

MSB Energy Associates, Incorporated

7507 Hubbard Ave. • Middleton, WI 53562-3135 • 608/831-1127 • Fax 608/836-1290 • www.msbnrg.com

Case Number 2007-00155

June 15, 2007

Kentucky Public Service Commission
P.O. Box 615
211 Sower Blvd.
Frankfort, Kentucky 40602

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COMMISSION

Attention: Charles Bright

Dear Mr. Bright:

As you requested, I have enclosed 10 bound copies of the assessment of need for Kentucky Power Company's proposed Morgan Fork-Hays Branch 138 kV transmission line. I also enclosed one loose copy for your convenience if you need to reproduce more copies.

Please let me know if there is anything else you need.

Sincerely,

Jerry E. Mendl
President

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Report on the Need for
Morgan Fork - Hays Branch 138 kV Transmission Line
In Floyd County, Kentucky
Proposed by Kentucky Power Company
Case Number 2007-00155

Prepared by

Jerry E. Mendl

MSB Energy Associates, Inc.

June 18, 2007

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Executive Summary

On May 15, 2007, Kentucky Power Company, (KPC) filed an application for a certificate of public convenience and necessity for the construction of a 138 kV transmission line in Floyd County, Kentucky. KPC proposes the Morgan Fork-Hays Branch project to meet the load requirements of Kentucky-West Virginia Gas Company, which is converting natural gas-fired pipeline compressor engines to electric motors and is substantially expanding its compressor capability at its Maytown Compressor Station near Langley, Kentucky. The customer requests service to begin in March 2008.

The proposed project taps the existing Beaver Creek-Betsy Lane 138 kV line at Morgan Fork. The proposal is to construct a radial 138 kV transmission line approximately 8.3 miles to the Hays Branch Station near Langley. The customer requests taking power at 138 kV at Hays Branch.

Conclusions

- 1) Kentucky-West Virginia Gas Company intends to expand its compressor capacity and convert its compressor engines to electric motors at the Maytown Compressor Station near Langley, Kentucky.
 - a) Operating electric motors at the Maytown Compressor Station will add 24 MW, on average, to the electrical loads near Langley.
 - b) Starting the large electric motor at the Maytown Compressor Station will require 60 MW.
- 2) To serve the Maytown Compressor load, Kentucky Power Company will need to upgrade its transmission and sub-transmission networks to resolve low voltage and thermal overload problems, especially during compressor motor startup.

- 3) Providing service to the Maytown Compressor Station at 138 kV is reasonable.
 - a) At 46 kV, the Maytown compressor motors could not be started due to low voltage.
 - b) Upgrading the 46 kV system to 69 kV would be costly, could not be accomplished in time to meet customer service requirements and may not be able to maintain voltage levels during attempts to start the motors.
 - c) Tapping into the existing 138 kV line and serving the Maytown Compressor load at 138 kV eliminates overload and low voltage problems and allows Kentucky Power Company to provide reliable service to the project area.
 - d) Tapping into a nearby 765 kV line is costly and could not be accomplished in time to meet customer service requirements.

- 4) Strategies to reliably serve load after the addition of the Maytown Compressor Station without building transmission infrastructure are limited.
 - a) Wheeling across neighboring systems is not viable because adequate interconnections to neighboring systems and to the Maytown Compressor load do not exist.
 - b) There are no power plants that exist to be redispatched, or that could be built in the project area to timely meet Maytown Compressor service requirements.
 - c) Load management and energy efficiency in the project area are not sufficient to offset the 60 MW startup demand of the Maytown compressors.
 - d) Kentucky-West Virginia Gas Company could potentially reduce startup load by replacing the two largest compressor motors with several smaller ones. Reducing the startup load may make lower voltage transmission alternatives more viable.

Section I Characteristics Driving the Need for Transmission

The Proposed Project

Kentucky Power Company's (KPC) application states that the proposed Morgan Fork-Hays Branch project is required to meet the load of a new customer near Langley, Kentucky. Kentucky-West Virginia Gas Company is converting natural gas fired pipeline compressor engines to electric motors and is substantially expanding its compressor capability at its Maytown Compressor Station. The customer is adding a 24 MW average load to KPC's system. The load is at high load factor, anticipated to operate 24 hours per day 7 days per week. Moreover, KPC anticipates the peak load during motor startup to be 60 MW.

The proposed project taps the existing Beaver Creek-Betsy Lane 138 kV line at Morgan Fork and runs a radial 138 kV transmission line approximately 8.3 miles to the Hays Branch Station near Langley. The customer requests taking power at 138 kV at Hays Branch, and will own the 138 kV equipment on the customer side of the meter. The Hays Branch Station is not a substation to provide electricity for KPC's other retail customers at typical distribution voltages. Figure 1 is a map showing the location of the proposed project.

KPC's application also lists some additional benefits of the 138 kV proposal, such as allowing the future addition of a 138 kV loop to enhance supply reliability, providing more flexibility in serving future local loads, and other benefits which will be considered in more detail later in this report.

Typical Motivations to Build Transmission Projects

The need to build transmission lines is typically motivated by reliability concerns and/or economic concerns. As loads grow and power plants are built, transmission system improvements are needed in order to serve customers reliably - i.e., delivering the power customers demand while operating the transmission system within normal loading and

voltage parameters. The transmission improvements are needed to ensure reliability of service and the integrity of the bulk power supply system.

In other cases, the transmission system improvements are needed to provide access to lower cost power supplies. Adequate generation may exist in the area where the power is used, but it may be more costly than power generation from more distant sources. If transmission system improvements are needed in order to be able to deliver the lower cost power, the need is driven by economic considerations.

Frequently the need for transmission improvements is driven by both economic and reliability considerations. The rest of Section I describes the purpose of KPC's proposed Morgan Fork-Hays Branch transmission line and helps characterize the problem KPC is proposing to solve with the Morgan Fork-Hays Branch proposal.

Appendix A is an overview of transmission systems.

Forecasts of Electricity Demands

Growth of electricity demands can occur as new customers are added or as new loads are added by existing customers. As loads increase, the utility must secure new power supplies and ensure adequate transmission paths between the power supplies and the loads. In the project area, future electric demands are driven by baseline growth and block loads.

Baseline Growth

Baseline growth refers to the relatively stable and steady growth of electrical demand that occurs as a result of ongoing development. It is characterized by the additions of a mix of residential, commercial and industrial loads driven by local population and economic growth.

Baseline load growth in the project area is projected at less than 1% per year (KPC Response to Item No. 15). Total loads in the area served by the 46 kV lines¹ (See Figure 2) are about 80 MW without the new Maytown Compressor load. As such, baseline growth in the area is less than 1 MW per year. Baseline growth is not the reason the proposed transmission line is needed.

Block Loads

Block loads refer to large load increments added by single, large customers. These may be factories, mines or, as in this case, a natural gas compressor station. Block loads represent step increases rather than continuous increases in load growth.

Kentucky-West Virginia Gas Company's Maytown Compressor is a 24 MW block load increase. Figure 3 compares the baseline load forecast for the project area to the total forecast including the Maytown Compressor block load. Figure 3 shows that the block load increase is large relative to the baseline growth. The load with the Maytown Compressor will in 2008 be equivalent to what the baseline load (without the Maytown Compressor) would have been in 2034. Stated differently, the Maytown Compressor block load addition is equivalent to over 25 years of baseline growth in the project area.

Information provided by KPC indicates that the project area is located in an active coal mining region. KPC serves coal mines in the area, and other mines may be opened on relatively short notice. Coal mines could also add substantial block loads to the electricity demands in the project area in the future. While potential future block loads at currently unidentified potential future coal mines are not the reason for building the proposed 138 kV line, they affect the robustness and longevity of the proposal and alternatives.

¹ This includes loads at substations at Kenwood, Prestonsburg, East Prestonsburg, Middle Creek, Allen, Martin, Salisbury, McKinney, Garrett, Saltlick and Spring Fork

Starting vs Steady State Load

The impact of the Kentucky-West Virginia Gas Company Maytown Compressor load is actually much more severe than described above. The steady state load is 24 MW to run two 11,000-horsepower synchronous motors and three 3,000-horsepower induction motors. According to the KPC response to item 31, the starting load for the motors can range from 5-10 times the steady state load. KPC assumed a 60 MW starting load, which would be at the low end of the range of 55 MW to 110 MW KPC estimates for an 11,000-horsepower motor.

There is a drawback to the customer having such large motors. In order to start, the motor will draw high currents which will cause voltages to drop. This is not unlike the lights in a household dimming momentarily when the vacuum cleaner is turned on. The difference is that the 60 MW starting load can cause the voltages to drop so much that the motor cannot start, and the issue is no longer one of momentary dimming. Instead there would be compressor load that could not be served and/or low voltages over the entire project area.

The 60 MW startup load assumes that the compressor motors would be started sequentially. The situation would be exacerbated if one or more compressor motors were started simultaneously. To put it into perspective relative to the baseline load growth, the 60 MW startup load is equivalent to 55 years of growth in baseline load at 1% per year.

From a transmission reliability perspective, the 24 MW steady state load is a large step increase. However, even if the transmission network were capable of handling the steady state load, it may not be capable of handling the startup load without substantial modifications. This fact limits the alternatives available to serve the Maytown Compressor loads.

Economic Need

As indicated earlier, two common motivations to build transmission lines are reliability need and economic need. As described above, reliability need is a major factor in the proposed Morgan Fork-Hays Branch transmission line, particularly the inability to reliably serve a large block load with an even greater startup load.

Economic need refers to situations in which the transmission system is adequate to serve load reliably, but is not adequate to allow full utilization of the lowest cost generation resources. In these situations, building additional transmission would increase access to lower cost power, resulting in economic savings to ratepayers.

The proposed project does not involve any economic need considerations - at least not in the foreseeable future.

- The proposed project does not enhance access to lower cost resources. Instead the proposed project is a high voltage interconnection to a large new load.
- The proposed project does not increase regional power transfers between KPC and other utilities or power suppliers, nor does it complete a loop that would enhance regional power transfers. Instead the proposed project is a radial transmission line to a large customer load. It cannot provide power to KPC; it can only distribute power from KPC.

In its application, KPC raised several benefits of its proposal that may occur at some indeterminable time in the future. These include some reliability benefits, such as ability to serve increased load growth. They also include benefits that may also have an economic component, such as using the proposed line as a platform to upgrading KPC's interconnection to East Kentucky Power Cooperative from 46 kV to 69 kV. These will be addressed in more detail in Section III, which discusses the pros and cons of potential alternatives to the proposed line.

The Electrical System in the Project Area

The area of interest related to the proposed Morgan Fork-Hays Branch project is generally defined by the 46 kV subtransmission facilities located between Beaver Creek (north of Wheelwright) and Paintsville, and west of the existing Beaver Creek-Paintsville 138 kV line. Refer to Figure 2.

Loads in the project area are served from the 46 kV system. The 46 kV subtransmission system in this area is supplied at Beaver Creek, Betsy Layne and Thelma (near Paintsville) from KPC's 138 kV transmission system. A 765 kV transmission line passes through the project area, but is not electrically tapped or terminated at any of the local substations. Some 69 kV transmission facilities are located east and south of the project area, but they do not appear to generally contribute to the power supplies to the 46 kV system.

The area around the Maytown Compressor is served from distribution lines supplied by the 46 kV subtransmission lines. Placing a 24 MW steady state and 60 MW starting load on the distribution lines would not be feasible. Even connecting it to the 46 kV system would result in low voltage and overload conditions throughout the project area.

The question from an electrical perspective is how to get sufficient power to the Maytown Compressor without low voltage and/or overload conditions on the 46 kV subtransmission system serving the area.

KPC's Transmission Planning Approach

KPC's approach to transmission planning is similar to that used by other electric utilities and will reasonably provide for reliable service. KPC models the transmission system based on its physical parameters and assumptions about power plant output and load levels. These power flow models calculate voltage levels and the amount of power flowing through each component of the transmission system. To accurately represent the transmission system, each transmission substation is individually modeled based on

individually forecasted substation loads. Service reliability is compromised when the power flow runs indicate that there are serious overloads or low voltage problems, and especially when voltage collapse can cause widespread blackouts.

When problems are indicated by the power flow runs, potential solutions must be identified in order to ensure service reliability. Generally, electric utilities identify solutions that improve the transmission infrastructure. Sometimes solutions involving operating procedures (e.g., redispatching the power plants to alleviate line loading) can be identified. While these may be acceptable as interim solutions, most utilities believe that they are not permanent solutions and should not be considered a planned substitute for appropriate infrastructure improvements.

Single Contingency Planning

Transmission components can fail. Single contingency planning means that the transmission system is designed to operate without problems (overloads, low voltage) even if any one element of the transmission system fails. KPC, like most electric utilities, plans its transmission system to function even with the outage of any one transmission line, transformer or other component. Power flow models generally run a system intact case, and then remove one element at a time to test for transmission system performance under single contingency outage conditions.

Radial Lines

Transmission systems are normally built with looped lines to provide multiple paths to reliably serve load. Think of it as a square with the power source on one corner and the load on another, and the sides of the square are the connecting transmission lines. If one of the looped lines fails, power can flow to the load on the other one. Radial lines are not looped. If the line fails, power does not reach the load and service is interrupted. The proposed Morgan Fork-Hays Branch line is a radial line. If that line fails, the compressor load at Hays Branch will not be served.

Thermal Overloads

Thermal overloads refer to a component exceeding its rating. Overloading the component results in heat buildup and temperature increases. The heat is from the electric power losses, caused by the passage of current against the resistance in the conductor. The electric power losses increase as the square of the current flow, and are more significant as the power level approaches the rated maximum.

Since heat from the conductor is harder to dissipate when the air temperature is higher, thermal limits are often based on summer conditions. Utilities often use a summer normal rating, which is not to be exceeded when all facilities are in service, for each transformer and transmission line. They also often use a summer emergency rating, which is not to be exceeded during the outage of any transmission component or generating unit, for each transformer and transmission line.

KPC is a winter-peaking utility, and based its thermal overload ratings for its 46 kV lines on maintaining a 203° F conductor temperature during the winter. As a comparison, East Kentucky Power Cooperative uses summer normal and summer emergency ratings. KPC uses only one rating for 46 kV lines in the project area because many of the 46 kV lines have distribution underbuild, which means that higher temperatures could cause the 46 kV lines to sag enough that they would fail to maintain clearance requirements with the underbuilt lines below.

Low Voltage

Low voltage conditions can cause customers' lights to dim, motors to stall, or sensitive equipment to be damaged. KPC's low voltage criterion as applied in the power flow studies conducted for the Morgan Fork-Hays Branch transmission proposal is that voltages should not be less than 92% of nominal voltage. Some utilities use a 95% system intact rating and a 90% contingency rating (with the latter being resolved to the 95% rating within 30 minutes). East Kentucky Power Cooperative, by comparison, uses 92.5% of nominal voltage as the low voltage threshold.

Summary of Section I

Regarding the assessment of reliability need for the proposed transmission line:

- KPC forecasts baseline growth in system peak demand to be less than 1% per year in the project area. Baseline growth is not a factor in the need for the proposed transmission line.
- KPC electricity demand in the project area is driven by large block loads, in this case the 24 MW steady state load added by Kentucky-West Virginia Gas Company's compressor load, which is equivalent to over 25 years of baseline growth in the project area.
- KPC expects the Kentucky-West Virginia Gas Company's compressor motor starting load to be 60 MW.
- Both the Kentucky-West Virginia Gas Company's compressor steady state and starting loads are the prime drivers of the reliability need for the proposed line.

Regarding the assessment of economic need for the proposed transmission line:

- Economic need is not a factor in the need for the proposed line for the foreseeable future.

Regarding the transmission network:

- The Maytown Compressor is in an area served from KPC's 46 kV subtransmission system.
- KPC's 46 kV system in the area of the Maytown Compressor load is at risk for low voltage and overload.

Section II Transmission System Adequacy - Without Morgan Fork-Hays Branch Line

Assessing the adequacy of KPC's transmission system without the proposed Morgan Fork-Hays Branch transmission line is a key part of characterizing the nature of the problem. This section defines the problem in terms of which transmission system components become overloaded or experience low voltages and under what circumstances. Identifying the problems that would occur in the absence of taking action leads is an assessment of the *need to take **some** action*, and is the focus of Section II. In Section III, MSB provides an assessment of the alternatives and thus an assessment of the *need to take the **specific** action* proposed by KPC (to build the Morgan Fork-Hays Branch 138 kV transmission line).

Without Maytown Compressor Load

With only baseline load growth, that is, without adding the Kentucky-West Virginia Gas Company's Maytown Compressor load, the loads in the project area would be served by the existing distribution system supplied by the 46 kV subtransmission system.

System Intact Analyses

In response to Item No. 35, KPC stated that the existing facilities are capable of serving the existing load without low voltage or thermal overload problems in the project area under system intact conditions.

Single Contingency Outage Analyses

In response to Item No. 35, KPC stated that the existing facilities are capable of serving the existing load without low voltage or thermal overload problems in the project area under single contingency outage conditions.

With Maytown Compressor Load at Steady State

Adding the Kentucky-West Virginia Gas Company's Maytown Compressor load at 24 MW requires, at a minimum, a direct interconnection at 46 kV. The area distribution system is not able to handle loads of that magnitude. The 46 kV subtransmission system is the closest higher-voltage source in the project area. KPC modeling assumed that a 46 kV circuit would be extended from the Salisbury Substation approximately 3.6 miles to the Hays Branch metering station.

System Intact Analyses

KPC indicated that under system intact conditions, there were no low voltage problems or thermal overloads when the 24 MW steady state Maytown Compressor load was connected at 46 kV².

Single Contingency Outage Analyses

KPC power flow modeling showed that several single contingency outages resulted in low voltages and thermal overloads when the Maytown Compressor station was operating at a steady state load of 24 MW served at 46 kV. These overload and low voltage conditions take on additional significance because the 24 MW steady state load is expected virtually continuously. Based on the load factor information provided in response to Item No. 32, on average, the 24 MW steady state load would occur 85% of the time annually. Thus there is a high probability that the Maytown Compressor load would be at or near 24 MW anytime that a first contingency outage occurred, even during a planned outage to conduct scheduled maintenance.

² KPC response to Items 7, 8 and 9. Also, answers to follow-up questions regarding those Items given during a telephone interview on May 31, 2007, involving MSB Energy Associates (Mendl), Kentucky Public Service Commission Staff (Rogness, Gorjian), and Kentucky Power Company representatives (Wagner, et. al.).

Table 1 summarizes the results of the single contingency outage analysis of the Maywood Compressor operating at 24 MW at a 46 kV interconnection. The "Outage Facility" refers to the transmission component that was assumed to be out of service - the single contingency outage. The "Critical Facilities" columns refer to the transmission components that overload ("Thermal") or experience low voltage ("Low Voltage").

Table 1 - Summary of Single Contingency Outage Problems Steady State Load Served at 46 kV		
Outage Facility	Critical Facilities - Thermal	Critical Facilities - Low Voltage
Beaver Creek Transformer # 2	Beaver Creek Transformer # 1 (105%)	NA
Beaver Creek - Lackey 46 kV line	Beaver Creek - McKinney 46 kV line (121%)	Maytown Compressor (92.2%) Saltlick Substation (91.8%) Springfork Substation (91.2%)
Beaver Creek - McKinney 46 kV line	Beaver Creek - Lackey 46 kV line (105%)	Maytown Compressor (89.2%) Salisbury Substation (91.0%) McKinney Substation (91.5%) Martin Substation (91.6%)

The percentages in the "Critical Facilities - Thermal" column show how much the calculated power flows exceeded the thermal ratings for that component. Generally, a 5% overload would not be considered severe because overloads tend to occur under system peak conditions (which occur only a few hours per year), and because it takes time for the component temperatures to build up during slight overload conditions. In this case, while still not a severe overload, the 5% overload takes on additional significance because the compressor load is continuous and large relative to other loads on the system. That is, the system is likely to be at or near load levels at which overloads occur for large periods of time.

The percentages in the "Critical Facilities - Low Voltage" column show the calculated voltage levels as a percent of the nominal voltage at that component. Generally, voltages above 90% of nominal would not be considered severe because they tend to occur under system peak conditions, which occur only a few hours per year. In this case, those conditions could occur more frequently due to the nature and relative size of the compressor load.

With Maytown Compressor Load at Startup Conditions

Adding the Kentucky-West Virginia Gas Company's Maytown Compressor load at 60 MW using a direct interconnection at 46 kV from the Salisbury Substation to the Hays Branch metering station, exacerbates the steady state loading.

System Intact Analyses

KPC indicated that under system intact conditions, there were both low voltage problems and thermal overloads when the 60 MW Maytown Compressor startup load was connected at 46 kV³. Attempting to draw 60 MW of startup power across the 46 kV system depressed voltages on the 46 kV system throughout the entire project area. Voltages at the Maytown Compressor dropped below 80%, which would be inadequate to start the compressor motors. Thermal overloads would occur at the Beaver Creek Transformer No. 1, the Allen - Martin 46 kV line and the Beaver Creek - McKinney 46 kV transmission line.

Table 2 summarizes the results of the system intact analysis of the Maywood Compressor operating at 60 MW startup load at a 46 kV interconnection.

³ KPC response to Items 6, 7, 8 and 9.

Table 2 - Summary of System Intact Problems Startup Load Served at 46 kV		
Outage Facility	Critical Facilities - Thermal	Critical Facilities - Low Voltage
None	Beaver Creek Transformer # 1(108%) Allen - Martin 46 kV line (129%) Beaver Creek - McKinney 46 kV line (134%)	Maytown Compressor (79.3%) Saltlick Substation (91.3%) Springfork Substation (90.7%) Lackey Switching Station (92.3%) Salisbury Substation (84.9%) McKinney Substation (89.5%) Martin Substation (85.8%) Allen Substation (89.4%) Garrett Substation (91.6%) East Prestonsburg (89.2%) Prestonsburg (89.4%) Middlecreek Substation (91.0%) Kenwood Substation (89.4%) Kenwood Tap (90.2%)

Single Contingency Outage Analyses

KPC either did not perform or did not provide power flow modeling that showed low voltages and thermal overloads under single contingency outages resulted when the Maytown Compressor station was operating at a startup load of 60 MW served at 46 kV. It is clear that they would be substantially worse than the problems under system intact conditions during motor startup. Because the system intact condition under startup conditions already showed problems that needed to be addressed, conducting further analysis of the single contingency outage conditions is unnecessary.

Discussion

The addition of the block load requires upgrades to the transmission and subtransmission systems in order to be able to start the large motors. Due to the size of the motors and large startup current draw, voltages drop to unacceptable levels throughout the 46 kV system in the project area even under system intact conditions. If the voltages were depressed momentarily but remained at levels high enough to start the large motors, the transmission and subtransmission problems could probably be resolved through a number

of improvements to the lower voltage system. The fact that voltages become depressed as extensively as they do during startup under system intact conditions means that the new customer load cannot be served from the 46 kV system.

To expand on that point, if the motors could be started, the single contingency outages of key facilities result in slight overloads that could probably be addressed by reconductoring or rebuilding several 46 kV lines. Though there are some low voltage problems, they are quite contained and relatively more manageable. However, that is moot because the startup conditions are so severe that the motors cannot be started on the 46 kV system. Thus, higher voltage solutions must be considered, unless the size of the starting load can be reduced.

Ability to Serve Future Loads

The relatively low growth in baseline demand is an advantage in that it does not add much pressure to build extra capability to serve imminent load increases. The baseline growth being so low does not greatly exacerbate the immediate problem, i.e., of designing a transmission solution that is capable of starting the large Maytown compressor motors.

On the other hand, the transmission solution should have sufficient robustness to accommodate other large block loads that may occur from coal mining activity in the area. Finding a transmission solution that barely solves the immediate problem of connecting and serving the Maytown compressor load would provide little capacity to serve future potential block loads, even if it may be able to absorb three, five, or even ten years of baseline load growth.

Summary of Section II

The problems with transmission and subtransmission in the Morgan Fork-Hays Branch project area are local reliability-driven problems - driven by the addition of a large block load with an even greater startup load.

- There are no low voltage or thermal overload problems in the project area prior to the addition of the Maytown Compressor load.
- There are no low voltage or thermal overload problems in the project area when the Maytown Compressor motors are operating at their steady state loads (24 MW) under system intact conditions.
- Several relatively minor low voltage and thermal overload problems arise in the project area when the Maytown Compressor motors are operating at their steady state loads (24 MW) under single contingency outage conditions.
- Severe low voltage and moderate overload conditions arise in the project area when the large Maytown Compressor motors are being started (60 MW) from the 46 kV system even under system intact conditions.
- The large motors at the Maytown Compressor cannot be started from the 46 kV system.

Section III Potential Solutions

This section examines the potential solutions analyzed by KPC and also identifies other possible solutions. Potential solutions would typically include transmission solutions as well as non-transmission solutions.

Transmission solutions

Potential transmission solutions in this case are dictated by their ability to maintain voltage levels during the large current draws when the large compressor motors are starting.

Connecting the Maytown Compressor load at 46 kV

KPC Alternative: KPC analyzed the potential alternative of connecting in the Maytown Compressor at 46 kV. This involved building a new 46 kV line from Salisbury Substation to the Hays Branch metering station. This potential alternative is the reference case set forth in Section II of this report. As indicated in Section II of this report, the 46 kV connection alternative has many deficiencies including low voltage and overload problems during steady state operations under single contingency conditions and during startup under system intact conditions. KPC's 46 kV alternative will not reliably serve the load.

MSB Alternative: MSB noted that the problems occurring under single contingency outage steady state conditions were quite manageable. Reconductoring the existing 46 kV lines to a larger conductor size would increase the current (and power) carrying capability sufficiently to mitigate the calculated overloads. It appears that the Beaver Creek - McKinney, Beaver Creek - Lackey and Allen - Martin 46 kV lines are all equipped with 336,400 kcmil ASCR conductors. Increasing them to 556,500 kcmil ASCR conductors, the other size prevalent in the project area, would increase the power carrying capability by about 35%, which would be sufficient to remove the expected overloads. As shown in Table 1, thermal overloads during first contingency outage

conditions and steady state operating loads were less than 121% of ratings. Reconductoring would remove the overloads. Even under system intact startup conditions, the thermal overloads are 134% of ratings or less, and thus reconductoring would eliminate those overloads as well.

MSB does not consider this to be a viable alternative. The 46 kV approaches, according to KPC power flow analyses, are simply unable to maintain voltage levels during the motor startup. As long as startup loads are on the order of 60 MW, a higher voltage solution will be needed to start the motors and serve the load.

In addition, KPC also noted that the structures supporting the 46 kV lines in the project area are loaded to their weight-bearing capacity. That would mean that reconductoring would also require replacing most of the support structures - in effect rebuilding the line. KPC estimated that the cost to rebuild the 7.5 miles of the Beaver Creek-McKinney and 10 miles of the Beaver Creek-Lackey lines at 46 kV, together with the replacement of the Beaver Creek Transformer, would cost approximately \$13 million.⁴ In addition, there would be another approximately \$2 million cost to build the 46 kV line from Salisbury to the Maytown Compressor.

Thus a total of about \$15 million would be required to upgrade the 46 kV system, in comparison to KPC's estimated \$15.4 million for its 138 kV proposal. But the 46 kV approach would still be unable to maintain acceptable voltage levels during motor startup, and would have more limited capability to address new block and baseline loads in the project area. MSB does not consider the enhanced 46 kV alternative to be viable.

Connecting the Maytown Compressor load at 69 kV

KPC Alternative: In paragraph 18 of the application, KPC indicated that its proposed 138 kV solution provides a potential 69 kV source that could be used in any conversion of the existing 46 kV system to 69 kV. MSB interpreted that to mean that KPC had some

⁴ Item No. 35 response by KPC.

long term plans to upgrade the 46 kV system to 69 kV as loads grew in the future. In response to Items 16, 17 and 35, KPC clarified that the existing 46 kV system in the project area was not designed to be upgraded to 69 kV and that doing a large scale conversion would cost on the order of \$120 million for lines and substation equipment and would take five years to complete. This would be well beyond the March 2008 date by which Kentucky-West Virginia Gas Company plans to start using electric motors for compression. MSB agrees with KPC that large scale upgrading of the 46 kV system to 69 kV is not a viable alternative.

MSB Alternative: During the May 31 telephone interview following the responses to Item Nos. 1-30, KPC provided clarification of its intent regarding the 69 kV conversion in application paragraph 18. KPC indicated that it was currently interconnected with East Kentucky Power Cooperative at the Falcon Substation at 46 kV, but was considering upgrading the interconnection to 69 kV. Referring to Figure 2, that would entail upgrading the Falcon-Middle Creek 46 kV line to 69 kV. KPC in its application was suggesting that the proposed 138 kV line could ultimately be terminated with a 138 kV to 69 kV transformer at Hays Branch. That new 138/69 kV substation would be somehow connected to the 69 kV Falcon-Middle Creek upgrade, thus completing the interconnection with East Kentucky Power Cooperative at 69 kV.

If KPC intends to complete a 69 kV interconnection to the west from Hays Branch to Falcon, then the alternative of serving the Maytown Compressor load at 69 kV may be more attractive. The cost to upgrade the interconnection may be expended anyway, so there could be minimal incremental cost to serve the Maytown Compressor load. However, there are several reasons this potential alternative is not reasonable. First, connecting a large load over a long radial 69 kV line from the west is not likely to provide the required level of reliability, and may, in fact, be electrically unworkable - KPC did not perform power flow studies of any 69 kV alternatives.

Second, to be a useful interconnection between the utilities, the 69 kV cannot terminate at Hays Branch but instead must tie into strong sources in KPC. To tie into the 69 kV

system, the Falcon-Hays Branch 69 kV line would have to be extended to Betsy Layne or Beaver Creek, the two nearest locations of existing 69 kV lines. Either of those extensions is longer than KPC's proposed line which taps the Beaver Creek-Betsy Layne 138 kV line near its midpoint.

An alternate means of tying the interconnection to strong sources in KPC, Falcon-Hays Branch 69 kV could be terminated at a 138/69 kV substation at Hays Branch or at Morgan Fork. The former would build the proposed line as 138 kV; the latter would build it at 69 kV. If built at 138 kV, this is the same as KPC's proposal. If built at 69 kV, it would increase losses, reduce flexibility and not fit in to a possible future 138 kV loop also mentioned by KPC in paragraph 18 of the application.

MSB does not consider the 69 kV upgrade to be a viable alternative. It is not likely to produce any significant electrical benefits, and is likely to take longer to fully implement. In the meantime, it would either not serve the Maytown Compressor load as soon or as reliably. Finally, it might ultimately end up with the same configuration that KPC is contemplating with its proposal, only constructed in a different order.

Connecting the Maytown Compressor load at 138 kV

KPC Alternative: This is KPC's proposal. KPC's proposal resolves the low voltage and overload conditions resulting from the addition of the Maytown Compressor load. KPC evaluated a Northern, Central and Southern route. Each route connected the same endpoints and is electrically indistinguishable from the other two. The proposed route is the shortest, shares right of way with the 765 kV line, and is the least expensive. MSB agrees with KPC that the proposed 138 kV line is a viable alternative.

MSB Alternative: MSB did not identify any other reasonable 138 kV sources. Tapping the Beaver Creek - Betsy Layne 138 kV line is shorter and utilizes more corridor sharing than other potential 138 kV sources.

Connecting the Maytown Compressor load at 138/765 kV

KPC Alternative: KPC identified this alternative in the application: to tap into the 765 kV line that the proposed line parallels for nearly half of its length, rather than to tap into the Beaver Creek-Betsy Layne 138 kV line. The 765 kV tap would be transformed down to 138 kV, and then extended from the tap substation to the Hays Branch metering station. The advantage of this alternative is that there is not a redundant 138 kV line built parallel to the 765 kV line to serve Maytown Compressor loads. It also creates a strong 138 kV source for a 138 kV loop that KPC could eventually build to improve reliability if loads in the project area grow sufficiently. At present, KPC has no plans to build such a 138 kV loop, but indicates that one could be needed if block loads grow.

In responses to Item No. 35, KPC identified three reasons that tapping into the 765 kV line was not practical. First, it would require the construction of a 20-acre switching station and substation to convert to 138 kV. Second, it would need 20 acres of flat land, which is not readily available in the mountainous regions through which the 765 kV line passes. Not only would the land be at a premium, it may require the construction of 765 kV lines to access it from the existing line. Third, the project could not be implemented for about three years, much after the March 2008 date requested by the customer to begin service.

MSB concurs with KPC that the 765 kV alternative is not practical due to cost and timing concerns.

MSB Alternative: MSB did not consider any other 765 kV tap alternatives.

Non-transmission solutions

Potential non-transmission solutions in this case are dictated by the size of the block load, and particularly the motor startup load. Non-transmission solutions would typically include building new power plants in locations to alleviate transmission needs and

building distributed generation (smaller and more closely located to the load). Redispatching existing generation may also be a viable non-transmission option to eliminate overloads or low voltages. Non-transmission alternatives would also include load management and energy efficiency programs to reduce usage on the customer side of the meter. Customer owned generation on the customer side of the meter could also be an effective tool to reduce transmission problems.

Wheeling Power on Neighboring Systems

Wheeling power on neighboring systems is not an alternative in this case. The new Maytown Compressor load is located well within KPC service territory. The load is currently not interconnected and some new construction must be done in order to connect and serve the load. Thus, there is no viable wheeling alternative to serve the Maytown compressor load in the near term.

Over the longer term, if KPC decides to upgrade the interconnection with East Kentucky Power Cooperative at Falcon to 69 kV and then extends it to Hays Branch, that will create a second path for power supplies from the west rather than from the east. The western supply would involve some wheeling on the neighboring system. However, this arrangement to the west would not normally be expected to move significant amounts of power under system intact conditions. That is because stronger 138 kV sources are located nearer to the Maytown Compressor load from the east, and these sources are likely to dominate over more distant power supplies at 69 kV from the west. Thus, while a second path may eventually exist that in theory could be used to wheel power across neighboring systems to serve Maytown Compressor load, it is not likely to be a significant flow path for power under system intact conditions.

Redispatching

Redispatching, or increasing generator output out of economic order at locations strategic to maintaining transmission system integrity, is not an alternative in this case. Redispatching alleviates loading on transmission lines by shaping where power sources

are and what paths power flows along from the sources to the loads. In this case, the issue is connecting a large block load at the Maytown Compressor. There is no generation in the vicinity of the Maytown Compressor load that would allow the motors to start and the load to be served.

In addition, redispatching can be economic when the incremental cost of dispatching out of economic order is less than the cost of building the transmission line. The high load factor of the Maytown compressor would require dispatching out of economic order many hours each year, which is likely to make redispatching very costly relative to building the additional transmission lines.

Building Large Power Plants

The location of large power plants can and does affect the power flows and voltage conditions on the transmission network. Normally, power plants are much more costly to build than transmission, and it is generally not cost effective to consider building a large power plant in order to avoid building a transmission line. However, if a power plant needs to be built to meet power supply needs, the benefits to the transmission system could influence the location of that power plant. In this case, constructing a large scale power plant to serve the Maytown Compressor load is not applicable. First of all, building a large scale power plant would require extensive interconnections of the plant to the high voltage transmission network. Rather than building one transmission line into the project area to serve a large block load there, KPC would have to build multiple high voltage lines through the project area to deliver power from the plant to the transmission system. Building multiple high voltage lines to connect a generator to avoid building one high voltage line to connect a large load is not a practical option.

Load Management

Load management can in some instances control the peak loads sufficiently to defer or avoid the need to build transmission or generation projects. Load management as used in this report refers to direct load control methods and is aimed at shifting or shedding load

at the time of peak (or other critical times) through voluntary curtailment of customer service or an interruption of a controlled appliance/process.

Interruptible tariffs are one form of load management that may be applicable to the Kentucky-West Virginia Gas Company. The Gas Company has existing compressor engines powered by natural gas. Initially, additional compression capacity will be added using electric motors, and both the natural gas and electric motors will be run.

Eventually, the gas engines will be replaced by electric motors and retired. Having both the gas and electric motors on site provides an opportunity to interrupt part of the electric load when the need arises while continuing the compression work with the gas engines.

KPC offered Kentucky-West Virginia Gas Company the opportunity to go onto interruptible tariffs. The Gas Company declined because it did not consider its loads interruptible and because KPC's loads peak in the winter when the Gas Company has its highest loads and the greatest value of gas burned for compression. (Item Nos. 4 and 34)

Ultimately as it applies to this 138 kV transmission proposal, however, the problem is the large 60 MW starting load. The 60 MW load cannot be interrupted because it is the smallest amount of starting load associated with the large motor - if you want to start the 11,000-horsepower motor you will incur the 60 MW starting load. The transmission network must be designed to supply that 60 MW starting load.

One possible strategy for shaping the customer's loads to reduce the starting load is to select different motor sizes. For example, all else being equal, replacing each 11,000-horsepower motor with two 5,500-horsepower motors would cut the starting load to 30 MW. Since there were no low voltage or overload problems for the system intact steady state condition (24 MW) and relatively few problems for the first contingency outage steady state condition, peak starting loads approaching 24 MW potentially could be sustainable on the 46 kV system.

Of course it is the customer's choice as to the number and size of motors he/she installs. And it is the utility's obligation to serve the loads that are demanded. Thus the utility and the Commission cannot control the number and size of motors; they can only assure that the customer pays a fair price for the MWs and MWHs consumed and that costs incurred by the utility to serve that customer are reasonably allocated to that customer.

Energy Efficiency

Energy efficiency programs focus on appliances and processes that use less energy whenever they are in use. As such, not only will they reduce overall electrical energy consumed, they also will reduce the peak load to the extent they are on during time of peak. Properly designed energy efficiency programs can be useful in reducing overall growth of peak loads and energy requirements. In this case, because the baseline growth is small relative to the block demand growth, energy efficiency opportunities in the baseline growth will not materially affect the need for the proposed transmission line. Again, that is because the need for the proposed line is driven so strongly by the starting load imposed by the large motors.

To the extent that the improvement in the energy efficiency of the compressor motors reduces the starting load of the motor, energy efficiency can help offset the problems during startup. Again, that is the customer's choice. MSB did not conduct any analysis of the efficiency of the compressor motors, and especially the large motors. However, MSB assumes that motors that large with that high of load factors are designed and selected by the Gas Company with energy efficiency in mind.

Distributed Generation

Distributed generation refers to small generators, typically 15 MW or less, located near to the load. Distributed generation reduces the need for large power plants. Distributed generation, being located nearer to the load, can reduce transmission losses and the need for transmission system improvements. Distributed generation can be implemented as customer owned and controlled (on customer side of meter reducing net load), utility

owned and controlled (on utility side of meter adding to the supply), or somewhere in between (e.g., customer owned but utility co-controlled, etc).

In the context of the Morgan Fork-Hays Branch proposal, the electric motors are replacing an existing distributed power source. In effect a distributed power resource is being retired by the customer and replaced by an electric load that requires electric system upgrades.

Other Benefits of the Proposal

KPC in paragraph 18 of the application asserted that the proposed 138 kV line "will provide a platform to enable Kentucky Power to provide improved reliability for the eastern Kentucky area transmission and distribution systems." KPC listed five benefits:

- a) Reliability on KPC's 138 kV network will be improved with the installation of two circuit breakers at Morgan Fork Station;
- b) Additional capacity to serve additional load from Morgan Fork Station;
- c) Potential 69 kV source that could be used in any conversion of the 46 kV system to a 69 kV system;
- d) Opportunity to locate a future station at the intersection of the Morgan Fork-Hays Branch line and the Martin-Salisbury-McKinney 46 kV line; and
- e) Opportunity for a future 138 kV loop from Thelma to Beaver Creek:

MSB has assessed each of these other benefits and agrees each of these points can have bearing on the long-range transmission system configuration. However, because the anticipated demand growth rates are quite low, there are no immediate needs for or plans implement points b) through e). None of these points rise to being determinative of choices between alternatives, though each may be valuable under certain circumstances. In other words, while the five points of the platform are reasonable considerations to help ensure sufficient flexibility to meet future conditions, they are not, in and of themselves, significant drivers of the need for the proposed project.

Summary of Section III

The large block load, and especially the large motor startup load, being added create severe low voltage problems as identified in Section II. This limits the types of transmission alternatives that could be developed to primarily higher voltage alternatives. KPC's obligation to serve the new load, coupled with its size, greatly limits the number of non-transmission alternatives to the proposed project that could be viable.

- KPC concluded that connecting the Maytown Compressor load at 46 kV was not viable. MSB concurs.
- MSB concluded that an enhanced connection at 46 kV, one including some rebuilding of existing 46 kV lines, was not a viable means to serve the Maytown Compressor load.
- KPC concluded that large scale rebuilding of the 46 kV system to 69 kV is not a viable means to serve the Maytown Compressor load. MSB concurs.
- MSB concluded that upgrading a targeted 46 kV line 69 kV is not a viable means to serve the Maytown Compressor load.
- KPC concluded that the proposed 138 kV alternative is a viable means to serve the Maytown Compressor load. MSB concurs.
- KPC concluded that the proposed 765 kV tap to 138 kV alternative is not a viable means to serve the Maytown Compressor load. MSB concurs.
- MSB concluded that wheeling power on neighboring systems was not a viable means to serve the Maytown Compressor load.
- MSB concluded that redispatching power plants to alleviate transmission system problems was not a viable means to serve the Maytown Compressor load.

- MSB concluded that building new utility-scale power plants to alleviate transmission system problems was not a viable means to serve the Maytown Compressor load.
- MSB concluded that implementing traditional load management programs to alleviate transmission system problems was not a viable means to serve the Maytown Compressor load.
- MSB concluded that customer willingness to adjust the size and number of electric motors driving the compressors could substantially reduce the startup load and thus the seriousness of low voltage and overload problems. MSB cannot rule out the possibility that startup loads could be affected enough that the Maytown Compressor loads could be served from the 46 kV system.
- MSB concluded that energy efficiency programs were not a viable means to serve the Maytown Compressor load.
- MSB concluded that distributed generation was not a viable means to serve the Maytown Compressor load.

Section IV Conclusions

MSB concluded that:

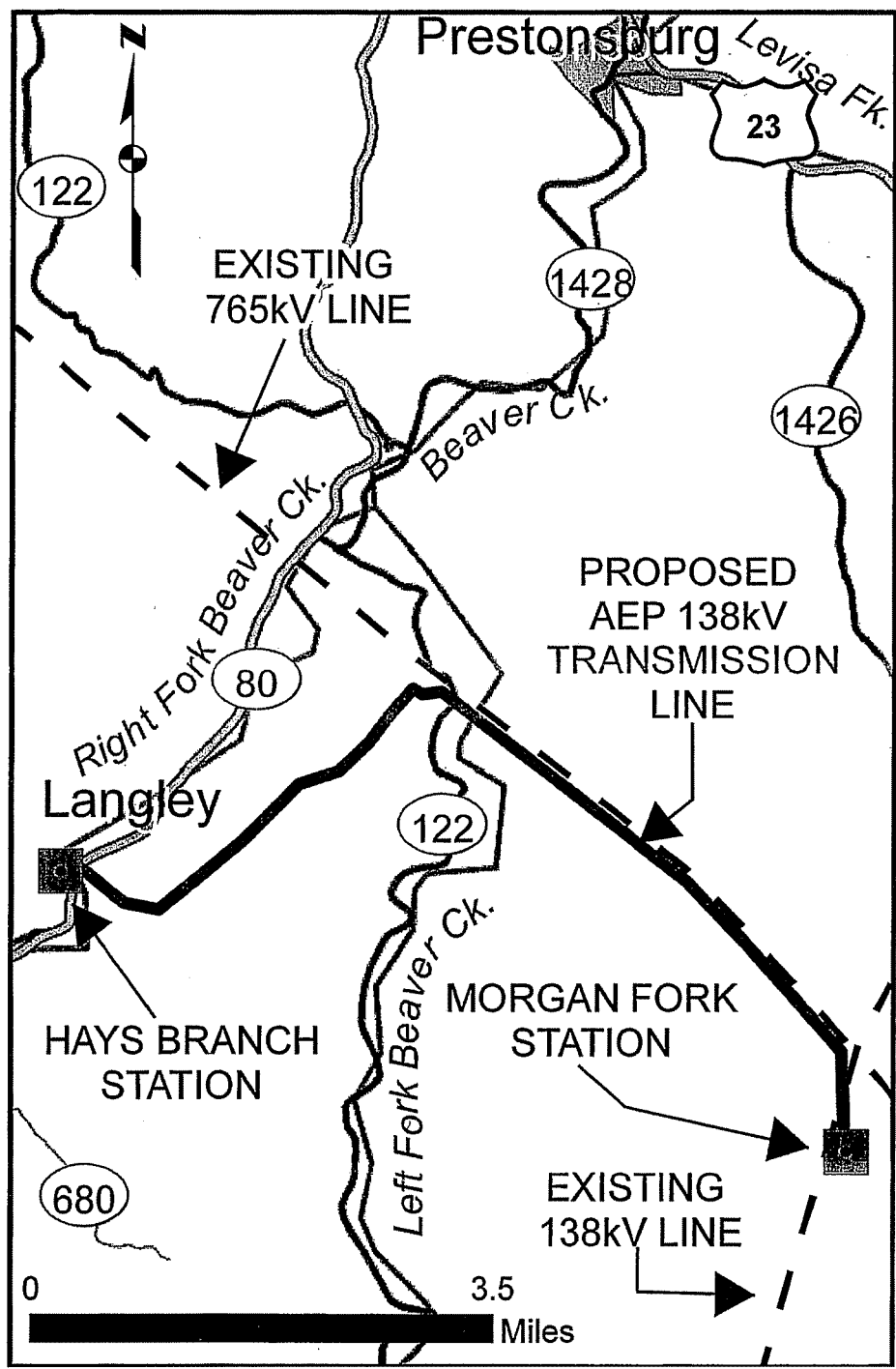
- 1) Kentucky-West Virginia Gas Company intends to expand its compressor capacity and convert its compressor engines to electric motors at the Maytown Compressor Station near Langley, Kentucky.
 - a) Operating electric motors at the Maytown Compressor Station will add 24 MW, on average, to the electrical loads near Langley.
 - b) Starting the large electric motor at the Maytown Compressor Station will require 60 MW.

- 2) To serve the Maytown Compressor load, Kentucky Power Company will need to upgrade its transmission and sub-transmission networks to resolve low voltage and thermal overload problems, especially during compressor motor startup.

- 3) Providing service to the Maytown Compressor Station at 138 kV is reasonable.
 - a) At 46 kV, the Maytown compressor motors could not be started due to low voltage.
 - b) Upgrading the 46 kV system to 69 kV would be costly, could not be accomplished in time to meet customer service requirements and may not be able to maintain voltage levels during attempts to start the motors.
 - c) Tapping into the existing 138 kV line and serving the Maytown Compressor load at 138 kV eliminates overload and low voltage problems and allows Kentucky Power Company to provide reliable service to the project area.
 - d) Tapping into a nearby 765 kV line is costly and could not be accomplished in time to meet customer service requirements.

- 4) Strategies to reliably serve load after the addition of the Maytown Compressor Station without building transmission infrastructure are limited.
 - a) Wheeling across neighboring systems is not viable because adequate interconnections to neighboring systems and to the Maytown Compressor load do not exist.
 - b) There are no power plants that exist to be redispatched, or that could be built in the project area to timely meet Maytown Compressor service requirements.
 - c) Load management and energy efficiency in the project area are not sufficient to offset the 60 MW startup demand of the Maytown compressors.
 - d) Kentucky-West Virginia Gas Company could potentially reduce startup load by replacing the two largest compressor motors with several smaller ones. Reducing the startup load may make lower voltage transmission alternatives more viable.

Figure 1



CASE NO. 2007-00155
EXHIBIT 1

Figure 2

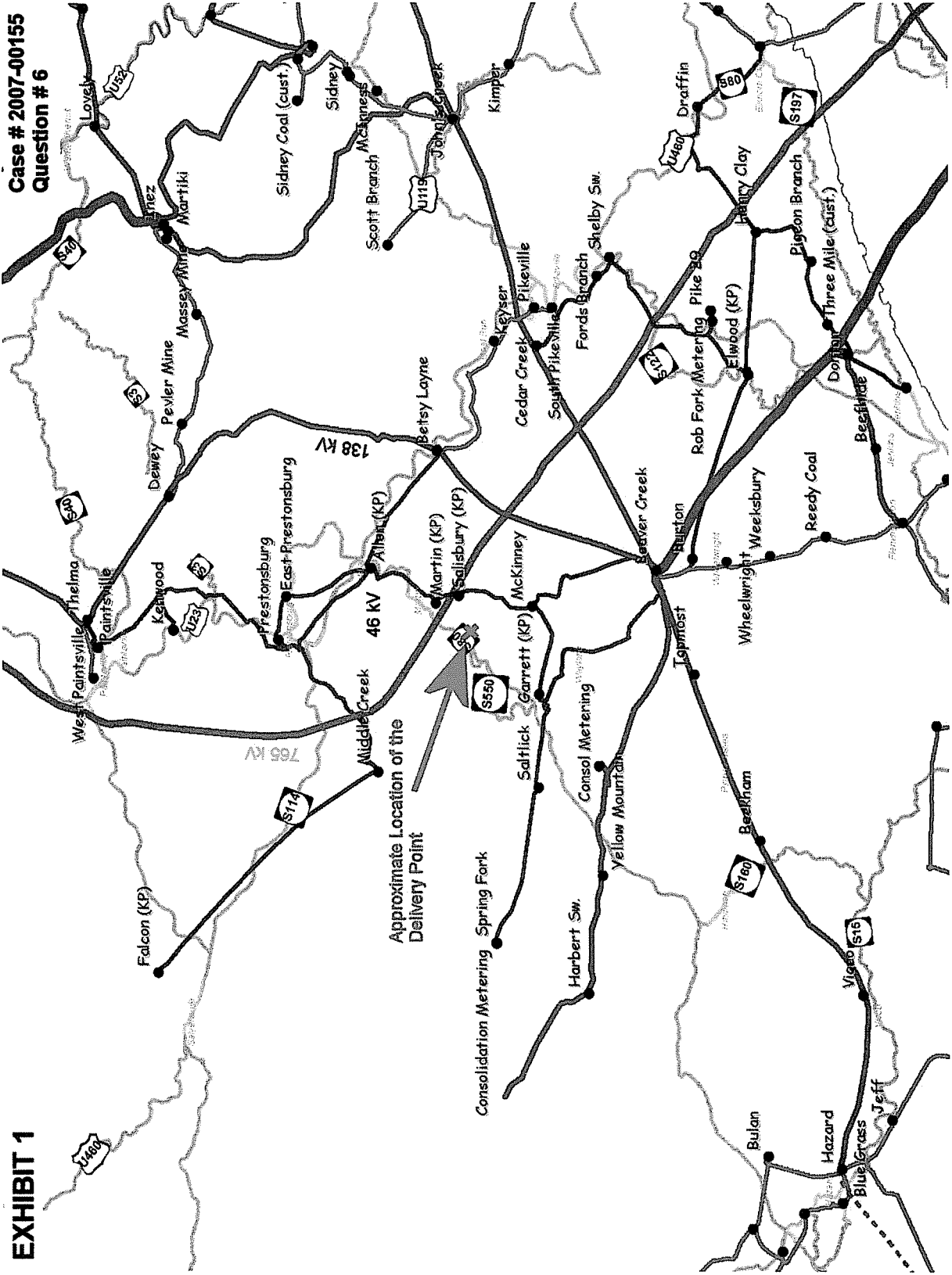


Figure 3

IMPACT OF MAYTOWN COMPRESSOR BLOCK LOAD ON PROJECT AREA BASELINE LOAD

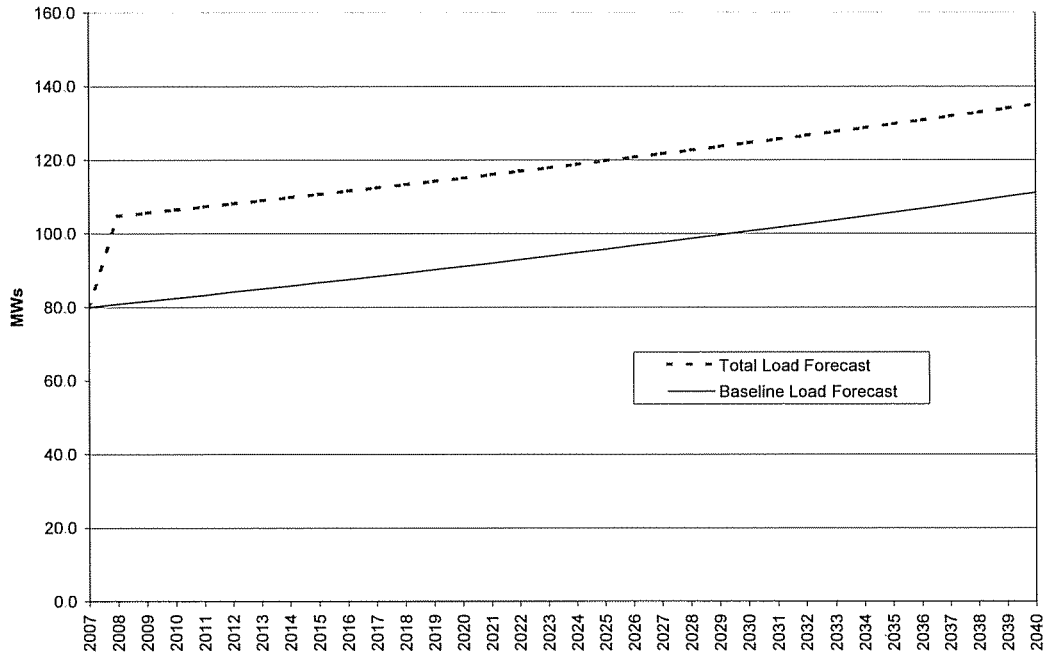


Figure 3 is not a forecast of annual peak demands. Its purpose is to illustrate the effect of the Maytown Compressor block load relative to baseline load growth (assumed at 1% per year). Kentucky Power Company forecasts growth in the project area at less than 1%.

Appendix A

Overview of Transmission Systems

Power plants generate electricity, often at points distant from the location that the electricity is actually used. Power plants tend to be quite large, each often being capable of serving hundreds of thousands of homes. Power must be transported from these large power plants to the homes and businesses where it is used. Power is transmitted over great distances by the high voltage transmission network to substations where it is converted to lower voltages. Transmission lines normally operate at voltages between 69,000 volts (69 kV) and 765,000 volts (765 kV). These voltages are much too high to be used in homes and most businesses. Transformers at substations convert transmission voltages to successively lower voltages that ultimately supply the distribution lines that fan out from distribution substations to deliver power to the customer. One final transformer reduces the distribution voltage to voltages typically used by customers; e.g., most smaller businesses and residential customers typically use power at 220 volts.

Path of Least Resistance

Electricity flows from the source (power plant) to the sink (end user) in accordance with the laws of physics. Power will flow most freely along the path of least resistance. Transmission systems are interconnected and provide multiple paths for power to flow. This complicates the analysis of transmission systems. Power will flow across multiple parallel transmission paths as it moves from the power plant to the end user. It will also come from multiple power plants. The transmission system can be viewed as a collector of power from the various power plants on the system and as a supplier of power to the various distribution substations connected to it. It is important to remember that power will flow from multiple power plants to the point of end use along multiple parallel paths, with the paths of lesser resistance taking more of the power flow, even if doing so will overload a transmission facility. Power flow models simulate the operation of the transmission network based on its physical parameters, the location and size of power plants, the location and size of load, and the laws of physics.

Increasing Line Capacity

The maximum amount of power that can be carried by a transmission line depends on the voltage and current that the line is designed for. At a given voltage, the larger the conductors, the more power it can carry. If an existing line is running at full capacity, the capacity can be increased by reconductoring the line, that is, to remove the old conductors and replace them with larger conductors capable of handling higher current flows. This assumes that the existing structures are able to support the additional weight of the larger conductors. If not, reconductoring may require substantial rebuilding of the line.

The other way to increase the amount of power a line can carry is to increase the voltage at which it operates. Higher voltages require more insulation (larger insulators between the towers and the conductors) and increased clearances (wider rights of way and taller towers). For an existing line, upgrading the voltage may be difficult if clearance requirements cannot be met; e.g., the line was built on small structures or through land uses that do not allow widening the rights of way.

Losses occur in all transmission lines. The resistance of the conductor to current flowing through it causes the conductor to heat up. These losses increase as the square of the current flowing through the line, so that doubling the current quadruples the losses. For a given conductor size, doubling the voltage (e.g., from 69 kV to 138 kV) will halve the current for any given power level and result in one-fourth of the losses. All else equal, the higher the voltage at which a transmission line operates, the more power it can carry and the lower the losses.

