AEP Exhibit No. 2

IN THE UNITED STATES OF AMERICA

BEFORE THE
SECURITIES AND EXCHANGE COMMISSION

In the Matter of American Electric Power Company, Inc.: File No. 3-11616

PREPARED DIRECT TESTIMONY OF
PAUL B. JOHNSON
ON BEHALF OF
THE AMERICAN ELECTRIC POWER SYSTEM

December 7, 2004

PREPARED DIRECT TESTIMONY

PAUL B. JOHNSON

SEC ADMIN PROCEEDING

FILE NO. 3-11616

I. INTRODUCTION AND QUALIFICATIONS

Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS AND CURRENT POSITION.

A. My name is Paul B. Johnson. I am currently employed by American Electric Power Service Corporation (AEP) as Manager, East Transmission Planning. My business address is 700 Morrison Road, Gahanna Ohio 43230.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL AND PROFESSIONAL BACKGROUND.

A. I earned my Bachelor of Science degree in Engineering in 1975 and my Master of Science degree in Management in 1979 from Purdue University. After receiving my Bachelors degree, I joined Sargent and Lundy Engineers in Chicago, Illinois where I was in the engineer trainee program. The following year, I joined Northern Indiana Public Service Corporation (NIPSCo) where I was an electrical field engineer and later a distribution planning engineer. During my employment at NIPSCo, I earned my Master of Science degree in Management. In 1981, I joined American Electric Power Service Corporation. During the course of my employment I obtained my Professional Engineer license and for the past eighteen years I have been an adjunct professor at Franklin University in Columbus, Ohio. I was initially employed by AEP as an engineer in the Regional Planning Division in the System Planning Department. Between 1981 and

1994, I was also assigned responsibilities in the System Performance Appraisal Section and the Extra High Voltage ("EHV") Planning Section. During this period, I was promoted to Senior Engineer. In 1994, I was named manager of the System Performance Appraisal Section. As a result of the June 2000 merger with Central & South West Corporation, I assumed broader responsibilities in my position as manager of the newly formed East Bulk Transmission Planning section. Recently, East Bulk Transmission Planning section and the East Area Transmission Planning sections were combined, and I assumed the position of Manager – East Transmission Planning.

Q. PLEASE DESCRIBE YOUR DUTIES AND RESPONSIBILITES IN YOUR CURRENT POSITION.

A. To put my response in perspective, let me first describe the AEP Service Corporation and the services it provides to the eleven subsidiary operating companies of American Electric Power Company, Inc. The Service Corporation, another subsidiary of American Electric Power Company, Inc., is the management, professional, and technology arm of the AEP System, providing a wide range of services to the parent and subsidiary companies in fields such as system analysis and planning, engineering, design, operations, financial services, legal services and administration.

Transmission Planning is a part of the Transmission Asset Management Department within the Service Corporation. East Transmission Planning is part of Transmission Planning. Specifically, East Transmission Planning provides the analytical and planning services for the eastern part of the AEP transmission system, which consists of transmission facilities ranging in voltage from 23 kV to 765 kV, including those transmission facilities that serve as interconnections with neighboring utilities. Such services include future system performance appraisal and planning studies for all eastern transmission facilities, near term transmission assessment studies, and the integration of merchant generation facilities and customer connections to the transmission system. Based on an evaluation of the results of these studies, the East Transmission Planning group initiates programs for the reinforcement of the eastern part of the AEP System's transmission network and facilities necessary to reliably integrate new generation facilities into the transmission network. East Transmission Planning also performs short-term assessments of the anticipated performance of the transmission system to support Transmission Operations. In addition, the East Transmission Planning group actively participates in regional and inter-regional coordination studies.

II. PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I will generally describe the North American electric system, which consists of three parts – the Eastern Interconnection, the Western Interconnection and the ERCOT (Texas) Interconnection. I will then trace the development of the Eastern Interconnection from its early days, when it consisted of individual isolated electric utilities, to its present state as a highly-interconnected power grid. I then will describe how the Eastern Interconnection operates electrically as a single unit -- a fact dramatically confirmed by the August 2003 electricity blackout. Finally, I will briefly describe the present state of the electric industry and how contemporary regulatory policies and business models take advantage of the electrical unity of the Eastern Interconnection to achieve economic benefits. The testimony of AEP witness J. Craig Baker explores this last topic in much greater detail.

III. THE NORTH AMERICAN ELECTRIC SYSTEM

Q. PLEASE DESCRIBE THE NORTH AMERICAN ELECTRIC SYSTEM.

A. The North American electric system covers all of the 48 contiguous United States, the adjacent seven Canadian Provinces and a part of Baja Norte, Mexico. Peak electric usage is typically measured in millions of watts (megawatts or MW). For comparison, a typical reading lamp consumes approximately 100 watts of electricity (or 10,000 typical reading lamps consume 1 MW of electricity). The total peak summer electric demand (or "load") on the North American Electric System is approximately 817,000 MW of which 745,000 MW is within the 48 States, 70,000 MW is within the Canadian Provinces and nearly 2,000 MW is in Baja Norte, Mexico. The total winter peak electric demand is approximately 716,000 MW of which 622,000 MW, 92,000 MW and 2,000 MW is in the 48 States, Canada, and Mexico, respectively. For comparative purposes, Columbus, Ohio (a metropolitan area of nearly 1.5 million people) has a summer peak demand of approximately 3,500 MW.

To serve this electric demand there is in excess of 990,000 MW of generation capacity. Of this capacity, 893,000 MW is within the 48 States, 95,000 MW is in Canada, and the remainder is in Baja Norte, Mexico. The generating facilities are predominately fueled by coal, nuclear power, natural gas and oil. Smaller amounts of generation are obtained from water (hydroelectric), wind and geo-thermal power. The largest power plant in North America is the Palo Verde Plant in Arizona consisting of approximately 3,800 MW of generation.

The bulk transmission system, a network of high-voltage electric transmission wires and associated facilities, connects these power sources to electric distribution systems that deliver electricity to customers. The bulk transmission system operates at voltages ranging from 115 kV up to 765 kV. (one kV is 1,000 volts). Within the contiguous 48 states there are over 160,000 miles of transmission circuitry operating at or above 230 kV. Within Canada, there are approximately 46,600 miles of circuitry operating at 230 kV or above and there are about 600 miles of circuitry in Baja Norte, Mexico operating at these voltage levels.

The North American Electric System consists of three "Interconnections": the Eastern Interconnection, Western Interconnection and the ERCOT (Texas) Interconnection. The smallest Interconnection is the ERCOT Interconnection, comprising approximately 63,000 MW of (summer) load, 79,000 MW of generation capacity and approximately 8,000 miles of transmission circuitry operating at or above 230 kV. The ERCOT Interconnection covers the majority of the State of Texas.

In contrast, the largest interconnection is the Eastern Interconnection. The geographic boundary of the Eastern Interconnection is virtually the North American continent east of the Rocky Mountains excluding the area of the ERCOT Interconnection. The Eastern Interconnection has over 610,000 MW of (summer) load, in excess of 725,000 MW of generation and nearly 130,000 miles of transmission circuitry operating at 230 kV or above.

The Western Interconnection covers all or portions of 12 western States and the two western Canadian Provinces. The Western Interconnection has approximately 143,000 MW of (summer) load, 188,000 MW of generation resources and nearly 70,000 miles of transmission circuitry operating at or above 230 kV.

Attached as AEP Exhibit No. 3 is a map of the North American Electric System showing the three Interconnections. The first page shows the areas covered by the three Interconnections and the second and third pages show the major transmission facilities.

Q. WHY ARE THESE THREE PARTS OF THE NORTH AMERICAN ELECRIC SYSTEM CALLED "INTERCONNECTIONS"?

A. They are called Interconnections because all of the electric utilities within each of the three are interconnected with one another and operate in synchronism with one another at 60 Hertz (cycles per second). As I will describe in the next section, these three large Interconnections developed over time as smaller-scale Interconnections among individual electric utilities were tied together.

Q. PLEASE EXPLAIN WHAT IT MEANS TO OPERATE IN SYNCHRONISM .

A. When an electric system operates in synchronism, the entire electric system is operating at the exact same frequency and is "in-phase". Within North America, electricity is generated, transmitted and utilized at 60 Hertz (or cycles per second or alternating current). The utilities that operate in synchronism must be all interconnected – either directly – or through interconnections with utilities that are then interconnected with other utilities.

Q. ARE THE THREE INTERCONNECTIONS INTERCONNECTED WITH ONE ANOTHER?

A. Yes. There are a few electrical ties between the Interconnections, all of which are direct current) and are of comparatively small capacity. Equipment at each end of the ties between the Interconnections converts alternating current to direct current or vice-versa depending upon which Interconnection is providing or receiving the electricity. For example, there are two electrical ties between the ERCOT and Eastern Interconnections. The total capacity of these ties is approximately 800 MW. There are seven ties between the Eastern and Western Interconnections and an eighth tie is expected to be in service prior to the end of 2004. These eight ties will have a total tie capacity of approximately 1400 MW. There are no electrical ties between the ERCOT and Western Interconnections. Because the Interconnections are connected only via DC ties, the three Interconnections do not operate in synchronism with one another.

IV. <u>EVOLUTION OF THE EASTERN INTERCONNECTION</u>

Q. PLEASE DESCRIBE THE HISTORICAL EVOLUTION OF THE EASTERN INTERCONNECTION.

A. Approximately 100 years ago, electrification of the nation was at its infancy. Power systems were local in nature and spanned geographic areas measured in tens of miles, at most. In those early years, the individual power systems covered metropolitan areas, and transmission voltages were relatively low. Because of these comparatively low voltages electricity could not be transmitted long distances or at large magnitudes. As electrification progressed, technologies improved and the opportunities to interconnect the individual transmission systems became more numerous. During the 1920s the AEP affiliated companies interconnected with one another and with neighboring systems. The first high voltage interconnection was established in 1918 by the construction of a 26 mile 132 kV Line between AEP's (Ohio Power's) Sunnyside Station and FirstEnergy's predecessor company in Akron. During that same era, initial interconnected operations began with the construction of several 132 kV lines emanating from the Peach Bottom Power Company's Windsor Station (a jointly owned subsidiary of AEP and Allegheny

Power's predecessor companies), which connected the metropolitan areas of Cleveland, Akron, and Pittsburgh into a common integrated system. This small interconnected system experienced difficulties maintaining a constant frequency, which led to the individual systems disconnecting the interconnecting lines between them when the maximum time deviation of 60 seconds was exceeded. (When an interconnection is disconnected, it is said to be "opened" and when it is reconnected, it is "closed.") Interconnections were established in northern Indiana and into the Chicago area also in the mid-1920's. Further east, utilities in eastern Pennsylvania and New Jersey initiated efforts to establish a three-company power pool, which would ultimately be connected together via 210 miles of 230 kV transmission lines by 1931.

In 1926 there was sufficient "wire in the air" to connect Chicago to Boston via interconnected transmission circuitry. An experiment was conducted on November 19,1926, connecting over 40 power plants (total capacity of 4750 MW) from Chicago to Boston. But the test only lasted a few minutes because some utilities disconnected after concluding that the test had been successful.

Over the next two decades, the Pennsylvania –New Jersey Interconnection grew to include several additional Pennsylvania and New Jersey utilities. In addition, the Baltimore utility also interconnected with this growing Interconnection, along with several other smaller systems. This expanded system was then called the Pennsylvania – New Jersey- Maryland Interconnection ("PJM"). Prior to 1962, PJM operated in isolation from adjacent systems except for temporary closures to the New York transmission systems. In the 1930s utilities in New England and New York operated in parallel as part of the Northeast Interconnection. By the late 1950s, the Northeast

Interconnection grew to encompass the Province of Ontario and lower Michigan. This expanded interconnection was named the Canada- United States Eastern Interconnection (CANUSE).

Q. WHAT WAS THE NEXT STAGE OF INTERCONNECTED AND COORDINATED OPERATIONS?

A. By the mid-1930s it became obvious that informal coordinated operations arrangements were insufficient. In 1933 utilities formed the Interconnected Systems Group ("ISG") which started to establish common criteria for interconnected operations. These early criteria addressed issues such as frequency deviation, time error correction, interchange schedule ramp rates and tie line control. Prior to establishment of these early "Rules of the Road", uncoordinated but interconnected operation resulted in continued facility overloading and unilateral line openings to control those loadings. By the late 1930s three regional committees under the ISG banner were formed – Northeast, Northwest and Southeast. The Interconnected Systems Group, made up of the three committees, covered the geographic area extending from eastern Pennsylvania to the southeastern portions of the United States to areas west of Chicago.

By 1935, several utilities operated with closed interconnections. However, these interconnections were opened whenever any utility experienced an overload or otherwise determined that it was beneficial to open the interconnection. The operating rules were based on ad-hoc and mostly informal operating agreements. Systems in the Northeast United States tended to operate independently as did the near southwest utilities.

In 1941, the Southwest area, then encompassing 11 utilities covering parts of Arkansas, Oklahoma, Louisiana, Missouri, and Nebraska, interconnected during World

War II to increase reliability and minimize construction to support the war effort. Following the war, these companies agreed that continued interconnected operation was beneficial. In the ensuing years the Southwest area interconnected with and joined the ISG.

By the 1950s there were three separate Interconnections -- ISG, PJM and CANUSE -- within the footprint of what was to become the Eastern Interconnection. In 1962, seven utility to utility interconnections were established, tying together the three separate Interconnections, which then collectively became the Eastern Interconnection.

Q. PLEASE DESCRIBE HOW CHANGES IN ELECRICITY USE AND TECHNOLOGY DROVE THE INCREASING INTERCONNECTION OF ELECTRIC SYSTEMS.

A. The use of electricity, and its importance to the national economy, grew at astounding rates from the early years of the electric industry. For example, the average household use of electricity between 1935 and 1950 tripled. During the 1950s and 1960s and even into the early 1970s, the demand for electricity grew at rates of approximately 7% per year. At this rate of growth, the use of electricity would double each decade. Technical advancements within the industry increased to match this pace. For example, the highest transmission voltage in the 1920s was 132 kV. By the early 1950s, transmission facilities at voltages of 330 kV and 345 kV were being constructed. Less than two decades later, transmission voltages at 500 kV and 765 kV were becoming commonplace. The size of generating stations increased at an equally astounding pace. In 1920, a 30 MW generating unit was considered the state of the art. By the mid-1940s, generating units of 150 MW were being constructed. By the mid-1950s a large generating unit was 300 to

500 MW. By the 1960s, generators in the range of 800 to 1300 MW were being constructed. The sheer size of the new generating units created logistical challenges. Abundant amounts of fuel and water (for cooling) were essential. Environmental concerns also required generating units to be constructed outside urban areas. Since the sources of electric power were "moving away" from the load centers where it was being consumed, there was a growing reliance upon the bulk transmission system. The establishment of transmission interconnections continued to be advantageous. Establishing transmission interconnections reduced transmission construction (by eliminating the need for each utility to construct sufficient transmission facilities if it were to operate as an independent "stand-alone" system), improved reliability, and provided a means to provide and receive back-up power from a neighboring utility during unexpected or temporary generation resource shortages. Because of this growing interdependence between and among interconnected utilities, disconnecting when there was an overload problem was simply no longer an option.

Q PLEASE DESCRIBE HOW THE TECHNOLOGICAL ADVANCEMENT IN INCREASED TRANSMISSION VOLTAGES IMPACTED THE DEVELOPMENT OF THE EASTERN INTERCONNECTION.

A. In the 1920s the highest transmission voltage was 132 kV. In the early 1930s, 230 kV transmission circuitry was being built. The 1950s experienced the development of 345 kV technology and by the late 1960s and early 1970s 500 kV and 765 kV facilities were quickly becoming common. These higher transmission voltages allowed electricity to be "shipped" further and further. These higher transmission voltages no longer required the generation resources to be physically located within or even near the urban load centers.

As dictated by the laws of physics, as the transmission voltage increases the corresponding electrical impedance (i.e., the resistance to electricity flow) decreases. A 5-mile transmission line built in the 1920s (at 132 kV) has similar electrical impedance as a 50-mile 345 kV transmission built in the 1950s and a 250-mile 765 kV transmission line built in the 1970s. The increase in transmission voltage thus permitted larger amounts of electricity to be transmitted over much greater distances.

Q. DID INTERCONNECTED OPERATION REQUIRE INCREASED COORDINATION?

A. Yes. As a direct result of interconnected operation, the utilities became interdependent, which required coordinated operation, development of reliability criteria, required generation reserve margins and other processes. The objective of these rules was (and continues to be) to promote reliability and to ensure that an unplanned transmission element failure and/or generation outage is confined to a small geographic area and does not propagate, causing adverse or detrimental conditions on neighboring systems.

The creation of the Eastern Interconnection in 1962, 37 years after the passage of the Public Utility Holding Company Act, was accomplished by tying together the then three regional interconnections. The creation of the Eastern Interconnection was a tacit, if not explicit, statement that the systems comprising the Eastern Interconnection would "hang together" to reap the benefits of interconnected operation, while recognizing the fact that no system can be operated independently without any concern for conditions on interconnected systems.

In 1965 the largest blackout to that date occurred, covering an area from Niagara Falls Ontario to New York City. This incident was a painful acknowledgement that in a highly interconnected system an unexpected outage of a facility can have dire consequences extending hundreds of miles, and impacting customers of numerous utilities.

IV. THE PRESENT EASTERN INTERCONNECTION – A SINGLE MACHINE

Q. PLEASE DESCRIBE THE EASTERN INTERCONNECTION AS IT PRESENTLY EXISTS.

A. The Eastern Interconnection covers diverse weather, load densities and generation resources. The transmission facilities are owned and operated by numerous entities including investor-owned utilities, federally (or provincially) chartered utilities and state and municipal electric companies and electric cooperatives.

For more than forty years the individual electric companies that comprise the Eastern Interconnection have been electrically tied together and cooperatively and collectively operate the Eastern Interconnection. A direct outcome of the 1965 blackout was the formalization of existing voluntary ad-hoc utility operations committees into what would become ten Regional Reliability Councils and the formation of the National Electric Reliability Council (later to become North American Electric Reliability Council -- "NERC") to coordinate the actions of the regional entities. The goal of these new entities was to "…review, discuss, and assist in resolving matters affecting interregional coordination". There are eight Reliability Councils covering the entire Eastern Interconnection footprint. The original members of these Councils were the electric utilities and transmission operators from within the Interconnection. Since then they have grown to include non-utility stakeholders. The purpose of the Reliability Councils was to develop common operating criteria and practices to ensure reliable electric performance and provide a forum to resolve operational differences between operating entities. Over the years, the mission of these reliability councils has grown to include reliability assessments, generation resource assessments, coordinated expansion planning and, in some councils, administration of electric tariffs and oversight of the moment-to-moment operation of the electric system. Transmission coordination within the Eastern Interconnection continues to evolve. Covering approximately two-thirds of the Eastern Interconnection footprint are four Regional Transmission Organizations ("RTOs"). The purposes of these RTOs include independent operational oversight of the electric facilities, reliability assurance and facilitation of a competitive generation electric market.

Q. WHAT TRANSMISSION VOLTAGES ARE USED IN THE EASTERN INTERCONNECTION?

A. The predominant bulk transmission voltages within the Eastern Interconnection are 765 kV, 500 kV, 345 kV, 230 kV and 138 kV. Each transmission circuit operating at these voltages has a corresponding large electrical capacity. For example a 765 kV circuit typically has a capacity of approximately 4,000 MW. Similarly, typical ratings for 500 kV, 345 kV, and 230 kV circuits are 2500 MW, 1500 MW and 800 MW respectively. Considering that the generation resources within the Eastern Interconnection are highly dispersed and typically located near fuel and/or water resources, it is the transmission system operating at 230 kV or above that delivers the majority of the electric energy to customers. Within the Eastern Interconnection there are also tens of thousands of miles of transmission circuitry operating at 161 kV, 138 kV, 120 kV, 115 kV and even more transmission facilities operating a voltages below 100 kV. However, the transmission circuits operating at voltages of 161 kV and below generally deliver power within or between load centers covering relatively small geographical areas.

Q. PLEASE DESCRIBE THE ENTITIES THAT MAKE UP THE EASTERN INTERCONNECTION.

A. The Eastern Interconnection is comprised of over 100 Control Areas.

Q. WHAT IS A CONTROL AREA?

A. A Control Area is an individual electric system within the Eastern Interconnection bounded by interconnection metering at each of its transmission connections with adjoining Control Areas. Historically, the Control Areas have been utility companies or holding company systems. Each Control Area must balance its load, generation and net imports and exports to and from adjoining Control Areas, as measured by the interconnection meters. For example, suppose a particular Control Area has 10,00 MW of load and 12,000 MW of generation resources. Now suppose at any given time it uses its generation within its boundaries to supply all of its load (with the unused amount held in reserve). In that case, its operating generation and load would be in balance, it would not be importing or exporting anything, and thus the summation of its interconnection metering would be zero. But that would be a very unlikely circumstance, since in actual practice, purchases and sales among Control Areas are happening all the time. Now suppose the same Control Area is selling 500 MW to an adjoining Control Area and buying 400 MW from another adjoining Control Area. Now, its <u>net</u> interconnection metering would show it to be 100 MW short. Because of its obligation to always keep its generation, load and net imports/exports in balance, the Control area would have to increase the output of its generators by 100 MW to make up the shortage. Similarly, a

Control Area that does not have enough internal generation to serve its load at any given time must have an amount of net imports sufficient to bring its generation and load into balance. Invariably for any Control Area, the sum of its respective interconnection metering includes generation being supplied to and received from other Control Areas. Therefore, the aggregate of all interchanges of all the Control Areas within the Eastern Interconnection must sum to zero (excluding the small amount of power interchange between the Eastern, Western and the ERCOT Interconnections). If any control area within the Interconnection does not fulfill its obligation to balance its load, generation and net imports/exports, the system will speed up or slow down to frequencies different from nominal (60 Hertz). If the magnitude of the deviation is significant, generating units will automatically shut-down, jeopardizing the reliability of the system. The fact that all systems within the Eastern Interconnection are interconnected with each other facilitates power exchanges between adjacent Control Areas as well as Control Areas that are at opposite ends of the Eastern Interconnection.

Q. WHAT ARE THE BENFITS OF INTERCONNECTED OPERATION OF THE EASTERN INTERCONNECTION?

A. The benefits of the Eastern Interconnection encompass both economic and reliability aspects. Inexpensive generation resources in one part of the Interconnection can be "transferred" to another part of the Interconnection to achieve generation dispatch economies. Further, if one area of the Interconnection experiences an unexpected shortage of generation resources (caused, for example, by coincident unplanned generation unit outages), these resources can be replaced by generation in adjoining areas. Similarly, if there is an unplanned transmission facility outage, the power from the designated generation resources will still be able to serve that load area using other transmission paths within the Interconnection to deliver the power from the generation to the load center. Unlike distribution systems, the outage of a transmission circuit will typically not result in a customer outage. Since the transmission system is a network, electricity that was previously flowing on the outaged transmission facility is automatically redirected to other parallel facilities as governed by the laws of physics.

Q. WHAT CHALLENGES ARISE FROM INTERCONNECTED OPERATION?

A. Because all of the Control Areas are interconnected, the operation of any single Control Area affects the operation of all nearby electric systems. The operation of any system can impact interconnected systems in many ways. The physics of electricity are such that power flowing from a source to a load will use all electric paths between those two locations. Thus, when a Control Area supplies a quantity of power to a neighboring Control Area, the electricity does not flow on just the electrical interconnections between the two systems, but rather a portion of the power also flows on nearby parallel systems, increasing (or possibly decreasing) the flows on systems not party to the power transfer itself. If there is a transmission circuit outage within one system, the power that was flowing on that outaged transmission facility is automatically redirected to other electrical circuits in parallel with the outaged circuit. Some of this redirected power will result in increased flows on transmission facilities of adjacent systems. In addition, even if a Control Area is merely supplying its own load requirements from generating resources within its borders, some of that power will flow on adjacent systems' facilities, impacting the loadings of those facilities. These unintentional or inadvertent power flows are commonly referred to as "loop-flows". Loop flows from neighboring systems, added to the normal flows on a given facility, can cause that facility to experience loadings up to its maximum capability rating, resulting in transmission congestion. If these flows are not mitigated, reliability of the transmission system is jeopardized. When this situation occurs in real-time operation, or appears imminent, existing processes and procedures must be invoked to ensure that acceptable levels of reliability are maintained.

Q. WHAT PROCEDURES ARE AVAILABLE TO MAINTAIN RELIABILITY?

A. These procedures include changing levels of generation impacting the constrained facility, opening another transmission facility (*i.e.* opening the switch causing power not to flow on the facility) thereby redirecting some power flows to other facilities, or invoking the NERC Transmission Loading Relief procedure. These Eastern Interconnection-wide TLR procedures involve the proportional reduction of use of every electric system that causes flows on that constrained facility.

Electrically the Eastern Interconnection operates as a single entity. The specific operation of one part of the Interconnection will impact the loadings and voltages on other parts of the Interconnection. The individual actions of each Control Area are coordinated to ensure that those individual actions do not <u>adversely</u> impact the operation or reliability of neighboring systems. This coordination is accomplished by approximately 13 Reliability Coordinators that have a wide-area view of the particular loadings and voltages on multiple Control Areas within the Eastern Interconnection. The role of each Reliability Coordinator is to ensure the continued reliable operation of the Interconnection. In that role a Reliability Coordinator may order a transmission operator of a particular electric system to take specific action(s) to safeguard transmission reliability. Through this multi-layered control (Control Areas and Reliability

Coordinators), the Eastern Interconnection operation is controlled in a coordinated, but dispersed fashion.

Q. PLEASE GIVE A REAL-LIFE EXAMPLE OF THE INTERDEPENDENCE AND INTERACTION OF UTILITY SYSTEMS WITHIN THE EASTERN INTERCONNECTION.

A. Perhaps the most recent incident exemplifying the interdependence and interaction within the Eastern Interconnection was the blackout of August 14, 2003. This blackout affected over 60,000 MW of load (approximately 10% of the Eastern Interconnection) impacting a geographical area covering portions of eight mid-west and northeastern States and the Canadian province of Ontario. The blackout started with failures of transmission circuits in northeast Ohio caused by transmission lines coming in contact with trees. Coincidentally, monitoring systems designed to detect these failures failed and the corresponding inability to gauge the impact of these failures (once detected) upon transmission reliability led to delayed and insufficient mitigating actions. The outage originated in northeast Ohio, spread to Detroit and eastern Michigan, and then cascaded eastward to the northeast Atlantic coast. From the start of this incident to the final "state" only approximately 4 minutes elapsed. The majority of the blackout occurred within 10 seconds.

Q. WERE AREAS OF THE EASTERN INTERCONNECTION THAT WERE NOT BLACKED OUT AFFECTED BY THE ABOVE EVENTS?

A. Yes, the remainder of the Eastern Interconnection "felt" the separation of the blacked-out portion of the system. One of the basic electrical principles is when the amount of generation exactly equals the load, the frequency will be exactly 60 Hertz. During the course of a day the frequency remains within a few one-hundredths of a Hertz as the load varies and the generation output is automatically adjusted, either up or down , in response to this change in load level. For example, when the electrical demand on the system is suddenly increased, the frequency on the system is momentarily decreased. This tiny decrease in frequency is automatically detected and the generation is automatically increased to return the frequency to 60 Hertz. Similarly, if a large generator unexpectedly disconnected from the Interconnection, there is a deficiency in generation relative to load and the frequency throughout the Eastern Interconnection declines slightly. The frequency deviation is automatically detected, and generators throughout the Interconnection increase their generation levels to restore nominal frequency. On August 14, 2003, the separation of the northeastern portion of the Interconnection disconnected approximately 60,000 MW of load. In addition, a smaller amount of generation was also disconnected from the Eastern Interconnection. Immediately flowing this separation, there was an excess of generation, relative to load, on the surviving portion of the Eastern Interconnection. Immediately following the separation, frequency exceeded 60.2 Hertz, over 3% above nominal, a very large deviation. Recordings from various locations in the Midwest, Minnesota, Iowa, Alabama, and Florida, all documented this unusually high frequency deviation. Generating units throughout the Eastern Interconnection, in response to this high frequency, immediately began to reduce the generation level and returned to nearly 60 Hertz over the following minutes.

Q. WHAT LESSON CAN BE DRAWN FROM THE ABOVE DISCUSSION?

A. The lesson that can be drawn from the above discussion was aptly stated by The United States Department of Energy ("D.O.E."), in a report entitled "Is Our Power Grid More

Reliable One Year After the Blackout", a copy of which is attached as AEP Exhibit No. 4. The D.O.E. said, and I concur, that:

> The eastern interconnection is perhaps the world's largest synchronized machine. Spread across the eastern half of the United States, hundreds of large and small generators (all of which are connected electrically and spin in perfect unison) generate electricity at …60 hertz (cycles per second).

V. SUMMARY

Q. WOULD YOU SUMMARIZE YOUR TESTIMONY ON THE HISTORICAL DEVELOPMENT AND PRESENT STATE OF THE EASTERN INTERCONNECTION?

A. Yes. The early years of the electric industry, like most industries, saw phenomenal growth in demand and supporting technologies. Unlike most industries, however, it was advantageous for the individual electric utilities to work together to minimize costs and to foster greater reliability, which they accomplished by establishing utility-to-utility interconnections. In these early years, these utility-to-utility interconnections were arrangements for mutual cost reduction and convenience. If any individual utility was not receiving expected benefits, or was simply experiencing a presumably temporary overload, the utility-to-utility interconnection was simply disconnected to restore conditions to acceptable levels. As the demand for electricity continued to grow, and technology advanced, the character of these utility to utility interconnections changed from one of convenience to one of necessity.

Since the establishment of the Eastern Interconnection over 40 years ago, the interconnection of utilities has continued to increase and evolve. More interconnections, at higher transmission voltages, (as high as 765 kV) have produced an increasingly interconnected electric power grid, resulting in greater economies and reliability, but with the corresponding need for greater coordination, joint planning and more definitive reliability criteria.

Perhaps it is ironic to tout the August 2003 blackout as an exemplification of the Eastern Interconnection as a single, huge network. However, in decades past, such an event was simply not possible. Utility to utility interconnections were typically weak and were surely not used as a long-term delivery mechanism for generation resources that are hundreds of miles and several systems away from the load being supplied. In the early years power would be exchanged (typically) between neighboring entities. By the 1990s it was not unusual, if not typical, for large quantities of (comparatively cheap coal-fired) electric power generated in the Midwest to be shipped across the Eastern Interconnection to serve loads on the Eastern seaboard or southern locations to displace relatively expensive oil or gas fired generation. Similar arrangements existed in other parts of the Eastern Interconnection. A strong single reliable bulk transmission system was essential to allow this business model to be feasible. Such was the case in August 2003. Unplanned (and actually unobserved) transmission outages in Northeast Ohio, aggravated by local generation shortages in Cleveland, initiated a blackout propagating from northern Ohio to eastern Michigan, Ontario, New England, and including New York City. Obviously, the potential for such widespread effects is a serious, albeit extremely rare, downside to interconnected operation. However, the fact that the vast majority of the outaged load was restored within many hours, and virtually all load restored within four days further demonstrates the benefits of the interconnectedness and "oneness" of the Eastern Interconnection.

Q. PLEASE BRIEFLY DESCRIBE THE CONTEMPORARY ELECTRIC INDUSTRY.

A. Several FERC Orders culminating in FERC Open Access Order 888, and the entry of new industry entrants such as Exempt Wholesale Generators (EWGs), fostered a change in the character of the Eastern Interconnection. The bulk transmission system now is effectively a common carrier, the transportation mechanism of wholesale (and in some areas, retail) power. The addition of EWGs and power marketers has increased the number of industry participants tremendously. However, since the Eastern Interconnection is a single entity, coordinated operation is still paramount. However, the voluntary, but formal, regional reliability council format is being replaced with mandatory reliability standards and the transmission system, in many areas, are operated under the auspices of independent Regional Transmission Organizations (RTOs). These independent entities oversee the reliable interconnected operation of the Eastern Interconnection and manage wholesale generation markets within their respective footprint. This new business model takes advantage of the Eastern Interconnection's "oneness" to foster greater economic benefits to entities within the eastern footprint.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes, it does.

ADMINISTRATIVE PROCEEDING
FILE NO. 3-11616

UNITED STATES OF AMERICA
Before the
SECURITIES AND EXCHANGE COMMISSION

In the Matter of **AMERICAN ELECTRIC POWER COMPANY, INC.**	**AFFIDAVIT OF WITNESS, PAUL B. JOHNSON**

AFFIDAVIT OF WITNESS

I, the undersigned, being duly sworn, depose and say that the Prepared Testimony of Paul B. Johnson served on behalf of the AEP Service Corporation in this proceeding is the testimony of the undersigned, and I hereby adopt said testimony as if given by me in formal hearing, under oath.

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Paul B. Johnson

SUBSCRIBED AND SWORN to before me, a Notary Public, in Franklin County, Ohio on the ____ day of December, 2004.

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Notary Public