345-kV Switchyard at Plant, 3 breaker ring bus	2,400,000
New 345-kV Switchyard at Plant, 6 breaker ring bus	4,000,000
New 345-kV Substation, 4 breaker ring bus	2,700,000
New 765-kV Substation, 3 breaker ring bus	5,000,000
New 765-kV Substation, 4 breaker ring bus	6,000,000
138-kV breaker	150,000
345-kV breaker	300,000
Step-up transformer - to 765-kV Single phase winding	2,100,000
Upgrade 25 miles 138-kV transmission line	3,000,000
Build 25 miles new double circuit 138-kV transmission line	6,250,000
Build 35 miles new single circuit 345-kV transmission line	14,525,000
Build 35 miles new double circuit 345-kV transmission line	17,500,000

.425(25) = $10.6 M
$250K/MILE
415K/MILE
1.5(35) = $52.5 M
500K/MILE

EAGLE

BUILD 25 MILES 138 KV TRANSMISSION LINE .155 (25) = $4.6 M
R/W PURCHASE @ $[illegible] AC 100' R/W [illegible] / 43,560 = .2 AC = $12,000 [illegible]

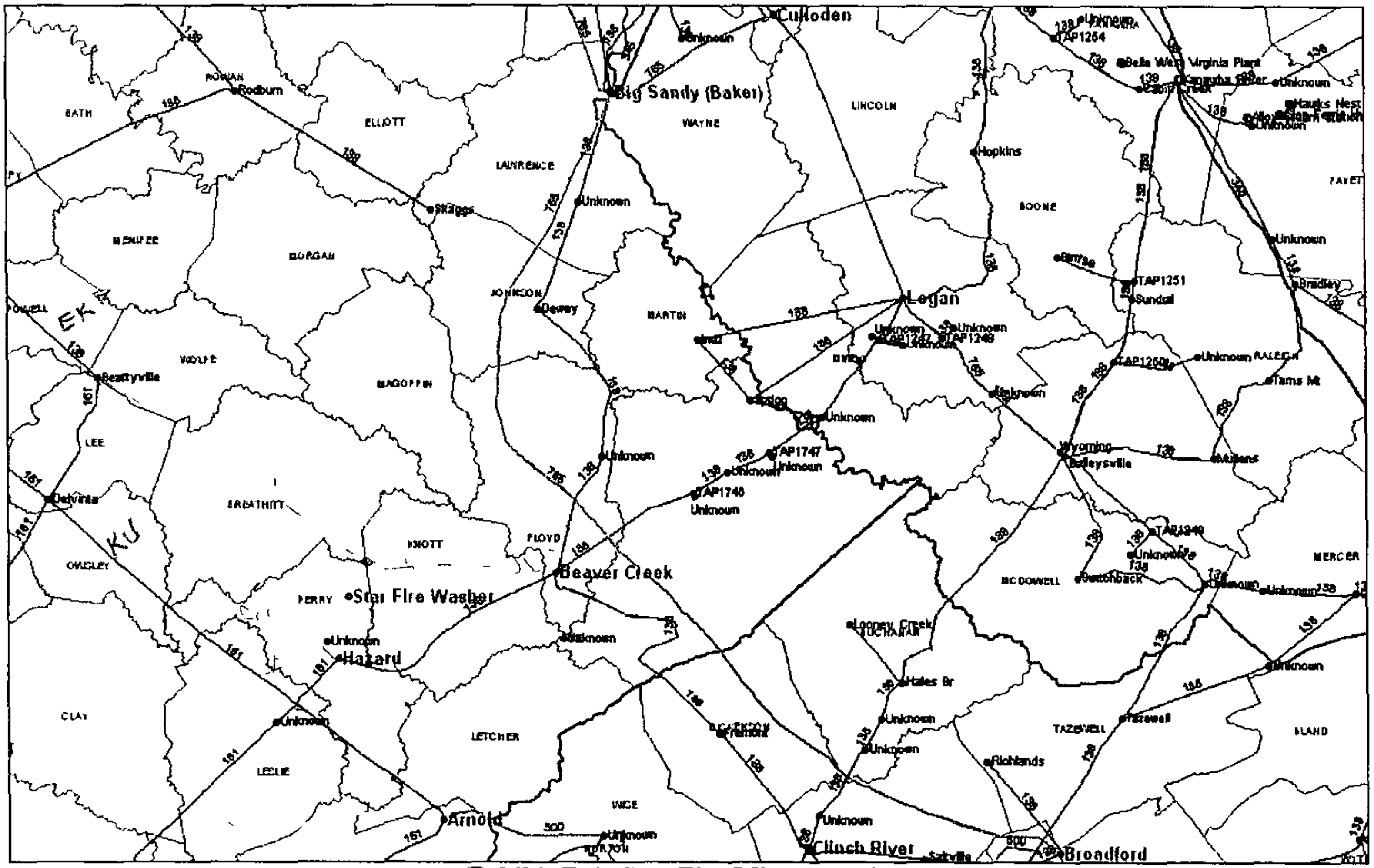

Exhibit B-1: Star Fire Mine Location

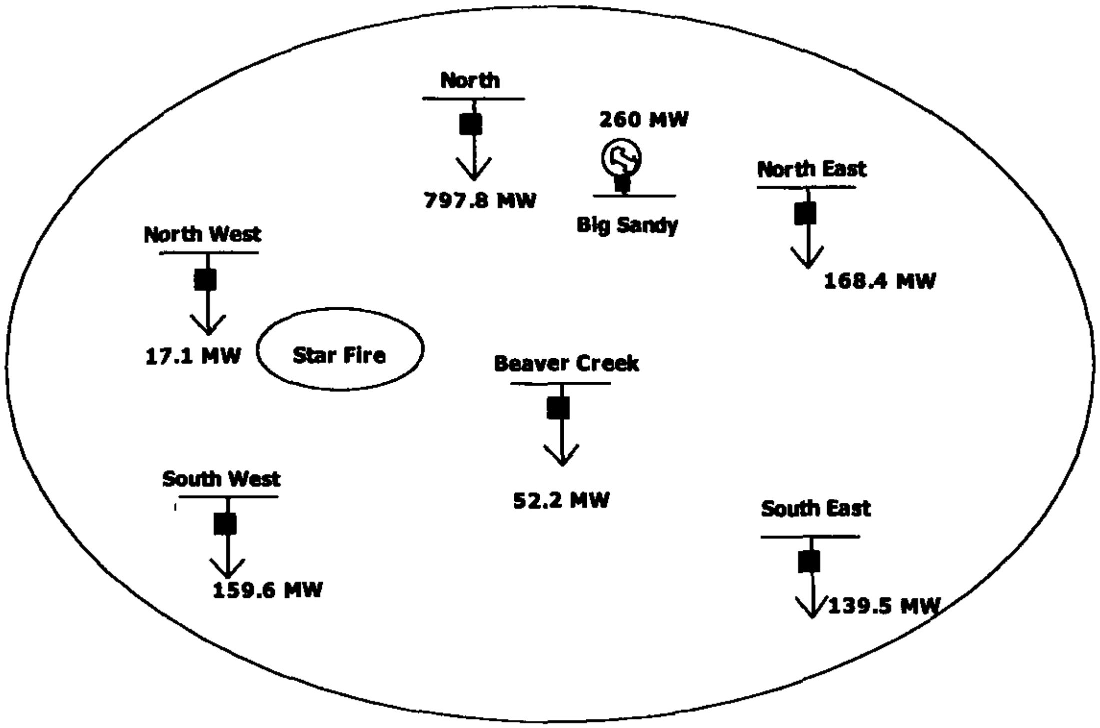

Exhibit B-2: AEP-KP Zone Load and Generation Locations

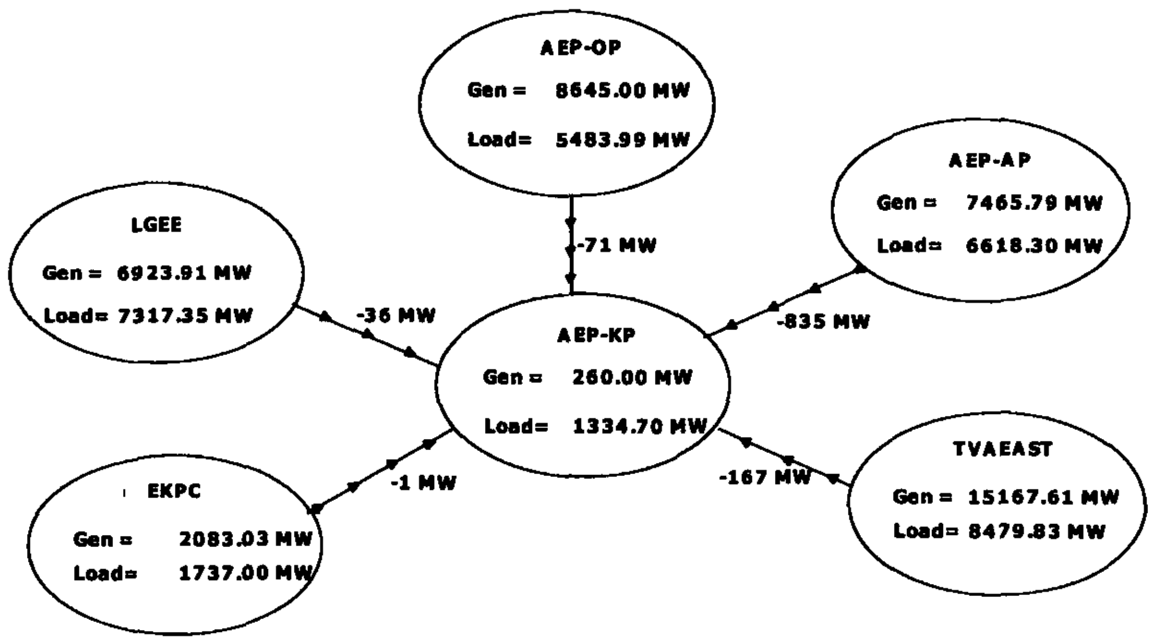

Exhibit B-3: AEP-KP Zone MW Interchanges without the Project's Generation

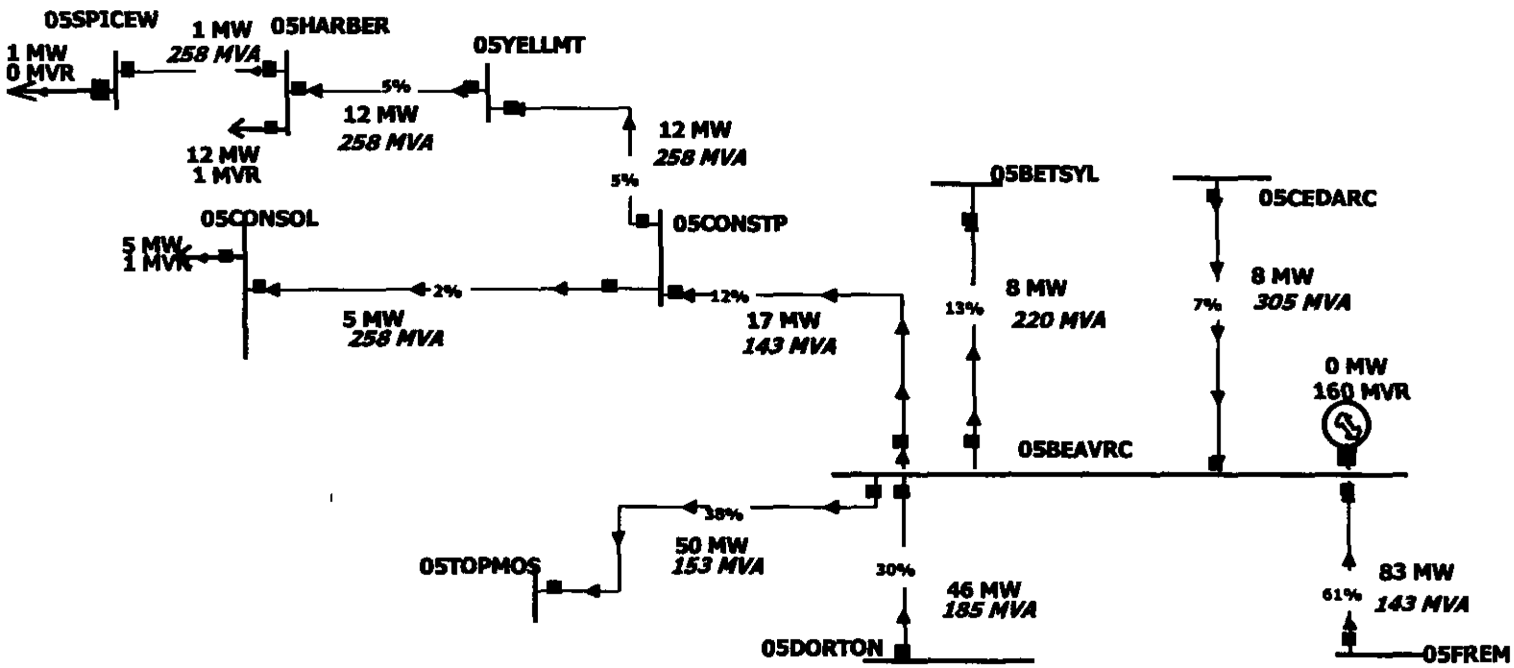

Exhibit B-4: Beaver Creak 138 kV Line Power Flows in the Base Case without The Project's Generation

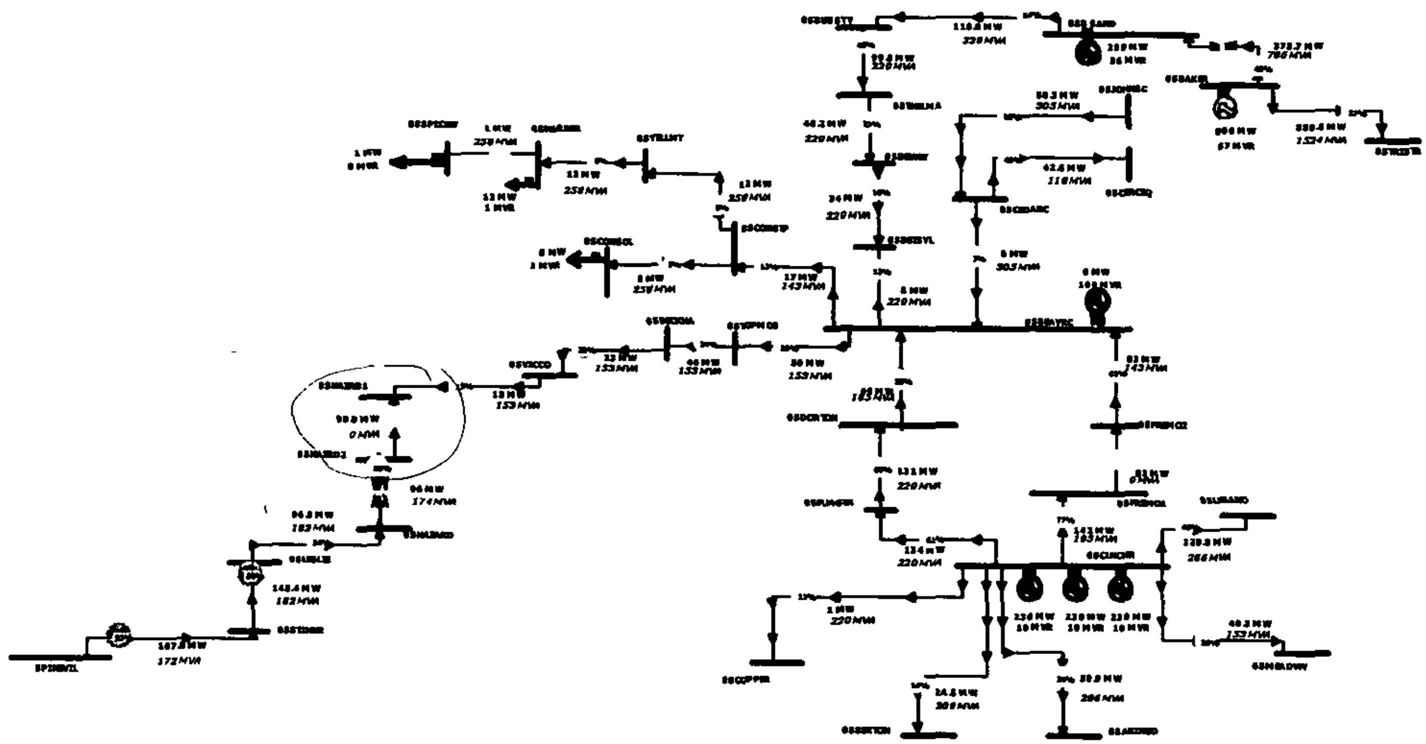

Exhibit B-5: 138 kV system Power Flows in the Base Case without the Project's Generation

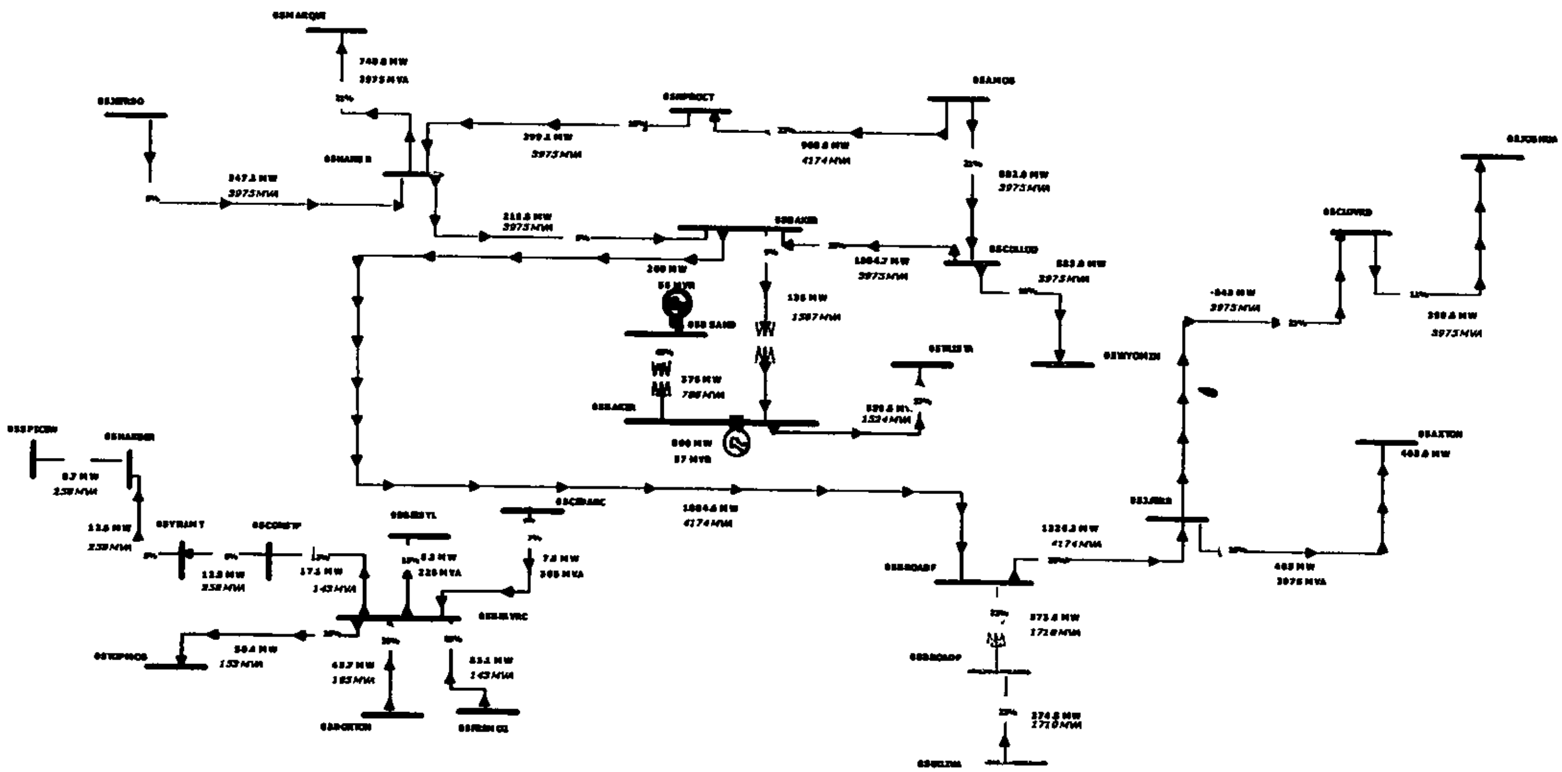

Exhibit B-6: 765 kV System Power Flows in the Base Case without the Project's Generation

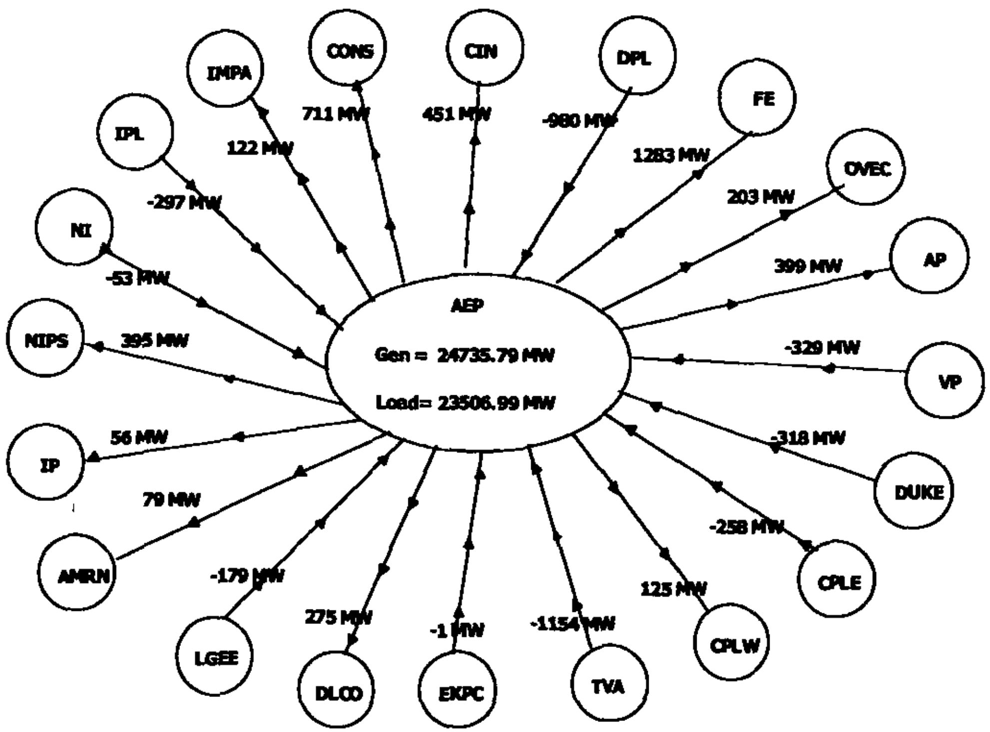

Exhibit B-7: AEP MW Interchanges with Neighboring Utilities in the Base Case without Project's Generation

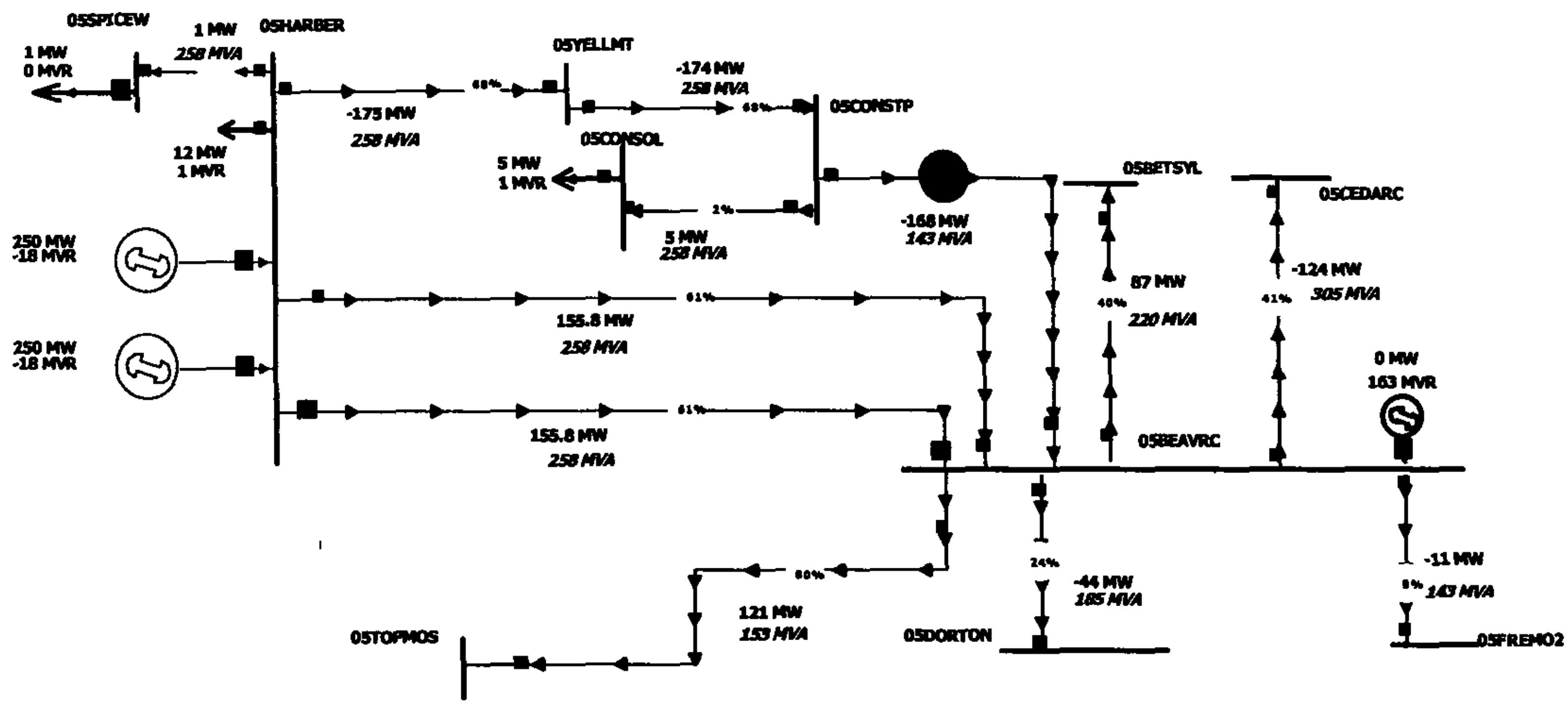

Exhibit B-8: 500 MW Project's Generation Tapped to Beaver Creek 138 kV substation

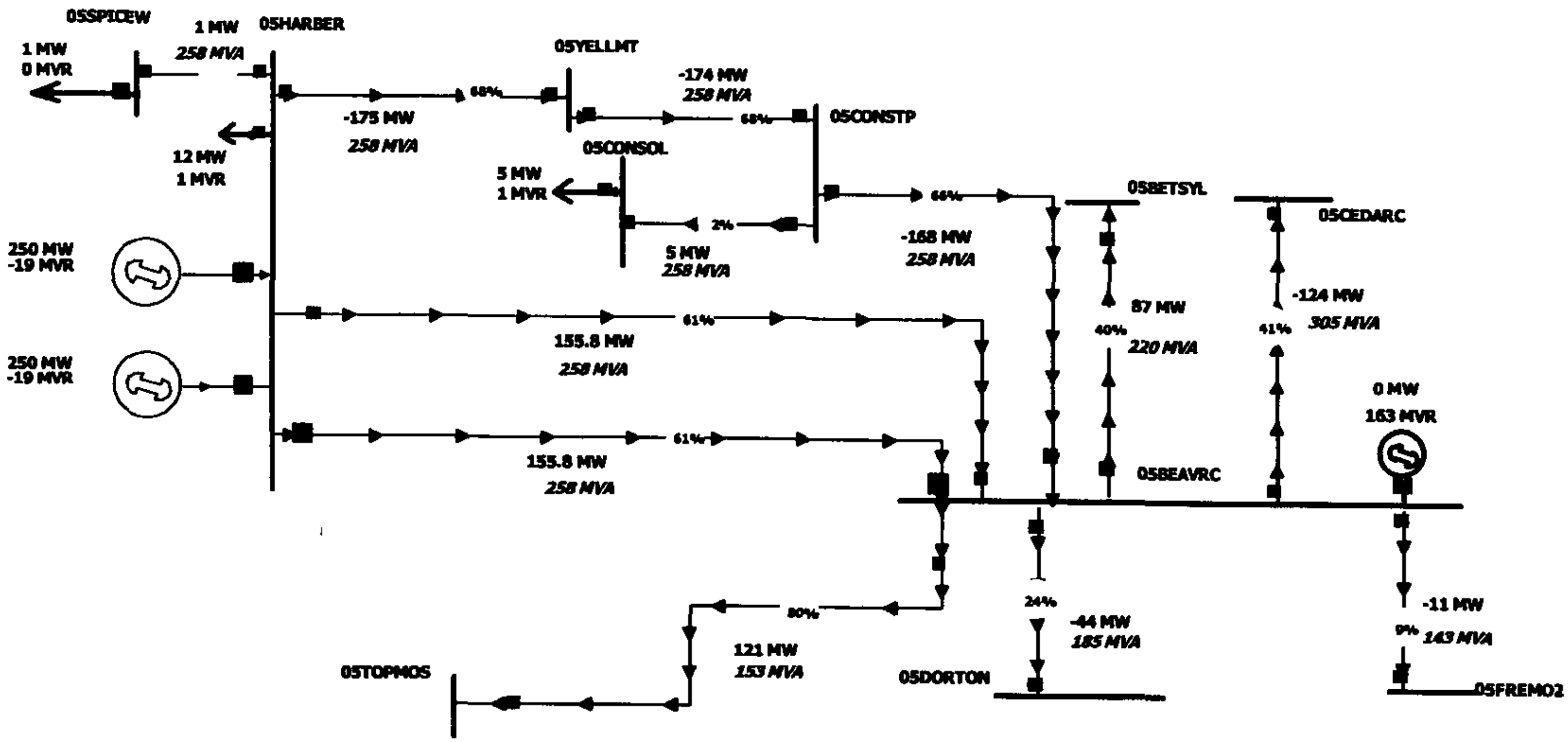

Exhibit B-9: 500 MW Project's Generation Tapped to Beaver Creek 138 kV substation With Beaver Creek – Consolidate Coal Tap Line Upgrade

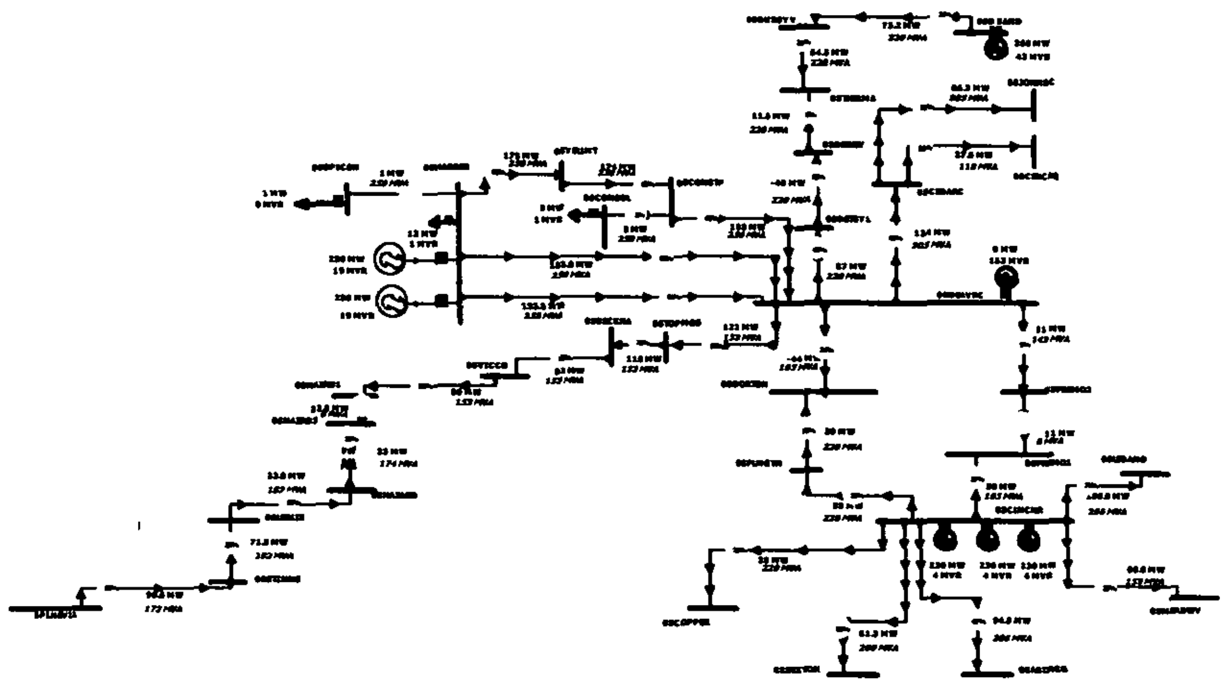

Exhibit B-10: Power Flows in the 138 kV System with 500 MW Project's Generation

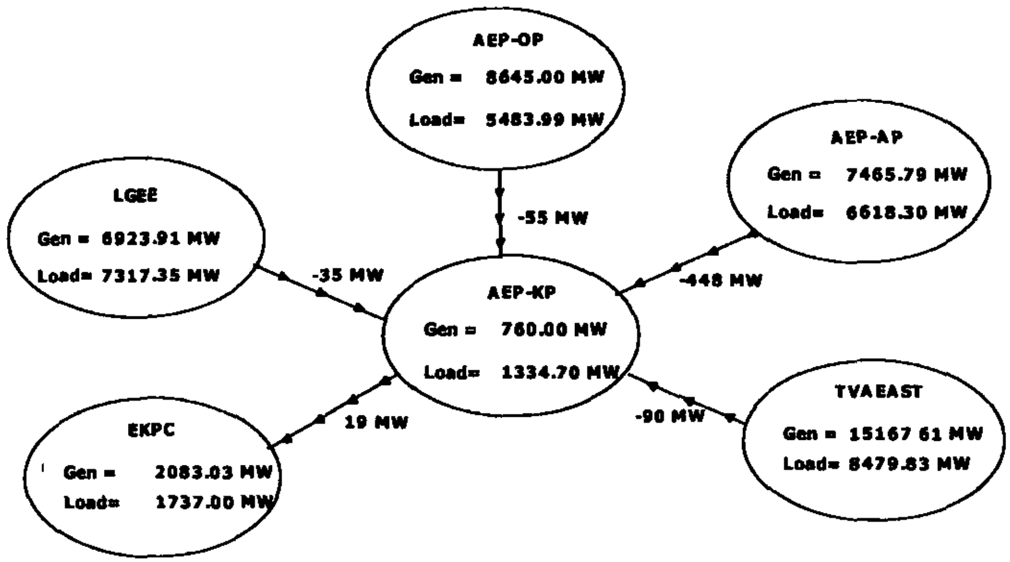

Exhibit B-11: AEP-KP Zone MW Interchanges with 500 MW Project's Generation at the 138 kV System

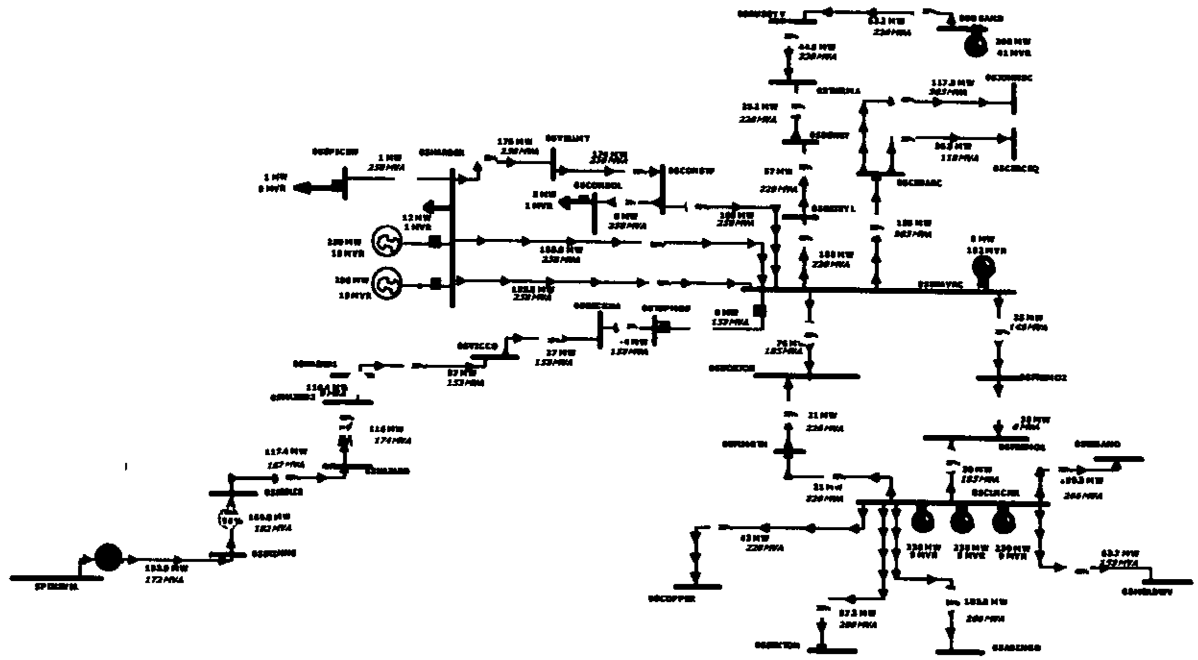

Exhibit B-12: Beaver Creek –Topmost 138 kV Line Contingency with 500 MW Project's Generation

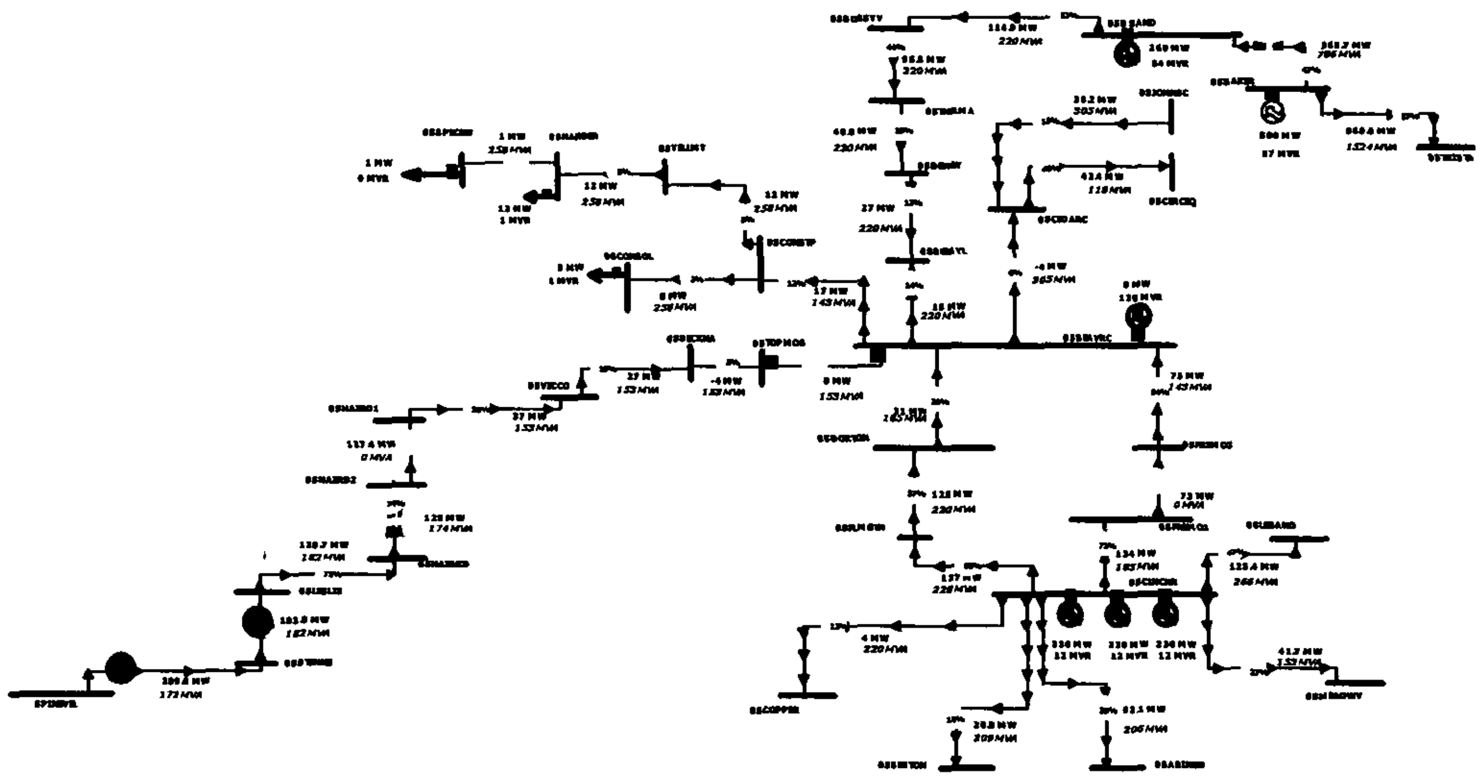

Exhibit B-13: Beaver Creek – Topmost 138 kV Line Contingency without the Project's Generation

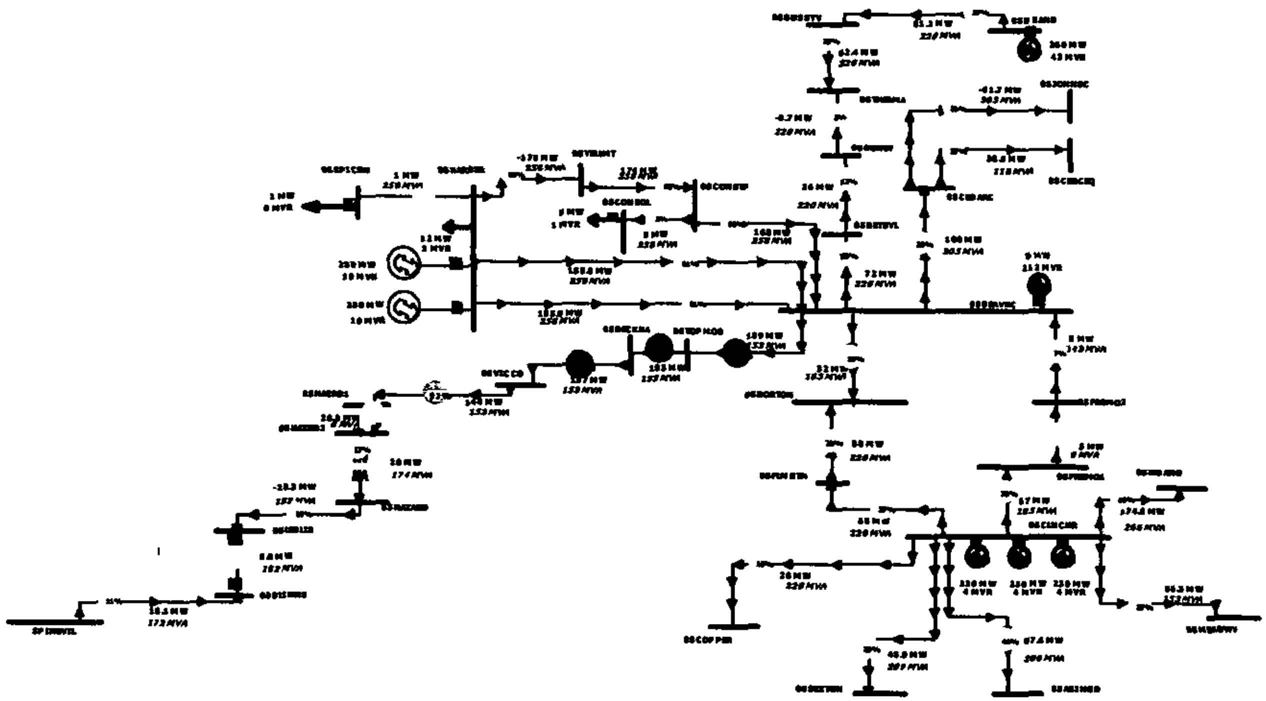

Exhibit B-14: Stinnett-Leslie 161 kV Line Contingency with 500 MW Project's Generation

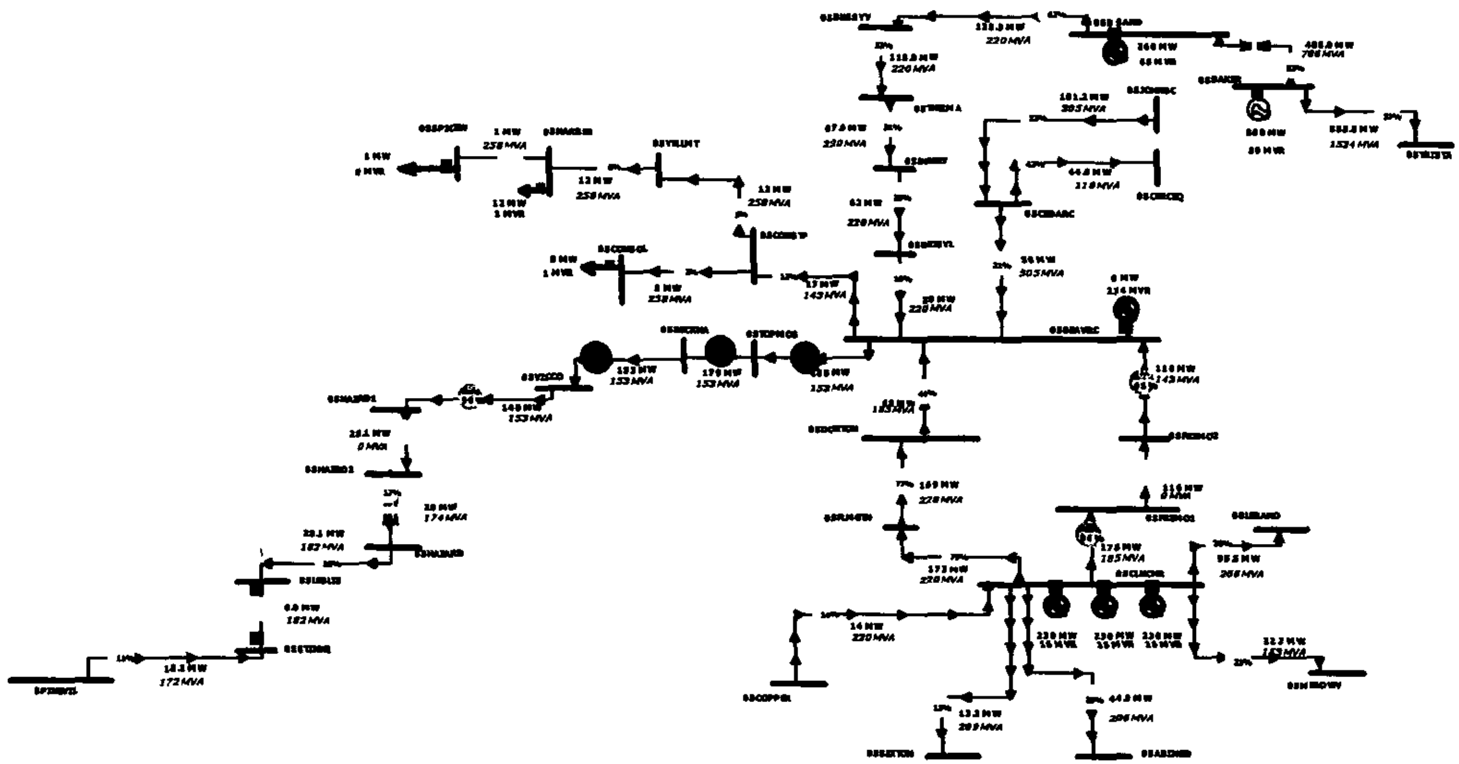

Exhibit B-15: Stinnett-Leslie 161 kV Line Contingency without the Project's Generation

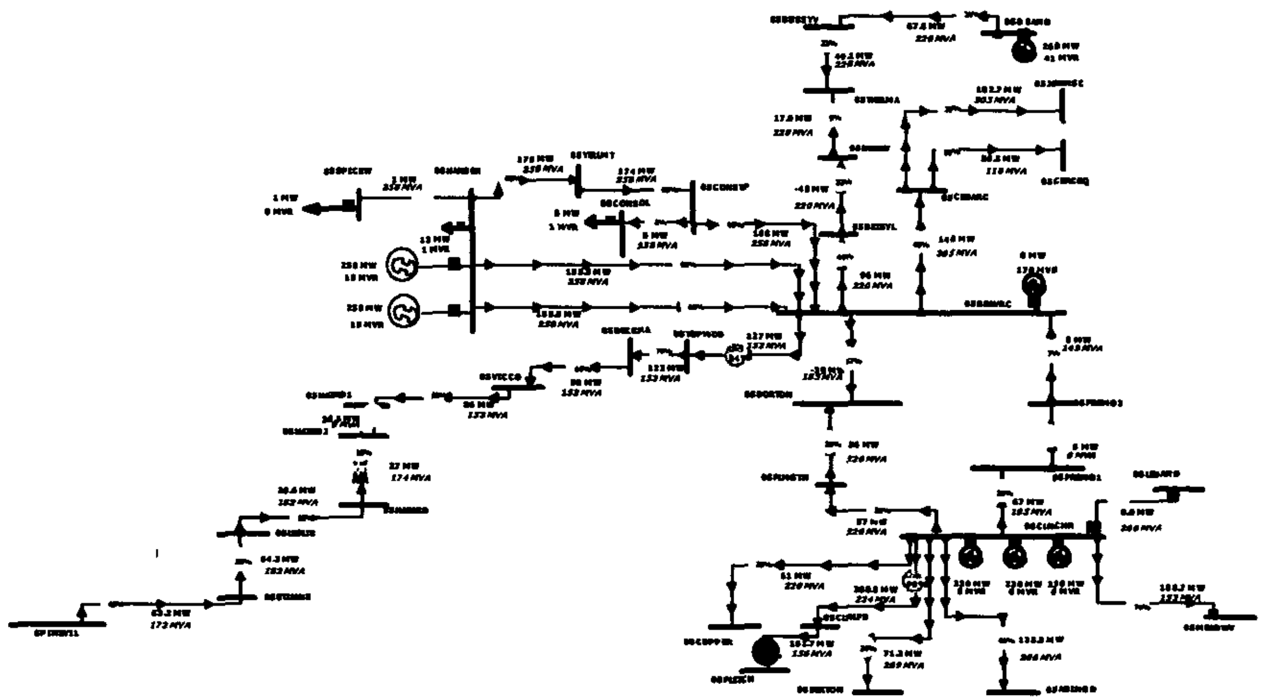

Exhibit B-16: Clinch River – Lebanon 138 kV line Contingency with 500 MW Project's Generation

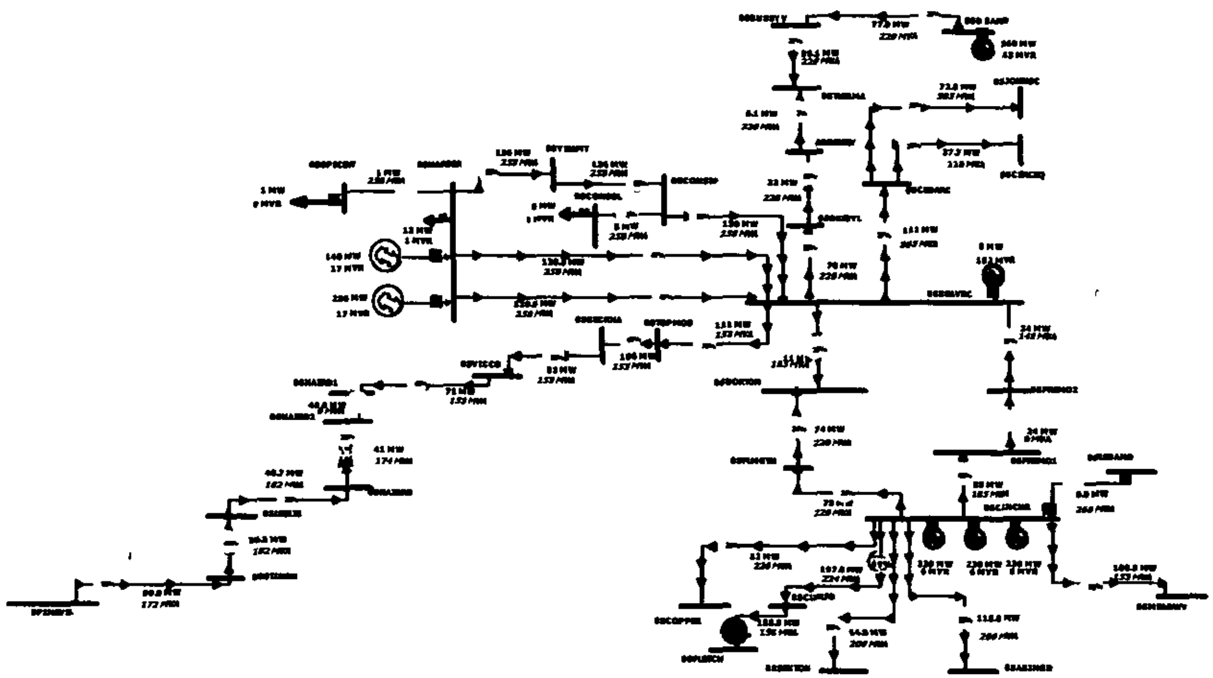

Exhibit B-17: Clinch River – Lebanon 138 kV line Contingency Mitigation

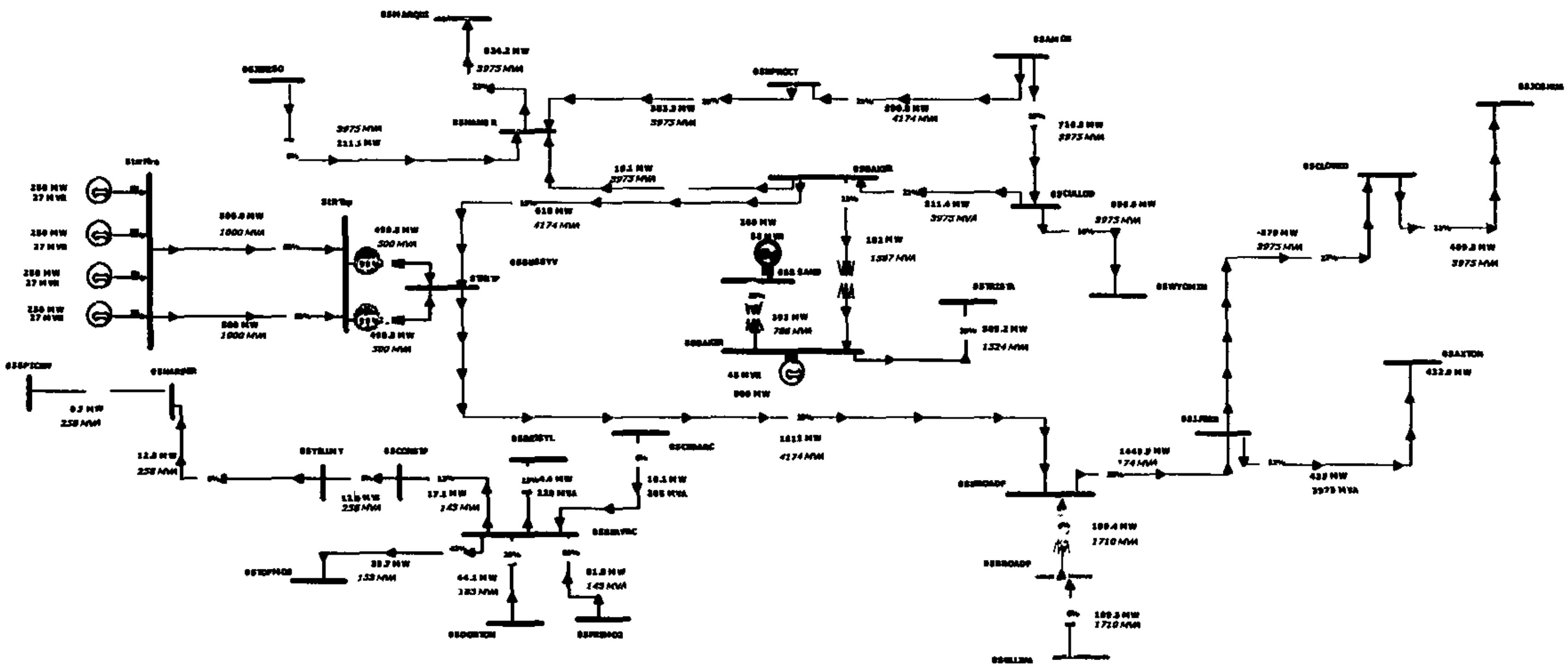

Exhibit B-18: 1000 MW Project's Generation Tapped at Baker-Broadford 765 kV Line

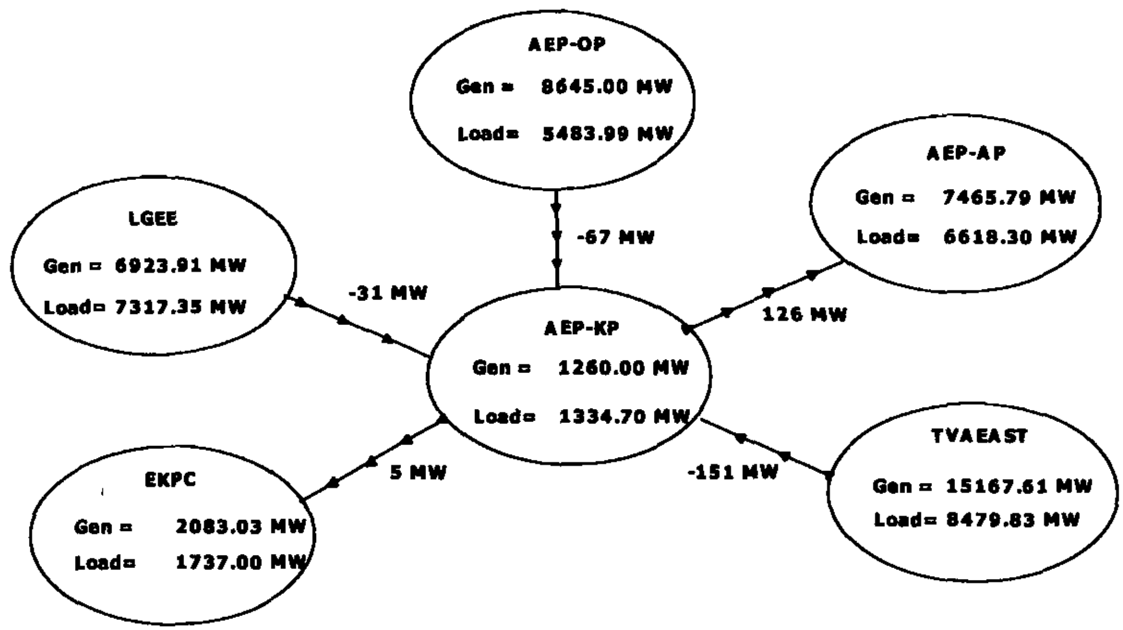

Exhibit B-19: AEP-KP Zone MW Interchanges With 1000 MW Project's Generation at the 765 kV System

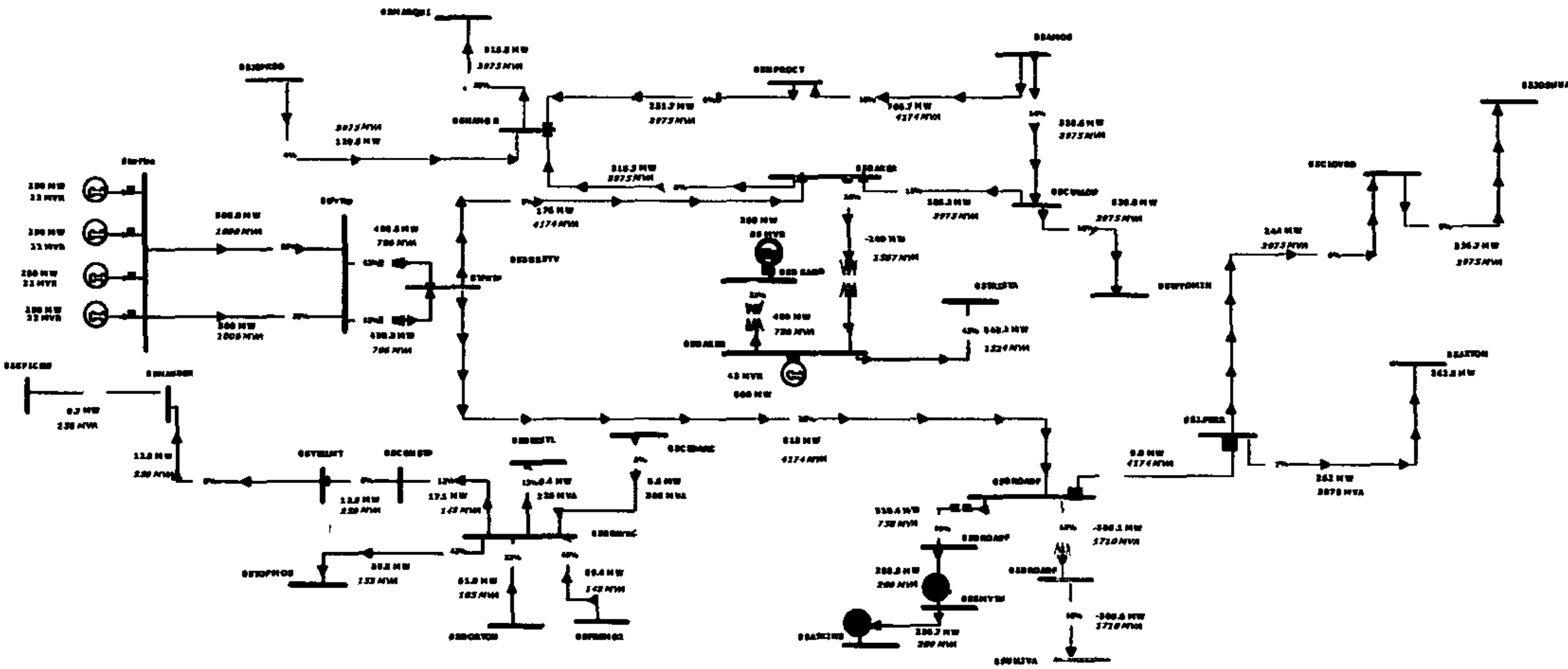

Exhibit B-20: Broadford-Jackson Ferry 765 kV Contingency with 1000 MW Project's Generation

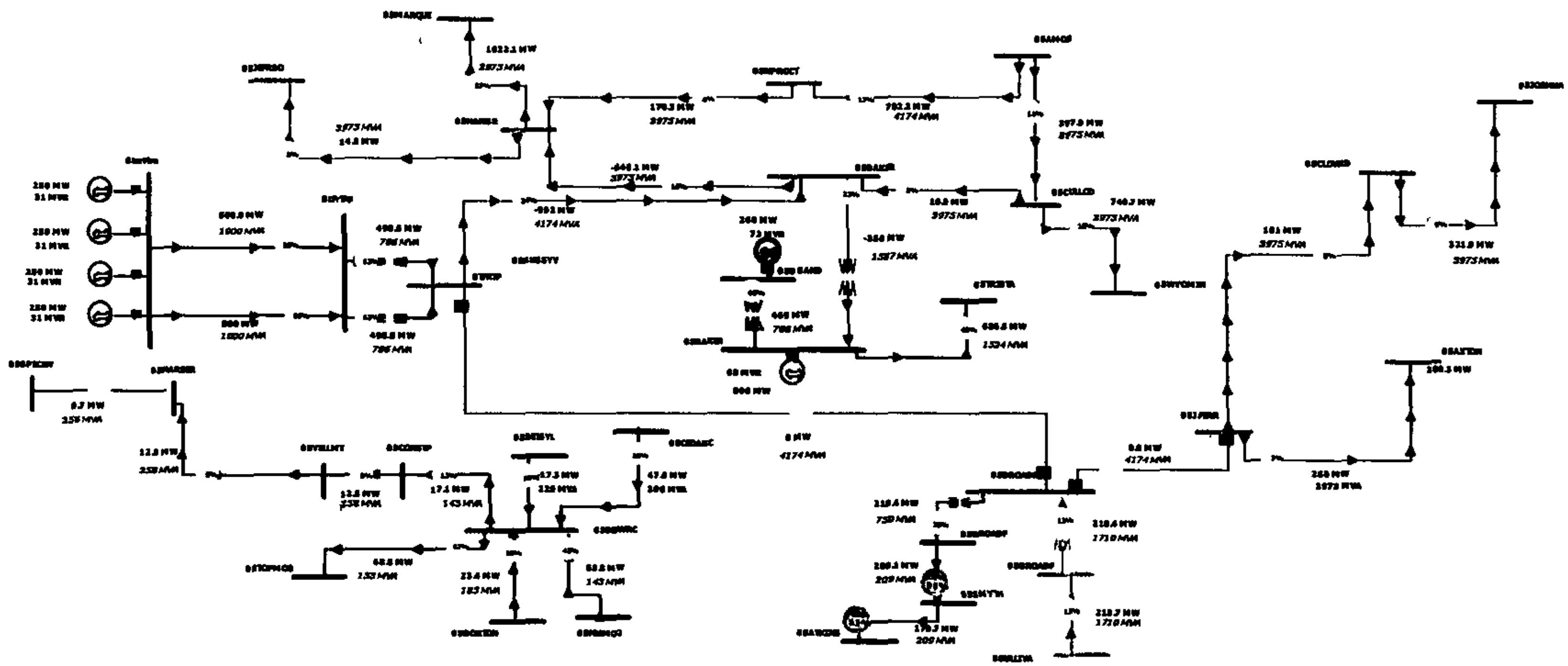

Exhibit B-21: Broadford-Jackson Ferry 765 kV Contingency Mitigation

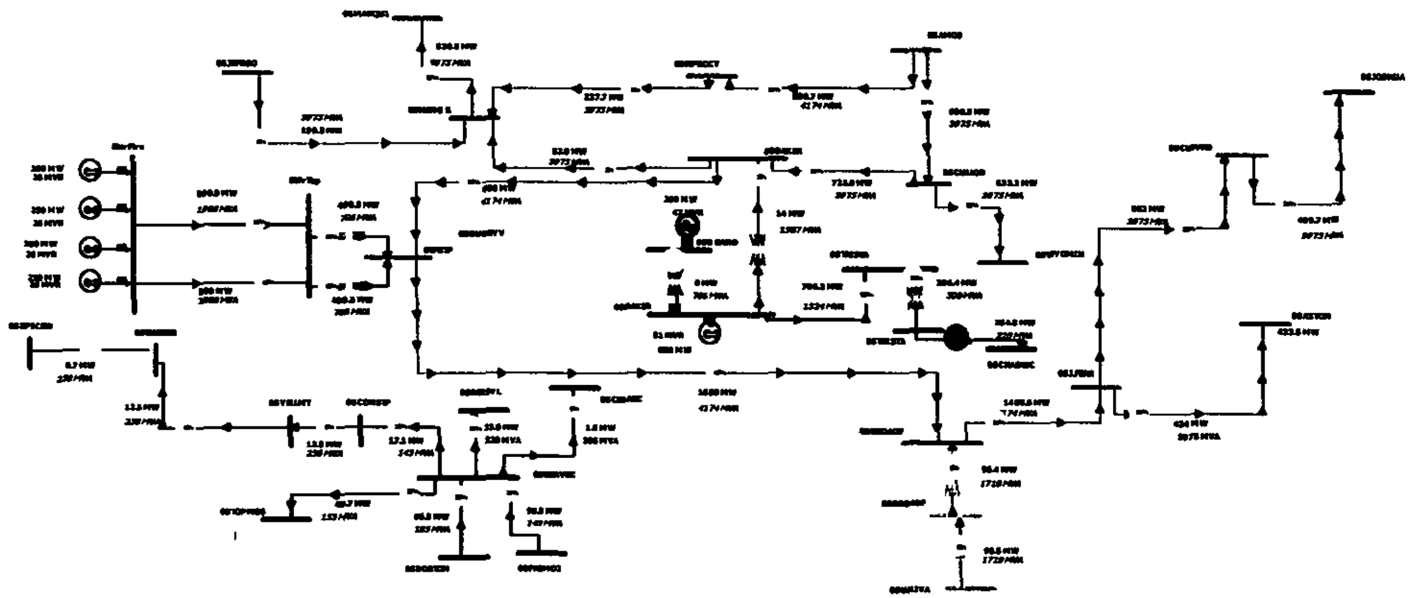

Exhibit B-22: Big Sandy-Baker 138/345 kV Transformer Contingency with 1000 MW Project's Generation

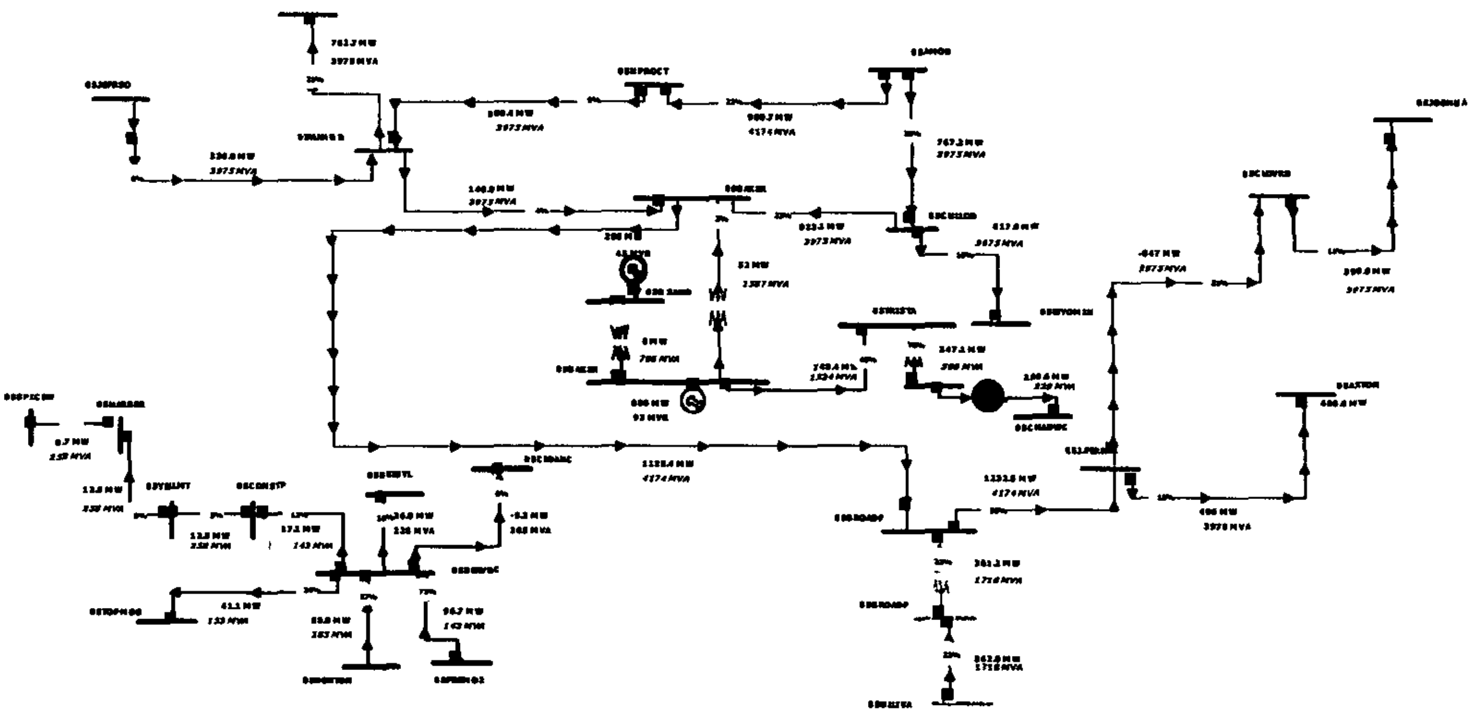

Exhibit B-23: Big Sandy-Baker 138/345 kV Transformer Contingency without the Project's Generation

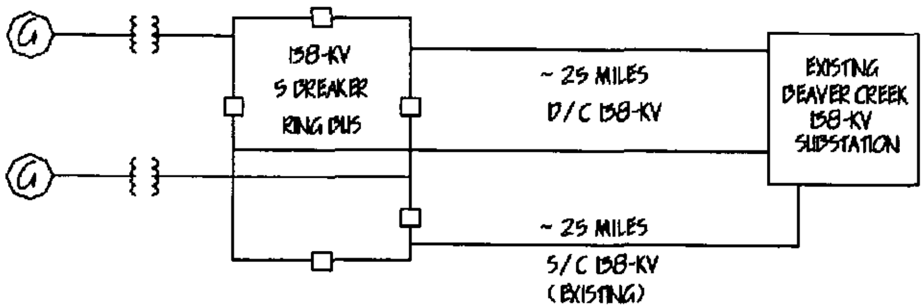

Exhibit B-24: 500 MW Generation: Interconnection Option A

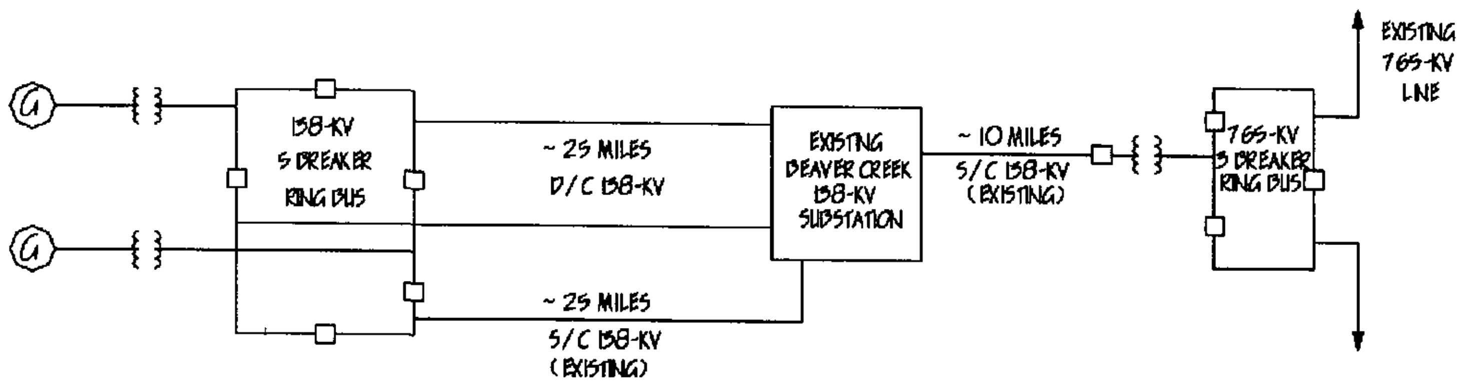

Exhibit B-25: 500 MW Generation: Interconnection Option B

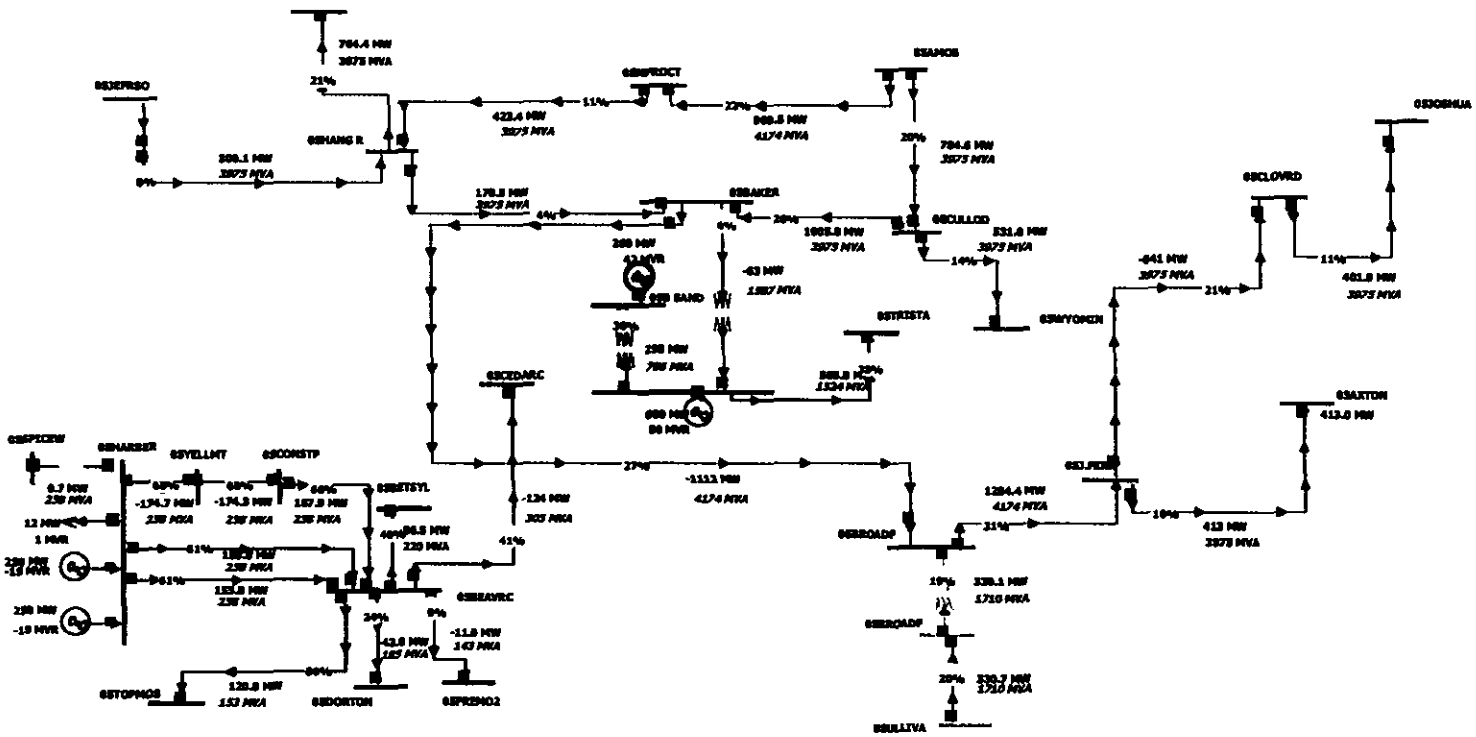

Exhibit B-26: 500 MW Generation: Interconnection Option A Power Flow Solution

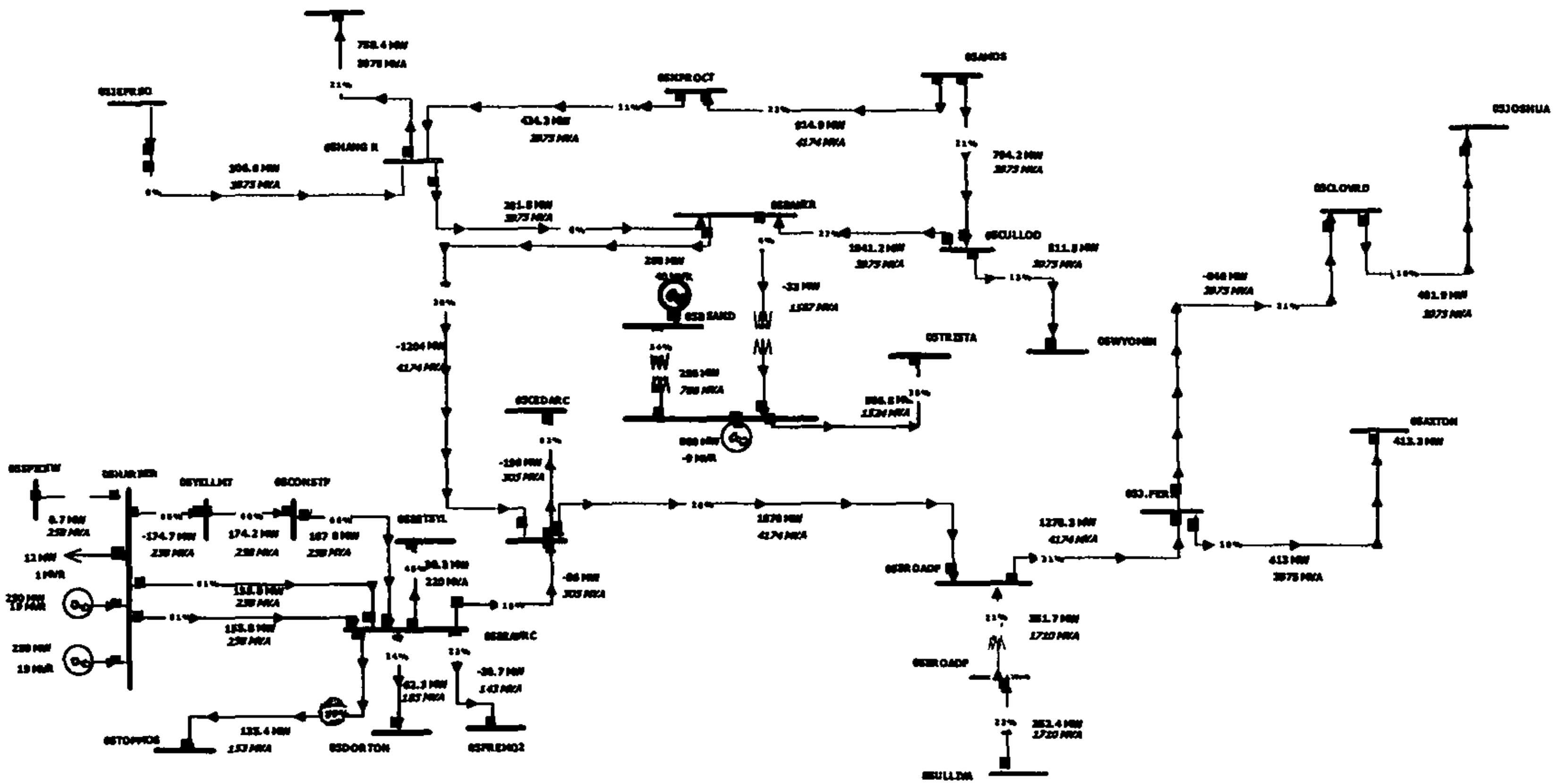

Exhibit B-27: 500 MW Generation: Interconnection Option B Power Flow Solution

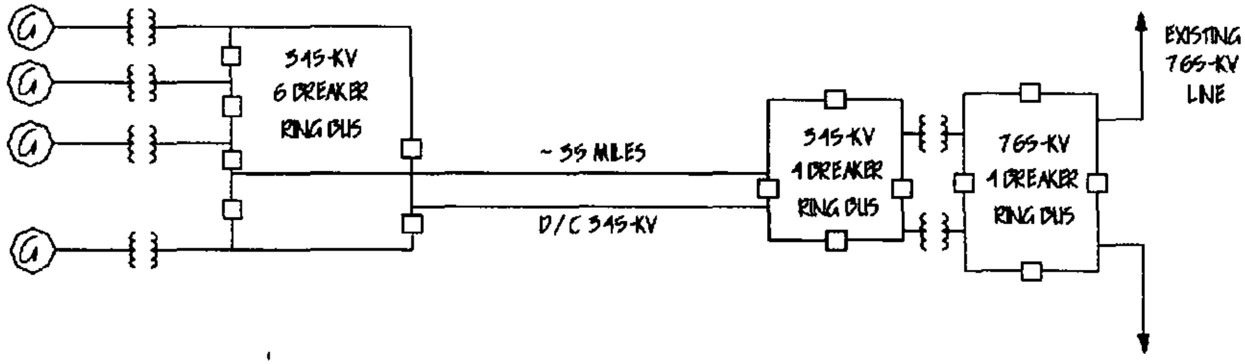

Exhibit B-28: 1000 MW Generation: Interconnection Option A

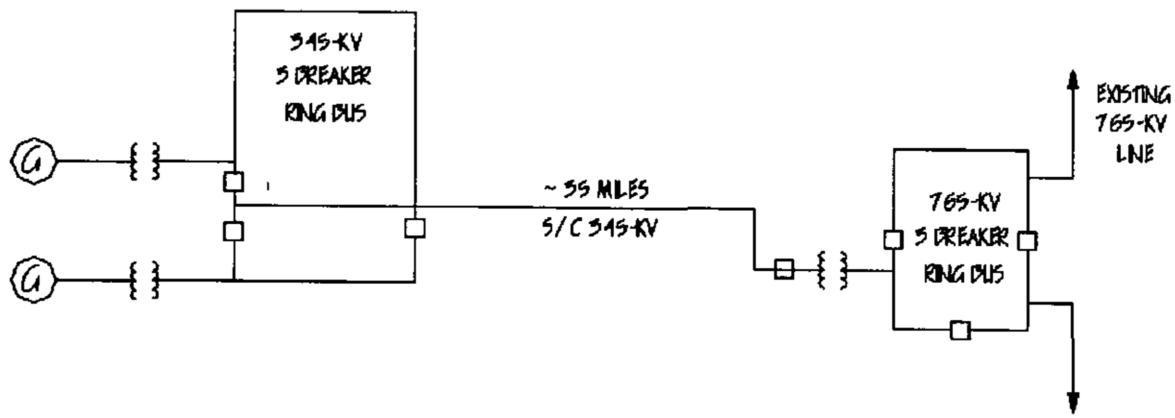

Exhibit B-29: 1000 MW Generation: Interconnection Option B
(Stage 2 after the 500 MW Generation – Option A)