Using a Multiphysics Model to Ensure Power Cables are Restrained Safely

Presented by: David Parker CMP Products

Abstract - Trefoil cable formation is used where three phases are carried by three single core power cables, rather than a single three phase multicore cable. The advantage of installing three single cores in such a configuration is that it minimises the induction of eddy currents, therefore reducing the effect of localised heating, while maintaining the current carrying capacity of the circuit. Trefoil cable restraining devices are structures used to hold the three single core power cables in a triangular touching (trefoil) formation, along the length of the laid cables. Short-circuit fault conditions of single core cables in trefoil formation result in high dynamic electromagnetic forces; these forces need to be restrained correctly in order to prevent extensive damage to the cable management system, and more importantly potential loss of human life.

Manufacturers of trefoil cable restraining devices, or cleats, are required to physically test their product designs in an applied test, where a section of three single core power cables is held with cable restraining devices and exposed to a three phase short-circuit. Each assembly of cable restraining device, cable and applied current will yield a different result, so in theory, an infinite number of tests are required. These physical tests can be costly in terms of both expense and time. To assist the testing process, a time-dependent multiphysics model, including currents, induced electromagnetic forces, material plasticity and contact analysis has been developed to quickly assess various designs and implementation scenarios, greatly reducing the time and cost to assets, and quantify a trefoil cleat design during a short-circuit fault condition.

Electrical Technical Interfacing on Large and Mega Projects for Success

Presented by: Jim Oracheski, TXRX Engineering Inc.

Industrial or commercial projects of all sizes typically have a number of different electrical components (power distribution, protection and control, instrumentation, DCS/PLC/SCADA, etc.) On most projects, whether it is to build or upgrade plants, facilities, or systems, the electrical disciplines’ scopes of work most often play a supporting role on projects, and usually are the most fluid scopes during project design and execution, due to scope changes in other disciplines. Electrical installations are usually the last to be commissioned before a project is completed. Also, the budgets allocated to electrical discipline scopes are typically significantly less than the budgets for mechanical, civil/structural, and/or process scopes of work on projects.

Electrical technical interfacing is critical for the success of a project, but experience has shown that a lack of technical interfacing, especially between the electrical disciplines and others, can have a significant impact on a project’s success, including budget, schedule, and quality. This presentation will discuss the concept of technical interfacing on large and mega projects, with a focus on the electrical disciplines. It will discuss the challenges of executing electrical scopes, how the electrical scope relates to other discipline scopes, and the impacts of inadequate technical interfacing. It will also present methods and strategies that can be employed by project teams to improve technical interfacing.
between the electrical disciplines and others, as well as interfacing with internal and external project stakeholders.

Maximize Power Efficiency and Profitability through Medium Voltage Electric Heating Technology with Zero Emissions

Presented by: Chris Molnar Chromalox

Low voltage (below 1000V) electric heating equipment has limited the use of electric heating for industrial plant operations due to high output and current draw. This paper introduces the benefits of medium voltage (MV) electric heat and MV thyristor control technology to enable alternative heating methods. The focus will be on the enablement of new application methods and the reduction in installation, maintenance, and operational costs. In addition, the presentation will introduce medium voltage electric heating technology as an alternative, emergent solution for large-scale process heating needs traditionally served by fuel-fired equipment, or not utilized at all. Medium voltage electric heating technology opens the door for new solutions in reducing emissions and decreasing plant start-up time and efficiency through the use of clean, efficient, emissions-free electric heating. Lab data, original analysis, and third party testing results will be presented as a means of educating the audience and to provide a model for industry standards regarding this new technology.

A medium voltage electric heating element has been developed capable of very large power output that can operate on voltages up to 7,000 Volts. These elements are superior to low voltage element with the invention of new dielectric materials that provides an ultra-high insulation resistance and enables the element to reach withstand voltages in excess of 13,000V during safety testing. These two properties deliver superior performance and reliability, even at high temperatures. Typical failure modes seen with low voltage elements (e.g. stitching and dielectric breakdown) are not evident with new MV elements technology. The elements can be integrated into applications requiring welded connections or fittings to facilitate serviceability. MV elements are capable of controlling process streams to 1°C utilizing SCR control technology. This ensures maximum heat production at close to 99% efficiency and minimal I²R losses over long distances.

ASD’s and Reflected Waves – A Review of Problems and Solutions

Presented by: Dale Tardiff Innovative Power

The problem with reflected waves at motors in Adjustable Speed Drive (ASD) applications has been studied for at least 25 years. Although it has been solved for various applications, new applications with longer leads, difficult application environments, or even newer drive technology can cause this issue to reappear. A variety of solutions have been implemented, including filtering, transient suppression and new drive topologies. This presentation will summarize the causes of reflected waves and examine the history of several methods to solve the problem. This will provide the background for an overview and comparison of the latest techniques to mitigate reflected waves. Possible solutions will be examined for cost, effectiveness, and potential side effects. The intent of this presentation is not to recommend a particular solution, but to provide the audience with the information to make choices regarding the best
mitigation technique for a particular application. The author will address the problem from his experience developing solutions for reflected waves.

**Electrical Space Heating for Buildings is coming of Age**  
Authors: Tony DeFrancesco - Aeromation Inc. & Tim Driscoll - OBIEC Consulting

Electrical heating is starting to become a major portion of the space heating market, and is also becoming a contributing factor in obtaining Leed certifications for buildings. This presentation will provide some of the key design concepts for applying low wattage floor, ceiling and wall heating for space heating in buildings. Significant changes were made to the Canadian Electrical Code to pave the way for installation of new technologies and concepts in space heating. Section 62 was rewritten in the 2015 CE Code and the major technical changes were in space heating. The Canadian product standards are currently being revised, and changes are underway to support space heating technologies. These Code and standards changes will also be discussed in this presentation.

**New Approach to Selective Coordination**  
Presented by: Greg Briggs - Eaton & Raed Altayawi - Eaton

Whenever the system reliability and life safety is of concern, then selective coordination should be your first consideration. Every electrical system designer’s dream is achieving the most cost effective, highest uptime, safest electrical distribution system. However, designers are facing more difficulties in meeting the Canadian Electrical Code selective coordination requirements when designing healthcare electrical systems, elevator feeders, emergency systems, industrial processes and computer loads. Designers are required to have an in depth understanding of the nature of the overcurrent protective devices whether breakers or fuses are being used and properly applied, so the device closest to the fault will open to clear an overload or short circuit condition. This will allow the industry to achieve better up time, but it’s often difficult or elusive to obtain when balanced with other system design constraints. Each selected low voltage circuit breaker or fuse must have a voltage rating and interrupting capacity equal to or greater than the system voltage and available fault current at its point of application in the electrical distribution system.

This presentation will discuss some new techniques for selecting low voltage circuit breaker and fuse protective devices to provide selective coordination. A new approach for achieving that utilizing tested combinations between current limiting fuses and circuit breakers will allow the designers to obtain and maintain up time, limit fault currents while minimizing the cost and equipment size impact.

**Fire Rated Cables in a Commercial Application**  
Presented by: Ernie Gagnon SSC

Fire Rated Cables in a Commercial Application This paper discussed the requirement for fire rated cables in Commercial Applications.

The National Building Code NBC requires the use of fire rated cables in Buildings over seven floors and high occupancy and or hospitals and institutions.

This paper will also review the testing standard and offer some insight to the removal of the standard by Underwriters Laboratory in 2012.

Additionally, the technology of the cable is discussed.
The 2015 CE Code for Hazardous Locations has No Class, but it does have Significant Changes.

Presented by: Marty Cole, Hubbell Canada; Tim Driscoll, OBIEC Consulting, Bill Lawrence, FM Approvals, Dave Adams, QPS Evaluation Services

The 2015 Canadian Electrical Code, Part I has seen significant changes from the 2012 Code, and Section 18 Hazardous Locations has essentially been rewritten to include Zones 20, 21 and 22 for Dusts. In the rewrite, the Class and Division system for Dusts and Fibers has been moved to Appendix J, Annex j18, alongside the Class and Division system for Gasses. Existing Dust facilities with Class II or III Hazardous Locations may continue to use the Class system but all new construction must use the Zone system, which is the same as that for Gasses. In addition to the significant changes for the Dust section, numerous changes were made to definitions, the general section and the Gasses section for Zones. Many of these changes were to simplify and clarify wording, correct errors, incorporate the latest concepts from the IEC and clarify wording for Table J1.2 and Annex J18 in Appendix J. An Engineering Guideline for Area Classification has also been added as Appendix L. There are several major additional changes being discussed in the Section 18 subcommittee, and status of these will also be reported on in this presentation.

The target dates for acceptance of the 2015 CE Code in Alberta and BC is adopt in Jan. 2016, and for Saskatchewan possibly a month or two earlier. Enforcement will probably be less than 3 months after adoption in each.

Risk Assessment and Your Electrical Safety Program

Presented BY: Daniel Roberts - Schneider Electric Canada Inc.

The 2015 editions of NFPA 70E and CSA Z462 have integrated Occupational Health and Safety Management System and Risk Management principles. This significant revision changes and advances the electrical safety culture and enables sustainable improvement in prevention of electrical incidents and injuries. The paper will discuss how these changes can be integrated into an organizations electrical safety program and how risk assessment can be performed at an organizational level and at a worker level.

Benefits of an Intellectually Integrated Project Delivery Approach

Presented by: Pankaj Sharma Bantrel

Most projects are delivered utilizing a silo approach treating Engineering, Procurement and Construction as independent functions. Current project execution models tend to optimize their individual Engineering, Procurement or Construction scopes not considering impacts and interaction between the project stages. This silo approach does not take advantage of an integrated, collaborative, construction lead strategy to minimize over project installed cost to produce predictable and consistent results.
Significant benefits of this approach have included reduction in overall project cost, achievement of accelerated schedules, minimization of rework and increase in overall satisfaction. This paper will provide details of this EPC approach and provide proofs of benefits though actual case studies.

**Overcurrent Mitigation in a Crop Cobble Shear System for Steel Rolling Mill**

**Presented By: Sorin Deleanu - NAIT**

The paper describes how a Direct Torque Control (DTC) drive technology has been used to control the Crop Cobble Shear (CCS) system in a steel rolling mill. The CCS is a highly dynamic load and requires a high performance torque control drive. During the CCS cobble cutting mode, depending on the bar length, the original DTC drive experienced overcurrent faults that cause production downtimes. A model of the overall system has been developed and has been used to provide the parameters for simulating the system. This has allowed the CCS operation to be analyzed and modified to improve performance. The simulated DTC induction motor drive has been compared with the existing system from a steel plant. Measured data from the original system in the steel mill are compared with simulation results. This comparison shows that the system has been successfully simulated to determine a suitable approach to improving the CCS operation. New control strategies have been identified and simulations of the modified system have been carried out. Follow these simulations, the modifications were made to the actual system and measurements were carried out to verify the improvement. These measured and simulated results are also shown in the paper. Conclusions from this project are discussed.

**Behind the Fence System Planning for Distributed Generation**

**Presented by: Hartley Harris Catch Engineering**

In all industries, facility owners are continually evaluating their operational costs and how they can reduce these. As the only truly open electricity market in Canada and one of the few in North America, doing business and operating facilities in Alberta has its advantages. Alberta’s electricity market allows anyone to become a market participant and generate electricity for their own use and to sell excess electricity into the power pool. Alberta is preparing itself for the eventual decommissioning of its coal generation fleet of units which presently accounts for more than 50% of the province’s base electricity supply.

In order for facility owners to generate their own electricity and potentially sell electricity back into the grid, there is a significant amount of planning and foresight necessary especially depending on the size of generation being contemplated.

From small scale generating units including solar, heat recovery generation and small scale CHP to large scale reciprocating and turbine driven generators, there are common steps that all potential projects must go through.

This presentation will provide an introduction of the potential benefits of having on-site generation and considerations facility owners may contemplate in deciding to install on-site generation. The
SR motors and drives – The Ideal Drive Solution for High Torque, Variable Speed Applications
Presented by: Nicole Hampton Synergy Engineering
Switched reluctance motors have been around since the 1800’s, but they have only recently become practical drive solutions for a wide variety of applications, due to recent technological advancements in their control. SR motors have yet to gain popularity as the drive of choice for large industrial applications, however there are many characteristics inherent to the SR motor and drive that, when considered as a total system, deliver superior operational advantages to certain applications.
The construction of the switched reluctance motor is relatively simple and very robust, making it ideal for harsh industrial environments. The switched reluctance drive components are common among other drive technologies, with straightforward assembly. Advanced control algorithms allow for precise control of the SR motor to utilize the motor characteristics to their full advantage.
The SR drive system produces good torque control over the entire speed range, with high overload torque capacity at zero speed. The system is also capable of unlimited back to back start cycles, and is more efficient than many variable speed drive systems. These unique attributes make the switched reluctance drive system ideal for high torque, variable speed applications.

An overview of CSA Z463 & PD offline and online testing
Presented by: Wheeler O’Harrow Shermco
This presentation will give an overview of the CSA standard and explore the strategies ensuring dependability in electrical power distribution equipment and systems. Subject matter will be specifically discussed in areas of “on line” and “off line” testing techniques developed by NETA to attain maximum safety and reliability. A special focus will be put on the latest technology advancements in Partial Discharge testing on high & medium voltage cables and other electrical power apparatus.

ELECTICAL ASSET CONDITION BASED RELIABILITY MANAGEMENT SYSTEM
Presented By: John Hodson Advanced CRM Software
For some time a necessary change has been evolving in how we look at maintenance of electrical power systems and equipment. This is being driven by many influences including cost, technology and an ever evolving human resource base to name but a few. Efforts are being directed to explore new approaches and techniques regarding the monitoring, diagnosis, life assessment and condition evaluation of critical facility infrastructure. Power interruptions and failures are one of the major symptoms of ageing electrical distribution components. Facility managers are understandably out to maximize the use and performance of the electrical distribution network assets, while ensuring that quality and reliability are not compromised.
Organizations are migrating from traditional time based maintenance to a condition based reliability maintenance (CBRM) program for their electrical assets. CBRM or more simply CBM periodically and more commonly continuously determines the state of equipment deterioration and maintains equipment when the condition falls below acceptable risk thresholds. The process of transition from a reactive maintenance organization to a totally proactive structure is not an overnight project. It will take time, effort and planning to accomplish. The transition requires commitment from all levels of the organization.

The key to this approach is to have a reliable means to evaluate the condition of equipment and the system as a whole. To do this all information regarding the equipment is stored and weighted as to its value in determining condition. This includes all “cradle to grave” information starting with manufacturer’s tests and specifications, site acceptance tests and routine maintenance testing. Now more and more on line diagnostics are being used to input real (or close to) real time input to the formula. In addition the more accomplished and superior algorithms will include a component of risk weighting, in other words how critical is the equipment to the ultimate process.

Although the ultimate aim is to develop and implement condition and risk-based asset management strategies and capabilities, it is prerequisite or necessity for organizations to fully understand its capability gap and realign its asset management functions by addressing all the necessary building blocks or pillars of asset management. The comprehensive approaches must effectively deal with leadership mindset, integrated asset information system, condition assessment technologies, organizational structure and human competencies and remain consistent with industry standard asset management practices as per ISO PAS 55-1.

In conclusion, this paper will provide an update on these evolving practices and some early adopters experience with the new methodology. A sample working system utilizing a transformer will be described with the pros and cons of operating such a system rationalized. Real life data will be utilized to explain the principals of operation and if possible real time streaming data from an operational installation will be utilized.

**Hex Cooling for Electrical Equipment**

*Presented by: Dan Stelzner ABB*

Air Cooled Heat Exchangers are used in many process applications in the petrochemical industry. As with all process equipment, reliability is crucial. In many cases, excess fans are installed to ensure a process will not have to be stopped due to a cooling failure. The most prevalent cause of downtime is failure of the right angle gearbox or mechanical components in the drive train, such as belts, fan shaft bearings, or motor bearings. Eliminating the mechanical components increases reliability. Further, the elimination of these components reduces the losses in the drive system and offers the possibility for improved overall system efficiency. There are also process improvements available. This presentation describes new developments in motor technology which allow for the replacement of the high speed motor,
driveshaft, and mechanical drive with a slow speed permanent magnet (PM) motor. A case study is presented with maintenance and efficiency improvement data provided.

**Motor Starting Challenges for Large Medium Voltage Motors on a Weak Utility System**

*Presented By: Hartley Harris Catch Engineering*

Oil and Gas facilities are often located at large distances from utility substations. Being connected to a long distribution feeder has its challenges for large loads, and especially for starting large motors. Voltage dips during motor starts can pull down the bus voltage not only at the connected bus, but also other buses within the facility.

This case study walks through the issues identified during the recent commissioning of an oil and gas facility, and how they were addressed. Adjusting motor starting reduced the impact; altering the protection settings made the system less sensitive. Other changes to the distribution feeder voltage regulator and capacitor bank settings provided additional required support. Using a combination of these solutions, motor starting has been successful and has provided the operational flexibility desired by the operator.

This presentation concludes with lessons learned and suggestions to be incorporated at the design stage of future facilities.

**Power System Modeling and Analysis – An attempt to bridge the gap between the Brown Book and the software vendors’ instructions**

*Presented by: Duane Leschert, lead author Worley*

Modern power system analysis software is complex. While many vendors have made substantial improvements in their user interface, in all cases the software remains a tool for use by power system engineers. There is no available power analysis software which is an “engineer in a box,” nor is any anticipated in the foreseeable future, despite the optimistic musings of computing futurists. The use of any power system software requires power system engineering expertise. However, while all major vendors of power system analysis software offer training on their software, sometimes advertised as training in power system engineering, many important issues are not commonly discussed. University courses and the associated reference texts provide some understanding of the underlying physics of power systems. The IEEE Brown Book provides some discussion of power systems analyses. The vendors provide instruction on using their software tools, but there remain issues not covered by any of these sources.

This session will discuss the creation, use, and maintenance of power system models for the variety of analyses for which they are needed in modern industrial power systems. Ample reference will be made
to IEEE 399 (the Brown Book), but this is not a Brown Book Course. Examples will be provided from a variety of vendor software tools, but this is not a course on how to use any given vendor’s tools. This session attempts to discuss aspects of creating and using power system models which many people today either assume or ignore, but which are important in power system engineering, even though they are not commonly discussed. If the work is adequately planned prior to starting to use any software tool, and then systematically executed, the power system analysis tasks will be performed more efficiently, with results that are appropriate for the phase of work being performed.

**Panel Discussions (Both set)**

Panel #1 Switching Transients, a Case Study  
Pat Petrie – TransCanada  
Jim Sheppard – Eaton  
Peter Pietramala – Eaton  
Case study around failure of primary windings of transformer in a drive application. Includes History, measurement and solution design

Panel #2 Communications, Smart Device and Security  
Pat Robinson – Altelec  
Assorted GE people

**Tutorials**


System Grounding and Ground Fault Protection – R. Rifaat, Jacobs

Transformer Design and Design Parameters - Ronnie Minhaz, Transformer Consulting Services Inc.