



## AEP Interstate Projects to Employ Latest Technology

American Electric Power has always been a leader in developing and implementing new technology at both its power plants and its transmission facilities. As we continue into the 21st century, AEP believes that an advanced interstate transmission system should be part of a shared national vision. We believe that this new vision – conceptually known as “I-765<sup>TM</sup>” -- will efficiently deliver wholesale power regionally within a competitive market while enhancing regional reliability. As AEP moves forward with new 765 kV projects we will continue AEP’s legacy of employing the most efficient and advanced technologies available. Among them are:

### **Six-Conductor Phase Bundle**

Until recently, four conductors per phase have been used in 765 kV transmission lines. Although the audible noise performance of such lines generally has been satisfactory, a six-conductor bundle further limits noise, particularly at higher altitudes. This improved design offers an added benefit of reduced levels of radio and television interference.

### **Phase and Shield Wire Transposition**

At 765 kV, large physical separations between phases ensure acceptable electrical clearances. For practical reasons, horizontal phase geometry is used to minimize the tower height. The resulting unequal phase-to-phase distances, in combination with occasionally dissimilar single-phase station equipment forming a three-phase bank, give rise to unequal phase voltages and currents across the phases. This phenomenon, known as system unbalance, has been effectively managed with suitable countermeasures. Nonetheless, due to long transmission distances and high loading levels anticipated in this project, which can intensify system unbalance, plans are to transpose (i.e., rotate) phases on the new line.

### **Fiber-Optic Shield Wires**

Protection of the new 765 kV line, particularly when 765/500 kV transformation is out of service at the intermediate station, will present new challenges because of the long transmission distance involved. Shield wires with fiber-optic cores will enable the use of so-called differential line protection -- a superior technique borrowed from transformer protection that reliably detects short circuits. Also, fiber-optic shield wires facilitate grid monitoring with Phasor Measuring Units (PMUs), which are basically system “stress detectors,” and aid remote control/diagnostics of the equipment.

### **Wide-Area Monitoring and Control**

Reliable operation of a power system requires accurate and timely system intelligence, normally obtained from Supervisory Control and Data Acquisition (SCADA). This information can be greatly enhanced through continuous monitoring via PMUs. The PMU network and associated computer tools offer a novel approach to time-synchronized, wide-area condition assessment for the management and operation of interconnected systems. PMU devices will be installed at remote sites to communicate, via the line’s optical channels, real-time data. These same channels also will allow the operators to switch station equipment in/out of service to maintain system reliability.

### **Remote Station Equipment Diagnostics**

Large, critical station equipment will be installed at locations outside of the AEP System. To ensure proper functioning of the equipment, its physical status and “health” will need to be monitored on a periodic basis. Due to the long distance involved, routine inspections of station equipment normally performed on-site will not be practicable. Instead, consideration is being given to installing special remote sensors, detectors and audio/video devices -- linked via optical channels to AEP’s computers/databases – to secure the necessary equipment diagnostics.

### **Single-Phase Switching**

Single-phase switching (SPS) allows integration of a major generating station with the system using only two 765 kV lines. SPS takes advantage of the superior outage performance of 765 kV lines by momentarily interrupting only one of three phases to clear temporary single-phase faults. This feature, made possible by the fact that all 765 kV-connected station equipment (circuit breakers, shunt reactors, etc.) are built as single-phase units, will enhance the line's availability and minimize system disturbances caused by faults and associated switching operations.

### **Switchable Shunt Reactors**

Long 765 kV transmission lines normally require that banks of shunt reactors be installed at each terminal to control high voltages. These reactor banks are commonly connected to the line via simple air-break switches, requiring an outage of the line to disconnect/reconnect the reactors. Special circuit breakers and/or power electronics will be used to permit (de)energization of these reactors automatically or by remote control without taking the line out of service. This feature will enhance operating flexibility and enable SPS implementation.

### **Static Var Compensators**

The load-carrying ability of a transmission line (loadability) is highly dependent on the line length. This relationship between loadability and length indicates that the loadability of a 550-mile-long transmission line is merely 60% of surge impedance loading. For the proposed 765 kV line, this translates to 1400-1500 MW, i.e., only about one-third of its projected thermal capacity. In order to increase the loadability, a static var compensator (SVC) with an estimated control range of -500 Mvar to +1000 Mvar will be installed at the intermediate station and at the end terminal. By providing the required dynamic voltage regulation and firming up the receiving systems, these SVCs will reduce the effective transmission distance to less than 300 miles, thus boosting the loadability by 80% to about 110% of SIL, or above 2600 MW.

The SVC device at each designated location will be integrated with the 765 kV switchable shunt reactors provided for line-charging compensation. This arrangement will place the shunt reactors under the SVC control, extending the SVC’s dynamic range in a cost-effective manner. Additional switched capacitors, also controlled by the SVC, will be included in the design to extend the dynamic range further and provide harmonic filtering, as required. Single-phase controls, with "ride-through" capability during fault conditions, are planned for the SVC to help maintain balanced phase voltages during normal and contingency operation.

Essentially, all technologies described will promote individual-phase approach to the AEP Interstate Project, unlike the vast majority of transmission lines in the nation today that operate as a three-phase unit. This approach will ensure greater system reliability and power-carrying capability for the benefit of consumers.