EXHIBIT 4

COMMONWEALTH OF KENTUCKY
BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

THE APPLICATION OF EAST KENTUCKY	**)**
POWER COOPERATIVE, INC. FOR A CERTIFICATE	**)**
OF PUBLIC CONVENIENCE AND NECESSITY FOR	**) CASE NO.**
THE CONSTRUCTION OF A 345 kV ELECTRIC	**) 2006-00463**
TRANSMISSION LINE IN CLARK, MADISON, AND	**)**
GARRARD COUNTIES, KENTUCKY	**)**

PREPARED TESTIMONY OF DARRIN ADAMS
ON BEHALF OF
EAST KENTUCKY POWER COOPERATIVE, INC.

1. Please state your name and business address.

A. Darrin W. Adams, East Kentucky Power Cooperative (EKPC), 4775 Lexington Road, Winchester, Kentucky 40391

2. By whom are you employed and in what position?

A. I am employed by East Kentucky Power Cooperative, Inc., as Manager of Transmission Planning in the Power Supply Business Unit.

3. As background for your testimony, please briefly describe your educational background and work experience?

A. I am a graduate of Transylvania University with a Bachelor of Arts degree in Liberal Studies, and a graduate of the University of Kentucky with a Bachelor of Science degree in Electrical Engineering. I am a Licensed Professional Engineer in the Commonwealth of Kentucky. I have more than 13 years of experience in the electric utility industry. From May 1991 to August 1996, I was employed by Kentucky Utilities Company (KU) as an engineer responsible for planning of the

KU transmission system. From March 1999 to October 2001, I was employed by LG&E Energy as an engineer within the Operations Department, primarily responsible for transmission system operational analysis. From October 2001 through June 2004, I was employed as the Group Leader of Transmission Planning at LG&E Energy. I have been employed at EKPC as an engineer responsible for transmission planning since June of 2004, and have been the Supervisor of Transmission Planning since February of 2005.

4. What are your duties and responsibilities as Manager of Transmission Planning in EKPC's Power Supply Business Unit?

A. My duties include both the direct performance and the supervision of planning studies for all additions and modifications to the EKPC transmission system.

5. Were the planning studies that provide the determination of need for transmission system modifications and the justification for the J.K. Smith-West Garrard electric transmission line that is the subject of this Case No. 2006-00463 performed directly by you or under your direct supervision?

A. Yes.

6. What is the purpose of your testimony?

A. My testimony will provide an explanation of the need for the J.K. Smith-West Garrard 345 kV electric transmission line and describe the studies that were performed to determine that need.

7. Why is EKPC proposing to construct the J.K. Smith to West Garrard Line?

A. This line is needed to enable EKPC to reliably deliver energy from its existing and planned future generating resources to its member systems. EKPC has identified the need for construction of additional generating units at the J.K. Smith Station. This site presently has seven Combustion Turbines (CTs) installed, with a total net capacity of 594 MW in the summer and 826 MW in the winter. EKPC's generation expansion plan includes the addition of five CTs and a coal-fired baseload unit, with a total net capacity added of 698 MW in the summer and 768 MW in the winter. The total net capacity installed at the site after these unit additions will be 1292 MW in the summer and 1594 MW in the winter. The capacity and performance of the existing transmission lines in the vicinity of the J.K. Smith Station are not adequate to deliver this generation to native load customers. The proposed J.K. Smith-West Garrard Line is necessary to accommodate the planned generation additions at J.K. Smith and to enable EKPC to continue providing reliable, low-cost energy to its member systems.

8. How did EKPC determine the need for the proposed Smith-West Garrard Line?

A. EKPC performed a System Impact Study (SIS) from October 2004 through May 2006 based on a request made by EKPC's resource planners for connection of the proposed generators to the EKPC transmission system at the J.K. Smith site. An ad hoc study group consisting of representatives from EKPC's neighboring utilities was formed to provide input and comments related to the SIS. EKPC's Transmission Planning staff performed and documented the SIS, including power flow, short-circuit, and transient stability analyses, incorporating input from the ad hoc study group. The SIS identified constraints on the EKPC and neighboring transmission systems that might limit the output of the J.K. Smith generators, and identified potential transmission system modifications to address these limitations.

A copy of the documentation for the SIS is attached as **Adams Exhibit I**, and incorporated herein by reference.

9. What were the results of the SIS performed by EKPC?

A. The SIS identified 41 unique overloaded facilities in 2010 Summer and 36 unique overloaded facilities in 2010-11 Winter. The SIS also identified marginal transient stability for the generating units at J.K. Smith Station and Dale Station. As a result, the transmission system in the vicinity of the J.K. Smith Station is insufficient to accommodate the planned generation additions at J.K. Smith.

10. Did EKPC evaluate whether any alternatives to the proposed Smith-West Garrard 345 kV Line could address the transmission system requirements?

A. Yes. In the SIS, 38 possible 345 kV or 138 kV outlets from the J.K. Smith Station were assessed singularly and in various combinations to address the transmission system problems. The analyses performed determined that most of the outlets considered did not provide adequate system performance. Ultimately, the analysis identified two possible 345 kV transmission outlets – J.K. Smith-West Garrard or J.K. Smith-Tyner -- that provide a significant improvement in transmission system performance. These two outlets were the basis of three transmission Alternatives that were developed and compared to identify the recommended transmission Plan. The major components of these Alternatives are as follows:

- Alternative 1 includes the J.K. Smith-West Garrard 345 kV line and associated substations as the major components. In addition, upgrades of nine existing facilities were identified for this Alternative.

- Alternative 2 includes a new 345 kV line from J.K. Smith to the Tyner Substation and a new 345-161 kV transformer at the Tyner Substation as the major components. In addition, upgrades of 18 existing transmission facilities were identified for this Alternative.
- Alternative 3 includes a new 345 kV line from J.K. Smith to the Tyner Substation, a new 345-161 kV transformer at Tyner, and a new 138 kV line from J.K. Smith to LGEE's Spencer Road Substation as the major components. In addition, upgrades of 15 existing transmission facilities were identified for this Alternative.

11. Why was the proposed Smith-West Garrard 345 kV Line chosen for implementation instead of another alternative?

A. All three transmission Alternatives developed in the SIS eliminate the thermal overloads caused by the additional generation at J.K. Smith and provide improved generating-unit stability. The three Alternatives were compared using ten different categories, such as costs, future expansion possibility, local area support, power flow impacts, etc. Alternative 1 was determined to be the best Alternative based on this comparison. In particular, the present value costs of Alternative 1 ($69,685,000) were approximately 27% lower than Alternative 2 ($88,169,000) and 36% lower than Alternative 3 ($94,963,000). In addition to these large cost differences, another important factor favoring Alternative 1 is the better future expansion possibilities for EKPC to address future system load growth in the central and western parts of its system. Another benefit identified is that the J.K. Smith-West Garrard 345 kV line will complete a 345 kV loop around the eastern side of the Lexington area. The line will complete a 345 kV path that connects from southern Ohio through the Spurlock Station in Maysville, KY and then through the J.K. Smith Station to West Garrard. A connection from West Garrard to the Pineville 345/500 kV Substation provides a link to the TVA 500 kV system that stretches into Tennessee. Therefore, this line will complete a 345 kV path that will provide regional benefits related to power transfers.

12. Has EKPC conducted any other studies related to the proposed J.K. Smith-West Garrard Line?

A. Yes. The original SIS and associated documentation were completed in May of 2006. In August of 2006, another study was conducted which compared the J.K. Smith-West Garrard Line to other electrical alternatives in the area. A copy of the documentation for this study is attached as **Adams Exhibit II**, and incorporated herein by reference. The conclusion from this study is that the J.K. Smith-West Garrard Line is a better electrical alternative than other possible lines that could be constructed in this area. The specific point of connection to LGEE's Brown-Pineville 345 kV line could vary somewhat without impacting electrical performance. However, one of the key factors in siting the substation that connects the new line from J.K. Smith to LGEE's Brown-Pineville line is the ability to build future lines out of the new substation to the western part of EKPC's system.

13. Have any other studies or coordination of planning activities been performed related to the proposed project?

A. Yes. As discussed above, an ad hoc study group was formed for this SIS. This ad hoc study group included representatives from American Electric Power (AEP), Big

Rivers Electric Corporation (BREC), Cinergy (Duke Energy), Dayton Power & Light (DPL), LGEE, Midwest ISO (MISO), and the Tennessee Valley Authority (TVA). Input was solicited from the ad hoc study group throughout the study process. A meeting was held between AEP, CIN, DPL, and LGEE after the study was completed to discuss the results. Since the majority of the impacts on other utilities are in the LGEE system and since EKPC is requesting a new interconnection with LGEE at West Garrard, detailed coordination has taken place between EKPC and LGEE. LGEE and MISO as its Independent System Operator began a detailed review of the proposed Alternative in June of 2006. After LGEE's exit from the MISO on September 1, 2006, the SPP ITO began its own review on behalf of LGEE. EKPC, LGEE, and the SPP ITO are working to resolve the outstanding issues and to add the new interconnection to the existing Interconnection Agreement between EKPC and LGEE.

14. What is the impact on the J.K. Smith-West Garrard Project of the decision by the Warren Rural Electric Cooperative Corporation (WRECC) to remain with TVA for all of its power supply rather than obtaining its power supply from EKPC?

A. The studies performed in the SIS assumed that EKPC would be serving the WRECC load. The decision by WRECC to remain with TVA for its power supply does not change the need for the Smith-West Garrard Project. This line is needed due to the planned addition of generation at the J.K. Smith site. Studies indicate that the addition of more than approximately 100 MW of generation at J.K. Smith will trigger the need for transmission modifications. EKPC's latest generation expansion plan still indicates the need for two CTs in 2009 and the J.K. Smith baseload CFB unit in 2011, and the Commission, on May 5, 2007, affirmed the CPCN for these three units. Therefore, the need for additional transmission still exists. Furthermore, EKPC still expects to add additional CTs -- and possibly another baseload unit -- at J.K. Smith within the next ten years. This level of generation is consistent with the assumptions made in the SIS. Therefore, the study results are still valid.

EKPC has updated its original SIS and documented the analysis since WRECC announced its decision to continue its power supply arrangements with TVA in 2009 and beyond. For the reasons explained in the previous paragraph, this document confirms that the need for the Smith-West Garrard Line in 2009 still exists. A copy of this documentation is attached as **Adams Exhibit III**, and is incorporated herein by reference.

15. From an electrical planning perspective, will the J.K. Smith-West Garrard Line result in unnecessary duplication of facilities?

A. No. EKPC assessed the ability of the existing transmission system to deliver the existing and proposed future generation from the J.K. Smith site to EKPC's customers. A large number of thermal overloads resulted. EKPC considered the possibility of upgrading these existing facilities to provide the needed capacity. However, this was not feasible for the following reasons:

- More than 20 significant upgrades of existing facilities would be required.
- System outages of the facilities to be upgraded would be required for long durations, and these outages would need to be taken prior to the generation

additions at J.K. Smith. These outages would be extremely difficult to schedule, and would create potential reliability issues and higher costs.

- These upgrades would not provide the desired level of generating unit stability at J.K. Smith and Dale.

Therefore, use of existing electrical facilities to provide the needed transmission capacity is not possible.

16. Have you performed any analysis to determine the impacts on electrical system performance if existing transmission lines are rebuilt to accommodate the proposed line?

A. Yes. In May of 2006, an analysis was performed to gather information regarding the viability of rebuilding existing lines in the study area to add the new Smith-West Garrard 345 kV line on the same structures. This analysis evaluated the system performance impacts due to extended outages on these existing lines to facilitate construction of the new Smith-West Garrard Line. The results of the analysis indicated that of the thirteen EKPC transmission facilities within the study area, five were viable candidates for rebuilding. This information was then incorporated into the routing process.

In January of 2007, the possibility of rebuilding the existing J.K. Smith-Fawkes 138 kV transmission line as a double-circuit line with the proposed Smith-West Garrard line was examined. This examination centered on the possibility of building a new double-circuit line beside the existing Smith-Fawkes 138 kV line, and then tearing down the existing line once the new construction is completed. This approach would avoid the system problems that would be caused by an extended construction outage of the Smith-Fawkes 138 kV line. However, the analysis determined that placing the proposed Smith-West Garrard line on the same structures as the Smith-Fawkes line would create unacceptable reliability risks for the region's transmission grid. Therefore, this approach was excluded from further consideration. A copy of an EKPC memorandum summarizing this analysis is attached as **Adams Exhibit IV**, and incorporated herein by reference.

17. Why is the J.K. Smith-West Garrard Line required for public convenience and necessity?

A. EKPC has an obligation to provide reliable, low-cost service to its member systems. EKPC has established a need for additional generation capacity at the J.K. Smith Station to meet its customers' electrical needs. The proposed line is necessary to transmit the EKPC generation capacity to its customers, and therefore is consistent with public convenience and necessity.

18. Do you have an opinion as to whether the J.K. Smith-West Garrard Line best addresses the transmission system needs that you have described?

A. Yes.

19. What is that opinion?

A. It is my opinion that the J.K. Smith-West Garrard Line is the best means to address the transmission system needs created by the addition of generation at J.K. Smith.

20. Does this conclude your testimony?

A. Yes, it does.

COMMONWEALTH OF KENTUCKY
BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

THE APPLICATION OF EAST KENTUCKY POWER COOPERATIVE, INC. FOR A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE CONSTRUCTION OF A 345 kV ELECTRIC TRANSMISSION LINE IN CLARK, MADISON, AND GARRARD COUNTIES, KENTUCKY	**) CASE NO.) 2006-00463**

AFFIDAVIT

STATE OF KENTUCKY)
)
COUNTY OF CLARK)

Darrin Adams, being duly sworn, states that he has read the foregoing prepared testimony and that he would respond in the same manner to the questions if so asked upon taking the stand, and that the matters and things set forth therein are true and correct to the best of his knowledge, information and belief.

Darrin Adams
Darrin Adams

Subscribed and sworn before me on this 21st day of May 2007.

Teri K. Isaacs (Combs)
Notary Public
My Commission expires: 12/20/08

ADAMS EXHIBIT 1

SYSTEM IMPACT STUDY

GENERATION INTERCONNECTION REQUESTS #30-33

JK SMITH COMBUSTION TURBINES #8-12 AND CFB UNIT #1 PROJECT IN CLARK COUNTY, KENTUCKY

EAST KENTUCKY POWER COOPERATIVE
A Touchstone Energy Cooperative

May 17, 2006

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Executive Summary

This report contains the System Impact Study (SIS) results for Generation Interconnection Requests (GIR) #30 through #33 in the East Kentucky Power Cooperative, Inc. (EKPC) queue. The purpose of this study is to evaluate the impact of the addition of the following generators at EKPC's existing J.K. Smith Power Plant:

a) Five (5) combustion turbines, each with a net capacity of 84 MW in the summer and 98 MW in the winter. These units will be designated as J.K. Smith CTs #8, #9, #10, #11, and #12.
b) One (1) Circulating Fluidized Bed (CFB) steam generator with a net capacity of 278 MW in both summer and winter. This unit will be designated as J.K. Smith CFB #1 throughout this report.

The existing four 138 kV transmission lines connected to the J.K. Smith Substation are insufficient to accommodate delivery of the total net output of the expanded J.K. Smith Power Plant. In fact, it was determined that the existing transmission outlets cannot accommodate any generation additions at the site. Therefore, this study identifies various transmission expansion plans needed to support the total expected output of the expanded J.K. Smith site.

Input was solicited from EKPC's neighboring utilities -- American Electric Power (AEP), Big Rivers Electric Corporation (BREC), Cinergy Corporation (CIN), Dayton Power & Light Company (DPL), LG&E Energy LLC (LGEE), the Tennessee Valley Authority (TVA), and the Midwest Independent System Operator (MISO) -- prior to beginning the SIS.

The thermal performance of the transmission systems of EKPC and its neighboring utilities was analyzed for both normal conditions (no transmission elements outaged) and for single-contingency conditions (one transmission element out in conjunction with the worst-case generating unit) for the 2010 time period. This analysis identified 41 overloaded facilities in 2010 Summer and 36 overloaded facilities in 2010-11 Winter due to the addition of the proposed generators. Nearly all of these overloaded facilities are either owned by EKPC or LGEE, or are EKPC-LGEE interconnections. Other than those facilities, one of the overloaded facilities is an AEP facility and one is an LGEE-AEP interconnection.

The problems identified with the proposed generators and without any transmission system additions are primarily concentrated in two areas:

1. The immediate area around the J.K. Smith, Dale, Fawkes, Lake Reba Tap, Powell County, and Clark County Substations.
2. Along the 161 kV system extending southeast from the Lake Reba Tap Substation to the Delvinta Substation and on the other 161 kV lines out of Delvinta.

Transient-stability analysis was also performed to determine the impacts of the proposed generator additions on system stability. The results of that analysis indicate that unit stability is decreased for the generating units at J.K. Smith and at Dale Station, but all of the units appear to remain stable. This analysis included the new J.K. Smith-North Clark 345 kV line and associated substation facilities, which are scheduled to be completed by June 2007.

Some common facilities are required at the J.K. Smith site to accommodate the proposed generator additions. These requirements are necessary regardless of the transmission system additions or upgrades needed to address thermal overloads. These common facilities are necessary to accommodate the connection of the proposed generators to EKPC's transmission network. The estimated installed costs of these common facilities are $21,500,000.

In addition to the common facilities needed at J.K. Smith, transmission-system modifications are required to accommodate the generation additions at J.K. Smith due to the numerous thermal overloads that would occur. Upgrades of the overloaded facilities were considered. However, this is not a feasible or desirable alternative for the following reasons:

- The numerous outages required to upgrade all of the overloaded facilities would need to occur by March of 2010. Since many of these facilities are critical links in the existing transmission system, these outages would cause significant operational issues. Generation would need to be substantially restricted at J.K. Smith in particular.
- The scope, cost, and completion time of the numerous upgrades is unknown. Engineering evaluations would be required for each upgrade, further decreasing the time available for construction while increasing the risk of incurring higher costs.
- Upgrading existing facilities would not provide significant additional margin for multiple contingencies or large power transfers.
- Transmission-system losses would not be significantly reduced.

Thirty-eight possible 345 kV or 138 kV transmission outlets from the J.K. Smith Substation were evaluated to determine their impacts on the thermal overloads identified. The screening process eliminated most of these outlet options for one of the following two reasons:

- An outlet either singularly or in combination with other outlets did not eliminate a substantial number of the thermal overloads caused by the proposed generators
- An outlet did not provide any significant additional benefits when compared to the performance of another outlet that would be shorter and/or less expensive

As a result of the screening analysis, it was determined that one 138 kV outlet from the J.K. Smith site would not be adequate. Screening showed that at least three 138 kV outlets would be required to accommodate the added generation. Additionally, significant upgrades would still be required on the transmission system with these multiple 138 kV outlets. Furthermore, transmission-system losses will be higher with these 138 kV outlet options than with a 345 kV outlet option. For these reasons, no options were considered that only provided 138 kV outlets from J.K. Smith Substation. All transmission alternatives considered therefore included a new 345 kV outlet from the J.K. Smith site.

The screening analysis performed determined that two of the 345 kV outlet options considered have a greater impact on the transmission-system problems identified than did the remainder of the outlet options. These two outlet options are:

- ✓ The J.K. Smith-Tyner 345 kV line and the installation of a 345-161 kV transformer at Tyner
- ✓ The J.K. Smith-West Garrard 345 kV line and a new 345 kV switching station at West Garrard connecting this line with LGEE's Brown-Pineville 345 kV circuit

These two outlets substantially reduce the number and severity of overloads caused by the proposed generators. These options appear to provide these benefits for two primary reasons:

- Each is a 345 kV outlet providing a high outlet capacity from the J.K. Smith site
- Each provides a connection to the transmission system in the southern and southeastern parts of the Kentucky transmission system. A small amount of generation exists in this area. Therefore, a large amount of the power required by customers in this area presently flows into the area on the 138 kV and 161 kV interfaces in the Richmond, KY area (through the Fawkes and Lake Reba Tap substations). Either the J.K. Smith-Tyner or J.K. Smith-West Garrard 345 kV line would provide an EHV path bypassing these heavily loaded 138 and 161 kV interfaces.

The other outlet options screened either did not provide as much benefit as either of these two options or provided similar benefits at the expense of much more construction.

Three transmission alternatives were developed to address the thermal overloads identified with the proposed generators. One of these alternatives includes the J.K. Smith-West Garrard 345 kV project (Alternative 1). The other two alternatives include the J.K. Smith-Tyner 345 kV project. Of the two alternatives that include the J.K. Smith-Tyner 345 kV project, one includes a series reactor in the Dale-Boonesboro North 138 kV line (Alternative 2), whereas the other includes a new J.K. Smith-Spencer Road 138 kV line (Alternative 3). The estimated costs for the three Alternatives are as follows:

Cost Estimate Summary for J.K. Smith Transmission Outlet Alternatives			
Alternative	**Planning Estimate Total (2006$)**	**Inflated Cost (Install Year $)**	**Present Worth (2006$)**
Alternative 1	$51,095,000	$57,560,000	$69,685,000
Alternative 2	$64,875,000	$73,086,000	$88,169,000
Alternative 3	$69,785,000	$78,618,000	$94,963,000

The three transmission Alternatives were compared using the following categories:

- Power Flow Impacts
- Transmission System Losses
- Transient Stability Impacts
- Short Circuit Impacts
- Physical Issues
- System Reliability
- Future Expansion
- Local Area Support
- Costs
- Performance for Double Contingencies

Alternative 1 is considered the best of the three alternatives in five of the nine categories considered. Alternative 3 is considered the best in three of the categories considered. All three Alternatives are considered equal in one of the categories considered (short-circuit impacts). Based on the comparison of these nine categories, Alternative 1 is the preferred Alternative.

Although, official requests for interconnection to the transmission system and/or transmission service have not been made for a second and third CFB unit at J.K. Smith, an analysis of transmission requirements was undertaken as part of this study to ensure that the transmission plan developed for the proposed units would mesh with the ultimate requirements if further units are developed at J.K. Smith. A detailed analysis of the problems and requirements was not performed, since these units are not part of the official request. The focus of the analysis was to identify the significant problems, and potential modifications to the transmission system to address those problems.

The analysis determined that additional transmission facilities are required with Alternatives 1 and 2 to add a second and a third CFB unit at J.K. Smith. For Alternative 3, a second CFB unit can be added without any significant transmission upgrades. The third CFB unit would require construction of a major 345 kV circuit, however. Therefore, the ultimate transmission configuration necessary for three CFB units at J.K. Smith is similar regardless of which transmission Alternative is implemented for the first

CFB unit. As a result, implementation of any of the three Alternatives will be compatible with the ultimate requirements for continued generation expansion at J.K. Smith.

In addition to the base scenario evaluated, several sensitivities were also analyzed to identify the potential impacts of these sensitivities on the preferred transmission Alternative (Alternative 1) with the generator additions at J.K. Smith. The sensitivities analyzed were:

1. The planned interconnections with TVA in the Bowling Green area (at East Bowling Green, Memphis Junction, and Salmons) opened; Trimble County Unit #2 and associated transmission not modeled
2. The Adkins generators in DPL modeled at maximum output with the surplus generation exported to SERC; Trimble County Unit #2 and associated transmission not modeled
3. The proposed Estill County IPP generation station (and associated transmission facilities) modeled at maximum output with the surplus generation exported equally to northern ECAR and to SERC; Trimble County Unit #2 and associated transmission not modeled
4. The proposed Thoroughbred Energy IPP generation station (and associated transmission) modeled at maximum output with the output exported to AEP, CIN, MAIN, and SERC; Trimble County Unit #2 and associated transmission not modeled
5. The LGEE Brown CT generation reduced in the summer with the required generation increased at Trimble County and in northern ECAR. The LGEE Brown CT generation increased in the winter with the surplus generation exported equally to northern ECAR and to SERC; Trimble County Unit #2 and associated transmission not modeled
6. The LGEE Trimble County Unit #2 and associated transmission modeled
7. The planned interconnections with TVA in the Bowling Green area (at East Bowling Green, Memphis Junction, and Salmons) opened; Trimble County Unit #2 and associated transmission modeled
8. The Adkins generators in DPL modeled at maximum output with the surplus generation exported to SERC; Trimble County Unit #2 and associated transmission modeled
9. The proposed Estill County IPP generation station (and associated transmission facilities) modeled at maximum output with the surplus generation exported equally to northern ECAR and to SERC; Trimble County Unit #2 and associated transmission modeled
10. The proposed Thoroughbred Energy IPP generation station (and associated transmission) modeled at maximum output with the output exported to AEP, CIN, MAIN, and SERC; Trimble County Unit #2 and associated transmission modeled
11. The LGEE Brown CT generation reduced in the summer with the required generation increased at Trimble County and in northern ECAR. The LGEE Brown CT generation increased in the winter with the surplus generation exported equally to northern ECAR and to SERC; Trimble County Unit #2 and associated transmission modeled

The sensitivity analyses that were performed identified several overloads created by the change in conditions modeled for each sensitivity. The sensitivity that opened the future EKPC-TVA 161 kV interconnections in the Bowling Green area is not a valid operating scenario. Therefore, the problems identified for that sensitivity do not need to be addressed. Also, the sensitivities that include the proposed Estill County generators or the proposed Thoroughbred Energy generators are scenarios that may not materialize. Therefore, until these units are constructed, there is no need to address the problems identified for those scenarios. Other scenarios involve the existing Adkins and Brown CT units. Since the Adkins and Brown CT units are existing units currently operating on the transmission grid, the possibility of these units operating at either maximum or minimum levels during peak load periods exists. Therefore, the problems identified for those sensitivities could occur, which could impact the dispatch of the proposed J.K. Smith units. Addressing these problems may therefore be desired. Finally, LGEE's Trimble County Unit #2 is proceeding on schedule as planned. This unit will be a baseload unit connected to the LGEE transmission system, and will be a network resource for LGEE native load customers. Therefore, this unit is highly likely to be built, and to operate at a very high capacity factor. As a result, problems identified with the Trimble County Unit #2 have a high likelihood of occurring. Addressing these problems may be desired to avoid frequent generation reduction at J.K. Smith. The expected timeframe between the completion of J.K. Smith CFB Unit #1 and Trimble County Unit #2 is a few months. Therefore, the need to address problems created by sensitivities without Trimble County Unit #2 is minimized. Consequently, the sensitivities for which resulting problems should potentially be addressed are #6, #8, and #11.

Twenty-nine ratings increases for twenty-one separate facilities are identified for these three sensitivities. Nine of these are facilities that are already specified for ratings increases as part of the proposed transmission plan. These ratings increases can be expanded by relatively small amounts to provide the required ratings. Furthermore, the upgrades necessary to provide the ratings for these facilities that are specified as needed as part of the recommended transmission plan may result in sufficient ratings for these sensitivities. Therefore, no additional cost may be incurred to provide the higher ratings for these sensitivities. The other twelve facilities identified were not overloaded without the three sensitivity scenarios under consideration. These remaining facilities should be evaluated to determine the scope of work necessary to provide the ratings specified. After the scope of work and cost estimates are provided, a decision on performing these additional upgrades can be made.

The following recommendations are made based on the analysis performed for the proposed generator additions at J.K. Smith:

1. The following common transmission facilities should be completed for connection of the proposed J.K. Smith units to the transmission network:
   a) Install a second 345-138 kV, 450 MVA autotransformer at J.K. Smith CT Substation by June 1, 2007.

b) Add 138 kV terminal facilities at the J.K. Smith CT Substation to connect J.K. Smith CT #8 by June 30, 2008.
c) Add 345 kV terminal facilities at the J.K. Smith CT Substation to connect CTs #9 and #10 by April 30, 2008.
d) Add 345 kV terminal facilities at the J.K. Smith CT Substation to connect CTs #11 and #12 by September 30, 2007.
e) Construct a second 345 kV Substation at J.K. Smith for the CFB Unit #1 (J.K. Smith CFB Substation) by March 1, 2009.
f) Construct two 345 kV lines between the J.K. Smith CT 345 kV Substation and the J.K. Smith CFB Substation (using bundled 954 MCM ACSR conductor) and associated terminal facilities by March 1, 2009.

2. The following transmission system additions and upgrades should be completed to provide sufficient capacity for delivery of the additional generation at J.K. Smith:
   a) Construct a 345 kV line from J.K. Smith to LGEE's Brown-Pineville double-circuit 345 kV line (using bundled 954 MCM ACSR conductor) and associated terminal facilities at the J.K. Smith CFB Substation by June 30, 2009.
   b) Add 345 kV terminal facilities at LGEE's Brown Substation and Pineville Substation to energize the existing Brown-Pineville 345 kV circuit by June 30, 2009.
   c) Construct a 345 kV switching substation (West Garrard) to connect the new 345 kV line from J.K. Smith to LGEE's Brown-Pineville 345 kV circuit by June 30, 2009.
   d) Increase the Hyden Tap-Wooten 161 kV LGEE-AEP interconnection rating to at least 203 MVA summer emergency and 252 MVA winter emergency by June 30, 2009.
   e) Increase the ratings of LGEE's Fawkes-Clark County 138 kV line to at least 187 MVA summer emergency by June 30, 2009.
   f) Increase the ratings of LGEE's Boonesboro North-Winchester Water Works 69 kV line to at least 146 MVA summer emergency by June 30, 2009.
   g) Increase the ratings of LGEE's Boonesboro North 138-69 kV transformer to at least 164 MVA summer emergency by June 30, 2009.
   h) Increase the ratings of LGEE's Lake Reba-Waco 69 kV line to at least 63 MVA summer emergency by June 30, 2009.
   i) Increase the ratings of LGEE's Parker Seal-Winchester 69 kV line to at least 75 MVA summer emergency by June 30, 2009.
   j) Increase the limits of LGEE's Alcalde-Elihu 161 kV line to at least 230 MVA summer emergency and 292 MVA winter emergency by June 30, 2009.
   k) Replace EKPC's Dale 138-69 kV, 82.5 MVA transformer with a 100 MVA transformer, and increase the ratings of the associated terminal facilities to at least 147 MVA winter emergency by November 30, 2009.
   l) Increase the limits of AEP's Leslie 161-69 kV transformer to at least 134 MVA winter emergency by November 30, 2009.

EKPC will coordinate with AEP and with LGEE to determine the scope, cost, and schedule of the required upgrades on their respective systems.

3. The following transmission system upgrades should be evaluated to determine the scope and cost to avoid potential generation limitations at J.K. Smith and other area generating plants due to planned generation additions at J.K. Smith with modified generation dispatches at LGEE's Brown Power Plant and/or the Adkins Generation Station in the DPL control area:
   a) An increase of the ratings of EKPC's J.K. Smith-Union City 138 kV line to at least 258 MVA/343 MVA summer normal/emergency and 397 MVA winter emergency by March 1, 2010.
   b) An increase of the ratings of the EKPC-LGEE Union City-Lake Reba Tap 138 kV line to at least 246 MVA/322 MVA summer normal/emergency and 290/373 MVA winter normal/emergency by March 1, 2010.
   c) An increase of the ratings of the DPL-AEP Adkins-Beatty 345 kV line to at least 1048 MVA summer emergency by March 1, 2010.
   d) An increase of the ratings of the Fawkes EKPC-Fawkes LGEE 138 kV line to at least 323 MVA summer emergency by March 1, 2010.
   e) An increase of the ratings of LGEE's Fawkes Tap-Fawkes LGEE 138 kV line to at least 321 MVA summer emergency and 328 MVA winter emergency by March 1, 2010.
   f) An increase of the ratings of EKPC's J.K. Smith-Dale 138 kV line to at least 312 MVA summer emergency by March 1, 2010.
   g) An increase of the ratings of the EKPC-LGEE Fawkes EKPC-Fawkes Tap 138 kV line to at least 297 MVA summer emergency and 317 MVA winter emergency by March 1, 2010.
   h) An increase of the ratings of EKPC's Three Forks Jct.-Fawkes EKPC 138 kV line to at least 227 MVA summer emergency by March 1, 2010.
   i) An increase of the ratings of LGEE's Pineville 345-161 kV transformer to at least 658 MVA winter emergency by November 30, 2010.
   j) An increase of the ratings of AEP's Hazard 161-138 kV transformer to at least 226 MVA winter emergency by November 30, 2010.
   k) An increase of the ratings of EKPC's Powell County 138-69 kV transformer to at least 145 MVA winter emergency by November 30, 2010.
   l) An increase of the ratings of AEP's Leslie-Hazard 69 kV line to at least 66 MVA winter emergency by November 30, 2010.
   m) An increase of the ratings of AEP's Morehead-Hayward 69 kV line to at least 49 MVA winter emergency by November 30, 2010.

EKPC will coordinate with AEP, DPL and LGEE to determine the scope and cost of these potential upgrades. Once this information is gathered, a decision can be made regarding whether to implement the upgrades.

Section 1: Introduction and Project Description

This report contains the System Impact Study (SIS) results for Generation Interconnection Requests (GIR) #30 through #33 in the East Kentucky Power Cooperative, Inc. (EKPC) queue. The purpose of this study is to evaluate the impact of the addition of the following generators at EKPC's existing J.K. Smith Power Plant site:

a) Five (5) combustion turbines, each with a net capacity of 84 MW in the summer and 98 MW in the winter. These units will be designated as J.K. Smith CTs #8, #9, #10, #11, and #12.
b) One (1) Circulating Fluidized Bed (CFB) steam generator with a net capacity of 278 MW in both summer and winter. This unit will be designated as J.K. Smith CFB #1 throughout this report.

Additionally, two more CFB units identical to the CFB unit described above were considered in the study for transmission planning purposes. This was done since the J.K Smith site has the capability to allow construction of additional baseload units. The transmission plan developed for this request should be compatible with the ultimate plan that would be needed if a total of three CFB units are constructed at J.K. Smith. The timeframes in which these second and third units would be added are not known, so for purposes of this study, they were included at the end of EKPC's transmission planning horizon, which is presently 2015.

The existing four 138 kV transmission lines connected to the J.K. Smith Substation are insufficient to accommodate delivery of the total net output of the expanded J.K. Smith Power Plant. In fact, it was determined that the existing transmission outlets cannot accommodate any generation additions at the site. Therefore, this study identifies various transmission expansion plans needed to support the total expected output of the expanded J.K. Smith site. The timeframe in which each project in a plan is needed is determined as well based on the expected timing of generation additions at J.K. Smith.

See Appendix A for maps of the EKPC transmission system. Figure A-1 is a map of the EKPC transmission system. Figure A-2 is a map of the transmission system around the J.K. Smith Generating Station.

The initial request submitted to EKPC was for connection of a total of six General Electric (GE) 7EA CTs at J.K. Smith, each with net output of 75 MW summer and 100 MW winter, plus the single CFB unit at J.K. Smith. However, the request was later modified for connection of five GE LMS100 CTs with net output of 84 MW summer and 98 MW winter instead of the six 7EA CTs. Also, the expected commercial operation dates (COD) have been modified from those included in the original generation request. Table 1-1 shows the generation addition schedule that was used for this study.

Table 1-1 J.K. Smith Planned Generation Additions			
Requested Project	**Commercial Operation Date**	**Summer Net Capacity (MW)**	**Winter Net Capacity (MW)**
JK Smith #12	March 2008	84	98
JK Smith #11	April 2008	84	98
JK Smith #10	October 2008	84	98
JK Smith #9	November 2008	84	98
JK Smith #8	December 2008	84	98
JK Smith CFB #1	March 2010	278	278

Section 2: Criteria, Methodology, and Assumptions

2.1 Study Criteria

The EKPC Transmission System Planning Criteria related to thermal loadability and transient stability were applied for this analysis. These criteria are consistent with North American Electric Reliability Council (NERC), East Central Area Reliability Coordination Agreement (ECAR), and Southeastern Reliability Council (SERC) planning standards and guidelines. (EKPC was a member of ECAR from the commencement of this study until January 1, 2006. At that time, EKPC became a member of SERC.) EKPC's Transmission System Planning Criteria are attached as Appendix B.

Additionally, input was solicited from EKPC's neighboring utilities prior to beginning the SIS. A study scope was developed and provided for input to representatives from American Electric Power (AEP), Big Rivers Electric Corporation (BREC), Cinergy Corporation (CIN), Dayton Power & Light Company (DPL), LG&E Energy LLC (LGEE), the Tennessee Valley Authority (TVA), and the Midwest Independent System Operator (MISO). Two conference calls were also held among these representatives and representatives of EKPC to discuss issues related to the study scope prior to EKPC beginning the study.

2.2 Transmission Planning Methodology

Steady-state power flow analysis, short-circuit analysis, and transient-stability analysis were performed for this SIS.

2.2.1 Power Flow Analysis

The performance of the transmission systems of EKPC and its neighboring utilities was analyzed for both normal conditions (no transmission elements outaged) and for single-contingency conditions (one transmission element out in conjunction with the worst-case generating unit) for the 2010 time period. Furthermore, an n-2 analysis of 345 kV and selected lower-voltage facilities was also performed to identify potential overloads that could limit the output of the J.K. Smith Power Plant due to transmission maintenance outages, common-tower outages, simultaneous forced outages, etc.

A list of thermal loading problems due to the addition of the queued generators was developed. Then, transmission alternatives were developed to integrate the proposed generators into the EKPC transmission system and to address associated thermal limitations on neighboring transmission systems. Next, conceptual plans to accommodate two additional CFB units at the J.K. Smith site were developed from the transmission alternatives identified for the queued generators.

All thermal loading problems that were identified due to the addition of the proposed generators were also evaluated without the proposed units to determine if the overloads would occur in the 2010 time period. All the normal-system overloads with a 3% response to J.K. Smith generation and the contingency overloads with a 5% response to J.K. Smith generation that were not pre-existing without the proposed units are attributed in this study to the addition of the units.

2.2.2 Transient-Stability Analysis

The performance of the transmission system both with and without the requested generating units was analyzed with and without appropriate system disturbances. The types of disturbances selected for the stability analysis were:

a) with all transmission facilities and equipment in service, a sustained three-phase fault on a bus or line followed by either a three-phase or, where appropriate, single-pole circuit-breaker failure with appropriate operation of backup circuit breakers
b) with one transmission facility out of service, a sustained single-phase-to-ground fault with normal fault clearing by appropriate circuit breakers

2.2.3 Short-Circuit Analysis

The fault current levels at selected buses with and without the requested generating units were determined to evaluate the adequacy of existing circuit breakers. The fault analysis included 3-phase and single-phase line-to-ground faults.

2.3 Modeling & Assumptions

2.3.1 Power Flow Models

The models used for the power flow analysis were from EKPC's internal model library. The models used were the following peak-load representations:

2005 Summer	2005/06 Winter
2010 Summer	2010/11 Winter
2015 Summer	2015/16 Winter

These models were jointly developed by EKPC and LGEE in early 2004, and therefore include a detailed representation of both the EKPC and LGEE transmission systems. The representation of EKPC's other neighboring utilities (AEP, BREC, CIN, DPL, and TVA) is the representation submitted by these utilities for the NERC MMWG 2003 Series Model Development. The remainder of the "outside world" is a reduced representation from that NERC MMWG 2003 Series. In order to develop the EKPC/LGEE 2015 Summer case, the outside world representation from the NERC MMWG 2012 Summer case was used. In order to develop the 2015/16 Winter case, the outside world representation from the NERC MMWG 2010/11 Winter case was used.

For all utilities other than EKPC and LGEE, the analysis used the loads included in the base NERC MMWG cases for the appropriate year. For these utilities, the loads in the 2015 Summer case are identical to those in the NERC MMWG 2012 Summer model. Likewise, the loads modeled in the 2015/16 Winter models for these utilities are identical to those modeled in the NERC MMWG 2010/11 Winter models. For EKPC and LGEE, the loads in the models are based on forecast data available to the two companies at the time these models were developed in March of 2004.

As with the loads modeled, the analysis used the future transmission projects that each utility had included in the NERC MMWG 2003 series of cases for all utilities other than EKPC and LGEE. For EKPC and LGEE, the future transmission projects in the models are those that were included by each company during development of the joint base cases. Any projects that were expected to be attributable to the J.K. Smith generation additions were removed, since the need for these projects will be addressed as part of this SIS.

EKPC and the Warren Rural Electric Cooperative Corporation (WRECC) have an agreement that stipulates that EKPC will become WRECC's generation and transmission supplier beginning on April 1, 2008. Therefore, the WRECC load has been included in EKPC's control area in models representing time periods beyond this date. Additionally, the proposed transmission plan that has been developed to connect EKPC to the WRECC system and to connect EKPC to BREC has been included in these models. A fourth generating unit at Spurlock has also been included in those same models.

For the purposes of this study, the proposed units were modeled at maximum output in the analyses. If this resulted in excess generation (beyond EKPC's load requirements), the surplus generation was exported equally to "virtual" generators that were connected to AEP's Cook 765 kV bus and to the Bowen 500 kV bus in SERC. This effectively simulates equal exports to the north and south. This is necessary to ensure adequate transmission capacity for maximum output at the J.K. Smith Plant. All other EKPC units, including the future Spurlock #4, were modeled at maximum output. The Laurel Dam Hydro units were not dispatched in the models. Table 2-1 summarizes the generation output of the existing and future EKPC units dispatched for this study.

Table 2-1 EKPC Base Case Generation			
Unit	**Commercial Operation Date**	**Summer Net Capacity (MW)**	**Winter Net Capacity (MW)**
Cooper #1	existing	116	116
Cooper #2	existing	225	225
Dale #1	existing	24	24
Dale #2	existing	24	24
Dale #3	existing	80	80
Dale #4	existing	80	80
Spurlock #1	existing	325	325
Spurlock #2	existing	535	535
Gilbert #3	existing	268	268
Spurlock #4	February 2009	278	278
JK Smith CT #1	existing	98	142
JK Smith CT #2	existing	98	142
JK Smith CT #3	existing	98	142
JK Smith CT #4	existing	75	100
JK Smith CT #5	existing	75	100
JK Smith CT #6	existing	75	100
JK Smith CT #7	existing	75	100
JK Smith CT #8	December 2008	84	98
JK Smith CT #9	November 2008	84	98
JK Smith CT #10	October 2008	84	98
JK Smith CT #11	April 2008	84	98
JK Smith CT #12	March 2008	84	98
JK Smith CFB #1	March 2010	278	278

2.3.2 Transient-Stability Model

The model used for this analysis is the ECAR 2009 Summer Dynamic Case developed in early 2003 by General Electric for ECAR from the NERC MMWG 2009 Summer Dynamic Case (2002 Series). The associated NERC MMWG 2009 Summer Power Flow Case was used for initialization of the transient-stability model. Loads were modeled as constant current for real power (kW) and constant impedance for reactive power (kVAR) components.

2.3.3 Short-Circuit Model

The model used for this analysis is a modified 2005 Summer power flow model. This model was developed from EKPC's 2005 Summer model that was described in subsection 2.3.1. The model was modified to make it suitable for fault analysis. The modifications made included the following:

- Removed all control areas except EKPC, LGEE, AEP, OVEC, CIN, BREC, TVA, and the OHIO EQUIVALENT
- Included actual zero-sequence impedances for EKPC facilities
- Assumed zero-sequence impedance equals three times the positive-sequence impedance for all transmission lines outside of EKPC
- Assumed zero-sequence impedance equals positive sequence impedance for all transformers outside of EKPC
- Assumed zero-sequence generator impedance equals 999.0 per-unit for all generators outside of EKPC

Faults were run at neighboring utility buses to which EKPC are connected. The fault levels from this analysis were provided to the neighboring utilities for input and to validate the accuracy of EKPC's model.

2.4 Sensitivity Analysis

Several sensitivities were identified for evaluation in the SIS. These sensitivities are discussed below.

a. **EKPC-TVA Interconnections for WRECC Service** – As mentioned earlier, EKPC will become WRECC's generation and transmission supplier on April 1, 2008. EKPC has developed a transmission plan to serve WRECC that includes three 161 kV interconnections with TVA in the Bowling Green, KY area. These interconnections are at East Bowling Green, Memphis Junction, and Salmons. A sensitivity analysis with these three interconnections opened was performed at TVA's request.

b. **Adkins IPP Project** – A 480 MW IPP-owned generation station has been constructed in southern Ohio. These generators are located in the DP&L control area. EKPC now has 345 kV connections to the DP&L and Cinergy systems at Spurlock. Therefore, a sensitivity analysis was performed with the six units at Adkins at maximum output, with the excess output exported to SERC.

c. **Estill County IPP Project** – A 120 MW IPP-owned generating station has been proposed in Estill County, KY. The timeframe for construction of this unit is unknown. A Generation Interconnection Study has been performed by the MISO for this project. The MISO study identified transmission upgrades necessary to connect this generator to the LGEE transmission system. These were a new 161 kV line from the new generating station to LGEE's West Irvine Substation, a new 161 kV line from LGEE's West Irvine Substation to the existing Lake Reba Tap-Delvinta 161 kV line to loop this line through West Irvine, and enlargement of LGEE's West Irvine 161-69 kV autotransformer. A sensitivity analysis with this new generating unit and the associated transmission upgrades was performed in this SIS. The output of this unit was exported equally to northern ECAR and to SERC (60 MW in each direction).

d. **Thoroughbred Energy IPP Project** – A 1500 MW IPP-owned generation station is planned in Muhlenberg County, KY. The timeframe for construction of this unit is unknown. Generation Interconnection Studies have been performed by BREC and by TVA. These studies identified several transmission upgrades to be made to the BREC, LGEE, and TVA systems. In particular, the study recommended a project to connect BREC's existing Wilson-Coleman 345 kV line to LGEE's existing Smith-Hardin County 345 kV line by constructing a 345 kV breaker station. This project is expected to increase power flows from western Kentucky into central Kentucky. Therefore, a sensitivity analysis with the new Thoroughbred units and the associated transmission projects was performed in this SIS. The output from the two 750 MW units was exported to AEP (250 MW), CIN (250 MW), southern MAIN (250 MW), and SERC (750 MW).

e. **Reduced Generation at LGEE's Brown CT Station** – A sensitivity analysis was desired to determine the impacts of reduced generation at LGEE's Brown CT Station with maximum output at JK Smith. The purpose of this sensitivity is to identify problems that may occur when LGEE's CTs are not fully dispatched while EKPC's CTs are fully dispatched for summer peak-load conditions. This analysis was conducted for 2010 Summer conditions.

f. **Maximum Generation at LGEE's Brown CT Station** – A sensitivity analysis was conducted to determine the impacts of full output of the coal-fired and CT generation at LGEE's Brown Station. This dispatch was modeled in the primary cases for the 2010 Summer period. However, LGEE's forecasted winter peak load in the 2010-11 Winter model does not require any CT generation at the Brown CT site. Therefore, the Brown CT generation was increased to maximum, and the surplus generation was exported equally to northern ECAR and to SERC. The purpose of this sensitivity is to identify problems that may occur when both LGEE's and EKPC's CTs in central Kentucky are dispatched simultaneously at full output during winter peak-load conditions.

g. **Trimble County Unit #2** – LGEE plans to construct a 732 MW (summer net) baseload unit at its existing Trimble County Power Plant in the 2010 timeframe. Several major transmission lines are planned to support this unit's integration into the transmission network. These lines are a 345 kV line between the Mill Creek and Hardin County substations, a 345 kV double-circuit from Trimble County to the existing Ghent-Speed 345 kV line to loop the line through Trimble County, a 138 kV line between the Tyrone and West Frankfort substations, and a 138 kV line between the Higby Mill and West Lexington substations. A sensitivity analysis was performed in this SIS with these projects and the Trimble County #2 Unit in the 2010 Summer and 2010/11 Winter models.

In addition to the seven sensitivities identified above, all of the sensitivities listed as items a through f above were also tested with the Trimble County Unit #2 and associated transmission improvements modeled. This resulted in a total of 13 sensitivities being evaluated.

These sensitivity analyses were performed on the recommended transmission alternative developed from this study, using the 2010 Summer and 2010/11 Winter models to identify any potential issues. The discussion of the results of these sensitivity analyses is contained in Section 6 of this report.

Section 3: Power Flow and Transient Stability Analyses With Proposed Generators Added and Without Transmission Upgrades

3.1 Power Flow Analysis

The power flow analysis was conducted to identify and address critical contingencies and overloads on the EKPC and neighboring systems. The initial power flow analysis identified the overloads, including the magnitudes, with the proposed generators at J.K. Smith in 2010 Summer and 2010/11 Winter, and with no new transmission outlets modeled. Tables 3-1 and 3-2 show the major problems (for the worst-case contingency only) identified in 2010 Summer and 2010/11 Winter, respectively, with the proposed generating units and no transmission additions. These results are sorted by the severity of the overload. Appendix B contains the complete listing of overloads identified in 2010 Summer and 2010/11 Winter.

Table 3-1
2010 Summer Identified Problems with Proposed Generators and with no Additional Transmission

Limiting Facility	Company	Contingency	Worst-Case Dispatch	Rating	MVA Flow	% Overload
Fawkes Tap-Fawkes LGEE 138 kV Line	LGEE	Fawkes EKPC-Fawkes LGEE 138 kV Line	Brown #3 off, import from AEP	219	398.7	182.1%
JK Smith-Dale 138 kV Line	EKPC	JK Smith-Union City 138 kV Line (EKPC)	Dale #4 off, import from AEP	311	539.4	173.4%
JK Smith-Union City 138 kV Line	EKPC	JK Smith-Dale 138 kV Line (EKPC)	Brown #3 off, import from AEP	311	518.7	166.8%
Union City-Lake Reba Tap 138 kV Line	EKPC-LGEE	JK Smith-Dale 138 kV Line (EKPC)	Brown #3 off, import from AEP	302	488.2	161.7%
Fawkes LGEE-Clark County 138 kV Line	LGEE	Dale-Boonesboro North-Avon 138 kV Line (EKPC)	Spurlock #2 off, import from TVA	172	258.2	150.1%
Fawkes EKPC-Fawkes LGEE 138 kV Line	EKPC-LGEE	Dale-Boonesboro North-Avon 138 kV Line (EKPC)	Brown #3 off, import from AEP	287	429.6	149.7%
West Irvine Tap-Delvinta 161 kV Line	LGEE	JK Smith-Powell County 138 kV Line (EKPC)	Cooper #2 off, import from AEP	162	241.6	149.1%
JK Smith-Fawkes EKPC 138 kV Line	EKPC	JK Smith-Dale 138 kV Line (EKPC)	Brown #3 off, import from AEP	311	461.9	148.5%
JK Smith-Dale 138 kV Line	EKPC	None	Base	251	372.1	148.2%

Table 3-1 2010 Summer Identified Problems with Proposed Generators and with no Additional Transmission						
Limiting Facility	**Company**	**Contingency**	**Worst-Case Dispatch**	**Rating**	**MVA Flow**	**% Overload**
JK Smith-Union City 138 kV Line	EKPC	None	Base	251	363.7	144.9%
Rice Tap-West Irvine 69 kV Line	LGEE	Lake Reba Tap-West Irvine Tap 161 kV Line (LGEE)	Cooper #2 off, import from AEP	41	58.9	143.7%
Union City-Lake Reba Tap 138 kV Line	EKPC-LGEE	None	Base	243	345	142.0%
Lake Reba-Waco 69 kV Line	LGEE	Lake Reba Tap-West Irvine Tap 161 kV Line (LGEE)	Cooper #2 off, import from AEP	56	78.7	140.5%
Dale-Three Forks Jct. 138 kV Line	EKPC	Dale-Boonesboro North-Avon 138 kV Line (EKPC)	Brown #3 off, import from AEP	222	304.1	137.0%
Lake Reba Tap-West Irvine Tap 161 kV Line	LGEE	JK Smith-Powell County 138 kV Line (EKPC)	Cooper #2 off, import from AEP	190	259.4	136.5%
Waco-Rice Tap 69 kV Line	LGEE	Lake Reba Tap-West Irvine Tap 161 kV Line (LGEE)	Cooper #2 off, import from AEP	52	70.6	135.8%
Three Forks Jct.-Fawkes EKPC 138 kV Line	EKPC	Dale-Boonesboro North-Avon 138 kV Line (EKPC)	Brown #3 off, import from AEP	222	292.3	131.7%
Beattyville-Delvinta 161 kV Line	EKPC-LGEE	Lake Reba Tap-West Irvine Tap-Delvinta 161 kV Line (LGEE)	Cooper #2 off, import from AEP	167	205.9	123.3%
Powell County 138-69 kV Transformer	EKPC	Powell County-Beattyville 161 kV Line (EKPC)	Dale #3 off, import from AEP	129	157.9	122.4%
JK Smith-Powell County 138 kV Line	EKPC	JK Smith-Dale 138 kV Line (EKPC)	Cooper #2 off, import from AEP	287	345.6	120.4%
West Irvine-Dark Hollow 69 kV Line	LGEE	West Irvine Tap-Delvinta 161 kV Line (LGEE)	Cooper #2 off, import from AEP	49	58.9	120.2%
Fawkes EKPC-Fawkes Tap 138 kV Line	EKPC-LGEE	Fawkes EKPC-Fawkes LGEE 138 kV Line	Brown #3 off, import from AEP	287	343	119.5%
Boonesboro North-Winchester Water Works 69 kV Line	LGEE	Fawkes LGEE-Clark County 138 kV Line (LGEE)	Ghent #1 off, import from TVA	143	170.4	119.2%
Beattyville 161-69 kV Transformer	EKPC-LGEE	Beattyville-Delvinta 161 kV Line (EKPC-LGEE)	Cooper #2 off, import from AEP	64	75.9	118.6%
Dale 138-69 kV Transformer	EKPC	JK Smith-Powell County 138 kV Line (EKPC)	Dale #3 off, import from AEP	111	131.4	118.4%

Table 3-1 2010 Summer Identified Problems with Proposed Generators and with no Additional Transmission						
Limiting Facility	**Company**	**Contingency**	**Worst-Case Dispatch**	**Rating**	**MVA Flow**	**% Overload**
JK Smith-Fawkes EKPC 138 kV Line	EKPC	None	Base	251	293.4	116.9%
Winchester South-Winchester 69 kV Line	LGEE	Fawkes LGEE-Clark County 138 kV Line (LGEE)	Ghent #1 off, import from TVA	112	129.7	115.8%
Boonesboro North 138-69 kV Transformer	LGEE	Fawkes LGEE-Clark County 138 kV Line (LGEE)	Ghent #1 off, import from TVA	160	182.3	113.9%
Lake Reba Tap 138-161 kV Transformer	LGEE	JK Smith-Powell County 138 kV Line (EKPC)	Cooper #2 off, import from AEP	230	259.4	112.8%
Dale-Hunt #2 69 kV Line	EKPC	JK Smith-Powell County 138 kV Line (EKPC)	Cooper #2 off, import from AEP	69	77.7	112.6%
Fawkes LGEE-North Madison Jct. 69 kV Line	LGEE	Dale-Boonesboro North-Avon 138 kV Line (EKPC)	Brown #3 off, import from AEP	57	64.1	112.5%
Powell County 138-161 kV Transformer	EKPC	Lake Reba Tap-West Irvine Tap-Delvinta 161 kV Line (LGEE)	Cooper #2 off, import from AEP	193	214.5	111.1%
Powell County 138-69 kV Transformer	EKPC	None	Base	96	105.7	110.1%
Brown North-Brown Tap #2 138 kV Line	LGEE	Brown North-Brown Tap #1 138 kV Line (LGEE)	Brown #3 off, import from AEP	426	467.2	109.7%
Clark County-Sylvania 69 kV Line	LGEE	Dale-Boonesboro North-Avon 138 kV Line (EKPC)	Brown #3 off, import from AEP	117	127.9	109.3%
Hyden Tap-Wooten 161 kV Line	LGEE-AEP	Pineville-Stinnett 161 kV Line (TVA-AEP)	Base	190	207.4	109.2%
Powell County 138-161 kV Transformer	EKPC	None	Base	145	158.3	109.2%
Hunt #2-JK Smith 69 kV Line	EKPC	JK Smith-Powell County 138 kV Line (EKPC)	Cooper #2 off, import from AEP	69	74.6	108.1%
Fawkes LGEE-Clark County 138 kV Line	LGEE	None	Base	146	157.5	107.9%
Lake Reba Tap-West Irvine Tap 161 kV Line	LGEE	None	Base	167	178.3	106.8%
Richmond South-Richmond #3 69 kV Line	LGEE	Lake Reba 138-69 kV Transformer (LGEE)	Cooper #2 off, import from AEP	69	73.3	106.2%
Clark County-Mount Sterling 69 kV Line	LGEE	Clark County-Spencer Road 138 kV Line (LGEE)	Spurlock #2 off, import from TVA	53	56.3	106.2%

Table 3-1 2010 Summer Identified Problems with Proposed Generators and with no Additional Transmission						
Limiting Facility	**Company**	**Contingency**	**Worst-Case Dispatch**	**Rating**	**MVA Flow**	**% Overload**
Delvinta-Hyden Tap 161 kV Line	LGEE	Delvinta-Green Hall Jct. 161 kV Line (LGEE-EKPC)	Base	190	201.7	106.2%
Delvinta-Green Hall Jct. 161 kV Line	LGEE-EKPC	Delvinta-Hyden Tap 161 kV Line (LGEE)	Cooper #2 off, import from AEP	201	213	106.0%
Winchester Water Works-Boone Avenue 69 kV Line	LGEE	Fawkes LGEE-Clark County 138 kV Line (LGEE)	Ghent #1 off, import from TVA	152	160.8	105.8%
JK Smith-Trapp 69 kV Line	EKPC	JK Smith-Powell County 138 kV Line (EKPC)	Cooper #2 off, import from AEP	69	72.7	105.4%
Fawkes EKPC-Fawkes LGEE 138 kV Line	EKPC-LGEE	None	Base	259	270	104.2%
Powell County-Jeffersonville 69 kV Line	EKPC	Goddard-Hillsboro 69 kV Line (EKPC)	Spurlock #2 off, import from TVA	69	70.6	102.3%
Dale-Boonesboro North Tap 138 kV Line	EKPC	Fawkes LGEE-Clark County 138 kV Line (LGEE)	Spurlock #2 off, import from TVA	383	390.4	101.9%
Trapp-Hargett Jct. 69 kV Line	EKPC	JK Smith-Powell County 138 kV Line (EKPC)	Base	69	69.8	101.2%

Table 3-2 2010-11 Winter Identified Problems with Proposed Generators and with no Additional Transmission						
Limiting Facility	**Company**	**Contingency**	**Worst-Case Dispatch**	**Rating**	**MVA Flow**	**% Overload**
Fawkes Tap-Fawkes LGEE 138 kV Line	LGEE	Fawkes EKPC-Fawkes LGEE 138 kV Line (EKPC-LGEE)	Brown #3 off, import from AEP	283	505	178.4%
Fawkes EKPC-Fawkes LGEE 138 kV Line	EKPC-LGEE	Dale-Boonesboro North-Avon 138 kV Line (EKPC)	Brown #3 off, import from AEP	287	498.2	173.6%
JK Smith-Dale 138 kV Line	EKPC	JK Smith-Union City 138 kV Line (EKPC)	Dale #4 off, import from AEP	389	656.8	168.8%
JK Smith-Union City 138 kV Line	EKPC	JK Smith-Dale 138 kV Line (EKPC)	Brown #3 off, import from AEP	389	646.3	166.1%
Union City-Lake Reba Tap 138 kV Line	EKPC-LGEE	JK Smith-Dale 138 kV Line (EKPC)	Brown #3 off, import from AEP	371	595.3	160.5%
Beattyville-Delvinta 161 kV Line	EKPC-LGEE	Lake Reba Tap-West Irvine Tap-Delvinta 161 kV Line (LGEE)	Cooper #2 off, import from AEP	167	266.1	159.3%
Union City-Lake Reba Tap 138 kV Line	EKPC-LGEE	None	Base	277	424.8	153.4%
Fawkes EKPC-Fawkes Tap 138 kV Line	EKPC-LGEE	Fawkes EKPC-Fawkes LGEE 138 kV Line	Brown #3 off, import from AEP	287	433.8	151.1%
JK Smith-Powell County 138 kV Line	EKPC	JK Smith-Dale 138 kV Line (EKPC)	Dale #3 off, import from AEP	287	426.9	148.7%
JK Smith-Fawkes EKPC 138 kV Line	EKPC	JK Smith-Union City 138 kV Line (EKPC)	Brown #3 off, import from AEP	389	576	148.1%
West Irvine Tap-Delvinta 161 kV Line	LGEE	JK Smith-Powell County 138 kV Line (EKPC)	Cooper #2 off, import from AEP	218	303.9	139.4%
Lake Reba Tap-West Irvine Tap 161 kV Line	LGEE	None	Base	167	228	136.5%
Lake Reba Tap-West Irvine Tap 161 kV Line	LGEE	JK Smith-Powell County 138 kV Line (EKPC)	Cooper #2 off, import from AEP	237	323.1	136.3%
Powell County 138-69 kV Transformer	EKPC	Powell County-Beattyville 161 kV Line (EKPC)	Dale #3 off, import from AEP	143	186.4	130.3%
Beattyville 161-69 kV Transformer	EKPC-LGEE	Beattyville-Delvinta 161 kV Line (EKPC-LGEE)	Cooper #2 off, import from AEP	72	93.8	130.3%

Table 3-2 2010-11 Winter Identified Problems with Proposed Generators and with no Additional Transmission						
Limiting Facility	**Company**	**Contingency**	**Worst-Case Dispatch**	**Rating**	**MVA Flow**	**% Overload**
JK Smith-Union City 138 kV Line	EKPC	None	Base	349	451.7	129.4%
Lake Reba-Waco 69 kV Line	LGEE	Lake Reba Tap-West Irvine Tap 161 kV Line (LGEE)	Cooper #2 off, import from AEP	80	103.1	128.9%
Dale 138-69 kV Transformer	EKPC	JK Smith-Powell County 138 kV Line (EKPC)	Dale #3 off, import from AEP	136	175	128.7%
JK Smith-Dale 138 kV Line	EKPC	None	Base	349	447.1	128.1%
Delvinta-Green Hall Jct. 161 kV Line	LGEE-EKPC	Delvinta-Hyden Tap 161 kV Line (LGEE)	Cooper #2 off, import from AEP	218	277	127.1%
Waco-Rice Tap 69 kV Line	LGEE	Lake Reba Tap-West Irvine Tap 161 kV Line (LGEE)	Cooper #2 off, import from AEP	72	90.1	125.1%
Dale-Three Forks Jct. 138 kV Line	EKPC	Dale-Boonesboro North-Avon 138 kV Line (EKPC)	Brown #3 off, import from AEP	278	345.6	124.3%
Lake Reba Tap 138-161 kV Transformer	LGEE	JK Smith-Powell County 138 kV Line (EKPC)	Cooper #2 off, import from AEP	260	323.1	124.3%
Fawkes LGEE-Clark County 138 kV Line	LGEE	Dale-Boonesboro North-Avon 138 kV Line (EKPC)	Spurlock #2 off, import from TVA	186	229.5	123.4%
Powell County 138-161 kV Transformer	EKPC	Lake Reba Tap-West Irvine Tap-Delvinta 161 kV Line (LGEE)	Cooper #2 off, import from AEP	220	269.3	122.4%
Fawkes EKPC-Fawkes LGEE 138 kV Line	EKPC-LGEE	None	Base	287	350.5	122.1%
JK Smith-Powell County 138 kV Line	EKPC	None	Base	287	343.9	119.8%
Three Forks Jct.-Fawkes EKPC 138 kV Line	EKPC	Dale-Boonesboro North-Avon 138 kV Line (EKPC)	Brown #3 off, import from AEP	278	328.5	118.2%
Powell County 161-138 kV Transformer	EKPC	None	Base	178	203.2	114.2%
Delvinta-Green Hall Jct. 161 kV Line	LGEE-EKPC	None	Base	167	189	113.2%
Boonesboro North-Winchester Water Works 69 kV Line	LGEE	Fawkes LGEE-Clark County 138 kV Line (LGEE)	Ghent #1 off, import from TVA	143	160.3	112.1%
Rice Tap-West Irvine 69 kV Line	LGEE	Lake Reba Tap-West Irvine Tap 161 kV Line (LGEE)	Cooper #2 off, import from AEP	66	73.8	111.8%
West Berea Jct.-	EKPC	Delvinta-Green Hall	Cooper #2	101	112.9	111.8%

Table 3-2 2010-11 Winter Identified Problems with Proposed Generators and with no Additional Transmission						
Limiting Facility	**Company**	**Contingency**	**Worst-Case Dispatch**	**Rating**	**MVA Flow**	**% Overload**
Three Links Jct. 69 kV Line		Junction 161 kV Line (LGEE-EKPC)	off, import from AEP			
West Berea-West Berea Jct. 69 kV Line	EKPC	Delvinta-Green Hall Junction 161 kV Line (LGEE-EKPC)	Cooper #2 off, import from AEP	101	111.7	110.6%
Morehead-Hayward 69 kV Line	AEP	Rowan County-Skaggs 138 kV Line (EKPC)	Base	48	52.1	108.5%
Clark County-Sylvania 69 kV Line	LGEE	Dale-Boonesboro North-Avon 138 kV Line (EKPC)	Brown #3 off, import from AEP	117	124.6	106.5%
JK Smith-Fawkes EKPC 138 kV Line	EKPC	None	Base	349	367	105.2%
Beattyville-Delvinta 161 kV Line	EKPC-LGEE	None	Base	167	174.7	104.6%
West Irvine 161-69 kV Transformer	LGEE	West Irvine Tap-Delvinta 161 kV Line (LGEE)	Cooper #2 off, import from AEP	62	64.3	103.7%
Dale-Hunt #2 69 kV Line	EKPC	JK Smith-Powell County 138 kV Line (EKPC)	Cooper #2 off, import from AEP	87	90.1	103.6%
Davis-Nicholasville 69 kV Line	EKPC	Avon-Loudon Avenue 138 kV Line (EKPC-LGEE)	Brown #3 off, import from AEP	87	89.6	103.0%
Dale-Newby #1 69 kV Line	EKPC	Dale-Boonesboro North-Avon 138 kV Line (EKPC)	Cooper #2 off, import from AEP	87	89	102.3%
Lake Reba Tap-Lake Reba 138 kV Line	LGEE	Lake Reba Tap-West Irvine Tap 161 kV Line (LGEE)	Cooper #2 off, import from AEP	191	195.1	102.1%
West Berea 138-69 kV Transformer	EKPC	Fawkes LGEE-Crooksville Jct. 69 kV Line (LGEE-EKPC)	Cooper #2 off, import from AEP	143	145.8	102.0%
West Irvine-Dark Hollow 69 kV Line	LGEE	West Irvine Tap-Delvinta 161 kV Line (LGEE)	Cooper #2 off, import from AEP	70	71	101.4%
West Irvine Tap-Delvinta 161 kV Line	LGEE	None	Base	209	211.2	101.1%
Avon-Loudon Avenue 138 kV Line	EKPC-LGEE	Ghent-West Lexington 345 kV Line (LGEE)	Brown #3 off, import from AEP	287	288.1	100.4%
Powell County 138-69 kV Transformer	EKPC	None	Base	119	119.4	100.3%

The power flow results contained in Tables 3-1 and 3-2 indicate that a total of 41 unique facilities are overloaded in 2010 Summer and 36 facilities are overloaded in 2010-11 Winter. A breakdown of the ownership of these facilities is provided in Table 3-3.

Table 3-3
Summary of Ownership of Overloaded Facilities

Ownership	Number of Facilities Overloaded in 2010 Summer	Number of Facilities Overloaded in 2010-11 Winter
AEP	0	1
EKPC	15	15
EKPC-LGEE	6	7
LGEE	19	13
LGEE-AEP	1	0
Total	41	36

These power flow results indicate that substantial thermal overloading of the existing transmission system will be created by the addition of the proposed generators at the J.K. Smith site.

See Figure A-3 in Appendix A for an overview of the overloaded lines identified in Tables 3-1 and 3-2. The overloaded lines are highlighted in red on this figure.

3.2 Transient-Stability Analysis

Transient-stability analysis was performed to determine if problems would exist with the addition of the proposed generators.

3.2.1 Approach

The models utilized for the transient-stability analysis were derived from the 2002 Series ECAR 2009 Summer power flow and dynamics data obtained in GE PSLF format from ECAR. EKPC's and LGEE's areas were updated for major changes in planned facilities between the time the cases were initially developed and the present.

The same additions were made to the ECAR dynamic model for future generation and associated facilities in the area of interest as were included in the power flow model. Loads were modeled as constant current for real power (kW) and constant impedance for reactive power (kVAR) components.

An initial transient-stability analysis was performed to characterize overall system needs. The analysis consisted of determining system responses with all facilities in-service and a three-phase fault accompanied by breaker failure followed by operation of backup circuit breakers. Both single-pole and total breaker-failure scenarios were analyzed. Breaker-failure schemes were assumed to operate in a specified time period to clear a fault.

Base models were allowed to operate without faults for 10 seconds and all units were examined to validate the modeling and determine that the various components were stable and operating correctly prior to faults being applied. Three-phase faults were applied for a specified period of time followed by a single line-to-ground fault to simulate a stuck pole or a continued three-phase fault for a stuck breaker.

Fault values were computed using a GE PSLF model derived from fault cases provided by EKPC and LGEE.

3.2.2 Results

The proposed J.K. Smith generators were added to the base model to create the stability model for testing of system performance. The following modifications were made to the transmission system for this model:

- the addition of a new 345 kV line from J.K. Smith to the Spurlock-Avon 345 kV line at a point called North Clark
- the addition of a new J.K. Smith 345 kV CT Substation yard with a 345-138 kV tie to the existing J.K. Smith 138 kV CT Substation yard
- the addition of a new J.K. Smith 345 kV CFB Substation yard with 345 kV ties to the J.K. Smith 345 kV CT Substation yard

Refer to Figures 3-1 through 3-3 for one-line diagrams of each of the three substation yards at J.K. Smith. Refer to Figure 3-4 for a one-line showing the three connected yards.

The transient stability studies began with simulation of system reactions to both 138 kV and 345 kV bus faults in the J.K. Smith Generating Station Substation (J.K. Smith). Refer to Figures 3-1 and 3-2 for the layouts of the expanded J.K. Smith 138 kV CT Substation yard and the new J.K. Smith 345 kV CT Substation yard after the addition of the J.K. Smith-North Clark 345 kV line and associated facilities.

The existing JK Smith 138 kV relaying utilizes solid-state relays with breaker failure ("BF") implemented with timers. The existing relay settings combined with equipment characteristics result in the clearance of a "close-in" three-phase fault in not less than 5 cycles. The existing BF scheme requires an additional 7.75 cycles in total backup-clearing time. The total clearing time is currently 12.75 cycles.

The assumed normal clearing time for the new J.K. Smith-North Clark 345 kV line is 3.75 cycles. For the breaker failure scheme, an additional 6.0 cycles of clearing time is assumed.

A "stuck pole" ("SP") is the failure of one pole (phase) of a circuit breaker to open when the power circuit breaker is required to open all three phases. A "stuck breaker" ("SB") is defined as all three poles of a circuit breaker failing to open when the power circuit breaker is required to open.

The 138 kV faults of concern are "close-in" faults on the lines from J.K. Smith to Dale, Fawkes, or Lake Reba Tap. The worst case identified is a fault on the J.K. Smith-Dale 138 kV line. As shown on Figure 3-1, this fault would trip breakers E63-834 and E63-91T. Then, for a failure (either SP or SB) of breaker E63-91T, breaker E63-844 would trip. This would de-energize the J.K. Smith-Fawkes 138 kV line, resulting in both the J.K. Smith-Dale and J.K. Smith-Fawkes 138 kV lines being simultaneously disconnected from the transmission system.

Another fault of concern is a "close-in" fault on the new J.K. Smith-North Clark 345 kV line. As shown on Figure 3-2, this fault would trip breakers E112-1474 and E112-153T. Then, for a failure of breaker E112-153T, breaker E112-1424 would trip. This would disconnect one of the two new 345 kV ties between the J.K. Smith 345 kV CT yard and the J.K. Smith 345 kV CFB yard.

Faults were simulated with the total clearing times specified above. Case results are summarized in Table 3-4. Table 3-4 also lists the figure numbers showing time plots of the performance for these fault scenarios. Case B1 indicates that the JK Smith generating units are likely to remain stable for a fault on the JK Smith-Dale 138 kV line with breaker failure (see Figure 3-5). Figure 3-5 shows a large swing after the disturbance for J.K. Smith CT Units 3 and 4 (Units 1-3 are identical as are Units 4-7). However, the oscillations for these units appear to damp out acceptably. Therefore, the units appear to be stable for this disturbance. Yet, the first swing is large enough to be of some concern.

TABLE 3-4 SUMMARY OF STABILITY ANALYSIS WITH PROPOSED J.K. SMITH GENERATORS			
System Reactions to Faults at JK Smith Generating Station Maximum Peak to Peak Rotor Angle Changes			
Case Designation		B1	B2
Transmission Configuration		Base System (J.K. Smith-North Clark 345 kV Plus Expansion at J.K. Smith)	Base System (J.K. Smith-North Clark 345 kV Plus Expansion at J.K. Smith)
Reference Figure		3-5, 3-6	3-7, 3-8
Fault Clearing Type		138 kV SB[1]	345 kV SB[2]
Normal Clearing Time (cycles)		5	3.75
Additional Clearing Time for Breaker Failure (cycles)		7.75	6
Damping Time		Less than 5 sec.	Less than 5 sec.
Dale	#1	43	47
Dale	#2	43	47
Dale	#3	54	54
Dale	#4	61	59
JK Smith	CT #1	164	104
JK Smith	CT #2	164	104
JK Smith	CT #3	164	104
JK Smith	CT #4	161	102
JK Smith	CT #5	161	102
JK Smith	CT #6	161	102
JK Smith	CT #7	161	102
JK Smith	CT #8	91	78
JK Smith	CT #9	79	85
JK Smith	CT #10	79	85
JK Smith	CT #11	79	85
JK Smith	CT #12	79	85
JK Smith	CFB #1	121	122

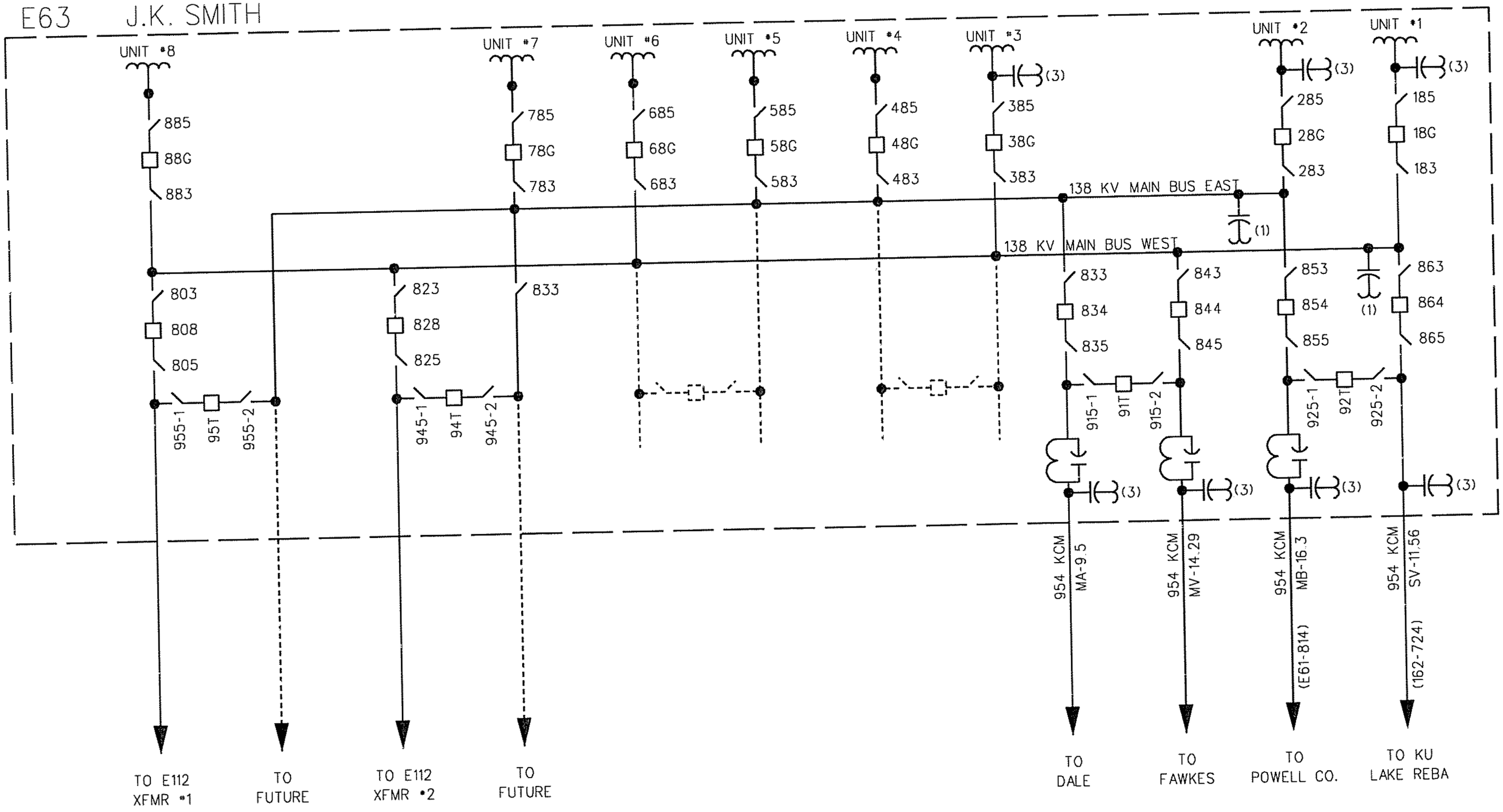
Notes:

[1] Fault on J.K. Smith-Dale 138 kV line with breaker failure; trip J.K. Smith-Fawkes 138 kV line

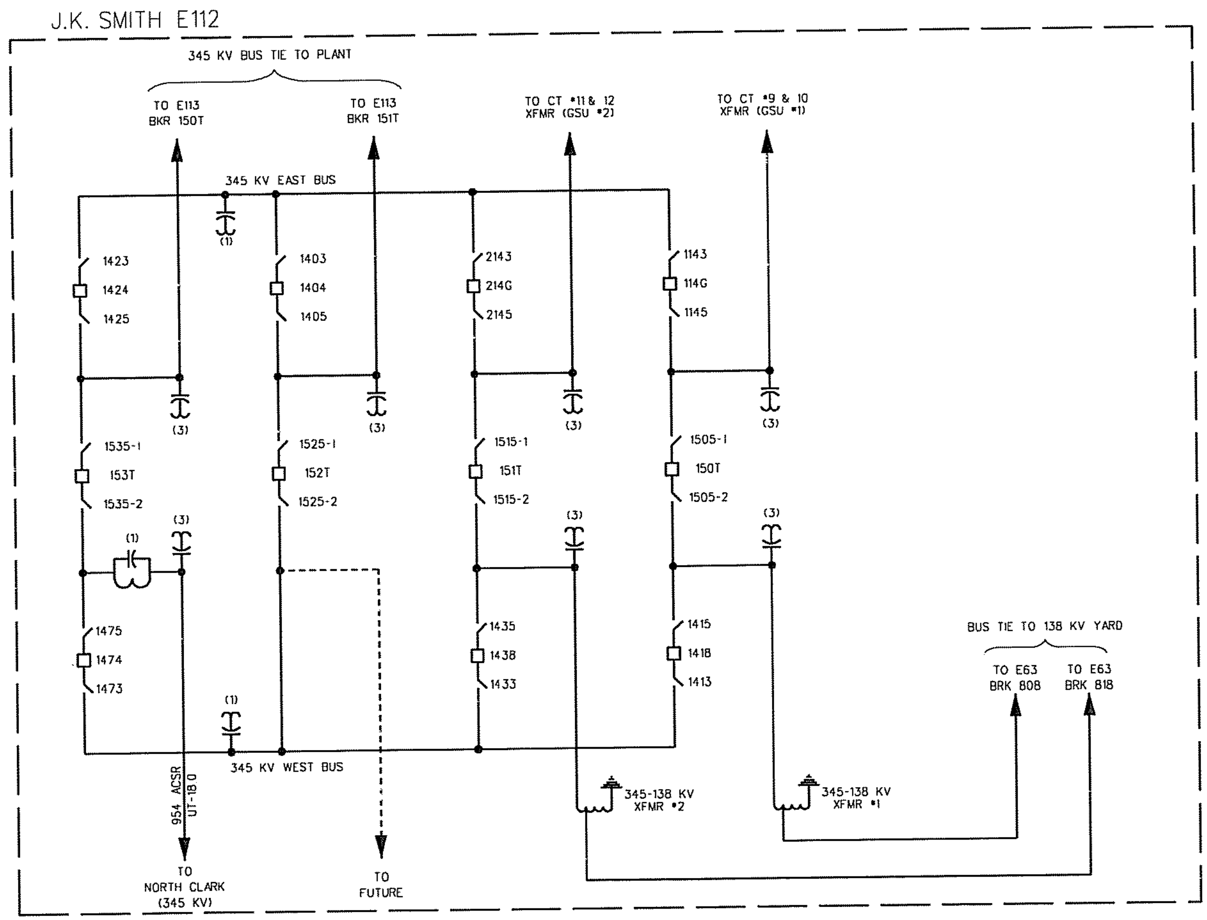
[2] Fault on J.K. Smith-North Clark 345 kV line with breaker failure; trip one J.K. Smith 345 kV CT-J.K. Smith 345 kV CFB tie

In summary, the results in Cases B1 and B2 indicate that the additions of the proposed generators at J.K. Smith decrease the level of generating unit stability at J.K. Smith and at Dale, but do not create instability.

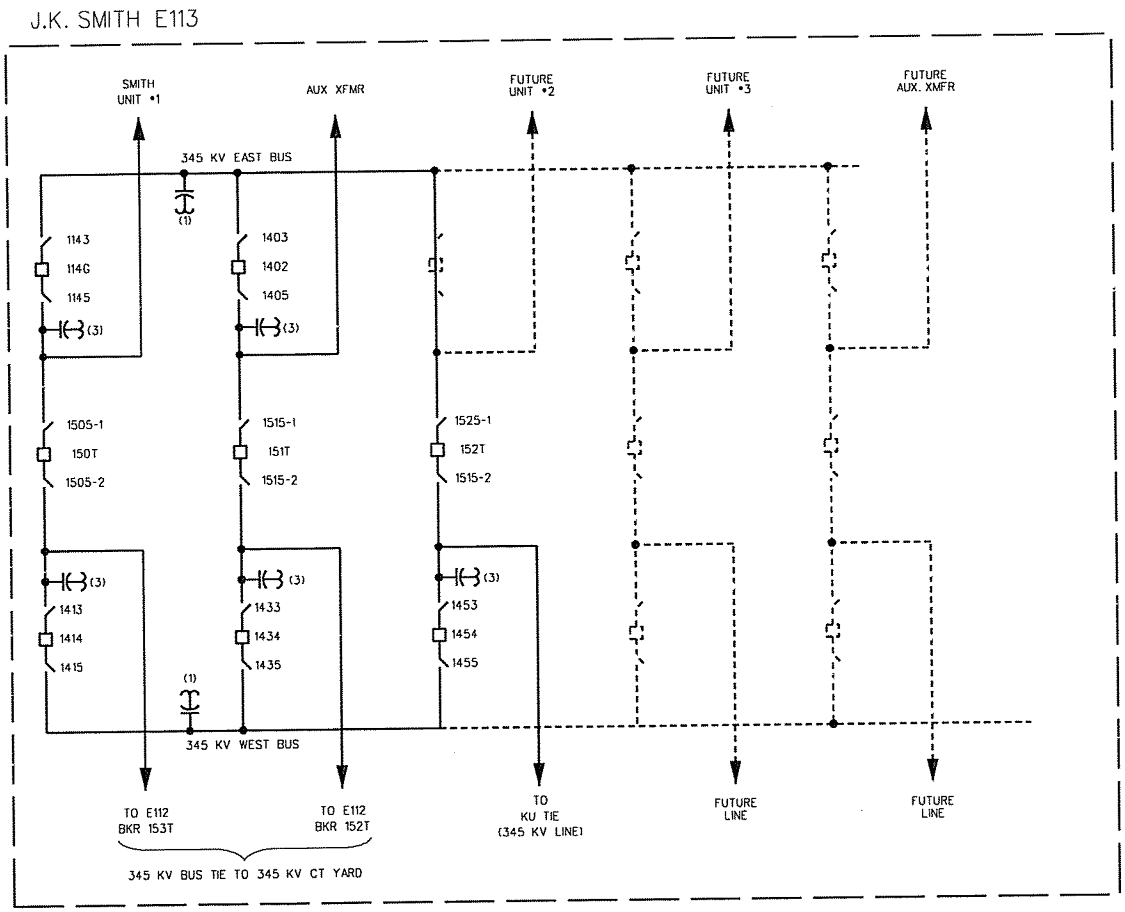
Based on the power flow analysis performed, the transmission system requires modifications to address thermal overloads that will be created by the addition of the proposed units. Furthermore, transmission system modifications are desired to improve the generating unit stability profile at J.K. Smith and at Dale. Therefore, the next step is to identify potential transmission alternatives to address these issues.



APPROVALS	DATE	
DRAWN Mark Mefford	5-5-2006	EAST KENTUCKY POWER WINCHESTER, KENTUCKY 40392
DESIGNED		FIGURE 3-1 J.K. SMITH 138 KV SUBSTATION EXISTING CONFIGURATION PLUS NEW CONNECTIONS TO J.K. SMITH 345 KV CT YARD
CHECKED		
APPROVED		
B.C. _____ W.O. _____		SCALE: NONE / SHEET 1 OF 1 / A / DWG. NO. ATOL06-02 / REV 0
AS BUILT =		

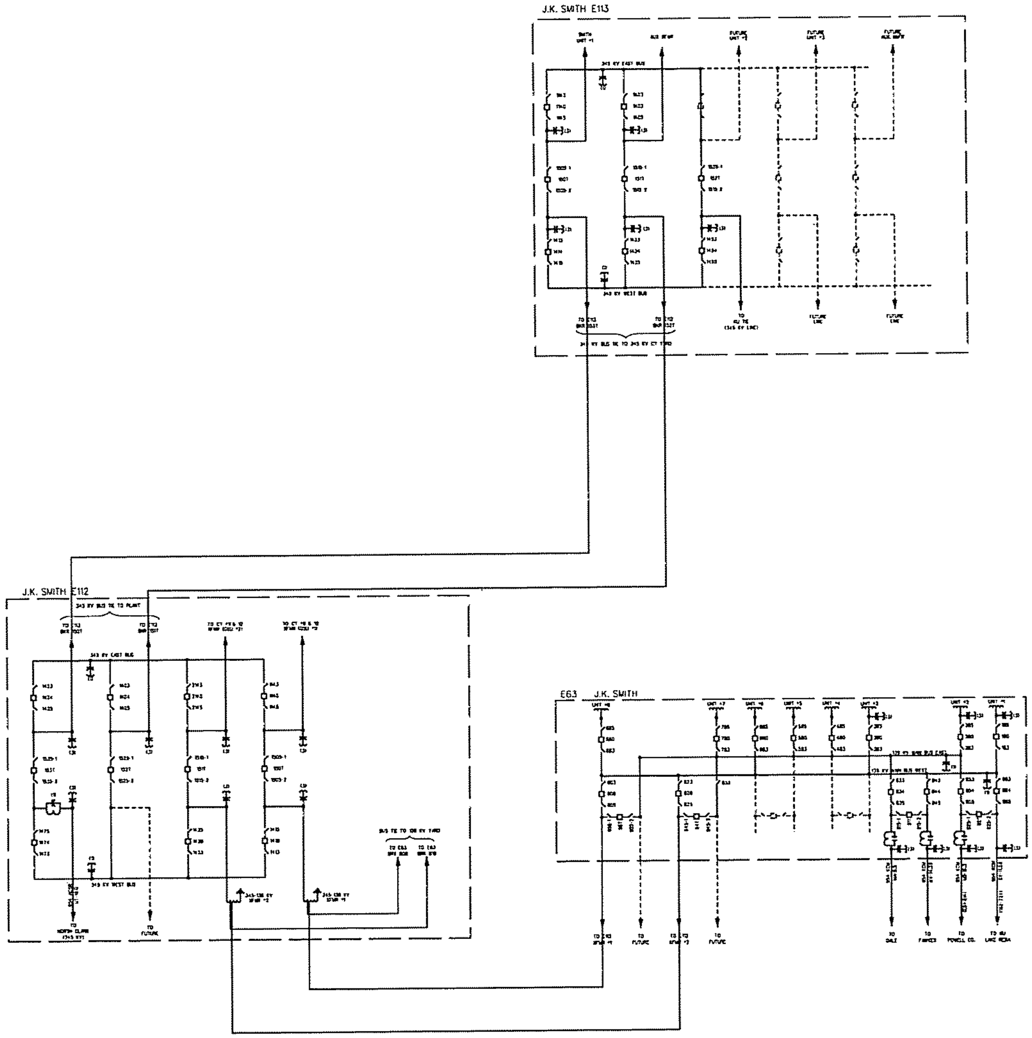


APPROVALS	DATE	EAST KENTUCKY POWER WINCHESTER, KENTUCKY 40392
DRAWN Mark Mefford	5-5-2006	FIGURE 3-2 NEW J.K. SMITH 345 KV CT YARD WITH J.K. SMITH - NORTH CLARK LINE ADDITION
DESIGNED		
CHECKED		
APPROVED		
B.C. ____ W.O. ____		SCALE: NONE · A · DWG. NO. ATOL06-01 · REV 0
AS BUILT =		SHEET 1 OF 1

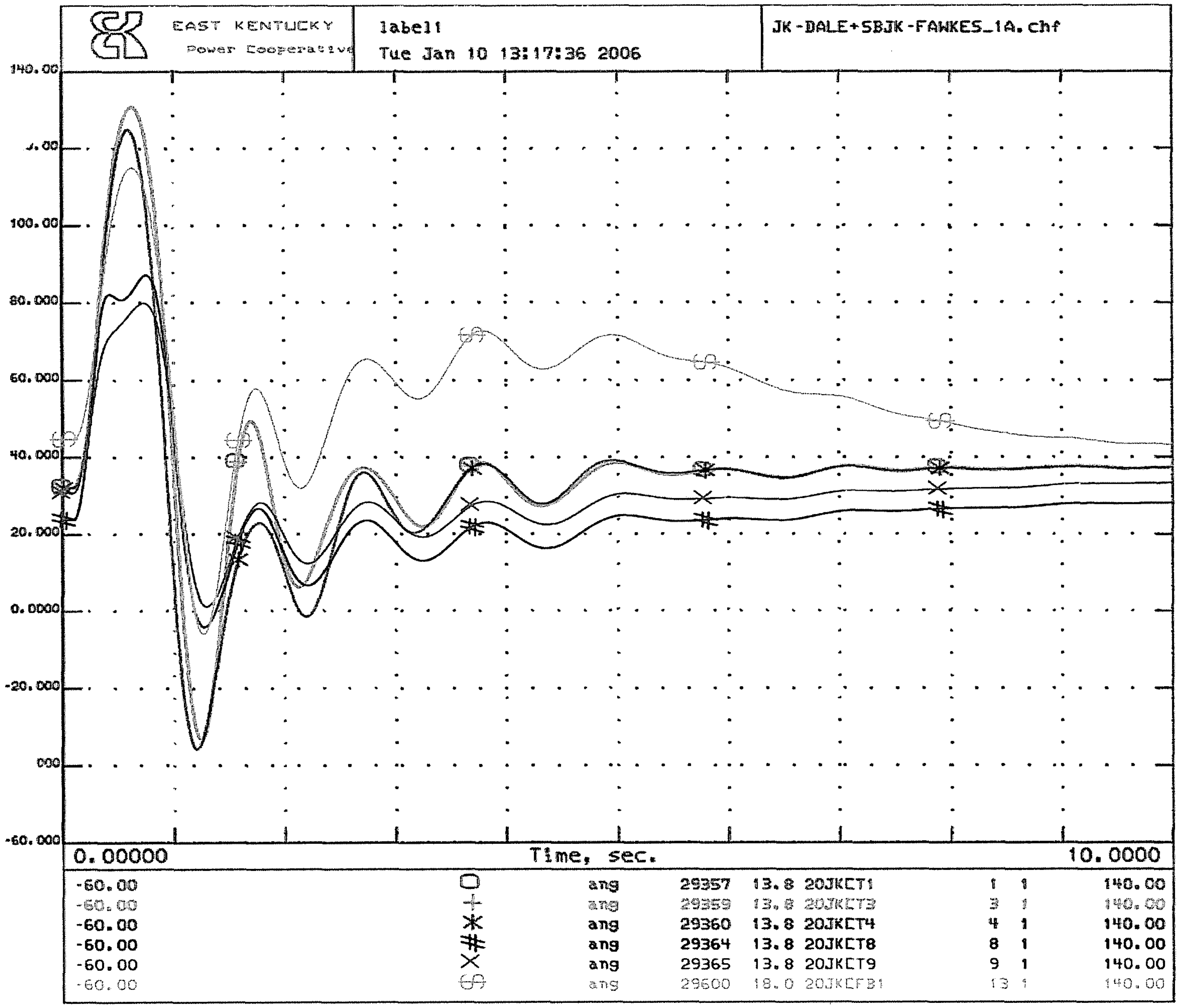


APPROVALS	DATE	
DRAWN Mark Mefford	5-5-2006	EAST KENTUCKY POWER WINCHESTER, KENTUCKY 40392
DESIGNED		FIGURE 3-3 NEW J.K. SMITH 345 CFB YARD
CHECKED		
APPROVED		
B.C. ____ W.O. ____		SCALE: NONE
AS BUILT =		SHEET 1 OF 1

A | DWG. NO. ATOL06-03 | REV 0



APPROVALS	DATE	EAST KENTUCKY POWER WINCHESTER, KENTUCKY 40392
DRAWN Mark Mefford	5-5-2006	
DESIGNED		FIGURE 3-4 J.K. SMITH EXPANSION OVERVIEW ONE LINE DIAGRAM
CHECKED		
APPROVED		
B.C. ____ W.O. ____ AS BUILT =		SCALE: NONE / SHEET 1 OF 1 / A / DWG. NO. ATOL06-04 / REV 0

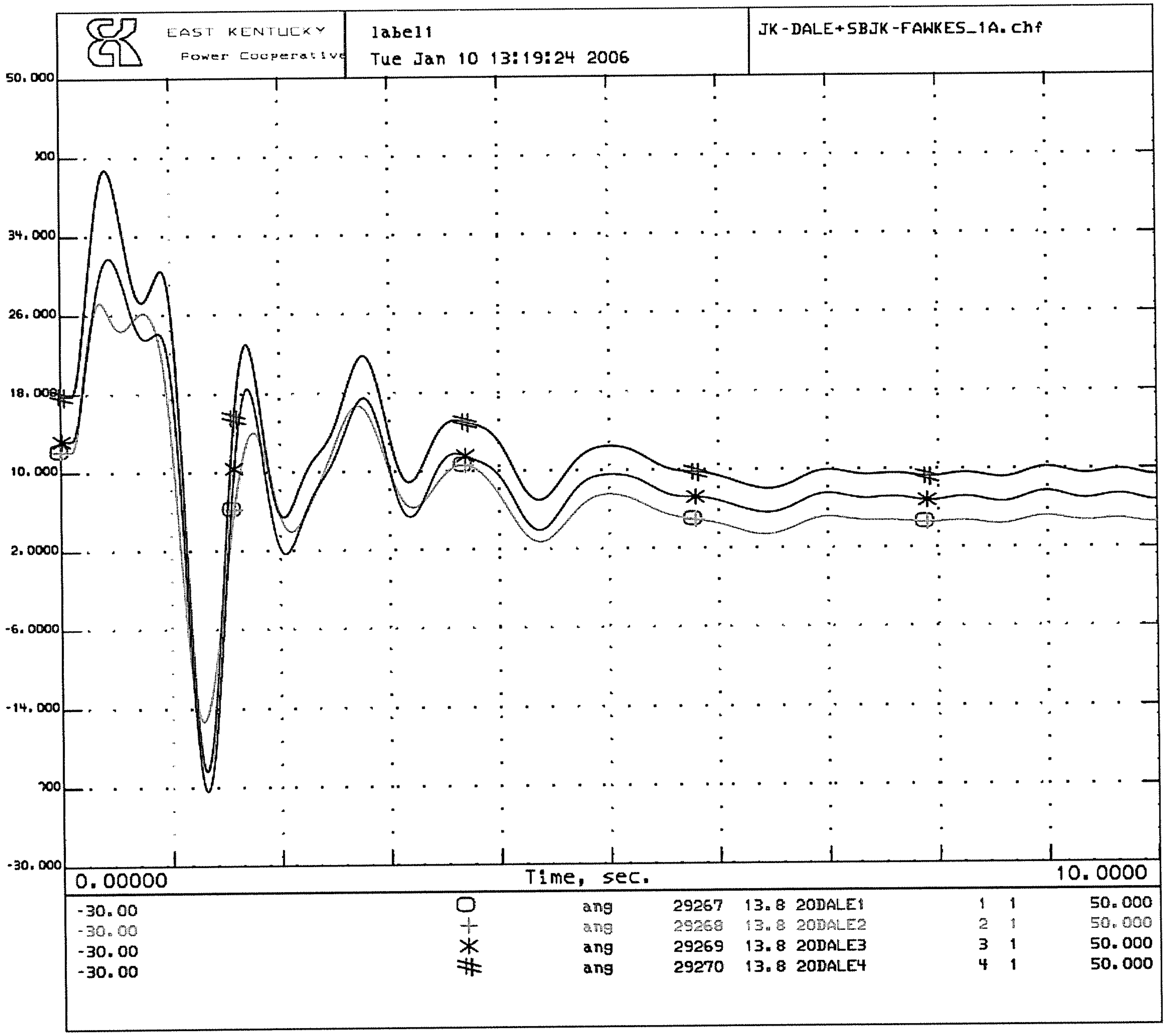


12.75 Cycle clearing time (5.00 Normal + 7.75 Backup)
Stuck Breaker at JKSMITH 138 KV on DALE Line
3 Phase Fault at JKSMITH 138 kV on DALE Line
Trip JKSMITH-FAWKES LINE @ 12.75 Cycles
JK-DALE+SBJK-FAWKES.p

2009/10 WINTER EKPC STABILITY BASE CASE JANUARY 2006
JKSMITH CFB1+CT'S 8-12;JK-SIDEVIEW 345;JK 345/138(2-450 MVA XFMRS)

REFERENCE CASE:
2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 3-5
J.K. Smith Generating Unit Responses
Fault on J.K. Smith-Dale 138 kV Line with Stuck Breaker E63-91T
Subsequent Trip of J.K. Smith-Fawkes 138 kV Line

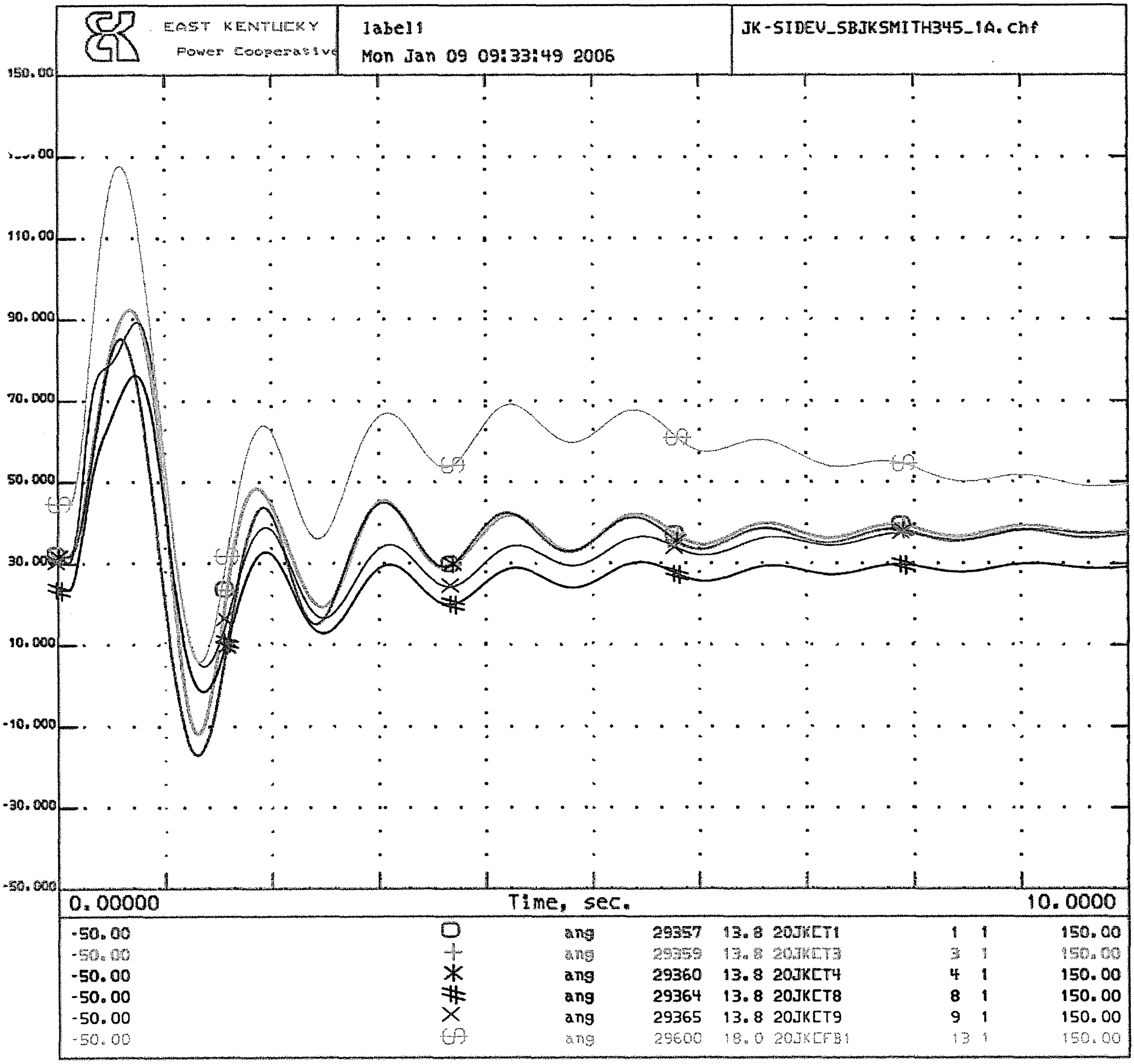


12.75 Cycle clearing time (5.00 Normal + 7.75 Backup)
Stuck Breaker at JKSMITH 138 KV on DALE Line
3 Phase Fault at JKSMITH 138 kV on DALE Line
Trip JKSMITH-FAWKES LINE @ 12.75 Cycles
JK-DALE+SBJK-FAWKES.p

2009/10 WINTER EKPC STABILITY BASE CASE JANUARY 2006
JKSMITH CFB1+CT'S 8-12;JK-SIDEVIEW 345;JK 345/138(2-450 MVA XFMRS)

REFERENCE CASE:
2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

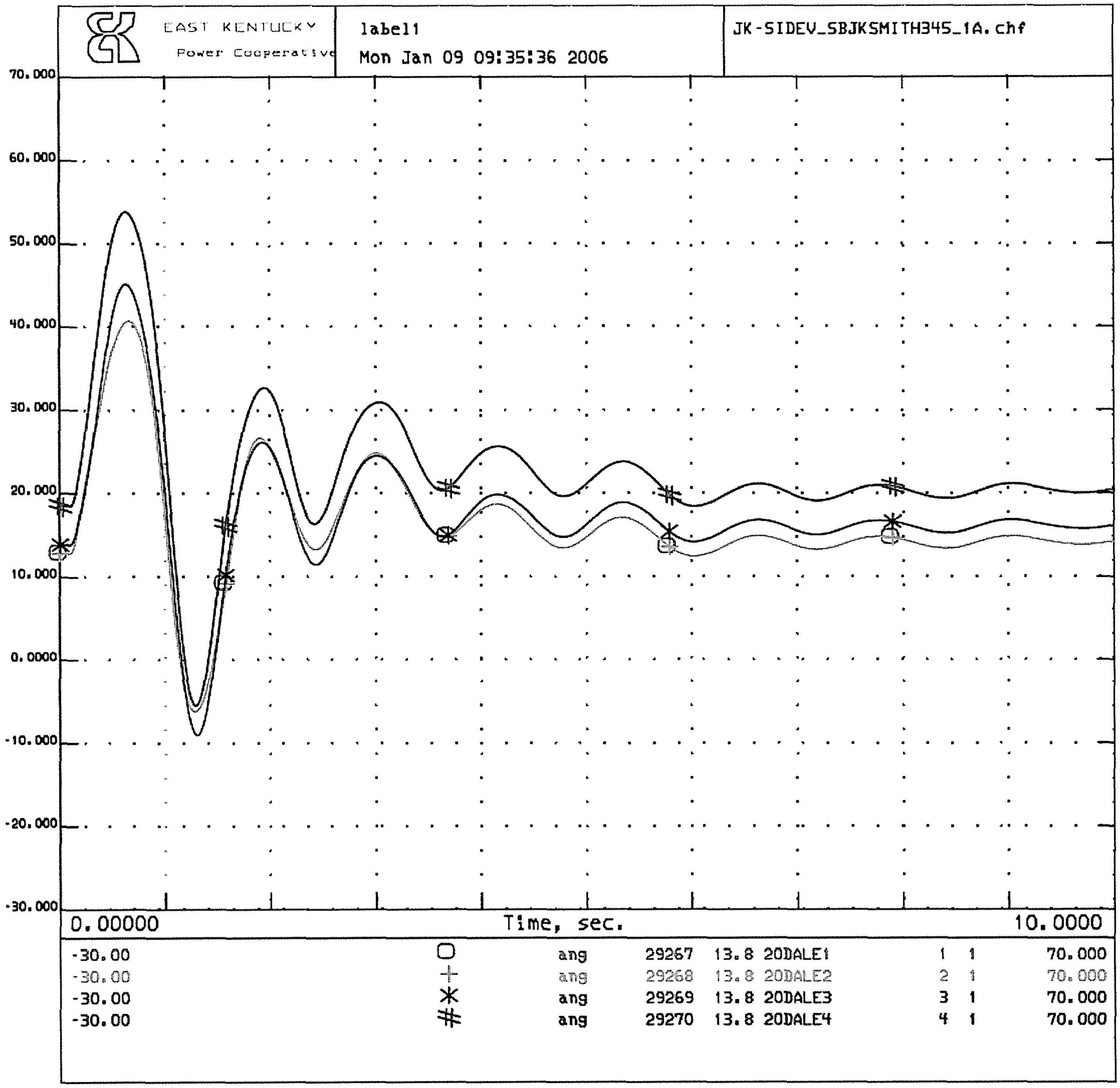
Figure 3-6
Dale Station Generating Unit Responses
Fault on J.K. Smith-Dale 138 kV Line with Stuck Breaker E63-91T
Subsequent Trip of J.K. Smith-Fawkes 138 kV Line



9.75 Cycle clearing time (3.75 Normal + 6.00 Backup)
3 Phase Fault at JK Smith 345 kV on Sideview Line
Stuck Breaker at JK Smith 345 kV
Trip JKSMITH2-JKCFB #1 LINE @ 9.75 Cycles
JK-SIDEV_SBJKSMITH345.p

2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 3-7
J.K. Smith Generating Unit Responses
Fault on J.K. Smith-North Clark 345 kV Line with Stuck Breaker E112-153T
Subsequent Trip of One J.K. Smith CT-J.K. Smith CFB 345 kV Circuit



9.75 Cycle clearing time (3.75 Normal + 6.00 Backup)
3 Phase Fault at JK Smith 345 kV on Sideview Line
Stuck Breaker at JK Smith 345 kV
Trip JKSMITH2-JKCFB #1 LINE # 9.75 Cycles
JK-SIDEV_SBJKSMITH345.p

2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 3-8
Dale Station Generating Unit Responses
Fault on J.K. Smith-North Clark 345 kV Line with Stuck Breaker E112-153T
Subsequent Trip of One J.K. Smith CT-J.K. Smith CFB 345 kV Circuit

Section 4: Alternatives Considered

Alternatives are desired that eliminate the overloads of the facilities identified in Tables 3-1 and 3-2. Furthermore, since all four of the existing 138 kV outlets from the J.K. Smith Station are overloaded, the alternatives developed must either upgrade all four of these outlets or establish at least one new outlet from the J.K. Smith Station.

4.1 Impact of J.K. Smith-North Clark Proposed Project on Alternatives to be Considered

Concurrently with this J.K. Smith SIS, EKPC conducted a parallel study to identify a solution for existing transmission-system problems. These problems are:

- Frequent overloading of the Avon 345-138 kV, 450 MVA autotransformer in the June-August 2005 time period, and expected future overloading
- Potential instability of the existing combustion turbines (CTs) at J.K. Smith
- Economic impacts of generation re-dispatch due to a potential failure of the Avon 345-138 kV transformer

The results of that parallel study are documented in a document developed by EKPC titled *Justification of J.K. Smith-Sideview 345 kV Line*, dated October 31, 2005. [Note that the Sideview endpoint was later re-named North Clark]. The recommended solution from that study was to:

- Construct a new 345 kV breaker substation (to be named North Clark) in the Sideview area with three line exits. Loop the existing Spurlock-Avon 345 kV line through this substation.
- Install 345 kV facilities at the J.K Smith Substation to accommodate a new line exit
- Install a new 345-138 kV, 450 MVA autotransformer at the J.K. Smith Substation
- Construct 18 miles of 345 kV line using bundled 954 MCM ACSR conductor between the J.K. Smith Substation and the new North Clark Substation

This recommended construction addresses the problems of the existing transmission system. It also provides some benefits for the proposed generators that are the subject of this SIS. However, power flow analysis with the J.K. Smith-North Clark Project added to the models indicates that transmission-system overloads would still exist with the proposed generators. While the proposed J.K. Smith-North Clark Project does help reduce the severity of many of the overloads identified in Tables 3-1 and 3-2, it does not eliminate them. In particular, all of the existing 138 kV lines from the J.K. Smith Substation would still be overloaded with the proposed Project. Therefore, alternatives must be developed that incorporate the planned J.K. Smith-North Clark Project while still addressing the overloads identified in Tables 3-1 and 3-2. Therefore, as stated above, the alternatives developed must either include capacity upgrades for the four existing 138 kV outlets from the J.K. Smith Station or the construction of at least one additional new outlet from J.K. Smith.

4.2 Consideration of Upgrading Existing J.K. Smith Outlets

Increasing the capacity of the existing four 138 kV outlets from the J.K. Smith Station was considered. These four outlets are:

- J.K. Smith-Dale 138 kV Line (9.5 miles)
- J.K. Smith-Fawkes 138 kV Line (14.3 miles)
- J.K. Smith-Union City-Lake Reba Tap 138 kV Line (11.6 miles)
- J.K. Smith-Powell County 138 kV Line (16.3 miles)

The conductor presently installed for each of these lines is 954 MCM ACSR (Aluminum Conductor Steel Reinforced) operated at a maximum operating temperature of 212 °F. In order to increase the capacity of each line, the conductor would have to be replaced with either bundled conductor or with ACSS (Aluminum Conductor Steel Supported) conductor. ACSS can be operated at conductor operating temperatures above 212 °F without damaging or annealing the conductor provided that adequate

In addition to replacement of the conductors in the four 138 kV outlets from J.K. Smith, several other upgrades would be required to eliminate all overloads. The most significant of these facilities to be upgraded are:

- Fawkes LGEE-Clark County 138 kV LGEE Line (18.3 miles)
- Clark County-Mount Sterling 69 kV LGEE Line (12.2 miles)
- Lake Reba-Waco-Rice Tap 69 kV LGEE Line (11.8 miles)
- Dale-Hunt-J.K. Smith-Trapp 69 kV EKPC Line (11.2 miles)
- Dale-Newby #1 69 kV EKPC Line (11.1 miles)
- Powell County-Jeffersonville 69 kV EKPC Line (8.5 miles)
- Dale-Three Forks-Fawkes 138 kV EKPC Line (7.3 miles)
- Boonesboro North-Winchester Water Works-Boone Avenue 69 kV LGEE Line (5.9 miles)
- Davis-Nicholasville 69 kV EKPC Line (3.8 miles)
- Lake Reba Tap 161-138 kV, 200 MVA LGEE Transformer
- Boonesboro North 138-69 kV, 150 MVA LGEE Transformer
- Powell County 161-138 kV, 150 MVA EKPC Transformer
- Powell County 138-69 kV, 100 MVA EKPC Transformer
- Dale 138-69 kV, 82.5 MVA EKPC Transformer
- Beattyville 161-69 kV, 56 MVA LGEE Transformer
- West Irvine 161-69 kV, 50 MVA LGEE Transformer

Each of the facilities to be upgraded would need to be removed from service for construction at some point during the period from June 2006 through March 2010. This would require multiple simultaneous outages in the area, which would create significant reliability and operational concerns. Furthermore, it is not known if all of the upgrades can be completed by their needed dates, since there are more than 20 facilities requiring significant upgrades.

Another disadvantage of upgrading the overloaded facilities as opposed to building one or more new outlets is higher transmission-system losses. The transmission-system losses will be much higher if the existing facilities are upgraded instead of another outlet – especially a 345 kV outlet – from J.K. Smith being constructed.

Another disadvantage is that upgrading of existing transmission facilities does not provide additional margin to allow multiple simultaneous outages in the area for maintenance. Generation reductions would probably be required to allow simultaneous transmission outages.

Another disadvantage is the uncertainty in the scope, cost, and completion time of the numerous upgrades that would be required. The expected cost to upgrade all problem facilities is at least $30 million (2006 dollars). This cost could be much higher depending on the scope of work required for each upgrade, which in many cases can only be determined through a detailed field review of the facility. The expectation is that the cost of upgrading facilities will be comparable to the cost of alternatives that construct new facilities, particularly when transmission-system losses are factored in.

For the reasons discussed above, an alternative to upgrade all of the overloaded facilities identified in Tables 3-1 and 3-2 was not evaluated. Only alternatives that include construction of a new outlet from the J.K. Smith Station were developed and evaluated.

4.3 Screening of J.K. Smith Outlet Alternatives

An exhaustive set of new outlets for the J.K. Smith Station were screened singularly and in various combinations to evaluate the performance with the proposed generators added at J.K. Smith. Table 4-1 lists all of the potential J.K. Smith outlets that were screened, along with estimated mileages for line construction.

Table 4-1
List of J.K. Smith Outlet Alternatives Screened

Screened Outlet	Estimated Mileage	Other Required Facilities
J.K. Smith-Cooper 345 kV	73.2	Cooper 345-161 kV
J.K. Smith-Marion County 345 kV	72.2	Marion County 345-161 kV
J.K. Smith-Maggard 345 kV	61.5	Maggard 345-138 kV; convert Maggard-Skaggs 69 kV to 138 kV; Maggard 138-69 kV
J.K. Smith-Rowan County 345 kV	48.3	Rowan County 345-138 kV
J.K. Smith-Goddard 345 kV	47.4	Goddard 345-138 kV
J.K. Smith-Tyner 345 kV	43.5	Tyner 345-161 kV
J.K. Smith-Brodhead 345 kV	40.6	Brodhead 345-161 kV; new 161 kV outlet from Brodhead; Brodhead 161-69 kV
J.K. Smith-Maytown Jct. 345 kV	37.9	Maytown Jct. 345-138 kV; Powell County-Maytown Jct. 138 kV; Maytown Jct. 138-69 kV

J.K. Smith-Brown North LGEE 345 kV	37.5	None
J.K. Smith-West Garrard 345 kV	35.5	New 345 kV switching station at West Garrard connecting to LGEE's Brown-Pineville 345 kV line; 345 kV terminal facilities at Brown and Pineville
J.K. Smith-Delvinta LGEE 345 kV	34.2	Delvinta 345-161 kV
J.K. Smith-Beattyville 345 kV	32.1	Beattyville 345-161 kV
J.K. Smith-Three Links Jct. 345 kV	31.7	Three Links Jct. 345-138 kV; Three Links Jct. 138-69 kV
J.K. Smith-West Berea 345 kV	25.5	West Berea 345-138 kV
J.K. Smith-West Irvine Tap 345 kV	17.3	New 345 kV switching station at West Irvine Tap connecting to LGEE's Lake Reba Tap-Delvinta 161 kV line; West Irvine Tap 345-161 kV
Convert J.K. Smith-Powell County 138 kV line to 345 kV	16.4	Powell County 345-161 kV
J.K. Smith-Fawkes 345 kV	16.1	Fawkes 345-138 kV
J.K. Smith-West Irvine LGEE 345 kV	14.8	West Irvine 345-161 kV; Loop LGEE's Lake Reba Tap-Delvinta 161 kV through West Irvine Substation
J.K. Smith-Powell County 345 kV	14.2	Powell County 345-161 kV
J.K. Smith-Lake Reba Tap LGEE 345 kV	11.9	Lake Reba Tap 345-161 kV
Convert J.K. Smith-Dale 138 kV line to 345 kV	9.4	Dale 345-138 kV
J.K. Smith-Rowan County 138 kV	48.3	None
J.K. Smith-Goddard 138 kV	47.5	None
J.K. Smith-Three Links Jct. 138 kV	31.7	Three Links Jct. 138-69 kV
J.K. Smith-Baker Lane 138 kV	28.7	None
J.K. Smith-Higby Mill LGEE 138 kV	27.2	None
J.K. Smith-Loudon Avenue LGEE 138 kV	26.1	None
J.K. Smith-West Berea 138 kV	25.5	None
J.K. Smith-Fayette 138 kV	22.5	None
J.K. Smith-Newby 138 kV	20.1	Convert Dale-Newby 69 kV to 138 kV; Newby 138-69 kV
J.K. Smith-Spencer Road LGEE 138 kV	17.9	None
J.K. Smith-Avon 138 kV	17.2	None
J.K. Smith-Fawkes 138 kV	16.1	None

J.K. Smith-Powell County 138 kV	14.2	None
J.K. Smith-Lake Reba Tap LGEE 138 kV	11.9	None
J.K. Smith-Boonesboro North LGEE 138 kV	10.0	None
J.K. Smith-Dale 138 kV	9.7	None
J.K. Smith-Clark County LGEE 138 kV	9.1	None

These outlets were developed by evaluating potential line construction from the J.K. Smith Station to other stations throughout the area. At that point in the process, no consideration of the constructability of an outlet option was given. It was assumed that all of these outlet options could be constructed.

The screening process eliminated most of these outlet options for one of the following two reasons:

- An outlet either singularly or in combination with other outlets did not eliminate a substantial number of the thermal overloads caused by the proposed generators
- An outlet did not provide any significant additional benefits when compared to the performance of another outlet that would be shorter and/or less expensive

4.3.1 Discussion of Results from the Screening Analysis

As shown in Figure A-3 in Appendix A, the problems identified with the proposed generators and without any transmission system additions are primarily concentrated in two areas:

1. The immediate area around the J.K. Smith, Dale, Fawkes, Lake Reba Tap, Powell County, and Clark County Substations.
2. Along the 161 kV system extending southeast from the Lake Reba Tap Substation to the Delvinta Substation and on the other 161 kV lines out of Delvinta.

Other isolated problems (Avon-Loudon Avenue LGEE 138 kV, Davis-Nicholasville 69 kV, Morehead AEP-Hayward AEP 69 kV, West Berea-Three Links Jct. 69 kV) were identified outside of the two primarily impacted areas.

The screening analysis determined that two of the outlet options considered have a greater impact on the transmission-system problems identified than did the remainder of the outlet options. These two outlet options are:

- ✓ The J.K. Smith-Tyner 345 kV line and the installation of a 345-161 kV transformer at Tyner
- ✓ The J.K. Smith-West Garrard 345 kV line and a new 345 kV switching station at West Garrard connecting this line with LGEE's Brown-Pineville 345 kV circuit

These two outlets substantially reduce the number and severity of overloads caused by the proposed generators. These options appear to provide these benefits for two primary reasons:

- Each is a 345 kV outlet providing a high outlet capacity from the J.K. Smith site
- Each provides a connection to the transmission system in the southern and southeastern parts of the Kentucky transmission system. A small amount of generation exists in this area. Therefore, a large amount of the power required by customers in this area presently flows into the area on the 138 kV and 161 kV interfaces in the Richmond, KY area (through the Fawkes and Lake Reba Tap substations). Either the J.K. Smith-Tyner or J.K. Smith-West Garrard 345 kV line would provide an EHV path bypassing these heavily loaded 138 and 161 kV interfaces.

The other outlet options listed in Table 4-1 either did not provide as much benefit as either of these two options or provided similar benefits at the expense of much more construction. The performance of these other outlet options will be discussed briefly, beginning with the 345 kV outlet alternatives.

4.3.1.1 Discussion of 345 kV Outlets Considered

➢ **J.K. Smith-Cooper 345 kV**

This line provides many of the same benefits as the J.K. Smith-Tyner or J.K. Smith-West Garrard 345 kV lines. However, it requires a substantial amount of additional 345 kV line construction.

➢ **J.K. Smith-Marion County 345 kV**

This line provides some reduction in the number and severity of overloads caused by the proposed generators. However, it does not perform as well as the J.K. Smith-Tyner or J.K. Smith-West Garrard 345 kV lines. Furthermore, it requires a substantial amount of additional 345 kV line construction.

➢ **J.K. Smith-Maggard 345 kV; J.K. Smith-Rowan County 345 kV; J.K. Smith-Goddard 345 kV**

Each of these lines provides a 345 kV path between J.K. Smith and the northeastern part of the EKPC system. These lines do not provide great benefits, primarily because they build into an area that already has a generation surplus due to the presence of the Spurlock Units. Furthermore, each of these lines is longer than either the J.K. Smith-Tyner or J.K. Smith-West Garrard 345 kV line.

➢ **J.K. Smith-Brodhead 345 kV; J.K. Smith-Three Links Jct. 345 kV**

These two options involve construction of 345 kV line into an area where only 69 kV facilities currently exist. Therefore, in addition to the 345 kV line construction, at least one new 161 kV or 138 kV line is required. In reality, multiple new 161 kV or 138 kV lines would be required for either option to obtain reasonable performance, although the performance is still inferior to that provided by either J.K. Smith-Tyner or J.K. Smith-West Garrard.

- **J.K. Smith-Maytown Jct. 345 kV**

This option involves construction of 345 kV line into an area where only 69 kV facilities currently exist. EKPC does have included in its long-range plan a new 138 kV line from Powell County to Maytown Junction. Therefore, this line plus new 138 kV facilities connecting Maytown Junction to the 138 kV system to the east (Rowan County-Skaggs-Maggard) would be needed to obtain reasonable performance. However, this performance is still inferior to the performance of either the J.K. Smith-Tyner or J.K. Smith-West Garrard line, even with all of these modifications to the transmission system.

- **J.K. Smith-Brown North LGEE 345 kV**

This option performs similarly to the J.K. Smith-West Garrard 345 kV line. However, it requires slightly more new 345 kV line construction. Furthermore, the West Garrard option is preferred, since it would establish a new EKPC 345 kV substation in the central portion of the EKPC transmission system.

- **J.K. Smith-Delvinta LGEE 345 kV; J.K. Smith-Beattyville 345 kV; J.K. Smith-West Irvine Tap 345 kV; J.K. Smith-West Irvine LGEE 345 kV**

These options all perform similarly. Each constructs a new 345 kV line to either Delvinta or a neighboring transmission substation/junction, which would then be connected to the existing 161 kV system that connects at Delvinta. Each of these options provides some reduction of the overloads in the immediate vicinity of the J.K. Smith and Fawkes Substations. However, each of these options results in a significant increase in the number and severity of overloads in the Delvinta/West Irvine area. Therefore, to make these outlet options work, significant upgrades would be required of the 161 and 69 kV systems in the Delvinta/West Irvine area. In addition, overloads in other areas of the system would also need to be addressed. For these reasons, these outlet options were eliminated from further consideration.

- **J.K. Smith-West Berea 345 kV; J.K. Smith-Fawkes 345 kV; J.K. Smith-Lake Reba Tap LGEE 345 kV**

These options each provide a new 345 kV outlet into the Richmond/Berea area. However, this still results in severe overloads of the underlying 138 and 161 kV transmission system in the area. None of these options provide an outlet of sufficient distance to "get beyond" the area where system overloads occur.

- **Convert J.K. Smith-Powell County 138 kV to 345 kV; Convert J.K. Smith-Dale 138 kV to 345 kV**

These conversion options do not provide substantial benefits for system loadings for three primary reasons. First, the new 345 kV line terminating at either Dale or Powell County would terminate into a 345-138 kV or 345-161 kV transformer, since no other 345 kV outlets would be in place at those stations. Therefore, the system impedances at those stations would restrict the flow on either of these new 345 kV outlets from J.K. Smith. Second, while a new 345 kV outlet is created for the J.K. Smith Substation, an existing

138 kV line is eliminated. Therefore, the net gain in outlet capability is relatively small. Finally, the new 345 kV lines would be connected to substations adjacent to J.K. Smith. This results in a number of overloads still occurring in the vicinity of the J.K. Smith substation.

- **J.K. Smith-Powell County 345 kV**

This option connects a new 345 kV line to a substation adjacent to J.K. Smith. This results in a number of overloads still occurring in the vicinity of the J.K. Smith Substation. Furthermore, additional overloads are created on the transmission lines connected to the Powell County Substation.

4.3.1.2 Discussion of 138 kV Outlets Considered

- **J.K. Smith-Rowan County 138 kV; J.K. Smith-Goddard 138 kV**

Either of these lines provides a 138 kV path between J.K. Smith and the northeastern part of the EKPC system. These lines do not provide great benefits, primarily because they build into an area that already has a generation surplus due to the presence of the Spurlock Units. Furthermore, each of these lines is a particularly long 138 kV line. The screening analysis indicates that these potential lines would not transmit a significant amount of power.

- **J.K. Smith-Three Links Jct. 138 kV**

This option involves construction of 138 kV line into an area where only 69 kV facilities currently exist. Therefore, at least one more new 161 kV or 138 kV line connected to the Three Links Jct. Substation is needed for this option to perform reasonably well. However, even with these additions, several significant overloads would still exist on the transmission system due to the proposed generators at J.K. Smith.

- **J.K. Smith-Baker Lane 138 kV; J.K. Smith-Higby Mill LGEE 138 kV; J.K. Smith-Loudon Avenue 138 kV; J.K. Smith-Fayette 138 kV**

These four outlet options provide outlets from the J.K. Smith Substation to the west to the Lexington area. However, this provides limited benefits. The Lexington area already has several strong sources encircling it. The addition of a 138 kV line into the area does not result in a substantial flow increase into the area. Therefore, these outlets do not transmit a large amount of power out of the J.K. Smith area.

- **J.K. Smith-West Berea 138 kV; J.K. Smith-Fawkes 138 kV; J.K. Smith-Lake Reba Tap LGEE 138 kV**

These options each provide a new 138 kV outlet into the Richmond/Berea area, which does help to reduce loadings on the 138 kV lines from J.K. Smith into the Richmond area. However, none of the options significantly impact several of the severe overloads caused by the proposed generators at J.K. Smith, particularly the overloads on the 161 kV system connected to Delvinta.

- **J.K. Smith-Newby 138 kV**

This option involves construction of 138 kV line into an area where only 69 kV facilities currently exist. Therefore, at least one more new 161 kV or 138 kV line connected to the

Newby Substation would be needed for this option to perform reasonably well. A new 138 kV line from Dale-Newby was tested in conjunction with this option. However, even with this addition, several significant overloads would still exist on the transmission system due to the proposed generators at J.K. Smith.

- **J.K. Smith-Spencer Road LGEE 138 kV**

This option provides a new 138 kV connection into LGEE's existing two-way feed 138 kV system that stretches from Fawkes to Rodburn. The screening analysis indicates that this line would carry a considerable amount of power. Therefore, it would provide some significant benefits. However, as a stand-alone option, it would not be sufficient to address many of the problems caused by the proposed generators.

- **J.K. Smith-Avon 138 kV**

This option provides a new 138 kV connection to EKPC's Avon 345-138 kV Substation. However, this has limited value with the addition of the J.K. Smith-North Clark 345 kV line, which will connect to the Spurlock-Avon 345 kV line. Therefore, much of the power flow between J.K. Smith and Avon will occur on this new 345 kV line.

- **J.K. Smith-Powell County 138 kV**

This option connects a new 138 kV line to a substation adjacent to J.K. Smith. This results in a large number of overloads still occurring in the vicinity of the J.K. Smith Substation. Furthermore, additional overloads are created on the transmission lines connected to the Powell County Substation. Finally, the power flows are not substantial enough on this new line to have a significant impact on the overloads caused by the proposed generators.

- **J.K. Smith-Boonesboro North LGEE 138 kV; J.K. Smith-Dale 138 kV**

These options provide a new 138 kV connection to the west of J.K. Smith. The construction of the J.K. Smith-North Clark 345 kV line will limit the usefulness of these lines in helping reduce loadings on facilities in the area between the Avon and Dale Substations. Furthermore, these outlets would not provide significant loading relief for the 138 and 161 kV facilities in the Fawkes and Delvinta areas, respectively.

- **J.K. Smith-Clark County LGEE 138 kV**

This option provides a new 138 kV connection into LGEE's existing two-way feed 138 kV system that stretches from Fawkes to Rodburn. The screening analysis indicates that this line would carry a considerable amount of power. In fact, due to its close proximity to the J.K. Smith Substation, the amount of power flow into the Clark County Substation would result in the introduction of severe loadings in the immediate vicinity. The J.K. Smith-Spencer Road 138 kV line provides similar flows and system benefits without creating the same number or magnitude of new loading issues in the area.

As a result of the screening analysis, it was determined that one 138 kV outlet from the J.K. Smith site would not be adequate. Screening showed that at least three 138 kV outlets would be required to accommodate the added generation. Additionally, significant upgrades would still be required on the transmission system with these multiple 138 kV outlets. Furthermore, transmission-system losses will be higher with these 138 kV outlet options than with a 345 kV outlet option. For these reasons, no options were considered that only provided 138 kV outlets from J.K. Smith Substation. All transmission alternatives considered therefore included a new 345 kV outlet from the J.K. Smith site.

4.3.2 Discussion of Common Facilities Required

Some common facilities are required at the J.K. Smith site to accommodate the proposed generator additions. These requirements are necessary regardless of the new outlet or outlets to be built. These system additions/modifications are necessary to accommodate the connection of the proposed generators to EKPC's transmission network. Table 4-2 lists these proposed system additions, the reason for which each is needed, and the date needed based on the latest schedule that has been provided for the generation additions.

Table 4-2
Common Transmission Facilities Required to Connect the Proposed J.K. Smith Units

Install Date	Project Description	Reason for Need
September 2007	Install a second 345-138 kV, 450 MVA transformer at JK Smith CT Substation	Addition of CTs #11 & #12 at JK Smith; needed for desired redundancy for this critical connection between the 345 kV and 138 kV buses at J.K. Smith
September 2007	Add 345 kV Terminal Facilities at JK Smith CT Substation for CTs #11 & #12	Addition of CTs #11 & #12 at JK Smith
April 2008	Add 345 kV Terminal Facilities at JK Smith CT Substation for CTs #9 & #10	Addition of CTs #9 & #10 at JK Smith
June 2008	Add 138 kV Terminal Facilities at JK Smith CT Substation for CT #8	Addition of CT #8 at JK Smith
March 2009	Construct a second 345 kV substation at JK Smith for the CFB Unit	Addition of CFB Unit #1 at JK Smith
March 2009	Add 345 kV Terminal Facilities at JK Smith CFB Substation for CFB Unit #1	Addition of CFB Unit #1 at JK Smith
March 2009	Construct two 345 kV lines (0.8 miles each) between the JK Smith CT 345 kV substation and the JK Smith CFB 345 kV substation using bundled 954 MCM ACSR conductor	Addition of CFB Unit #1 at JK Smith
March 2009	Add 345 kV Terminal Facilities at JK Smith CT Substation for the two 345 kV lines to the JK Smith CFB Substation	Addition of CFB Unit #1 at JK Smith
March 2009	Add 345 kV Terminal Facilities at JK Smith CFB Substation for the two 345 kV lines to the JK Smith CT Substation	Addition of CFB Unit #1 at JK Smith

The facilities listed in Table 4-2 include the following:

- Terminal facilities to connect J.K. Smith CT #8 to the existing 138 kV bus at J.K. Smith

- Terminal facilities to connect J.K. Smith CTs #9 through #12 to a new 345 kV switchyard to be constructed at the J.K. Smith CT Substation
- A new 345 kV switchyard near the J.K. Smith CFB Unit #1 with terminal facilities to connect J.K. Smith CFB Unit #1
- Construction of a two 345 kV lines connecting the J.K. Smith 345 kV CT Substation and the J.K. Smith 345 kV CFB Substation

Table 4-3 provides the planning estimates for costs of the projects listed in Table 4-2. Cost information is provided for the expected costs in 2006 dollars, install year dollars, and present worth dollars.

Table 4-3 Estimated Costs of Common Transmission Facilities Required to Connect the Proposed J.K. Smith Units				
Install Date	**Project Description**	**Planning Estimate (2006$)**	**Inflated Cost (Install Year $)**	**Present Worth (2006$)**
September 2007	Install a second 345-138 kV, 450 MVA transformer at JK Smith CT Substation	2,850,000	3,064,000	4,363,000
September 2007	Add 345 kV Terminal Facilities at JK Smith CT Substation for CTs #11 & #12	2,160,000	2,322,000	3,307,000
March 2009	Construct a second 345 kV substation at JK Smith for the CFB Unit #1	2,160,000	2,433,000	2,952,000
April 2008	Add 345 kV Terminal Facilities at JK Smith CT Substation for CTs #9 & #10	2,160,000	2,376,000	3,122,000
June 2008	Add 138 kV Terminal Facilities at JK Smith CT Substation for CT #8	270,000	297,000	390,000
March 2009	Construct two 345 kV lines (0.8 miles each) between the JK Smith CT 345 kV substation and the JK Smith CFB 345 kV substation using bundled 954 MCM ACSR conductor	1,150,000	1,296,000	1,572,000
March 2009	Add 345 kV Terminal Facilities at JK Smith CT Substation for the two 345 kV lines to the JK Smith CFB Substation	4,310,000	4,856,000	5,891,000
March 2009	Add 345 kV Terminal Facilities at JK Smith CFB Substation for the two 345 kV lines to the JK Smith CT Substation	4,310,000	4,856,000	5,891,000
	Total	$19,370,000	$21,500,000	$27,488,000

4.3.3 Discussion of Alternatives Developed

As discussed earlier, the screening analysis determined that two 345 kV outlets in particular – the J.K. Smith-West Garrard and J.K. Smith-Tyner lines – have a greater impact on the transmission-system overloads than the other outlets considered. Therefore, construction alternatives were developed that included these outlet options along with other transmission-system additions and modifications necessary to eliminate all thermal overloads caused by the proposed generators. One alternative that included the J.K. Smith-West Garrard 345 kV line was ultimately developed to address all system problems. Two other alternatives that included the J.K. Smith-Tyner 345 kV line were also developed to address all system problems. These two alternatives that included J.K. Smith-Tyner were similar, but did differ with respect to some of the 138 kV projects included.

4.3.3.1 Construction Plan for J.K. Smith-West Garrard Alternative

Table 4-4 shows the construction plan that was developed to include a new 345 kV line from EKPC's J.K. Smith Substation to LGEE's Brown-Pineville 345 kV double-circuit line. It should be noted that the original assumption for the planning studies was that the new 345 kV line would actually connect to the LGEE Brown-Pineville 345 kV line near Stanford, KY. However, subsequent preliminary review of potential line routes indicated that the line routing process would more likely result in a recommended route that connected to LGEE's Brown-Pineville line in the western portion of Garrard County, approximately 12 miles north of the previously assumed connection point in the Stanford area. This change resulted in a significantly shorter line length from the J.K. Smith site (35.5 miles versus 48.3 miles). However, this change in the new line's length (and its impedance), as well as the change in the distance of the new 345 kV switching station from LGEE's Brown North Substation, did not result in a significant change in system power flows. The models were modified to account for these changes along with some other model changes provided during the course of the study.

Table 4-4 Alternative 1 – Project Descriptions and Reasons for Need					
Install Date	Project Ref #	Project Description	Reason for Need	Critical Contingency	Unit Outage
June 2009	1.1	Construct 35.5 miles of 345 kV line from JK Smith to LGEE's Brown-Pineville double-circuit line at West Garrard using bundled 954 MCM ACSR conductor	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	1.2	Add 345 kV Terminal Facilities at JK Smith CFB Substation for the West Garrard line.	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	1.3	Add terminal facilities at LGEE's Brown and Pineville Substations to energize the Brown-Pineville 345 kV circuit	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	1.4	Construct a 345 kV breaker station at West Garrard with three line exits. Loop the Brown-Pineville 345 kV line through the station and terminate the new line from JK Smith	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	1.5	Ensure that the Hyden Tap-Wooten 161 kV LGEE-AEP interconnection has minimum ratings of 198/198 MVA summer and 252/252 MVA winter	Overload of the 190 MVA summer emergency rating and the 223 MVA winter emergency rating of the Hyden Tap-Wooten 161 kV LGEE-AEP interconnection	Pineville TVA-Stinnett 161 kV Line	Base
June 2009	1.6	Increase the terminal limits at LGEE's Fawkes and Clark County stations and the conductor limits associated with the Fawkes-Clark County 138 kV circuit to at least 775A (185 MVA) summer emergency.	Overload of the 172 MVA summer emergency rating of the Fawkes-Clark County 138 kV line	Avon-Boonesboro North-Dale 138 kV Line	Ghent #1
June 2009	1.7	Increase the terminal limits at LGEE's Boonesboro North associated with the Boonesboro North-Winchester Water Works 69 kV circuit to at least 1225A (146 MVA) summer emergency.	Overload of the 143 MVA summer emergency rating of the Boonesboro North-Winchester Water Works 69 kV line	Fawkes-Clark County 138 kV Line	Ghent #1

Table 4-4 Alternative 1 – Project Descriptions and Reasons for Need					
Install Date	**Project Ref #**	**Project Description**	**Reason for Need**	**Critical Contingency**	**Unit Outage**
June 2009	1.8	Increase the terminal limits at LGEE's Boonesboro North associated with the Boonesboro North 138-69 kV transformer to at least 1350A (161 MVA) summer emergency.	Overload of the 160 MVA summer emergency rating of the Boonesboro North 138-69 kV transformer	Fawkes-Clark County 138 kV Line	Ghent #1
June 2009	1.9	Increase the limits of LGEE's Lake Reba-Waco 69 kV line to at least 515A (62 MVA) summer emergency.	Overload of the 56 MVA summer emergency rating of the Lake Reba-Waco 69 kV line	Lake Reba Tap 138-161 kV Transformer	Cooper #2
June 2009	1.10	Increase the limits of LGEE's Parker Seal-Winchester 69 kV line to at least 630A (75 MVA) summer emergency.	Overload of the 72 MVA summer emergency rating of the Parker Seal-Winchester 69 kV line	Avon-Boonesboro North-Dale 138 kV Line	Brown #3
June 2009	1.11	Increase the limits of LGEE's Alcalde-Elihu 161 kV line to at least 805A (224 MVA) summer emergency and 1015A (283 MVA) winter emergency.	Overload of the 190 MVA summer emergency rating and the 268 MVA winter emergency rating of the Alcalde-Elihu 161 kV line	Wolf Creek TVA-Russell County Junction 161 kV Line	Cooper #2
November 2009	1.12	Replace the Dale 138-69 kV, 82.5 MVA transformer with a 100 MVA transformer	Overload of the Dale 138-69 kV, 82.5 MVA transformer	JK Smith-Powell County 138 kV Line	Dale #3
November 2009	1.13	Increase the limits of AEP's Leslie 161-69 kV transformer to at least 124 MVA winter emergency	Overload of the 120 MVA winter emergency rating of AEP's Leslie 161-69 kV transformer	Wooten-Hazard 161 kV Line	Base

Projects 1.1 through 1.4 in Table 4-4 are the projects necessary to establish a 345 kV line from J.K. Smith to West Garrard. Project 1.5 represents a need to increase the ratings of an interconnection between LGEE and AEP at Hyden to accommodate increased flows across the interconnection caused by the proposed generators. Project 1.6 specifies a required upgrade of terminal limits and/or conductor clearance limits on LGEE's Fawkes-Clark County 138 kV line. Projects 1.7 and 1.8 are needed to increase the ratings of the Boonesboro North 138-69 kV transformer (1.7) and the Boonesboro North-

Winchester Water Works 69 kV line (1.8). Projects 1.9 and 1.10 identify required upgrades of 69 kV lines on the LGEE system. Project 1.11 identifies a needed upgrade on LGEE's Alcalde-Elihu 161 kV line. This upgrade is needed due to the increased power flows on the LGEE 345 kV system between Brown and Pineville caused by the connection of the proposed 345 kV line from J.K. Smith to LGEE's 345 kV line. Project 1.12 specifies a required transformer replacement at EKPC's Dale Station to accommodate increased power flows from the 138 kV bus to the 69 kV bus. The summer emergency rating of the existing transformer is not exceeded with the addition of the proposed generators, while the winter emergency rating is exceeded. Therefore, this project is not needed until the winter period when the J.K. Smith CFB Unit will be connected to the grid and being dispatched for unit testing (2009/10 Winter). Project 1.13 is an upgrade identified on the AEP transmission system in the Hyden/Hazard area.

Table 4-4 indicates that this alternative results in the need for one major project that includes EKPC's construction of the 345 kV line from J.K. Smith to LGEE's 345 kV line, construction of a 345 kV switching station at the connection point, and 345 kV terminal additions at J.K. Smith, Brown, and Pineville. Only one other EKPC project is required with this Alternative -- replacement of the Dale 138-69 kV transformer. Most of the remaining projects identified for this alternative are expected to be terminal equipment replacements and/or increases of line conductor clearances on the LGEE transmission system. An upgrade may also be required by AEP for its portion of the Hyden interconnection with LGEE, and for its Leslie 161-69 kV transformer. Therefore, the construction of the new 345 kV line from J.K. Smith to the LGEE 345 kV line is effective in eliminating most or all of the significant problems. Some relatively minor problems remain that will need to be addressed, and the scope of the work required to address these problems on the LGEE and AEP system is unknown. However, based on the information that is available to EKPC, the conclusion is that the required upgrades for LGEE and AEP are likely to be relatively minor in scope and cost.

The planning cost estimates for this Alternative are listed by project in Table 4-5. Costs are provided in 2006 dollars, install year dollars, and present worth dollars.

Table 4-5 Estimated Costs for Alternative 1				
Install Date	**Project Description**	**Planning Estimate (2006$)**	**Inflated Cost (Install Year $)**	**Present Worth (2006$)**
June 2009	Construct 35.5 miles of 345 kV line from JK Smith to LGEE's Brown-Pineville double-circuit line at West Garrard using bundled 954 MCM ACSR conductor	41,750,000	47,035,000	57,062,000
June 2009	Add 345 kV Terminal Facilities at JK Smith CFB Substation for the West Garrard line.	1,080,000	1,217,000	1,476,000
June 2009	Add terminal facilities at LGEE's Brown and Pineville Substations to energize the Brown-Pineville 345 kV circuit	2,160,000	2,433,000	2,952,000
June 2009	Construct a 345 kV breaker station at West Garrard with three line exits. Loop the Brown-Pineville 345 kV line through the station and terminate the new line from JK Smith	3,235,000	3,644,000	4,421,000
June 2009	Ensure that the Hyden Tap-Wooten 161 kV LGEE-AEP interconnection has minimum ratings of 198/198 MVA summer and 252/252 MVA winter	100,000	110,000	145,000
June 2009	Increase the terminal limits at LGEE's Fawkes and Clark County stations and the conductor limits associated with the Fawkes-Clark County 138 kV circuit to at least 775A (185 MVA) summer emergency.	350,000	394,000	478,000
June 2009	Increase the terminal limits at LGEE's Boonesboro North associated with the Boonesboro North-Winchester Water Works 69 kV circuit to at least 1225A (146 MVA) summer emergency.	110,000	124,000	150,000
June 2009	Increase the terminal limits at LGEE's Boonesboro North associated with the Boonesboro North 138-69 kV transformer to at least 1350A (161 MVA) summer emergency.	140,000	158,000	191,000
June 2009	Increase the limits of LGEE's Lake Reba-Waco 69 kV line to at least 515A (62 MVA) summer emergency.	110,000	124,000	150,000

Table 4-5 Estimated Costs for Alternative 1				
Install Date	Project Description	Planning Estimate (2006$)	Inflated Cost (Install Year $)	Present Worth (2006$)
June 2009	Increase the limits of LGEE's Parker Seal-Winchester 69 kV line to at least 630A (75 MVA) summer emergency.	10,000	12,000	14,000
June 2009	Increase the limits of LGEE's Alcalde-Elihu 161 kV line to at least 805A (224 MVA) summer emergency and to at least 1015A (283 MVA) winter emergency.	50,000	56,000	65,000
November 2009	Replace the Dale 138-69 kV, 82.5 MVA transformer with a 100 MVA transformer	920,000	1,036,000	1,187,000
November 2009	Increase the limits of AEP's Leslie 161-69 kV transformer to at least 124 MVA winter emergency	1,080,000	1,217,000	1,394,000
	Total	$51,095,000	$57,560,000	$69,685,000

4.3.2.2 Construction Plan for J.K. Smith-Tyner Alternatives

Two construction plans were developed that included a new 345 kV line from EKPC's J.K. Smith Substation to EKPC's Tyner Substation. These two Alternatives are presented below.

Alternative 2: J.K. Smith-Tyner 345 kV Line; Dale-Boonesboro North 138 kV Reactor Addition

This Alternative specifies the construction of a 345 kV line from J.K. Smith to Tyner and the addition of a 345-161 kV autotransformer at Tyner. Additionally, the installation of a 5% series reactor is included in the Dale-Boonesboro North 138 kV line. Several other transmission system modifications are included in this Alternative, as shown in Table 4-6.

Table 4-6 Alternative 2 – Project Descriptions and Reasons for Need					
Install Date	**Project Ref #**	**Project Description**	**Reason for Need**	**Critical Contingency**	**Unit Outage**
June 2009	2.1	Construct 43.5 miles of 345 kV line from JK Smith to Tyner using bundled 954 MCM ACSR conductor	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	2.2	Add 345 kV Terminal Facilities at JK Smith CFB Substation for the Tyner line	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	2.3	Install a 345-161 kV, 450 MVA transformer at Tyner	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	2.4	Install a 138 kV, 5% series reactor at Dale in the Dale-Boonesbro North 138 kV line	Overload of the 954 MCM ACSR conductor in LGEE's Boonesboro North-Winchester Water Works 69 kV line	Fawkes-Clark County 138 kV Line	Ghent #1
June 2009	2.5	Ensure that the Hyden Tap-Wooten 161 kV LGEE-AEP interconnection has minimum ratings of 194/194 MVA summer and 252/252 MVA winter	Overload of the 190 MVA summer emergency rating and the 223 MVA winter emergency rating of the Hyden Tap-Wooten 161 kV LGEE-AEP interconnection	Pineville TVA-Stinnett 161 kV Line	Base
June 2009	2.6	Replace the Tyner 161-69 kV, 65 MVA transformer with a 93 MVA transformer	Overload of the Tyner 161-69 kV, 65 MVA transformer	Tyner-Pittsburg-London 161 kV Line	Cooper #2
June 2009	2.7	Reconductor LGEE's Pittsburg-East Bernstadt 69 kV line (2.1 miles) using 397 MCM ACSR conductor	Overload of the 266 MCM ACSR conductor in the Pittsburg-East Bernstadt 69 kV line	Pittsburg 161-69 kV Transformer	Cooper #2

Table 4-6 Alternative 2 – Project Descriptions and Reasons for Need					
Install Date	**Project Ref #**	**Project Description**	**Reason for Need**	**Critical Contingency**	**Unit Outage**
June 2009	2.8	Increase the terminal limits at LGEE's Brown North associated with the Brown North-Brown Plant-Brown CT 138 kV circuit #2 to at least 1855A (443 MVA) summer emergency	Overload of the 426 MVA summer emergency rating of the Brown North-Brown Tap #2 138 kV line section	Brown North-Brown Tap #1 138 kV Line	Brown #3
June 2009	2.9	Increase the terminal and conductor limits of LGEE's Delvinta-Hyden Tap 161 kV line section to at least 765A (213 MVA) summer emergency and 1005A (280 MVA) winter emergency	Overload of the 190 MVA summer emergency rating and 218 MVA winter emergency rating of the Delvinta-Hyden Tap 161 kV line section	J.K. Smith-North Clark 345 kV Line or Tyner-Pittsburg-London 161 kV Line	Cooper #2
June 2009	2.10	Increase the terminal limits of LGEE's Clark County-Sylvania 69 kV line section to at least 1140A (136 MVA) summer emergency	Overload of the 124 MVA summer emergency rating of the Clark County-Sylvania 69 kV line section	Avon-Boonesboro North-Dale 138 kV Line	Brown #3
June 2009	2.11	Increase the terminal limits of LGEE's Hopewell-Sweet Hollow 69 kV line to at least 630A (75 MVA) summer emergency and 745A (89 MVA) winter emergency	Overload of the 72 MVA summer and winter emergency ratings of LGEE's Hopewell-Sweet Hollow 69 kV line section	Pittsburg-London 69 kV Line	Base
June 2009	2.12	Increase the limits of AEP's Hazard 161-138 kV transformer to at least 175/203 MVA summer normal/emergency	Overload of the 174 MVA summer normal rating and the 202 MVA summer emergency rating of AEP's Hazard 161-138 kV transformer	Normal Conditions or an outage of Clinch River-Dorton 138 kV	Base

Table 4-6 Alternative 2 – Project Descriptions and Reasons for Need					
Install Date	**Project Ref #**	**Project Description**	**Reason for Need**	**Critical Contingency**	**Unit Outage**
November 2009	2.13	Increase the limits of the North London 69 kV EKPC-LGEE interconnection to at least 815A (97 MVA) winter emergency	Overload of the 93 MVA winter emergency rating of the North London EKPC-LGEE 69 kV interconnection	Pittsburg 161-69 kV Transformer	Brown #3
November 2009	2.14	Increase the limits of the LGEE's Fawkes Tap-Fawkes LGEE 138 kV line to at least 1645A (393 MVA) winter emergency	Overload of the 283 MVA winter emergency rating of the Fawkes Tap-Fawkes LGEE 138 kV line	Fawkes EKPC-Fawkes LGEE 138 kV Line	Brown #3
November 2009	2.15	Increase the terminal limits at Fawkes LGEE for the Fawkes EKPC-Fawkes LGEE 138 kV interconnection to at least 1655A (396 MVA) winter emergency	Overload of the 370 MVA winter emergency rating of the Fawkes EKPC-Fawkes LGEE 138 kV interconnection	Fawkes Tap-Fawkes LGEE 138 kV Line	Brown #3
November 2009	2.16	Replace the 1200A switch at Fawkes EKPC for the Fawkes EKPC-Fawkes LGEE 138 kV interconnection with a 2000A switch	Overload of the 373 MVA winter emergency rating of the 1200A switch at Fawkes EKPC associated with the Fawkes EKPC-Fawkes LGEE 138 kV interconnection	Fawkes Tap-Fawkes LGEE 138 kV Line	Brown #3
November 2009	2.17	Replace the 600A high-side and 1200A low-side terminal equipment at Powell County associated with the Powell County 138-69 kV transformer	Overload of the 143 MVA winter emergency rating of the terminal equipment at Powell County associated with the Powell County 138-69 kV transformer	Dale 138-69 kV Transformer	Dale #3
November 2009	2.18	Increase the limits of AEP's Leslie 161-69 kV transformer to at least 128 MVA winter emergency	Overload of the 120 MVA winter emergency rating of AEP's Leslie 161-69 kV transformer	Wooten-Hazard 161 kV Line	Base

Table 4-6 Alternative 2 – Project Descriptions and Reasons for Need					
Install Date	**Project Ref #**	**Project Description**	**Reason for Need**	**Critical Contingency**	**Unit Outage**
November 2009	2.19	Increase the limits of AEP's Leslie-Hazard 69 kV line to at least 520A (62 MVA) winter emergency	Overload of the 59 MVA winter emergency rating of AEP's Leslie-Hazard 69 kV line	Wooten-Hazard 161 kV Line	Base
November 2009	2.20	Replace the Dale 138-69 kV, 82.5 MVA transformer with a 100 MVA transformer	Overload of the Dale 138-69 kV, 82.5 MVA transformer.	JK Smith-Powell County 138 kV Line	Dale #3
November 2009	2.21	Increase the terminal limits of AEP's Morehead-Hayward 69 kV line to at least 475A (57 MVA) winter emergency	Overload of the 48 MVA winter emergency rating of AEP's Morehead-Hayward 69 kV line	Rowan County-Skaggs 138 kV Line	Base

Projects 2.1 through 2.3 in Table 4-6 are the projects necessary to establish a 345 kV line from J.K. Smith to the Tyner Substation and a connection to the existing Tyner 161 kV bus. Project 2.4 is needed to restrict the flow into LGEE's 69 kV system in the Boonesboro North area that would be caused by the proposed generators. Project 2.5 specifies a required increase of the summer and winter ratings identified in the power flow models for the Hyden Tap-Hyden 161 kV interconnection between LGEE and AEP. Project 2.6 is a required replacement of the existing Tyner 161-69 kV transformer with a larger unit due to increased power flows into the Tyner Substation with this Alternative. Project 2.7 is a required reconductor of an LGEE 69 kV line in the vicinity of the Tyner Substation, again due to the increased power flows caused by the J.K. Smith-Tyner 345 kV line addition. Project 2.8 is an upgrade of an LGEE 138 kV facility in the vicinity of the Brown Power Plant. Project 2.9 is an upgrade of an LGEE 161 kV facility in the Delvinta area. Project 2.10 is an upgrade of an LGEE 69 kV facility in the Clark County area. Project 2.11 is an upgrade of an LGEE 69 kV line in the area near Tyner. Projects 2.12, 2.18, and 2.19 are upgrades identified on the AEP transmission system in the Hyden/Hazard area. Project 2.13 is an upgrade of a recently energized new 69 kV interconnection between EKPC and LGEE in the area near Tyner. Projects 2.14 and 2.15 are upgrades of LGEE 138 kV facilities in the area near Fawkes. Project 2.16 is an upgrade of an EKPC 138 kV facility in the Fawkes area. Project 2.17 is a terminal upgrade of the Powell County 138-69 kV transformer to accommodate increased power flows from the 138 kV bus to the 69 kV bus. Project 2.20 specifies a required transformer replacement at EKPC's Dale Station to accommodate increased power flows from the 138 kV bus to the 69 kV bus. Finally Project 2.21 is an upgrade of an AEP 69 kV facility in the Morehead area.

Table 4-6 indicates that this Alternative results in the need for one major project that includes EKPC's construction of the 345 kV line from J.K. Smith to Tyner, addition of a

345-161 kV transformer and associated terminals at Tyner, and a 345 kV terminal addition at J.K. Smith. The other projects identified in Table 4-6 indicate that the addition of the J.K. Smith-Tyner 345 kV line creates several overload issues on the 69 kV system at Tyner and in the surrounding area. Also, loadings are increased on LGEE's 161 kV line section from Delvinta to Hyden Tap, and on the AEP transmission system from Hyden Tap to Hazard, resulting in several overloads in this area. As with Alternative 1, this plan also requires the replacement of the 138-69 kV transformer at Dale due to the increased power flows caused by the proposed generators. The remaining upgrades needed for Alternative 2 are expected to be relatively minor projects.

The planning cost estimates for this Alternative are listed by project in Table 4-7. Costs are provided in 2006 dollars, install year dollars, and present worth dollars.

Table 4-7 Estimated Costs for Alternative 2				
Install Date	**Project Description**	**Planning Estimate (2006$)**	**Inflated Cost (Install Year $)**	**Present Worth (2006$)**
June 2009	Construct 43.5 miles of 345 kV line from JK Smith to Tyner using bundled 954 MCM ACSR conductor	51,155,000	57,630,000	69,917,000
June 2009	Add 345 kV Terminal Facilities at JK Smith CFB Substation for the Tyner line	1,080,000	1,217,000	1,476,000
June 2009	Install a 345-161 kV, 450 MVA transformer at Tyner	4,300,000	4,844,000	5,877,000
June 2009	Install a 138 kV, 5% series reactor at Dale in the Dale-Boonesboro North 138 kV line	645,000	727,000	882,000
June 2009	Ensure that the Hyden Tap-Wooten 161 kV LGEE-AEP interconnection has minimum ratings of 194/194 MVA summer and 252/252 MVA winter	100,000	110,000	145,000
June 2009	Replace the Tyner 161-69 kV, 65 MVA transformer with a 93 MVA transformer	915,000	1,031,000	1,251,000
June 2009	Reconductor LGEE's Pittsburg-East Bernstadt 69 kV line (2.1 miles) using 397 MCM ACSR conductor	170,000	192,000	219,000
June 2009	Increase the terminal limits at LGEE's Brown North associated with the Brown North-Brown Plant-Brown CT 138 kV circuit #2 to at least 1855A (443 MVA) summer emergency	10,000	11,000	13,000
June 2009	Increase the terminal and conductor limits of LGEE's Delvinta-Hyden Tap 161 kV line section to at least 765A (213 MVA) summer emergency and 1005A (280 MVA) winter emergency	645,000	727,000	832,000
June 2009	Increase the terminal limits of LGEE's Clark County-Sylvania 69 kV line section to at least 1140A (136 MVA) summer emergency	20,000	23,000	26,000
June 2009	Increase the terminal limits of LGEE's Hopewell-Sweet Hollow 69 kV line to at least 630A (75 MVA) summer emergency and 745A (89 MVA) winter emergency	85,000	96,000	110,000

Table 4-7 Estimated Costs for Alternative 2				
Install Date	**Project Description**	**Planning Estimate (2006$)**	**Inflated Cost (Install Year $)**	**Present Worth (2006$)**
June 2009	Increase the limits of AEP's Hazard 161-138 kV transformer to at least 175/203 MVA summer normal/emergency	2,155,000	2,428,000	2,781,000
November 2009	Increase the limits of the North London 69 kV EKPC-LGEE interconnection to at least 815A (97 MVA) winter emergency	20,000	23,000	26,000
November 2009	Increase the limits of the LGEE's Fawkes Tap-Fawkes LGEE 138 kV line to at least 1645A (393 MVA) winter emergency	225,000	253,000	290,000
November 2009	Increase the terminal limits at Fawkes LGEE for the Fawkes EKPC-Fawkes LGEE 138 kV interconnection to at least 1655A (396 MVA) winter emergency	200,000	225,000	258,000
November 2009	Replace the 1200A switch at Fawkes EKPC for the Fawkes EKPC-Fawkes LGEE 138 kV interconnection with a 2000A switch	30,000	34,000	39,000
November 2009	Replace the 600A high-side and 1200A low-side terminal equipment at Powell County associated with the Powell County 138-69 kV transformer	110,000	124,000	142,000
November 2009	Increase the limits of AEP's Leslie 161-69 kV transformer to at least 128 MVA winter emergency	1,080,000	1,217,000	1,394,000
November 2009	Increase the limits of AEP's Leslie-Hazard 69 kV line to at least 520A (62 MVA) winter emergency	900,000	1,014,000	1,162,000
November 2009	Replace the Dale 138-69 kV, 82.5 MVA transformer with a 100 MVA transformer	920,000	1,036,000	1,187,000
November 2009	Increase the terminal limits of AEP's Morehead-Hayward 69 kV line to at least 475A (57 MVA) winter emergency	110,000	124,000	142,000
	Total	$64,875,000	$73,086,000	$88,169,000

Alternative 3: J.K. Smith-Tyner 345 kV Line; J.K. Smith-Spencer Road 138 kV Line

This Alternative specifies the construction of a 138 kV line from the J.K. Smith Substation to LGEE's Spencer Road Substation, as well as the 345 kV line from J.K. Smith to Tyner and the addition of a 345-161 kV autotransformer at Tyner. Several other transmission system modifications are included in this Alternative, as shown in Table 4-8.

Table 4-8 Alternative 3 – Project Descriptions and Reasons for Need					
Install Date	**Project Ref #**	**Project Description**	**Reason for Need**	**Critical Contingency**	**Unit Outage**
June 2009	3.1	Construct 43.5 miles of 345 kV line from JK Smith to Tyner using bundled 954 MCM ACSR conductor	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	3.2	Add 345 kV Terminal Facilities at JK Smith CFB Substation for the Tyner line	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	3.3	Install a 345-161 kV, 450 MVA transformer at Tyner	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	3.4	Replace the Tyner 161-69 kV, 65 MVA transformer with a 93 MVA transformer	Overload of the Tyner 161-69 kV, 65 MVA transformer	Tyner-Pittsburg-London 161 kV Line	Cooper #2
June 2009	3.5	Ensure that the Hyden Tap-Wooten 161 kV LGEE-AEP interconnection has minimum ratings of 221/221 MVA summer and 260/260 MVA winter	Overload of the 190 MVA summer emergency rating and the 223 MVA winter emergency rating of the Hyden Tap-Wooten 161 kV LGEE-AEP interconnection	Pineville TVA-Stinnett 161 kV Line	Base
June 2009	3.6	Reconductor LGEE's Pittsburg-East Bernstadt 69 kV line (2.1 miles) using 397 MCM ACSR conductor	Overload of the 266 MCM ACSR conductor in the Pittsburg-East Bernstadt 69 kV line	Pittsburg 161-69 kV Transformer	Cooper #2
June 2009	3.7	Increase the terminal limits at LGEE's Brown North associated with the Brown North-Brown Plant-Brown CT 138 kV circuit #2 to at least 1790A (428 MVA) summer emergency	Overload of the 426 MVA summer emergency rating of the Brown North-Brown Tap #2 138 kV line section	Brown North-Brown Tap #1 138 kV Line	Brown #3

Table 4-8 Alternative 3 – Project Descriptions and Reasons for Need					
Install Date	**Project Ref #**	**Project Description**	**Reason for Need**	**Critical Contingency**	**Unit Outage**
June 2009	3.8	Increase the terminal limits of LGEE's Delvinta-Hyden Tap 161 kV line section to at least 730A (204 MVA) summer emergency and 980A (273 MVA) winter emergency	Overload of the 190 MVA summer emergency rating and 218 MVA winter emergency rating of the Delvinta-Hyden Tap 161 kV line section	Tyner-Pittsburg-London 161 kV Line	Cooper #2
June 2009	3.9	Construct 17.9 miles of 138 kV line from J.K. Smith to LGEE's Spencer Road using 954 MCM ACSR conductor	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	3.10	Add 138 kV Terminal Facilities at J.K. Smith CT Substation for the Spencer Road Line	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	3.11	Add 138 kV Terminal Facilities at LGEE's Spencer Road Substation for the J.K. Smith Line	Numerous Overloads (See Tables 3-1, 3-2, C-1, & C-2)	Numerous Contingencies (See Tables 3-1, 3-2, C-1, & C-2)	
June 2009	3.12	Replace LGEE's Clark County 138-69 kV, 93 MVA transformer with a 150 MVA transformer	Overload of LGEE's Clark County 138-69 kV, 93 MVA transformer	Avon-Boonesboro North-Dale 138 kV Line	Brown #3
June 2009	3.13	Reconductor LGEE's Clark County-Sylvania-Parker Seal 69 kV line (0.8 miles) using 1272 MCM ACSR conductor	Overload of the 795 MCM ACSR conductor in the Clark County-Sylvania-Parker Seal 69 kV line section	Avon-Boonesboro North-Dale 138 kV Line	Brown #3
June 2009	3.14	Increase the terminal limits of LGEE's Clark County-Sylvania 69 kV line section to at least 1200/1505A (143/180 MVA) summer normal/emergency	Overload of the 96 MVA summer normal rating and the 124 MVA summer emergency rating of the Clark County-Sylvania 69 kV line section	Normal Conditions or Avon-Boonesboro North-Dale 138 kV Line	Brown #3

Table 4-8 Alternative 3 – Project Descriptions and Reasons for Need					
Install Date	**Project Ref #**	**Project Description**	**Reason for Need**	**Critical Contingency**	**Unit Outage**
June 2009	3.15	Increase the terminal limits of LGEE's Hopewell-Sweet Hollow 69 kV line to at least 615A (73 MVA) summer emergency and 735A (88 MVA) winter emergency	Overload of the 72 MVA summer and winter emergency ratings of LGEE's Hopewell-Sweet Hollow 69 kV line section	Pittsburg-London 69 kV Line	Base
June 2009	3.16	Replace LGEE's Spencer Road 138-69 kV, 56 MVA transformer with a 93 MVA transformer (use the 93 MVA transformer removed from Clark County)	Overload of the Spencer Road 138-69 kV, 56 MVA transformer	Spencer Road 138-69 kV, 33 MVA Transformer	Base
June 2009	3.17	Replace LGEE's Spencer Road 138-69 kV, 33 MVA transformer with a 90 MVA transformer	Overload of the Spencer Road 138-69 kV, 33 MVA transformer	Spencer Road 138-69 kV, 56 MVA Transformer	Base
June 2009	3.18	Reconductor LGEE's Spencer Road-AO Smith Tap-Camargo 69 kV line (2.8 miles) using 556 MCM ACSR conductor	Overload of the 266 MCM ACSR conductor in the Spencer Road-AO Smith Tap-Camargo 69 kV line section	Clark County 138-69 kV Transformer	Base
November 2009	3.19	Increase the limits of AEP's Leslie 161-69 kV transformer to at least 128 MVA winter emergency	Overload of the 120 MVA winter emergency rating of AEP's Leslie 161-69 kV transformer	Wooten-Hazard 161 kV Line	Base
November 2009	3.20	Increase the limits of AEP's Leslie-Hazard 69 kV line to at least 520A (62 MVA) winter emergency	Overload of the 59 MVA winter emergency rating of AEP's Leslie-Hazard 69 kV line	Wooten-Hazard 161 kV Line	Base
November 2009	3.21	Increase the terminal limits of AEP's Morehead-Hayward 69 kV line to at least 475A (57 MVA) winter emergency	Overload of the 48 MVA winter emergency rating of AEP's Morehead-Hayward 69 kV line	Rowan County-Skaggs 138 kV Line	Base

Projects 3.1 through 3.3 in Table 4-8 are the projects necessary to establish a 345 kV line from J.K. Smith to the Tyner Substation and a connection to the existing Tyner 161 kV bus. Project 3.4 is a required replacement of the existing Tyner 161-69 kV transformer with a larger unit due to increased power flows into the Tyner Substation with this

Alternative. Project 3.5 specifies a required increase of the summer and winter ratings specified in the power flow models for the Hyden Tap-Hyden 161 kV interconnection between LGEE and AEP. Project 3.6 is a required reconductor of an LGEE 69 kV line in the vicinity of the Tyner Substation, again due to the increased power flows caused by the J.K. Smith-Tyner 345 kV line addition. Project 3.7 is an upgrade of an LGEE 138 kV facility in the vicinity of the Brown Power Plant. Project 3.8 is an upgrade of an LGEE 161 kV facility in the Delvinta area. Projects 3.9 through 3.11 specify the addition of a 138 kV line between J.K. Smith and Spencer Road as an additional outlet for the J.K. Smith generation. Projects 3.12 through 3.14 are upgrades required on the LGEE system in the vicinity of its Clark County Substation as a result of the addition of the J.K. Smith-Spencer Road 138 kV line. Project 3.15 is an upgrade of an LGEE 69 kV line in the area near Tyner. Projects 3.16 through 3.18 are upgrades required on the LGEE system in the vicinity of the Spencer Road Substation attributable to the addition of the J.K. Smith-Spencer Road 138 kV line. Projects 3.19, and 3.20 are upgrades identified on the AEP transmission system in the Hyden/Hazard area. Finally, Project 3.21 is an upgrade of an AEP 69 kV facility in the Morehead area.

Table 4-8 indicates that this Alternative results in the need for two major projects -- EKPC's construction of the 345 kV line from J.K. Smith to Tyner and associated terminal facilities, and the construction of the J.K. Smith-Spencer Road 138 kV line. The other projects identified in Table 4-8 indicate that the addition of these two lines creates several overload issues on the 69 kV systems in the Tyner, Clark County, and Spencer Road areas. Also, loadings are increased on LGEE's 161 kV line section from Delvinta to Hyden Tap, and on the AEP transmission system from Hyden Tap to Hazard, resulting in several overloads in this area. The remaining upgrades needed for Alternative 3 are expected to be relatively minor projects.

The planning cost estimates for this Alternative are listed by project in Table 4-9. Costs are provided in 2006 dollars, install year dollars, and present worth dollars.

Table 4-9 Estimated Costs for Alternative 3				
Install Date	**Project Description**	**Planning Estimate (2006$)**	**Inflated Cost (Install Year $)**	**Present Worth (2006$)**
June 2009	Construct 43.5 miles of 345 kV line from JK Smith to Tyner using bundled 954 MCM ACSR conductor	51,155,000	57,630,000	69,917,000
June 2009	Add 345 kV Terminal Facilities at JK Smith CFB Substation for the Tyner line	1,080,000	1,217,000	1,476,000
June 2009	Install a 345-161 kV, 450 MVA transformer at Tyner	4,300,000	4,844,000	5,877,000
June 2009	Replace the Tyner 161-69 kV, 65 MVA transformer with a 93 MVA transformer	915,000	1,031,000	1,251,000
June 2009	Ensure that the Hyden Tap-Wooten 161 kV LGEE-AEP interconnection has minimum ratings of 221/221 MVA summer and 260/260 MVA winter	100,000	110,000	145,000
June 2009	Reconductor LGEE's Pittsburg-East Bernstadt 69 kV line (2.1 miles) using 397 MCM ACSR conductor	170,000	192,000	219,000
June 2009	Increase the terminal limits at LGEE's Brown North associated with the Brown North-Brown Plant-Brown CT 138 kV circuit #2 to at least 1790A (428 MVA) summer emergency	10,000	11,000	13,000
June 2009	Increase the terminal limits of LGEE's Delvinta-Hyden Tap 161 kV line section to at least 730A (204 MVA) summer emergency and 980A (273 MVA) winter emergency	20,000	23,000	26,000
June 2009	Construct 17.9 miles of 138 kV line from J.K. Smith to LGEE's Spencer Road using 954 MCM ACSR conductor	6,370,000	7,176,000	8,706,000
June 2009	Add 138 kV Terminal Facilities at J.K. Smith CT Substation for the Spencer Road Line	270,000	304,000	369,000
June 2009	Add 138 kV Terminal Facilities at LGEE's Spencer Road Substation for the J.K. Smith Line	270,000	304,000	348,000
June 2009	Replace LGEE's Clark County 138-69 kV, 93 MVA transformer with a 150 MVA transformer	1,120,000	1,262,000	1,446,000

Table 4-9 Estimated Costs for Alternative 3				
Install Date	**Project Description**	**Planning Estimate (2006$)**	**Inflated Cost (Install Year $)**	**Present Worth (2006$)**
June 2009	Reconductor LGEE's Clark County-Sylvania-Parker Seal 69 kV line (0.8 miles) using 1272 MCM ACSR conductor	150,000	169,000	194,000
June 2009	Increase the terminal limits of LGEE's Clark County-Sylvania 69 kV line section to at least 1200/1505A (143/180 MVA) summer normal/emergency	110,000	124,000	142,000
June 2009	Increase the terminal limits of LGEE's Hopewell-Sweet Hollow 69 kV line to at least 615A (73 MVA) summer emergency and 735A (88 MVA) winter emergency	85,000	96,000	110,000
June 2009	Replace LGEE's Spencer Road 138-69 kV, 56 MVA transformer with a 93 MVA transformer (use the 93 MVA transformer removed from Clark County)	265,000	299,000	342,000
June 2009	Replace LGEE's Spencer Road 138-69 kV, 33 MVA transformer with a 90 MVA transformer	905,000	1,020,000	1,168,000
June 2009	Reconductor LGEE's Spencer Road-AO Smith Tap-Camargo 69 kV line (2.8 miles) using 556 MCM ACSR conductor	400,000	451,000	516,000
November 2009	Increase the limits of AEP's Leslie 161-69 kV transformer to at least 128 MVA winter emergency	1,080,000	1,217,000	1,394,000
November 2009	Increase the limits of AEP's Leslie-Hazard 69 kV line to at least 520A (62 MVA) winter emergency	900,000	1,014,000	1,162,000
November 2009	Increase the terminal limits of AEP's Morehead-Hayward 69 kV line to at least 475A (57 MVA) winter emergency	110,000	124,000	142,000
	Total	$69,785,000	$78,618,000	$94,963,000

Section 5: Comparison of the Developed Alternatives

The following issues were considered in comparing the three Alternatives, and are discussed in this section:

- Power Flow Impacts
- Transmission System Losses
- Transient Stability Impacts
- Short Circuit Impacts
- Physical Issues
- System Reliability
- Future Expansion
- Local Area Support
- Costs
- Performance for Double Contingencies

5.1 Power Flow Impacts

Details of the required system additions and modifications for each of the three Alternatives that were developed were provided in subsection 4.3.3. As shown, Alternative 1 requires a substantially smaller number of projects than does either Alternative 2 or Alternative 3. This indicates that Alternative 1 reduces the power flow impacts on the 161 kV, 138 kV, and 69 kV facilities in the region. The large number of upgrades required in specific areas for either Alternative 2 or Alternative 3 indicates that transmission bottlenecks remain with these two Alternatives that must be mitigated.

To further compare the impacts of the three Alternatives, two other comparisons were performed. First, a comparison of normal-system flows on a number of transmission facilities in the region was developed. Next, a comparison of system flows with an incremental 4000 MW north-south transfer was developed.

5.1.1 Impact on Normal-System Flows on Transmission Facilities in the Region

Table 5-1 lists the flows on various facilities in the region with the proposed generation additions at J.K. Smith for both 2010 Summer and 2010-11 Winter peak conditions. The flows are provided for each of the three developed Alternatives, as well as for the scenario without any added transmission or the proposed J.K. Smith generator additions.

Table 5-1
MVA Flows on Transmission Facilities in the Region with the Proposed Generation Additions at J.K. Smith for the Developed Transmission Alternatives

	2010 Summer Peak				2010-11 Winter Peak			
Transmission Facility	No Added Transmis sion*	Alt. 1	Alt. 2	Alt. 3	No Added Transmis sion*	Alt. 1	Alt. 2	Alt. 3
Pineville-Pocket North 500 kV	(37)	73	(15)	(15)	(29)	129	26	25
Pocket North-Phipps Bend 500 kV	(212)	(115)	(169)	(173)	(239)	(88)	(179)	(183)
Pocket North 500-161 kV	179	167	160	161	223	207	198	199
Ghent-West Lexington 345 kV	468	431	452	453	625	561	602	603
West Lexington-Brown 345 kV	280	218	250	254	440	322	399	404
Smith-Hardin County 345 kV	174	171	173	173	236	229	235	235
Hardin County-Brown 345 kV	(117)	(134)	(120)	(121)	(37)	(60)	(41)	(41)
Brown-Alcalde 345 kV	382	312	331	336	498	413	431	435
Alcalde-Pineville 345 kV	256	154	249	250	327	198	320	320
Brown-West Garrard 345 kV	0	(88)	0	0	0	(167)	0	0
West Garrard-Pineville 345 kV	0	307	0	0	0	414	0	0
Spurlock-North Clark 345 kV	35	197	144	185	127	383	284	329
North Clark-Avon 345 kV	377	315	352	305	472	374	421	378
J.K. Smith-North Clark 345 kV	347	112	201	115	343	(29)	136	49
J.K. Smith-West Garrard 345 kV	0	393	0	0	0	589	0	0
J.K. Smith-Tyner 345 kV	0	0	382	372	0	0	509	498
Alcalde 345-161 kV	123	156	80	84	164	211	107	110
Pineville 345-161 kV	291	391	258	260	345	478	301	303
Brown 345-138 kV	(233)	(167)	(217)	(217)	(116)	57	(94)	(94)
Hardin County 345-138 kV	291	303	292	292	260	279	262	262
West Lexington 345-138 kV	233	271	249	244	204	262	225	222
Delvinta-Hyden Tap 161 kV	128	102	185	178	173	138	250	243
Hyden Tap-Wooten 161 kV	144	132	182	177	168	150	218	213
Wooten-Leslie 161 kV	(8)	(29)	8	6	6	(24)	24	22
Wooten-Hazard 161 kV	151	159	176	172	162	174	195	191
Pineville-Stinnett 161 kV	80	104	69	70	85	117	71	72
Wolf Creek-Russell Co. Jct. 161 kV	107	99	91	92	149	136	126	127
Tyner-Pittsburg 161 kV	67	46	179	172	102	72	253	246
Pittsburg-London 161 kV	28	(22)	104	98	45	(27)	155	149
Alcalde-Elihu 161 kV	28	62	(7)	(5)	53	104	14	16
Lake Reba Tap 161-138 kV	(159)	(136)	(82)	(80)	(209)	(177)	(107)	(106)
Hazard 161-138 kV	151	160	176	172	163	175	195	192
Leslie 161-69 kV	48	50	51	50	66	69	69	69
Tyner 161-69 kV	26	26	62	61	33	34	83	82
Pittsburg 161-69 kV	53	48	76	75	68	62	99	98

Table 5-1 MVA Flows on Transmission Facilities in the Region with the Proposed Generation Additions at J.K. Smith for the Developed Transmission Alternatives								
	2010 Summer Peak				2010-11 Winter Peak			
Transmission Facility	No Added Transmission*	Alt. 1	Alt. 2	Alt. 3	No Added Transmission*	Alt. 1	Alt. 2	Alt. 3
J.K. Smith-Dale 138 kV	225	180	164	150	310	233	233	210
J.K. Smith-Fawkes 138 kV	215	177	172	144	289	230	233	201
J.K. Smith-Powell County 138 kV	232	201	162	150	298	251	204	192
J.K. Smith-Union City 138 kV	283	240	217	190	372	305	284	254
J.K. Smith-Spencer Road 138 kV	0	0	0	181	0	0	0	194
Avon-Boonesboro North 138 kV	(25)	(25)	24	(41)	29	41	39	(33)
Dale-Boonesboro North 138 kV	147	134	96	126	121	101	82	107
Fawkes-Clark County 138 kV	132	125	142	67	109	99	118	39
Brown North-Brown Tap 138 kV #1	(184)	(164)	(190)	(183)	(35)	33	(36)	(33)
Brown North-Brown Tap 138 kV #2	(184)	(164)	(190)	(183)	(35)	33	(36)	(33)
Clinch River-Dorton 138 kV	121	121	115	115	121	122	114	114
Fawkes EKPC-Fawkes LGEE 138 kV	215	174	199	141	296	230	266	206
Fawkes EKPC-Fawkes Tap 138 kV	63	57	48	42	80	70	57	51
Fawkes Tap-Fawkes LGEE 138 kV	57	39	63	37	88	59	94	67
Rowan County-Skaggs 138 kV	74	71	69	80	106	101	99	111
Boonesboro North 138-69 kV	128	122	112	91	124	113	108	85
Dale 138-69 kV	74	73	74	70	97	91	92	87
Powell County 138-69 kV	89	82	88	82	103	93	102	96
Clark County 138-69 kV	48	47	56	82	40	39	48	74
Spencer Road 138-69 kV #1	39	39	40	52	33	33	34	49
Spencer Road 138-69 kV #2	31	31	32	41	26	26	27	39
Boonesboro North-Winchester Water 69 kV	114	108	99	78	110	99	94	71
Lake Reba-Waco 69 kV	34	30	18	18	47	41	25	25
Dix Dam-Buena Vista 69 kV	55	53	45	46	67	65	54	54
Boyle County-Vaksdahl 69 kV	43	43	38	38	48	47	41	41
Pittsburg-North London 69 kV	(16)	(13)	(21)	(21)	(12)	(9)	(20)	(20)
Clark County-Sylvania 69 kV	32	32	42	80	27	27	37	77
Laurel County-Hopewell 69 kV	42	38	54	53	44	38	59	59
Pittsburg-London 69 kV	65	56	94	92	78	65	116	115

Table 5-1 MVA Flows on Transmission Facilities in the Region with the Proposed Generation Additions at J.K. Smith for the Developed Transmission Alternatives								
	2010 Summer Peak				2010-11 Winter Peak			
Transmission Facility	No Added Transmission*	Alt. 1	Alt. 2	Alt. 3	No Added Transmission*	Alt. 1	Alt. 2	Alt. 3
North London EKPC-North London LGEE 69 kV	23	24	30	30	15	17	33	32
Leslie-Hazard 69 kV	(8)	8	8	8	19	21	21	21
Morehead-Hayward 69 kV	28	26	27	35	35	31	33	41
Spencer Road-AO Smith Tap 69 kV	24	25	26	37	15	17	18	34

*Does not include the proposed generators at J.K. Smith

Table 5-1 shows that the power flows are similar on many facilities when comparing Alternative 2 with Alternative 3. The primary differences are in the Boonesboro North/Fawkes/Clark County/Spencer Road areas due the addition of the J.K. Smith-Spencer Road 138 kV line in Alternative 3 versus the addition of a 5% series reactor in the Dale-Boonesboro North 138 kV line in Alternative 2.

A comparison of the power flows on facilities for Alternative 1 versus Alternatives 2 and 3 shows that the flows are higher on the 345 kV and 500 kV system south of the Brown area with Alternative 1. Alternatives 2 and 3 result in increased power flows in the Delvinta/Tyner/Pittsburg area, since the J.K. Smith-Tyner 345 kV line terminates into the Tyner 161 kV bus through a 345-161 kV transformer. This is the primary reason significantly more upgrades are required with Alternatives 2 and 3. Therefore, Alternative 1 appears to provide some advantages compared to Alternatives 2 and 3, since the 345 and 500 kV bulk systems are utilized more for power transmission.

5.1.2 Impact on Transmission-System Flows with North-South Transfers

An incremental power transfer of 4000 MW from the region north of Kentucky to the region south of Kentucky was simulated through power flow analysis to determine the relative performance of the three developed Alternatives. Generation was increased in the region north of Kentucky as follows:

- A generation increase of 2000 MW in the Michigan Electric Coordinated Systems (MECS) control area
- A generation increase of 1000 MW in the First Energy (FE) control area
- A generation increase of 1000 MW in the northern MAIN area (which includes Commonwealth Edison and Illinois Power)

Generation was decreased in the region south of Kentucky as follows:

- A generation decrease of 2000 MW in the TVA control area

- A generation decrease of 2000 MW in the remainder of the SERC region (which includes Southern Company)

These generation changes were simulated by scaling generation up proportionally in the sending areas and scaling generation down proportionally in the receiving areas.

A contingency analysis was performed with a 4000 MW incremental transfer for 2010 Summer and 2010-11 Winter peak conditions. Tables 5-2 and 5-3 list the flows on the potentially overloaded facilities for 2010 Summer and 2010-11 Winter, respectively. The flows are provided for each of the three developed Alternatives with the proposed generation additions at J.K. Smith, as well as for the scenario without the proposed generators and without any added transmission.

Table 5-2
2010 Summer Normal and/or Contingency MVA Flows on Potentially Limiting Transmission Facilities with an Incremental 4000 MW North-South Transfer with the Proposed Generation Additions at J.K. Smith for the Developed Transmission Alternatives

Transmission Facility	Facility Rating	No Added Transmission#	Alt. 1	Alt. 2	Alt. 3
Tyner 345-138 kV	434	*	*	445.2	436.4
J.K. Smith-Union City 138 kV	311	*	329.3	326	*
West Frankfort-Frankfort East 138 kV	303	313.5	*	290.3	289.7
Union City-Lake Reba Tap 138 kV	302	*	312.9	310	*
Fawkes-Fawkes Tap 138 kV	287	*	*	289	*
Fawkes-Fawkes LGEE 138 kV	287	*	*	329.5	*
Spurlock-Maysville Jct. 138 kV	280	290.6	271.3	266.3	*
Maysville Jct.-Plumville 138 kV	280	281.3	*	*	*
Ghent-Owen County Tap 138 kV	277	287.5	266.8	269	268.2
J.K. Smith-Union City 138 kV	251	*	255.6	*	*
Union City-Lake Reba Tap 138 kV	243	*	243.6	*	*
Blue Lick-Bullitt County 161 kV	235	274.9	257.5	261.5	261.5
Blue Lick-Bullitt County 161 kV	235	239.9	229.3	230.6	230.6
Dale-Three Forks Jct. 138 kV	222	234.6	233.4	239.7	*
Three Forks Jct.-Fawkes 138 kV	222	226.3	225.1	231.1	*
Fawkes Tap-Fawkes LGEE 138 kV	220	*	*	327.3	*
Mercer County-Lebanon 138 kV	220	231.4	225.8	236.7	237.7
Lake Reba Tap-West Irvine Tap 161 kV	211	200.6	211.1	*	*
Clifty Creek-Carrollton 138 kV	210	218.4	203	204.6	204
Hyden Tap-Wooten 161 kV	194	*	*	207.4	*
Delvinta-Hyden Tap 161 kV	190	*	*	258	250.7
Alcalde-Elihu 161 kV	190	248.9	266.7	216.8	219.7
Mercer County-Lebanon 138 kV	179	*	177.2	178.8	179.6
Fawkes LGEE-Clark County 138 kV	172	*	*	190.3	*
Delvinta-Hyden Tap 161 kV	167	*	*	222.2	216.1
Marion County 161-138 kV	167	184.3	171.3	176.8	177.7
Boonesboro North 138-69 kV	143	146.4	*	152.7	150.1
Stanley Parker 138-69 kV	143	143.5	140.6	140.8	140
Sylvania-Parker Seal 69 kV	138	*	*	*	140.3
Paddys Run 138-161 kV #1	131	137.9	130.5	131.1	131.3

Table 5-2
2010 Summer Normal and/or Contingency MVA Flows on Potentially Limiting Transmission Facilities with an Incremental 4000 MW North-South Transfer with the Proposed Generation Additions at J.K. Smith for the Developed Transmission Alternatives

Transmission Facility	Facility Rating	No Added Transmission#	Alt. 1	Alt. 2	Alt. 3
Paddys Run 138-161 kV #2	131	137.9	130.5	131.1	131.3
Pittsburg 161-69 kV	129	*	*	163.5	160.1
Boone County 138-69 kV	129	138.1	135.1	135.2	134.5
Clark County-Sylvania 69 kV	117	111.6	115	*	155.1
North London EKPC-LGEE 69 kV	86	*	*	86.7	85
Leitchfield 138-69 kV	86	89.8	85.1	85.7	85.7
Middletown-Mid Valley Simpsonville 69 kV	82	85.8	77.9	78.5	78.3
Marion County-Casey County 161 kV	78	108.6	88.3	84.4	85.4
Casey County-Liberty Junction 161 kV	78	83.8	*	*	*
Hopewell-Sweet Hollow 69 kV	75	*	*	88.9	87.8
North London EKPC-London EKPC 69 kV	69	*	*	71.6	69.2
Laurel Industrial Jct.-West London 69 kV	69	*	*	73.3	72.4
Dale-Newby #1 69 kV	69	*	68	70.9	69.8
Rodburn 138-69 kV	69	78.6	71	70.8	*
Goddard-Plummers Jct. 69 kV	69	73.2	69.5	69.3	*
Woosley-Boston KU 69 kV	69	73	74.2	73.4	73.6
Plumville-Murphysville 69 kV	69	72	69.6	71.3	70.3
Dale-Hunt #2 69 kV	69	66.6	69.2	*	*
Loudon Avenue-Haley 69 kV	67	69.1	*	*	*
Dale-Newby #1 69 kV	57	*	*	57.9	56.5
Carrollton-Metal&Thermit 69 kV	56	63.6	61	60.8	60.5
Waco-Rice Tap 69 kV	56	58.4	61.8	*	*
Shelby City Tap-Stanford 69 kV	54	59.7	57.7	*	*
Farmers 138-69 kV	48	53.1	53.8	54.6	54.7
Hitchins-Leon 69 kV	48	50.4	*	*	*
Simpsonville-Shelbyville 69 kV	46	55.2	49.9	50.4	50.3
Shelbyville-Shelbyville East 69 kV	44	50.7	45.5	45.6	45.2
Rodburn-Morehead East 69 kV	37	55.6	45.2	43.9	*
Springfield-North Springfield 69 kV	36	38.4	39.8	40.2	40.2
Morehead East-Morehead 69 kV	33	43.8	33.2	31.9	35.1
Woodlawn-Fredricksburg Jct. 69 kV	23	33.1	31.3	29.5	29.9
Fredricksburg Jct.-North Springfield 69 kV	23	29.5	27.7	25.8	26.3
North Springfield-South Springfield Jct. 69 kV	19	20	21.4	21.8	21.8

#Does not include the proposed generators at J.K. Smith
*MVA Flow is less than 95% of the facility rating

Table 5-3 2010-11 Winter Normal and/or Contingency MVA Flows on Potentially Limiting Transmission Facilities with an Incremental 4000 MW North-South Transfer with the Proposed Generation Additions at J.K. Smith for the Developed Transmission Alternatives					
Transmission Facility	Facility Rating	No Added Transmission#	Alt. 1	Alt. 2	Alt. 3
Avon 345-138 kV	662	681.9	*	*	*
Pineville 345-161 kV	558	*	654.8	*	*
Tyner 345-138 kV	536	*	*	570.1	561.5
Avon 345-138 kV	536	546.9	*	*	*
West Lexington 345-138 kV	478	550.9	495.7	500.8	499.7
J.K. Smith-Union City 138 kV	389	*	418.7	421.5	386.1
Union City-Lake Reba Tap 138 kV	371	*	393.4	394.2	361.8
Tyner-Pittsburg 161 kV	335	*	*	388.4	381.5
Blue Lick 345-161 kV	312	337.8	314.7	322.8	321.9
Blue Lick 345-161 kV	288	292.1	278.7	279.6	279.7
Fawkes-Fawkes LGEE 138 kV	287	309.3	338.8	429.1	348.1
Fawkes-Fawkes Tap 138 kV	287	307.2	334	362.8	304.3
J.K. Smith-Powell County 138 kV	287	307.1	328.6	333.6	318
Avon-Loudon Avenue 138 kV	287	300.1	*	298.1	299.7
Blue Lick-Bullitt County 161 kV	279	337.8	314.7	322.8	321.9
Blue Lick-Bullitt County 161 kV	279	292.1	278.7	279.6	279.7
Dale-Three Forks Jct. 138 kV	278	311.7	298.3	301.4	*
Three Forks Jct.-Fawkes 138 kV	278	297.6	284.5	287.6	*
Union City-Lake Reba Tap 138 kV	277	*	305.5	289.8	*
Frankfort East-Tyrone 138 kV	269	305.1	*	266.2	266.9
Fawkes Tap-Fawkes LGEE 138 kV	269	272.3	335.2	426.4	345.5
Alcalde-Elihu 161 kV	268	298.1	316.6	256.5	258.8
Lake Reba Tap 161-138 kV	260	263.5	266.6	*	*
Hyden Tap-Wooten 161 kV	252	*	*	262.9	257.5
Lake Reba Tap-West Irvine Tap 161 kV	237	263.5	266.6	244.9	242.5
Paddys Run-Summershade 161 kV	223	243	*	*	*
Powell County 161-138 kV	220	216.9	224.3	211.4	*
Delvinta-Hyden Tap 161 kV	218	*	208.3	332.8	326.1
West Irvine Tap-Delvinta 161 kV	218	246.2	248.8	229.4	227.6
Delvinta-Green Hall Jct. 161 kV	218	232.7	235	219.6	216.5
Beattyville-Delvinta 161 kV	218	216.4	223.6	135.2	134.5
Clifty Creek-Carrollton 138 kV	210	238	217.9	220.9	220.5
Haefling-American Avenue 138 kV	191	243.7	193	212.6	214
West Lexington-Pisgah 138 kV	191	214.8	*	187	188.5
Delvinta-Hyden Tap 161 kV	167	*	*	287.6	281.9
Marion County 161-138 kV	167	210.6	196	198.1	202
Lake Reba Tap-West Irvine Tap 161 kV	167	190.6	198.4	*	*
Virginia City 138-69 kV	150	150.5	*	*	*
Boone County 138-69 kV	147	152.8	151.4	151.7	151
Boonesboro North 138-69 kV	143	*	*	141.8	143.2
Pittsburg-London 69 kV	143	*	*	157.4	155.6
Pittsburg 161-69 kV	143	*	*	209.3	206.2
Goddard 138-69 kV	143	144.6	*	*	*
Dale 138-69 kV	136	148.4	155.9	153.8	144.8
Paddys Run 138-161 kV #1	131	195.3	184	185.8	186

Table 5-3
2010-11 Winter Normal and/or Contingency MVA Flows on Potentially Limiting Transmission Facilities with an Incremental 4000 MW North-South Transfer with the Proposed Generation Additions at J.K. Smith for the Developed Transmission Alternatives

Transmission Facility	Facility Rating	No Added Transmission#	Alt. 1	Alt. 2	Alt. 3
Paddys Run 138-161 kV #2	131	195.3	184	185.8	186
Fawkes-Richmond 69 kV	117	123.3	123.2	112.3	112.7
Skaggs 138-69 kV	111	106.8	105.3	103.8	114.5
Elihu-Ferguson South	109	*	114.9	*	*
West Berea-West Berea Jct. 69 kV	101	105.3	107.2	99.1	99
West Berea Jct.-Three Links Jct. 69 kV	101	105.3	104.7	100.4	100.2
North London EKPC-LGEE 69 kV	97	*	*	107.9	106.3
Middletown-Mid Valley Simpsonville 69 kV	93	122.1	110.6	112.2	112.1
Bonds Mill-Bonds Mill Junction 69 kV	93	111.2	107.1	108.1	108.3
Bardstown-Bardstown Industrial Tap 69 kV	93	96.6	96.1	94.2	94.5
Bullitt County-Beam Junction 69 kV	93	95.3	89.1	89.4	89.4
Thelma 138-69 kV	92	106.5	101	93.6	93.1
Middletown-Mid Valley Simpsonville 69 kV	90	97.4	88.4	89.1	89.1
Hopewell-Sweet Hollow 69 kV	88	*	*	103.8	102.7
North London EKPC-London EKPC 69 kV	87	*	*	89.9	87.8
Laurel Industrial Jct.-West London 69 kV	87	*	*	89.7	88.9
Liberty Jct.-Mt. Olive Jct. 69 kV	87	*	92.3	*	*
Davis-Nicholasville 69 kV	87	92.9	*	93	92.5
Dale-Newby #1 69 kV	87	86	87.8	92.3	90.8
Dale-Newby #1 69 kV	78	*	74.6	80.4	78.8
Waco-Rice Tap 69 kV	75	77.7	79.1	*	*
Shelbyville-Shelbyville South 69 kV	72	76.1	70	71	71.2
Tyrone-Florida Tile Tap #2 69 kV	72	75.8	74.7	72.7	73.8
Beattyville 161-69 kV	72	74.7	78.8	63.8	61.4
Toms Creek Tap-Bond 69 kV	72	73.1	*	*	*
Frankfort-Versailles West Tap 69 kV	70	74.3	*	*	*
Three Links Jct.-Brodhead 69 kV	68	*	*	70.3	70.1
Leon EKPC-AEP 69 kV	68	69.3	66.9	64.8	65.2
Simpsonville-Shelbyville 69 kV	60	80.6	73.2	74.2	74.1
London-Campground Jct. 69 kV	59	*	*	62.7	62.1
Shelbyville-Shelbyville East 69 kV	58	66.3	60.1	60.2	60.3
Rodburn-Morehead East 69 kV	53	53.9	*	*	*
Morehead-Hayward 69 kV	48	*	*	47.3	55.6
London-Campground Jct. 69 kV	48	*	*	49.1	48.4
Hitchins-Leon 69 kV	48	57.5	52	47.8	*
Springfield-North Springfield 69 kV	36	41.1	42.6	42.8	42.4

#Does not include the proposed generators at J.K. Smith
*MVA Flow is less than 95% of the facility rating

Tables 5-2 and 5-3 show that potential overloads are present for the existing system and for each of the alternatives considered. A count of the potential facilities loaded at 95% or greater indicates the following:

Alternative	2010 Summer Number of Overloaded Facilities	2010-11 Winter Number of Overloaded Facilities
Without Proposed Generators and Associated Transmission	42	58
Alternative 1	42	54
Alternative 2	51	67
Alternative 3	40	62

These statistics indicate that Alternatives 1 and 3 provide better system performance during periods of north-south transfers than does Alternative 3. Also, Alternative 1 is the only Alternative of the three considered that does not result in more overloaded facilities after the proposed generators are added to the system for both 2010 Summer and 2010-11 Winter.

Based on these results, Alternative 1 appears to have an advantage over Alternatives 2 and 3 in terms of impacts on transmission-system power flows during periods of significant north-south transfers.

5.2 Transmission System Losses

The transmission system losses for EKPC, LGEE, AEP, BREC, CIN, DP&L, and TVA were compared for 2010 Summer and 2010-11 Winter for the base system without any of the proposed generators and for the three developed transmission Alternatives. These losses were compared for both a peak case with all generation dispatched at J.K. Smith and for a shoulder peak case with all CT generation off-line at J.K. Smith. For the shoulder-peak case, both the EKPC and LGEE system loads were scaled to 80% of the peak loads. Additionally, any CT generation still required by EKPC at this load level was displaced by equal purchases from northern ECAR and southern SERC. Therefore, in the 80% load case, the only generation dispatched at J.K. Smith was the CFB unit. Table 5-3 shows the comparison of transmission-system losses.

Table 5-3
Comparison of Transmission System MW Losses for Base System without the Proposed J.K. Smith Generators and for the Three Transmission Alternatives Developed with the Proposed Generators

	Without Proposed Generators	With Proposed Generators		
Company	**Base System**	**Alternative 1**	**Alternative 2**	**Alternative 3**
MW Losses for 2010 Summer Peak Case				

Table 5-3 Comparison of Transmission System MW Losses for Base System without the Proposed J.K. Smith Generators and for the Three Transmission Alternatives Developed with the Proposed Generators				
	Without Proposed Generators	With Proposed Generators		
Company	**Base System**	**Alternative 1**	**Alternative 2**	**Alternative 3**
EKPC	123.3	130.9	130.2	126.0
LGEE	243.7	241.7	239.5	234.0
AEP	866.9	875.4	873.8	873.8
BREC	8.7	8.3	8.3	8.3
CIN	591.5	596.8	596.8	596.7
DPL	134.8	140.9	140.9	140.8
TVA	684.8	675.6	675.6	675.7
MW Losses for 2010 Summer 80% Load Case				
EKPC	96.5	95.6	93.0	92.2
LGEE	176.1	171.9	169.9	167.6
AEP	864.0	866.2	865.3	865.2
BREC	8.6	8.5	8.5	8.5
CIN	591.9	593.4	593.8	593.8
DPL	132.1	133.7	133.5	133.4
TVA	682.8	678.0	678.3	678.4
MW Losses for 2010-11 Winter Peak Case				
EKPC	173.0	176.8	177.1	171.7
LGEE	232.3	227.2	226.4	222.9
AEP	740.6	744.9	744.1	744.3
BREC	7.4	7.0	7.1	7.1
CIN	385.4	390.5	390.5	390.4
DPL	110.1	114.8	116.1	116.0
TVA	629.5	616.0	617.5	617.6
MW Losses for 2010-11 Winter 80% Load Case				
EKPC	125.6	125.6	119.6	119.3
LGEE	171.5	168.3	162.6	160.9
AEP	733.1	732.7	730.8	730.9
BREC	7.7	7.7	7.6	7.6
CIN	384.1	385.1	385.2	385.1
DPL	106.9	108.2	107.6	107.5
TVA	626.4	619.4	620.0	620.1

The conclusions drawn from Table 5-3 are as follows:

- Whichever transmission alternative is chosen will have no impact on the system losses for BREC and for CIN.
- The choice of transmission alternative has relatively small potential impacts on the system losses for AEP, DPL, and TVA.

- The biggest impacts by far are seen on the EKPC and LGEE systems.
- In all cases, the system losses for LGEE are lower with the proposed generators and with any of the three transmission alternatives implemented when compared to the case without any of the proposed generators and associated transmission.
- In all cases the largest reduction in LGEE system losses is accomplished with Alternative 3. Likewise, Alternative 1 provides the smallest reduction in LGEE system losses.
- For EKPC, the results are more varied. At peak load levels, the addition of the proposed generators and associated transmission results in increased losses. For the shoulder peak case however, the EKPC losses are either the same or lower with the proposed generators and associated transmission when compared to the scenario without any of the proposed generators and associated transmission. Of the three transmission Alternatives evaluated, Alternative 3 results in the lowest losses on the EKPC system.

The conclusion based on this loss analysis is that Alternative 3 has an advantage over the other two Alternatives with regard to impact on transmission system losses. Also, Alternative 2 has an advantage compared to Alternative 1.

5.3 Transient-Stability Impacts

Transient-stability analysis was performed for the three Alternatives to determine their impacts on unit stability at J.K. Smith and Dale.

Faults were simulated with the total clearing times that were discussed earlier in subsection 3.2. The results of the stability analysis for the three alternatives are summarized in Table 5-4. Table 5-4 also lists the figure numbers showing time plots of the performance for these fault scenarios. The addition of another 345 kV outlet from J.K. Smith provides increased unit stability for the generating units located there.

TABLE 5-4
COMPARISON OF STABILITY ANALYSIS WITH PROPOSED J.K. SMITH GENERATORS FOR THE THREE TRANSMISSION ALTERNATIVES

System Reactions to Faults at JK Smith Generating Station

Maximum Peak to Peak Rotor Angle Changes

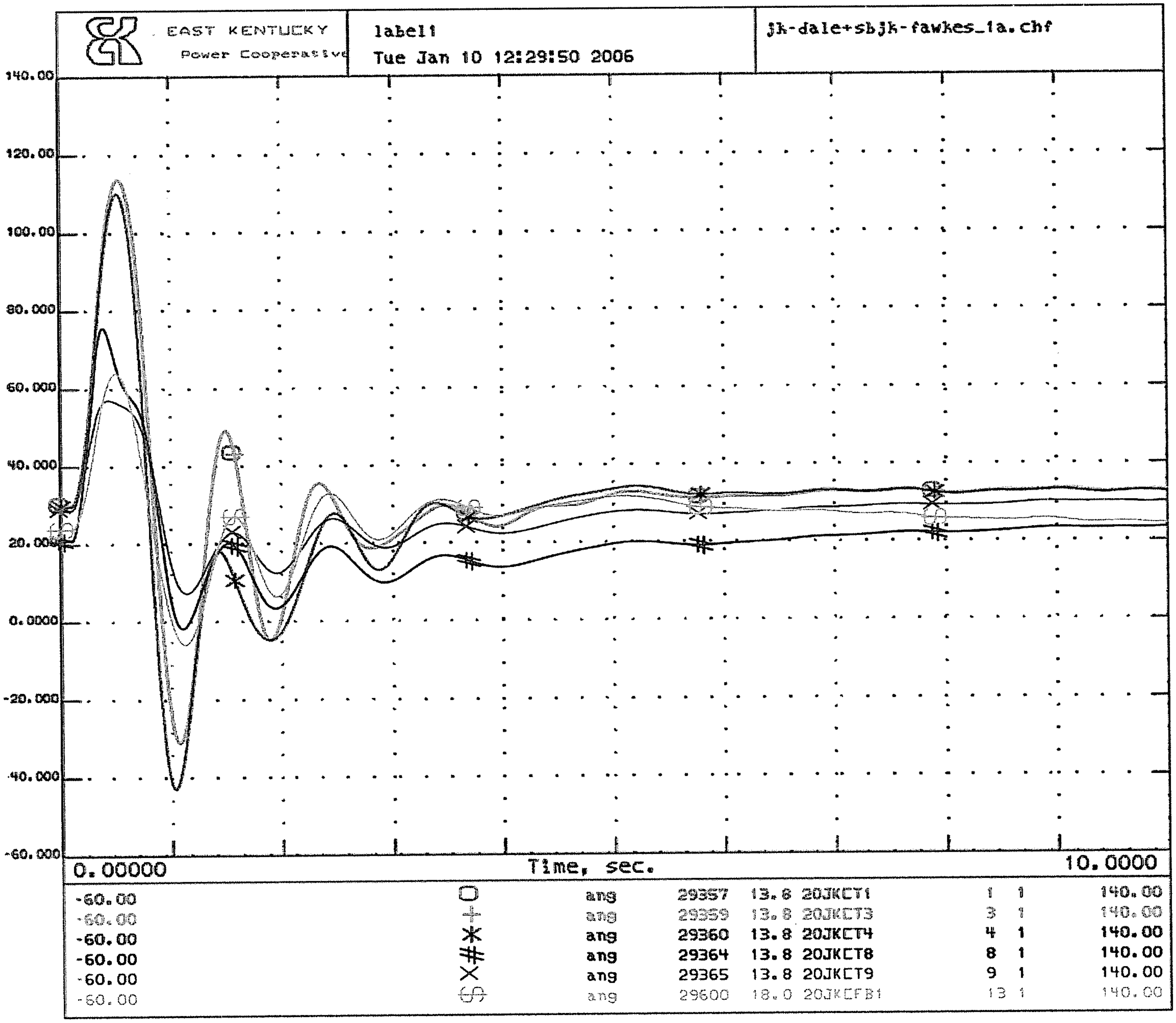
Case Designation		A1-1	A1-2	A2-1	A2-2	A3-1	A3-2
Transmission Configuration		Alternative 1	Alternative 1	Alternative 2	Alternative 2	Alternative 3	Alternative 3
Reference Figure		5-1, 5-2	5-3, 5-4	5-5, 5-6	5-7, 5-8	5-9, 5-10	5-11, 5-12
Fault Clearing Type		138 kV SB[1]	345 kV SB[2]	138 kV SB[1]	345 kV SB[2]	138 kV SB[1]	345 kV SB[2]
Normal Clearing Time (cycles)		5	3.75	5	3.75	5	3.75
Additional Clearing Time for Breaker Failure (cycles)		7.75	6	7.75	6	7.75	6
Damping Time		Less than 5 sec.	Less than 5 sec.	Less than 5 sec.	Less than 5 sec.	Less than 5 sec.	Less than 5 sec.
Dale	#1	44	41	49	52	49	44
Dale	#2	44	41	49	52	49	44
Dale	#3	51	45	60	63	59	51
Dale	#4	55	47	67	68	65	55
JK Smith	CT #1	145	79	163	107	156	92
JK Smith	CT #2	145	79	163	107	156	92
JK Smith	CT #3	145	79	163	107	156	92
JK Smith	CT #4	153	93	164	110	160	100
JK Smith	CT #5	153	93	164	110	160	100
JK Smith	CT #6	153	93	164	110	160	100
JK Smith	CT #7	153	93	164	110	160	100
JK Smith	CT #8	77	52	86	75	83	61
JK Smith	CT #9	50	59	69	77	65	70
JK Smith	CT #10	50	59	69	77	65	70
JK Smith	CT #11	50	59	69	77	65	70
JK Smith	CT #12	50	59	69	77	65	70
JK Smith	CFB #1	70	87	94	109	92	100

Notes:

[1] Fault on J.K. Smith-Dale 138 kV line with breaker failure; trip J.K. Smith-Fawkes 138 kV line

[2] Fault on J.K. Smith-North Clark 345 kV line with breaker failure; trip one J.K. Smith 345 kV CT-J.K. Smith 345 kV CFB tie

As shown in Table 5-4, none of the transmission alternatives change the swing of the Dale units during disturbances by an appreciable amount. The three alternatives do provide to varying degrees changes in the swing of the J.K. Smith CTs and the CFB unit. Of the three alternatives, Alternative 1 provides the greatest reduction in the swing seen by each of the 12 CTs and the CFB unit at J.K. Smith. Also, a comparison of the plots of the rotor swings during the simulated disturbances shows that the swings damp out more quickly at both J.K. Smith and at Dale Station for Alternative 1 than for the other two Alternatives. Therefore, this transmission alternative provides the best improvement in unit stability.

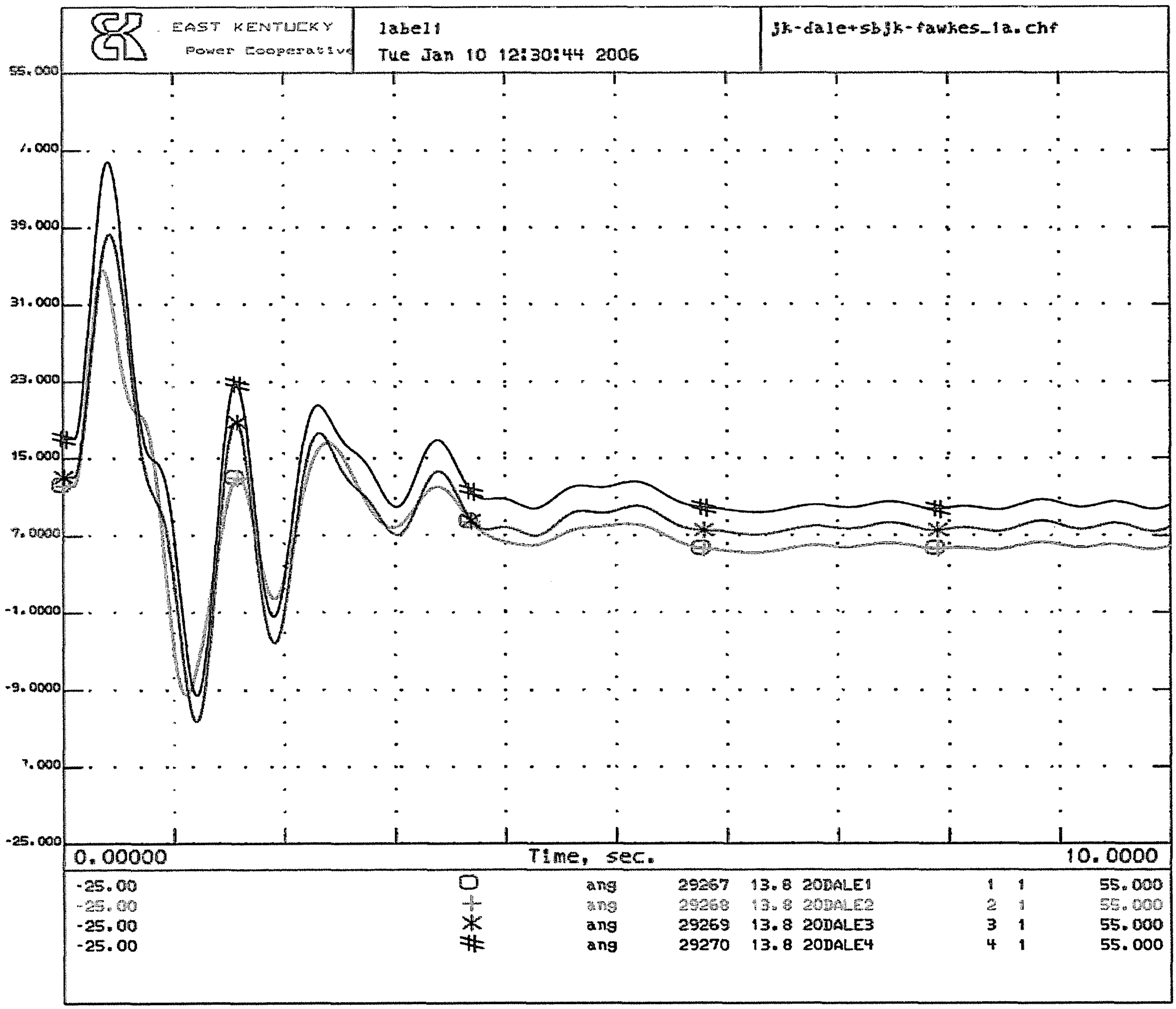


12.75 Cycle clearing time (5.00 Normal + 7.75 Backup)
Stuck Breaker at JKSMITH 138 KV on DALE Line
3 Phase Fault at JKSMITH 138 kV on DALE Line
Trip JKSMITH-FAWKES LINE @ 12.75 Cycles
JK-DALE+SBJK-FAWKES.p

2009-10 WINTER EKPC STABILITY BASE CASE JANUARY 2006
JK CFB1+CT'S 8-12;JK-BRYANTSVILLE+SIDEVIEW 345;JK 345/138(2-450 MVA XFMR)

REFERENCE CASE:
2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 5-1
J.K. Smith Generating Unit Responses for Alternative 1
Fault on J.K. Smith-Dale 138 kV Line with Stuck Breaker E63-91T
Subsequent Trip of J.K. Smith-Fawkes 138 kV Line

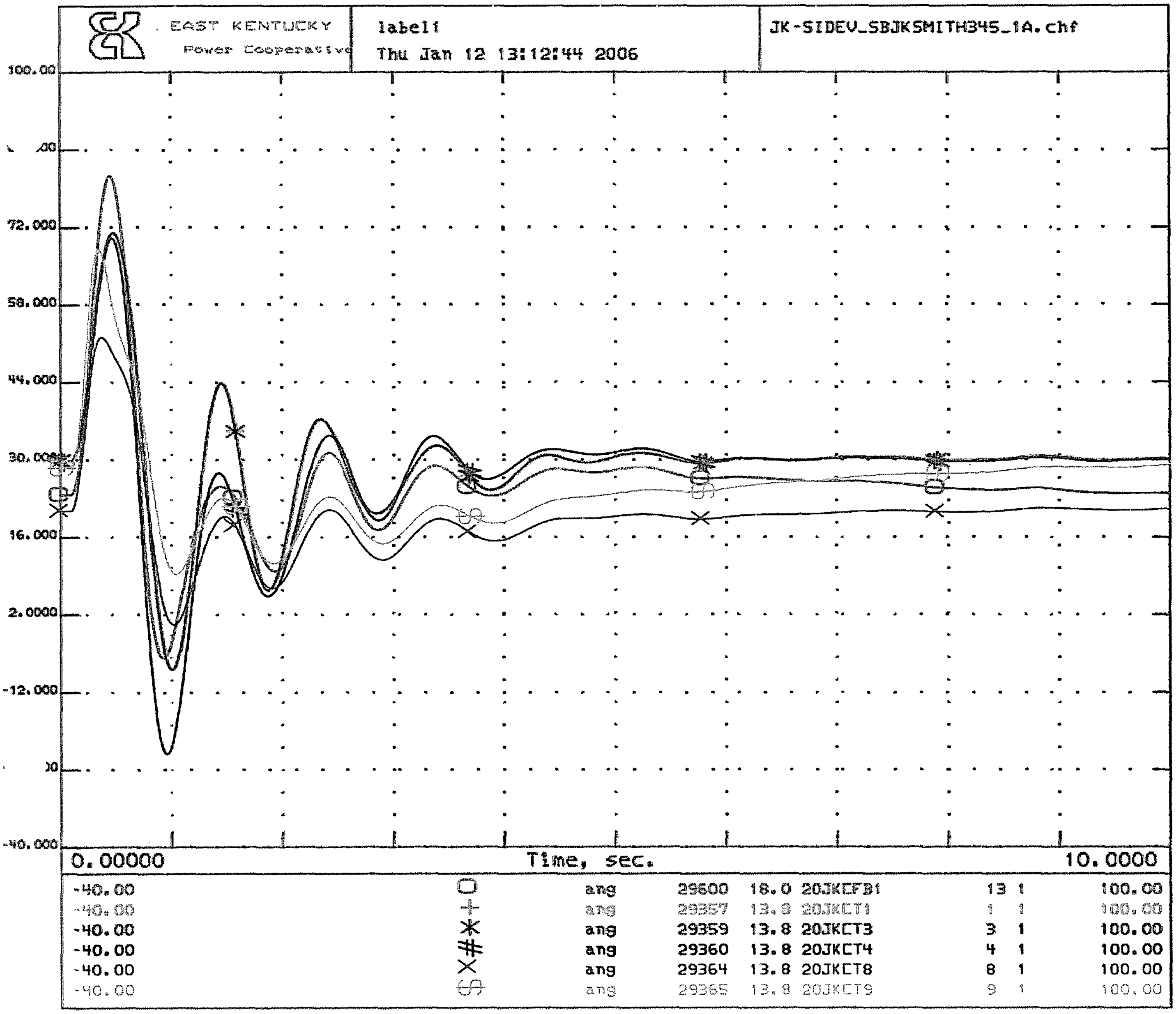


12.75 Cycle clearing time (5.00 Normal + 7.75 Backup)
Stuck Breaker at JKSMITH 138 KV on DALE Line
3 Phase Fault at JKSMITH 138 kV on DALE Line
Trip JKSMITH-FAWKES LINE @ 12.75 Cycles
JK-DALE+SBJK-FAWKES.p

2009-10 WINTER EKPC STABILITY BASE CASE JANUARY 2006
JK CFB1+CT'S 8-12;JK-BRYANTSVILLE+SIDEVIEW 345;JK 345/138(2-450 MVA XFMR)

REFERENCE CASE:
2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 5-2
Dale Station Generating Unit Responses for Alternative 1
Fault on J.K. Smith-Dale 138 kV Line with Stuck Breaker E63-91T
Subsequent Trip of J.K. Smith-Fawkes 138 kV Line

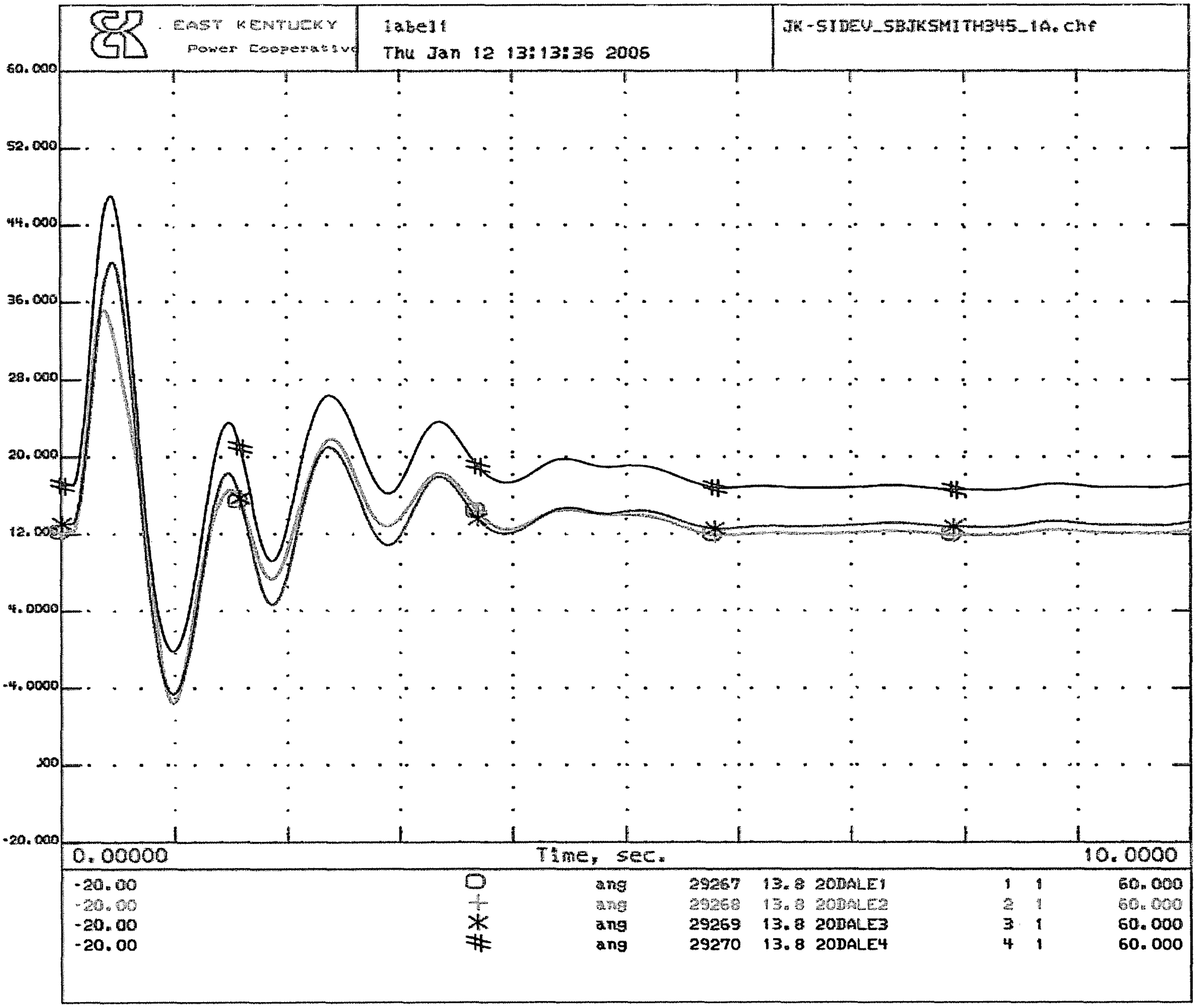


9.75 Cycle clearing time (3.75 Normal + 6.00 Backup)
3 Phase Fault at JK Smith 345 kV on Sideview Line
Stuck Breaker at JK Smith 345 kV
Trip JKSMITH2-JKCFB #1 LINE @ 9.75 Cycles
JK-SIDEV_SBJKSMITH345.p

2009/10 WINTER EKPC STABILITY BASE CASE JAN 2006
JKSMITH CFB1+CT'S 8-12;JK-SIDEVIEW+BRYANTSVL345;JK345/138(2-450 MVA XFMR)

REF CASE:2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 5-3
J.K. Smith Generating Unit Responses for Alternative 1
Fault on J.K. Smith-North Clark 345 kV Line with Stuck Breaker E112-153T
Subsequent Trip of One J.K. Smith CT-J.K. Smith CFB 345 kV Circuit

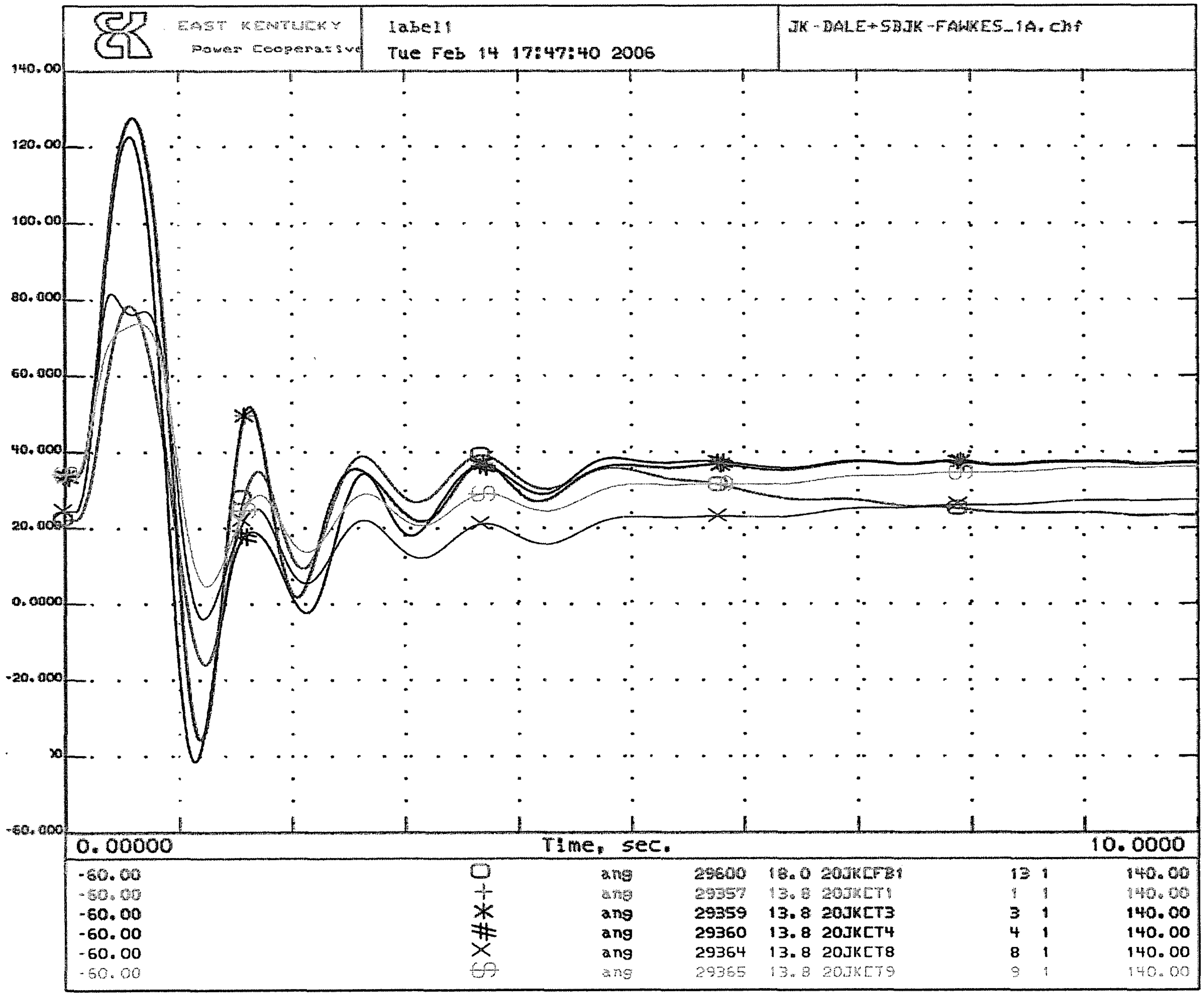


9.75 Cycle clearing time (3.75 Normal + 6.00 Backup)
3 Phase Fault at JK Smith 345 kV on Sideview Line
Stuck Breaker at JK Smith 345 kV
Trip JKSMITH2-JKCFB #1 LINE @ 9.75 Cycles
JK-SIDEV_SBJKSMITH345.p

2009/10 WINTER EKPC STABILITY BASE CASE JAN 2006
JKSMITH CFB1+CT'S 8-12;JK-SIDEVIEW+BRYANTSVL345;JK345/138(2-450 MVA XFMR)

REF CASE:2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 5-4
Dale Station Generating Unit Responses for Alternative 1
Fault on J.K. Smith-North Clark 345 kV Line with Stuck Breaker E112-153T
Subsequent Trip of One J.K. Smith CT-J.K. Smith CFB 345 kV Circuit

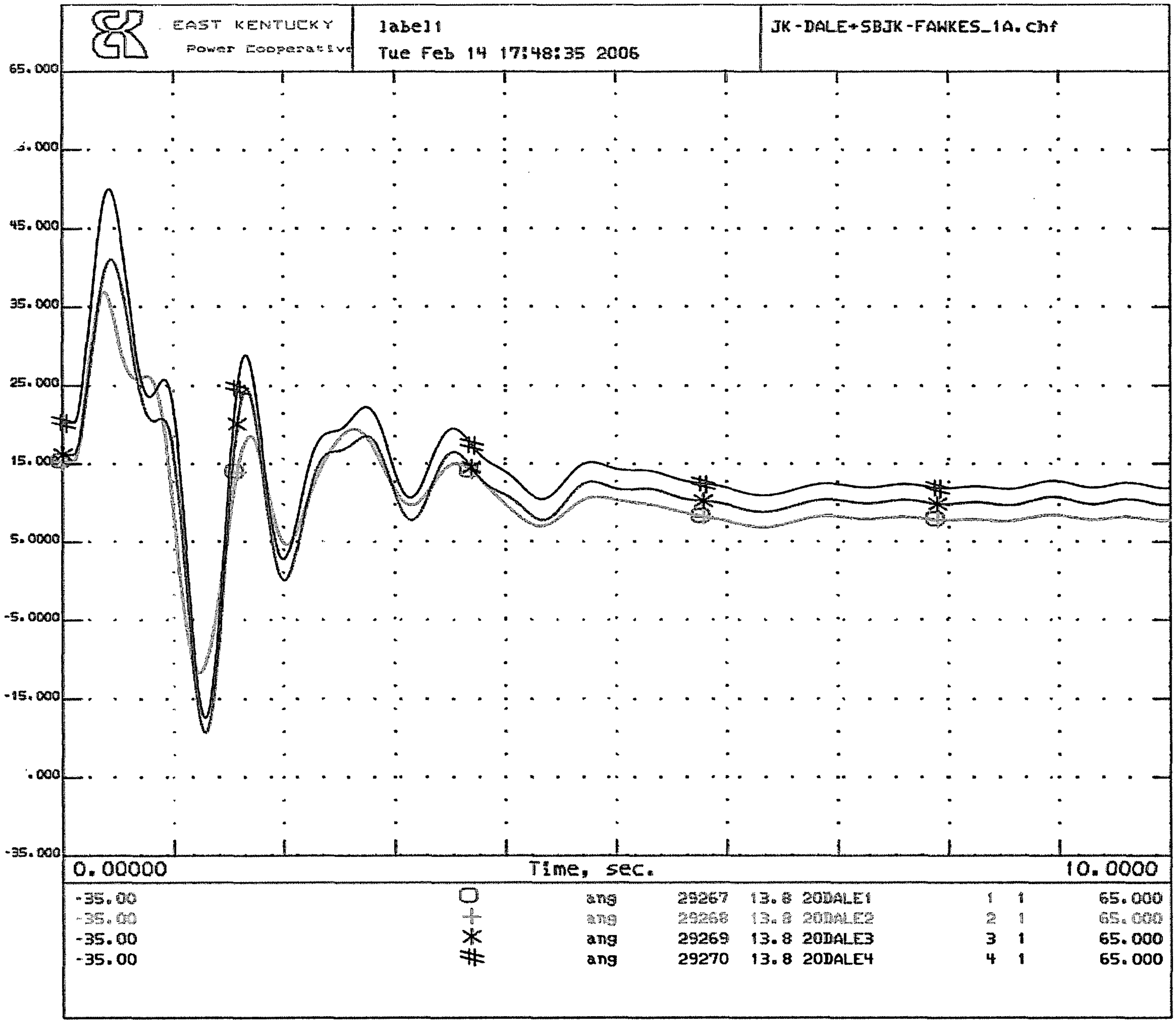


12.75 Cycle clearing time (5.00 Normal + 7.75 Backup)
Stuck Breaker at JKSMITH 138 KV on DALE Line
3 Phase Fault at JKSMITH 138 kV on DALE Line
Trip JKSMITH-FAWKES LINE @ 12.75 Cycles
JK-DALE+SBJK-FAWKES.p

2009/10 WINTER EKPC STABILITY BASE CASE JAN 2006
ALT2:JKSMITH CFB1+CT'S 8-12;JK-SIDEVIEW+TYNER345;JK345/138(2-450 MVA XFMR)
5% REACTOR IN DALE-BOONESBORO TAP 138 KV LINE

REF CASE:2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 5-5
J.K. Smith Generating Unit Responses for Alternative 2
Fault on J.K. Smith-Dale 138 kV Line with Stuck Breaker E63-91T
Subsequent Trip of J.K. Smith-Fawkes 138 kV Line

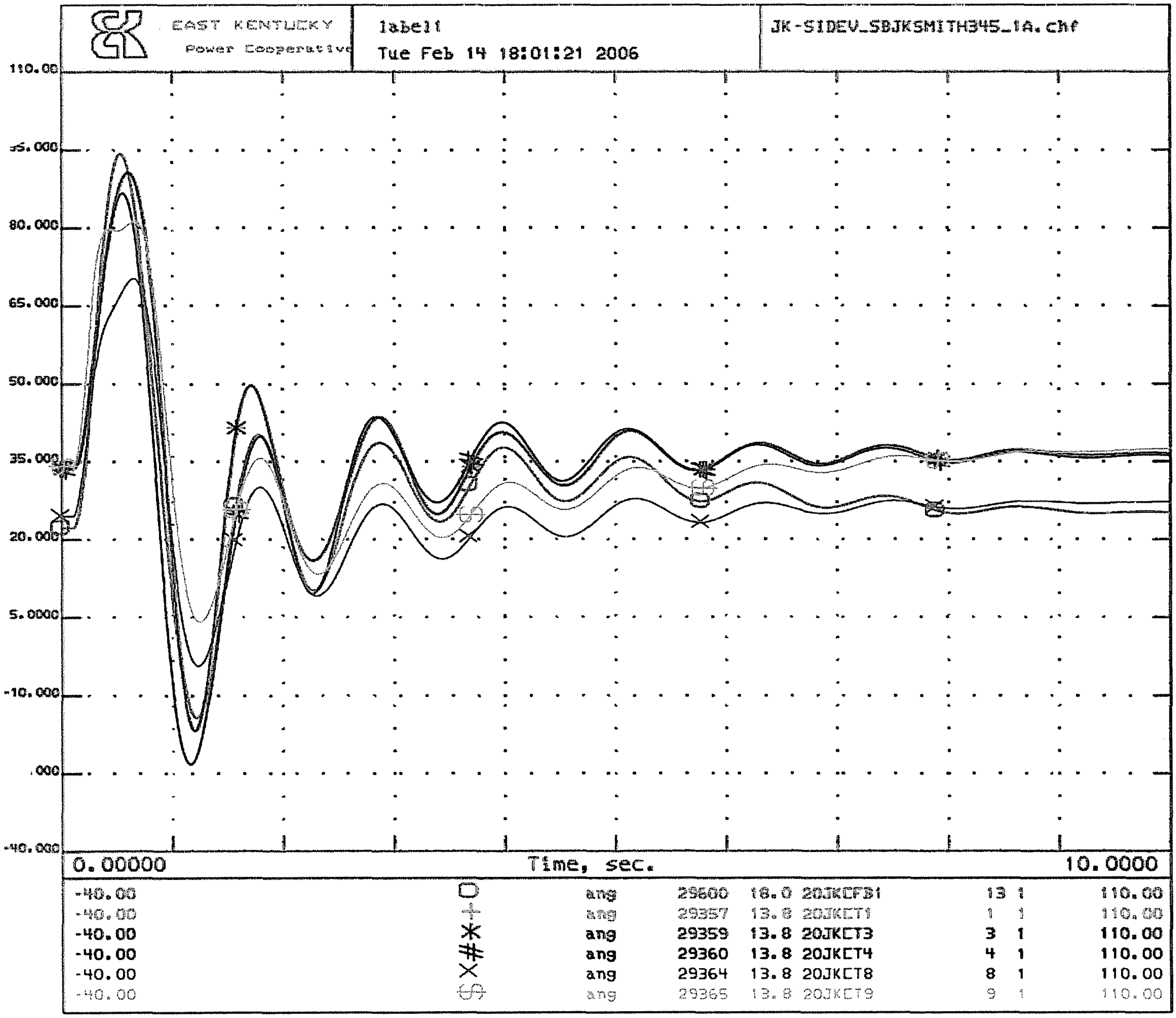


12.75 Cycle clearing time (5.00 Normal + 7.75 Backup)
Stuck Breaker at JKSMITH 138 KV on DALE Line
3 Phase Fault at JKSMITH 138 kV on DALE Line
Trip JKSMITH-FAWKES LINE @ 12.75 Cycles
JK-DALE+SBJK-FAWKES.p

2009/10 WINTER EKPC STABILITY BASE CASE JAN 2006
ALT2:JKSMITH CFB1+CT'S 8-12;JK-SIDEVIEW+TYNER345;JK345/138(2-450 MVA XFMR)
5% REACTOR IN DALE-BOONESBORO TAP 138 KV LINE

REF CASE:2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 5-6
Dale Station Generating Unit Responses for Alternative 2
Fault on J.K. Smith-Dale 138 kV Line with Stuck Breaker E63-91T
Subsequent Trip of J.K. Smith-Fawkes 138 kV Line

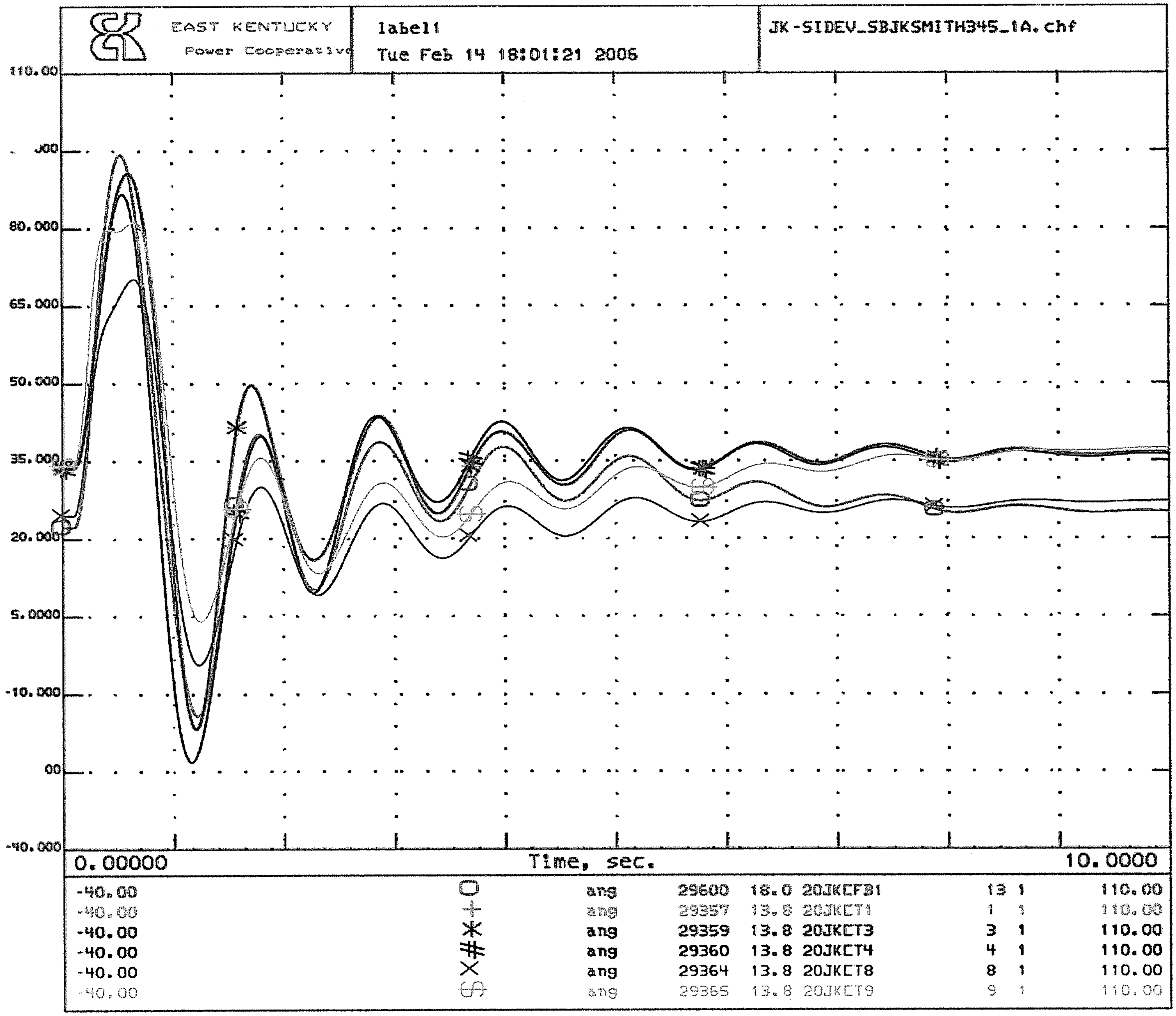


9.75 Cycle clearing time (3.75 Normal + 6.00 Backup)
3 Phase Fault at JK Smith 345 kV on Sideview Line
Stuck Breaker at JK Smith 345 kV
Trip JKSMITH2-JKCFB #1 LINE @ 9.75 Cycles
JK-SIDEV_SBJKSMITH345.p

2009/10 WINTER EKPC STABILITY BASE CASE JAN 2006
ALT2:JKSMITH CFB1+CT'S 8-12;JK-SIDEVIEW+TYNER345;JK345/138(2-450 MVA XFMR)
5% REACTOR IN DALE-BOONESBORO TAP 138 KV LINE

REF CASE:2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 5-7
J.K. Smith Generating Unit Responses for Alternative 2
Fault on J.K. Smith-North Clark 345 kV Line with Stuck Breaker E112-153T
Subsequent Trip of One J.K. Smith CT-J.K. Smith CFB 345 kV Circuit

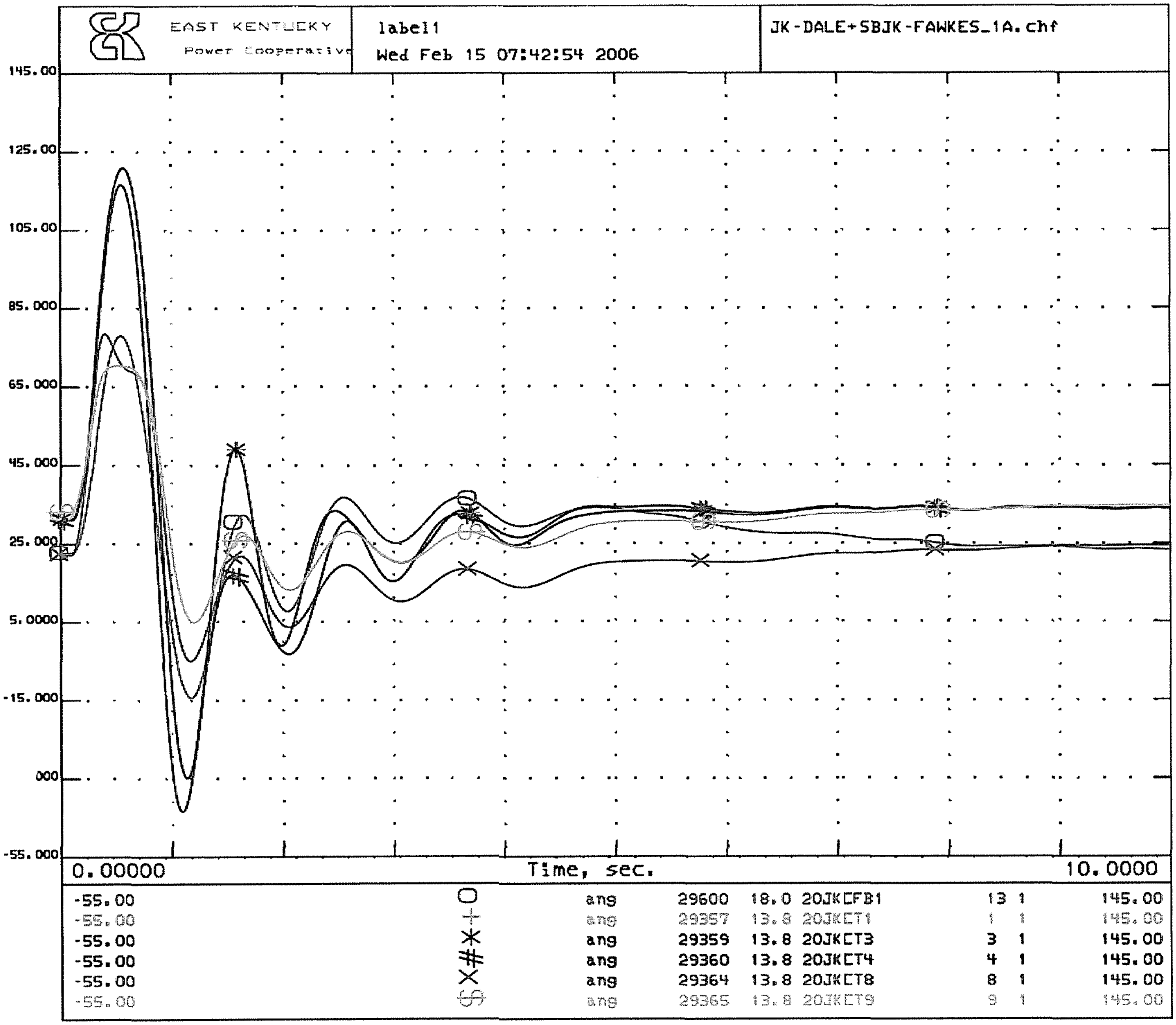


9.75 Cycle clearing time (3.75 Normal + 6.00 Backup)
3 Phase Fault at JK Smith 345 kV on Sideview Line
Stuck Breaker at JK Smith 345 kV
Trip JKSMITH2-JKCFB #1 LINE @ 9.75 Cycles
JK-SIDEV_SBJKSMITH345.p

2009/10 WINTER EKPC STABILITY BASE CASE JAN 2006
ALT2:JKSMITH CFB1+CT'S 8-12;JK-SIDEVIEW+TYNER345;JK345/138(2-450 MVA XFMR)
5% REACTOR IN DALE-BOONESBORO TAP 138 KV LINE

REF CASE:2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 5-8
Dale Station Generating Unit Responses for Alternative 2
Fault on J.K. Smith-North Clark 345 kV Line with Stuck Breaker E112-153T
Subsequent Trip of One J.K. Smith CT-J.K. Smith CFB 345 kV Circuit

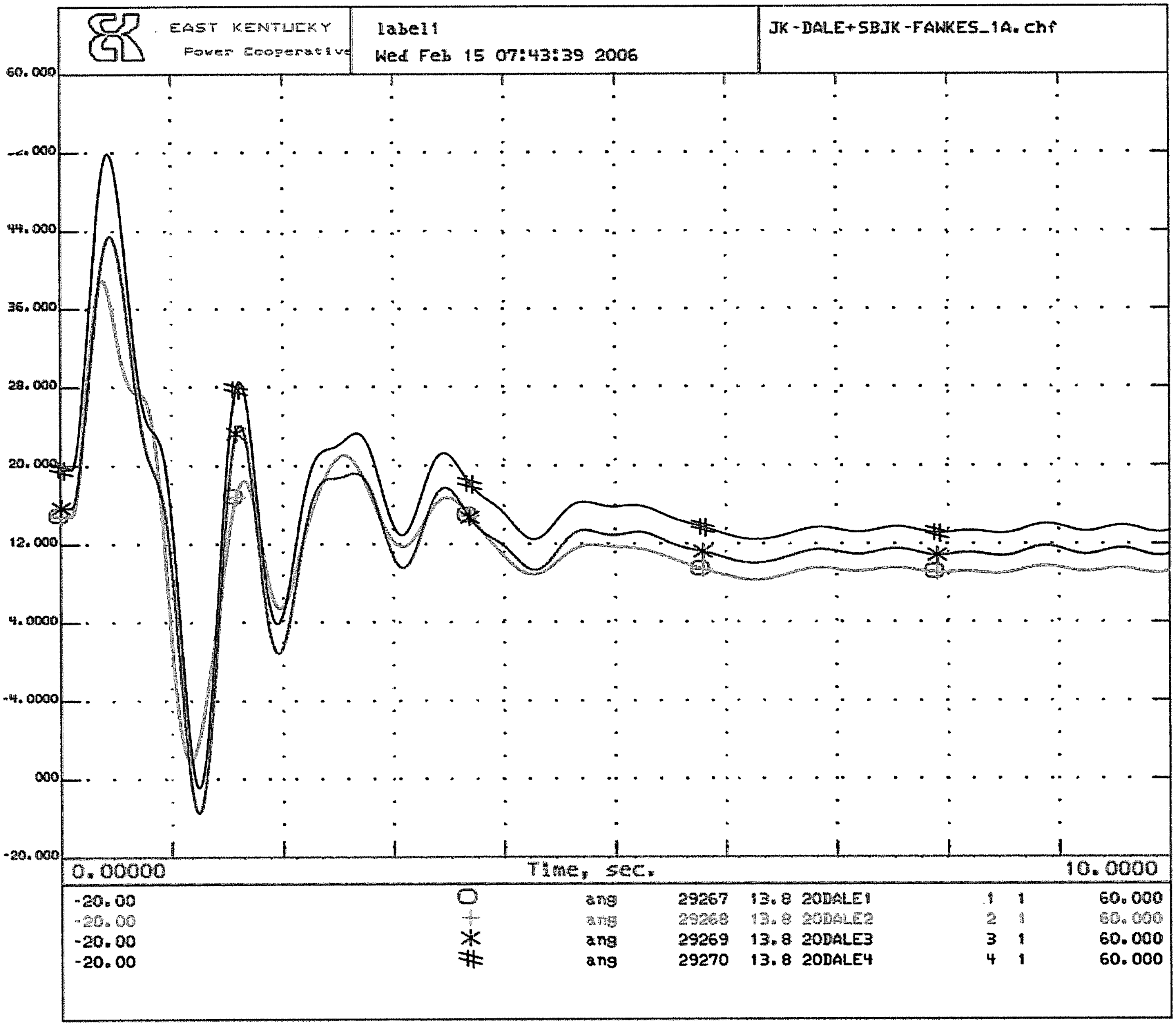


12.75 Cycle clearing time (5.00 Normal + 7.75 Backup)
Stuck Breaker at JKSMITH 138 KV on DALE Line
3 Phase Fault at JKSMITH 138 kV on DALE Line
Trip JKSMITH-FAWKES LINE @ 12.75 Cycles
JK-DALE+SBJK-FAWKES.p

2009/10 WINTER EKPC STABILITY BASE CASE JAN 2006
ALT3:JKSMITH CFB1+CT'S 8-12;JK-SIDEVIEW+TYNER345;JK345/138(2-450 MVA XFMR)
JKSMITH-SPENCER ROAD 138 KV ADDED

REF CASE:2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 5-9
J.K. Smith Generating Unit Responses for Alternative 3
Fault on J.K. Smith-Dale 138 kV Line with Stuck Breaker E63-91T
Subsequent Trip of J.K. Smith-Fawkes 138 kV Line

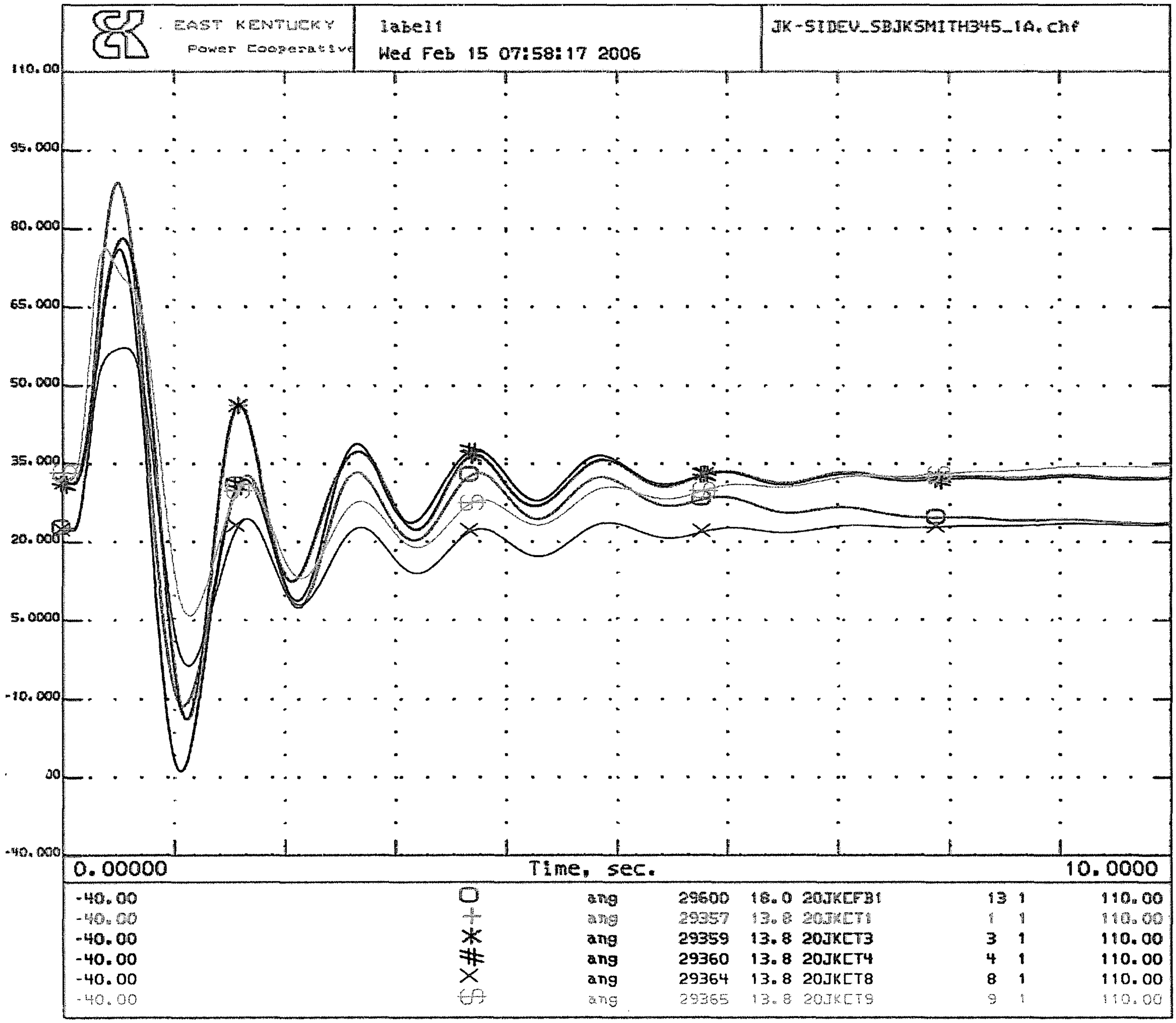


12.75 Cycle clearing time (5.00 Normal + 7.75 Backup)
Stuck Breaker at JKSMITH 138 KV on DALE Line
3 Phase Fault at JKSMITH 138 kV on DALE Line
Trip JKSMITH-FAWKES LINE @ 12.75 Cycles
JK-DALE+SBJK-FAWKES.p

2009/10 WINTER EKPC STABILITY BASE CASE JAN 2006
ALT3:JKSMITH CFB1+CT'S 8-12;JK-SIDEVIEW+TYNER345;JK345/138(2-450 MVA XFMR)
JKSMITH-SPENCER ROAD 138 KV ADDED

REF CASE:2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 5-10
Dale Station Generating Unit Responses for Alternative 3
Fault on J.K. Smith-Dale 138 kV Line with Stuck Breaker E63-91T
Subsequent Trip of J.K. Smith-Fawkes 138 kV Line

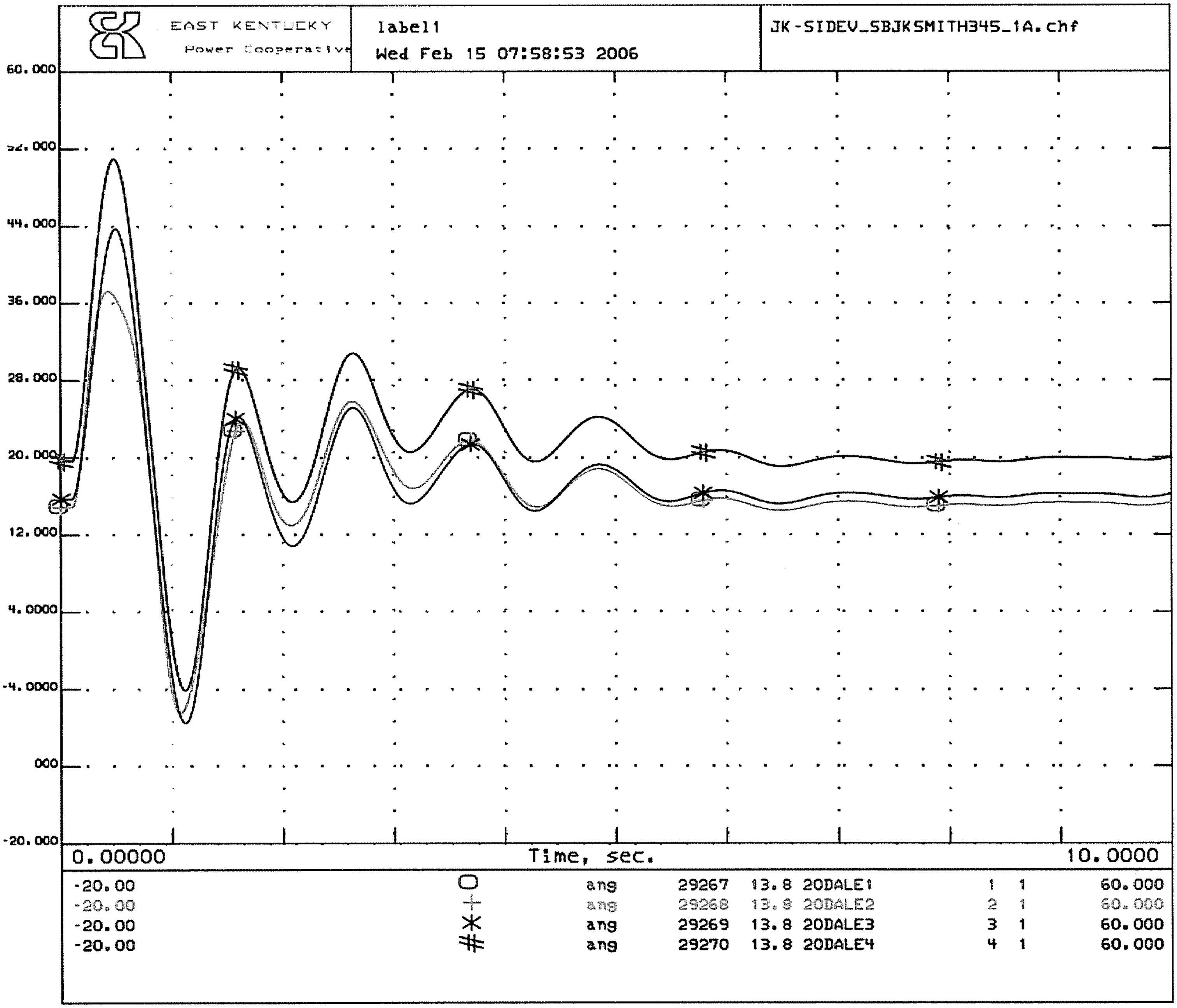


9.75 Cycle clearing time (3.75 Normal + 6.00 Backup)
3 Phase Fault at JK Smith 345 kV on Sideview Line
Stuck Breaker at JK Smith 345 kV
Trip JKSMITH2-JKCFB #1 LINE @ 9.75 Cycles
JK-SIDEV_SBJKSMITH345.P

2009/10 WINTER EKPC STABILITY BASE CASE JAN 2006
ALT3:JKSMITH CFB1+CT'S 8-12;JK-SIDEVIEW+TYNER345;JK345/138(2-450 MVA XFMR)
JKSMITH-SPENCER ROAD 138 KV ADDED

REF CASE:2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 5-11
J.K. Smith Generating Unit Responses for Alternative 3
Fault on J.K. Smith-North Clark 345 kV Line with Stuck Breaker E112-153T
Subsequent Trip of One J.K. Smith CT-J.K. Smith CFB 345 kV Circuit



9.75 Cycle clearing time (3.75 Normal + 6.00 Backup)
3 Phase Fault at JK Smith 345 kV on Sideview Line
Stuck Breaker at JK Smith 345 kV
Trip JKSMITH2-JKCFB #1 LINE @ 9.75 Cycles
JK-SIDEV_SBJKSMITH345.p

2009/10 WINTER EKPC STABILITY BASE CASE JAN 2006
ALT3:JKSMITH CFB1+CT'S 8-12;JK-SIDEVIEW+TYNER345;JK345/138(2-450 MVA XFMR)
JKSMITH-SPENCER ROAD 138 KV ADDED

REF CASE:2009 WINTER PEAK LOAD CASE EQUIVALIZED FOR ECAR APPLICATIONS
REDUCED FROM 2004 SERIES NERC/MMWG BASE CASES

Figure 5-12
Dale Station Generating Unit Responses for Alternative 3
Fault on J.K. Smith-North Clark 345 kV Line with Stuck Breaker E112-153T
Subsequent Trip of One J.K. Smith CT-J.K. Smith CFB 345 kV Circuit

5.4 Short-Circuit Impacts

The fault current levels at J.K. Smith and all nearby electrical buses were assessed for three-phase-to-ground and single-phase-to-ground faults without any new facilities, with the proposed generators only (no transmission modifications), and with the three transmission alternatives implemented. Table 5-5 shows the results for this analysis. The columns titled **3-phase** show the fault currents (in amperes) at the respective bus for a three-phase fault at that bus. The columns titled **1-phase** show the fault currents at the respective bus for a single-phase-to-ground fault at that bus. The columns titled **% change** show the percentage change in fault current values for the scenario with the proposed generators added only and for each of the proposed alternatives when compared to the case with no new facilities constructed.

Table 5-5
Comparison of Fault Currents (in Amperes) for Preferred Alternatives

	With No New Facilities		With Proposed Generators Only				Alternative 1 (Smith-West Garrard 345 kV)				Alternative 2 (Smith-Tyner 345 kV)				Alternative 3 (Smith-Tyner 345 kV, Smith-Spencer Road 138 kV)			
	3-ph	1-ph	3-ph	% diff	1-ph	% diff	3-ph	% diff	1-ph	% diff	3-ph	% diff	1-ph	% diff	3-ph	% diff	1-ph	% diff
JK Smith 345 kV	N/A	N/A	15587	######	17204	#####	19765	######	20888	#####	16699	######	18619	######	16835	#####	18753	######
JK Smith CFB 345 kV	N/A	N/A	15417	######	16946	#####	19639	######	20667	#####	16544	######	18402	######	16677	#####	18531	######
West Garrard 345 kV	N/A	N/A	N/A	######	N/A	#####	15630	######	12022	#####	N/A	######	N/A	######	N/A	#####	N/A	######
Tyner 345 kV	N/A	N/A	N/A	######	N/A	#####	N/A	######	N/A	#####	7190	######	9057	######	7217	#####	9091	######
North Clark 345 kV	11473	8453	14749	28.6%	11111	31.4%	16269	41.8%	11737	38.9%	15122	31.8%	11307	33.8%	15243	32.9%	11399	34.9%
Brown North 345 kV	12537	12236	12638	0.8%	12333	0.8%	17623	40.6%	16446	34.4%	12713	1.4%	12464	1.9%	12763	1.8%	12718	3.9%
JK Smith 138 kV	29862	33152	38249	28.1%	43681	31.8%	41099	37.6%	46297	39.7%	38206	27.9%	43813	32.2%	39689	32.9%	45367	36.8%
Avon 345 kV	9128	6993	10667	16.9%	8102	15.9%	11279	23.6%	8368	19.7%	10675	16.9%	8074	15.5%	10885	19.2%	8230	17.7%
Pineville 345 kV	12037	9199	12103	0.5%	9251	0.6%	14483	20.3%	11526	25.3%	12243	1.7%	10699	16.3%	12261	1.9%	7322	-20.4%
West Lexington 345 kV	11207	14779	11300	0.8%	14907	0.9%	13160	17.4%	17164	16.1%	11353	1.3%	15013	1.6%	11403	1.7%	15103	2.2%
Brown North 138 kV	29896	36262	30169	0.9%	36586	0.9%	33943	13.5%	40897	12.8%	30323	1.4%	36852	1.6%	30459	1.9%	36966	1.9%
Brown CT 138 kV	29230	25363	29492	0.9%	25550	0.7%	33076	13.2%	27610	8.9%	29645	1.4%	25735	1.5%	29779	1.9%	36061	42.2%
Brown Plant 138 kV	29194	33192	29459	0.9%	33479	0.9%	32963	12.9%	36901	11.2%	29614	1.4%	33712	1.6%	29748	1.9%	27515	-17.1%
Avon 138 kV	20132	16270	21454	6.6%	17429	7.1%	21911	8.8%	17728	9.0%	19914	-1.1%	16547	1.7%	21667	7.6%	17628	8.3%
Hardin County 345 kV	6158	5508	6200	0.7%	5552	0.8%	6656	8.1%	5964	8.3%	6235	1.3%	5647	2.5%	6259	1.6%	6640	20.6%
Union City 138 kV	15647	16040	16618	6.2%	16720	4.2%	16902	8.0%	16673	3.9%	16597	6.1%	16446	2.5%	16789	7.3%	12857	-19.8%
Fawkes EKPC 138 kV	20796	22003	22126	6.4%	23004	4.5%	22434	7.9%	23148	5.2%	21836	5.0%	22656	3.0%	22343	7.4%	21136	-3.9%
Fawkes LGEE 138 kV	20765	21980	22089	6.4%	22975	4.5%	22394	7.8%	23125	5.2%	21805	5.0%	22639	3.0%	22309	7.4%	21147	-3.8%
Alcalde 345 kV	9751	6023	9809	0.6%	6058	0.6%	10502	7.7%	6391	6.1%	9934	1.9%	8026	33.3%	9962	2.2%	7648	27.0%
Pineville 161 kV	18049	14597	18139	0.5%	14672	0.5%	19429	7.6%	16428	12.5%	18455	2.2%	16430	12.6%	18484	2.4%	12294	-15.8%
Lake Reba Tap 138 kV	16499	17151	17475	5.9%	17852	4.1%	17756	7.6%	17767	3.6%	17455	5.8%	17531	2.2%	17671	7.1%	13404	-21.8%
Pineville Switching 161 kV	17927	14450	18016	0.5%	14525	0.5%	19280	7.5%	16243	12.4%	18331	2.3%	9418	-34.8%	18361	2.4%	7704	-46.7%
West Lexington 138 kV	20675	20829	20864	0.9%	21010	0.9%	22219	7.5%	22153	6.4%	20928	1.2%	21125	1.4%	21076	1.9%	21115	1.4%
Dale 138 kV	20817	19668	22215	6.7%	20570	4.6%	22345	7.3%	20166	2.5%	19770	-5.0%	18073	-8.1%	22068	6.0%	19990	1.6%
Pisgah 138 kV	16381	20613	16517	0.8%	20789	0.9%	17441	6.5%	21996	6.7%	16585	1.2%	20908	1.4%	16704	2.0%	15997	-22.4%

Table 5-5
Comparison of Fault Currents (in Amperes) for Preferred Alternatives

	With No New Facilities		With Proposed Generators Only				Alternative 1 (Smith-West Garrard 345 kV)				Alternative 2 (Smith-Tyner 345 kV)				Alternative 3 (Smith-Tyner 345 kV, Smith-Spencer Road 138 kV)			
	3-ph	1-ph	3-ph	% diff	1-ph	% diff	3-ph	% diff	1-ph	% diff	3-ph	% diff	1-ph	% diff	3-ph	% diff	1-ph	% diff
Higby Mill 138 kV	19179	18487	19360	0.9%	18644	0.8%	20388	6.3%	19551	5.8%	19419	1.3%	18753	1.4%	19568	2.0%	25161	36.1%
Hardin County 138 kV	13668	12413	13760	0.7%	12517	0.8%	14516	6.2%	13373	7.7%	13837	1.2%	12781	3.0%	13889	1.6%	15048	21.2%
Lake Reba 138 kV	13519	14419	14143	4.6%	14892	3.3%	14349	6.1%	14863	3.1%	14158	4.7%	14703	2.0%	14318	5.9%	9323	-35.3%
Boonesboro North 138 kV	17401	15098	18270	5.0%	15599	3.3%	18451	6.0%	15593	3.3%	12364	-28.9%	10911	-27.7%	18295	5.1%	15596	3.3%
Pineville 500 kV	13095	8664	13164	0.5%	8712	0.6%	13881	6.0%	10551	21.8%	13237	1.1%	10834	25.0%	13245	1.1%	5503	-36.5%
Three Forks 138 kV	15604	1977	16346	4.8%	1982	0.3%	16514	5.8%	1997	1.0%	15810	1.3%	1987	0.5%	16436	5.3%	1998	1.1%
Clays Mill 138 kV	15693	16171	15826	0.8%	16299	0.8%	16604	5.8%	17062	5.5%	15891	1.3%	16401	1.4%	16013	2.0%	21093	30.4%
Haefling 138 kV	20817	17763	21039	1.1%	17925	0.9%	22023	5.8%	18650	5.0%	21054	1.1%	18005	1.4%	21248	2.1%	18421	3.7%
Baker Lane 138 kV	14548	19274	14669	0.8%	19439	0.9%	15380	5.7%	20478	6.2%	14732	1.3%	19552	1.4%	14848	2.1%	18909	-1.9%
IBM North 138 kV	17345	5392	17530	1.1%	5430	0.7%	18206	5.0%	5585	3.6%	17537	1.1%	5462	1.3%	17724	2.2%	5551	2.9%
Smith 345 kV	4027	4067	4056	0.7%	4099	0.8%	4208	4.5%	4266	4.9%	4078	1.3%	4138	1.7%	4092	1.6%	3457	-15.0%
Powell County 138 kV	8647	7662	8888	2.8%	7806	1.9%	9019	4.3%	7884	2.9%	9069	4.9%	7930	3.5%	9130	5.6%	7964	3.9%
Loudon Avenue 138 kV	15775	11106	15974	1.3%	11204	0.9%	16431	4.2%	11521	3.7%	15922	0.9%	11231	1.1%	16159	2.4%	11622	4.6%
Tyrone 138 kV	12208	16448	12293	0.7%	16572	0.8%	12708	4.1%	17216	4.7%	12359	1.2%	16679	1.4%	12435	1.9%	12823	-22.0%
Fawkes KU 69 kV	21815	25314	22432	2.8%	25860	2.2%	22699	4.1%	26131	3.2%	22420	2.8%	25847	2.1%	22720	4.1%	26110	3.1%
Alcalde 161 kV	16055	11192	16138	0.5%	11250	0.5%	16701	4.0%	11648	4.1%	16446	2.4%	13155	17.5%	16490	2.7%	11983	7.1%
Loudon Avenue #618 69 kV	28796	20594	29084	1.0%	20752	0.8%	29939	4.0%	21370	3.8%	29068	0.9%	20838	1.2%	29446	2.3%	21343	3.6%
Loudon Avenue #628 69 kV	28772	19008	29060	1.0%	19148	0.7%	29914	4.0%	19711	3.7%	29044	0.9%	19232	1.2%	29422	2.3%	20174	6.1%
Pineville 69 kV	19367	16940	19455	0.5%	17023	0.5%	20131	3.9%	18001	6.3%	19764	2.0%	17852	5.4%	19802	2.2%	15851	-6.4%
Goddard 138 kV	8694	7082	8993	3.4%	7095	0.2%	9033	3.9%	7129	0.7%	9017	3.7%	7118	0.5%	9305	7.0%	7305	3.1%
Fayette 138 kV	7829	5279	8006	2.3%	5376	1.8%	8128	3.8%	5455	3.3%	7823	-0.1%	5311	0.6%	8091	3.3%	5437	3.0%
Howards Branch 161 kV	8985	4643	9027	0.5%	4665	0.5%	9325	3.8%	4847	4.4%	9144	1.8%	5926	27.6%	9160	1.9%	3864	-16.8%
Lake Reba Tap 161 kV	8711	9372	8931	2.5%	9538	1.8%	9040	3.8%	9300	-0.8%	9058	4.0%	9292	-0.9%	9134	4.9%	8486	-9.5%
Ghent 345 kV	16422	21026	16505	0.5%	21140	0.5%	17003	3.5%	21807	3.7%	16544	0.7%	21240	1.0%	16586	1.0%	21337	1.5%
Spurlock 345 kV	35872	32707	36845	2.7%	33267	1.7%	37137	3.5%	33127	1.3%	36909	2.9%	32560	-0.4%	36920	2.9%	32979	0.8%

Table 5-5
Comparison of Fault Currents (in Amperes) for Preferred Alternatives

	With No New Facilities		With Proposed Generators Only				Alternative 1 (Smith-West Garrard 345 kV)				Alternative 2 (Smith-Tyner 345 kV)				Alternative 3 (Smith-Tyner 345 kV, Smith-Spencer Road 138 kV)			
	3-ph	1-ph	3-ph	% diff	1-ph	% diff	3-ph	% diff	1-ph	% diff	3-ph	% diff	1-ph	% diff	3-ph	% diff	1-ph	% diff
Harlan Y 161 kV	10705	7918	10750	0.4%	7953	0.4%	11069	3.4%	8451	6.7%	10891	1.7%	11280	42.5%	10908	1.9%	7698	-2.8%
Lake Reba 69 kV	16352	17720	16707	2.2%	17990	1.5%	16898	3.3%	18109	2.2%	16792	2.7%	18013	1.7%	16954	3.7%	17961	1.4%
Pocket North 500 kV	12767	10579	12827	0.5%	10631	0.5%	13193	3.3%	10597	0.2%	12884	0.9%	12982	22.7%	12890	1.0%	9857	-6.8%
Fayette 69 kV	9454	7139	9573	1.3%	7228	1.2%	9718	2.8%	7345	2.9%	9484	0.3%	7191	0.7%	9681	2.4%	7317	2.5%
Powell County 161 kV	5943	5304	6026	1.4%	5352	0.9%	6104	2.7%	5398	1.8%	6273	5.6%	5502	3.7%	6307	6.1%	5516	4.0%
West Berea 138 kV	6468	8544	6561	1.4%	8656	1.3%	6640	2.7%	8741	2.3%	6594	1.9%	8681	1.6%	6673	3.2%	8484	-0.7%
Paris 138 kV	7339	6578	7427	1.2%	6636	0.9%	7533	2.6%	6737	2.4%	7369	0.4%	6612	0.5%	7511	2.3%	6719	2.1%
Paris 69 kV	12138	13132	12261	1.0%	13251	0.9%	12443	2.5%	13466	2.5%	12222	0.7%	13236	0.8%	12402	2.2%	13425	2.2%
Boonesboro North 69 kV	13170	14507	13361	1.5%	14670	1.1%	13485	2.4%	14788	1.9%	12067	-8.4%	13243	-8.7%	13651	3.7%	15123	4.2%
West Irvine 161 kV	8236	9619	8321	1.0%	9685	0.7%	8427	2.3%	8523	-11.4%	8809	7.0%	8737	-9.2%	8862	7.6%	8926	-7.2%
Jacksonville 138 kV	7681	3758	7769	1.1%	3783	0.7%	7859	2.3%	3828	1.9%	7713	0.4%	3777	0.5%	7843	2.1%	3822	1.7%
Clark County 138 kV	7592	7473	7677	1.1%	7522	0.7%	7762	2.2%	7613	1.9%	7692	1.3%	7543	0.9%	9211	21.3%	9517	27.4%
West Berea 69 kV	8972	10575	9048	0.8%	10643	0.6%	9155	2.0%	10771	1.9%	9132	1.8%	10748	1.6%	9218	2.7%	10768	1.8%
Laurel County 161 kV	6865	6535	6884	0.3%	6550	0.2%	7005	2.0%	6674	2.1%	7817	13.9%	7196	10.1%	7841	14.2%	7235	10.7%
Clark County 69 kV	12122	13345	12235	0.9%	13433	0.7%	12368	2.0%	13598	1.9%	12160	0.3%	13387	0.3%	13678	12.8%	15277	14.5%
Beattyville 161 kV	7384	6738	7426	0.6%	6744	0.1%	7530	2.0%	6621	-1.7%	8505	15.2%	7187	6.7%	8546	15.7%	7028	4.3%
Delvinta 161 kV	8959	9371	9006	0.5%	9387	0.2%	9133	1.9%	8788	-6.2%	11156	24.5%	10177	8.6%	11208	25.1%	9420	0.5%
Pittsburg 161 kV	6424	6080	6434	0.2%	6083	0.0%	6543	1.9%	6190	1.8%	8217	27.9%	7328	20.5%	8244	28.3%	7371	21.2%
Renaker 138 kV	8513	9248	8582	0.8%	9312	0.7%	8660	1.7%	9400	1.6%	8559	0.5%	9297	0.5%	8652	1.6%	9395	1.6%
Green Hall 161 kV	7129	4942	7143	0.2%	4930	-0.2%	7251	1.7%	4900	-0.8%	10069	41.2%	6110	23.6%	10109	41.8%	6023	21.9%
Tyner 161 kV	6930	6859	6938	0.1%	6851	-0.1%	7048	1.7%	6904	0.7%	13147	89.7%	14621	113.2%	13195	90.4%	14639	113.4%
Tyner 69 kV	10380	12237	10368	-0.1%	12209	-0.2%	10545	1.6%	12414	1.4%	10874	4.8%	12415	1.5%	10914	5.1%	12462	1.8%
Spencer Road 138 kV	5720	6097	5750	0.5%	6117	0.3%	5805	1.5%	6183	1.4%	5764	0.8%	6137	0.7%	10470	83.0%	9970	63.5%
Fall Rock 69 kV	5674	6494	5658	-0.3%	6470	-0.4%	5757	1.5%	6591	1.5%	6632	16.9%	7411	14.1%	6653	17.3%	7436	14.5%
Spurlock 138 kV	41255	44040	41684	1.0%	44379	0.8%	41840	1.4%	44414	0.8%	41713	1.1%	44232	0.4%	41940	1.7%	44609	1.3%

Table 5-5
Comparison of Fault Currents (in Amperes) for Preferred Alternatives

	With No New Facilities		With Proposed Generators Only				Alternative 1 (Smith-West Garrard 345 kV)				Alternative 2 (Smith-Tyner 345 kV)				Alternative 3 (Smith-Tyner 345 kV, Smith-Spencer Road 138 kV)			
	3-ph	1-ph	3-ph	% diff	1-ph	% diff	3-ph	% diff	1-ph	% diff	3-ph	% diff	1-ph	% diff	3-ph	% diff	1-ph	% diff
Spencer Road 69 kV	8570	10236	8604	0.4%	10265	0.3%	8686	1.4%	10376	1.4%	8625	0.6%	10298	0.6%	12333	43.9%	14135	38.1%
Inland CT 138 kV	35395	33168	35713	0.9%	33364	0.6%	35836	1.2%	33398	0.7%	35738	1.0%	33288	0.4%	35923	1.5%	33529	1.1%
Farmers 138 kV	5622	4562	5637	0.3%	4568	0.1%	5678	1.0%	4608	1.0%	5656	0.6%	4586	0.5%	6640	18.1%	5846	28.1%
Sharkey 138 kV	5305	2206	5319	0.3%	2208	0.1%	5357	1.0%	2226	0.9%	5337	0.6%	2217	0.5%	6157	16.1%	2542	15.2%
Stuart 345 kV	52952	20271	53345	0.7%	20313	0.2%	53449	0.9%	14710	-27.4%	53367	0.8%	9919	-51.1%	53372	0.8%	13676	-32.5%
Rodburn 138 kV	7793	6899	7817	0.3%	6910	0.2%	7865	0.9%	7009	1.6%	7842	0.6%	6932	0.5%	8701	11.7%	7788	12.9%
Rowan County 138 kV	7777	7060	7780	0.0%	7071	0.2%	7847	0.9%	7148	1.2%	7826	0.6%	7077	0.2%	8592	10.5%	7755	9.8%
Farmers 69 kV	6304	6604	6310	0.1%	6606	0.0%	6359	0.9%	6663	0.9%	6333	0.5%	6633	0.4%	7003	11.1%	7472	13.1%
Maysville Industrial 138 kV	18152	5231	18242	0.5%	5238	0.1%	18296	0.8%	5249	0.3%	18261	0.6%	5246	0.3%	18400	1.4%	5278	0.9%
Goddard KU 138 kV	5688	4788	5702	0.2%	4796	0.2%	5733	0.8%	4824	0.8%	5719	0.5%	4833	0.9%	5986	5.2%	5698	19.0%
Rodburn 69 kV	7040	7382	7045	0.1%	7384	0.0%	7091	0.7%	7572	2.6%	7070	0.4%	7406	0.3%	7547	7.2%	7678	4.0%
Plumville 138 kV	10252	7643	10286	0.3%	7658	0.2%	10322	0.7%	7681	0.5%	10304	0.5%	7678	0.5%	10452	2.0%	7776	1.7%
Flemingsburg 138 kV	8061	5453	8084	0.3%	5463	0.2%	8115	0.7%	5484	0.6%	8102	0.5%	5476	0.4%	8270	2.6%	5572	2.2%
Kenton 138 kV	11083	8821	11113	0.3%	8837	0.2%	11157	0.7%	8637	-2.1%	11130	0.4%	9254	4.9%	11287	1.8%	9796	11.1%
Stanley Parker 138 kV	8354	7288	8369	0.2%	7299	0.2%	8407	0.6%	7366	1.1%	8380	0.3%	7344	0.8%	8408	0.6%	7357	0.9%
Zimmer 345 kV	28090	29959	28124	0.1%	29971	0.0%	28174	0.3%	29544	-1.4%	28145	0.2%	29733	-0.8%	28152	0.2%	29496	-1.5%
Dale 69 kV	18085	22121	18358	1.5%	22401	1.3%	15549	-14.0%	18836	-14.9%	15310	-15.3%	18558	-16.1%	15517	-14.2%	18803	-15.0%

Table 5-5 shows that large changes in fault current levels are expected at the J.K. Smith, Avon, and North Clark Substations with the addition of the proposed generators. Additional large changes are seen at several substations, depending on the transmission alternative implemented. For instance, the proposed alternative (Alternative 1) increases the three-phase fault current seen at LGEE's Brown North 345 kV bus by more than 40%. Likewise, Alternatives 2 and 3 both result in large increases in fault current level at EKPC's Tyner Substation, as well as at other substations in the vicinity of Tyner.

The fault current levels at EKPC buses for the proposed alternatives are within the interrupting-capability of the circuit breakers installed at all locations except J.K. Smith and Dale. At J.K. Smith, eight of the existing 138 kV circuit breakers (rated 40 kA) will need to be replaced due to inadequate interrupting capability. At Dale, three 138 kV circuit breakers (rated 21 kA) will need to be replaced. The replacements at Dale could possibly be avoided if Alternative 2 is implemented. However, the expected fault currents are marginally close to the 21 kA rating of the breakers. Therefore, replacement of these breakers would still be recommended with Alternative 2.

The foreign-owned buses significantly impacted by the addition of the proposed generators and/or the transmission modifications are all in the LGEE system. A review of these results by LGEE will be needed to ascertain whether any circuit-breaker interrupting capabilities will be exceeded.

Based on these results, the conclusion is that none of the alternatives have any significant advantage over the other alternatives in terms of short-circuit impacts.

5.5 Physical Issues

The physical issues for these alternatives are related to the constructability of the transmission lines and the substation terminals. The facilities required at J.K. Smith are identical for either Alternative 1 or Alternative 2. Alternative 3 requires an additional 138 kV line exit at J.K. Smith that is not needed for either of the other two alternatives. These substation facilities at J.K. Smith can be constructed without significant difficulty. The relative constructability of the other facilities will be discussed for each alternative.

5.5.1 Alternative 1 Physical Issues

This alternative includes the construction of a new 345 kV substation in the Garrard County area. This substation needs to be located near LGEE's existing Brown-Pineville double-circuit 345 kV line to minimize the amount of 345 kV line construction required to connect one of the circuits with the new 345 kV line from J.K. Smith. There is a large area in Garrard and Lincoln counties where a new substation could be located; it is expected that sufficient land is available in the vicinity to obtain for construction of the new 345 kV substation.

This alternative also calls for the construction of a new 345 kV line between the J.K. Smith Substation and the new substation in the Garrard County area. (The approximate length of the new line is 35 to 45 miles depending on line routing and the location of the new 345 kV switching substation). The city of Richmond is generally located between these two endpoints. Furthermore, the area surrounding Richmond has become highly developed. Therefore, the routing of the new 345 kV line may be difficult through this area. However, EKPC has several existing 69 and 138 kV transmission line corridors in the area, which may be able to be utilized for rebuild and/or co-location. A preliminary evaluation of potential line routes to ascertain the expected length of the new 345 kV transmission line indicates that these existing corridors can possibly be utilized to reduce the need to acquire new rights-of-way and to address the difficulty of constructing the line through the congested areas in the region. In particular, EKPC has two 138 kV lines exiting the J.K. Smith Substation to the west or southwest – J.K. Smith-Dale and J.K. Smith-Fawkes. These corridors could potentially be used for co-location of the new 345 kV line. Rebuilding of either of these 138 kV lines as a double-circuit 345/138 kV line was eliminated as a viable option for two primary reasons:

1. The time required to rebuild either of these existing 138 kV lines as a 345/138 kV double-circuit line would be a minimum of six months. This means that the 138 kV circuit to be rebuilt would be out of service for this duration. Major operational problems and generation restrictions would be created due to an outage of either of these critical circuits for this period.
2. The reduced reliability of placing two critical circuits out of the J.K. Smith Generating Station on common structures is undesirable. The probability of simultaneous outages of these two circuits would be much higher than for a "Greenfield" route or even for a parallel route.

In addition to the new 345 kV line and the new 345 kV switching substation, 345 kV terminal additions are required at LGEE's Brown and Pineville Substations. Additionally, several upgrades of existing facilities are required with this alternative. In particular, this alternative requires the following:

- Replacement of an existing EKPC 138-69 kV transformer
- Upgrades of terminal facilities at five LGEE substations associated with four LGEE facilities
- Operating temperature upgrades for two LGEE facilities
- An unknown upgrade of one AEP facility

At this time, no significant issues are apparent that would make these terminal additions and upgrades substantially difficult. Input from AEP and LGEE will be required on these projects to identify any significant issues.

5.5.2 Alternative 2 Physical Issues

This alternative includes addition of all facilities required at the existing Tyner Substation to terminate the proposed J.K. Smith-Tyner 345 kV line and to add a new 345-161 kV autotransformer. The substation does not have adequate space to allow these additions. Additional land would be needed in the area to construct the new 345-161 kV substation, and to connect it to the existing Tyner Substation. This could involve additional transmission lines between the two substations, depending on the location and availability of suitable land in the vicinity.

This alternative also includes the construction of a new 345 kV line between the J.K. Smith Substation and the Tyner Substation. (The approximate length of the new line is 40 to 50 miles, depending on line routing). The area in a straight-line approximation between these two endpoints does not appear to have any large areas that are densely populated or highly developed. However, the Daniel Boone National Forest is located in a large area between these endpoints. Therefore, the routing of the new 345 kV line may require working with the United States Forest Service (USFS) to identify and select the preferred route through the USFS lands. Past experience indicates that this could add 2 to 3 years to the expected time necessary to design, permit, and construct this line. Furthermore, EKPC does not have any existing transmission line corridors in the majority of the area to the south and southeast of J.K. Smith. Therefore, there are limited opportunities for rebuild and/or co-location for this line in that area. In the area closer to the Tyner Substation, EKPC does have an existing 161 kV line and a 69 kV line that could potentially be used for rebuild and/or co-location with the new 345 kV line.

In addition to the new 345 kV line and the new 345 kV switching substation, the addition of a 138 kV series reactor at EKPC's Dale Station is required. The ability to expand the Dale Substation is restricted due to it being bounded by the Kentucky River, the Dale Station power plant and coal yard, and Kentucky Route #1924. This will make expansion for the reactor addition difficult.

Additionally, several upgrades of existing facilities are required with this alternative. In particular, this alternative requires the following:

- Replacement of an existing EKPC 138-69 kV transformer
- Reconductors or rebuilds of an existing LGEE 138 kV line and an existing LGEE 69 kV transmission line
- Upgrades of terminal facilities at two EKPC substations associated with two transmission facilities
- Upgrades of terminal facilities and/or line switches associated with six LGEE facilities
- An operating temperature upgrade for one LGEE facility
- Unknown upgrades of four AEP facilities

At this time, no significant issues are apparent that would make these upgrades substantially difficult. Input from AEP and LGEE would be required on the projects identified for their respective systems to determine if there are any significant issues.

5.5.3 Alternative 3 Physical Issues

This alternative has many of the same physical issues as Alternative 2. The primary difference is that this alternative includes construction of a new 17.9-mile 138 kV line between J.K. Smith and LGEE's Spencer Road Substation in lieu of the addition of a series reactor at Dale Station. The new line between J.K. Smith and Spencer Road also creates several additional projects on the LGEE system in the Spencer Road area. All of the issues discussed above in subsection 5.5.2 related to the Tyner Substation expansion and the new 345 kV line between J.K. Smith and Tyner are also applicable for this alternative.

The area between the J.K. Smith and Spencer Road Substations does not appear to have significant development or dense population, based on review of area maps. EKPC does have an existing 138 kV line from J.K. Smith to its Powell County Substation that is routed in the same general direction out of the J.K. Smith site. However, it turns in the opposite direction after a few miles. Other than this line, there are limited existing facilities located in the area between the two substations. Therefore, there are some opportunities available for rebuild and/or co-location, but these opportunities are somewhat limited.

This alternative would require expansion of LGEE's Spencer Road Substation and replacement of both 138-69 kV transformers at Spencer Road with larger units. Therefore, a significant amount of work would be required at this site to implement this alternative.

Additionally, several upgrades of existing facilities are required with this alternative. In particular, this alternative requires the following:

- Replacement of an existing EKPC 138-69 kV transformer
- Reconductors or rebuilds of three existing LGEE 69 kV transmission lines
- Upgrades of terminal facilities and/or line switches associated with four LGEE facilities
- Replacement of another existing LGEE 138-69 kV transformer
- Unknown upgrades of three AEP facilities

At this time, no significant issues are apparent that would make these upgrades substantially difficult. Input from AEP and LGEE would be required on the projects identified for their respective systems to determine if there are any significant issues.

5.5.4 Relative Constructability of The Developed Alternatives

The discussion above indicates that Alternative 1 requires a new substation site, whereas Alternatives 2 and 3 do not. However, acquisition of a new substation site in the Garrard County area is expected to be feasible. Alternatives 2 and 3 both require significant expansion of existing substations within the EKPC and/or LGEE systems that is expected to present some difficulty.

All three Alternatives require significant new 345 kV line construction. Alternative 1 includes a new 345 kV line from J.K. Smith to the Garrard County area and is expected to be 35 to 45 miles in length. Alternatives 2 and 3 both require a new 345 kV line from J.K. Smith to the existing Tyner Substation. This line is expected to be 40 to 50 miles long. This line is expected to be more difficult to construct, since the Daniel Boone National Forest is between the two endpoints. Furthermore, it is expected to have more potential impact, since it is likely to be longer and since there are less opportunities for co-location with existing lines. Also, Alternative 3 requires additional construction of