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AADE 2009NTCE-01-01 CHESAPEAKE ENERGY'S DRILLING RIG ELECTRICITY PROJECT AT DALLAS/FORT WORTH AIRPORT

AUTHOR & AFFILIATIONS:
KURT A. SHIPLEY, CHESAPEAKE ENERGY

In October, 2006, Chesapeake Energy entered an agreement with Dallas/Fort Worth (DFW) Airport. DFW Airport is the second largest and the third busiest airport in the United States and is located in north Texas in the Barnett shale field. The area of the airport that covers 18,453 acres is planned for approximately 330 horizontal Barnett shale wells drilled from 53 pad sites. As of March, 2009 there have been 110 horizontal wells drilled. There can be as many as 1900 flights per day at DFW Airport so there are many special considerations, some that are governed by the Federal Aviation Administration (FAA) that must be addressed when drilling wells. Some of the special considerations include, safety, security, drilling rig heights in restricted airspace areas, derrick lighting, radar interference, environmental protection and drilling rig emissions. The drilling rig emissions restriction was particularly challenging because it limited the time that drilling rigs could be operated on diesel fuel.

Chesapeake's solution to the emissions limits was to convert the five drilling rigs that were dedicated to the project to all electric power connected to the DFW Airport electricity grid. Drilling rig electrification is not new, it is actually done quite frequently, but this project does have some unique characteristics such as capacitor bank installations to reduce voltage distortion, power factor considerations and electrical equipment sharing with production facilities while utilizing five drilling rigs on electricity simultaneously. There are many benefits to converting the drilling rigs to all electric power including the additional benefit of the tremendous cost savings of electric power when compared to higher diesel fuel costs.

The primary reason that the drilling rigs were converted to all electric power was due to the environmental regulations that were intended to limit drilling rig engine emissions. The emissions that are the highest concern are NOX (nitrogen oxides) and VOC (Volatile Organic Compounds) produced from the exhaust of the diesel electric generators. The FAA and the National Environmental Protection Act regulate the allowable levels of emissions for a project of this type. It would not have been possible to maintain this drilling program and comply with the FAA's limitations without converting the drilling rigs to electricity.

Many hurdles had to be overcome in order to convert the drilling rigs to electricity. The logistics of installing high line power poles, designing mobile transformers and coordination with the electric utility company made the project extremely difficult. In addition, the electric utility company required compliance with IEEE-519 (Institute for Electrical and Electronic Engineering) Standard. The IEEE-519 Standard regulates voltage distortion in electricity service. Voltage distortion can consist of two types of distortion, voltage harmonics and voltage notching. Alternating current voltage, when graphed, has a very sinusoidal shape. When voltage notching occurs due to voltage harmonics, there are interruptions in the sine wave shown in Figure 1.

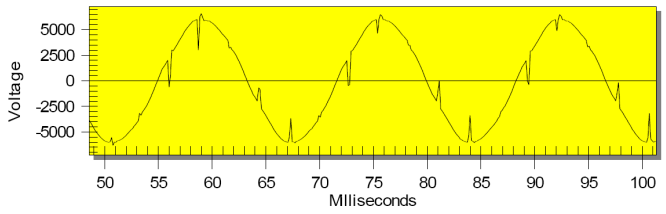

Figure 1. Example of Voltage Notching

The interruptions in voltage due to voltage notching and voltage harmonics can cause disruptions in electrical currents and affect electrical devices. Voltage distortion produced at one location can affect other users on the power grid. The electric utility company and DFW Airport personnel were particularly concerned with voltage distortion because it can disrupt and cause damage to electronics such as computers and radar. This was an unacceptable hazard for the operations at DFW Airport and voltage distortion had to be controlled and monitored.

Chesapeake Energy worked closely with Nomac Drilling and the electric utility company (TXU Energy) to design electrical equipment and a system to run all five drilling rigs on electricity simultaneously. An additional company, Rapid Power Management of Dallas, Texas was added to the team to provide engineering design and fabrication of equipment to mitigate voltage harmonics. Total Harmonic Distortion (THD) was measured at various places on the drilling rig, prior to installing capacitor banks. Figure 2 shows the measurements of the Total Harmonic Distortion at three positions A, B, and C on the drilling rig.

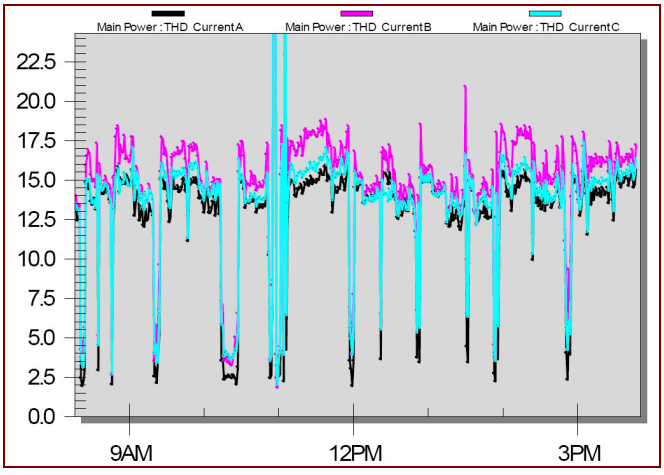

Figure 2. Measurement of Total Harmonic Distortion (THD) in Position A, B and C in Percentage of Current

The maximum Total Harmonic Distortion was 17.5% prior to installing the capacitor banks. In order to reduce harmonics, Rapid Power

Management designed mobile capacitor banks to be used with the electrical equipment on the drilling rigs. Two sizes of capacitor banks were designed for the different sized drilling rigs. There is a significant cost difference in the 500 KVAr and 1000 KVAr capacitor banks so they were designed according to the maximum required load for each drilling rig. The capacitor banks were successful in eliminating the voltage notching and reducing total voltage harmonics from 17.0% to 3.0%. This reduction in voltage distortion allowed for compliance with the IEEE-519 Standard.

An additional benefit that is achieved when installing capacitors to an electrical system is an improvement in the power factor of the electric power system. Power factor of an AC (alternating current) power system is the ratio of the real power compared to the apparent power. Real power is the capacity of the electric circuit. Apparent power is the actual power used in the system. Power Factor is expressed as a percentage, for example Power Factor = 95%. Electric utilities often charge a penalty on their electricity bills when electric power systems have a low power factor. Adding capacitors to the electric power system have the additional benefit of improving the power factor and thus lowering the electric utility bill.

The remaining electrical equipment was designed based on the available electricity capacity at DFW Airport and compliance with various electrical codes in the north Texas area and at DFW Airport. The drilling rigs require 600 volts of electricity to operate. Two types of drilling rigs have been primarily used at DFW Airport. These two types of drilling rigs are provided by Nomac Drilling and Mountain Drilling. The Nomac Drilling rigs are National 610 drilling rigs with 750 horsepower. These drilling rigs require 1500 kilowatts of electric power. The Mountain Drilling rigs are Drillmec HH-220 drilling rigs with 1500 horsepower. These drilling rigs require 2200 kilowatts of electric power. The electrical equipment was designed to be mobile and travel with the drilling rig so it was all mounted on transportable skids. The electricity grid at DFW Airport is designed with 25,000 volts. Transformers were designed and fabricated to convert the electricity from 25,000 volts to 600 volts. Voltage regulators were designed and fabricated to maintain the voltage constant at 600 volts. The equipment is wired together by licensed electricians at each well location. The electricity from the power lines allows for by-passing the diesel electric generators on the drilling rig and delivering the electricity into the drilling rig's SCR (silicon controlled rectifier) house.

Many advantages have been realized by converting the drilling rigs to electricity. The benefits include eliminating drilling rig emissions, reducing drilling rig noise and economic benefits. In many cases it has been identified that the drilling rig actually runs more efficiently on high line electric power. There is also less wear and maintenance that is required on the diesel generators because they are rarely being utilized.

The economic benefit to using high line electric power has been significant. When diesel prices reached $4.00 per gallon in the summer of 2008, Chesapeake was realizing a savings between $60,000 and $100,000 for a 25 day well depending on the drilling rig involved. The National 610 drilling rigs average 1600 gallons per day of diesel fuel usage and the Drillmec HH-220 drilling rigs average 2200 gallons of diesel fuel usage each day. The purchase of diesel fuel is virtually eliminated for the drilling rigs running on electricity. The drilling rig does, however, use a large amount of electric power and there is a cost involved. Each pad site also requires an electrical equipment installation and the cost can be quite expensive. It has, however, proven to be far more economic to operate drilling rigs on electricity than on diesel fuel. An economic sensitivity model has been generated to estimate the cost savings at various prices of each commodity. Summarizing this model, there is a savings of $60,000 at $4.00 per gallon diesel, $35,000 at $3.00 and $20,000 at $2.00 for the smaller horsepower drilling rigs. There is a savings of $100,000 at $4.00 per gallon diesel, $58,000 at $3.00 and $33,000 at $2.00 for the larger horsepower drilling rigs.

There have also been many disadvantages that have been identified from converting drilling rigs to electricity. The primary disadvantage is that the logistics are extremely difficult. It is very difficult to coordinate the electrical equipment movements with the drilling rig schedule. It is also difficult to work with the scheduling and service order requirements of the electric utility companies. All electric work has to be approved by electrical inspectors before equipment can be energized. Another disadvantage is the fact that electricity is not always available at all locations. Furthermore, when electricity is available, the utility company may not be willing or have the excess electrical power available to sell for drilling rig use. Another disadvantage is that the equipment requires an expensive equipment purchase. Finally, there can be disruptions in the electrical power due to equipment failure, black outs and weather storms so the drilling rig must have an alternative source of electric power such as the diesel electric generators.

Converting the five drilling rigs at DFW Airport has been an outstanding success. There have been minimal interruptions in power and when it does happen it has only been for a short period of time. The operation, overall, has been efficient due to great teamwork. There have, however, been some notable areas that could be improved. The main improvement that has been identified is attempting to reduce as much interaction with the utility company as possible. This can be accomplished with the fabrication of the proper equipment. Also, the entire operation could be improved by combining all equipment on one mobile skid, if possible. Finally, the system at DFW Airport was designed to receive one voltage on the receiving end of the electrical equipment at 25,000 volts. Voltages for power grids change from place to place and in order to use this electrical equipment off of DFW Airport it would have to be modified. Chesapeake Energy, Nomac Drilling, and Rapid Power Management held several design sessions to create a new and improved design for the electrical equipment. The result was a design of a multiple voltage electrical skid containing safety disconnect switches, voltage regulators and capacitor banks. This equipment was assembled by Rapid Power Management and is truly unique. The multiple voltage electrical unit has the ability to connect to any voltage from the electric utility lines on one end and any diesel electric drilling rig on the other end. This unit is flexible, fully mobile, eliminates drilling rig emissions, reduces drilling rig noise and lowers drilling cost by operating on electricity instead of diesel fuel.

In summary, Chesapeake Energy began a large drilling project in the Barnett shale at DFW Airport in 2006. One of the requirements of the drilling program was to reduce drilling rig exhaust emissions. Chesapeake Energy's solution to this was to operate the five drilling rigs on all electric power. Further complicating this project was the standard from the electric utility company and DFW Airport to control voltage distortion. The electric equipment was designed and fabricated. The voltage distortion caused by the electric power system was

mitigated by the installation of capacitor banks. The project has been very successful and allowed for drilling to continue at DFW Airport in compliance with the regulations from the FAA. The original reason for converting the drilling rigs from diesel fuel to electricity was to reduce engine exhaust emissions at DFW Airport but Chesapeake Energy has received the added benefit of a significant cost savings from operating the drilling rigs on electricity.