Facilities Study
to Connect
EnviroPower's
New Generators
to the AEP Transmission Network

Knott County, Kentucky
(AEP IPP Project # 34)

Transmission Planning

October 2000

AEP: America's Energy Partner℠

1. INTRODUCTION

EnviroPower, LLC (EnviroPower) by letter dated April 4, 2000, requested American Electric Power (AEP) to conduct a limited scope power flow analysis to evaluate the feasibility of connecting a new merchant generating plant to the AEP transmission system in the Beaver Creek-Hazard Area. EnviroPower plans to install a 500 MW plant facility in Knott County, Kentucky. The plant will consist of one 500 MW base loaded waste-coal fired unit. The closest 138 kV transmission facility to the plant site, as shown in Figure 1, is the Harbert Station on the Beaver Creek-Spicewood 138 kV line. The line is about 5 miles away from the plant site. The Beaver Creek and Hazard 138 kV stations are at a distance of about 22 and 14 miles, respectively. The expected service date for the project is June 1, 2003.

The load flow and stability analyses, conducted earlier, are summarized in two reports issued in August 2000. As indicated in the load flow report, 138 kV lines and 138/subtransmission station facilities experience increased loadings as a result of connecting EnviroPower's 500 MW generating facility to the AEP System. New transformer and/or system re-configuration would be required to mitigate those problems.

This facility connection study defines the scope of the facilities necessary to integrate the proposed 500 MW generating plant. It addresses system improvements required to mitigate the thermal performance issues resulting from the generation addition. The details of facilities required to accommodate this generation are identified in this report.

AEP has an existing 161 kV interconnection with Tennessee Valley Authority (TVA) in the area. In addition, several low voltage connections north of the Beaver Creek Station exist between AEP and East Kentucky Power Cooperative (EKPC). Therefore, AEP will share this report with TVA and EKPC for review of the impact on their systems.

This analysis was conducted for interconnection feasibility purposes only. A complete System Impact Study will be required should transmission service be requested. Transmission Service Requests (TSR) must be made to deliver the output of the merchant plant to specific points of delivery and these TSRs must be made in accordance with the AEP Open Access Transmission Tariff (OATT). This study addresses only the feasibility of integrating the merchant plant to the AEP system and does not address the availability of transmission capability to support transmission services to deliver the output of the merchant plant to specific points of delivery.

2. OVERVIEW OF POWER SUPPLY FACILITIES NEAR THE PROPOSED SITES

The Beaver Creek - Hazard area, the eastern most portion of the Commonwealth of Kentucky, is located within AEP's Roanoke Transmission Region. As shown in Figure 1, the transmission facility closest to the plant site is the Harbert Station on the Beaver Creek-Spicewood 138 kV line. This line, which is radially connected to the Beaver Creek Station, serves several coal-mining customer loads. The line capacity is limited by the 795 kcm ACSR conductor (Summer normal and emergency ratings 258/345 MVA). The Hazard Station, located at approximately 14 miles south of the proposed plant site, connects to the rest of the AEP transmission system via

two transmission lines. These lines terminate at the Beaver Creek 138 kV Station and the Leslie 161 kV Station (connected via three single-phase 45 MVA, 161/138 kV, transformer units). The combined summer normal and emergency thermal capabilities of these two outlets are 327 and 396 MVA, respectively. Hazard Station also serves the local area sub-transmission load via two 138/69 kV transformers. The Beaver Creek Station, a major switching station in the area is about 22 miles away from the EnviroPower's proposed plant site. The ± 125 MVAr Static VAR Compensator and four (4) 138 kV shunt capacitors at the Beaver Creek Station together with capacitor banks at several other stations provide reactive power and voltage support in the area. Stations on the 74-mile long Beaver Creek-Hazard-Pineville line serve a major portion of the area load.

Phase voltage unbalance exists on the AEP transmission system in the Beaver Creek - Hazard area. The unbalance is affected by changes in system conditions, and consequently varies over time. Consequently, it is recommended that the EnviroPower plant equipment be rated accordingly.

3. SCOPE OF STUDY

The scope of this study is to determine the facilities required for integrating EnviroPower's proposed Knott County Generating Plant into the existing AEP System. This includes facilities necessary to connect the plant into the existing AEP Transmission System in the Beaver Creek - Hazard area and address thermal overload problems and other concerns which have been identified in phase 1 and phase 2 of the System Impact Study. Only one option to integrate the Knott County Project was considered for this phase of the study, which is as follows:

- The 500 MW EnviroPower Generating Plant connected to a new 138 kV switching station located at the plant site (Figure 2):
  - ❖ Integrate the new switching station into the AEP transmission system via three new 138 kV lines – two to Beaver Creek Station (one direct and one via Harbert), and one to Hazard Station via a new Bulan 138/69 kV Station (Figure 3).
  - ❖ Construct a new 138/69 kV station at a site provided by EnviroPower – approximately 2-miles north of the existing Bulan 69 kV Station.

The cost estimates for facilities required to integrate EnviroPower's proposed generating plant into the existing AEP System, including facilities necessary to address thermal overload problems, circuit breaker duty and transmission system stability concerns are broken down into two groups:

- Direct Interconnect costs: facilities **required** to connect the proposed generating plant;
- Transmission System Upgrades: AEP System facility upgrades or additions, which are required to eliminate system contingency thermal overloads resulting from the addition of the proposed generating plant.

The direct interconnection facilities include the lines, metering, circuit breakers and associated equipment required to connect EnviroPower's proposed generating plant. Also included are replacement or addition of facilities to reduce thermal overloads during normal peak load conditions and to accommodate increases in the short circuit levels due to the plant addition. The direct interconnection facilities consist of the three plant outlets, additions of 138 kV circuit breakers and associated equipment at the Beaver Creek, Harbert, and Hazard 138 kV stations.

Transmission system upgrades include all costs associated with mitigating contingency thermal overload concerns. The facility thermal overloads were outlined in the report titled "System Impact Study Phase I – Loadflow Analysis, System Impact Study to Connect EnviroPower's New Generators to AEP Transmission Network, Knott County, Kentucky" which was issued to EnviroPower in August 2000. Table 1 shows the loading on transformers and lines, which would experience thermal loading in excess of their normal and or emergency capabilities. These loadings are based on AEP's existing transmission system and EnviroPower's generating plant in service. The transmission system upgrades include the installation of the New Bulan 138/69 kV Station and 69 kV line reconfigurations to integrate the new station into the AEP Transmission System.

Loadflow and short circuit models were created with the proposed generation and the system facility plan as outlined earlier in this report. Analyses were then conducted to simulate various contingency conditions.

Table 2 shows the result of the short circuit analysis. As can be observed, the three phase and line to ground circuit breaker duties increase at existing stations. The magnitude of these increases ranges from a maximum of 1100 MVA for line to ground faults to 1300 MVA for three phase faults. The increased fault levels are all well within the capabilities of the existing circuit breakers. None of the existing circuit breakers will need to be replaced due to the increased short circuit levels.

Figures 4.1 and 4.2 show base system condition power flows – with all facilities in service. Single contingency outages did not cause any facility loading to exceed 87 % of their respective emergency capability or loading levels that existed prior to the addition of the EnviroPower Generating facility.

With the proposed facility additions, the AEP System in the vicinity of EnviroPower's proposed generating plant area will be capable of accommodating receipt of the full 500 MW output.

4. Cost Estimates:

Figures 2 and 5 through 8 show the simplified one line diagram of the planned transmission system configuration in the vicinity of EnviroPower's plant site. The cost estimates for the interconnection station facilities at the plant site to be constructed by EnviroPower are not included.

EnviroPower will be responsible for constructing the 138 kV switching station at their plant site. AEP will provide minimum functional requirements for the in-line station facilities. In addition, AEP will design and install 138 kV metering, all line potential and carrier relaying equipment for the three (3) 138 kV lines, as well as panels, data recorders etc. inside the control house provided by EnviroPower. EnviroPower will make a Contribution In Aid of Construction (CIAC) covering the full cost of the facilities described in this report including any tax consequences that may result from the CIAC.

Direct Interconnection Facilities:

Station Work

New 138 kV Switching Station - Located at EnviroPower's Plant Site: (Figures 2 and 3)
Install four (4) 138 kV circuit breakers, associated switches, wave traps, metering and relaying to connect the three newly created 138 kV lines to Beaver Creek, Harbert, and Hazard stations. EnviroPower will be responsible for constructing the 138 kV switching station at their plant site. AEP will provide minimum functional requirements for the in-line station facilities. AEP will design and install 138 kV metering, all line potential and carrier relaying equipment for the three (3) 138 kV lines, as well as panels, data acquisition and fault recording equipment inside the control house provided by EnviroPower.

The metering system will measure bi-directional power and energy flows at the 138 kV interconnection to the power plant. It will include CTs/VTs, kWh meters, data recorders and a dial-up phone line for remote data retrieval, a new Remote Terminal Unit (RTU) and a leased phone line for remote control and monitoring of the new switching devices. Additional metering and telemetry equipment may be required at the EnviroPower's Plant when the plant one-line configuration and its control instrumentation system are finalized.

Estimated Cost [1, 2] **$ 739,000**

[2] The estimate does not include cost to establish the new station at the plant site, install circuit breakers, structural steel, grounding, bus, control house, etc. EnviroPower will be responsible for designing and constructing the new station with the exception of the facilities as defined above.

Beaver Creek 138 kV Station: (Figures 3 and 5)
Install a new 138kV, 3000A circuit breaker, 138kV, 3000A gang operated breaker disconnect switches, bus work, 138kV structural steel, control cable, relaying, grounding and associated equipment.

Estimated Cost [1] **$ 714,000**

Hazard 138 kV Station: (Figures 3 and 6)
Install a new 138kV, 3000A circuit breaker, 138kV, 3000A gang operated breaker disconnect switches, bus work, 138kV structural steel, control cable, relaying, grounding and associated equipment.

Estimated Cost [1] **$ 513,000**

New Harbert 138 kV Station: (Figures 3 and 7)
Expand this station to accommodate the termination of a new 138kV line to the EnviroPower IPP interconnecting station, the existing feed to Spicewood and the metering and feed to Harbert Construction. Install a 138kV steel bay, foundations, grounding, 138kV 2000A circuit breaker and associated line, bus and breaker by-pass disconnect switches that supply the feed to Harbert Construction, 138kV, 3000A gang operated air break switch and carrier equipment in the IPP line, 138kV bus work, relaying, control cables, grounding and associated equipment. The purchase of additional land will be necessary at this location.

Estimated Cost [1] **$ 1,053,000**

Line Work

EnviroPower to Harbert 138 kV Double Circuit Tower Line: (Figure 3)
On a right-of-way provided by EnviroPower, construct a double circuit 138 kV steel lattice tower line between the EnviroPower Switching Station and Harbert Station – a distance of about 4.7 miles. Use six (6) 795 kCM ACSR (45/7) for phase conductors and 7#8 Alumoweld for ground wire. Use one side of the double circuit line to terminate at the Harbert Station while the other circuit will utilize the 19-mile line section described below and terminate at the Beaver Creek Station.

Estimated Cost [1] **$ 4,027,000**

Harbert to Beaver Creek 138 kV Line: (Figure 3)
On a new right-of-way, construct a single circuit wood H-Frame 138 kV line using 795 kCM ACSR for phase conductor and 7#8 Alumoweld for ground wire – a distance of about 19 miles. Utilize one set of conductors on the double circuit tower line, as mentioned above, to create the express Beaver Creek – EnviroPower 138 kV Circuit.

Estimated Cost [1, 3, 4] **$ 13,060,000**

EnviroPower to New Bulan 138 kV Line: (Figure 3)
On a right-of-way provided by EnviroPower, construct a single circuit wood H-Frame 138 kV line using 1,033.5 kCM ACSR for phase conductor and 7#8 Alumoweld for ground wire – a distance of about 6.8 miles.

Estimated Cost [1, 3] **$ 4,250,000**

New Bulan to Hazard 138 kV Line: (Figure 3)
On a new right-of-way, construct a single circuit wood H-Frame 138 kV line using 1,033.5 kCM ACSR for phase conductor and 7#8 Alumoweld for ground wire – a distance of about 7.2 miles.

Estimated Cost [1, 3] **$ 4,990,000**

Total Estimated Direct Interconnection Cost [1, 2, 3, 4] **$29,346,000**

AEP System Upgrades:

Station Work

New Bulan 138 kV Station: (Figures 3 and 8)

Construct a new 138/ 69kV station located at a site provided by EnviroPower. The new station will connect to the EnviroPower-Hazard 138 kV Line. Install a 138/69/12kV, autotransformer, 138kV, 2000A line and 1200A transformer motorized air break switches, 138 & 69kV bus work, three (3) 69kV, 2000A circuit breakers and associated line and bus disconnect switches, relaying and associated control cable, 138 & 69kV structural steel, foundation, grounding, site preparation, control building and associated equipment. Connect the Bonnyman and Hazard 69kV lines to the new 69 kV bus. The purchase of additional land will be necessary at this location.

Estimated Cost [1] $ 2,224,000

Line Work

New Bulan Station 69 kV Line Exits: (Figure 3)

On a new right-of-way, construct a double circuit wood H-Frame 69 kV line using 556.5 kCM ACSR for phase conductor and 7#10 Alumoweld for ground wire – a distance of about 2 miles.

Estimated Cost [1] $ 1,460,000

Total Estimated System Upgrade Cost [1] $ 3,684,000

Total Estimated Project Cost [1, 2, 3, 4] $33,030,000

1 The estimates are preliminary in nature, as they were determined without detailed engineering and design studies. Estimated costs are based on 2003 service date.

2 The estimate does not include cost to establish the new station at the plant site, install circuit breakers, structural steel, grounding, bus, control house, etc. EnviroPower will be responsible for designing and constructing the new station with the exception of the facilities as defined above.

3 The cost estimates for three 138 kV lines -- Beaver Creek Station to New Harbert Switching Station, EnviroPower Switching Station to New Bulan Station, and New Bulan Station to Hazard Station – assume single circuit wood H-Frame construction. If "Guyed-Vee" construction is required, the cost may increase by an additional $5,000,000.

4 The cost estimate for the Beaver Creek to New Harbert Switching Station line assumes single circuit wood H-Frame construction on a new line right-of-way parallel to the existing 138 kV line. If this line needs to be constructed using the existing line right-of-way and as a double circuit steel lattice tower, the cost may increase by an additional $1,500,000.

Note: The Beaver Creek-Hazard Area Transmission System is planned for single contingency reliability. The EnviroPower Plant out let is also designed to withstand single contingency outages. Immediately subsequent to a single-contingency outage, the plant output would need to be curtailed to prepare for the next contingency. The curtailment would be required to mitigate both thermal and stability concerns. Actual level of curtailment would depend on final impedance values of the system and the generating unit and step-up transformer test data. If EnviroPower proceeds with the project, AEP would conduct an operational study at cost to EnviroPower to determine the curtailment amounts and specific conditions for which they would be required.

Table 1 (Enviro Power Merchant Plant in Service - System Configuration based on three plant outlets only)

System Condition	Envirpower - Beaver Ck. # 1 138 kV MVA	Envirpower - Beaver Ck. # 2 138 kV (via Herbert St.) MVA	Envirpower - Hazard, 138 kV MVA
Base Condition - All Facilities in Service	133	130	237
Envirpower - Beaver Ck. # 1 138 kV Out	0	202	298
Envirpower - Beaver Ck. # 2 138 kV Out	202	0	298
Envirpower - Hazard 138 kV Out	248	252	0

	Beaver Ck.-Hazard 138 kV		Leslie-Pineville 161 kV		Beaver Ck-Spicewood 138 kV		Hazard 138/69 kV # 1		Hazard 138/69 kV # 2		Hazard-Blue Grass 69 kV		Hazard-Shamrock 69 kV	
Rating (SN/SE) in MVA	153 / 194		172 / 172		258 / 345		69 / 75		177 / 195		76 / 76		76 / 76	
System Condition	MVA	% of Normal	MVA	% of Normal	MVA	% of Normal	MVA	% of Normal	MVA	% of Normal	MVA	% of Normal	MVA	% of Normal
Base Condition - All Facilities in Service	15	10%	19	11%	116	45%	39	57%	80	45%	52	68%	25	33%
Beaver Ck - Hazard 138 kV Out	0	0%	17	10%	117	45%	38	55%	80	45%	52	68%	25	33%
Leslie-Pineville 161 kV Out	15	10%	0	0%	119	46%	38	55%	80	45%	51	67%	25	33%
Hazard 138/69 kV # 1 Out	17	11%	16	9%	117	45%	0	0%	102	58%	73	96%	6	8%
Hazard 138/69 kV # 2 Out	18	12%	19	11%	120	47%	77	112%	0	0%	20	26%	67	88%
Baker-Broadford 765 kV Out	15	10%	33	19%	111	43%	40	58%	81	46%	52	68%	52	68%
Big Sandy-Inez 138 kV Out	20	13%	18	10%	121	47%	37	54%	79	45%	52	68%	52	68%
Clinch River Generation Out	23	15%	27	16%	123	48%	38	55%	82	46%	51	67%	51	67%

Table 2

		Fault MVA w/o EnviroPower		Fault MVA with EnviroPower		Increase in Fault MVA	
Station Name	Voltage	3 Phase	Line to Ground	3 Phase	Line to Ground	3 Phase	Line to Ground
Beaver Creek	138	2390	2610	3270	3370	880	760
	69	820	830	860	850	40	20
	46	760	600	790	600	30	0
Harbert	138	850	630	2140	1730	1290	1100
Hazard	161	1170	1260	1900	1910	730	650
	138	1200	1330	2170	2240	970	910
Bus #1	69	660	740	1000	1060	340	320
Bus #2	69	800	940	1110	1230	310	290
Bulan	69	570	530	NA	NA	570	530
New Bulan	138	NA	NA	2320	2270	2320	2270
	69	NA	NA	1120	1230	1120	1230
EnviroPower	138	NA	NA	3500	3860	3500	3860

Table 3 (Enviro Power Merchant Plant in Service - System Configuration based on three plant outlets and Other System Improvements - Figure 3)

	Envirpower - Beaver Ck. # 1 138 kV	Envirpower - Beaver Ck. # 2 138 kV (via Herbert St.)	Envirpower - Hazard. 138 kV	Bulan 138/69 kV Transformer
System Condition	MW	MW	MW	MW
Base Condition - All Facilities in Service	131	143	226	61
Envirpower - Beaver Ck. # 1 138 kV Out	0	217	283	69
Envirpower - Beaver Ck. # 2 138 kV Out	210	0	290	69
Envirpower - Hazard 138 kV Out	243	257	0	0

	Beaver Ck.-Hazard 138 kV		Leslie-Pineville 161 kV		Beaver Ck-Spicewood 138 kV		Hazard 138/69 kV # 1		Hazard 138/69 kV # 2		Hazard-Blue Grass 69 kV		Hazard-New Bulan 69 kV	
Rating (SN/SE) in MVA	153 / 194		172 / 172		258 / 345		69 / 75		177 / 195		76 / 76		76 / 76	
System Condition	MW	% of Normal	MW	% of Normal	MW	% of Normal	MW	% of Normal	MW	% of Normal	MW	% of Normal	MW	% of Normal
Base Condition - All Facilities in Service	5	3%	10	6%	125	48%	10	14%	57	32%	29	38%	6	8%
Beaver Ck - Hazard 138 kV Out	0	0%	9	5%	123	48%	9	13%	56	32%	29	38%	6	8%
Leslie-Pineville 161 kV Out	1	1%	0	0%	127	49%	8	12%	58	33%	28	37%	5	7%
Hazard 138/69 kV # 1 Out	4	3%	8	5%	126	49%	0	0%	58	33%	28	37%	13	17%
Hazard 138/69 kV # 2 Out	2	1%	11	6%	127	49%	21	30%	0	0%	5	7%	4	5%
Baker-Broadford 765 kV Out	12	8%	27	16%	120	47%	10	14%	58	33%	29	38%	8	11%
Big Sandy-Inez 138 kV Out	3	2%	8	5%	130	50%	9	13%	52	29%	29	38%	5	7%
Clinch River Generation Out	6	4%	20	12%	131	51%	9	13%	60	34%	29	38%	4	5%

FIGURE 1

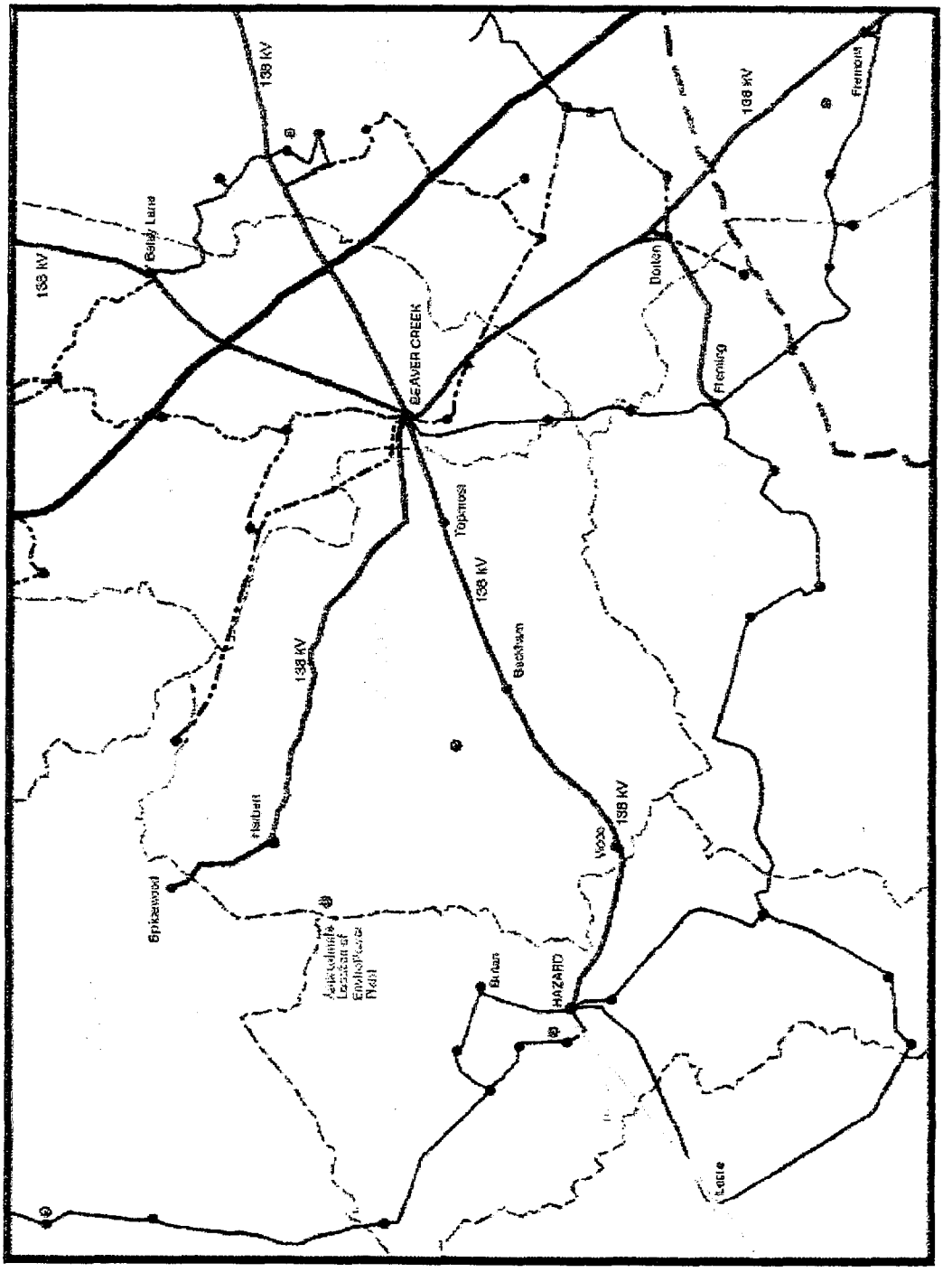

138 kV
Belfry Lane
138 kV
BEAVER CREEK
Dolton
138 kV
Fremont
Fleming
Topmost
138 kV
Beckham
138 kV
Hazard
Spicewood
Voss
138 kV
HAZARD
Breton
Leslie

FIGURE 2

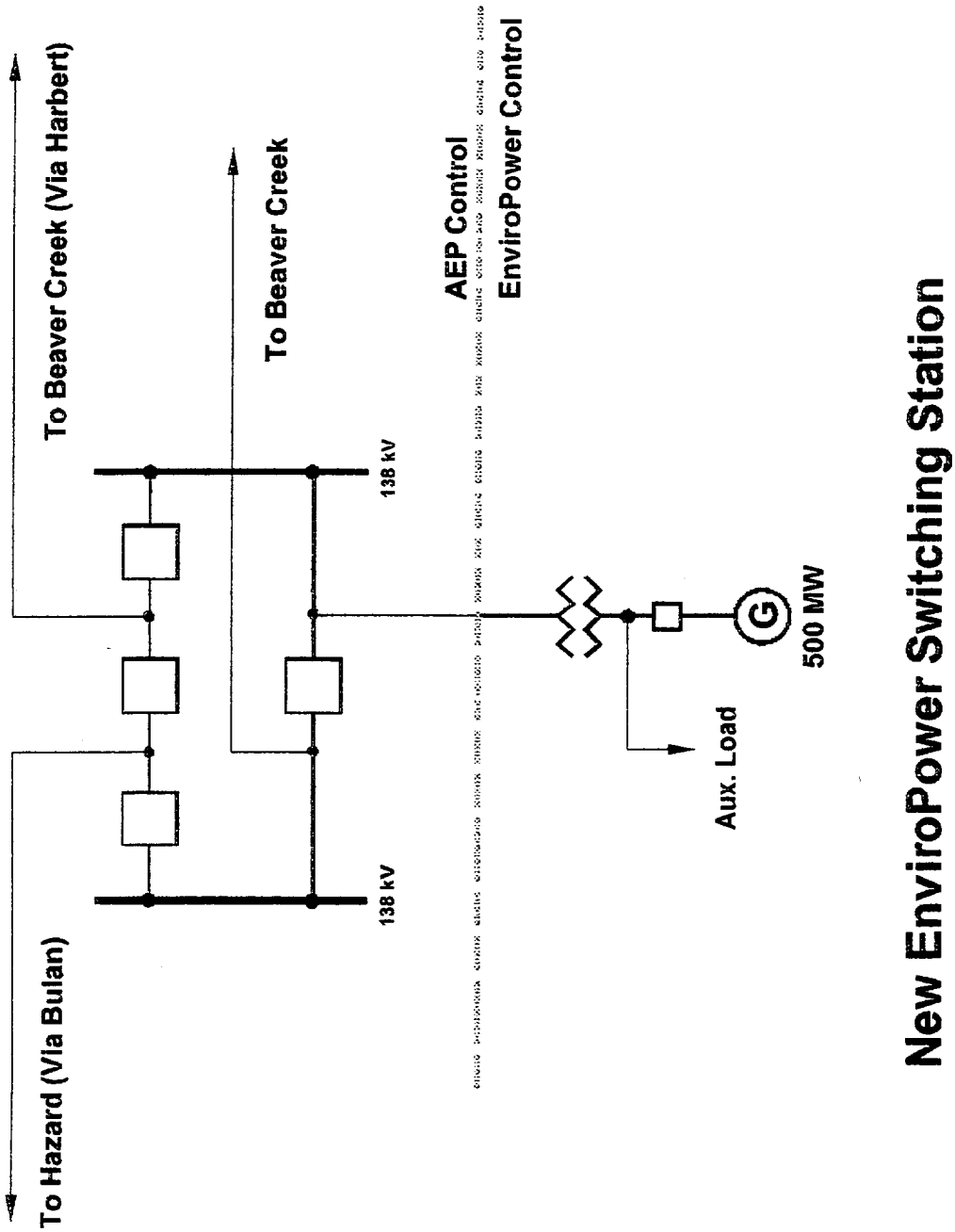

To Beaver Creek (Via Harbert)
To Beaver Creek
AEP Control
EnviroPower Control
138 kV
138 kV
To Hazard (Via Bulan)
Aux. Load
G
500 MW
New EnviroPower Switching Station

FIGURE 3

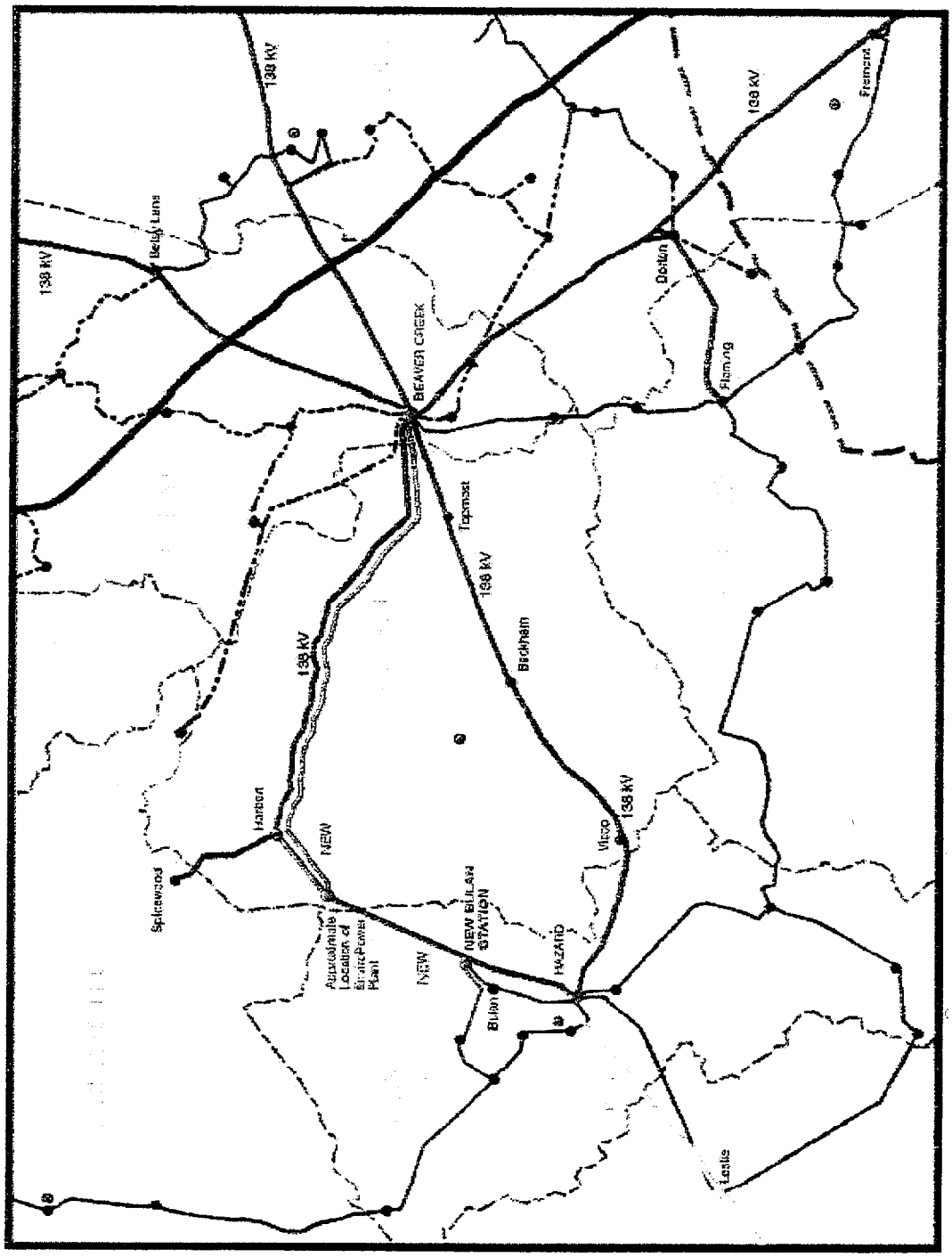

138 kV
Belly Lane
138 kV
BEAVER CREEK
Dorton
138 kV
Fremont
Fleming
Topmost
138 kV
Beckham
138 kV
138 kV
Hanben
NEW
Spicewood
Approximate Location of Entire Power Plant
NEW
NEW BULAN STATION
HAZARD
Vicco
Bulan
Leslie

FIGURE 4.1

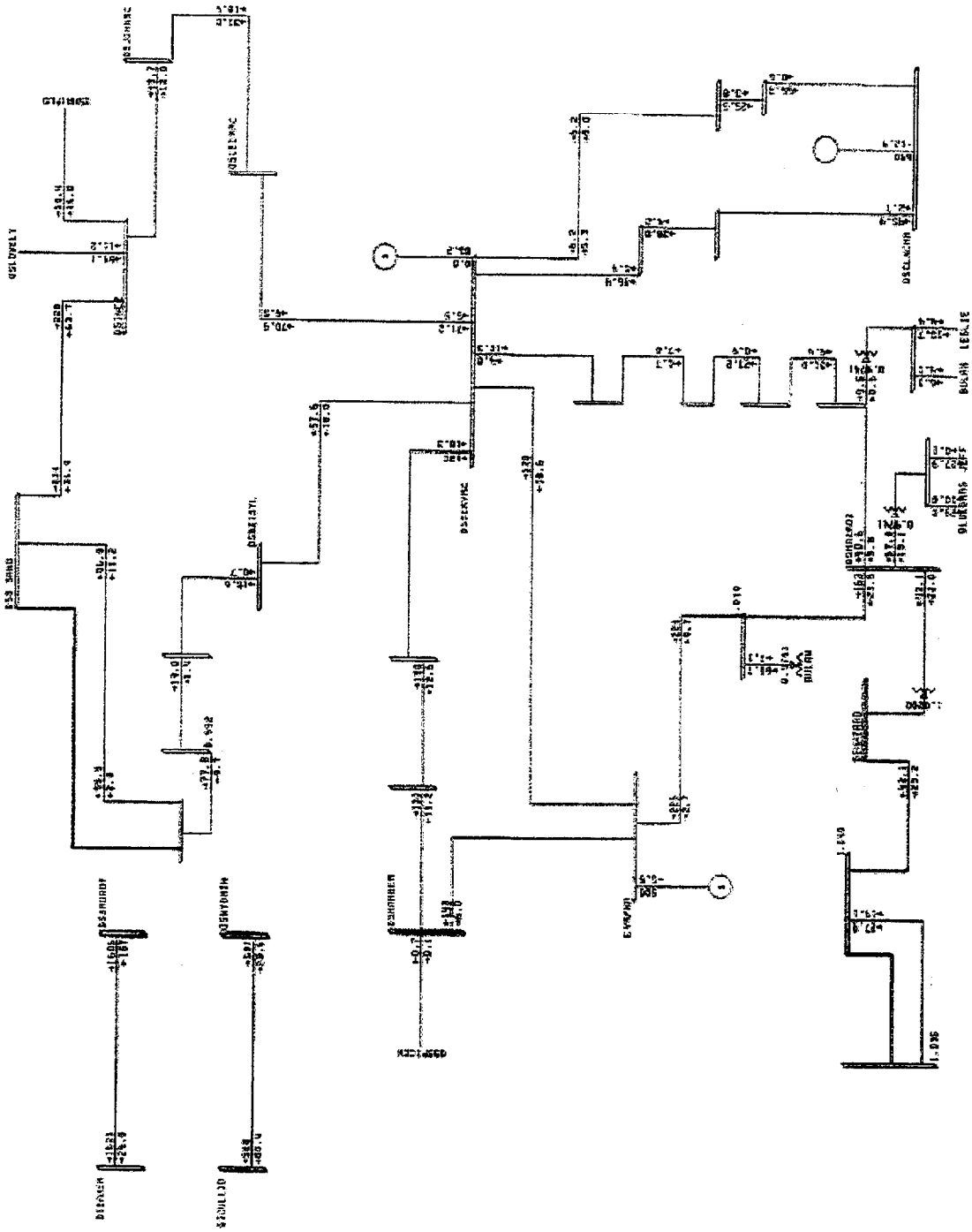


FIGURE 4.2

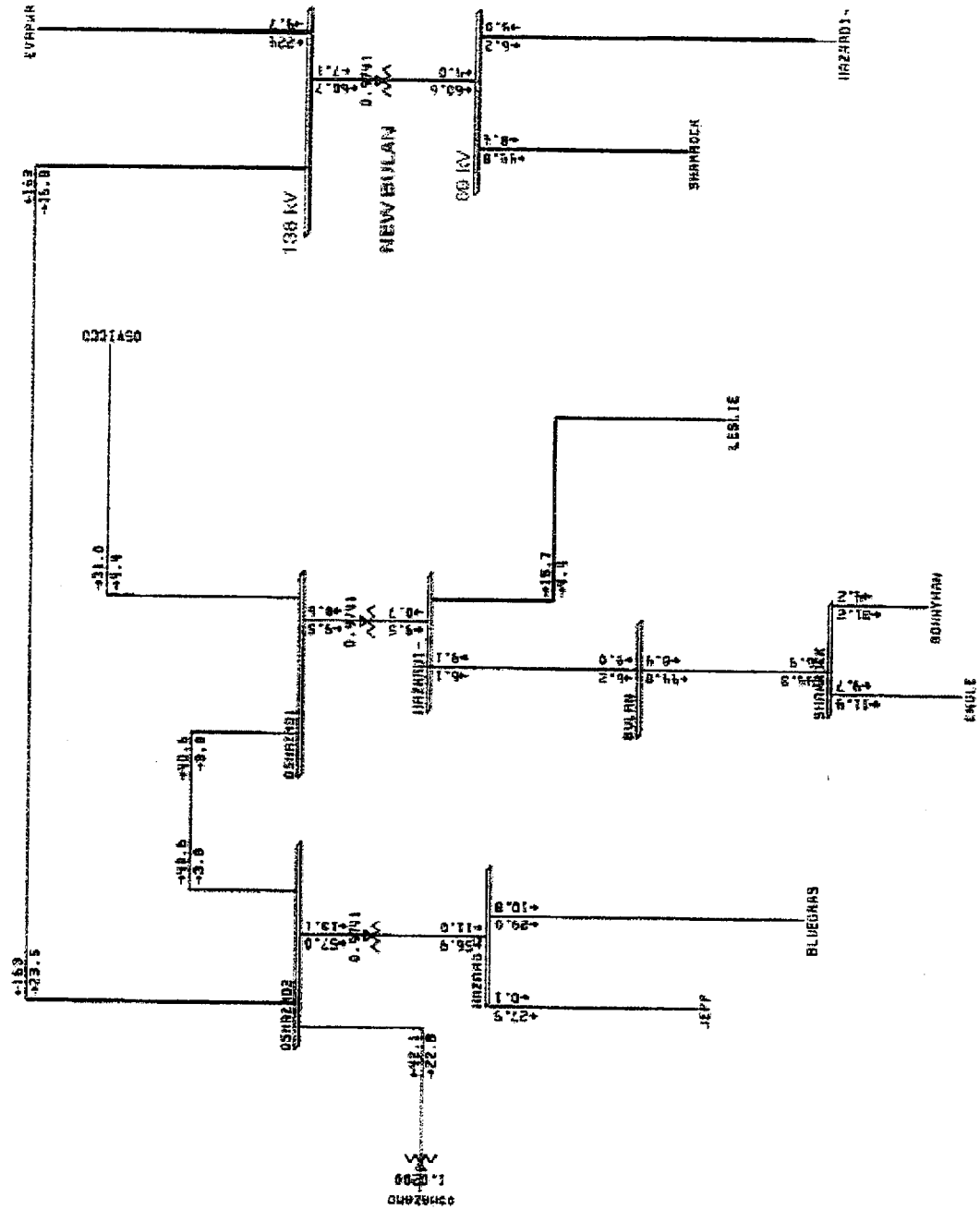
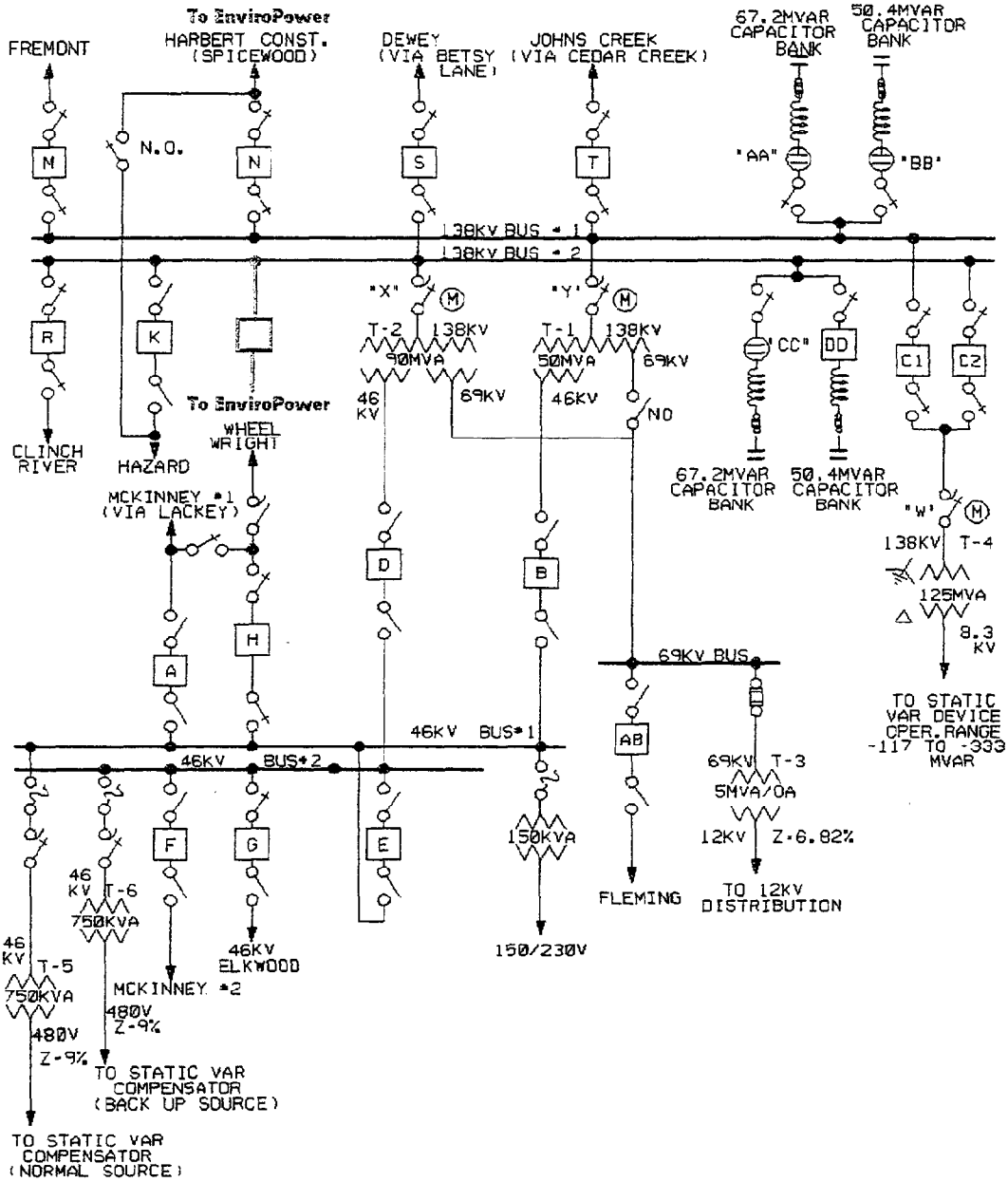
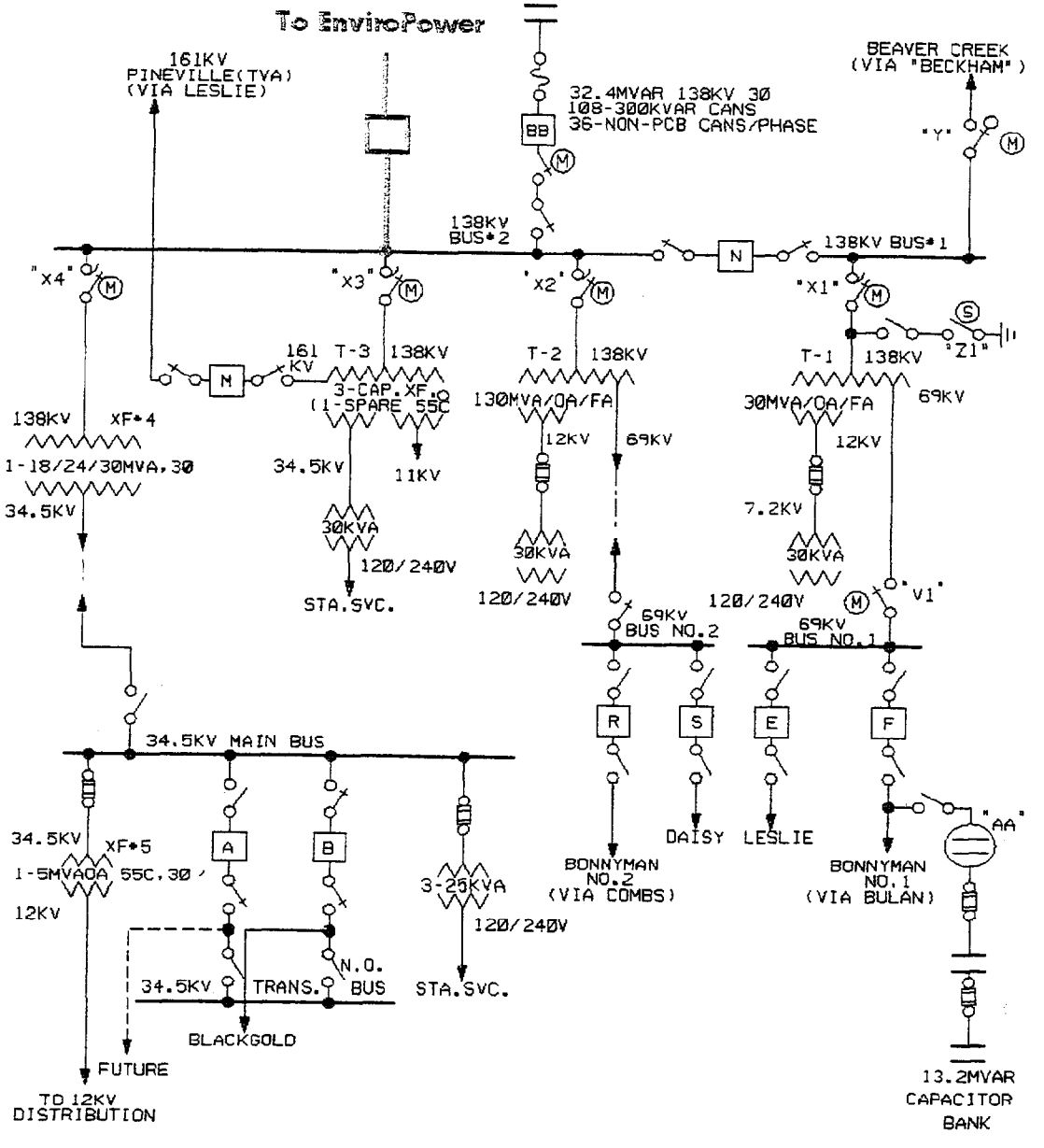

138 kV
69 kV
NEW BULAN
HAZARD1
SHAMROCK
BULAN
BLUEGRAS
JEFF
EAGLE

FIGURE 5



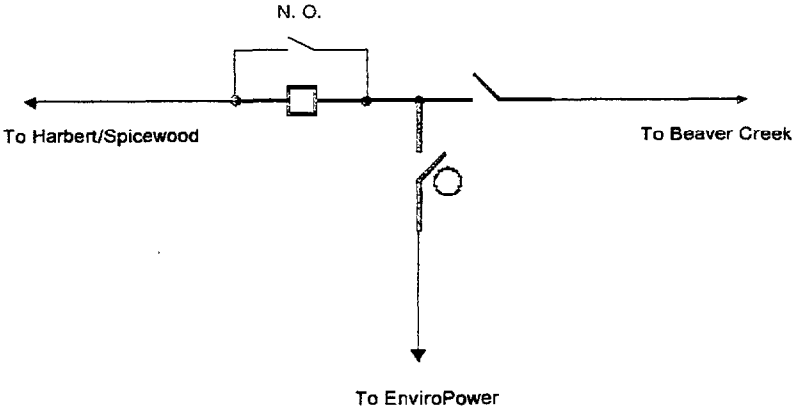
BEAVER CREEK STATION

FIGURE 6



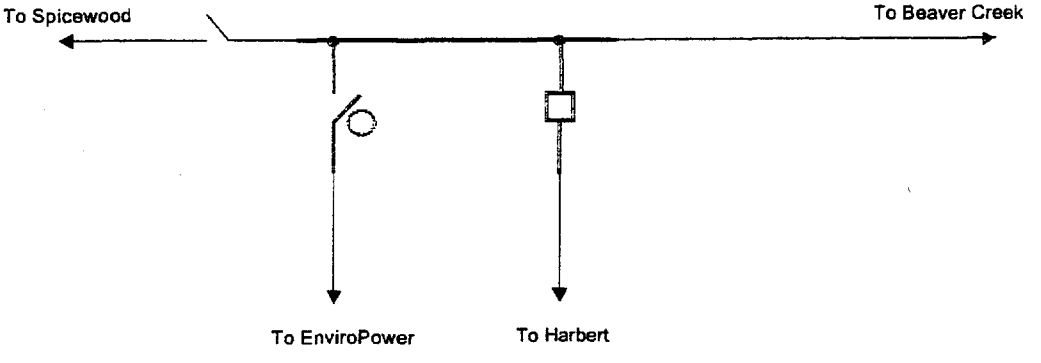
HAZARD STATION

FIGURE 7



OR

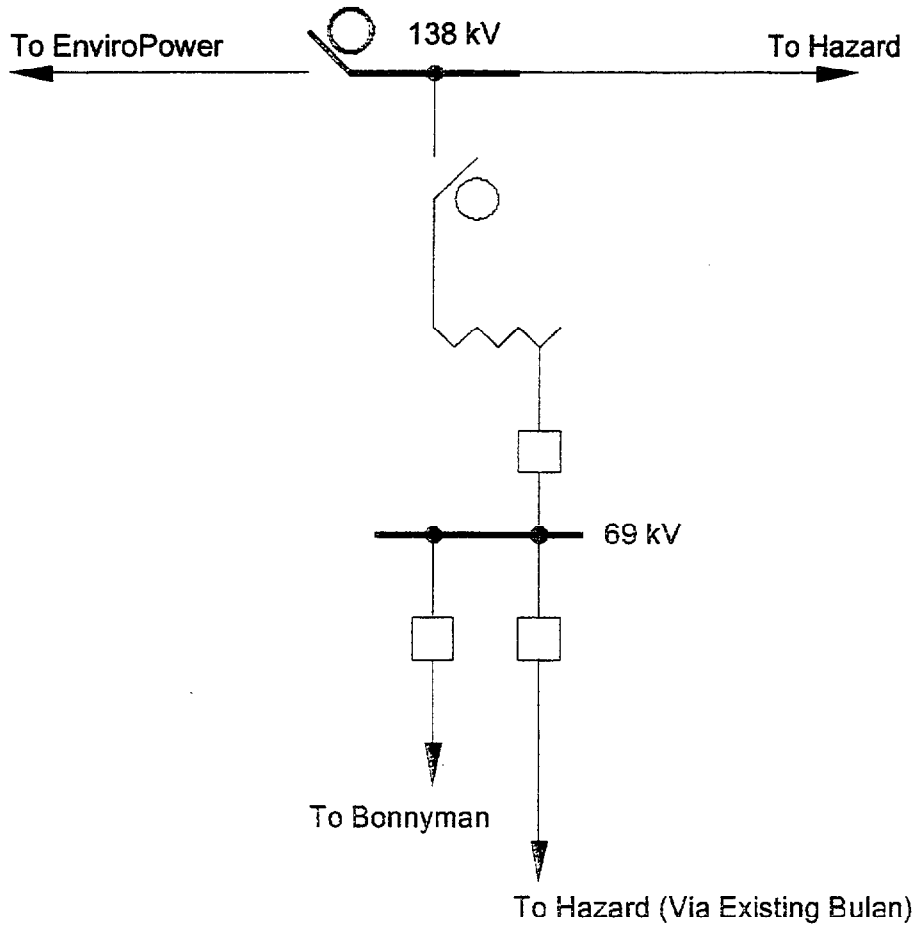
Depending on the Location of the Site



THE NEW HARBERT SWITCHING STATION

The Proposed One Line Diagram

FIGURE 8



NEW BULAN STATION

The Proposed One Line Switching Diagram

System Impact Study
Phase II – Stability Performance Study

EnviroPower LLC's
Connection of Proposed Generating Plant
To The AEP Transmission System

Kentucky Mountain Project
Project

Transmission Planning
August 2000

AEP AMERICAN® ELECTRIC POWER

AEP: America's Energy Partner℠

1. INTRODUCTION

Per EnviroPower, LLC's (EnviroPower) request, American Electric Power (AEP) has conducted a stability performance study to evaluate the feasibility of connecting 500 MW (net) of generation at a new station in Eastern Kentucky, Kentucky Mountain 138 kV. This station is to be connected to AEP's Beaver Creek 138 kV and Hazard 138 kV Stations. This report documents the stability performance study and is a companion report to the Phase I load flow study report dated August 2000, for the same proposed generation facility.

2. OVERVIEW OF GENERATION FACILITIES

Figure 1 of Attachment 1 shows the existing transmission system configuration in the vicinity of the proposed EnviroPower Kentucky Mountain Project along with the proposed connections to the 138 kV stations at Beaver Creek and Hazard. The configuration of the proposed Kentucky Mountain 138 kV Station is shown in Figure 2.

The proposed generating facility would consist of two identical coal burning steam turbine units each with a maximum winter capacity of 250 MW, for a total of 500 MW (net). Each generator would be connected through a generating unit breaker and step-up transformer as shown in Attachment 1, Figure 2. The dynamic modeling data for the generating units, as provided by EnviroPower and their equipment vendors, is documented in Attachment 2.

Dynamic modeling data for the turbine-governor of the steam turbine-generators was not provided. Should the proposed project move forward, this data should be forwarded to AEP when it becomes available from the equipment vendor.

3. TESTING CRITERIA

AEP transient stability criteria for 138 kV connected generation facilities shown in Table 1 below specify the conditions and events for which stable operation is required (see AEP FERC Form 715 filing). In addition, satisfactory damping of generator post-disturbance power oscillations is required.

These testing criteria are used in time domain simulations to evaluate the stability performance of a proposed generation facility. For each disturbance, the resulting transmission system response is simulated and then analyzed to assess the impact of the disturbance scenarios on the proposed generators and the surrounding system.

Table 1
AEP Stability Testing Criteria for 138 kV Connected Generation

Prefault System Condition		Fault Disturbance Scenario
All Transmission Facilities in Service	3A	Permanent single phase to ground fault with three phase breaker failure. Fault clearing by backup breakers.
	3B	Permanent three phase to ground fault with unsuccessful HSR if applicable. Fault cleared by primary breakers.
	3C	Three phase line opening without fault.
One Transmission Facility Out	3D	Permanent three phase to ground fault with unsuccessful HSR, if applicable. Fault cleared by primary breakers.
	3E	Three phase line opening without fault.

4. STUDY SCOPE

Dynamic simulations were conducted for selected event scenarios and various post-contingency network configurations as follows:

CASE 1 – Prior outage of KY Mt.-Harbert 138 kV line. Permanent three phase fault at KY Mt. 138 kV on line to Beaver Creek. Fault clearing in 5 cycles with no high speed reclosing. Proposed units remain connected through Hazard 138 kV. (Criterion 3D)

CASE 2 – Prior outage of KY Mt.-Harbert 138 kV line. Permanent three phase fault at KY Mt. 138 kV on line to Hazard. Fault clearing in 5 cycles with no high speed reclosing. Proposed units remain connected through Beaver Creek 138 kV. (Criterion 3D)

CASE 3 – Prior outage of Beaver Creek-Cedar Creek 138 kV line. Permanent three phase fault at KY Mt. 138 kV on line to Hazard. Fault clearing in 5 cycles with no high speed reclosing. Proposed units remain connected through Beaver Creek and Harbert 138 kV. (Criterion 3D)

CASE 4 – Prior outage of Hazard-Leslie 161 kV line. Permanent three phase fault at KY Mt. 138 kV on line to Beaver Creek. Fault clearing in 5 cycles with no high speed reclosing. Proposed units remain connected through Hazard 138 kV and Beaver Creek 138 kV via Harbert. (Criterion 3D)

CASE 5 – Prior outage of Hazard-Beaver Creek 138 kV line. Permanent three phase fault at KY Mt. 138 kV on line to Beaver Creek. Fault clearing in 5 cycles with no high

speed reclosing. Proposed units remain connected through Hazard 138 kV and Beaver Creek 138 kV via Harbert. (Criterion 3D)

CASE 6 – No prior outages. Permanent one phase fault at KY Mt. 138 kV on line to Beaver Creek. Fault clearing at Beaver Creek end in 5 cycles with circuit breaker failure at KY Mt. Sixteen cycles delayed clearing at KY Mt. including removal of KY Mt.-Harbert line. Proposed units remain connected through Hazard 138 kV. (Criterion 3A)

CASE 7 – No prior outages. Permanent one phase fault at KY Mt. 138 kV on line to Hazard. Fault clearing at Hazard end in 5 cycles with circuit breaker failure at KY Mt. Sixteen cycles delayed clearing at KY Mt. including removal of KY Mt.-Harbert line. Proposed units remain connected through Beaver Creek 138 kV. (Criterion 3A)

CASE 8 – Prior outage of KY Mt.-Harbert 138 kV line. Non-fault initiated tripping of KY Mt.-Hazard 138 kV. Proposed units remain connected through Beaver Creek 138 kV. (Criterion 3E)

High speed reclosing of faulted transmission lines was not simulated due to its adverse impact on transient stability performance for this merchant generation project. If the proposed project moves forward, use of high speed reclosing is not recommended on any of the three plant outlets.

5. DYNAMICS BASE CASE

An AEP dynamics base case representing 2001 summer peak load conditions was used for this study. The dynamics case was assembled using data from the 1999 NERC Dynamics Database. The new generating facilities were added to the case using data provided by EnviroPower and their equipment vendors as shown in Attachments 1 and 2. The transmission facilities added to connect the proposed generation to Hazard and Beaver Creek Stations were consistent with the Phase I study report. Nearby generation at Clinch River was dispatched at maximum MW capacity.

6. STABILITY SIMULATION RESULTS

The stability performance study results are presented in Attachment 3 and are summarized below. Attachment 3 contains a case summary table and plots of generator speed and voltage for the proposed EnviroPower generating units, as well as plots of speed for existing generation at Clinch River, and bus voltage at Kentucky Mountain Beaver Creek and Hazard.

	TRANSIENT STABILITY	OSCILLATORY STABILITY
Case 1	Stable	Unsatisfactory
Case 2	Unstable	N/A

Case 3	Stable	Satisfactory
Case 4	Stable	Satisfactory
Case 5	Stable	Satisfactory
Case 6	Stable	Unsatisfactory
Case 7	Unstable	N/A
Case 8	Stable	Unsatisfactory

The transient and oscillatory stability of the proposed generating facility was found to be unacceptable given the proposed transmission connections for the project.

7. SUMMARY

- The study results show that from a stability perspective, the proposed EnviroPower generation totaling 500 MW (net) may be accommodated at the proposed Kentucky Mountain site, but would require transmission reinforcements beyond the proposed new transmission. The nature of the transmission reinforcement required would be determined in the Facilities Study.

- Dynamic modeling data to represent the steam turbine governor must be provided if the proposed project moves forward.

- If the proposed generation project is built, follow-up stability studies by AEP will be required based on dynamics data and modeling for the proposed generating units that have been revised to reflect equipment commissioning tests and field settings.

- Other generation developments in the vicinity may result in a need to revisit this study.

Attachment 1

EnviroPower Generation

Configuration of Proposed Facility

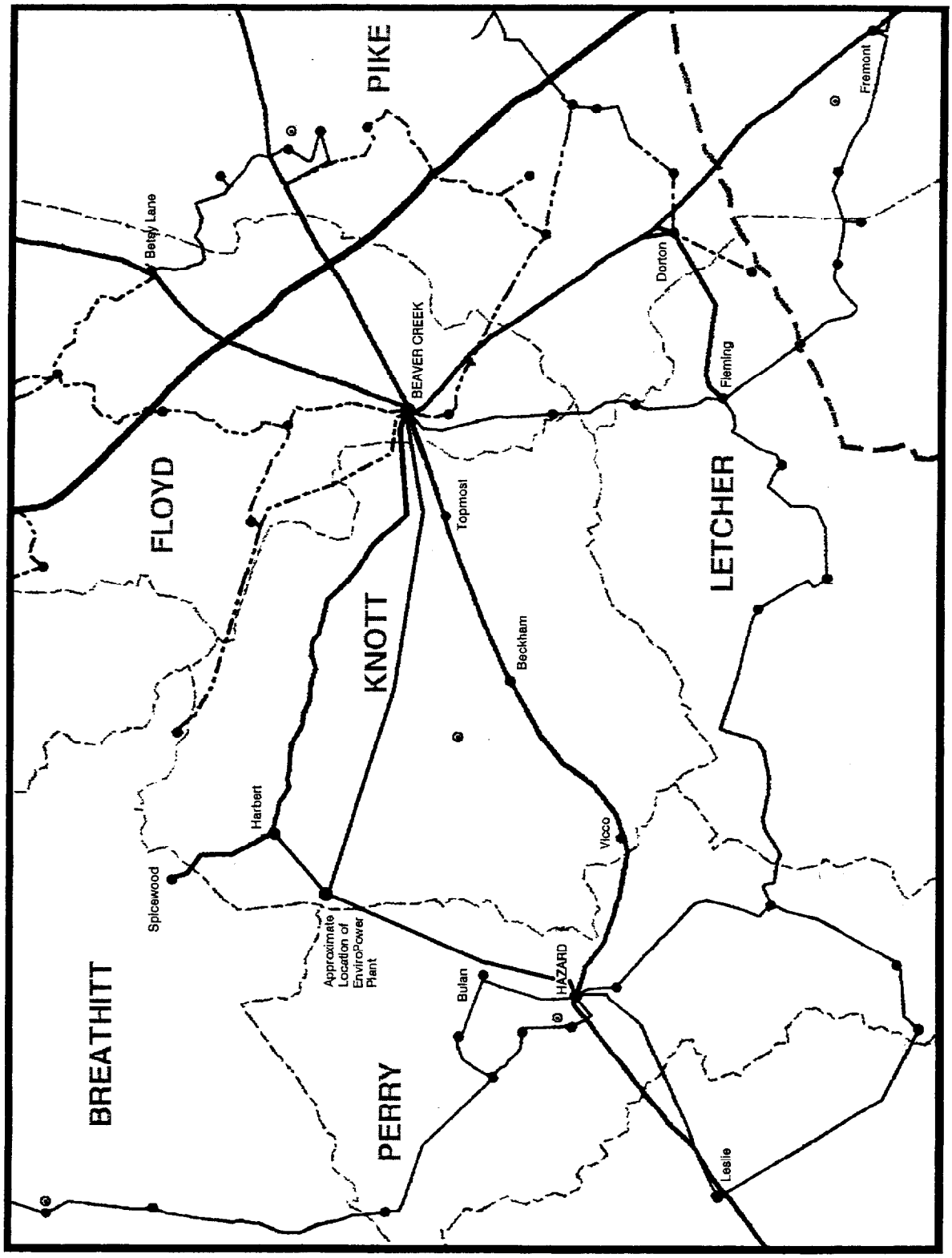


Figure 1 - Transmission Facilities at Beaver Creek, Hazard & Vicinity

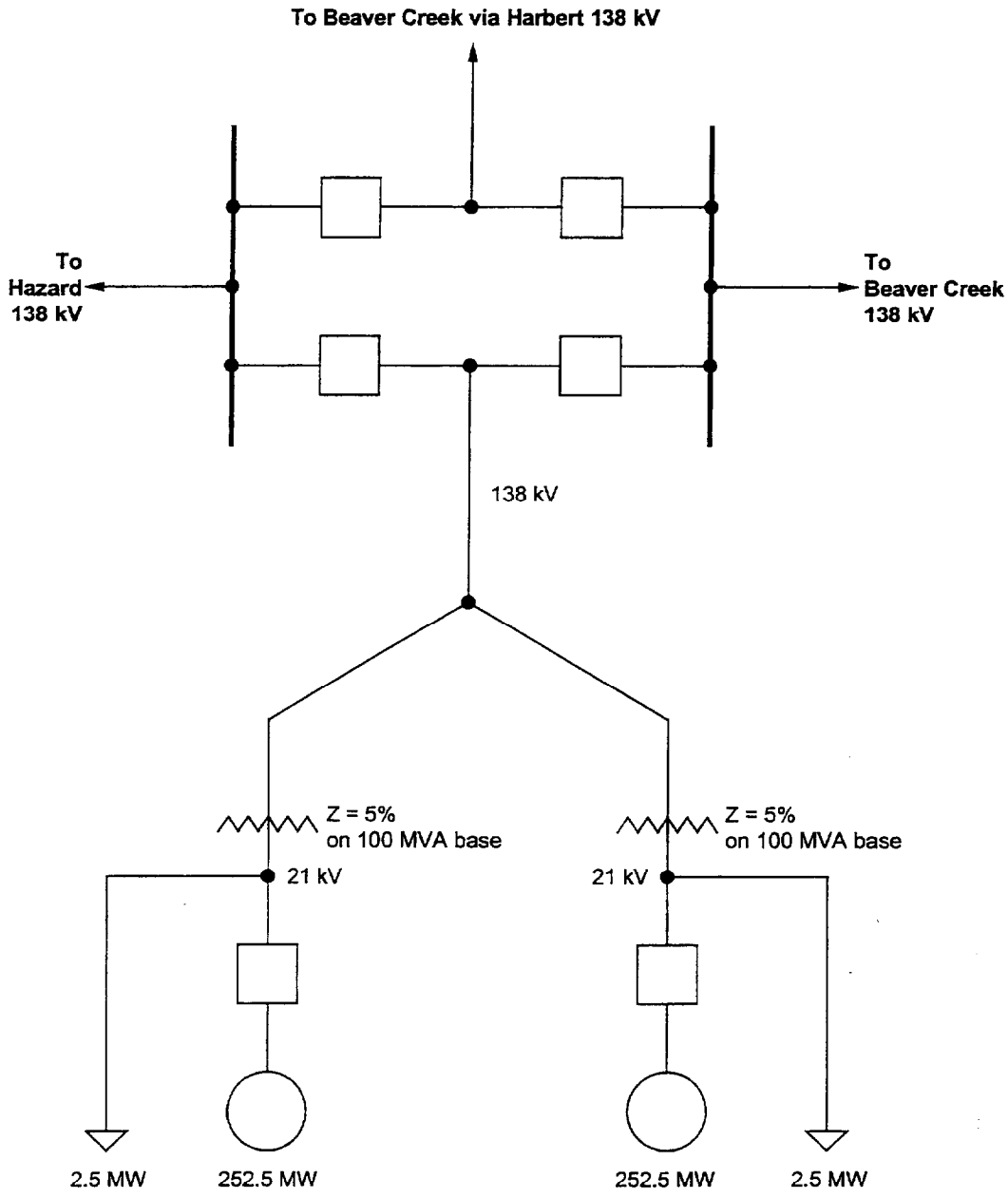


Figure 2 - Configuration of Proposed Kentucky Mountain Generation Facility

Attachment 2

EnviroPower Generation

Dynamics Data

GENROU

Value	Description
305.56	Base MVA
0.00193	R_a
9.48	T'_{do} (>0) (sec)
0.023	T''_{do} (>0) (sec)
0.992	T'_{qo} (>0) (sec)
0.034	T''_{qo} (>0) (sec)
3.68	Inertia, H
0	Speed damping, D
2.21	X_d
2.03	X_q
0.227	X'_d
0.366	X'_q
0.173	$X''_d = X''_q$
0.155	X_l
0.061	S(1.0)
0.225	S(1.2)

X_d, X_q, X'_d, X'_q, X''_d, X''_q, X_l, H, and D are in pu, machine MVA base.

X''_q must be equal to X''_d.

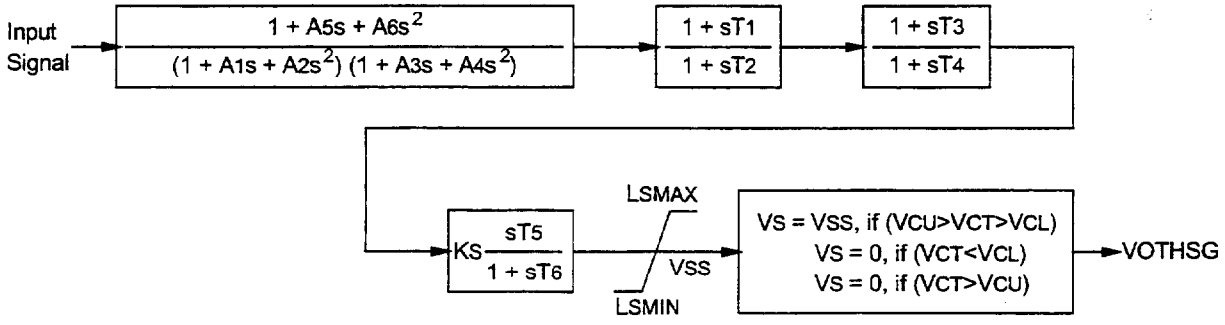
IBUS, 'GENROU', I, T'_{do}, T''_{do}, T'_{qo}, T''_{qo}, H, D, X_d, X_q, X'_d, X'_q, X''_d, X_l, S(1.0), S(1.2)/

IEEEST
IEEE Stabilizing Model

Value	Description
3	ICS, stabilizer input code: 1 - rotor speed deviation (pu) 2 - bus frequency deviation (pu) 3 - generator electric power on MBASE (pu) 4 - generator accelating power (pu) 5 - bus voltage (pu) 6 - derivative of pu bus voltage
0	IB, remote bus number 2, 5, 6

Value	Description
0	A_1
0	A_2
0	A_3
0	A_4
0	A_5
0	A_6
1.0	T_1 (sec)
1.0	T_2 (sec)
0	T_3 (sec)
0	T_4 (sec)
5.0	T_5 (sec)
5.0	T_6 (>0)(sec)
-0.3	K_S
0.05	L_{SMAX}
-0.05	L_{SMIN}
0	V_{CU} (pu) (if equal zero, ignored)
0	V_{CL} (pu) (if equal zero, ignored)

BUS, IEEEST, I, ICS, IB, A_1, A_2, A_3, A_4, A_5, A_6, T_1, T_2, T_3, T_4, T_5, T_6, K_S, L_{SMAX}, L_{SMIN}, V_{CU}, V_{CL}/

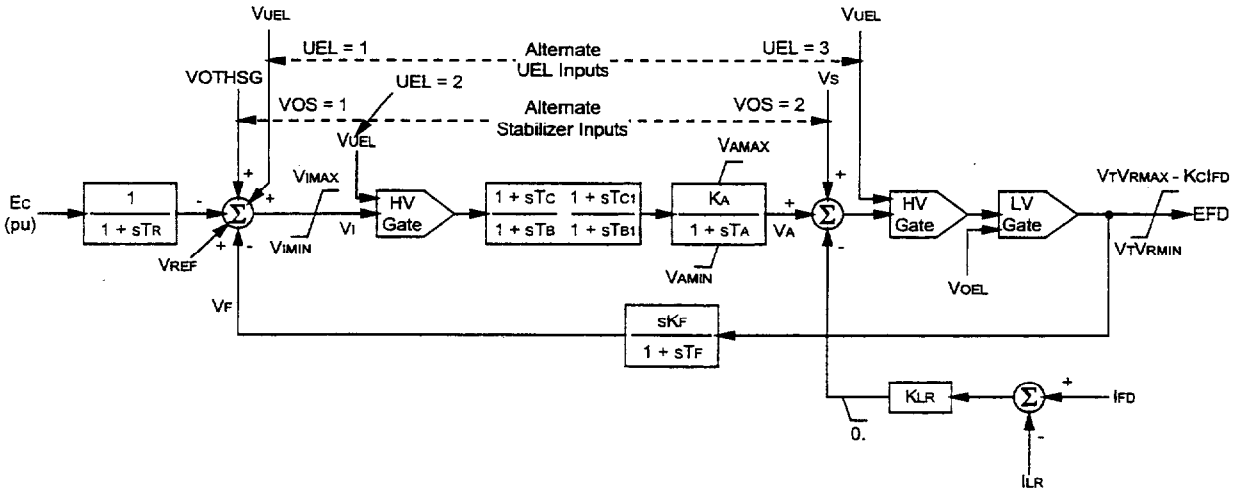


ESST1A
IEEE Type ST1A Excitation System

Value	Description
1	UEL (1, 2, or 3)
1	VOS (1 or 2)

Value	Description
0.02	T_R (sec)
0.17	V_{IMAX}
-0.15	V_{IMIN}
10.0	T_C (sec)
50.0	T_B (sec)
1.0	T_{C1} (sec)
1.0	T_{B1} (sec)
1000	K_A
0	T_A (sec)
5.0	V_{AMAX}
-4.5	V_{AMIN}
5.0	V_{RMAX}
-4.5	V_{RMIN}
0	K_C
0	K_F
10.0	$T_F > 0$ (sec)
0	K_{LR}
0	I_{LR}

IBUS, 'ESST1A', I, UEL, VOS, T_R, V_{IMAX}, V_{IMIN}, T_C, T_B, T_{C1}, T_{B1}, K_A, T_A, V_{AMAX}, V_{AMIN}, V_{RMAX}, V_{RMIN}, K_C, K_F, T_F, K_{LR}, I_{LR}/



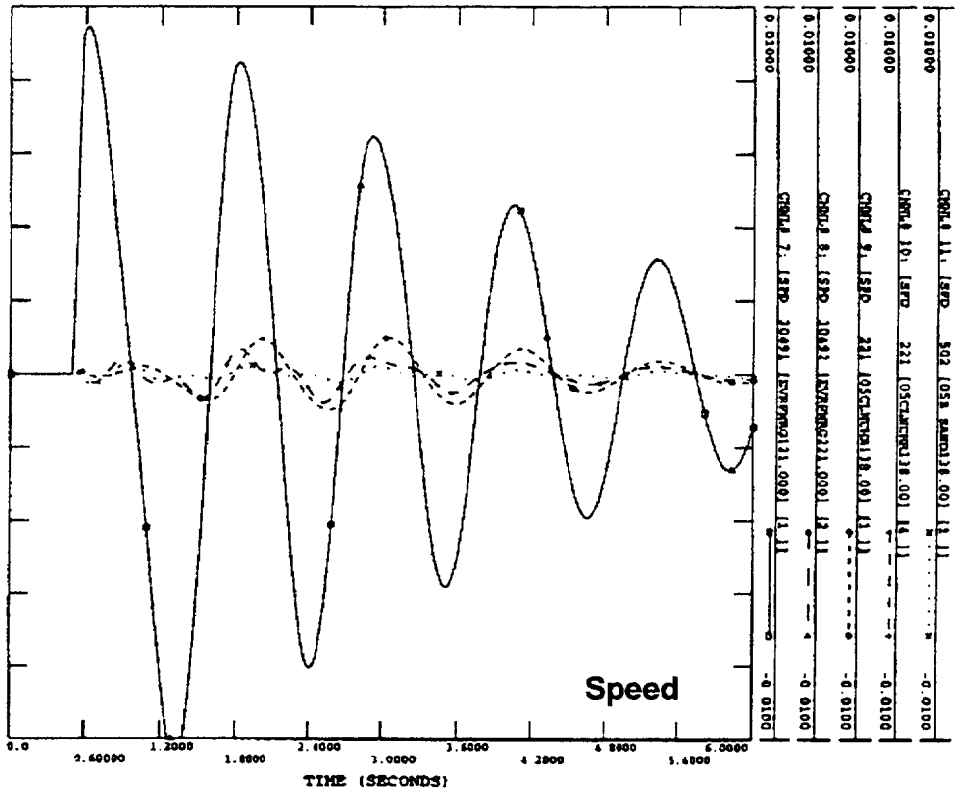
Attachment 3

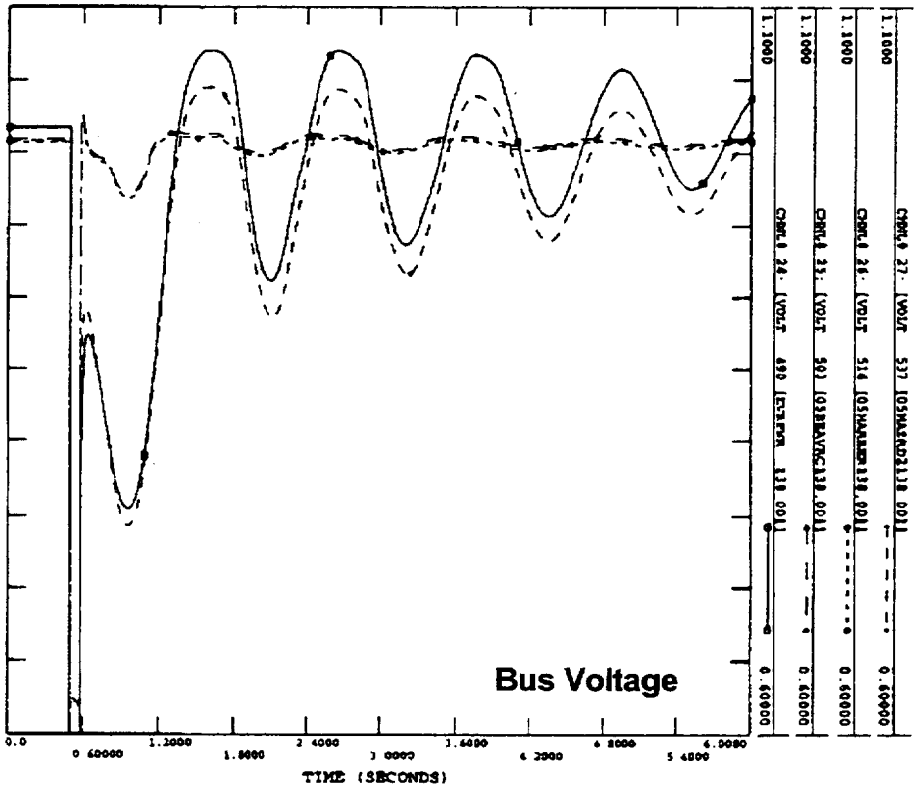
Results –

Individual Case Plots

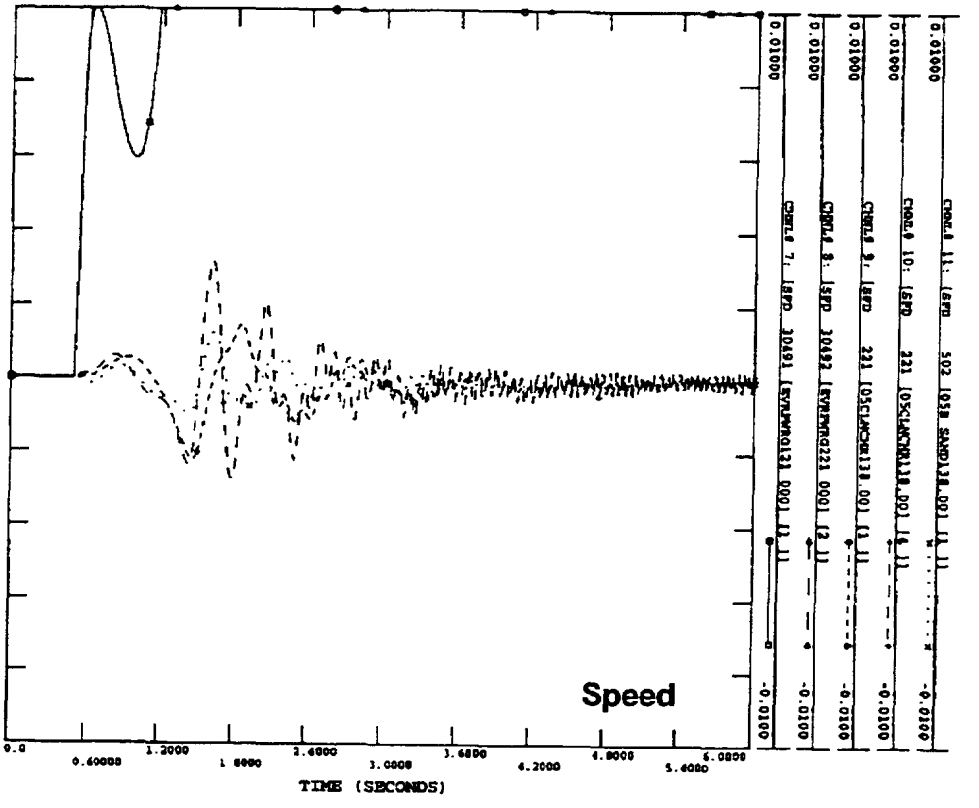
Case Number	Prior Outage	Faulted Line/Transformer	Fault Type	Comments on Study Results	
				Transient	Oscillatory
Case 1	KY Mt.-Harbert 138 kV	KY Mt.-Beaver Creek 138 kV	3 Phase	Stable	Unsatisfactory
Case 2	KY Mt.-Harbert 138 kV	KY Mt.-Hazard 138 kV	3 Phase	Unstable	N/A
Case 3	Beaver Creek-Cedar Creek 138 kV	KY Mt.-Hazard 138 kV	3 Phase	Stable	Satisfactory
Case 4	Hazard-Leslie 161 kV	KY Mt.-Beaver Creek 138 kV	3 Phase	Stable	Satisfactory
Case 5	Hazard-Beaver Creek 138 kV	KY Mt.-Beaver Creek 138 kV	3 Phase	Stable	Satisfactory
Case 6	None	KY Mt.-Beaver Creek 138 kV	1 Phase, Delayed	Stable	Unsatisfactory
Case 7	None	KY Mt.-Hazard 138 kV	1 Phase, Delayed	Unstable	N/A
Case 8	KY Mt.-Harbert 138 kV	KY Mt.-Hazard 138 kV	No Fault	Stable	Unsatisfactory

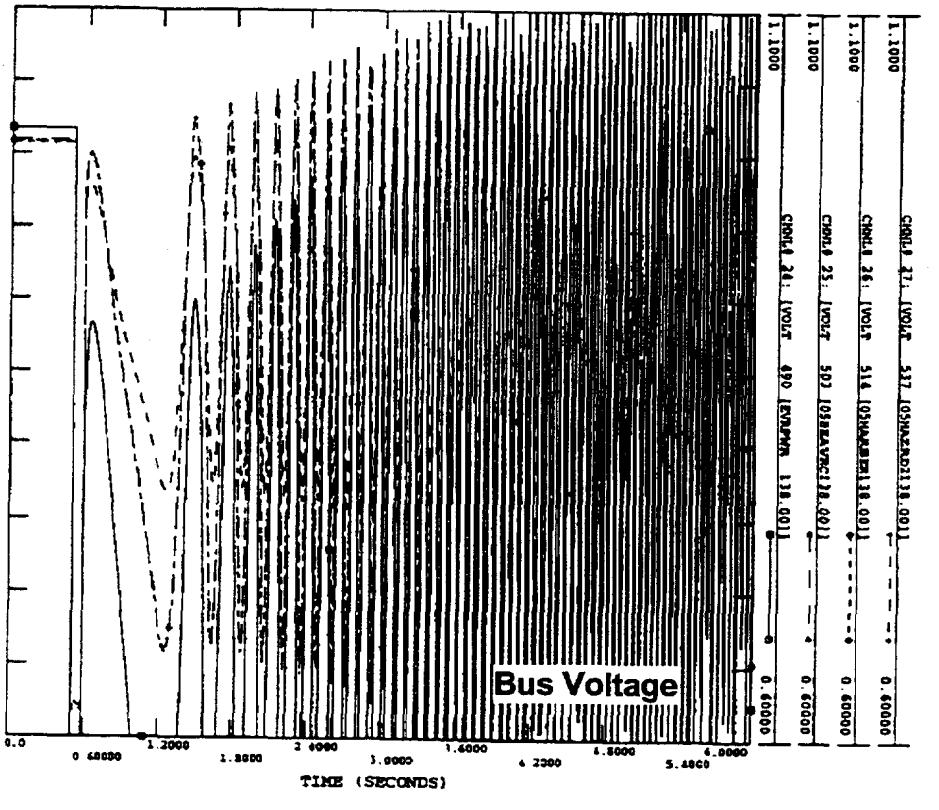
Case 1



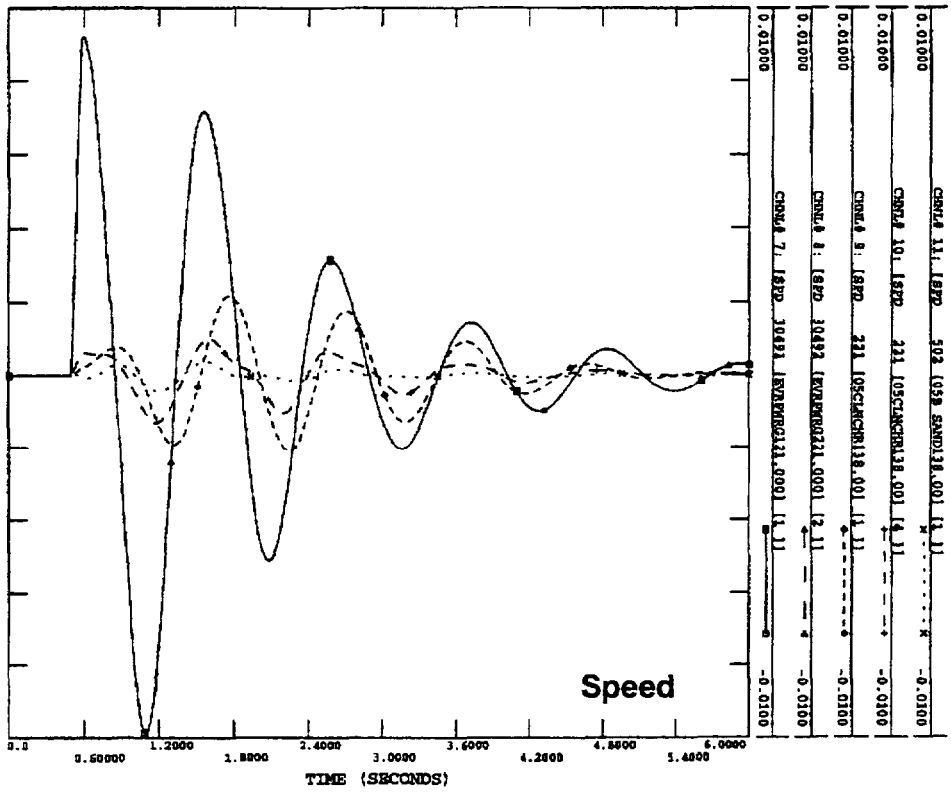


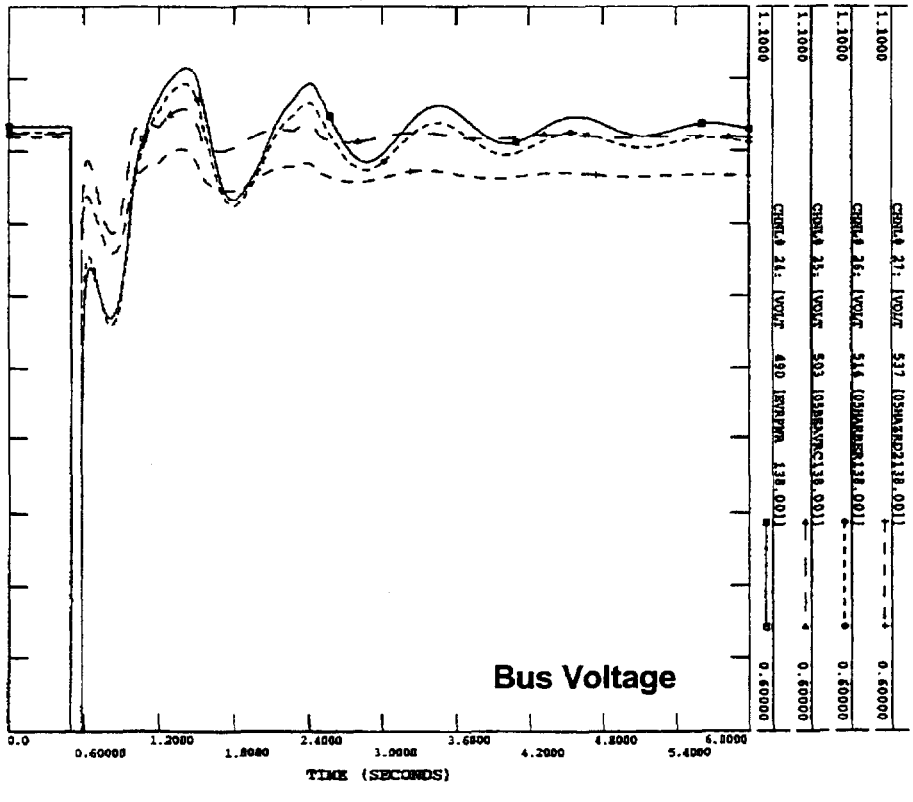
Case 2



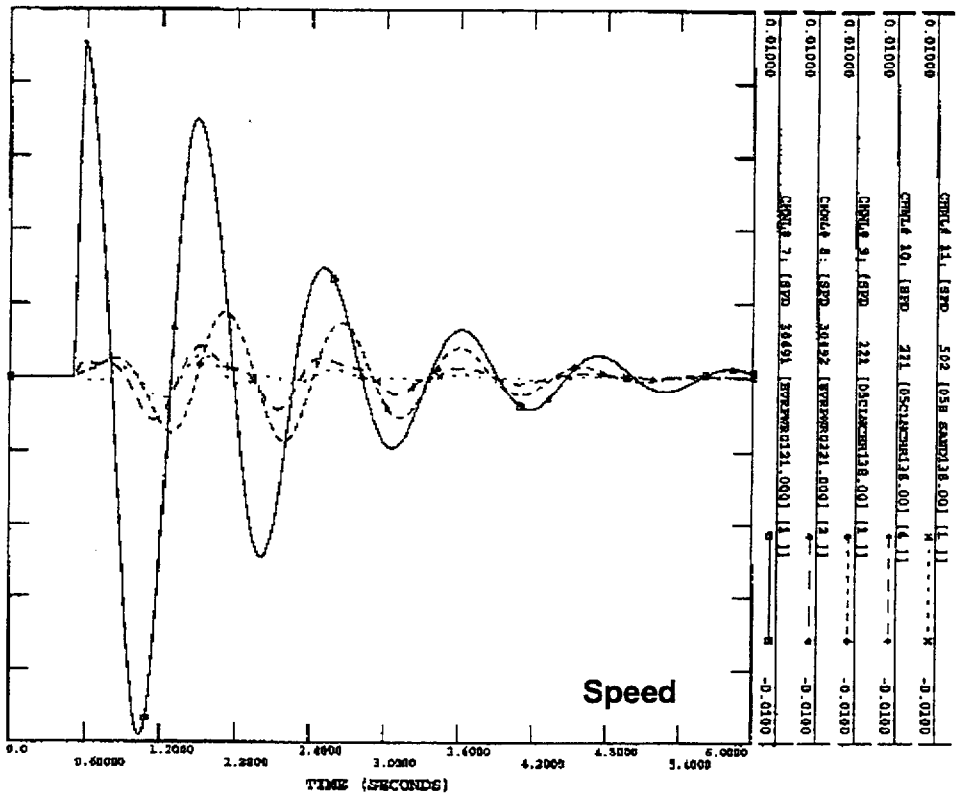


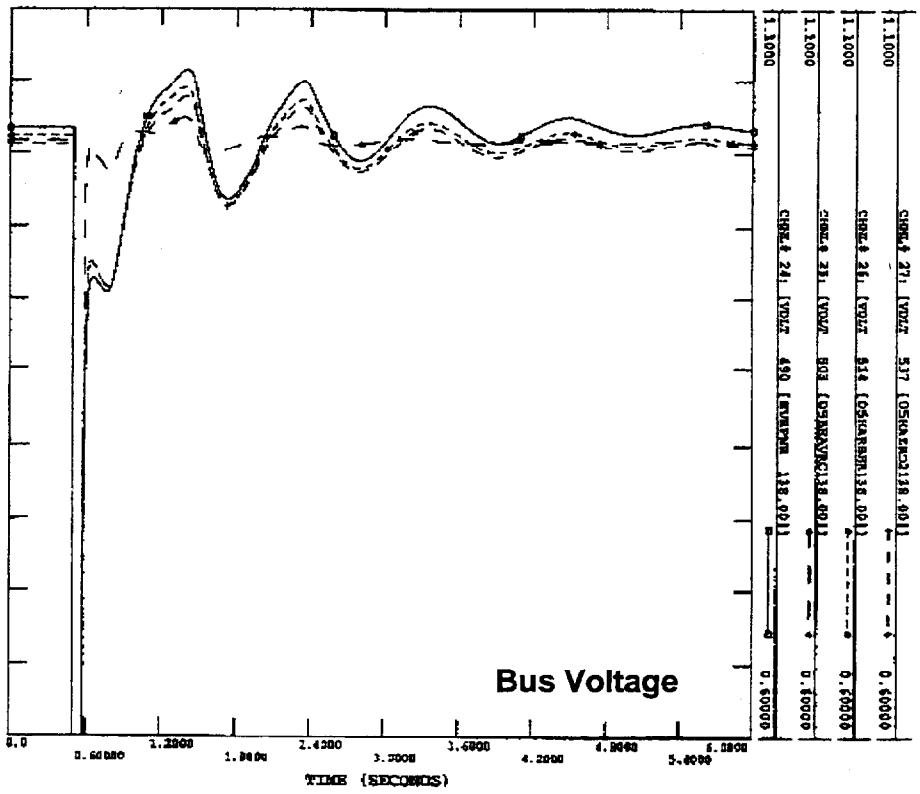
Case 3



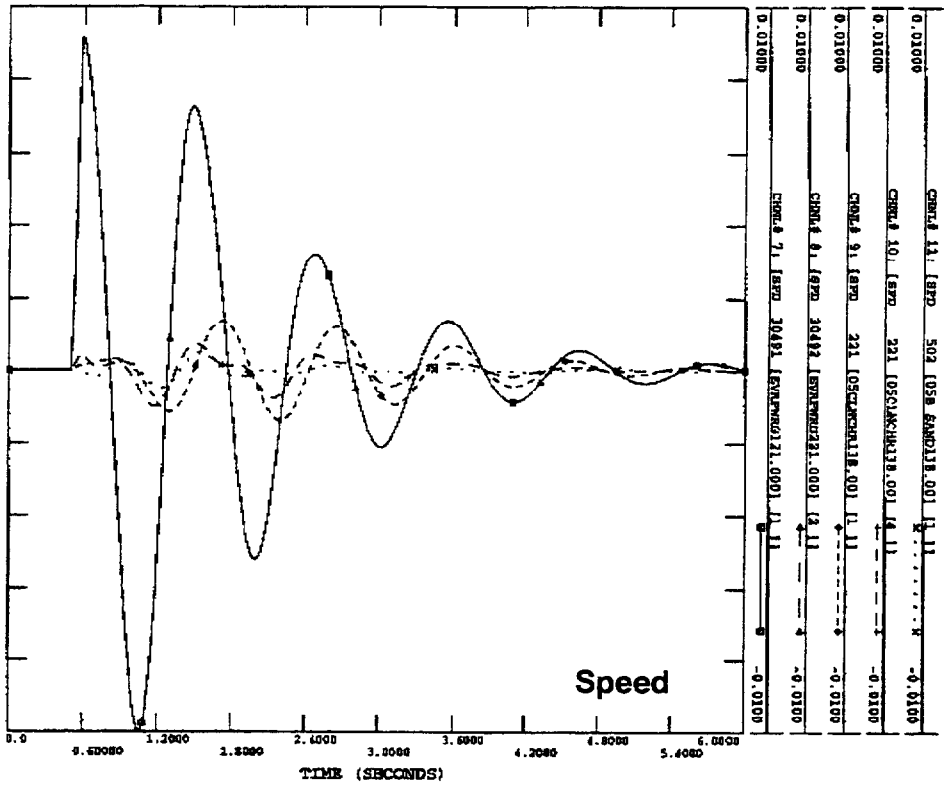


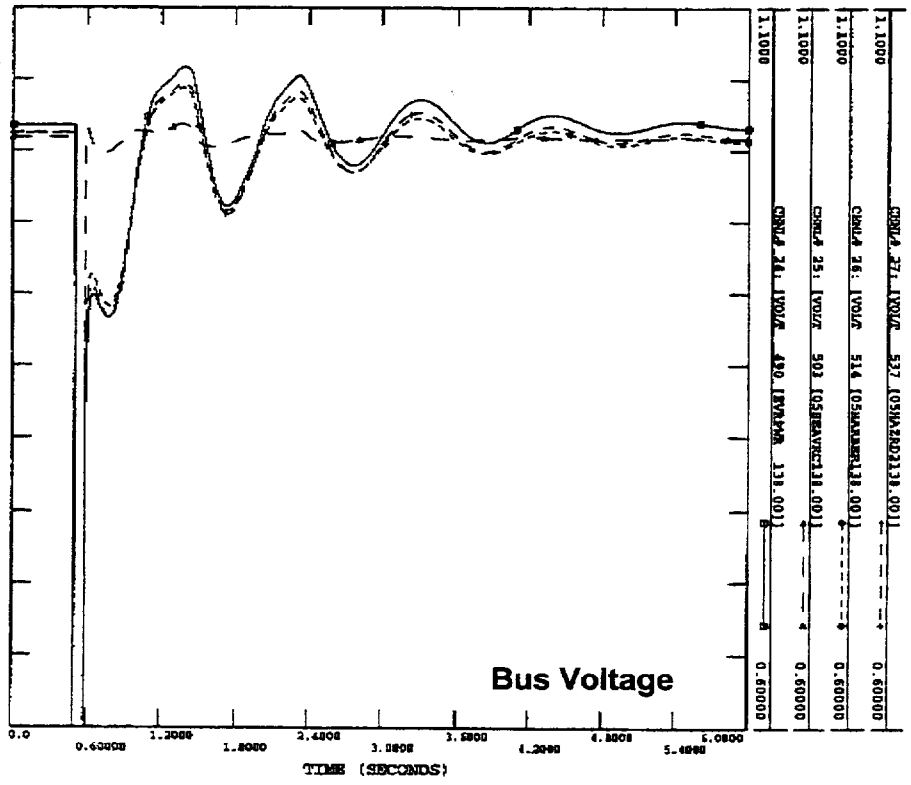
Case 4



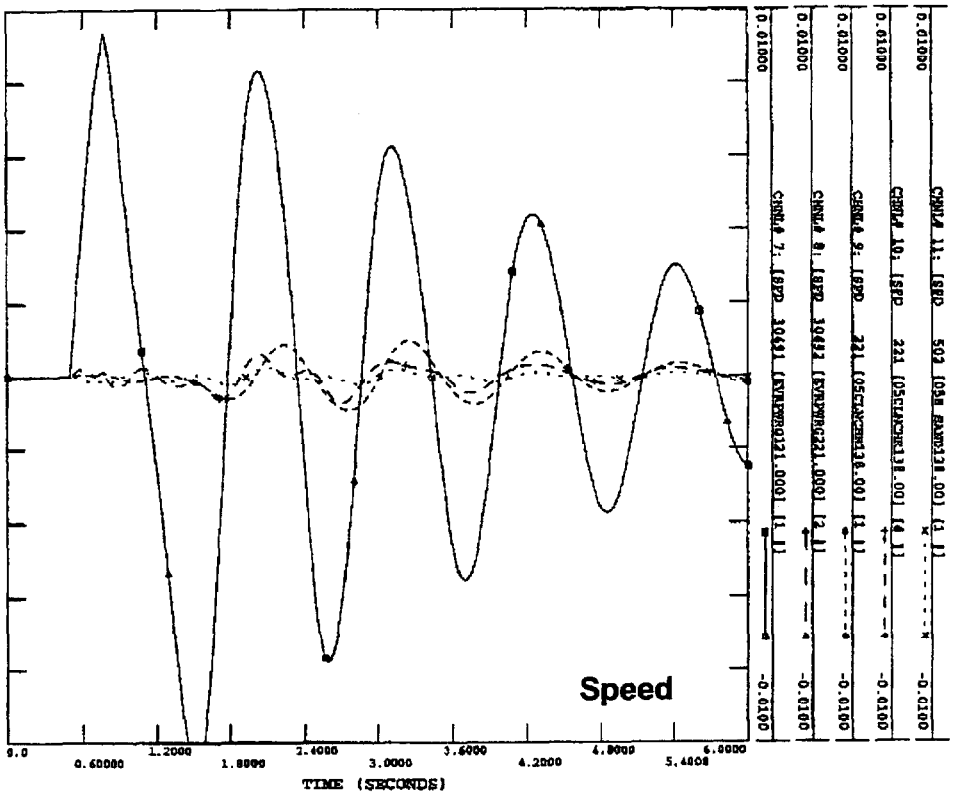


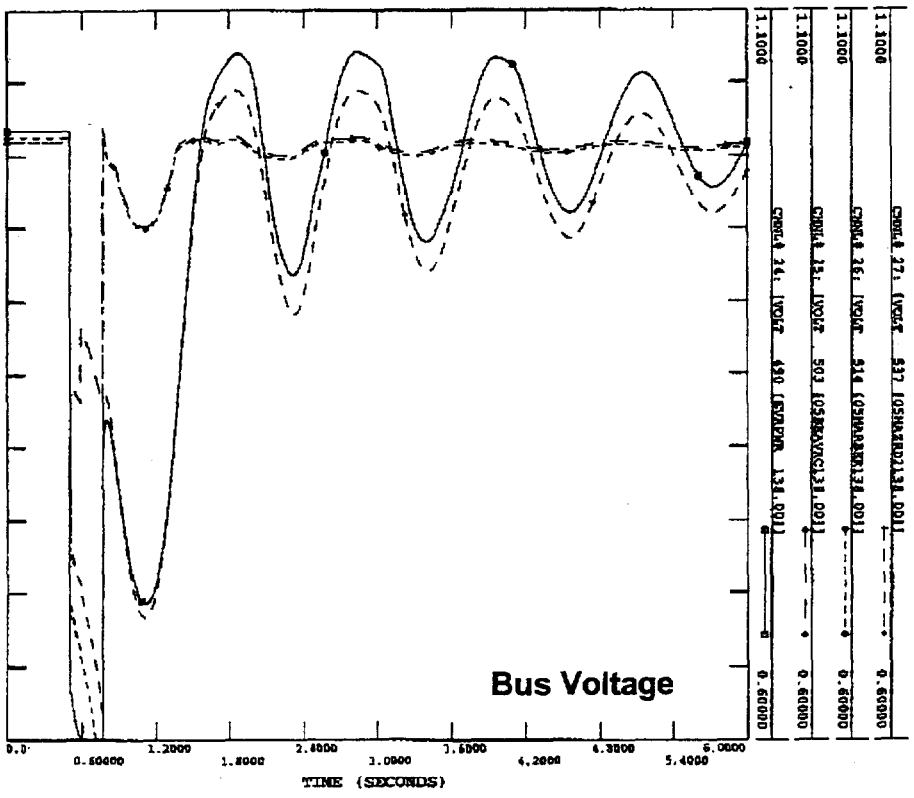
Case 5



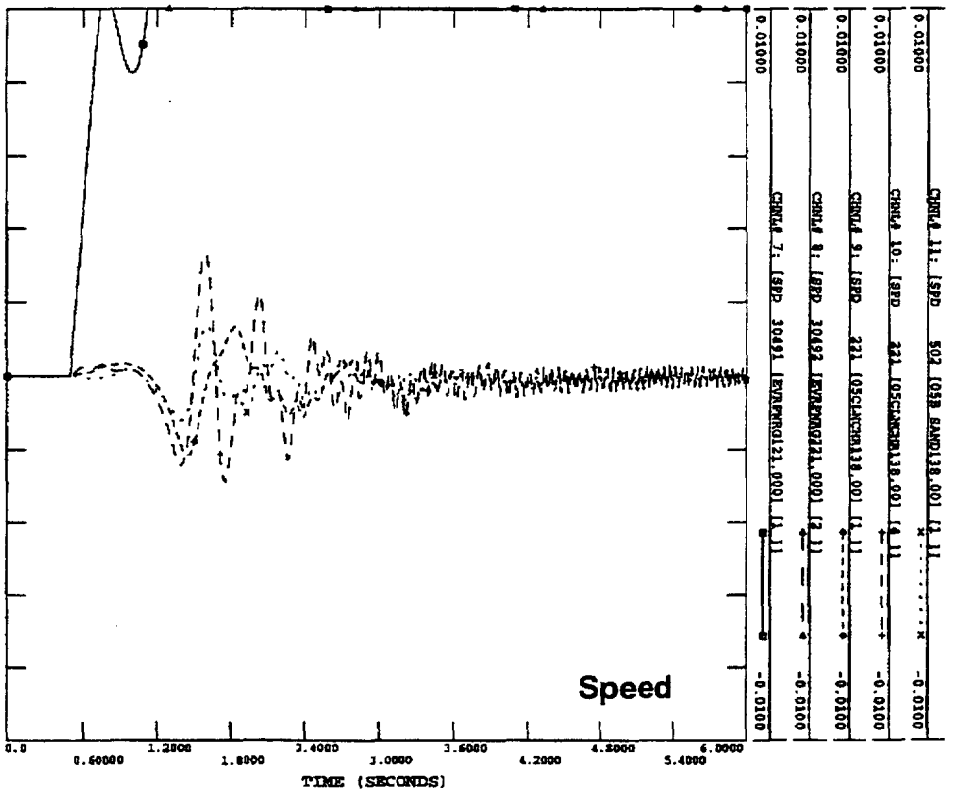


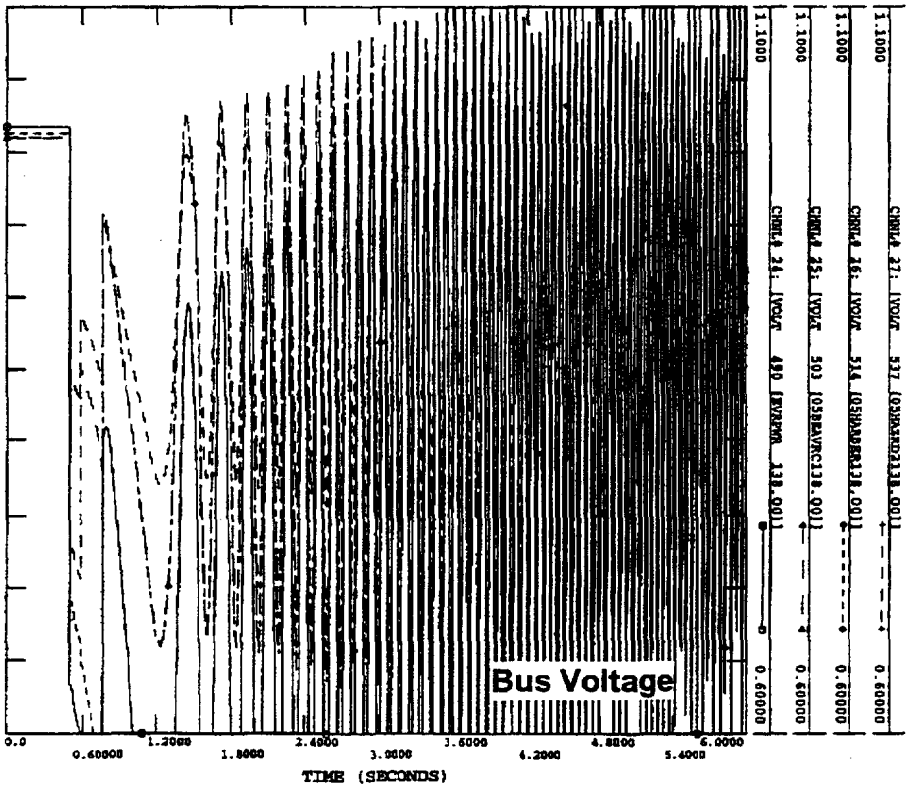
Case 6





Case 7





Case 8