

# **2022 IEEE IAS Petroleum and Chemical Industry Technical Conference (PCIC 2022)**

**Denver, Colorado, USA  
26 – 29 September 2022**



**IEEE Catalog Number: CFP22PCI-POD  
ISBN: 978-1-6654-9717-6**

**Copyright © 2022 by the Institute of Electrical and Electronics Engineers, Inc.  
All Rights Reserved**

*Copyright and Reprint Permissions:* Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

***\*\*\* This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP22PCI-POD
ISBN (Print-On-Demand):	978-1-6654-9717-6
ISBN (Online):	978-1-6654-9716-9
ISSN:	0090-3507

**Additional Copies of This Publication Are Available From:**

Curran Associates, Inc  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: (845) 758-0400  
Fax: (845) 758-2633  
E-mail: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

CURRAN ASSOCIATES INC.  
**proceedings**  
.com

# TABLE OF CONTENTS

## GENERAL TECHNICAL SESSION I

Monday, September 26, 2022 – 8:00 a.m. to 11:15 a.m. Presiding Jim Bowen: PCIC Chair

PCIC-2022-01	<b>Reflections on a 50 Year Journey in Electrical Safety</b>		1
	H. Landis Floyd II	The University of Alabama at Birmingham	
PCIC-2022-02	<b>Integrating Renewable Energy Behind the Meter in Upstream Oil and Gas Operations - Part 1</b>		7
	Alonzo Álvarez Meola	Chevron Technical Center	
	Patrick Collie	Algonquin (Liberty) Power	
	Zach McKinney	Chevron Technical Center	
	Ricardo Rangel	Chevron Technical Center	
PCIC-2022-03	<b>Spacing Considerations Between Substation Buildings and Liquid Type Transformers</b>		17
	Paul “Eddie” Guidry	Fluor Enterprises, Inc.	
	Richard P. Anderson	Fluor Enterprises, Inc.	
	Jinesh Malde	M&I Materials Inc.	
	Travis J. McClung	Marathon Petroleum Co., LP	

## GENERAL TECHNICAL SESSION II

Monday, September 26, 2022 – 2:00 a.m. to 5:00 p.m. Presiding: Kevin Peterson, PCIC Vice-Chair

PCIC-2022-04	<b>Lightning Protection at Petrochemical Facilities – Part 3 Alternative Protection Systems, Facts and Myths</b>		27
	Robert A. Durham	THEWAY Labs	
	Marcus O. Durham	THEWAY Labs	
	Tommy W. Gillespie	Donato, Brown, Poole, Molemonn	
PCIC-2022-05	<b>Extending the Operating Life of Critical High Voltage Motors</b>		37
	Terry Perilloux	Marathon Petroleum	
	Keith Lyles	Marathon Petroleum	
	Tom Reid	Integrated Power Services	
	Saeed Ul Haq	GE Power Conversion	
PCIC-2022-06	<b>Keep on Running—Select Motor Relay Settings to Balance Protection and Operation</b>		49
	Krithika Bhuvaneshwaran	Schweitzer Engineering Laboratories, Inc.	
	Derrick Haas	Schweitzer Engineering Laboratories, Inc.	
	Edgardo Miguel, Jr.	Phillips 66	
	Jim Payne	Phillips 66	

## CHEMICAL TECHNICAL SESSION I

Monday, September 26, 2022 – 2:00 a.m. to 5:00 p.m. Presiding: Keith Lyles, Chair

PCIC-2022-07	<b>Solving the Synchronization Problem of Line Start Permanent Magnet Motors</b>		59
	Robert F. McElveen, Jr.	Consultant	
	Rick Budzyski	ABB, Inc.	
	Jukka Jarvinen	ABB, Inc.	
	William E. Martin	ABB, Inc.	
PCIC-2022-08	<b>DOE Motor and Drive Assessment Leads to Energy Savings for Power Drive Systems</b>		69
	John Malinowski	ABB Motors & Drives - Retired	
	Bill Finley	Siemens Industry, Inc	
	Rick Huddle	Cadeo Group LLC	
	Prakash Rao	Lawrence Berkeley National Laboratory	
PCIC-2022-09	<b>Comparing On-Line Partial Discharge Monitoring Solutions for a Critical 6.6 kV Motor</b>		77
	Marc Foxall	HVPD Ltd.	
	Malcolm Seltzer-Grant	HVPD Ltd.	
	Young Wee Lee	Air Products	
	Nico van Luijk	Air Products	

## REFINING TECHNICAL SESSION I

Monday, September 26, 2022 – 2:00 a.m. to 5:00 p.m. Presiding: Thomas Panallo, Chair

PCIC-2022-10	<b>How to Specify a Motor with the Smorgasbord of Standards</b>		85
	Donald G. Dunn	WS Nelson	
	Dennis Bogh	Consultant	
	Barry Wood	Chevron - Retired	

PCIC-2022-11	<b>Enabling Digital Substations Through Substation Standardization</b>	Shebin Jalal Angela A. Brown Kasey Herman	Schneider Electric USA Inc ExxonMobil, EMRE ExxonMobil, UIS	99
--------------	--	---	---	----

PCIC-2022-12	<b>Optimizing Transformer Specification Based on Application and Rating</b>	Shankar Nambi John K John Balakrishnan Mani	Bechtel Energy, Inc. Virginia Transformer Corp Virginia Transformer Corp	107
--------------	---	---	--	-----

**TRANSPORTATION (MIDSTREAM) TECHNICAL SESSION I**  
**Monday, September 26, 2022 – 2:00 a.m. to 5:00 p.m. Presiding: Jonathan Havey, Chair**

PCIC-2022-13	<b>Decarbonizing Turbine Powered Oil and Gas Processes with Electrical Adjustable Speed Drive Systems</b>	Jeremy Andrews Fernando Arias-Gavilano Navid Binesh Dragan Ristanovic	Siemens Bechtel ABB Bechtel	115
--------------	---	--	--------------------------------------	-----

CIC-2022-14	<b>Compressor Applications in the Decarbonization Discussion</b>	Rainer Kurz Marybeth McBain Jay Mistry Matt Lubomirsky	Solar Turbines Incorporated Kinder Morgan Incorporated Solar Turbines Incorporated Solar Turbines Incorporated	127
-------------	--	---	---	-----

PCIC-2022-15	<b>Hybrid ASD Comparison with Conventional – Significant Efficiency Improvements are Still Available</b>	Mark Chisholm Manoj Biswas Wissam Moubarak	ELIN Motors Worley J.M. Voith SE & Co.	139
--------------	--	--	--	-----

**MINING COMMITTEE SESSION I**  
**Monday, September 26, 2022 – 2:00 a.m. to 5:00 p.m. Presiding: Galina Mirzaeva, Chair**

PCIC-2022-16	<b>Advanced Electric Mining Dredge Designs</b>	Kent Zehr Eliot Castanza Damon Gonzales Ken McConachie	384310 Alberta Ltd DSC Dredge LLC DSC Dredge LLC SS Engineering Ltd.	147
--------------	--	---	---	-----

PCIC-2022-17	<b>Matrix Converters: Challenges and Solutions</b>	Galina Mirzaeva Yuan Liu	The University of Newcastle The University of Newcastle	157
--------------	--	-----------------------------	--	-----

PCIC-2022-18	<b>Model Predictive Control for Industrial Drive Applications</b>	Galina Mirzaeva Yunxan Mo	The University of Newcastle The University of Newcastle	167
--------------	---	------------------------------	--	-----

**ELECTROCHEMICAL AND EMERGING TECHNOLOGIES TECHNICAL SESSION I**  
**Tuesday, September 27, 2022 – 8:15 a.m. to 11:15 a.m. Presiding – Andrew Ackerman, Chair**

PCIC-2022-19	<b>Strategies for Increasing Energy Efficiency of Electrical Aux Loads in LNG And Petrochemical Facilities</b>	Shankar Nambi Matt Armand Jerzy Kazmierczak Robert Ramsey	Bechtel Energy, Inc. Bechtel Energy, Inc. Hitachi Energy Bechtel Energy, Inc.	177
--------------	--	--	--	-----

PCIC-2022-20	<b>The Green Hydrogen Revolution - Integrating Hydrogen into Industrial Applications</b>	Terry Tadlock Dragan Ristanovic Omar Rubio	Bechtel Energy Inc. Consultant Siemens Energy	185
--------------	--	--	---	-----

<b>PCIC-2022-21</b>	<b>Specifying Battery Storage Solutions for Industrial Facilities</b>	195
	Carson Bates Clifton Oertli Don Bushby Joe Marquardt	NEI Electric Power NEI Electric Power ExxonMobil Corporation ExxonMobil Corporation

**INTERNATIONAL TECHNICAL SESSION I**

**Tuesday, September 27, 2022 – 8:15 a.m. to 11:15 a.m. Presiding – Allen Kachurovski, Chair**

<b>PCIC-2022-22</b>	<b>Practical Applications for the Essential Generator Monitoring and Protection System</b>	203
	Youngsu Kim Kezunovic Mladen	SK energy Texas A&M University

<b>PCIC-2022-23</b>	<b>Harmonic Mitigation in Offshore Power Systems; 24 Pulse VFDs is not Necessarily the Answer</b>	213
	Rakan El-Mahayni Cory Helfrich Yasser A. Howeish	Saudi Aramco Saudi Aramco Saudi Aramco

<b>PCIC-2022-24</b>	<b>Slow Rolling of Multiple Pump Motors at a Large Petrochemical Complex</b>	223
	Etienne Tremblay Richard Paes Nicholas Stewart Bryan Tremblay	Shell Canada Energy Rockwell Automation Shell Canada Energy Cybertech Automation

**MARINE TECHNICAL SESSION I**

**Tuesday, September 27, 2022 – 8:15 a.m. to 11:15 a.m. Presiding – Chris Heron, Chair**

<b>PCIC-2022-25</b>	<b>Incorrect Transformer Differential Operation Due to System Grounding</b>	233
	JC (Jacobus) Theron Lorne Clark David Roh	GE Energy Connections University of Alberta University of Alberta

<b>PCIC-2022-26</b>	<b>Analysis of Offshore Current Transformer Failures</b>	245
	Alok Gupta Mustafa Demiroglu Nick Issacs	BP America Inc. BP America Inc. BP America Inc.

<b>PCIC-2022-27</b>	<b>Long Cable Applications with PM Motors and MV Drives</b>	253
	Mukul Rastogi Richard Broderick David Liney Richard H. Osman	Siemens Industry, Inc. Shell Shell Siemens Industry, Inc.

**PRODUCTION TECHNICAL SESSION I**

**Tuesday, September 27, 2022 – 8:15 a.m. to 11:15 a.m. Presiding – Dane Martindale, Chair**

<b>PCIC-2022-28</b>	<b>Case Studies on Ground-Fault Protection of Microgrid Power Systems with Diverse Power Sources</b>	261
	Dirk Danninger Fernando Calero Scott Manson Ceeman Vellaithurai	Schweitzer Engineering Laboratories, Inc. Schweitzer Engineering Laboratories, Inc. Schweitzer Engineering Laboratories, Inc. Schweitzer Engineering Laboratories, Inc.

<b>PCIC-2022-29</b>	<b>Comprehensive Protection of Windings and Bearings for ASD Fed Motors</b>	271
	John Houdek Randy Herche Nitin Kulkarni	Allied Industrial Marketing, Inc. Helwig Carbon Products Helwig Carbon Products

<b>PCIC-2022-30</b>	<b>IEEE 1349-2021 – Electric Machines in Hazardous Locations – Worldwide Applications</b>	283
	Lorraine K. Padden Paul S. Hamer Bill Lockley Bharat Mlstry	Padden Engineering, LLC Chevron - Retired Lockley Engineering, Lt GE - Retired

## SAFETY TECHNICAL SESSION II

Tuesday, September 27, 2022 – 8:15 a.m. to 11:15 a.m. Presiding – Thomas Papallo, Chair

PCIC-2022-31	<b>Taking Medium Voltage Motor Control Centers to New Levels of Safety</b>		293
	John A. Kay	Rockwell Automation	
	Navinchandra Bhatt	Rockwell Automation	
	Jeffery L. Fowler	Rockwell Automation	
	David C. Mazur	Rockwell Automation	
PCIC-2022-32	<b>Approved, Listed, and Field Evaluated - Requirements for Low Voltage Electrical Equipment used for Power Distribution and Motor Control</b>		303
	Todd R. Sauve	Rockwell Automation	
	Ken Sellars	e-Hazard Management, LLC	
PCIC-2022-33	<b>Taking the Heat: IEEE Standard 80 and Bimetallic Conductors</b>		311
	Robert D. Southey	SafEngServices & technologies ltd.	
	Farid P. Dawalibi	SafEngServices & technologies ltd.	
	Jeffrey T. Jordan	Copperweld Bimetallics	

## ELECTROCHEMICAL & EMERGING TECHNOLOGY TECHNICAL SESSION II

Wednesday, September 28, 2022 – 8:15 a.m. to 11:15 a.m. Presiding – Greg Clement, Vice-Chair

PCIC-2022-34	<b>Visualizing Fault Induced Traveling Waves in Medium Voltage Systems</b>		319
	Kumaraguru Prabakar	National Renewable Energy Laboratory	
	Monte Lunacek	National Renewable Energy Laboratory	
	Yaswanth Nag Velaga	National Renewable Energy Laboratory	
	Akanksha Singh	National Renewable Energy Laboratory	
PCIC-2022-35	<b>Considerations for the Protection of Adjustable Speed Drive Installations</b>		327
	Bhairavi Pandya	Schweitzer Engineering Laboratories, Inc.	
	Iulian Constantin	Tengizchevroil	
	Derrick Haas	Schweitzer Engineering Laboratories, Inc.	
	Anil Pandya	Tengizchevroil	
PCIC-2022-36	<b>Challenges in Designing a 10 kV Skin Effect Trace Heating System</b>		337
	Paul Becker	nVent Thermal Management	
	Florian Koch	Physikalisch-Technische Bundesanstalt	
	Frank Lienesch	Physikalisch-Technische Bundesanstalt	
	David Parman	nVent Thermal Management	

## INTERNATIONAL TECHNICAL SESSION II

Wednesday, September 28, 2022 – 8:15 a.m. to 11:15 a.m. Presiding – Allen Gibson, Vice-Chair

PCIC-2022-37	<b>CO2 Emission Reduction in Chemical and Petrochemical Plants by Steam and Gas Turbine Replacement with Electrical Drivers</b>		347
	Hartmut Walter	Siemens AG	
	Bart Sauer	Siemens Industry Inc.	
	Travis Tyer	Williams Pipeline	
	Jon Kitchel	Chevron	
PCIC-2022-38	<b>Risk Assessment of Electrical Defects in MV Switchgear using Partial Discharge Diagnostics</b>		357
	G. Amjad Hussain	American Uni. of Kuwait	
	Waqar Hassan	Uni. Of Engg & Tech	
	John A. Kay	Rockwell Automation - Retired	
	Farhan Mahmood	Uni. Of Engg & Tech	
PCIC-2022-39	<b>Lightning and Grounding Issues Impacting Safety and Performance of Liquefied Natural Gas Supplied Power Generation Plants</b>		365
	José M. Vallejo	Universal Star Energy Services	
	José A. Hernandez Batista	AES Panama	
	David Shipp	Capstone Power Systems Engineering	

**MARINE TECHNICAL SESSION II**

Wednesday, September 28, 2022 – 8:15 a.m. to 11:15 a.m. Presiding – Ethan Dong, Vice-Chair

PCIC-2022-40	<b>Introducing Connected Lighting into Hazardous Locations for Sustainability and Maintenance Optimization</b>	Edward Brann Ravindra Gurjar	Emerson Electric Emerson Innovation Center	373
PCIC-2022-41	<b>What are the Driving Forces in the Selection of a Hazardous Location Electric Motor - Divisions Vs. Zones?</b>	Rajendra Mistry Paul S. Hammer William G. Lawrence Bharat Mistry	Siemens Industry Inc. Chevron - Retired FM Approvals LLC GE - Retired / Consultant	377
PCIC-2022-42	<b>A Novel Method to Executing Main-Tie-Main LV Secondary Selective Systems</b>	Gautami Bhatt Matt Armand Vincent Duong	Bechtel Energy Bechtel Energy ABB	389

**PRODUCTION TECHNICAL SESSION II**

Wednesday, September 28, 2022 – 8:15 a.m. to 11:15 a.m. Presiding – Matthew Marchiano, Vice-Chair

PCIC-2022-43	<b>Extending the Life of Low Voltage Adjustable Speed Drives</b>	John A. Kay Bhanu Srilla	Grace Technologies, Inc. Grace Technologies, Inc.	397
PCIC-2022-44	<b>Transformer Sympathetic Inrush Effect on Radially Fed Off-Shore Oil Production Platform: A Case Study</b>	Omar Alarfaj Hossam Al-Dossary Hajhouj Al-Shammari Rakan El-Mahayni	Saudi Aramco Saudi Aramco Saudi Aramco Saudi Aramco	407
PCIC-2022-45	<b>Options for Converting Sound Power Levels to Sound Pressure Levels at 3 Feet</b>	Fred Reiter, Jr.	ABB, Inc.	415

**SAFETY TECHNICAL SESSION II**

Wednesday, September 28, 2022 – 8:15 a.m. to 11:15 a.m. Presiding: Tony Parsons, Vice-Chair

PCIC-2022-46	<b>Arc Flash Exposure Outside of Enclosed Equipment</b>	Clinton Carne Henry (Hank) Clark Michael McConnell	Schneider Electric Chevron Pipe Line & Power Company Schneider Electric	423
PCIC-2022-47	<b>Applying Arc Fault Standard IEC 62477-2 Annex AA to High Voltage Adjustable Speed Drives</b>	Christopher Johnson Paul Barnhart Troy Parvino Daniel Petersen	Siemens Industry Inc. UL, LLC Chevron USA Siemens Industry Inc.	431
PCIC-2022-48	<b>Practical use of Protective Relays to Enhance Personnel Safety in Process Industries</b>	Michael Pilon Brian Morgan Palak Parikh Thomas Welmore	GE Grid Solutions Irving Paper GE Grid Solutions Irving Paper	439

**CHEMICAL TECHNICAL SESSION II**

Wednesday, September 28, 2022 – 2:00 a.m. to 5:00 p.m. Presiding: Jason Obermeyer, Vice-Chair

PCIC-2022-49	<b>Ensuring Accuracy and Quality when Performing Arc Flash Studies on Low-Voltage Power Distribution Equipment</b>	Ryan Downey Cecil Gordon James Niethammer Nicholas Weber	CBS Field Services Enbridge Enbridge Enbridge	447
PCIC-2022-50	<b>How to Safely Island a Chemical Facility</b>	Assad Mohammad Aaron Fontenot Nigel Jordan Hariharan Subramanian	Schweitzer Engineering Laboratories, Inc. The Dow Chemical Company The Dow Chemical Company Schweitzer Engineering Laboratories, Inc.	457

PCIC-2022-51	<b>Expanding Availability Horizons: New Battery Technologies in Industrial UPS Systems</b>	465
	Joe Marquardt Elena Chernetsova Emiliano Paolin Pierre Queyroi	ExxonMobil UIS CHLORIDE Industrial FZSONICK SA CHLORIDE Industrial

#### REFINING TECHNICAL SESSION II

Wednesday, September 28, 2022 – 2:00 a.m. to 5:00 p.m. Presiding: Thomas Papallo, Vice-Chair

PCIC-2022-52	<b>Active Detection and Identification of Incipient Faults in Liquid Filled Transformers</b>	475
	Emilio Morales Cruz Radu Udrescu	Qualitrol Iris Power LP a Qualitrol Company
PCIC-2022-53	<b>Operating in the 'Danger Zone': Contactor Dropout vs. Fuse Clearing Time</b>	483
	John C. Webb Andrea Delpozso Ilaria Dognini Christian Reuber	ABB Inc. ABB S.p.A. ABB S.p.A. ABB AG
PCIC-2022-54	<b>Electric Motors for use in Hazardous/Explosive Atmosphere need to Meet the Relevant Safety Requirements for Industrial Equipment or Safe Locations</b>	493
	Bharat Mistry William G. Lawrence Paul A. Anderson Jacqueline B. Morris	Independent Consultant- GE Retired F.M. Approvals LLC Toshiba International Corporation

#### TRANSPORTATION (MIDSTREAM) TECHNICAL SESSION II

Wednesday, September 28, 2022 – 2:00 a.m. to 5:00 p.m. Presiding: Manish Verma, Vice-Chair

PCIC-2022-55	<b>Optimization of AC Substation Ground Grid Design and Calculations</b>	503
	Amnit Dhindsa	Enbridge Pipelines Inc.
PCIC-2022-56	<b>A Case Study on Lifetime Assessment of Stator Windings in Large Machines can be a Critical and Effective Tool in a Predictive Maintenance Plan</b>	513
	Cajetan T. Pinto Vijay Anand Robert N. Strickler	ABB S.A. ABB Inc. Chevron Products Company
PCIC-2022-57	<b>High Torque Low Inrush Current Motor Design or Voltage Recovery Dependence for Loaded Start Conditions</b>	521
	Fredemar Runcos Michael Bachmeyer Miguel Sarris Adrain Stafford	WEG WEG Doris Inc. Modec

#### MINING COMMITTEE SESSION II

Wednesday, September 28, 2022 – 2:00 a.m. to 5:00 p.m. Presiding: Hélder de Paula, Vice-Chair

PCIC-2022-58	<b>DC and AC Microgrids for Mining Applications</b>	533
	Galina Mirzaeva Dmitry Miller	The University of Newcastle Amppcontrol CSM
PCIC-2022-59	<b>Electrostatic Shield to Mitigate the High Frequency Circulating Bearing Current – A Study for Design Guidelines</b>	543
	Marco T. A. Êvo Hélder de Paula Caio Eduardo Silva Isabela O. Zapparoli	Federal University of São João Del Rei Federal University of Uberlândia Federal University of Uberlândia Federal University of Uberlândia
PCIC-2022-60	<b>Electrostatic Shielding for Bearing Current Mitigation - An Analysis of its Thermal Impact on the Motor</b>	553
	Marco T. A. Êvo Arismar M. G. Júnior Hélder de Paula Caio Eduardo Silva	Federal University of São João Del Rei Federal University of Uberlândia Federal University of Uberlândia Federal University of Uberlândia