STATE OF ILLINOIS

ILLINOIS COMMERCE COMMISSION

Grain Belt Express Clean Line LLC	)	
	)	
Application for an Order Granting Grain Belt Express Clean Line LLC a Certificate of Public Convenience and Necessity pursuant to Section 8-406.1 of the Public Utilities Act to Construct, Operate and Maintain a High Voltage Electric Service Transmission Line and to Conduct a Transmission Public Utility Business in Connection Therewith and Authorizing Grain Belt Express Clean Line Pursuant to Sections 8-503 and 8-406.1(i) of the Public Utilities Act to Construct the High Voltage Electric Transmission Line.	)	**Docket No. 15-____**

DIRECT TESTIMONY OF

DR. WAYNE GALLI

ON BEHALF OF

GRAIN BELT EXPRESS CLEAN LINE LLC

GRAIN BELT EXPRESS EXHIBIT 2.0

APRIL 10, 2015

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I. WITNESS INTRODUCTION

Q. Please state your name, present position and business address.

A. My name is Anthony Wayne Galli. I am Executive Vice President – Transmission and Technical Services of Clean Line Energy Partners LLC ("Clean Line"). Clean Line is the ultimate parent company of Grain Belt Express Clean Line LLC ("Grain Belt Express"), the Petitioner in this proceeding. My business address is 1001 McKinney Street, Suite 700, Houston, Texas 77002.

Q. What are your duties and responsibilities as Executive Vice President – Transmission and Technical Services of Clean Line?

A. I oversee and am responsible for the planning, engineering, design, construction, and other technical activities of Clean Line and its subsidiaries with respect to their transmission projects. I am also involved in developing strategy for Clean Line.

Q. Please describe your education and professional background.

A. I received Bachelor of Science and Master of Science degrees from Louisiana Tech University and a Doctor of Philosophy degree from Purdue University, all in electrical engineering. I am a Senior Member of the Institute of Electrical and Electronics Engineers, a member of the International Council on Large Electric Systems, and a registered Professional Engineer in the Commonwealth of Virginia.

I have over 17 years of experience in the electric transmission industry, in both technical and managerial roles, ranging from power system planning and operations to regulatory matters and project development. Prior to joining Clean Line, I served as Director of Transmission Development for NextEra Energy Resources, a subsidiary of NextEra Energy, Inc. (formerly FPL Group, Inc.), where I developed transmission

projects under the Competitive Renewable Energy Zones ("CREZ") initiative in Texas. In this position, I focused on, among other issues, the development of High Voltage Direct Current ("HVDC") transmission solutions in the CREZ, and I led my company's efforts in routing, siting and engineering transmission lines in the CREZ. Previously, I spent six years at the Southwest Power Pool ("SPP"), where I led the implementation of several components of the SPP market and grew the SPP Operations Engineering Group over fourfold to help ensure reliable operations of the SPP grid as it moved toward a market paradigm. As the Supervisor of Operations Engineering at SPP, my group was responsible for the real-time and short-term engineering support of SPP's Regional Transmission Organization ("RTO") functions. These duties included activities primarily directed toward maintaining real-time system reliability through engineering support for the SPP Reliability Coordinator and Market Operations, performing short-term tariff studies, operational planning activities (e.g., processing outage requests), and engineering analysis support of the SPP Energy Imbalance Services Market. Additionally, my group led the implementation of several facets of the SPP market system and performed acceptance testing of various software systems.

My background also includes system planning experience with Southern Company Services, a subsidiary of Southern Company, where I analyzed expansion plans for 500 kilovolt ("kV") transmission facilities, and commercial power systems experience with Siemens Westinghouse Technical Services. Additionally, I have held academic positions at the university level and have helped design shipboard power systems for the U.S. Department of Defense.

Q. Have you testified previously before regulatory commissions?

A. Yes, I have provided testimony in proceedings before the Federal Energy Regulatory Commission ("FERC"), the Public Utility Commission of Texas, the Kansas Corporation Commission, the Oklahoma Corporation Commission, the Illinois Commerce Commission, the Indiana Utility Regulatory Commission, the Tennessee Regulatory Authority, the Arkansas Public Service Commission, and the Missouri Public Service Commission.

II. PURPOSE AND COVERAGE OF TESTIMONY

Q. What is the purpose of your direct testimony?

A. I am testifying on behalf of Grain Belt Express in connection with its request to be issued a Certificate of Public Convenience and Necessity pursuant to Section 8-406.1 of the Illinois Public Utilities Act ("PUA") to construct and operate the Grain Belt Express Clean Line transmission project ("Grain Belt Express Project" or "Project") in the State of Illinois and to conduct a transmission public utility business in connection with the Project, and for an order pursuant to Sections 8-503 and 8-406.1(i) of the PUA authorizing Grain Belt Express to construct the Project. Specifically, I will describe the reasons for and benefits of Grain Belt Express' use of HVDC technology for the Project, including a comparison of the cost and operational benefits of HVDC to Alternating Current ("AC") transmission for this application. I will provide information on the proposed design and technical specifications for the Project, including the justification for the right-of-way ("ROW") width that is being requested. I will describe the status of the interconnection process for the Project and describe Grain Belt Express' work with the PJM Interconnection, LLC ("PJM"), the Midcontinent Independent System Operator, Inc. ("MISO"), and SPP to process and obtain the interconnection studies and other approvals

from these organizations necessary to proceed with the Grain Belt Express Project. Finally, I will address Grain Belt Express' managerial and technical capabilities to construct, operate and maintain the Project and to be certificated as a public utility providing transmission-only services. My testimony will help to demonstrate that Grain Belt Express is capable of efficiently managing and supervising the construction process for the Project and has taken sufficient action to ensure adequate and efficient construction and supervision of construction.

Q. Will you be discussing route development for the Grain Belt Express Project?

A. No. While I am involved with all technical aspects of the Project, including environmental analysis and routing, I will not be testifying to route development or routing decisions. Testimony on these topics is presented by Grain Belt Express witnesses Tim Gaul and Mark Lawlor.

Q. In addition to your prepared testimony, which is identified as Grain Belt Express Exhibit 2.0, are you presenting any other exhibits?

A. Yes, I am also presenting Grain Belt Express Exhibits 2.1 through 2.4, which were prepared under my supervision and direction. I will discuss each of these exhibits in the course of my testimony. In addition, I have also referenced several web sites that provide additional information on certain of the firms that have been contracted to provide engineering and construction services for the Grain Belt Express Project. Further, I have also referenced, via footnotes, websites with information from MISO, PJM, SPP, and Grain Belt Express that are pertinent to our interconnection processes.

III. <u>OVERVIEW OF GRAIN BELT EXPRESS PROJECT</u>

Q. Please describe the Grain Belt Express Project and its planned interconnections to

the grid.

A. The Grain Belt Express Project is an approximately 780-mile, ±600 kV, multi-terminal overhead HVDC transmission line (the last approximately 5.2 miles of the transmission line will be AC facilities). The Project will deliver up to 4,000 megawatts ("MW") of wind generated electricity from western Kansas to customers in Missouri, Illinois, Indiana and states farther east. The western terminus of the Project will interconnect to the ITC Great Plains ("ITC") 345 kV system in SPP. Two delivery stations of the Project will be interconnected to, respectively, the Ameren Missouri ("Ameren") 345 kV system in MISO and the American Electric Power ("AEP") 345 kV system in PJM.

Q. Please describe the transmission facilities that Grain Belt Express proposes to build.

A. The Grain Belt Express Project will interconnect at a tap of ITC's Spearville to Clark County 345 kV transmission line in Ford County in southwestern Kansas, near Dodge City, and traverse approximately 580 miles to an interconnection location in northeastern Missouri along Ameren's Maywood to Montgomery 345 kV transmission line in Ralls County, Missouri. The Project will then cross the Mississippi River and enter Illinois. The Proposed Route in Illinois will continue approximately 202 miles through Illinois to the eastern converter station in Clark County, Illinois. Finally, AC lines of the Project will run approximately 3.6 miles to the Illinois-Indiana border and enter Indiana to terminate at AEP's Sullivan/Breed 345 kV substation in Southwestern Indiana. The final, AC segment will be approximately 5.2 miles long in total. This final Point-of-Interconnection ("POI"), which is approximately 1.6 miles into Indiana, will provide direct access to the 765 kV network in PJM via two 345/765 kV transformers in the AEP

765 kV Sullivan/Breed substation.[1] The Project will be capable of delivering up to 500 MW of power to the MISO market and up to 3,500 MW of power to the PJM market through the interconnections with the existing transmission grid in Missouri and Indiana, respectively. The HVDC portion of the Project will consist of the HVDC line and three HVDC converter stations located near the substations described above. Each converter station will be capable of converting DC into AC or vice versa. The converter in Ralls County, Missouri will interconnect with the MISO system along the Ameren 345 kV AC transmission line connecting the Maywood substation and the Montgomery substation. The connection will be made via a single 345 kV circuit from the converter station to a nearby tap point along the Ameren 345 kV transmission line. The converter in Clark County, Illinois will interconnect to the PJM system through one, double circuit 345 kV transmission line interconnecting the AC bus of the Clark County converter station to the Sullivan/Breed 345 kV substation of AEP in Sullivan County, Indiana.

Q. Why do you refer to the POI to the PJM electric grid as the Sullivan/Breed Substation?

A. AEP is in the planning stages of moving the existing Breed 345 kV substation to be located adjacent to the Sullivan 765 kV substation, with a projected completion date of June 2017, which would be prior to the completion date of the Grain Belt Express Project.[2] Therefore, the Project's POI to the PJM grid will be at the Sullivan/Breed 345 kV substation.

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[1] AEP is planning to install a third transformer at this location and therefore has assumed the third transformer exists in studies of the interconnection of the Grain Belt Express Project.

[2] PJM Transmission Expansion Advisory Committee, *Reliability Analysis Update September 25, 2014, page 38; (available at):*

Q. Why does the Project need to interconnect with the 345 kV ITC facility in Kansas?

A. Because the HVDC technology that is being proposed is Line Commutated Converter ("LCC"), there is a need to interconnect to the existing grid to ensure robust commutation performance. Additionally, the western converter station will be designed to meet all the requirements of ITC, SPP and North American Electric Reliability Corporation ("NERC") planning criteria.

Q. Please explain what is meant by commutation and its requirements for good performance.

A. Commutation is, simply put, the switching of current from one connection to another. During the operation of an LCC HVDC facility, current is transferred from one inductive phase to another based on the polarity of applied voltage across each thyristor valve (a thyristor valve is composed of many thyristors in series). The time it takes to transfer is called the commutation time. Robust commutation requires that the converter be connected to a relatively stiff voltage source (i.e., one that does not significantly fluctuate in magnitude during a disturbance) in order to ensure the right polarities are applied across the thyristor valve. The commutation time is related to the overlap angle where current is building up in the incoming valve and going out in the outgoing valve. Overlap angle increases with increasing DC current and with decreasing AC voltage. If the AC commutation voltage source is not sufficiently stiff, commutation may suffer during faulted conditions, periods of voltage distortion, or certain undervoltage events that directly affect the commutation voltage. In the case of the Grain Belt Express Project and

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http://www.pjm.com/~/media/committees-groups/committees/teac/20140925/20140925-reliability-analysis-update.ashx.

its interconnection to the ITC grid, the interconnection will be able to accommodate the Project's needs for a sufficiently stiff voltage signal.

IV. GRAIN BELT EXPRESS' USE OF HVDC TECHNOLOGY

Q. Why has Grain Belt Express decided to use HVDC technology for the Grain Belt Express Project?

A. It is a well-established fact that HVDC is a more efficient technology for the long-haul transmission of large amounts of electric power. Substantially more power can be transmitted with lower losses, narrower right-of-way, and fewer conductors than with an equivalent high voltage AC ("HVAC") system. In general, over long distances, extra-high voltage ("EHV") AC transmission lines require intermediate switching or substations approximately every 200 miles in order to segment the line to handle issues attendant with voltage support, transient over voltages, and transient recovery voltages. Additionally, EHV AC lines used for long-haul applications exhibit angular and voltage stability limitations, have a higher requirement of reactive power dependent upon loading, and have higher charging currents at light load. It takes more lines (and thus more right-of-way) to move large amounts of power over a long distance with AC than it does with DC. It is typically thought that at distances beyond about 300 miles, HVDC is the most efficient means to move power via overhead lines; however, this can vary depending on a number of factors. HVDC and HVAC facilities are quite complementary, however, when considering the integration of large amounts of renewable power into the electric transmission grid.

The use of HVDC technology is a particularly appropriate solution for the Grain Belt Express Project (and Clean Line's other HVDC transmission projects), for moving

large amounts of power from variable generation sources (such as wind farms) over long distances, primarily or exclusively in one direction. In this application, DC lines result in a lower cost of transmission than AC lines. The use of HVDC technology has a number of distinct benefits, including the following:

(1) HVDC lines can transfer significantly more power with lower line losses over longer distances than comparable AC lines;

(2) HVDC lines complement AC networks without contribution to short circuit current power or additional reactive power requirements;

(3) HVDC lines can dampen power oscillations in an AC grid through fast modulation of the AC-to-DC converter stations and thus improve system stability;

(4) HVDC technology gives the operators direct control of energy flows, which makes HVDC particularly well-suited to managing the injection of variable wind generation;

(5) HVDC lines, unlike AC lines, will not become overloaded by unrelated outages, because the amount of power delivered is strictly limited by the DC converters at each end of the HVDC line, thereby reducing the likelihood that outages will propagate from one region to another; and

(6) HVDC lines utilize narrower rights-of-way and fewer conductors than comparable AC lines, thereby making more efficient use of transmission corridors and minimizing visual and land use impacts.

Q. Is the HVDC technology that Grain Belt Express plans to use for the Grain Belt Express Project an experimental or recently introduced technology?

A. Absolutely not. HVDC technology has been used and proven for several decades. In North America, there are over 30 HVDC installations, dating back as far as 1968. Of the 30 plus projects, there are 14 HVDC lines in North America that have a combined capacity of approximately 16,440 MW. The remaining HVDC projects are back-to-back HVDC converters, which function the same as an HVDC line but have no overhead or underground line to connect the rectifier and inverter; rather, they are connected directly to each other within the same substation via a DC bus.

Worldwide, HVDC applications are commonplace and are continuing to increase in applications similar to what Grain Belt Express plans to use for the Grain Belt Express Project (and Clean Line plans to use for its three other DC transmission projects). For example, in India and China, there have been over 35 significant applications of the technology since the early 1990s. In China, alone, there are currently over 25 operating HVDC projects with more than 92,000 MW of capacity, with plans to add several additional projects totaling more than 55,000 MW of capacity. India has over 11,000 MW currently operational and approximately 6,000 MW in planning. Australia, New Zealand, Brazil, Japan and Europe have each installed large HVDC transmission projects since the late 1960s. Europe, in particular, has multiple HVDC projects underway to support major off-shore wind applications in the North Sea as well as around the United Kingdom.

Q. Can you give some examples of significant HVDC transmission installations in North America?

A. Yes. The Pacific Intertie project is an 846-mile ±500 kV HVDC line, which transmits 3,100 MW of power from the Pacific Northwest, with its vast hydro resources, to the Los Angeles area. This intertie originally went into service in 1970 and was upgraded to its current capacity in 1989. This project is undergoing yet another upgrade, which will further increase its capability to 3,220 MW by the end of 2016.

The Intermountain Power Project ("IPP") is an HVDC transmission system, operated by the Los Angeles Department of Water and Power, which was designed to move 1,920 MW of power from south of Salt Lake City, Utah into the Los Angeles Basin. In 2010, the IPP HVDC line was upgraded to a capacity of 2,400 MW in addition to adding controller functionality to allow integration of wind power at the source-end of the line.

Another example is in Canada where the Nelson River Bipole connects hydro resources in Northern Manitoba to the population centers in Southern Manitoba. The Nelson River projects have over 3,800 MW of capacity and cover over 550 miles. Currently, Manitoba Hydro is constructing a third bi-pole to the Nelson River project. Finally, the Quebec-New England project, which delivers 2,000 MW over 932 miles from the southern Hudson Bay area in Quebec to near Boston, Massachusetts, was commissioned in 1990-1992 by Hydro Quebec and National Grid USA.

Other North American HVDC projects include the CU Powerline and Square Butte Projects, which allow generating resources in North Dakota to access Minneapolis, Minnesota and Duluth, Minnesota, respectively; the TransBay Cable between Pittsburg, California and San Francisco, California; the Neptune Regional Transmission System between New Jersey (PJM) and Long Island, New York; the Cross Sound Cable between

Connecticut and Long Island; and multiple back-to-back (no overhead line) HVDC projects between the various Interconnections in North America. The most recent North American HVDC project, American Transmission Company's Mackinac HVDC Flow-Control Project, went into operation in 2014 and provides a means to better control power flows in and out of the Upper Peninsula of Michigan.

Q. Have you prepared an analysis of whether there are cost advantages of using HVDC technology for applications such as the Grain Belt Express Project rather than using AC transmission lines?

A. Yes. For the purpose of long distance transmission of large amounts of power, HVDC is a better alternative to using AC transmission lines as a result of the various technical factors I previously discussed, as well as due to lower costs relative to AC transmission lines for this application. The results of an analysis evaluating how an HVDC alternative compares to possible AC alternatives for long-distance transmission of large amounts of power are shown below. The primary assumption in this analysis is that 4,000 MW is to be delivered over 780 miles. In this analysis, series compensated 345 kV, 500 kV or 765 kV AC alternatives are included that would be necessary to achieve twice the surge impedance loading ("SIL") of each respective AC circuit.[3] The remaining assumptions for this analysis can be found in Grain Belt Express Exhibit 2.1. In summary, it would require at least six (6) series compensated 345 kV AC circuits, at least three (3) series compensated 500 kV circuits, or at least one (1) series compensated 765 kV circuit (though a single 765 kV circuit may not satisfy N-1 reliability criteria according to NERC

[3] SIL for a 345 kV single circuit line is assumed to be 400 MW. SIL for a single circuit 500 kV line is assumed to be 900 MW. SIL for a single circuit 765 kV line is assumed to be 2,400 MW.

planning standards, so a second circuit may be needed[4]) in order to deliver a comparable amount of power as the single, bi-polar HVDC line.

Solution to Transmit 4,000 MW, 780 miles (Transmission Line + Necessary Equipment)	**Cost ($ billion)**	**Annual Loss Costs ($ billion)**
Six, single circuit 345 kV transmission lines	10.02	1.90
Three, double circuit 345 kV transmission lines	7.74	1.90
Three, single circuit 500 kV transmission lines	7.84	1.38
One single circuit and one double circuit 500 kV transmission line	6.51	1.38
One single circuit 765 kV transmission line	3.45	1.50
One, ±600 kV HVDC bi-pole, multi-terminal system	2.26	0.89

Q. In the table above, what costs are included in the amounts in the "Cost" and "Annual Loss Costs" columns?

A. Included in the costs for each of the transmission alternatives (AC or DC) are: the per-mile cost for transmission line (structures, conductors, insulators and hardware) and ROW costs. Also included for the AC alternatives are the costs for four (4) substations, two (2) transformers per substation, Static VAR Compensators ("SVC"), series capacitors, shunt capacitors, and shunt reactors. Costs for four substations are included because AC systems typically require substations approximately every 200 to 300 miles. Included in the cost for the HVDC alternative are three HVDC converters (two large converters and one smaller, mid-point converter[5]) and three SVCs. The cost of each HVDC converter includes the costs for all equipment needed at that converter (including transformers, buswork, switchgear, capacitors and reactors).

[4] The North American electric grid is operated such that any single electric facility (generator, transmission line, or transformer) can "trip" out-of-service and the grid will remain secure and not cause cascading failures. This is referred to as "N-1" reliability criteria.

[5] The 500 MW "midpoint" converter station in this example is assumed to be 33% of the cost of the larger converter stations.

The "Annual Loss Costs" column of the table includes the capitalized cost of annual power losses and represents the value of the revenue lost due to the estimated power losses on the AC or DC line(s). More information about the calculation of the Annual Loss Costs is provided in Grain Belt Express Exhibit 2.1.

Q. What are the conclusions of this analysis?

A. The analysis demonstrates that the HVDC project is the lowest cost alternative as compared to AC projects for delivering a large amount of power over long distances, such as the distance that will be traversed by the Grain Belt Express Project.

V. TECHNICAL SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF THE GRAIN BELT EXPRESS PROJECT

Q. Please provide the voltage rating (kV), operating voltage (kV), and normal peak operating current rating for the Grain Belt Express Project.

A. The Project will be rated at ±630 kV, which includes a 5% overvoltage margin. The operating voltage will be ±600 kV. In a bipolar HVDC project, as proposed for the Grain Belt Express Project, the positive electrical pole ("pole") is at a potential of +600 kV relative to ground and the negative pole is at a potential of -600 kV relative to ground. Thus, the voltage of the project is stated as ±600 kV (plus-minus 600 kV). As measured between the poles, the voltage would be 1,200 kV. The Project will have a peak operating current of approximately 3,600 amperes ("A"). The Illinois converter station will be rated to deliver up to 3,500 MW and the Missouri converter station will be rated to deliver up to 500 MW. When one of the DC poles is out of service, the remaining "healthy" pole will still have the ability to carry at least half of the rating of the Illinois converter station (1,750 MW).

Q. In HVDC projects, does one refer to a "pole" as opposed to a "phase"?

A. Yes. In EHV AC transmission, there are three phases, hence three-phase power. Each phase has a set of conductors associated with it. With HVDC, we talk about "poles." These poles are not to be confused with the structures that hold the wires. A bi-polar HVDC project has two poles and each pole has a set of conductors associated with it. A very rough analogy would be the "poles" on your car battery where you have a positive pole and a negative pole.

Q. What are the various operating modes of an HVDC bipole?

A. An HVDC bipole project normally operates so that both poles are transmitting one-half of the power and the current is equal in the poles. However, certain circumstances, such as a contingency or maintenance condition, can occur, which result in only one pole being available for transmitting power. In this case, the project would be operating in what is known as monopolar mode. (Again, the term "monopole" in this context should not be confused with the structures used to support the conductors.) Monopolar operation may occur through an earth return path or a dedicated metallic return if the other pole conductor is not available to act as the return.

For example, if a maintenance outage is required to repair power electronic devices in the valve hall of one of the converter stations, then the monopolar operation would utilize both sets of pole conductors. However, if the pole outage were due to maintenance on one of the sets of pole conductors, then the monopolar operation will utilize a current return path via dedicated metallic return or earth return path.

Q. Please describe what is meant by a dedicated metallic return and an earth return and which one Grain Belt Express intends to utilize for the Project.

A. In HVDC configurations, a return path for current must always exist. During normal, bi-polar operation, the current flows through the positive pole and returns through the negative pole. If one of the poles were to be interrupted, the other pole could continue to operate as long as a closed path for the current existed. As indicated above, this is called "monopolar" operation. This path can either be through the earth (via a ground electrode), in what is described as "earth return," or through a separate set of conductors referred to as a dedicated metallic return. Grain Belt Express has opted to design the Project for use with a dedicated metallic return. This avoids interference issues with subsurface utilities during normal monopolar operations.

Q. What type of conductors will be utilized on this project?

A. The Grain Belt Express Project will utilize 2156 kilo-circular mil ("kcmil") ACSR ("Bluebird") in a triple bundle configuration for the pole conductors. For the dedicated metallic return ("DMR conductor"), we plan on using two, 1780 kcmil ACSR ("Chukar") conductors. Final engineering is typically completed after a final route has been approved by regulatory authorities, so the design could change slightly at that time or based upon further optimization studies.

Q. What type of support structures will be utilized?

A. On January 9, 2015, Grain Belt Express signed an Agricultural Impact Mitigation Agreement ("AIMA") with the Illinois Department of Agriculture. In the AIMA, Grain Belt Express committed to use only single-foundation structures (i.e., tubular steel "monopole" or self-supporting lattice mast) for the tangent portions of the transmission line in Illinois, except in certain circumstances that may require the larger, traditional lattice, self-supporting structures (e.g., dead-end structures, river crossings, and heavy

angle turning structures). Additionally, in the AIMA, Grain Belt Express has committed to avoid using guy-wire-supported structures, to the extent feasible, in Illinois.

The current designs for lattice mast structures and tubular steel monopoles anticipate typical, optimum span lengths of 1,200 feet. Given conditions that allow for such spans, there would typically be five tubular steel monopoles or lattice mast structures per mile. However, the number of structures per mile may be higher in certain areas where shorter spans are necessary based on topography, routing constraints, or engineering constraints. On occasion, longer spans may be required. These longer spans typically are used for conditions such as river crossings and situations where sensitive areas such as wetlands must be avoided. Longer spans may require larger structures than are needed for the typical 1,200-foot spans.

Q. How tall will the structures be?

A. Structure height will be determined by many factors, of which the primary factors are span length and topography. Most structure heights are expected to be between 100 feet and 175 feet (but typically 110 to 140 feet), based on preliminary engineering studies and experience using tubular steel, lattice mast, and lattice tower structures. River crossings and certain other situations may require taller towers.

Q. What do the proposed structures look like?

A. Grain Belt Express Exhibit 2.2 shows what the typical, single foundation structures and the lattice tower structures will look like as well as the loading tables and clearances of these structures under the various National Electrical Safety Code ("NESC") design cases. Exhibit 2.2 also includes the clearance calculations used to design the structures for the Grain Belt Express Project. Pages 1 and 2 show a drawing of a typical lattice mast and

steel monopole structure, respectively. Page 3 shows a drawing of a typical self-supporting lattice tower that could be used for this Project in areas where a single foundation structure may not be appropriate. Pages 4 through 9 show more detailed drawings of these structures along with dimensions and clearances. Pages 10 through 30 include the calculations and design source for the structure clearances.

Q. What width of right-of-way is planned for the Project?

A. The ROW for the Project will vary between 145 feet and 200 feet wide depending on Project requirements at particular locations. The preliminary design criteria for the Project assumes a 175 foot ROW as a typical or average value; this design also takes into account a minimum ground clearance at peak loading of 34 feet.[6] To accommodate the possible need for the maximum width at specific locations, Grain Belt Express is requesting authority for a 200 foot ROW. The transmission structures are anticipated to be located along the centerline of the acquired easements. For the final four miles of the Project which will utilize a double circuit 345 kV AC transmission line, Grain Belt Express is also seeking a 200 foot ROW. This line will exit the Illinois converter station, cross the Wabash River into Indiana, and interconnect to the Sullivan/Breed 345 kV substation in Indiana. The proposed ROW of 200 feet for the DC and AC portions of the transmission line are based on the factors I describe below.

Q. What factors typically determine the required ROW width for a transmission line?

[6] The calculated minimum ground clearance aligns with the minimum requirements from the NESC, but also includes a three (3) foot "buffer." Additional clearance would be built into the design to accommodate non-standard equipment, where utilized, to address particular needs or concerns of landowners on whose properties the Project is located. A minimum clearance across navigable waterways will be 55 feet, which is determined by NESC Rule 232D, Table 232-3, f (DC Calculation).

A. Two primary factors affecting ROW width include maintaining electrical safety clearances and providing access for construction and maintenance of the line. Of the two, maintaining electrical safety clearances is typically the controlling factor for transmission lines of this type.

Q. How does maintenance of electrical safety clearances impact the required ROW width?

A. Wind blowing on transmission line wires will cause them to move away from the center of, and towards the side of, the ROW. This movement is commonly referred to as "blowout" and can occur in either direction towards the edges of the ROW. Therefore, enough ROW width must be established to allow the predicted wire "blowout" movement on both sides of the ROW while maintaining required electrical clearances from vegetation, structures, and other infrastructure.

Q. Will there be locations in Illinois where ROW widths greater than 200 feet could be needed?

A. Yes. As I noted, the ROW width for projects of this type is typically controlled by the need to provide adequate room for wire "blowout" while maintaining required electrical clearances. The amount of predicted wire "blowout" increases as the span, or distance, between supporting structures/towers increases. Therefore, if a location on the Project requires an atypical span (to accommodate terrain features, land use considerations, and other local factors), then it is possible that a ROW wider than 200 feet would be required at that location. Specifically, in areas with a high degree of topographic complexity, such as the bluffs above the Mississippi and Illinois Rivers, longer spans may be needed to

optimize project design and to minimize impacts to wetlands, water bodies and other resources.

Locations along the Proposed Route that will require a wider ROW than the requested 200 feet are described below:

- In Pike County, in section 21 of Township 5 South, Range 7 West, of the 4th Principal Meridian, the Project will require a long span in order to cross the Mississippi River as the Project exits Missouri and enters Illinois. The longer span is required due to the width of the Mississippi River, thus requiring taller structures and therefore requiring a wider ROW. For this span, Grain Belt Express requests a 300-foot ROW. The 300-foot ROW will be required for the first 950 feet from the Mississippi River shoreline.
- Also in Pike County, in section 36 of Township 5 South, Range 6 West and sections 30 and 31 of Township 5 South, Range 5 West of the 4th Principal Meridian, there is a portion of the Proposed Route among the bluffs above the Mississippi River for which longer spans should be installed in order to avoid sub-optimal span lengths within the valley below these bluffs as well as to avoid impacts to the riparian corridor within the valley. For this span, Grain Belt Express requests a 275-foot ROW. The 275-foot ROW will be needed from a point approximately 385 feet west and 70 feet south of the northeast corner of Section 36 to a point approximately 1,785 feet east of the southwest corner of section 30.
- In section 12 of Township 6 South, Range 2 West of the 4th Principal Meridian and section 29 of Township 13 North, Range 13 West of the 3rd

Principal Meridian, as the Proposed Route crosses from Pike County into Scott County across the Illinois River, a longer span will be required for the river crossing. For this span, Grain Belt Express requests a 275-foot ROW. The 275-foot ROW would be required from a point approximately 100 feet from the western shore of the Illinois River to a point approximately 915 feet beyond the eastern shore of the Illinois River.

- In Scott County, in sections 33 and 34 of Township 13 North, Range 12 West of the 3rd Principal Meridian, the portion of the Proposed Route that crosses the Little Sandy Creek drainage basin may require longer spans to minimize impacts to the riparian corridor in the Little Sandy Creek valley as well as to ensure access to the line for future maintenance activity. For this span, Grain Belt Express requests a 275-foot ROW. The 275 foot ROW would be required from a point approximately 1,300 feet south and 400 feet east of the northwest corner of section 33 to a point approximately 1,315 feet south and 220 feet east of the northwest corner of section 34.

For the Alternate Route, Grain Belt Express requests a 300-foot ROW for the Mississippi River crossing and the Illinois River crossing to accommodate longer transmission spans at these locations. Assuming that the Alternate Route were chosen, the 300-foot ROW for the Mississippi River crossing would be required for approximately the first 950 feet from the Mississippi River shoreline; and at the Illinois River crossing, from a point approximately 250 feet from the western shore of the Illinois River to a point approximately 900 feet beyond the eastern shore of the Illinois River. Additionally, there are likely line sections within the Alternate Route that may

require, or for which Grain Belt Express would prefer in the exercise of good engineering judgment, a ROW wider than 200 feet to optimize reductions to land use impacts. However, these locations have not been specifically identified at this time. Therefore, if the Alternate Route were chosen, Grain Belt Express may need to make a supplemental filing with the Commission requesting a ROW greater than 200 feet at certain locations along the Alternate Route.

Q. Will the Project require temporary construction easements?

A. Yes, there are three situations for which a temporary construction easement may be needed. First, although the proposed permanent ROW width of up to 200 feet for the Project should generally be sufficient to accommodate construction vehicles and equipment, lay-down of materials, and actual construction work, it is possible that in certain areas, a temporary construction easement outside the permanent ROW may be needed in order to provide access for construction equipment. Second, in some portions of the route, temporary construction easements may be needed to provide access for vehicles and construction equipment from public roads and rights-of-way to the ROW for the Project where work is to be performed. Accordingly, Grain Belt Express is requesting authority for temporary construction easements of an additional 50 feet in those areas of the Project where the permanent authorized ROW is not sufficient for construction activities or to access the construction area.

Third, to accommodate the stringing of the conductor at locations along the route where a major turning structure (15 to 90 degree angle) is required, the pulling and/or tensioning equipment used for the conductor stringing process may need to operate outside the requested permanent ROW. While only the temporary construction easement

of 50 feet described above would be needed from the permanent ROW running parallel to the line before it reaches the turning structure, a temporary easement of up to 450 feet beyond the permanent 100-foot ROW on one side of a turning structure would also be needed. The calculation of this additional temporary workspace beyond the turning structure is based on a rule of three times the height of the structure (3 x 150 (the typical height of a turning structure) = 450). Although the specific locations of the turning structures along the Proposed Route cannot be determined until more detailed surveying and engineering work is performed following approval of the route, we estimate that the Proposed Route will have up to 80 such locations while the Alternate Route will have up to 111 such locations. However, we estimate that less than a third of these locations will require the full 450 feet of temporary work space beyond the permanent ROW. We estimate, for the Proposed Route, that 54 of the 80 major turning structures will require temporary workspace extending 300 feet or less outside the permanent ROW. Overall, temporary work space to pull and tension conductor at major turning structures will only be needed, on average, approximately every 2.5 miles in Illinois, although the placement of turning structures is a function of the location of turns in the line and the turning structures will not necessarily be spaced evenly along the route.

Any temporary construction easement would revert to the landowner when the Project has been constructed and placed into operation.

Q. Please describe any substations that will be associated with the Project.

A. There are three primary substations (referred to as converter stations for an HVDC line) associated with the project: the “windward” or western converter station will be located in Ford County, Kansas, the midpoint converter station will be located in Ralls County,

Missouri, and the eastern converter station will be located in Clark County, Illinois. Grain Belt Express has acquired an option to purchase the land in fee in Clark County where the eastern converter will be located. A typical plan drawing for an HVDC converter station, such as the converter station that will be installed in Clark County, Illinois, is presented as Grain Belt Express Exhibit 2.3.

VI. INTERCONNECTION REQUESTS AND OTHER INTERACTIONSWITH SPP, MISO, AND PJM

A. SPP

Q. What studies have been conducted for the interconnection of the Grain Belt Express Project to SPP in Kansas?A. Grain Belt Express has worked with, and continues to work with, SPP to conduct bulk electric grid reliability studies with affected Transmission Owners. In collaboration with Siemens Power Technologies International ("Siemens PTI"), Grain Belt Express has met with affected Transmission Owners and has submitted various technical studies to SPP.[7] Siemens PTI conducted both steady state and dynamic and voltage stability studies, in accordance with SPP Criterion 3.5[8], simulating the effect of the Project on SPP's and other affected parties' electric systems. Criterion 3.5 requires entities requesting transmission interconnections to work with SPP and affected parties to ensure grid reliability. Potentially affected parties were presented with the study models and reports in early 2013 and were given the opportunity to ask questions about the results and to request additional analyses. Furthermore, as part of

[7] Meeting minutes and copies of the submitted studies can be viewed at: http://www.grainbeltexpresscleanline.com/site/page/technical_studies.
The Stability and Steady State Study Reports can be viewed at: http://www.grainbeltexpresscleanline.com/site/page/technical_studies.

[8] Southwest Power Pool, *Southwest Power Pool Criteria; (available at):* https://www.oasis.oati.com/woa/docs/SWPP/SWPPdocs/SPP_Criteria.pdf.

Grain Belt Express' agreement with SPP, in the summer of 2013, SPP performed an independent review[9] of the studies and provided its opinion prior to seeking SPP Transmission Working Group approval.

Q. What are the objectives of steady state studies and stability studies in this context?

A. Steady state and stability studies identify the impact that a new project (transmission, generation, or other equipment) might have on the electric grid to which that equipment is being interconnected. The objective of the studies that were performed in order to meet SPP's Criterion 3.5 was to identify the impact that the Grain Belt Express Project would have on the SPP electric grid during abnormal conditions. Such conditions include when one or more transmission circuits within the SPP grid are out-of-service and, concurrently, the Grain Belt Express Project experiences a pole or bi-pole outage where the wind energy that was being delivered by the HVDC line is now temporarily injected into the SPP grid.

Q. Did Grain Belt Express work with SPP and affected parties to develop the scope of and to conduct studies under SPP Criterion 3.5?

A. Yes. Grain Belt Express initially met with SPP and affected parties on June 9, 2011 to develop the scope of the steady state and stability studies required under SPP Criterion 3.5. Based on the agreed-upon scope, the initial steady state results were shared with SPP and the affected parties on November 1, 2011 to gather their input and to incorporate any needed study scope modifications. Additional analyses were conducted based on feedback and the final steady state results were reviewed and vetted with SPP and

[9] Excel Engineering, Inc., *Grain Belt Express HVDC System Impact Study Final Report for Southwest Power Pool; (available at):* http://www.grainbeltexpresscleanline.com/sites/grain_belt/media/docs/SPP_GBX_HVDC_Study_Final_Report_09-06-2013.pdf.

affected parties during two webinars in February 2013. The final dynamic and voltage stability study results have been completed and were also reviewed and vetted with SPP and the affected parties on February 13, 2013. The models used in these studies, along with the study reports, were made available to SPP and the affected parties when the study results were shared with them. In September 2013, the SPP Transmission Working Group passed a motion to "approve the GBX [Grain Belt Express] studies completed to date as meeting their coordinated planning requirements under SPP Criteria ...."[10]

Q. What power transfers are anticipated between the Grain Belt Express Project and SPP during operation of the Project?

A. The Grain Belt Express Project is being designed so that during normal operating conditions, there is nominally zero active power exchange and very little, if any, reactive power exchange between the Project AC bus and the SPP grid. However, following the loss of a single pole of the HVDC transmission line, some of the power transmitted by the Project will temporarily flow into the SPP grid. The results of the SPP Criterion 3.5 studies indicate that during such an occurrence, using one of the scenario cases, only one circuit in the SPP grid would be loaded above its applicable rating; this overload could be mitigated by curtailing some amount of wind generation to bring the flow of this facility below its thermal limit. For all other scenarios included in the studies, the loss of a single DC pole does not cause any adverse impacts.[11]

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[10] SPP Transmission Working Group, *Minutes of the TWG Meeting, August 14-15 2013*; *(available at):* http://www.spp.org/publications/TWG%208.14-15.13%20Minutes%20&%20Attachments.pdf.

[11] The intent of the Criterion 3.5 study was to identify potential impacts of the Project to the SPP transmission system. Additional study work will be conducted in cooperation with SPP and the SPP Transmission Working Group based on the specific wind generation locations and characteristics. Appropriate mitigation measures, should any be needed, will be developed by and between Grain Belt

Q. Please explain your reference to "loss of a single DC pole."

A. As discussed previously in this testimony, an AC transmission line has three (3) phase conductors for every AC circuit. A DC transmission line, in contrast, has one pole conductor for each circuit. A DC bi-pole (as in the case of the Grain Belt Express Project) is really two DC circuits. An outage of one of these circuits is referred to as a "pole outage" while an outage of both circuits is considered a "bi-pole outage". The "loss of a single DC pole" is another way to say a DC pole outage occurs.

Q. What further steps does Grain Belt Express need to take with SPP to complete the interconnection study process and obtain approval to interconnect to the SPP grid?

A. Having obtained the Criterion 3.5 approval, Grain Belt Express is working with ITC and Sunflower Electric Power Corporation on an interconnection service agreement that will include a requirement to conduct additional studies in order to ensure that the Project can reliably interconnect to, and operate while connected to, the SPP grid. In September 2014, Grain Belt Express executed a Facilities Study Agreement with ITC, which began the process for ITC to determine the specific equipment needed in order to interconnect the Grain Belt Express Project to the ITC system.[12] This Facilities Study was completed in March 2015 and Grain Belt Express and ITC are now working on the interconnection service agreement. Additionally, Grain Belt Express is continuing discussions with SPP staff regarding the need for appropriate operating agreements, seams agreements, and possible administrative requirements (e.g. tariff administration).

Express, ITC, SPP, and any other affected party in order to ensure grid reliability is maintained during normal and contingency conditions.

[12] The scope of the Facilities Study includes identification of equipment such as switchgear, buswork, and metering that will be required in order to physically interconnect the Project to the ITC transmission system.

B. MISO

Q. Has an interconnection request for the Grain Belt Express Project been submitted to MISO?

A: Yes. MISO has conducted a Feasibility Study of the impacts of the Project delivering up to 500 MW of power into the 345 kV system in northeastern Missouri at and near Ameren's planned Maywood 345 kV substation, pursuant to an interconnection request filed in September 2012 with queue position J-255.[13] MISO completed the Feasibility Study for J-255 in October 2012.[14] The Feasibility Study did not identify any constraints associated with the 500 MW injection into MISO at the requested locations in northeastern Missouri.

Q. Was any additional analysis conducted by MISO for the interconnection of the Grain Belt Express Project?

A. Yes. Following the completion of the Feasibility Study, MISO's interconnection process includes two additional levels of analysis: (i) System Planning and Analysis ("SPA") and (ii) Definitive Planning Phase ("DPP"). The SPA is an analysis that the interconnection customer must undertake every 18 months while in "parked" status until the interconnection customer transitions its interconnection request to the DPP. The scope for the SPA study is determined by the interconnection customer using a generic scope template developed by MISO staff.[15] The Project's J-255 queue position, given its date

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[13] The MISO interconnection process allows for an interconnection customer to choose a primary and a secondary POI. Grain Belt Express chose a primary POI at the Palmyra Tap substation (now known as Maywood) and a secondary POI that would tap the 345 kV line between Maywood and Montgomery.

[14] MISO, *Queue Position J255 Feasibility study report; (available at):* https://www.misoenergy.org/_layouts/MISO/ECM/Redirect.aspx?ID=139420

[15] MISO, *System Planning and Analysis Study Scope; (available at):*

of entry into the MISO queue, was required to undergo a SPA study in May 2014. Grain Belt Express requested that a refresh of the Feasibility Study be conducted in order to ensure that similar impacts were identified. In November 2014, MISO released the SPA study report for J-255 which indicated that there are still no constraints that require mitigation with the interconnection and injection of 500 MW at the chosen POI.[16]

Q. What further steps need to be taken with MISO to complete the interconnection study process and obtain approval for the proposed interconnection?

A. The final study stage within MISO's interconnection process is the DPP. The scope for the DPP involves MISO performing a System Impact Study and an Interconnection Facilities Study, which is then followed by a Network Upgrade Facility Study, if required. As discussed further in my testimony, Grain Belt Express is also undergoing interconnection studies with PJM/AEP. Grain Belt Express anticipates entering the MISO DPP in 2016 when the PJM interconnection studies have either been completed or are sufficiently progressed. This will allow for the results of the PJM studies to be incorporated into the scope of the MISO DPP studies. The MISO DPP is estimated to take up to 180 days to complete.

C. PJM

Q. Has an interconnection request for the Grain Belt Express Project been submitted to PJM?

A. Grain Belt Express submitted an interconnection request to PJM's merchant transmission

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https://www.misoenergy.org/Library/Repository/Study/Generator%20Interconnection/SPA_Study_Scope.pdf.

[16] MISO, *SPA-2014-May-Missouri System Impact Study Final Report; (available at):* https://www.misoenergy.org/_layouts/MISO/ECM/Redirect.aspx?ID=187297.

interconnection queue in August 2011 for 3,500 MW to be interconnected to AEP's Sullivan 765 kV substation. The request was assigned queue position X3-028. The request asks for 1,500 MW to be allocated as Firm Transmission Injection Rights ("FTIR") and the remaining 2,000 MW to be allocated as Non-Firm Transmission Injection Rights ("NFTIR").

In August 2013, Grain Belt Express requested that PJM study whether modification of the POI from the Sullivan 765 kV substation to the nearby Breed 345 kV substation (which has direct ties to the Sullivan 765 kV substation through transformer facilities) would be considered a Material Modification as defined in PJM's Open Access Transmission Tariff ("OATT") and therefore disallowed. PJM subsequently determined that this change was not a Material Modification, and therefore the requested POI is now at AEP's Breed 345 kV substation in Sullivan County, Indiana. However, as I previously described, AEP is in the planning stages of moving the Breed 345 kV substation to be adjacent to the Sullivan 765 kV substation effectively making these two POIs electrical equivalents. Interconnecting at the 345 kV voltage level allows, among other things, for the use of 345 kV transmission lines to interconnect the Project's Illinois converter station to the PJM grid, rather than using 765 kV transmission lines.

Q. Please describe the PJM Merchant Transmission Interconnection process.

A. The PJM merchant transmission interconnection process is initiated by a developer submitting to PJM an executed Transmission Interconnection Feasibility Study Agreement per Attachment S to the PJM OATT. PJM's interconnection study process, which is outlined in PJM's Manual 14 series, involves a three-phase study approach.[17]

[17] PJM's Manuals are located on the PJM website at: http://www.pjm.com/documents/manuals.aspx.

Phase I is the Feasibility Study, which assesses the practicality and cost of accommodating the interconnection of a project with the PJM transmission system. This study focuses solely on the peak load flow analysis of probable contingencies and provides high-level, preliminary estimates of the type, scope, cost, and lead-time for construction of facilities required to interconnect a project.

Phase II is the Impact Study, the intent of which is to determine a plan, with cost and construction time estimates, to connect the project to the PJM network at a location specified by the interconnection customer. This study involves an expanded focus of not only load flow, but also voltage and angular stability and short circuit impacts of the proposed interconnection on the PJM network.

The final phase is the Facilities Study. The purpose of the Facilities Study is to provide engineering and, as appropriate, detailed design, including cost estimates and project schedules, to implement the conclusions of the Impact Study regarding new installations or modifications to existing facilities required to facilitate the requested interconnection to the PJM network.

The three phases of studies described above are all performed by PJM, the interconnected transmission owner (here, AEP), or by consultants retained by these entities, but they are paid for by the entity requesting interconnection.

Q. What is the status of the interconnection request that Grain Belt Express has submitted to PJM?

A. PJM released a draft Impact Study report in October 2014.[18] The results of the Impact

[18] PJM, *Merchant Transmission Interconnection PJM Impact Study Report For PJM Merchant Transmission Request Queue Position X3-028 Breed 345 kV; (available at):*https://www.misoenergy.org/_layouts/MISO/ECM/Redirect.aspx?ID=187297

Study outlined the scope and cost estimate for the interconnection facilities to interconnect the Project to the Sullivan/Breed 345 kV substation (the "Attachment Facilities") and also outlined the need to mitigate several impacts that ultimately would necessitate network upgrades to include a new 765 kV transmission line to be built in Indiana (the "Network Upgrades"). The Attachment Facilities include three, 345 kV circuit breakers and revenue metering at an estimated cost of $3.45 million. The Network Upgrades include:

- A new AEP 765 kV transmission line from the Sullivan substation to Northern Indiana Public Service Company's new Reynolds substation ("Sullivan to Reynolds") at an estimated cost of $500 million.
- A wavetrap at AEP's Dumont 765 kV substation at an estimated cost of $1 million.
- The possibility of work associated with re-arranging breakers at the Reynolds 345 kV substation; this upgrade does not currently have a cost estimate as it does not involve new equipment.

Q. What further actions are needed to complete the PJM interconnection study processes for the Project?

A. Upon receipt of the Impact Study results from PJM and review of its analysis and conclusions, Grain Belt Express identified an alternative to the aforementioned Sullivan to Reynolds line for PJM to consider as a network upgrade to address the required mitigation of the impacts that PJM identified in the Impact Study. The proposed alternative is a new 765 kV line between AEP's Sullivan/Breed and Jefferson substations.

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http://www.pjm.com/pub/planning/project-queues/merch-impact-studies/x3028_imp.pdf.

Although this network upgrade does not yet have a PJM/AEP cost estimate, it is approximately 5% longer than the network upgrade that was identified in the Impact Study and therefore it can be assumed to be approximately 5% more expensive, or $525 million. PJM is currently conducting a re-tool of the Impact Study to include this alternative and will then release a new report of the results of the study which will include this alternative. In October 2014, Grain Belt Express executed a Facilities Study Agreement with PJM. It is anticipated that, if PJM concludes from the re-tool Impact Study that the Sullivan/Breed to Jefferson line is an acceptable alternative to the Sullivan/Breed to Reynolds line, a new Facilities Study Agreement will be executed by Grain Belt Express. It is anticipated that PJM will begin the Facilities Study in April or May 2015 and will conclude its work in approximately 12 months. After the Facilities Study, PJM will issue an Interconnection Service Agreement to Grain Belt Express.

Q. Does Grain Belt Express expect that the Sullivan/Breed to Jefferson transmission line will address the impacts identified in the PJM Impact Study?

A. Yes, based on our review of the Impact Study and our analysis of the Sullivan/Breed to Jefferson line, we believe that this alternative will adequately address the reliability issues identified in the Impact Study that the Sullivan/Breed to Reynolds line was proposed to address.

Q. Will the chosen points of interconnection, as well as the electric grids of which these substations are a part, be able to accommodate the interconnection of the Grain Belt Express Project and the introduction of up to 4,000 MW of new generation capacity into the system?

A. Yes, this is what the interconnection study processes are intended to determine – either that the existing system can accommodate the proposed interconnection, or if not, what specific system upgrades, reinforcements, or operating protocols are needed in order to accommodate the proposed interconnections.

Q. Will the interconnection studies being performed by MISO, PJM, and the utilities to which the Project will interconnect include analyses of the impacts to the electric grid in Illinois?

A. Yes. PJM and MISO will each study the impact of the Project on one another's system as discussed in their joint operating agreement[19] and manuals/business practice manuals.

Q. Will the points of interconnection with the MISO grid in Missouri and the PJM grid in Indiana enable the electricity transmitted by the Grain Belt Express Project to be physically delivered into the electric grid within the State of Illinois?

A. Yes. The points of interconnection in both Missouri and Indiana have direct ties into Illinois. There are also additional transmission tie-lines that provide paths for energy delivery from Missouri into Illinois and from Indiana into Illinois. Grain Belt Express Exhibit 2.4 shows a map of the electric grid in Missouri, Illinois and Indiana with the tie-lines between Missouri and Illinois and between Indiana and Illinois marked.

The production simulation studies performed by Grain Belt Express witness Robert Cleveland provide demand cost reductions and locational marginal price reductions in Illinois due to the energy deliveries of the Grain Belt Express Project which

[19] PJM and MISO, *Joint Operating Agreement Between the Midwest Independent Transmission System Operator, Inc. And PJM Interconnection, L.L.C.; available at:* http://www.pjm.com/~/media/documents/agreements/joa-complete.ashx.

are made possible due to the interconnected nature of the electric grid in Illinois, Indiana and Missouri.

Q. Has Grain Belt Express had discussions with the utilities to which the Project will interconnect regarding the proposed interconnections?

A. Yes. Grain Belt Express has had numerous discussions with ITC, Ameren, and AEP. Additionally, through the interconnection processes of SPP, MISO and PJM, these utilities' planning personnel are directly involved in the analyses and/or scoping of the study work that resulted in the interconnection study results previously described.

VII. MANAGERIAL AND TECHNICAL CAPABILITIES

Q. Will Grain Belt Express and its parent company, Clean Line, have the managerial and technical capabilities to develop, construct and operate the Grain Belt Express Project?

A. Yes. Clean Line has established a management and technical team with significant experience in the relevant developmental, technical and regulatory areas for projects such as the Grain Belt Express Project. The testimony of Michael Skelly, the President and Chief Executive Officer of Clean Line, provides detailed information on the background and experience of the Clean Line management team.

The Clean Line management and technical teams will supervise and oversee the contractors who will perform the detailed engineering/design, procurement, construction, and operating and maintenance functions for the Grain Belt Express Project. Clean Line and Grain Belt Express will contract with and rely on experienced, qualified companies to perform these functions. We have and will select vendors, contractors and consultants with strong and suitable expertise in all areas relevant to the Grain Belt Express Project.

Q. Please identify the engineering and construction contractors and consultants that have been engaged for the Project to date.

A. POWER Engineers, Inc. ("POWER") is providing transmission line engineering support for the Grain Belt Express Project. POWER provides engineering/design, construction, asset management, and other services to the power generation and power delivery industries and other industries.[20] POWER has developed preliminary design criteria and structure designs for the Project and provided engineering support in the route development process. Further, POWER will serve as the Owner's Engineer for the Project.

Grain Belt Express has also engaged TransGrid Solutions Inc. ("TGS") to develop HVDC models of the Project to be used in the MISO and PJM interconnection study processes as well as to provide additional expertise based on its global experience in commissioning HVDC projects.[21] TGS has also provided consulting services for Clean Line's Plains & Eastern Clean Line project, including model development and HVDC engineering support. This work has included development of a performance specification document describing the expected operational characteristics of the Plains & Eastern project and its components. This document was used to advise the HVDC manufacturers in their initial design work, which will help Clean Line choose which HVDC manufacturer will build the converter stations for that project.

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[20] Additional information about POWER Engineers, Inc.'s qualifications, capabilities and scope of services is available at: http://powereng.com.

[21] Additional information about TGS can be found at: http://www.transgridsolutions.com/default.htm.

Grain Belt Express has also engaged Siemens PTI to conduct the SPP Criterion 3.5 studies that I previously described. Siemens PTI consults for the global electric power industry on system impact studies, renewables integration, power quality studies, grid code compliance, and more.[22] Siemens PTI has conducted similar studies for the Plains & Eastern Clean Line project.

Additionally, Grain Belt Express has entered into a Development Agreement with Quanta Electric Power Services, LLC ("Quanta"), under which Quanta is providing development support, construction advice and engineering services for the Grain Belt Express Project during the development phase. The Development Agreement contemplates that Quanta will enter into a contract to serve as the engineering, procurement and construction contractor for the Project. Quanta is a Fortune 400, global provider of engineering, procurement, and construction services for the electric power, oil, and natural gas industries.[23] Grain Belt Express witness Lee Jones of Quanta provides information on Quanta's capabilities and experience.

Q. Has Grain Belt Express identified any vendors for equipment and materials for the Grain Belt Express Project?

A. Yes. As part of Grain Belt Express' commitment to maximizing its use of local supply sources, Grain Belt Express has designated Southwire Company ("Southwire") as the preferred supplier of the overhead DMR conductor for the Project. The goal of this

[22] Additional information about Siemens PTI can be found at: http://w3.usa.siemens.com/smartgrid/us/en/transmission-grid/consulting-and-design/Pages/consulting-and-design.aspx.

[23] Additional information about Quanta can be found at: http://www.quantaservices.com/.

designation is for all of the DMR conductor for the Project to be produced in Southwire's Flora, Illinois facility. This order will be worth an estimated $35 million.

Additionally, Grain Belt Express has designated Hubbell Power Systems ("Hubbell") as the preferred supplier of conductor hardware and polymer insulators for the Project. Hubbell is a global manufacturer of a wide variety of transmission, distribution, substation, and telecommunications products that are well known and trusted throughout the industry and are used by many of the largest utilities in the U.S. Hubbell will also make its engineering resources available to aid in the design of conductor hardware assemblies and polymer insulators and will work to establish a supplier base within the Project area states, including Illinois and Indiana, to source raw material from businesses in states that host the Project.

Grain Belt Express has designated General Cable Industries, Inc. ("General Cable") as a preferred supplier of conductor for the Project. General Cable is a $6.4 billion, Fortune 500 company and is the third largest wire and cable manufacturer in the world. General Cable will manufacture and manage inventory and logistics for roughly 23 million feet of steel core for the transmission line conductor. General Cable will seek to source all of the aluminum rod used in the conductor it provides for the Project from the Noranda Aluminum smelter near New Madrid, MO.

Finally, Grain Belt Express has designated ABB, Inc ("ABB") the preferred supplier of AC transformers associated with the Project's AC collector system, which will connect new wind farms in Kansas with the HVDC line. ABB is a global leader in the design and manufacture of high voltage transformers with over 14,500 transformer units delivered globally with a capacity of over 17 million mega volt-amperes. ABB will

also make its engineering resources available to aid in the design of the transformers, which will be manufactured at ABB's St. Louis manufacturing facility.

Q. Will Grain Belt Express also contract with experienced services providers for operation and maintenance of the transmission line?

A. Yes. For operations, Grain Belt Express may contract with an entity that has a control room and transmission operating capabilities to operate and control the Grain Belt Express Project. Alternatively, Grain Belt Express may create a control room with appropriate staffing to ensure reliable operations. In connection with its request to FERC for negotiated rate authority, Grain Belt Express has committed to turn over functional control of the Grain Belt Express Project, including scheduling, to PJM.

With respect to maintenance of the Project, Grain Belt Express will contract with a firm or firms experienced in electric transmission maintenance and operations to provide maintenance services and capital replacements and upgrades as necessary. This contract could be with a utility or utilities or with a firm that performs transmission line maintenance and construction services. Given the approximately 780-mile length of the Project, Grain Belt Express could contract with more than one company to provide these services. Additionally, Grain Belt Express will work closely with the interconnected utilities, relevant RTOs and other entities in the region, to ensure that appropriate operational agreements, which ensure coordinated operations, are in place, per NERC reliability standards. Operations and maintenance will be performed to meet or exceed all applicable standards and codes.

Q. Do Clean Line and Grain Belt Express plan to open and maintain an office or offices in Illinois in connection with the construction and the operation and maintenance of the Grain Belt Express Project?

A. Yes. There will be temporary construction offices opened at various points along the route of the Grain Belt Express Project during its construction, including in Illinois. These offices may be facilities of Grain Belt Express or facilities of one or more of the project contractors. After the transmission line is placed into service, Grain Belt Express anticipates that there will one or more facilities opened along the route of the line as the base(s) of operations for operating and maintenance personnel. Again, these facilities will either be facilities of Grain Belt Express or facilities of the contractor or contractors retained to provide operating and maintenance services for the Grain Belt Express Clean Line. The facility or facilities will be located such that resources can be quickly allocated to any point on the transmission line where maintenance or restoration services may be needed.

Q. Will Clean Line and Grain Belt Express be prepared to comply with applicable regulations of the Commission in the design, construction and operation of the Grain Belt Express Project?

A. Yes. Clean Line and Grain Belt Express recognize that there are Commission regulations that will be applicable to Grain Belt Express' activities in constructing and operating a Commission-certificated transmission line. These regulations include 83 Illinois Administrative Code Part 305, Construction of Electric Power and Communications

Lines (which incorporates portions of the NESC).[24] As a certificated transmission facility in Illinois, the Grain Belt Express Project will be designed, constructed and maintained in accordance with the provisions of Code Part 305.

Q. Will Clean Line and Grain Belt Express be prepared to comply with applicable NERC reliability standards in operating the Grain Belt Express Project?

A. Yes. NERC reliability standards are mandatory and enforceable (through the imposition of monetary penalties or other sanctions), pursuant to Section 215 of the Federal Power Act and regulations and orders of the FERC. Compliance with these standards is important to ensure the reliability of the bulk power system. Grain Belt Express expects to be registered on the NERC Compliance Registry for the reliability functions of a "Transmission Owner," a "Transmission Operator," and a "Transmission Service Provider" (depending on the nature of its arrangements with a third party or parties to operate the Grain Belt Express Project, which could result in some or all of the Transmission Operator or Transmission Service Provider functions being assigned to the third party). Therefore, Grain Belt Express will be subject to applicable requirements of one or more NERC reliability standards in some or all of the following categories: Resource and Demand Balancing; Communications; Critical Infrastructure Protection; Emergency Preparedness and Operations Procedures; Facilities Design, Connections and Maintenance; Interchange Scheduling and Coordination; Interconnection Reliability Operations and Coordination; Modeling, Data, and Analysis; Personnel Performance, Training, and Qualifications; Protection and Control; Transmission Operations;

[24] For example, the Project's design criteria include provisions to withstand NESC Extreme Wind and Extreme Ice with concurrent wind conditions.

Transmission Planning; and Voltage and Reactive. Grain Belt Express will be prepared to comply with the requirements of the reliability standards that are applicable to its activities.

Q. Does this conclude your prepared direct testimony?

A. Yes, it does.