



GUIDEBOOK TO THE CONFERENCE

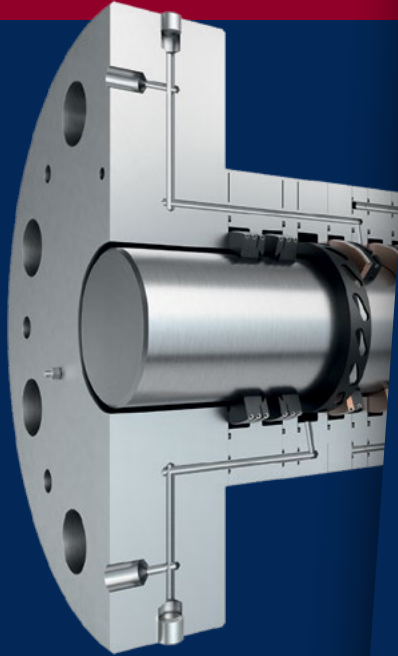


OCTOBER 6-9
TAMPA, FL

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GAS MACHINERY CONFERENCE FUTURE SITES

2025 Louisville, Kentucky



NOT JUST ANOTHER WORKSHOP

Our premier workshops and training events offer professionals of all levels the unique opportunity to learn from some of the industry's leading experts and network with other professionals in their field.

Benefits of attending one of our events:

- Be the first to hear about the latest technological advances in the industry.
- Learn directly from the industry's best and brightest.
- Gain necessary skills to increase productivity in the workplace.
- Receive and share valuable insight with fellow professionals in the field.

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IMPORTANT INFO

For inquiries at the conference, please visit the GMC Registration/Help Desk Sunday – Wednesday or contact:

Cindy Anderson

VP of Operations, SGA

cindy.anderson@southernngas.org

(512) 887-0188

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WIFI at the Tampa Convention Center
Network: **IDC Engineering**
Password: **IDCGMC2024**

WELCOME TO **SUNNY TAMPA** & THE 2024 GMC!



GMC 2024 President's Letter

Dear Colleagues,

It is with great enthusiasm that I welcome you to the Gas Machinery Conference, an event with a long-standing tradition of delivering cutting-edge research and insights that drive innovation and operational efficiency in our industry. For decades, the Gas Machinery Research Council (GMRC) has been at the forefront of these advancements, and this year's conference promises to continue that legacy.

Over the next few days, I'd like to give you a glimpse of what you can expect as we come together to explore, learn, and grow:

Short Courses and Technical Papers: Gain practical knowledge and insights that can directly impact the performance of your systems. Our diverse sessions are designed to enhance your technical expertise and provide you with the tools you need to improve operational efficiency.

Content on ESG and Alternate Fuels: As an industry, we are at the collision of reliability and low methane emissions in pipeline operations. The impact of new methane rules on emissions and compressor stations will be a learning curve for all. Look for sessions that will help operators strategize on equipment/emissions.

As the industry continues to focus on environmental, social and governance (ESG) principles and the growing

interest in alternative fuels, we will explore how natural gas plays a pivotal role in achieving net-zero goals. Expect discussions that challenge the status quo and offer innovative approaches to these critical topics.

Exhibit Hall: Visit our Exhibit Hall to engage with vendor partners showcasing the latest technology and solutions.

Networking Events: We understand the importance of building strong professional networks, and our scheduled events provide the perfect opportunity to meet peers, exchange ideas, and grow your connections within the industry.

I encourage you to make the most of your time here—whether diving into a technical session, learning about emerging ESG trends, or forming new professional relationships. Together, we can continue to drive the gas machinery industry forward, embracing both innovation and operational excellence.

Thank you for joining us, and I look forward to an engaging and insightful conference.

Warm regards,

SUZANNE OGLE
GMRC President



GMC 2024 PLANNING COMMITTEE CHAIRMAN'S MESSAGE

Dear Esteemed Attendees,

On behalf of the GMC Planning Committee, it is my distinct pleasure to extend a warm welcome to you for the 2024 Gas Machinery Conference (GMC) here in vibrant Tampa, Florida!

We are thrilled to have you join us for what promises to be an inspiring and impactful event. This year's conference is set to be exceptional, thanks to the incredible research and innovative contributions from our esteemed presenters. The papers and courses curated for this year's program are of the highest caliber, reflecting the very best in our field and offering valuable insights into the latest advancements and trends.

Tampa, with its welcoming spirit and dynamic energy, provides the perfect backdrop for our gathering. Known for its rich cultural heritage and flourishing energy sector, the city stands as a testament to progress and opportunity. We believe that the location itself will enhance your experience, offering both a stimulating environment for our discussions and a chance to enjoy the local attractions.

The energy industry continues to thrive, and it is with great excitement that we highlight the role of natural gas as a clean and renewable energy source. Our collective efforts are steering us toward a more sustainable future, and the contributions from this conference will undoubtedly propel us forward in this endeavor.

We look forward to engaging with you, sharing knowledge, and fostering connections that will drive our industry forward. Thank you for being part of this significant event. Your participation is integral to our success, and we are eager to embark on this journey of discovery and collaboration with you.

Welcome to Tampa, and welcome to the 2024 GMC!

Warmest regards,



WALLY BRATEK
Chair, GMC Planning Committee



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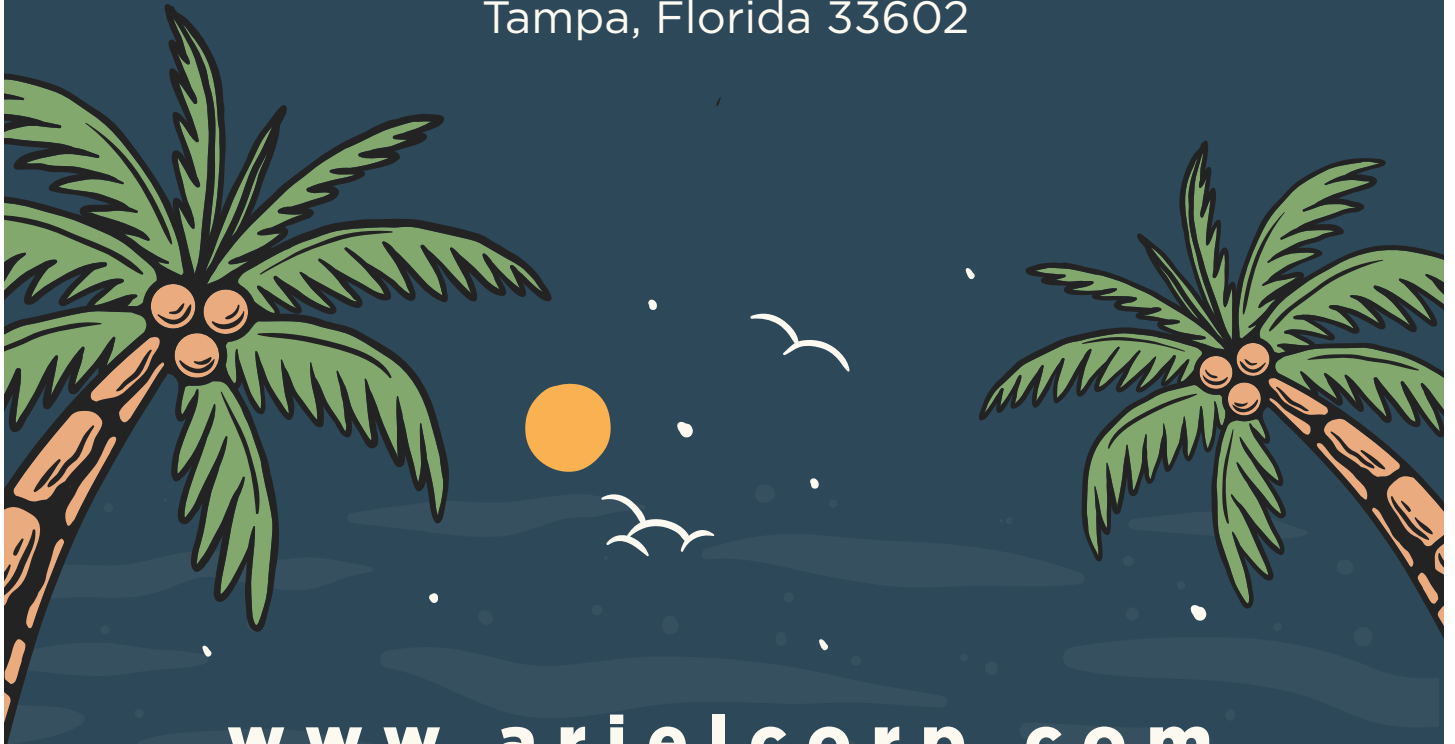
MONDAY NIGHT RECEPTION

G M C 2 0 2 4

Please Join Ariel for Food and Drinks at the
the Ariel Monday Night Reception.

MONDAY, OCTOBER 7TH 5:30 PM - 7:30 PM

The Florida Aquarium. 701 Channelside Drive
Tampa, Florida 33602



www.arielcorp.com

GMRC 2024 BOARD OF DIRECTORS CHAIRMAN'S MESSAGE

Welcome to the 2024 Gas Machinery Conference (GMC) in Tampa, Florida!

The GMC has the well-deserved reputation of being the premier conference for Gas Machinery and the associated operational and engineering challenges. Here at the GMC, you can network with expert-level operators and the top service and equipment providers under one roof. You can learn at multiple levels with a wide array of courses that will challenge the newer engineer/technician, and others geared to more experienced operators. Whether you have come to strengthen your network, earn your Professional Development Hours, or learn about the latest technology advancements, we encourage you to engage fully while you are here and to share your experience within your company and with your industry peers when you return home.

This conference is only possible through the hard work of the SGA/GMRC support staff as well as many dozens of volunteers who serve on the committees and the GMRC board. I can confidently say that most of the hours needed to develop this conference are volunteered from industry representatives. Thanks to all of the volunteers and to their companies that support them!

The importance of reliable, efficient gas compression has never been higher. We are expected to build and operate compressors that get the job done with reduced environmental impact, manageable costs, and sustainability into the future. The papers, courses, and presentations of this conference and the GMRC research program address these unique issues. The projected

energy needs of the world require ALL energy sources to be supported and expanded. Natural Gas is at the heart of it all, as the plentiful North American supply is transported to the coast for LNG export, much of which is consumed by economies that are transitioning to a safer, cleaner, more reliable fuel. Gas compression, whether for methane, carbon dioxide or hydrogen, is an essential part of the industry's growth and development, underscoring the need for this conference and organization.

We are glad you are here! I suggest you challenge yourself to learn something new and identify some key takeaways from your time here that you can reference later. Take advantage of this special opportunity to expand your network.

Enjoy your time in Tampa and at this conference!

Sincerely,



TOM BURGETT, P.E.
Chair, GMRC Board of Directors

MEET THE KEYNOTE SPEAKER **ADAM MARKEL**



Adam Markel, bestselling author, keynote speaker and resilience researcher, guides individuals and organizations to tap the power of resilience to master the challenges of constant change.

With 18 years as a trial attorney building a multi-million dollar enterprise and 10 years as the CEO of a leading personal development and business training company, Adam has much to share about resilience, culture and change. Yet, some of his most enduring lessons came from his years as an ocean first responder — a life and death environment where Adam learned the importance of cultivating high performance capacity and impeccable teamwork.

In his latest bestselling book, *Change Proof*, Adam shows how those principles of resilience are equally relevant today for any business that wants to move beyond managing change to actively embracing it and using times of uncertainty, crisis, and chaos to create opportunities.

As one of Huffington Post's top speakers to see and the #1 Wall Street Journal bestselling author of *Pivot*, Adam's messages have inspired tens of thousands worldwide. His keynotes, corporate workshops, and business mentoring integrate practical business strategies, personal development insights and a unique delivery style to create a high-energy and impactful learning environment.

Adam is currently the Co-Founder and CEO of WorkWell Labs, a TEDx speaker and influencer, and host of The Change Proof Podcast, facilitating insightful discussions with business leaders and social innovators and sharing strategies to fully embrace an uncertain world and build Change Proof organizations.

Adam is continuously inspired by his wife of more than 30 years and their 4 amazing children.

Adam Markel, a respected and revered culture catalyst resilience

speaker, digs deep and shares the highly personal challenges he has bounced forward through in his life to connect with, and inspire, his audiences.

A leading voice on the topic of resilience for leaders, Adam utilizes his own research with more than 5000 business leaders worldwide to demonstrate how being resilient allows leaders to effectively manage change, create solutions, optimize energy and take charge of how situations in your life unfold.

Whether your organization faces massive change or you simply want your employees to be proactive in their response to change, Adam holds the key to unlocking success.



ADAM MARKEL
Wall Street Journal #1 Bestselling Author

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SCHEDULE AT-A-GLANCE

SUNDAY, OCTOBER 6

2:00 pm – 6:00 pm | Registration Open
5:00 pm – 7:00 pm | Welcome Reception

MONDAY, OCTOBER 7

7:00 am – 5:00 pm | Registration
7:00 am – 8:00 am | Breakfast
8:00 am – 11:00 am | Short Courses & Mini Short Courses
11:00 am – 1:00 pm | Lunch & Keynote, Adam Markel

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Sloan Lubrication Systems

1:15 pm – 2:15 pm | Technical Papers
2:15 pm – 2:30 pm | Networking Break
2:30 pm – 3:30 pm | Technical Papers
3:30 pm – 3:45 pm | Refreshment Break
3:45 pm – 4:45 pm | Technical Papers
5:30 pm – 7:30 pm | Reception

SPONSORED BY **Ariel**

TUESDAY, OCTOBER 8

6:30 am – 8:00 am | Breakfast
7:00 am – 5:00 pm | SPONSORED BY **Hoerbiger**
Registration
8:00 am – 11:00 am | Short Courses & Mini Short Courses
11:00 am | Exhibit Hall Opening
11:00 am – 12:30 pm | Lunch with Exhibitors

SPONSORED BY
Compressor Engineering Corp.

1:00 pm – 2:30 pm | Tech Updates
SPONSORED BY **Burckhardt Compression**

2:15 pm – 2:30 pm | Refreshment Break
SPONSORED BY **ACI Services Inc.**

2:30 pm – 3:30 pm | Technical Papers
3:30 pm – 3:45 pm | Refreshment Break
3:45 pm – 4:45 pm | Technical Papers
4:45 pm – 6:00 pm | Industry Ignition Reception with Exhibitors

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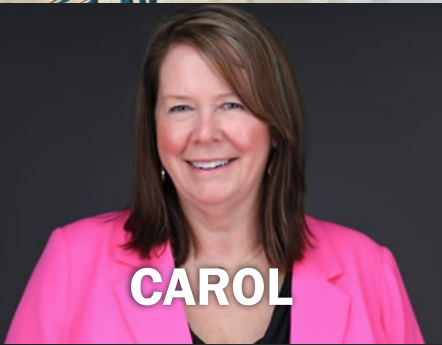
WEDNESDAY, OCTOBER 9

6:30 am – 8:00 am | Breakfast with Exhibitors
8:00 am – 10:15 am | Technical Papers
10:15 am – 10:30 am | Refreshment Break
SPONSORED BY **ACI Services Inc.**
10:30 am – 12:00 pm | Tech Updates
SPONSORED BY **Burckhardt Compression**

12:00 pm – 1:00 pm | Lunch with Exhibitors
1:15 pm – 4:15 pm | Short Courses
4:15 pm – 5:00 pm | GMRC Annual Membership Meeting
5:00 pm – 6:30 pm | Closing Reception

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- Browse abstracts and papers for each session
- Obtain the conference center WiFi password

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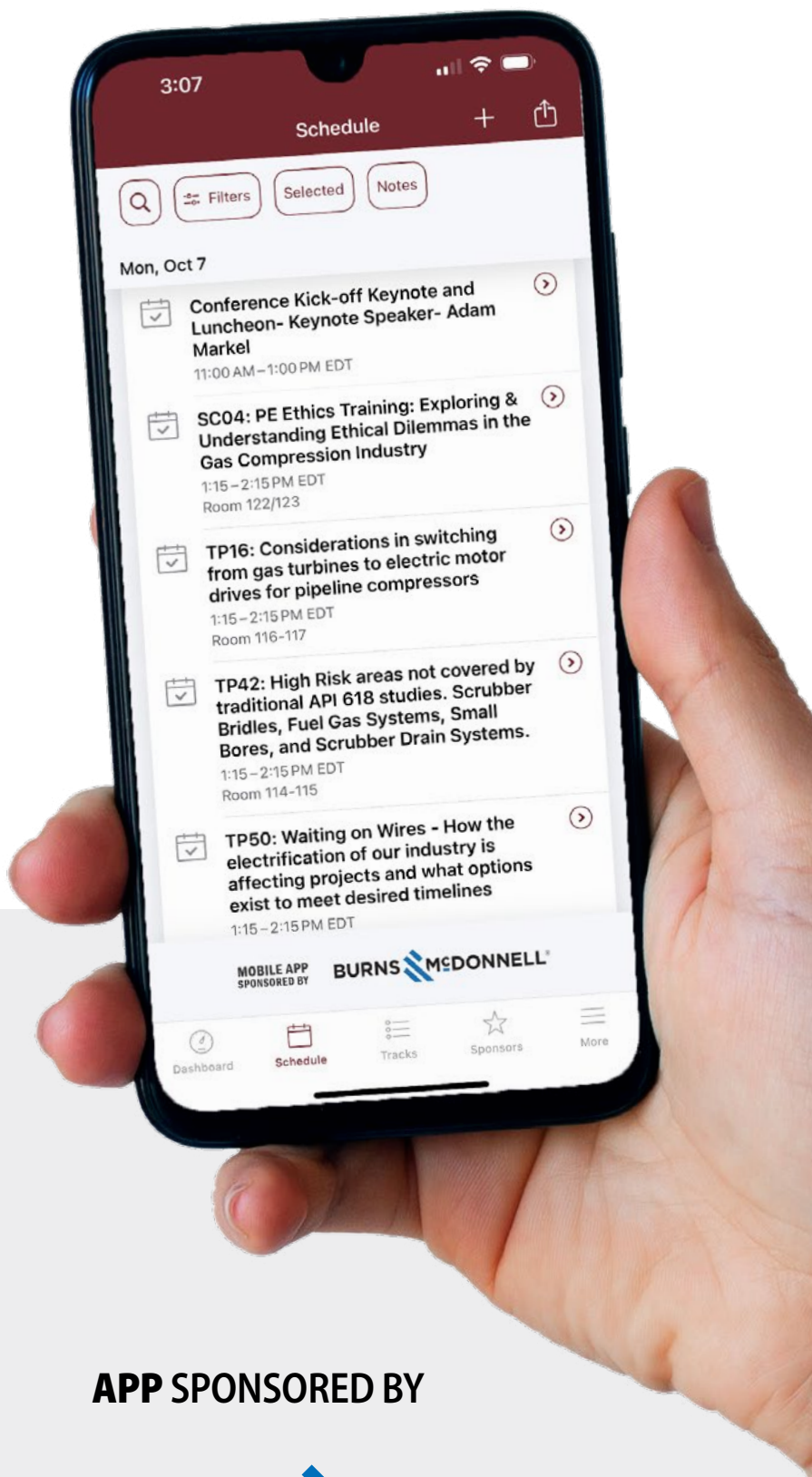


Google Play

Looking for a one-stop shop to access all 2024 GMC conference papers presented?

Visit **GMRC.org** to download papers from the conference.

After one month, papers will only be accessible in the GMRC Resource Library.



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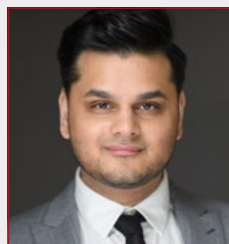
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WHO WE ARE

The **Gas Machinery Research Council (GMRC)** is a community of proactive natural gas companies dedicated to investigating technical issues within the rapidly evolving gas machinery industry and uncovering innovative solutions that improve reliability, efficiency and cost-effectiveness of mechanical and fluid systems.

GMRC leads the industry in advanced research and education opportunities. Our extensive resource library contains a wealth of technical knowledge and our annual Gas Machinery Conference is one of the industry's premier events.

Established in 1952, the Gas Machinery Research Council is a subsidiary of the Southern Gas Association.

Learn more at www.gmrc.org

Since 1908, **Southern Gas Association (SGA)** has been investing in the people who make up the natural gas industry by providing learning opportunities for personal and professional growth. Specializing in facilitating peer-to-peer collaboration, educating on industry and leadership topics, and developing and managing joint industry projects, SGA supports member company volunteers and industry leaders, who work to actively engage the industry for a sustainable tomorrow.

Learn more at www.southerngas.org

TAMPA CONVENTION CENTER EXHIBIT HALL



GMC 2024 EXHIBITORS

EXHIBITOR	BOOTH
A&M Equipment, LLC	728
ACI Services, Inc.	420
Accelleron	1016
Advanced Gas Engine Solutions Inc.	801
AeriNOx Inc.	326
Aletek, LLC	632
Altronic, LLC	607
American VULKAN Corporation	309
Amerson Engineering and Controls	914
Ariel Corporation	601
Atlas Copco	907
Baker Hughes	840
Basic Systems, Inc.	322
Bendix	408
Burns & McDonnell Engineering Co, Inc.	820
C&C PetroGas Engineering	805
Cambustion	529
Camfil Farr Power Systems AB	836
Catalytic Combustion Corporation	324
Caterpillar Inc.	809
Compression Dynamics Consulting, LLC	509
Compressor Engineering Corp.	421
Compressortech2	741
Continental Controls Corp.	1025
Cook Compression	721
Cooper Machinery Services	614
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Cypress Engine Accessories LLC	328
DCL America Inc.	931
Dynaflow Research Group, Inc.	630
ECOM America, LTD.	333
EMIT Technologies, Inc.	626
ENTRUST Solutions Group	915
Ellwood Crankshaft Group	313
Emerson Automation Solutions	1027
Engineering Dynamics, Inc.	1005

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Exline, Inc.	412
ExxonMobil Product Solutions Company	527
FW Murphy Production Controls	621
Fluitec International	928
Gas Compression Magazine	327
Geislinger Corporation	827
Global Compression Services	409
HEICO Fastening Systems	739
HOERBIGER Compression Technology	501
Hotstart	726
IDC Engineering	815
IMES USA	926
INNIO Waukesha Gas Engines Inc.	413
Idemitsu Lubricants America Corp.	321
John Crane	1014
John Hopkins Unlimited, Inc.	904
KATS Solutions, LLC	629
KB Delta, Inc.	520
Kaeser Compressors	922
Kams, Inc.	315
Kiene Diesel Accessories	304
Kistler Instrument Corp.	829
LO-REZ Vibration Control Ltd.	302
M&J Valve Services, Inc.	900
MAN Energy Solutions USA Inc.	331
MIBA Bearings US, LLC	838
MIRATECH Corporation	428
MRU Instruments, Inc.	330
MVF Process Controls	908
Machinery Monitoring Systems, LLC	410
Millennium Torque & Tensioning/Industrial Services	912
Monico, Inc.	422
Mueller Environmental Designs	711
Neuman & Esser USA, Inc.	513
Niterra North America	932
PSC Couplings	920

EXHIBITOR	BOOTH
Parker Hannifin (PECO)	633
Patton Lubricator Products	902
Petro-Canada Lubricants	521
Power Parts Supply	311
Process Innovations	303
Reich USA Corporation	320
Resonance Systems Inc	737
Reynolds-French & Co.	323
Riverhawk Co.	533
Rotating Machinery Services, Inc.	910
SAMCO ENTERPRISES, INC.	1006
SIEMENS Energy, Inc.	1021
Safety Seal Piston Ring/Wesco Valve & Mfg.	426
Sapphire Gas Solutions	745
Shell Lubricants	901
Sloan Lubrication Systems	1001
Solar Turbines Incorporated	613
Solberg Manufacturing, Inc.	1007
Southwest Research Institute	821
Spartan Controls	730
Sulzer Turbo Services New Orleans Inc.	933
Summit Lubrication	627
TF Hudgins – Allied Reliability	531
TTS Midstream	307
Testo, Inc.	833
U.P.S. Midstream Services, Inc. [Universal Plant Services]	717
Ultimate Chemicals	818
Vibratech TVD	631
Voith US Inc. (VTI)	913
WEG	628
Windrock, Inc.	430
Wolong Electric America	930
Wood	406
ZEVAC	831

GMC Sponsor

EXHIBIT HALL EVENTS

The exhibit hall stays **open all day**. Make sure to visit the space for some special events during those times:

OCT 8 TUESDAY

11:00 am – 2:15 pm

4:45 pm – 6:00 pm

OCT 9 WEDNESDAY

6:30 am – 8:00 am

10:30 am – 1:00 pm

EXHIBIT HALL FLOOR PLAN



GMC 2024

Heading to the sunshine state

Thank you, on behalf of the GMRC Association, to all of the exhibitors with us this year. GMC 2024 is poised to be a great event. **We could not do this without them!** From human capital to financial spend, we understand the investment it takes to be here. Please take a moment to visit their booths.

GMC 2025 will take place in Louisville, Kentucky. To pre-book your booth and be included in all exhibitor communications, please see our tradeshow manager, Tina Hamlin, for more information.

Tina.Hamlin@southerngas.org

We hope you have a successful conference!

GMC 2024

SCHEDULE

SUNDAY: OCT 6

5:30 PM – 7:30 PM

OPENING RECEPTION

Marriott Hotel

MONDAY: OCT 7

8:00 AM – 11:00 AM

SHORT COURSES

SC13: DRY GAS SEALS (DGS), SUPPORT SYSTEMS, AND GMRC DGS RELIABILITY TESTING

Author: Mr. Mark Anguiano & Mr. Aaron Rimpel – SwRI, Mr. Mark Slotnick – John Crane, & Dr. Rainer Kurz – Solar Turbines

Room: 111-113

Track: Centrifugal Compressors

Level: Beginner

Dry gas seals (DGS) are the state-of-the-art in shaft end seals for centrifugal turbines and compressors. DGSs operate with a small clearance between their rotating and stationary rings, resulting in a low-leakage rate which provides significant benefits over traditional mechanical seals. This tutorial discusses the basic principles of DGS operation, terminology, applications, API Standard 692 design requirements for DGS systems, and causes of DGS failures and practices to prevent them. This tutorial also discusses the test data from a continuation of GMRC research to enhance DGS reliability.

SC06: INTRODUCTION TO PULSATION & VIBRATION IN RECIPROCATING COMPRESSORS

Authors: Mr. Alasdair Robinson & Mr. Nick Cullingham – Wood – Vibration, Dynamics & Noise

Room: 114-115

Track: Reciprocating Compressors

Level: Beginner

This introductory short course is geared to entry and intermediate level engineers, technicians and other staff involved in the field operations, maintenance, and design of compressor systems. Attendees will learn about: Common sources of vibration problems on piping, foundation, skids, vessels, crankshaft and small-bore attachments, Pulsations and their impact on piping vibration, Techniques to avoid mechanical resonance, Design requirements for new and retrofit installations, Vibration guidelines, Best practices for design of reciprocating compressors, Basic commissioning and troubleshooting recommendations. We will discuss several real-life case studies and use video clips to illustrate and reinforce the concepts. The authors have significant vibration design and field experience from a wide range of applications, including pipelines, gas storage, offshore facilities and upstream compressors.

SC14: WINTERIZATION: OPERATOR PANEL SESSION

Authors: Mr. Marcos Sandoval – Occidental, Mr. Jeff Morris – National Fuel Gas, Mr. Kenneth L'Anglois – Phillips 66, Mr. Obi Oradiwe – Enbridge, Mr. Kyle Butler – Energy Transfer, & Mr. Hemanth Satish – TC Energy

Moderated by: Ms. Sarah Simons – SwRI

Room: 116-117

Track: Other

Level: Intermediate

This panel will consist of pipeline operators from various parts of the country discussing topics associated with winterization: common areas of compressor stations or pipelines that are subject to failures in cold weather events, solutions found to mitigate failures, inspection frequency and timing, and best maintenance practices.

There will be an open Q&A session at the end and audience participation is encouraged.

SC05: BASIC THERMODYNAMICS OF RECIPROCATING COMPRESSION

Authors: Mr. Patrick D. Campbell – Ariel Corporation

Room: 118-119

Track: Reciprocating Compressors

Level: Beginner

This course is for those who are looking to understand what is happening inside their reciprocating compressor cylinders and frames. We will examine the thermodynamic cycle using the Pressure-Volume (PV) diagram. We will also discuss how capacity control devices affect this PV diagram. Finally, this course will cover how compressor performance and safety criteria are calculated and how they are used to protect the compressor. By the end of this course, attendees will be able to identify the four events represented by the PV diagram and how changes in operating conditions will affect the compressor.



8:00 AM – 9:30 AM

MINI SHORT COURSE

MC15: AN INTRODUCTION TO TORSIONAL ROTORDYNAMICS

Author: Mr. Justin R. Hollingsworth & Mr. Chris D. Kulhanek – SwRI

Room: 120-121

Track: Other

Level: Beginner

This course will cover key concepts associated with torsional rotordynamics, and will be focused on methods for effectively reviewing a typical analysis. The following topics will be covered:

- » Key Elements of an Effective Torsional Mass Elastic Model
- » Interference (Campbell) Diagrams as a Screening Tool
- » Interpretation of Steady State Critical Speeds and Mode Shapes
- » Practical Use of a Forced Response Stress Analysis
- » Common Methods of Shifting Torsional Critical Speeds
- » Transient Analysis Considerations (Motor Startup and Short Circuit Effects)
- » Cumulative Fatigue Concepts
- » Special Considerations (Reciprocating Machinery, Coupling Types, Electric Motor Webs, etc.)
- » Instrumentation and Methods of Torsional Field Testing
- » Representative Case Studies

9:30 AM – 11:00 AM

MINI SHORT COURSE

MC03: FORCE FEED COMPRESSOR LUBRICATION, OPERATION, MAINTENANCE, TROUBLESHOOTING AND OPTIMIZATION

Author: Mr. Matt McCarthy – Sloan Lubrication Systems

Room: 122-123

Track: Auxiliary Systems

Level: Beginner

This mini short course will cover force-feed lubrication systems including design, operation, maintenance, and troubleshooting, focusing on power cylinder lubrication for legacy integral engines and compressor cylinder lubrication on both integral and separable compressors.

Key Topics Covered include, system design, required yearly preventative maintenance, troubleshooting, varying lubrication rates to match changing operational conditions, and problems caused by over-lubrication with strategies for oil reduction

11:00 AM – 1:00 PM

CONFERENCE KICK-OFF LUNCHEON

KEYNOTE ADDRESS FROM ADAM MARKEL

SPONSORED BY SLOAN LUBRICATION SYSTEMS

Ballroom A-D

1:15 PM – 2:15 PM

TECHNICAL PAPERS

TP51: INTRODUCTION TO TIME WAVEFORM AND SPECTRUM ANALYSIS: HOW THIS TOOL CAN BE INCORPORATED INTO AN EXISTING RECIPROCATING MONITORING PROGRAM TO PROVIDE ADDITIONAL INSIGHT

Authors: Ms. Mary Chapman & Ms. Ashley Byers – ChampionX & Windrock

Room: 111-113

Track: Data Analytics

Level: Beginner

This presentation is to help analysts further their reciprocating machinery monitoring program by introducing frequency-based vibration monitoring at a very basic level and give examples of faults that can be found. Time waveforms are collected and converted to frequency through FFT (Fast Fourier Transform). Analysts can analyze spectrum data and determine mechanical issues with their reciprocating machinery,

turbos, pumps, and fans. Topics covered will be time waveform, spectrum plots and their key components, data collection points, and some common faults identified using this tool. Understanding these topics will give analysts another tool to expand what they are presently doing.

TP42: HIGH-RISK AREAS NOT COVERED BY TRADITIONAL API 618 STUDIES. SCRUBBER BRIDLES, FUEL GAS SYSTEMS, SMALL BORES, AND SCRUBBER DRAIN SYSTEMS

Authors: Mr. Garth Sanders & Mr. David Lavoie – Wood

Room: 114-115

Track: Reciprocating Compressors

Level: Intermediate

This paper addresses a critical gap in current industry practices related to reciprocating compressors as it relates to non-API 618 auxiliary piping systems and components. While existing analyses predominantly concentrate on main process piping, our experience shows the necessity of incorporating auxiliary systems into the pulsation and mechanical designs. Examples of often-overlooked components include fuel gas piping (inclusive of pressure safety valves and scrubbers), scrubber drains, small bore systems, and level gauges on scrubbers. The paper outlines the advantages of broadening the design study to include mechanical review through to formal analysis on non-API 618 piping, and demonstrates potential risks associated with vibration fatigue.

TP16: CONSIDERATIONS IN SWITCHING FROM GAS TURBINES TO ELECTRIC MOTOR DRIVES FOR PIPELINE COMPRESSORS

Author: Mrs. Marybeth G Mcbain, Mr. Kalyan Malnedi & Mr. Shane Harvey – Elliott Group

Room: 116-117

Track: Centrifugal Compressors

Level: Intermediate

For pipeline operators, due to a motivation to decarbonize by reducing emissions, as well as the need to replace aging equipment, electric motors are being considered as replacements for gas turbine drives on pipeline compressors. We will

GMC 2024

SCHEDULE

MONDAY: OCT 7 *continued*

explore the considerations in switching from a gas turbine drive to an electric motor for a pipeline compressor station. This assessment involves 1) Torsional assessments; 2) Electric motor start-up and shutdown; 3) Possible gearbox addition; 4) Decoupling the various GT compressor subsystems and 5) Possible compressor modifications – shaft diameter review, dry gas seals and efficiency improvements.

TP55: A VIBRATION CASE STUDY ON A 1950'S COMPRESSOR FOUNDATION

Authors: Mr. Francisco Fierro, Mr. Benjamin White & Mr. Dylan Kraus – SwRI

Room: 118-119

Track: Vibration/Pulsation

Level: Beginner

Old compressor installations are more and more often being required to increase throughput to meet increased operating demands, and may be supplemented or replaced with newer units. For over 70 years a compressor station only operated half of the units at a time but would be transitioning to operating all units simultaneously. With all compressors sharing a common mat foundation, there were concerns about possible high vibration issues. This paper follows the gathering of vibration data on the existing foundation, a finite element analysis with proposed foundation modifications, and the post-modification vibration and pulsation data with the reinforced foundation.

TP50: WAITING ON WIRES - HOW THE ELECTRIFICATION OF OUR INDUSTRY IS AFFECTING PROJECTS AND WHAT OPTIONS EXIST TO MEET DESIRED TIMELINES

Author: Mr. Ryan Rudnitzki & Mr. Tony Mente – RPower

Room: 120-121

Track: Emissions

Level: Intermediate

With the intensifying focus on reducing emissions, the natural gas industry is increasingly looking to electrify their

operations. One major challenge to that trend is that the electrical grid is struggling to keep up; previous timelines for power to arrive onsite have pushed out significantly, negatively impacting projects with serious delays.

In these situations, there are a few options: use gas driven assets to reduce or eliminate electrical needs; use rental generators until line power arrives; or build a microgrid to provide bridge power and then leave the equipment on site to provide backup power. This presentation compares these options, as different situations have different optimal solutions, depending on duration of need, emissions landscape, etc.

1:15 PM – 4:15 PM

SHORT COURSE

SC04: PE ETHICS TRAINING: EXPLORING & UNDERSTANDING ETHICAL DILEMMAS IN THE GAS COMPRESSION INDUSTRY

Authors: Mr. Greg Lortie & Mr. William 'Bill' Couch – Ariel Corporation

Room: 122-123

Track: Career Enhancement

Level: Beginner

This short course provides the required annual or semi-annual PDH credits for Professional Engineers. Presented by experienced industry business leaders, the course pulls cases from several state boards and the National Society of Professional Engineers to generate participation and discussion around various ethical dilemmas and failures. A review of the NSPE Code of Ethics for Engineers is reinforced by discussion of numerous case studies and real experiences. During the Ethical Dilemma section, the attendees will participate in an anonymous ethical dilemma quiz, where the attendees' quiz responses will be discussed and reviewed in detail, including audience participation.

NETWORKING BREAK 2:15 PM – 2:30 PM

2:30 PM – 3:30 PM

TECHNICAL PAPERS

TP48: CHALLENGES ASSOCIATED WITH TRIBOLOGICAL TESTING OF POLYMERS AT HIGH TEMPERATURES, HIGH SPEEDS, AND HYDROGEN ENVIRONMENT

Authors: Dr. Jonathan Penaranda – Dover Precision Components

Room: 111-113

Track: Reciprocating Compressors

Level: Intermediate

While there is some data in the literature related to the effects of the gas environment on the wear and friction behavior of high-performance thermoplastics, like PI and PEEK, there is also a lack of knowledge on the combined effects of high-speed reciprocating motion at high temperatures in a hydrogen environment. This information is exceptionally critical for selecting the right materials to be used in dynamic sealing in reciprocating compressors towards the needs of the emerging hydrogen market, with applications in production, transportation, storage, injection, and refueling. The combination of high pressures and high speeds found in non-lube hydrogen compression presents an uncharted territory and a significant challenge for polymeric sealing solutions.

TP41: GMRC PROJECT: ELEMENTAL SULFUR MANAGEMENT GUIDANCE FOR NATURAL GAS SYSTEMS

Authors: Mr. Brandon Lee Ridens – SwRI

Room: 114-115

Track: Other

Level: Beginner

Elemental sulfur deposition has been a prevalent issue in natural gas transmission systems, impacting compressor stations, metering stations, pipelines, and processing stations. Elemental sulfur in gas systems can solidify and collect on machinery, leading to operational problems and failures. This paper provides a guidance for station and equipment owners and operators in mitigating the formation of elemental sulfur and managing its impacts on related equipment. Funded by GMRC, this guidance

includes an overview of elemental sulfur's impact on systems and equipment, the mechanisms of elemental sulfur formation, and recommended mitigation strategies based on current research, field experience, and successful applications.

TP12: ELECTROMAGNETIC EFFECTS IN TORSIONAL ANALYSIS AND DESIGN OF ELECTRIC MOTOR DRIVEN RECIPROCATING COMPRESSORS

Authors: Dr. Timo Pekka Holopainen, Mr. Jukka Jarvinen, & Mr. Tommi Ryyppo – ABB

Room: 118-119

Track: Vibration/Pulsation

Level: Advanced

Torsional vibrations in motor-driven reciprocating compressors pose a significant challenge. When soft coupling is employed, it becomes essential to account for magnetic effects in system analysis. Traditionally an additional spring is used to model the stiffening effect of magnetic fields. However, more advanced methods, including magnetic damping and fully coupled electromechanical analyses, have been proposed. In this paper, we outline alternative approaches evaluating the trade-off between accuracy and complexity. Our aim is to recommend appropriate models for early bidding and the final engineering phase of delivery projects. Additionally, we propose an accuracy-enhancing approach tailored for typical industrial applications.

TP24: A CASE STUDY OF ALTERNATIVE METHODS OF REDUCING ENGINE AND PEDESTAL VIBRATION

Authors: Mr. Kelly Eberle, Mr. David Lavoie – Wood

Room: 120-121

Track: Reciprocating Engines

Level: Beginner

The paper presents a case study where an engine and pedestal experienced high vibration at 1x operating speed. The usual approach of reducing engine and pedestal vibration is adding stiffness to the skid and pedestal. An alternative approach not often used is reducing the shaking force, the source of the vibration. A case study is presented where changing the coupling

index between the engine and compressor and changing weight of engine internal components was tested in the field. The engine vibration was reduced to acceptable levels without making structural changes to the skid or engine pedestal.

REFRESHMENT BREAK 3:30 PM – 3:45 PM

3:45 PM – 4:45 PM

TECHNICAL PAPERS

TP22: ROTOR VIBRATION ANOMALIES IN NATURAL GAS MACHINERY

Authors: Mr. Wally Bratek – Wood - Vibration, Dynamics & Noise

Room: 111-113

Track: Centrifugal Compressors

Level: Intermediate

With the increased prevalence of centrifugal compressors and electric motors in natural gas compressor stations, accurate interpretation of proximity probe measurements is crucial to maximize machinery availability. This technical paper provides case studies of rotating machinery diagnostics. The examination of bode, orbit, spectrum, waterfall and rotor centerline plots are demonstrated, including the interpretation of the plots to understand the state of the machinery. The cases include a natural gas expander rotor, centrifugal compressor gearbox, and an electric motor coupled to a reciprocating compressor. In each scenario, the vibration exceeded established guidelines, and the causes of the vibration readings were surprising.

TP26: METHANE EMISSION REDUCTION STRATEGIES FOR TWO-STROKE LARGE BORE NATURAL GAS ENGINES

Authors: Ms. Titilope Banji, Mr. Greg Vieira, Dr. Mark Patterson, & Dr. Daniel Olsen – Colorado State University

Room: 114-115

Track: Reciprocating Engines

Level: Advanced

Over 7000 gas compressor engines used along the natural gas pipelines across the United States emit methane primarily due to incomplete combustion. Methane

has 28 times the warming potential of carbon dioxide. The Inflation Reduction Act imposes a methane 'waste' fee on facilities with leaks and vents, accumulating yearly from 2024. This study evaluates three in-cylinder methane reduction strategies and references previously proven strategies. The techniques considered are late-cycle high-pressure fuel injection, hydrogen blending, and directional nozzles pre-combustion chamber design. Results show that methane emission is reduced when each or more of these strategies are applied to gas compressor engines.

TP58: DATA DASHBOARDS: DESIGNING FOR PERFORMANCE MONITORING AND EFFECTIVE DECISION-MAKING

Authors: Mr. Caleb Sargent – Process Innovations, Mr. Nawar Fattah – SoCalGas, & Mr. Dwayne Allen Hickman – ACI Services, Inc.

Room: 116-117

Track: Data Analytics

Level: Intermediate

This technical paper and presentation examines dashboard design from an end-user perspective, highlighting the importance of tailoring dashboards to effectively handle various data types and user goals.

It addresses appropriate visualizations, the relevance of data, and the integration of digital twin technology to enhance analytics. The study identifies common design pitfalls, such as overloaded interfaces and irrelevant metrics, through end-user interviews and case studies. Drawing from customer engagement, the paper offers guidelines for creating purposeful dashboards that empower users and support decision-making by providing actionable insights rather than causing confusion or misunderstandings.

TP57: A GMRC TECHNOLOGY: THE VIRTUAL ORIFICE (VO) – FIELD TESTING RESULTS FOR AN IMPROVED LOW-LOSS PULSATION CONTROL DEVICE

Authors: Mr. Eugene 'Buddy' Broerman III – SwRI, Mrs. Christine Scrivner – Kinder Morgan, & Mr. W. Norm Shade – ACI Services

Room: 118-119

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Track: Research
Level: Intermediate

It has become standard for reciprocating compressor installations used in pipeline and many other applications to include an orifice (loss element) in each and every cylinder nozzle for pulsation control. A 2005 DOE & GMRC-funded research project conceived a more efficient option/solution called the Virtual Orifice (VO). The VO was a field-proven orifice-replacement device by 2009. Despite the successful results of this research and testing, the VO failed to gain widespread acceptance. GMRC funded continued VO research programs in 2020-24 to improve and standardize the design. Research the last few years (2022-2024) focused on field testing the improved/new/standardized design.

TP20: OPTIMIZING MAINTENANCE INTERVALS ON PIPELINE GAS TURBINE MACHINERY

Author: Mr. Hemanth Satish – TC Energy, Mr. Chris Perullo, Dr. Scott Sheppard, & Mr. Corson Teasley – Turbine Logic

Room: 120-121
Track: Gas Turbines
Level: Intermediate

Often development of maintenance strategies relies on limited failure data, as regularly maintained gas turbines fail infrequently. In this study, the optimization of the maintenance interval is explored. Traditional approaches using Weibull analysis are limited by small datasets and fail to consider economic impacts of scheduled maintenance events and failures. This paper considers a case study using a Bayesian Weibull/Cost Curve analysis on a fleet of 30 gas turbines to assess failure risks and financial implications of maintenance intervals. Results indicated that for increasing failure rates, where parts are life-limited, higher failure costs justified shorter maintenance intervals.

5:30 PM – 7:30 PM

MONDAY NIGHT RECEPTION

SPONSORED BY ARIEL
Florida Aquarium
701 Channelside Dr, Tampa, FL

TUESDAY: OCT 8

6:30 AM – 8:00 AM

BREAKFAST

SPONSORED BY HOERBIGER
Ballroom A – D

8:00 AM – 11:00 AM

SHORT COURSES

SC01: CENTRIFUGAL COMPRESSORS: PRINCIPLES, DESIGN AND CONTROL

Authors: Dr. Rainer Kurz & Mr. Avneet Singh – Solar Turbines

Room: 111-113
Track: Centrifugal Compressors
Level: Beginner

Centrifugal Compressors are widely used to compress gas in oil and gas applications. The compressors have to be matched to the operating requirements of the specific application.

The goal of this shortcourse is to help the attendees to understand the function of the individual components, as well as the operational behavior and performance maps.

To provide the necessary background, the general working principles of centrifugal compressors are reviewed and explained.

Control strategies, including anti surge control, and process control, are discussed, based on typical compressor applications, such as in pipelines, gas plant compression, gas gathering, and gas storage.

SC12: ADVANCED TOPICS IN ACOUSTICS AND VIBRATIONS

Authors: Mr. Benjamin White, Mr. Eugene "Buddy" Broerman III, & Ms. Sarah Simons – SwRI

Room: 114-115
Track: Vibration/Pulsation
Level: Advanced

This short course will cover advanced topics in pulsations and acoustics in piping systems. Topics in this short course include equations of state, CO₂, hydrogen blending, pulsation bottle design, valve noise and vibration problems; high frequency pulsation and vibrations from blade pass excitation, valves or instrumentation in centrifugal compressor systems; alternate methods of pulsation control for high pressure systems, advanced pulsation attenuation devices, pump pulsation mitigation, mixed compression, screw piles, and the impact of changing gas compositions for reverse direction flow on pulsations and horsepower requirements.



9:00 AM – 10:00 AM

PSC RESEARCH SESSION

PSC GENERAL RESEARCH SESSION

Authors: Rich Fink, Enbridge

Room: 116-117

The natural gas industry is face with many regulatory and/or common concerns that impact our industry. Therefore, the GMRC/PSC takes on various projects to help with addressing these impacts. For 2024 these projects consist of:

DOE – Full Scale Compressor to Utilize Blends with up to 20% Hydrogen (\$1.5 million grant), Recompression Best Practices, Best Practices for Winterization, Analysis of Impacts on Natural Gas Pipeline Compressors and Piping when Converting to a CO2 Pipeline, Combined Recirculation of Crankcase and Rod Packing Gases.

8:00 AM – 9:30 AM

MINI SHORT COURSES

MC09: CASE STUDY: COMPLIANCE WITH THE NSPS OOOOb AND A GOAL OF ACHIEVING A ZERO WASTE EMISSION CHARGE

Authors: Mr. Brian Kromer – step2compliance & Mr. Russ Perry – Sequitur Energy Resources

Room: 118-119

Track: Emissions

Level: Intermediate

Over the past three years there has been the introduction of several new regulations for the oil and gas industry, NSPS OOOOb and EG OOOOc, amendments to GHGRP Subpart W, the Inflation Reduction Act (IRA) and the Waste Emissions Charge (WEC), PHMSA Pipeline Safety: Gas Pipeline Leak Detection and Repair, SEC reporting climate-related and GHG information, and proposed BLM rules. This list of federal rules does not include state-specific regulations that have also been adopted or amended. As operators evaluate what new compliance requirements are being imposed by these rules and creating a compliance strategy, it is easy to overlook the new and additional recordkeeping and reporting requirements

that go along with the required changes in equipment and operations to achieve compliance. There are two completely new federal reports and one report that is changing dramatically for 2025 that will be required for most operators. There are new recordkeeping requirements and changes to requirements that need to be evaluated to determine gaps in current recordkeeping processes.

MC10: VARIOUS APPROACHES AND DESIGN PRACTICES FOR THE SUPPORTING STRUCTURES AND FOUNDATIONS OF RECIPROCATING MACHINERY

Author: Mr. Jaehee Chae – Wood

Room: 120-121

Track: Reciprocating Compressors

Level: Beginner

Reciprocating machinery, such as pumps and compressors, is widely used both onshore and offshore, demanding various supporting structures, bases, or foundations, each affecting machinery performance differently. For example, a machine might be installed on piles, gravel, or concrete, each impacting its operation uniquely. Thus, ensuring safe and reliable machinery function depends on well-designed supports, incorporating both static and dynamic principles. A previous technical paper focused on design requirements for reciprocating compressor skids and foundations, covering static and dynamic considerations. In response to requests for more practical insights, we offer a mini-short course. This course will provide hands-on examples and discuss dynamic design principles, analysis methods, and recommendations to address vibration issues, enhancing practical knowledge for professionals in the field.

9:30 AM – 11:00 AM

MINI SHORT COURSE

MC26: MAINTAINING NOX COMPLIANCE ON INTEGRAL GAS ENGINE COMPRESSORS IN THE GOOD NEIGHBOR (GNR) WORLD!

Author: Mr. Steven Hawley – Siemens Energy & Mr. Seth Johnson – TC Energy

Room: 118-119

Track: Reciprocating Compressors

Level: Intermediate

There are a number of technologies available that help to bring the efficient large-bore reciprocating engine/compressor fleet up to snuff in today's demanding operational and emissions critical environment. Most of these technologies take a robust, rich burning, consistently operating unit, and drive them into progressively leaner air/fuel ratio conditions in order to bring the peak combustion temperatures down, thus attacking the formation of NOx at the source. This lean combustion approach pushes the units to the edge of the operating envelope, it makes them more susceptible to going out of compliance when problems do occur. One of the technologies that has been developed that helps to keep the units in check and operating well is automation of the cylinder balance process. The focus of the paper is on various diagnostic and analytical methods to determine when an automated system should be (and should not be) adjusting fuel to balance a system, and when it should be annunciating problems to get additional (human) assistance.

MC027: HOW TO ACHIEVE BENEFICIAL OUTCOMES WHEN UTILIZING EPOXY GROUT PUMPING FOR INSTALLATION OF SKID MOUNTED COMPRESSORS FOR NEW INSTALLATION PROJECTS, IN LIEU OF TRADITIONAL PLACEMENT METHODS

Authors: Mr. Scott Lawrence Bullentini – Bill Spitzer & Associates

Room: 120-121

Track: Other

Level: Advanced

The purpose of this presentation is to outline how to achieve beneficial outcomes using specialized pumping equipment to install epoxy and cementitious grouts for modularized rotating equipment in lieu of traditional placement methods. A clear understanding of grout and its role in the equipment system will be examined, as well as a complete understanding of key engineering concepts associated with choosing grouting materials for rotating

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TUESDAY: OCT 8 *continued*

equipment applications. Installation techniques will be shared emphasizing constructability and how to lower total installed costs. Several case studies will showcase how a construction-driven engineering approach to installation will lower total installed costs.

11:00 AM – 1:00 PM

LUNCH WITH EXHIBITORS

SPONSORED BY COMPRESSOR ENGINEERING CORP.

Exhibit Hall

1:00 PM – 2:15 PM

TECH UPDATES

Exhibit Hall

TU27: WINDROCK INSPIRES THE FUTURE OF EQUIPMENT RELIABILITY TO PROTECT THE HEARTBEAT OF OUR CLIENT OPERATIONS

Authors: Mr. James Flemming – ChampionX Windrock

Track: Data Analytics

TU25: CLAMP WARS II: A NEW HOPE FOR VIBRATION CONTROL AND PIPING FLEXIBILITY

Author: Ms. Starr Dalton – Wood

Track: Vibration/Pulsation

TU22: PRODUCT INNOVATIONS IN POWER TRANSMISSION COUPLINGS FOR THE GAS COMPRESSION MARKET

Author: Mr. Mauricio Alvarez & Mr. Saurin Patel – Reich USA Corporation

Track: Vibration/Pulsation

TU14: WIRELESS, BATTERY-FREE SENSOR MONITORING

Author: Mr. John Biondolillo & Mr. Bret V Hightower – Machinery Monitoring Systems, LLC

Track: Vibration/Pulsation

TU12: ELLIOTT TECHNOLOGY CO2 COMPRESSOR AND PUMP TECHNOLOGY

Author: Mr. Stephen Todd Omatick – Elliott Turbo

Track: Centrifugal Compressors

TU09: PACKING CASE ADVANCEMENTS

Author: Mr. Craig Martin – Cook Compression

Track: Reciprocating Compressors

TU03: NEW TECHNOLOGY PRESENTATION

Author: Mr. David Bell – Altronic LLC

Track: Reciprocating Engines

TU20: HERMETICALLY SEALED COMPRESSORS SET NEW STANDARDS

Author: Mr. Domingo Fernandez, Mr. Andrei Popescu – MAN Energy Solutions USA, Inc.

Track: Centrifugal Compressors

TU24: SOLAR TURBINES TECH UPDATE

Author: Mr. Avneet Singh – Solar Turbines

Track: Gas Turbines

TU13: EMIT TECHNOLOGIES TECH UPDATE

Author: Mr. Thomas Peterson – EMIT Technologies, Inc.

Track: Other

CUP OF JOE 2:15 PM – 2:30 PM

SPONSORED BY ACI SERVICES

2:30 PM – 3:30 PM

TECHNICAL PAPERS

TP01: FAILED CENTRIFUGAL COMPRESSOR COUPLINGS LEAD TO LENGTHY ANALYSIS INCLUDING MOTION AMPLIFICATION

Authors: Mr. Jim Anderson III & Mr. Tony DeMatteo – Coupling Corporation of America

Room: 111-113

Track: Centrifugal Compressors

Level: Intermediate

After overhauling 3 compressors, a pipeline operator had several surprise coupling failures within a day of startup. The 2500 HP motor-driven units had been running with the same motors and couplings for several

years without any issues. The couplings were quickly rebuilt with extra torque capacity, but the same result occurred. Then a vibration analysis was performed including a motion amplification study. The study seemed to indicate axial vibration problems with at least one motor, including evidence of cracks in the motor frame. Eventually the compressor cases were opened and the real culprit was discovered.

TP19: VIBRATION ISSUES WITH ENGINE DRIVEN RECIPROCATING COMPRESSOR SYSTEMS

Authors: Mr. Vaughn Cooper – Energy Transfer, Mr. Troy Feese, & Mr. Charles Hill – Engineering Dynamics, Inc.

Room: 114-115

Track: Vibration/Pulsation

Level: Intermediate

Several issues were encountered on engine driven reciprocating compressor units in natural gas service. Solutions to reduce vibration and improve reliability are presented for three case studies. In the first, mechanical natural frequencies (MNFs) of the engine mounted on the pedestal were found near 1x and 1.5x running speed. Structural modifications were made to detune these MNFs. In the second, the compressor was experiencing excessive lateral and torsional vibration levels at higher harmonics. The compressor crankshaft was retrofitted with an internal damper. This eliminated torsional-lateral interaction (TLI), which in turn reduced the compressor frame and cylinder vibration. In the third, pulsation bottle vibrations were deemed excessive. Adjustments were made to the piping and supports to improve alignment.

TP56: DATA ANALYSIS OF GAS QUALITY IMPROVEMENTS AND OPERATIONAL/ MAINTENANCE RESULTS FROM 3-1/2 YEARS OF A SUCCESSFUL 90% REDUCTION IN COMPRESSOR CYLINDER LUBRICATION RATES

Authors: Mr. Seth Johnson – TC Energy & Mr. Matt McCarthy Dynamics, Inc. – Sloan Lubrication

Room: 116-117



Track: Auxiliary Systems
Level: Intermediate

The paper by Johnson, Schafer, and McCarthy examines TC Energy's 2020 implementation of a 90% reduction in compressor cylinder lubrication rates on the Columbia Gas transmission pipeline. This was achieved using a specialty lubricant and a redesigned delivery system across 134 compressors at 35 stations. The study found a significant decrease in oil consumption and gas stream contamination. Over 3.5 years, oil use fell by 81,000 gallons, yielding substantial cost savings beyond just the oil savings, including reduced expenses from excessive oil contamination in the gas stream. Maintenance records show that reduced oil carry-over lessens mechanical issues, filter maintenance, and downtime, enhancing operational and environmental benefits.

TP08: 2024 GMRC CENTRIFUGAL COMPRESSORS IN GAS GATHERING APPLICATIONS – UPDATE

Author: Mr. Mike Clay, Mr. Matthew Morse, Mr. Reese Martin, Dr. Rainer Kurz, Mr. Avneet Singh, & Ms. Cassandra Vallecilla – Solar Turbines

Room: 120-121
Track: Centrifugal Compressors
Level: Intermediate

In the 2018 GMRC iteration of the Centrifugal Compressors in Gas Gathering Applications white paper, the suitability of utilizing centrifugal gas compressors for high ratio compressor projects with challenging

design conditions typical of gas gathering applications was reviewed. Often, gas gathering compression requirements could be typified as high ratio compression with low gas inlet pressures, conditions not usually deemed suitable for use with centrifugal gas compressors.

In this updated paper, using Solar Turbine data, we will compare the use of centrifugal & reciprocating compressors in a typical high ratio gas gathering scenario, review alternative approaches to equipment configuration, and discuss the behavior of these machines, and their impact. We will also review two gas gathering projects recently completed by EOG Resources wherein they are using 30,000 HP blocks of centrifugal gas compression as base load compression. We will discuss the requirements, challenges, and helpful tips when applying centrifugal compressors to these gas gathering projects.

TP23: METHANE OXIDATION CATALYSTS FOR RICH-BURN AND LEAN-BURN NATURAL GAS FUELED ENGINES

Author: Dr. Shazam Williams, Dr. Robin Hu, & Mr. Brendan Filby – DCL International

Room: 122-123
Track: Emissions
Level: Intermediate

Methane reduction in engine exhaust is difficult to achieve. However, by using next generation three-way catalysts (TWCs) near the stoichiometric point it is possible to show improved destruction efficiency under

both fresh and aged conditions on rich burn natural gas engines.

Lean burn natural gas engines require a system approach due to lower exhaust temperatures, water and sulfur poisoning. Sulfur suppression and high PGM loadings can slow down catalyst deactivation, but are insufficient for long-term operation. Fuel pretreatment and gas conditioning show promise to extend catalyst life and methane destruction performance.

2:30 PM – 4:00 PM

MINI SHORT COURSE

MC07: ESTABLISHING AN EFFECTIVE NATURAL GAS ENGINE OIL ANALYSIS PROGRAM

Author: Mr. Garrett Bapp & Mr. Howard Soule – Petro-Canada Lubricants

Room: 118-119
Track: Reciprocating Engines
Level: Intermediate

Oil analysis has widely been accepted by the industry to increase reliability; however, full commitment and proper usage remain challenging. Establishing an effective oil analysis program can not only maximize the investment but also safely extend oil drains and reduce costs. This presentation will give the audience the tools to effectively understand the roles and responsibilities of all parties involved, focus on proper training and sampling techniques and key in on how interpret results and the actions that must be taken. Effectively building a sustainable program and lowering over cost of ownership.

REFRESHMENT BREAK 3:30 PM – 3:45 PM

3:45 PM – 4:45 PM

TECHNICAL PAPERS

TP61: CONSIDERATIONS FOR THE USE OF SEMISYNTHETIC GAS COMPRESSOR OILS

Authors: Mr. Cesar Lizcano – Shell

Room: 111-113
Track: Gas Turbines

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TUESDAY: OCT 8 *continued*

Level: Intermediate

Gas compressor oils exhibit a wide range of chemistries, with formulation performance profiles targeting protection and reliability for known operational demands. The use of semi-synthetic instead of fully synthetic technologies in reciprocating and screw compressors is sometimes viable and preferred by end-users, primarily due to cost advantages and ease of implementation without process disruptions. This paper examines factors impacting oil formulation, applicability based on operational challenges, relative performance profiles, and degradation mechanisms in comparison with fully synthetic oils and conventional mineral-based technologies, along with successful field experiences.

TP45: MITIGATING METHANE SLIP IN INDUSTRIAL NATURAL GAS ENGINES: CAUSES AND SOLUTIONS

Authors: Mr. David Gordon Fisher – Continental Controls Corporation

Room: 114-115

Track: Emissions

Level: Intermediate

Although parts of the EPA's Good Neighbor Plan have been struck down by the Supreme Court, we are not out of the woods.

The amount of methane from a lean burn engine can be significant.

The EPA has released regulations focused on the transportation of natural gas and any releases of methane, from blowing down compressors, venting pilot gas, compressor seal leaks, and yes, unburned methane emitted in lean burn engine exhaust.

This presentation provides a brief overview of regulations, methods and technology used to improve combustion, reduce methane emissions, and other ways to mitigate the problem.

TP05: AN OVERVIEW OF THE FORTHCOMING API-11P 3RD EDITION

Authors: Mr. Norm Shade – ACI Services

Room: 116-117

Track: Reciprocating Compressors

Level: Intermediate

For more than two decades, the upstream natural gas compression sector has been without an adequate industry specification or standard for packaged high-speed reciprocating compressors. To address that gap, an API Task Group has worked for six years developing the new API-11P 3rd Edition Specification for Packaged Reciprocating Compressors for Oil and Gas Production Services. Much content is borrowed with permission from the GMRC Guideline for High-Speed Compressor Packages for Field Gas Applications. This paper provides a look at the history of spec development for this compression industry sector and an overview of the API-11P 3rd Edition's scope.

TP32: THE FORGOTTEN CHILD OF METHANE INTENSITY: RECORD KEEPING & REPORTING

Authors: Mr. Brian Kromer – Step2Compliance

Room: 120-121

Track: Emissions

Level: Intermediate

The recent introduction of several new regulations for the oil and gas industry – NSPS OOOOb and EG OOOOc, amendments to GHGRP Subpart W, the Inflation Reduction Act (IRA) and resulting Waste Emissions Charge (WEC), PHMSA Pipeline Safety: Gas Pipeline Leak Detection and Repair, SEC reporting climate-related information, and proposed BLM rules. State-specific regulations have also been adopted or amended at the same time. As operators evaluate what new compliance requirements are being imposed by these rules, a strategy around required and voluntary recordkeeping and reporting requirements is key to achieve compliance and minimize the cost impact.

TP33: ANOTHER CASE OF GAS CHARGED DAMPENERS NOT CONTROLLING PUMP SYSTEM PULSATIONS

Authors: Mr. Kelly Eberle & Nick Cullingham – Wood

Room: 122-123

Track: Vibration/Pulsation

Level: Intermediate

Pressure pulsation generated by reciprocating pumps can cause high shaking forces that put the pump system at risk of fatigue failures. Reciprocating pump package design typically includes selecting gas charged dampeners to protect the package from the negative effects of pulsation. Purchasers of reciprocating pump packages may not be aware of the limitations of gas charge dampeners and the consequences they could experience. The goal of this lecture is to provide information about vibration risks from reciprocating pumps, methods of reducing vibration risks and a case study involving field troubleshooting, redesign and site acceptance tests for a reciprocating pump installation.

4:45 PM – 6:00 PM

EXHIBIT HALL RECEPTION
INDUSTRY IGNITION RECEPTION
SPONSORED BY ATLAS COPCO & COMPRESSION DYNAMICS CONSULTING
Exhibit Hall

WEDNESDAY: OCT 9

6:30 AM – 8:00 AM

BREAKFAST WITH EXHIBITORS
Exhibit Hall

8:00 AM – 9:00 AM

TECHNICAL PAPERS

TP13: CASE STUDY: DESIGN AND ANALYSIS OF A HIGH-PRESSURE COMPRESSOR WITH UNIQUE REQUIREMENTS

Authors: Mr. Jaehee Chae, Mr. Richard Tchorzewski, Mr. Kelly Eberle, & Mr. Pavel Mayzus – Wood

Room: 111-113

Track: Reciprocating Compressors

Level: Beginner

Designing a reciprocating compressor package for high-pressure applications poses unique challenges. Chevron in western Canada launched a project for a new package featuring three compression stages, achieving discharge pressures up to 8900 psig and handling high flow rates of 18 mmscfd. Initially used to boost oil recovery for 2 to 4 years at one site, it will later be relocated. Key challenges include aligning understanding among end users, engineering firms, packaging companies, and analysis teams to ensure safety and minimize vibration issues. This paper covers design challenges such as application design, foundation analysis, and pulsation control, highlighting innovative solutions and the importance of comprehensive design studies. The case study demonstrates the effectiveness of simulation software and best practices in meeting performance criteria.

TP52: ADAPTH2 COMBUSTION SOLUTION: ENABLING THE NEXT LEVEL OF PERFORMANCE IN HYDROGEN & METHANE ENGINES

Authors: Mr. Keith Brooks, Mr. Matthias Huschenbett – Hoerbiger, & Ms. Emmanuella Sotiropoulou – Prometheus Applied

Room: 114-115
Track: Reciprocating Engines
Level: Beginner

Burning hydrogen and methane at engine power densities and efficiencies approaching those of Diesel engines creates the motivation to develop a holistic approach including:

Prechamber combustion occurring at very lean lambda to prevent preignition. Emmanuella Sotiropoulou team to provide knowhow and 3D simulation capabilities.

Adaptive ignition capable of same-cycle spark control to assure stable combustion. Keith Brooks and Emmanuella Sotiropoulou respective teams provide electronic design technology and arc dynamic simulation knowhow.

Fuel injection system assuring mixture homogeneity to prevent combustion abnormalities. Matthias Huschenbett and

Emmanuella Sotiropoulou respective teams provide fuel injection and flow diffusivity technologies.

TP60: OPTIMIZING THE PIPELINE: AI-POWERED DECARBONIZATION STRATEGIES FOR THE NATURAL GAS TRANSMISSION AND STORAGE SYSTEMS IN THE US

Authors: Ms. Jnana Bairy, Mr. Ovais Rehman Shah, & Ms. June Zhang – Enbridge

Room: 116-117
Track: Data Analytics
Level: Intermediate

The US faces the challenge of achieving energy independence while meeting climate goals. This study used advanced data science techniques on EPA-GHG data to develop an emissions forecasting model for the US energy midstream sector. It combined traditional statistical methods with machine learning and Generative AI to identify patterns and trends in emissions data. The research compared these approaches and found that ensemble models performed best in predicting GHG emissions. The study highlights the potential of AI in extracting valuable operational insights to drive down emissions in the natural gas and petroleum sector, contributing to environmental sustainability and carbon neutrality.

TP37: STATIC SEALING ROD PACKING: SOLVING HALF OF THE RECIP PACKING EMISSIONS PROBLEM

Authors: Mr. Benjamin Kluding – Hoerbiger

Room: 118-119
Track: Emissions
Level: Intermediate

Under the updated EPA regulations (Subpart OOOOb), natural gas compressor packing case leakage rates have specific limits. For reciprocating compressors, rod packing leaks must not exceed 2 standard cubic feet per minute (scfm) per cylinder. If exceeded, repairs and confirmatory leak measurements are required. These regulations target reducing methane and VOC emissions. This paper reviews three case studies utilizing static rod sealing technology, highlighting the emissions saved with these devices.

TP43: HOW TO ECONOMICALLY JUSTIFY IMPROVEMENT PROJECTS AND PROGRAMS

Authors: Mr. Brian Bertelsen – Atlas Copco

Room: 122-123
Track: Career Enhancement
Level: Intermediate

Tired and frustrated that your proposals for improvement projects and programs are not being “green-lighted” by your business management? If so, this paper provides an overview of how to communicate with management in financial terms, which will improve the likelihood your recommended improvement projects and programs will be approved. The paper reviews the typical business Income Statement and provides examples of how improvement projects and programs impact it. Additionally, the importance of Total Cost of Ownership, and methods for calculating Payback Period, Return on Investment, Net Present Value, and Internal Rate of Return are discussed and examples provided.

8:00 AM – 9:30 AM

MINI SHORT COURSES

MC02: SHAKE RATTLE & GROW - PIPE SUPPORT CLASSIFICATION FOR VIBRATORY AND THERMAL GROWTH APPLICATIONS

Authors: Mr. Zachary Dobberthien – Wood

Room: 120-121
Track: Vibration/Pulsation
Level: Intermediate

Engineers designing piping systems must choose from various pipe supports, each suited for specific conditions. A support effective for vibratory services (high-stiffness supports) can cause issues under thermal growth, such as high pipe stress, excessive nozzle loads, low-cycle fatigue, and machinery distortion.

This course provides insights on what properties classify pipe supports and presents a categorization methodology by appropriate use in vibratory vs non-vibratory service. Guidance on how to accurately model different support types is

GMC 2024

SCHEDULE

WEDNESDAY: OCT 9 *continued*

shown, and we further provide application examples of the prescribed tests on real-world gas machinery applications.

9:15 AM – 10:15 AM

TECHNICAL PAPERS

TP44: EMISSIONS REDUCTION THROUGH HYDROGEN BLENDING IN FUEL GAS

Authors: Mr. Ameerudeen Najumudeen – Burns & McDonnell

Room: 111-113

Track: Research

Level: Intermediate

This study evaluated the potential of hydrogen blending as a strategy to reduce emissions from natural gas-fired engines and gas turbines in natural gas transmission and gathering systems. Through detailed combustion analysis, this paper explored the impact of hydrogen blending on emission of carbon dioxide (CO₂) while analyzing the increase in formation of nitrogen oxides (NO_x). The paper discusses the theoretical framework of hydrogen blending and correlates an Aspen HYSYS model developed to simulate the combustion process of hydrogen-blended fuel gases to existing literature. It also addresses the technological advancements, operational challenges, and integration strategies required for hydrogen blending within the natural gas transmission industry. The findings emphasize the significance of stoichiometric analysis for quantifying emissions reductions and underscore the potential for hydrogen blending to help achieve emissions reduction targets in the natural gas industry.

TP54: NET CO₂E REDUCTION BY IMPROVED HORSEPOWER UTILIZATION

Authors: Mr. Joe Hagan – Ariel Corporation, Mr. Randy Dal Molin – Hoerbirger, & Mr. Dave Forster – Hess

Room: 114-115

Track: Reciprocating Compressors

Level: Intermediate

This technical paper presented a case study of how better horsepower utilization was achieved through efficiency upgrades to the compressor valves and automation of the capacity control systems on reciprocating compressors located at a gas compressor station in East McKenzie County, North Dakota. The six-month study focused on 3 of the 10 Ariel JGK/4 compressors with the findings then extrapolated to the other 8 units. Through the optimization of the existing compressors, the station could realize approximately \$30K in electrical savings annually with a corresponding 1836 metric tons of CO₂e or an estimated \$2.3M to 2.5M in additional revenue.

TP46: TECHNOLOGY ROAD MAP FOR MEETING GOOD NEIGHBOR EMISSIONS STANDARDS

Authors: Mr. Mark Patterson – Cooper Machinery Services

Room: 116-117

Track: Emissions

Level: Intermediate

Meeting the 3.0 g/bhp-h NO_x emission standards in EPA's "Good Neighbor Rule" requires a blend of technologies. This study examines two-stroke engines across various bore diameters and BMEP, recommending specific technologies for different scenarios. Depending on Brake Mean Effective Pressure (BMEP), engines may need fuel system retrofits and Pre-Combustion Chambers (PCCs) or turbocharger optimization. The study also analyzes screw-in vs. bolt-in PCCs and provides recommendations for each engine configuration. For each BMEP tier, an optimal mix of technologies is suggested based on cost and performance, ensuring clarity in future engine enhancements aligned with the regulations.

TP40: INSIGHTS FROM LONG-TERM MONITORING OF ACTUAL VERSUS THEORETICAL COMPRESSOR CAPACITY

Author: Mr. Bryan Long, Mr. Mehdi Arjmand, Mr. Kelly Eberle – Wood PLC & Mr. Matt Robinson – Canlin Energy Corporation

Room: 118-119

Track: Reciprocating Compressors

Level: Beginner

The condition and performance of field compressors has been monitored for more than 15 years. These compressors have flow meters and other instrumentation. This dataset provides a rare opportunity to compare predicted and measured flow and assess changes over time.

Results from three units are presented. Measured flow was found to correlate closely with theoretical flow. Calculated flow including slippage was also evaluated. Changes observed over long and short trends were correlated to valve leaks, ring wear, control anomalies and maintenance. A technique for estimating the compressor flow based on motor control center data and enthalpy change is also demonstrated.

TP35: CONTROL AND PROTECTION OF RECIPROCATING COMPRESSORS: THE PAST, THE PRESENT, AND THE FUTURE

Authors: Mr. Dwayne Allen Hickman – ACI Services, Inc., Mr. Ryan Fitzgerald – ENTRUST Solutions, & Mr. David Lepley – Hoerbirger

Room: 122-123

Track: Reciprocating Compressors

Level: Beginner

Historic hardware and automation approaches used to control and protect reciprocating compressors provide a foundation of industry experiences. And discussions on how controls and monitoring evolved to meet past compression challenges.

Overviews of current automation/control/monitoring solutions and the increasing power of today's PLCs and purpose-built control panels to execute complex compressor and thermodynamic models provide attendees exposure to the impressive technologies available now.

Finally, discussions of new and emerging technologies (e.g., A.I. and ML) to quickly identify and resolve issues, and next-level computing devices processing real-time modeling of pressure pulsations and dynamic valve performance – delivering digital twin safety and performance.

CUP OF JOE 10:15 AM – 10:30 AM
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10:30 AM – 11:45 AM

TECH UPDATES

Exhibit Hall

TU23: CONSIDERATIONS FOR THE USE OF SEMI-SYNTHETIC GAS COMPRESSOR OILS

Author: Mr. Cesar Lizcano – Shell Oil Products

Track: Gas Turbines

TU01: CONVERTING GMV ENGINE-COMPRESSORS TO GAS TURBINE WASTE HEAT GENERATED STEAM

Author: Mr. Norm Shade & Mr. Matt Janssen – ACI Services, Inc.

Track: Reciprocating Engines

TU04: ARIEL NON-LUBE, HIGH PRESSURE HYDROGEN COMPRESSOR UPDATE

Author: Mr. Jacob Shackelford – Ariel Corporation

Track: Reciprocating Compressors

TU21: THE CRITICAL ROLE OF ACCURATE REPORTING IN MITIGATING METHANE EMISSIONS

Author: Mr. Doug Patton – Onboard Dynamics, LLC

Track: Emissions

TU16: SMART CONTROL: SKIDIQ AND THE ADVANCEMENT OF THE VHP SERIES FIVE

Author: Mr. Nick Klosinski & Mr. Darnell Franco – INNIO

Track: Reciprocating Engines

TU15: IDEMITSU LUBRICANTS FOR RECIPROCATING COMPRESSOR FOR NATURAL GAS PIPELINE APPLICATION

Author: Mr. Thomas Khondaker – Idemitsu Lubricants America Corporation

Track: Auxiliary Systems

TU05: ELECTRIC COMPRESSION IN GAS TRANSMISSION: THE ADOPTION OF INTEGRATED SOLUTIONS

Author: Ms. Federica Fucas, Mr. Olivier Pellerin, & Mr. Nike Dupuis – Baker Hughes

Track: Centrifugal Compressors

TU08: RECIPROCATING GAS ENGINE-DRIVEN COMPRESSOR SYSTEM OPTIMIZATION

Author: Mr. Hassan Khalid – Caterpillar Oil & Gas

Track: Emissions

TU11: RELEASE OF THE NEW CPI PROFLO PF2 PROGRAMMABLE LUBRICATION MONITORING AND SHUTDOWN DEVICE FOR RECIPROCATING COMPRESSORS

Author: Mr. David Schroeder – Chart Industries

Track: Reciprocating Compressors

TU10: NEW EMISSIONS TECHNOLOGY OFFERING FROM COOPER MACHINERY SERVICES

Author: Mr. Hans Mathews – Cooper Machinery Services

Track: Reciprocating Engines

TU28: METHANE REDUCTION AND CARBON CAPTURE TECHNOLOGY ADVANCEMENT FOR RECIPROCATING COMPRESSORS

Author: Mr John C. Guoyunes – Axip

Track: Reciprocating Compressors

11:45 AM – 1:00 PM

LUNCH WITH EXHIBITORS

1:15 PM – 4:15 PM

SHORT COURSES

SC15: AIR REGULATORY UPDATE

Author: Jim McCarthy - IES

Room: 111-113

Track: Emissions

Level: Beginner

This annual update will focus on air quality and greenhouse gas (GHG) regulations and emission reduction requirements facing the natural gas industry, focusing on gas transmission. Clean Air Act criteria that establish the basis for regulations will be reviewed. Federal regulations and State actions that may establish national regulatory precedent will be discussed. Recent actions have focused on methane emissions and those actions will be

reviewed, including legal challenges to EPA rules. Actions to reduce NOx emissions that may affect legacy compressor drivers will be discussed, including recent state regulatory proposals for reciprocating engines and turbines.

SC03: PART 1: OPERATOR PANELISTS DISCUSSING HYDROGEN BLENDING

PART 2: FULL SCALE NATURAL GAS COMPRESSOR LOOP TESTING WITH BLENDED HYDROGEN--A GMRC/DOE PROJECT

Authors: Ms. Sarah Simons, Mr. Dylan Kraus, Mr. Benjamin White – SwRI, Mr. Terry Kreuz – NFG, Mr. Andy Lee – Enbridge, & Mr. Amado Galaviz – SoCalGas

Room: 122-123

Track: Reciprocating Compressors

Level: Intermediate

Part 1:

Operators from various companies will be presenting on work they are doing to evaluate hydrogen blending for end use or transportation. There will be time for audience Q&A with the presenters.

Part 2:

SwRI, GMRC and DOE are working to develop and demonstrate a full-scale compression system operating with blended hydrogen and natural gas by modifying and operating an installed Ariel JGT, 4-stage reciprocating compressor loop with H2/NG mixtures at incremental H2 concentrations up to 20%. The compression facility operates at conditions typical of pipeline service and is designed for 100% NG. Phase 1, summarized in this presentation, includes the initial equipment review, blending skid and compressor system modifications, equipment selection and purchasing, and separation unit.

GMC 2024

SCHEDULE

WEDNESDAY: OCT 9 *continued*

1:15 PM – 2:45 PM

MINI SHORT COURSE

MC24: A PRAGMATIC APPROACH TO SOLVING PIPING VIBRATION ISSUES

Author: Mr. Scott Stampka – Siemens Energy & Mr. Matt Stegmiller – Marathon Petroleum

Room: 116-117

Track: Vibration/Pulsation

Level: Beginner

Solving piping vibration issues associated with reciprocating compression can be intimidating and difficult. Vibration fundamentals are seemingly easy to understand, but they are difficult in practice. Vibration fundamentals can be easy to grasp, but the solutions can be complex. Many engineers are hesitant in their attempts to solve piping vibration issues out of concern they can move the problem. This is understandable, however, there are pragmatic approaches to solving piping vibration problems, which most critical thinking engineers can incorporate. This course presents, must know, piping vibration fundamentals and will discuss risks associated with vibration mitigation efforts and how to reduce them. This course will conclude with numerous exercises, which present examples of vibration issues and describes how to identify the causes and appropriate mitigation strategies.

MC04: POWER CYCLES: GAS ENGINES, GAS TURBINES, STEAM TURBINES AND OTHER HEAT ENGINES

Author: Dr. Rainer Kurz – Solar Turbines, Inc. & Mr. Avneet Singh – RKSBEnergy

Room: 118-119

Track: Other

Level: Intermediate

- » Defined thermodynamically as a device that converts heat energy into mechanical work.
- » Consists of series elements such as compressors, heat exchangers, expanders, etc. that introduce or extract heat or work to the working fluid.

- » Affected by the elements, a working fluid progresses through a series of thermodynamic states and ends at its initial state (closing the cycle)
- » Could be a steam turbine (Rankine cycle), gas turbine (Brayton Cycle), gasoline engine (Otto cycle), Diesel engine, Stirling engine, etc.

2:45 PM – 4:15 PM

MINI SHORT COURSE

MC11: NEW RELEASE: API 688 PULSATION AND VIBRATION CONTROL FOR POSITIVE DISPLACEMENT MACHINERY, 2ND EDITION

Authors: Mr. Wally Bratek – Wood, Ms. Christine Scrivner – Kinder Morgan, Mr. Eugene Buddy Broerman & Mr. Benjamin White – SwRI, & Mr. Charles Hill – EDI

Room: 120-121

Track: Vibration/Pulsation

Level: Intermediate

In 2012, the 1st edition of API RP-688 was released as a Recommended Practice document. RP-688 contained many fundamental concepts regarding the application of pulsation and vibration control requirements that are found in API specifications. However, RP-688 was only an informative document, and did not include specific industry requirements. In October 2023, API 688 2nd Edition was released. The 2nd edition is no longer a Recommended Practice document and now includes requirements similar to those found in the following standards: Reciprocating Compressors (Ref. API 618), Rotary Type PD Compressors (Ref. API 619), PD Pumps, Reciprocating and Controlled Volume (Ref. API 674 and 675), Rotary Pumps (Ref. API 676) The concept behind API 688 was to group the similar requirements for pulsation and vibration control of various types of machinery into one document. Also, API 688 2nd Edition contains valuable new content including the topics of Volume Index specification on screw compressors, Cavitation Potential of PD pumps, and small-bore piping design. The standard was drafted by a team of end-users and

dynamics analysis consultants who are also active participants of the GMRC.

MC19: A REVIEW OF KEY ENABLING TECHNOLOGIES FOR CO2 CAPTURE, COMPRESSION AND TRANSPORT

Author: Mrs. Marybeth G. Mcbain & Mr. Karl Wygant – Elliott Group

Room: 114-115

Track: Centrifugal Compressors

Level: Intermediate

Capturing, compressing and sequestering CO2 will likely be one of the primary solutions to a decarbonized energy sector. This mini-tutorial will explore the available market data and potential for CO2 capture projects on a global scale. Key CO2 capture market segments include power generation, cement plants, blue hydrogen and ammonia, iron and steel and natural gas processing. Based on the projects announced to date and the market segments, CO2 flow rates can be projected and aligned to more specific machinery. The authors will review the options for CO2 capture and compression, either in gaseous or liquid form. The paper will then briefly review the primary CO2 compressor options as well as pump options for pipeline transport (super-critical or gaseous phase), ship transport (CO2 as a liquid) and sequestration.

4:15 PM – 5:00 PM

GMRC ANNUAL MEMBERSHIP MEETING

Marriott Grand Salons A-E

5:30 PM – 6:30 PM

CLOSING RECEPTION

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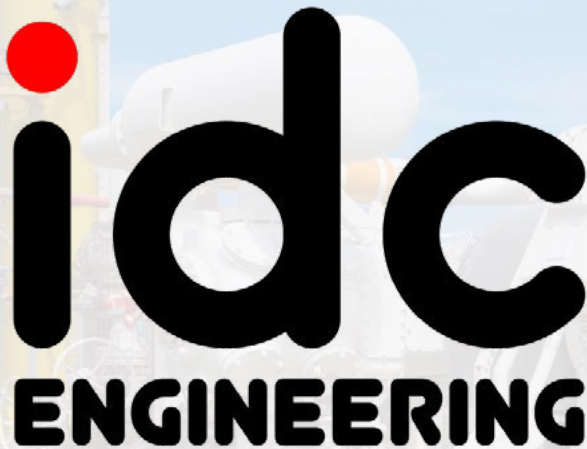
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RECENT RESEARCH PROJECTS

SOUTHWEST RESEARCH INSTITUTE

RECOMPRESSION BEST PRACTICES

Estimates suggest 72.4 Bcf per year of methane emissions to atmosphere from compressor stations. Most methane emissions are thought to come from compressor seals (reciprocating rod packing or DGS venting). However, there are other large sources of leakage, such as pneumatic devices, valve operation, and sensors. Most of this leakage is unavoidable, but it can be re-captured. Potential solutions are to compress back into the process system or could be used as fuel. Regardless, reducing methane emissions is an increasingly important consideration for natural gas operators in terms of lost product and potential future penalties. The project team will create a matrix for common leakage areas which also includes leakages from blowdowns and startups, investigate ideal locations for re-captured leakage, size idealized compressors, and summarized the data into a best practice guideline.

SOUTHWEST RESEARCH INSTITUTE

WINTERIZATION

Most pipeline operators already have established winterization programs for their facilities. Rather than reinventing the wheel and create new winterization guideline based on theory, operators will be interviewed and provide experience with preparing a facility for winter operations. Taking this information and identifying best approaches for successful solutions, and vendor solutions for both design and retrofit will reduce the risk of facility failure for operators during the next cold weather event. The project team will (1) Develop a list of problems encountered by pipeline operators that resulted in operational failures. (2) Interview cold weather pipeline operators to determine what's done to winterize facilities, and solutions for unexpected problems experienced, and failures that occur due to cold weather events (3) Identify vendors that offer solutions. Results will be reviewed and evaluated based on metrics determined by the Project Supervisory Committee. This work will then be summarized into a best practice guideline and report on winterization methods. The final task is to write a best practice guideline, that can be used by operators in its entirety or parts to enhance their own winterization programs.

SOUTHWEST RESEARCH INSTITUTE

ANALYSIS OF IMPACTS ON NATURAL GAS PIPELINE COMPRESSOR STATIONS FROM CONVERTING TO A CO₂ PIPELINE

There is a growing interest to investigate the potential conversion of natural gas pipelines into pipelines that transport carbon dioxide (CO₂). There is a potential growth in carbon capture and sequestration (CCS) and the existing use of CO₂ for oil well production enhancement. Both processes will or do require the transportation of CO₂. This topic is currently being pursued by the US Department of Energy (DOE) and throughout the energy industry. (One energy industry example is the Tallgrass Energy company's plans to convert their Trailblazer pipeline (450 miles) from natural gas to CO₂ (published ~July 2022).) However, before converting existing natural gas pipelines into CO₂ pipelines, several potential issues need to be considered (small list: safety, performance limitations, gas phase during start/stops, venting changes, gas metering, exhaust emissions, etc.). Therefore, a need exists to analyze the compression system changes assuming CO₂ gas becomes the flowing gas (capabilities of current architecture, identify technology gaps, analyze retrofit/buildup possibilities). However, prior to potential issue consideration will be defining ideal gas-phase conditions for a CO₂ pipeline (research and/or analysis) when converted from a natural gas pipeline and the dense phase (properties of both a liquid and a gas) has an MAOP of approximately

1160-2000 psi or higher and to maintain the CO₂ in the gaseous phase, the typical gas-phase pipeline MAOP is less than approximately 1,070 psig. It will be critical to know the operating conditions of the gas phase CO₂ pipeline, so the initial step of the research/analysis will be to identify the ideal/typical/practical/planned MAOP of a CO₂ pipeline. Then followed with other potential issues the researcher identified.

SOUTHWEST RESEARCH INSTITUTE **FULL SCALE NATURAL GAS COMPRESSOR LOOP TESTING WITH BLENDED HYDROGEN P3**

There is a growing interest to investigate the blending of hydrogen, with a focus of up to 20% by volume, into existing natural gas pipeline systems. The hydrogen, produced from rapidly expanding renewable energy sources, will help to enable decarbonization and energy storage. This topic is currently being pursued by the US Department of Energy (DOE) and throughout the energy industry. A multiyear research project which began in 2022, the phase 3 portion will carry on from phase 2 and will focus on LNG and Storage facility blending along with impacts to residential appliances. Many pipelines deliver gas to LNG facilities, and the ability for the LNG facilities to convert or use H₂ blended gas is not well known. Specific LNG operators will be identified to discuss expected impacts to refrigeration cycles or other aspects of their facilities. H₂ percent limitations will be identified

through discussions with operators or through published literature. A list of technology gaps or areas of research that need investigation prior to using hydrogen blended gas in LNG facilities will also be included. In addition to LNG, investigate the impact of hydrogen blended gas on storage facilities. While the research in this area is still limited, some studies have been performed on wells, mixing and stratification, and the effect of hydrogen gas on various types of storage caverns. Contractors specializing in storage will be contacted to request information on hydrogen blending impacts. A summary of this work along with technology gaps will be written on this topic. Then lastly, a literature review of studies performed on residential appliances operating with varying levels of hydrogen blended gas will be conducted. There are several published studies that look at compatibility of certain types of appliances with varying percentages of hydrogen. These studies will be evaluated and combined to form a cohesive summary of work performed to date on this topic. The information gathered will be summarized and added to the existing process change management guidance document.

COLORADO STATE UNIVERSITY **ROD-PACKING VENTILATION GAS CAPTURE AND USE**

The project is comprised of several stages. (1) Laboratory sampling of crankcase vent gas composition, oil entrainment, and flowrate on CSU's Caterpillar G3516J lean-burn natural gas engine. Collected data, along with compressor rod-packing vent

gas estimates from literature, will be used to inform system-level designs of coupled crankcase and rod-packing vent gas recirculation systems. (2) A comprehensive engine testing campaign will be carried out to simulate the recirculation of compressor rod-packing vent gas using surrogate gas streams. The surrogate gas supply system will be designed to simulate the pressure drop across necessary filters and anticipated pressure regulation, with safety hardware integrated for lab-testing. Simulated gas pressure and flow rate will be swept and resulting engine performance data will be collected to determine system limitations. Rod-packing failure conditions will be assessed, and bypass piping will be installed to protect the engine in the event of a failure. The final phase of the project will be a techno-economic analysis of the recirculation system to be carried out to determine emission reduction benefits against the regulatory penalties associated with direct atmospheric emission of methane. The final deliverable will take the form of a comprehensive report summarizing the system design, effect on engine performance, resulting emissions reduction, discussion of safety and hazard mitigation, and the final cost/benefit assessments.

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The value of the All-Access Program is already proven. We continue to add new subscribing companies each month as the popularity of this offering grows. Thanks to this model, we've offered more classes than ever on a larger variety of topics. More members are attending and stay current on natural gas trends, training, regulations, etc. If you are not an All-Access member yet and want more information, please contact Alesia Black at alesia.black@southerngas.org.

FIVE STAR REVIEWS

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"This has benefited me significantly! This is one of the only avenues to develop in the natural gas/utility areas."



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