

54th Annual **MINNESOTA POWER SYSTEMS CONFERENCE**

November 6–8, 2018

FINAL PROGRAM

**Saint Paul RiverCentre
175 W Kellogg Boulevard
Saint Paul, Minnesota**

POWERPOINTS

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UNIVERSITY OF MINNESOTA

Program at a Glance

| TUESDAY, NOVEMBER 6, 2018 | | | | |
|---------------------------|--|---|---|---|
| 7:00 a.m. | Registration and Continental Breakfast | | | |
| | General Session – Grand Ballroom | | | |
| 7:50 | Welcome and Opening Remarks *(PLEASE NOTE EARLIER START TIME) | | | |
| 8:00 | Increased Dependence on Electricity Drives Innovation | | | |
| 8:45 | Puerto Rico Power Restoration | | | |
| 9:45 | Break | | | |
| 10:15 | Grid Lessons Learned from Hosting Super Bowl LII | | | |
| 11:00 | Engineering Ethics | | | |
| Noon | Lunch | | | |
| | Substation Room 1 | Safety/Security Ballroom A | Delivery Systems Room 4 | Relaying I Ballroom E |
| 1:00 p.m. | RTU Life Extension and Migration Strategy | Integrating Roles Within Electric Utilities to Achieve Arc Flash Safety | Transmission Interconnection Planning for the Country's Largest Manufacturing Facility—In Less than Four Months | Beyond the Knee Point: A Practical Guide to CT Saturation |
| 1:45 | Introduction to IEEE 1818— IEEE Guide for the Design of Low-Voltage Auxiliary Systems for Electric Power Substations | Practical Operational Environment Security | MISO Generation Interconnection Process and Challenges | Improving Transformer Protection |
| 2:30 | Break | | | |
| 3:00 | Effectiveness of Surge Capacitors on Transformer Tertiary Connected Shunt Reactors in Preventing Failures—Field Measurements and Comparison with Transient Study Results | Implementing NERC Substation Security Requirements | Beating the Peak—Using Load Shifting Strategies to Lower Member Costs | Protection of Medium Voltage Standby Generators |

| | | | | |
|------------------------------------|--|--|---|--|
| 3:45 | Substation Grounding Design Challenges and Lessons Learned | Advances in Perimeter Security—Using Video Analytics to Mitigate Risks | Evaluating Dynamic Reactive Support Options for Minnesota's North Shore | Quantitative Analysis of Distribution Protection Enhancement Using Fault Circuit Indicator |
| 4:30 | Exhibitor Reception (4:30–7:00 p.m.) Exhibit Hall (Lower Level) | | | |
| 7:00 | Adjourn | | | |
| WEDNESDAY, NOVEMBER 7, 2018 | | | | |
| 7:30 a.m. | Registration and Continental Breakfast | | | |
| | Distribution Automation/ Communications Ballroom E | Project Management Ballroom A | Utility Industry Futures Room 4 | Power Generation Room 1 |
| 8:30 | SCADA Communications to Distributed Generation | Project Management Office: More than Schedules and Budgets | Minnesota's Electric Bus and EV Time-of-Use Charging | Advanced Coal-Fired Power Cycles |
| 9:15 | Converging Communications, Operational Technology (OT), and Information Technology | High Voltage DC Transmission Line Refurbishment Project | Utility Scale Storage Solutions | Dynamic Behavior of Islanded Distributed Energy Resources |
| 10:00 | Break | | | |
| 10:30 | Field Area Network for Multiple Grid Apps—Roadmap into Deployment | Leveraging GIS for Project Management—Small Utility Finds Big Results | Modeling and Stabilization of Low-Inertia Grids | The Benefits of a Cooling Tower Fan VFD Retrofit |
| 11:15 | Emerging Communications and Sensor Technologies that Advance Distribution Automation | Challenges of a Small Project | Energy Storage Resources in Wholesale Electricity Markets | Challenges of Simulation Model Validation for Renewable Resources |
| Noon | Lunch | | | |

WEDNESDAY, NOVEMBER 7, 2018 (CONTINUED)

| | Civil-Structural Ballroom A | Delivery Systems - Renewables Room 4 | Relaying II Ballroom E | Metering Room 1 |
|-----------|---|--|--|--|
| 1:00 p.m. | Spill Prevention Control and Countermeasures—SPCC Planning and Development | Minnesota's Distributed Energy Resource Interconnection Process | Do We Have to Reduce Under-Reaching Distance Reach Solely Based on System Impedance Ratio (SIR)? | History and Future of Electric Metering |
| 1:45 | Overcoming Foundation Construction Challenges in Power Delivery Projects | Do We Really Need to Worry about Harmonics in Wind and Solar Plants? | CCVT Failures and Their Effects on Distance Relays | Metering Installation Errors to Avoid |
| 2:30 | Break | | | |
| 3:00 | Modern Pile Load Testing Techniques to Support Optimized Pile Foundation Design | Reducing Contingency-Based Wind Farm Curtailments Through Use of Transmission Capacity Forecasting | Impact of Incipient Faults on Sensitive Protection | Metrology Challenges in the Brave New World of Electronics—Laboratory Test Results |
| 3:45 | Understanding Structure Deflection in Design and Construction | Integration of Renewable Generation | Summary Revision of C37.119 Guide for Breaker Failure Protection of Power Circuit Breakers | 20 Years into Interoperable Communication Standards—Why Aren't We There Yet? |
| 4:30 | Adjourn | | | |

THURSDAY, NOVEMBER 8, 2018

| 7:30 a.m. | Registration and Continental Breakfast | | | |
|-----------|--|------------------------------|-------------------------------|----------------------------------|
| | Tutorial I Ballroom E | Tutorial II Room 1 | Tutorial III Room 4 | Tutorial IV Ballroom A |
| 8:30 | Differential Relaying 101 | Power Quality 101 | Transformers 101 | Energy Storage |
| 10:00 | Break | | | |
| 10:30 | Differential Relaying 101 | Power Quality 101 | Transformers 101 | Energy Storage |
| Noon | Adjourn | | | |

Program Schedule

Tuesday, November 6, 2018

GENERAL SESSION – Grand Ballroom

7:50 a.m.–noon *(PLEASE NOTE EARLIER START TIME)

Moderator: *Greg Owen*

Co-Moderators: *Larry Brusseau, Michael Marz, Jay Morris*

Welcome and Opening Remarks

Greg Owen, Basin Electric Power Cooperative

Increased Dependence on Electricity Drives Innovation

Priti Patel, Great River Energy

Our increasing dependency on electric energy results in greater customer expectations of uninterrupted electric power, even as we face challenges of low load growth, aging infrastructure, and the advent of intermittent renewable resources. Despite increasing severity of storms, floods, tornados, and hurricanes, the story on the news should be about how the electric utilities have faced these challenges. – Fundamental

Puerto Rico Power Restoration

Luke Oberle, Scott Hafner, Xcel Energy; Aaron Nelson, Dean Erdman, Minnesota Power

Xcel Energy and Minnesota Power will discuss their experiences and lessons learned from sending crews to Puerto Rico after Hurricanes Irma and Maria for power system restoration, which had left nearly 1.4 million customers without power. – Fundamental

Grid Lessons Learned from Hosting Super Bowl LII

Kelly Bloch, Xcel Energy

Super Bowl LII was held in MN in 2018. Preparations to host this event included electric grid resiliency measures taken by Xcel Energy (power provider). We will highlight the process and steps taken to share how a drama-free, reliable Super Bowl was held. – Fundamental

Engineering Ethics

Kristine Kubes, Kubes Law Office, PLLC

Engineering ethics are essential to retain the public's trust with electric power providers. This will highlight practical ethical behavior and case studies. – Fundamental

CONCURRENT SESSIONS

1:00–4:30 p.m.

SUBSTATION – Room 1

Moderator: *Brianna Swenson*

Co-Moderators: *Bethlyn Cummings, Steven Mohs*

RTU Life Extension and Migration Strategy

Ernest Gust, Xcel Energy

Upgrading obsolete RTUs without touching the original field wiring using plug-and-play components and connectors in less than one day. – Intermediate

Introduction to IEEE 1818 – IEEE Guide for the Design of Low-Voltage Auxiliary Systems for Electric Power Substations

Joe Gravelle, Xcel Energy

A new IEEE guide has been created by the Substations Committee D9 Group that considers AC and DC system components from the sources to the distribution. Substation system design recommendations, reliability requirements, load characteristics, and distribution methods are discussed. – Fundamental

Effectiveness of Surge Capacitors on Transformer Tertiary Connected Shunt Reactors in Preventing Failures—Field Measurements and Comparison with Transient Study Results

Pratap Mysore, Pratap Consulting Services, LLC

This presentation covers mitigation of transient over-voltages during reactor switching due to current chopping by installing surge capacitors. EMTP results are compared with field records. – Intermediate

Substation Grounding Design Challenges and Lessons Learned

Eric Swenson, Ulteig Engineers, Inc.

Discussion of specific design challenges and resolutions on topics such as soil and aggregate electrical resistivity testing, ground rod length selection, ground wells, right-of-way counterpoise, winter soil modeling, step voltage over native soil, and ground grid testing. – Intermediate

SAFETY/SECURITY – Ballroom A

Moderator: *Larry Brusseau*

Co-Moderators: *Mike Crane, Jay Morris*

Integrating Roles Within Electric Utilities to Achieve Arc Flash Safety

Neil Stiller, Bob Cooke, Rochester Public Utilities

Arc flash safety is an organization-wide effort to build understanding, establish standards, modify work practices, train, and maintain the attitudes of safety and compliance. Current and evolving engineering, training, and business practices at Rochester Public Utilities will be discussed. – Intermediate

Practical Operational Environment Security

Joe Peterson, Warren LaPlante, Minnesota Power

The operational world has evolved to an integrated network of intelligent devices that requires attention to physical and cybersecurity measures to operate effectively, safely, and reliably. Practical approaches and available resources will be discussed. – Intermediate

Implementing NERC Substation Security Requirements

Gene Giesen, Justin Sipma, Basin Electric Power Cooperative

This presentation will cover Basin Electric's security design and implementation considerations that apply to medium- and low-impact substations, along with lessons learned including video analytics, installation improvements, and multi-entity facility access requirements. – Intermediate

Advances in Perimeter Security—Using Video Analytics to Mitigate Risks

Anthony Hackett, Senstar

With advances in video analytics, perimeter security has become very robust. This presentation will share how analytics are being used by utilities to mitigate threats, improve productivity and reduce costs. – Intermediate

DELIVERY SYSTEMS – Room 4

Moderator: *Will Lovelace*

Co-Moderators: *Al Haman, Mike Steckelberg*

Transmission Interconnection Planning for the Country's Largest Manufacturing Facility—In Less than Four Months

Chengyue Guo, Jui-Ning (Joey) Cheng, Michael Marz, American Transmission Company

In October 2017 Foxconn announced a 200 MW (potentially 400 MW) manufacturing facility for full operation in January 2020. How ATC developed the interconnection project, including regulatory submission in January 2018, is described. – Intermediate

MISO Generation Interconnection Process and Challenges

David Brauch, Midcontinent Independent System Operator (MISO)

With approximately 92 gigawatts of generation interconnection requests, MISO faces process challenges. This presentation will provide a fundamental overview of MISO's generator interconnection process and future challenges. – Fundamental

Beating the Peak—Using Load Shifting Strategies to Lower Member Costs

Eddie Webster III, Minnesota Valley Electric Cooperative

A discussion on techniques MVEC uses to manage wholesale power costs, in different constructs with disparate programs and technologies. – Intermediate

Evaluating Dynamic Reactive Support Options for Minnesota's North Shore

Christian Winter, Minnesota Power; Wenchun Zhu, Siemens Power Technologies International

As Minnesota's North Shore baseload generation transitions to less frequent operation, options for replacing the critical dynamic reactive support to ensure continued reliable service to the area have been evaluated. – Fundamental

RELAYING I – Ballroom E

Moderator: *Michael Ebert*

Co-Moderators: *Dave Bisel, Pete Malamen*

Beyond the Knee Point: A Practical Guide to CT Saturation

Michael Thompson, Schweitzer Engineering Laboratories, Inc.

Current transformer (CT) saturation, while a fairly common occurrence in protection systems, is not often clearly understood by protective relay engineers. This paper forgoes the usual physics equations to describe how CTs saturate in a simple and intuitive way. – Intermediate

Improving Transformer Protection

Wayne Hartmann, Beckwith Electric

Power transformers play a critical role in the power system. These transformers are subject to internal short circuits, external short circuits, and abnormal operating conditions. Several protection challenges to power transformers will be explored, and methods to improve the protection provided. – Intermediate

Protection of Medium Voltage Standby Generators

Timothy Coyle, Karges-Falconbridge, Inc.

This presentation will discuss the unique characteristics of standby generators and the systems they supply, issues with applying traditional protection schemes, and trade-offs between protection and service reliability. – Intermediate

Quantitative Analysis of Distribution Protection Enhancement Using Fault Circuit Indicator

Mohammad Zadeh, ETAP

Faulted circuit indicators (FCIs) used in today's distribution systems can achieve faster restoration by wirelessly transmitting FCI's signal to the upstream recloser within the time range of a power system cycle. Four applications of reduced device fault clearing time, using wireless protection sensor (WPS) signals, will be analyzed. – Intermediate

EXHIBITOR RECEPTION – Exhibit Hall (Lower Level)

4:30–7:00 p.m.

CONCURRENT SESSIONS

8:30 a.m.–noon

DISTRIBUTION AUTOMATION/COMMUNICATIONS – Ballroom E

Moderator: *Dan Nordell*

Co-Moderators: *Dave Bisel, Tom Guttormson*

SCADA Communications to Distributed Generation
Steve Nordahl, Steele-Waseca Cooperative Electric

This presentation will talk about normalizing your data and how to communicate to distributed generation with other devices in your distribution network to see what is happening and to operate in real time. – Intermediate

Converging Communications, Operational Technology (OT), and Information Technology
Joe LaCasse, Dan Lysaker, Xcel Energy

In this presentation, three speakers will detail Xcel Energy's strategy for operationalizing communications systems to enable a sustainable and scalable ADMS project from the deployment of intelligent field devices to the setup and design of the ADMS SCADA system. – Intermediate

Field Area Network for Multiple Grid Apps—Roadmap into Deployment
Tom Guttormson, Connexus Energy

This presentation will highlight the development of a hybrid communications roadmap for serving both legacy and advanced grid applications, and deployment of the network at Connexus Energy. – Intermediate

Emerging Communications and Sensor Technologies that Advance Distribution Automation
Shankar Achanta, Schweitzer Engineering Laboratories, Inc.

This paper describes applications of distribution automation with a focus on emerging communications technologies and advanced line sensors that help distribution utilities with faster fault detection, isolation, and restoration. – Advanced

PROJECT MANAGEMENT – Ballroom A

Moderator: *Denny Branca*

Co-Moderators: *Larry Brusseau, Bethlyn Cummings*

Project Management Office: More than Schedules and Budgets
Jennifer Johnson, Minnkota Power Cooperative, Inc.

There are five significant stages to a project, and some are often overlooked. This paper will discuss the processes needed to manage a large portfolio of projects and programs and the required documentation, tools, and processes essential to provide consistency, transparency, and defensibility of projects considered for execution. – Fundamental

High Voltage DC Transmission Line Refurbishment Project
Greg Schutte, Great River Energy

Great River Energy has operated a 400 kV high-voltage direct-current (HVDC) transmission line for 40 years. This presentation will cover GRE's 2011 HVDC system assessment process to determine that investment was needed to refurbish and extend the HVDC system life. – Intermediate

Leveraging GIS for Project Management—Small Utility Finds Big Results
Mike Riewer, Henry Wander, Otter Tail Power Company

The BSSE project faced many challenges related to the massive amounts of data required to manage the project effectively. This discussion will focus on how the challenge was met using an entirely paperless process. – Fundamental

Challenges of a Small Project

Dave Logan, POWER Engineers

A retrospective examination of a small project with large challenges. The general size of a project should not drive the scope development. A design team's ability to identify potential challenges early, and their ability to adapt to changing scope, will determine the success of the project.

– Intermediate

UTILITY INDUSTRY FUTURES – Room 4

Moderator: *Mike Steckelberg*

Co-Moderator: *Jesse Tomford*

Minnesota's Electric Bus and EV Time-of-Use Charging

Mike Fosse, Jane Siebenaler, Dakota Electric Association

Minnesota's first electric school bus completed its first year of operation. Learn about the history of the bus, bus technology, performance, economics, and the driver's experiences as well as customer responses to Dakota Electric's other electric vehicle-charging programs. – Fundamental

Utility Scale Storage Solutions

Owen Sandford, Tesla Energy

Utility energy storage solutions are rapidly evolving, growing in capacity and technological capabilities. This presentation will cover approving and financing storage projects, interconnection design requirements, operating and maintenance considerations, and challenges unique to storage projects. – Intermediate

Modeling and Stabilization of Low-Inertia Grids

Brian Johnson, University of Washington, Department of Electrical Engineering

Recent advances in the modeling and control of low-inertia power systems characterized by high inverter penetration will be discussed. Methods to mitigate model complexity will be examined, as well as how small-signal stability is impacted by inverter penetration level. – Advanced

Energy Storage Resources in Wholesale Electricity Markets

Scott Baker, PJM Interconnection

FERC Order 841 concerning storage in wholesale markets is a watershed moment for utility scale batteries. This presentation explores how RTOs and ISOs are preparing to comply with the Order and open storage opportunities in electricity markets. – Intermediate

POWER GENERATION – Room 1

Moderator: *Ryan Bergeron*

Co-Moderators: *Mike Crane, Pete Malamen*

Advanced Coal-Fired Power Cycles

Jason Laumb, University of North Dakota, Energy & Environmental Research Center

This presentation reviews the challenges and opportunities of using North Dakota lignite in the Allam Cycle process. Specific areas of focus will include gasifier selection, material corrosion, impurity management, and demonstration of a syngas combustor. – Intermediate

Dynamic Behavior of Islanded Distributed Energy Resources

Michael Ropp, Northern Plains Power Technologies

The dynamic behaviors of inverter- and machine-based distributed energy resources operating in unintentional islands, and factors affecting how quickly an island must be detected, are described.

– Intermediate

The Benefits of a Cooling Tower Fan VFD Retrofit

Greg Owen, Basin Electric Power Cooperative; Ryan Carlson, Burns & McDonnell

Basin Electric Power Cooperative recently upgraded cooling tower electrical equipment to improve reliability and reduce maintenance costs. This session will discuss project justification, design challenges, and the impact on operational and financial performance. – Advanced

Challenges of Simulation Model Validation for Renewable Resources

Dinemayer Silva, Daniel Durbak, Siemens Power Technologies International

Discussion on the challenges faced by model validation for renewable power plants such as field test challenges, model benchmark, model tools, and platforms. – Intermediate

CONCURRENT SESSIONS

1:00–4:30 p.m.

CIVIL STRUCTURAL – Ballroom A

Moderator: *Mike Jensen*

Co-Moderators: *Bethlyn Cummings, Greg Owen*

Spill Prevention Control and Countermeasures—SPCC Planning and Development

Mark Gerlach, Xcel Energy

NSP used EPRI software to determine substation oil discharge risk. Impacted sites were retrofitted with secondary containment and incorporated into a multifacility substation SPCC plan. – Intermediate

Overcoming Foundation Construction Challenges in Power Delivery Projects

Luke Karels, Stanley Consultants

Foundation construction is never easy. Whether the project includes installation of transmission structures, distribution foundations, or substation structure foundations, each project can carry several challenges. The presentation will review types of challenges and discuss best practices to overcome them. – Intermediate

Modern Pile Load Testing Techniques to Support Optimized Pile Foundation Design

Matt Wessale, Westwood Professional Services

Innovations in solar have significantly decreased the cost of pile load tests. Learn about modern pile load tests and their use in optimizing pile foundations for solar and wind energy, transmission lines, and energy storage. – Intermediate

Understanding Structure Deflection in Design and Construction

Duane Phillips, Hydaker-Wheatlake Company

Construction with “flexible” tubular steel structures creates additional challenges for construction means and methods. This presentation will go through design elements and construction challenges, and provide practical examples from projects to illustrate. – Intermediate

DELIVERY SYSTEMS—RENEWABLES – Room 4

Moderator: *Michael Marz*

Co-Moderators: *Will Lovelace, Jesse Tomford*

Minnesota’s Distributed Energy Resource Interconnection Process

Kristi Robinson, Star Energy Services

Minnesota’s Distributed Energy Resource Interconnection Process is being reviewed and updated to reflect current standards, policy, and technology. This presentation will discuss upcoming changes. – Fundamental

Do We Really Need to Worry about Harmonics in Wind and Solar Plants?

David Mueller, EnerNex

Inverter-based wind and solar power generators are sources of harmonics, making compliance with IEEE 519 and IEEE 1547 standards problematic. Additional issues to be addressed include resonance and converter controls interactions. – Intermediate

Reducing Contingency-Based Wind Farm Curtailments Through Use of Transmission Capacity Forecasting

Jack McCall, Lindsey Manufacturing Co USA

The use of dynamic line rating (DLR) technologies can provide increased flow capability and reduce transmission congestion. The presentation will show how forecasting dynamic line ratings using DLR technologies can be used to alleviate wind farm curtailments. – Intermediate

Integration of Renewable Generation

Nelson Bacalao, Siemens Power Technologies International

High levels of inverter-based generation present challenges such as output variability and reduced system inertia. This presentation investigates the levels of combined cycle generation and energy storage required to maintain reliability. – Fundamental

RELAYING II – Ballroom E

Moderator: *Dave Biesel*

Co-Moderators: *Ryan Bergeron, Michael Ebert*

Do We Have to Reduce Under-Reaching Distance Reach Solely Based on System Impedance Ratio (SIR)?

Pratap Mysore, Pratap Consulting Services, LLC

Distance relay performance has been linked to system impedance ratio (SIR). The paper presents a simplified analysis of zone-1 reach setting limit based on voltage difference (voltage discrimination), which has been a focus of recent industry discussions. It shares the results of testing from various relays. – Intermediate

CCVT Failures and Their Effects on Distance Relays

Ryan McDaniel, Schweitzer Engineering Laboratories, Inc.

Distance relays rely on accurate voltage and current signals to correctly determine if a fault is within their zone of protection. In this presentation we review three separate events that show unique coupling-capacitor voltage transformer (CCVT) failures and discuss relay performance during these failures. – Intermediate

Impact of Incipient Faults on Sensitive Protection

Tom Ernst, General Electric

This topic focuses on the impact of incipient faults on the sensitive protection, including transformer restricted earth fault (REF), sensitive ground fault protection, and others. This presentation also reviews a real field application case involving a 22 kV underground cable. – Intermediate

Summary Revision of C37.119 Guide for Breaker Failure Protection of Power Circuit Breakers

Adi Mulawarman, Xcel Energy

This presentation covers principles of breaker failure protection and changes and additions that compose IEEE C37.119-2016, Guide for Breaker Failure Protection of Power Circuit Breakers. – Intermediate

METERING – Room 1

Moderator: *Tom Guttormson*

Co-Moderators: *Mike Crane, Pete Malamen*

History and Future of Electric Metering

Dan Gunderson, Minnesota Power

A look back at the last 125 years of history in electricity metering, and a look forward at the new world of Advanced Meter Infrastructure. – Intermediate

Metering Installation Errors to Avoid

Greg May, Two Sockets Two Meters

A review of things that can go wrong with both accuracy and safety in electricity metering. – Intermediate

Metrology Challenges in the Brave New World of Electronics—Laboratory Test Results

Dan Nordell, Xcel Energy

Nonsinusoidal loads resulting from power electronics can produce unique challenges to metrology. This presentation will examine some of them. – Intermediate

20 Years into Interoperable Communication Standards—Why Aren't We There Yet?

Ed Beroset, Electric Power Research Institute

The industry has been working for more than 20 years to produce interoperable standards for electricity meter communications. What is preventing us from finishing the job? – Intermediate

THURSDAY, NOVEMBER 8, 2018

TUTORIAL I – Ballroom E

Moderator: *Larry Brusseau*

Co-Moderators: *Ryan Bergeron, Neil Stiller*

Differential Relaying 101

Dave Bisel, Schweitzer Engineering Laboratories, Inc

This tutorial covers high- and low-impedance bus differential, transformer differential, and line differential relaying concepts. Transformer inrush current is discussed along with second-harmonic blocking and restraint. A transformer differential relay setting example will be done so that engineers can see how the relay settings are calculated and entered into the relay. If time permits, differential relaying events will be shown with analysis of the oscillography from those events. – Intermediate

TUTORIAL II – Room 1

Moderator: *Scott Hoberg*

Co-Moderator: *Dan Nordell*

Power Quality 101

Michael Marz, American Transmission Company

This presentation defines power quality and reviews power quality issues including sags and surges, harmonics, interharmonics, and flicker by discussing their causes, effects, measurement, limits, and mitigation. – Intermediate

TUTORIAL III – Room 4

Moderator: *Brianna Swenson*

Co-Moderators: *Bethlyn Cummings, Mike Steckelberg*

Transformers 101

Yuriy Fradkin, William Herron, SPX Waukesha

This tutorial will cover: information to include when writing specifications to build the transformer you need, transformer physical and electrical theory and design, transformer maintenance and asset management best practices, and recommendations for transformer testing and diagnostics. – Advanced

TUTORIAL IV – Ballroom A

Moderator: *Tom Guttormson*

Co-Moderators: *Denny Branca, Jesse Tomford*

Energy Storage

Jeffrey Plew, NextEra Energy; Jason Knedlhans, Mortenson

An overview of energy storage design, examples of operating assets and services. Trends in battery technology and future technology, battery applications across the Midwest and US, ISO market design, and reliability. – Intermediate

General Information

POWERPOINTS

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WI-FI INFORMATION

Saint Paul RiverCentre's public Wi-Fi network is called "RC_FreeWifi" and can be accessed in all areas of the facility. Connect to the network, then review and accept the terms.

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Participants who attend the entire conference will receive 1.5 University of Minnesota College of Continuing and Professional Studies CEUs. Participants who attend only Tuesday and Wednesday will receive 1.2 CEUs. One CEU is defined as 10 contact hours of participation in an organized continuing education experience. A CEU certificate will be sent to each participant after the conference. A permanent record of CEUs earned will be maintained by the University of Minnesota Office of Admissions and Record Transcript Unit.

PRESENTATION TECHNICAL CLASSIFICATION

Each presentation has been given a technical depth rating to allow participants to judge the appropriateness of the presentation for their needs and interests.

ADDITIONAL INFORMATION

Visit the conference website—ccaps.umn.edu/mnpowersystems—for additional information on:

- 2019 call for presentations
- Conference papers and PowerPoint presentations

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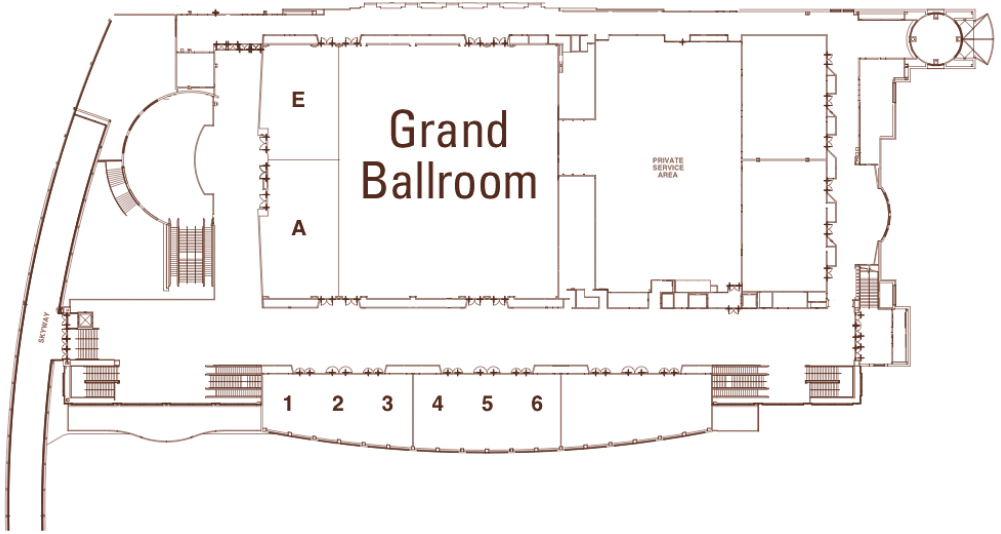
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Saint Paul RiverCentre

Main Level



Lower Level

